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INDICE

Leonardo Becchetti
Ecological transition:a game theoretic and statistical challenge 7

Barbara Boschetto, Elisa Marzilli
How women's work horizon is changing: an analysis of occupations across generations 25

Ali Abbasi, Farzin Ghanooni, Livia Celardo
Tourist destination loyalty: a case study of Rome 37

Stefania Della Queva, Valeriana Leporanico, Manuela Nicosia, Sabrina Stoppiello
The nonprofit Sector in Italian Inner Areas 49

Alessio Buonomo, Giuseppe Gabrielli, Rosa Gatti, Salvatore Strozza
Occupational characteristics and trajectories of young immigrants' descendants in Italy 61

Silvana Robone
Insights into alcohol consumption: does educational mismatch affect drinking behaviors in Russia? 73

Francesca Ceccato, Marilena Angela Ciarallo, Paola Conigliaro
Labour costs and their components in 2020: characteristics and dynamics in Italy and in euro area countries 85

Paolo Emilio Cardone
Remote working and new forms of work: evidence from INAPP-PLUS 97

Michele Camisasca, Ilaria Screpante*Human resources recruitment in Italian public sector post COVID 19: demographic characteristics, gender compositions, education for a new public employer branding. Focus on Istat experience* ……...109

Simona Ballabio, Elena Sorba, Alberto Vitalini
Income distribution in Lombardy during the pandemic transition: a territorial study..... 121

Sara Gigante, Silvia Pacini
An analysis of labour cost policies through statistical registers..... 133

Sheila Chapman, Vito Pipitone
The productivity of Italian firms: a spatial analysis..... 145

Marina Albanese, Francesco Busato, Gianluigi Cisco, Saverio Di Giorno
Behavioral factors, SDG awareness and sustainable policies in academia 157

Giuseppe Lecardane
Quality assessment of statistical information services. an exploratory analysis with Rasch model 169

Michele Camisasca, Eva Pietrantonio, Rosario Magro, Alessandro Arborea, Anna Fabiani, Claudio Giordano, Marcella Pietrantonio, Giacomo Guerriero, Adeodato Sparano
Psychosocial risks: work-related stress risk assessment in Istat as a goal for the workers' well-being 181

Daniela Fusco, Maria A. Liguori, Margherita M. Pagliuca
Gender gap of Italian region: a synthetic index propoposal..... 193

Rashad Mammadli
Unpacking determinants of water conservation behaviour and spatial heterogeneity in their coefficients 205

Gianni Carboni
The effect of great recession on european lifespan inequality 217

Annamaria Fiore
Youth and female unemployment: a critical issue for inner areas in Puglia (Italy). needs and opportunities in the silver economy age..... 229

Luca Muzzioli, Viola Taormina
Can the measure of development be improved?..... 241

Agata Maria Madia Carucci, Roberto Antonello Palumbo, Giovanni Vannella
The structural and economic profiles of enterprises with greater longevity..... 253

Elena Catanese, Francesca Inglese, Annalisa Lucarelli, Giuseppina Ruocco
Analysing the labour market through a web data source: the skill dynamic based on online job advertisements..... 265

Arianna Carciotto
Experimental Statistics: a New Common Language for Uncommon Data 277

ECOLOGICAL TRANSITION: A GAME THEORETIC AND STATISTICAL CHALLENGE

Leonardo Becchetti

Abstract. The challenges of global warming and environmental sustainability require a urgent move to the era of ecological transition. We survey contributions from the game theoretic approach modelling ecological transition as a collective action problem in a multiplayer social dilemma, highlighting the main coordination failure challenges and outlining potential solutions such as balanced budget policy measures and cooperative initiatives under the form of energy communities.

We also explain how the green revolution implies the move from the standard *productivity* to the novel *circularity* target and, as such, it requires a bridge between economic, statistic and natural science disciplines. The implications in terms of new competences and statistical indicators are discussed in reference to impact evaluation and hybrid circularity measures.

Keywords. ecological transition, circular economy, impact evaluation

1. Introduction

Global warming and environmental sustainability of economic development are the most daunting challenges of our future which require a thorough revision of our economic and statistical paradigm. The success of mankind in the last 2000 years has been witnessed by an increase in population (a long run proxy of economic prosperity) from 230 million to around 8 billion world inhabitants, paralleled by a rise in life expectancy from 24 to 73 years at world level (Dasgupta, 2020, Maddison, 2001). This change corresponds to a dramatic increase in the life year potential of the stock of living world population (the difference of the product between population and life years today and 2000 years ago) of around 578 billion years. Population and life expectancy have stagnated for centuries since most of this change has occurred after the Industrial Revolution and under the economic paradigm centered on the goals of efficiency and productivity, fueling the drive for creating and selling on the market as much as possible goods and services per unit of time. It is no wonder that at its origins, starting from a limited population, the industrial revolution did not pose to itself the question of the environmental sustainability limits of its expansion.

The problem, however, has now dramatically emerged due to the growing stock of carbon emissions in the atmosphere that is responsible for the sharp (actual and future expected) increase in the average world temperature from its preindustrial levels.[1] This is why the goal of most developed countries is zero net emissions in 2050 and their reduction of 55% by 2030.

Our current problems are embedded in the heritage of our old "reductionist" theoretical paradigm. In this paradigm the economic system is essentially made by household and firms that meet each other in product and labor markets determining demand, supply and prices of goods and services sold in equilibrium. Under this standard approach the effects of production and consumption on the ecosystem disappear so that economic activity is neutral on the environment. Under the new scenario of a broadened economic paradigm the separation between economics with human activities and natural sciences with the equilibrium of natural environments disappears. What is first acknowledged is that consumption and production wastes (and the same production processes) have strong impact on the ecosystem, weakening in turn its provision of services (quality of air, quality of water, fertility of soil) that are essential for human life with an estimated market value equal to the global GDP (Howarth and Farber, 2002).

The modified economic paradigm has now to consider environmental sustainability and, more specifically, according to the Do No Significant Harm principle (DNSH), the effect of any economic action on six main dimensions: mitigation (of carbon emissions), adaptation (to global warming and modified environment), quality of air, water, circular economy and biodiversity.

In essence, the revolution we need can be resumed in the move from the imperative of productivity and efficiency to that of circularity, where for circularity we mean the capacity of creating economic value in an environmentally sustainable way, that is, saving on raw materials and with as little as possible carbon and air polluting emissions. Circularity therefore implies a decoupling between creation of economic value and use of natural resources. The change in paradigm makes what appeared as a technological frontier just a few decades ago the most inadequate solution to the challenge. The example is throwaway plastic bottles we were proud of, a product that is used only once and cannot be recycled that is exactly the opposite of what we need in the era of circularity where the our target is creating product 100% made of recycled and not raw materials.

In our paper we start from the main policy responses needed to tackle the global challenge using as a synthetic scheme the Kaya equation which identifies four directions of policy action (population, living standards, use of energy, energy

[1] Climate change cannot be denied due to the wide evidence based on historical data. The anthropogenic cause of climate change is acknowledged by around 99 percent of scientific papers (Lynas et al. 2021).

efficiency in terms of carbon emissions). We then discuss how this challenge implies a redefinition of the economic paradigm and of the statistical approaches that must bridge competences between economic and natural sciences if they want to measure circularity. Last but not least, we describe the global warming challenge as a multiplayer social dilemma and explain that it is not possible to address the problem we face only with top-down policies, as acknowledged by the same United Nations with its Sustainable Development Goals at Goal 12 (responsible consumption and production).

2. The required policy response

A synthetic benchmark we can use for understanding the proper policy response to global warming is represented by the Kaya equation

$$CO_2 = POP * \frac{GDP}{POP} * \frac{E}{GDP} * \frac{CO_2}{E} \quad (1)$$

where CO2 is carbon emission, POP is population, GDP is gross per capita income and E is energy. The Kaya equation is an identity that however makes clear our options for tackling the climate threat, as it identifies four drivers determining greenhouse emissions: population, the population living standard, plus two factors of ecological efficiency of economic production. The first is the energy used per unit of GDP produced and the second is greenhouse emissions per energy used. Therefore, the identity indicates four potential directions for policy action. The first of them is a Neo-Malthusian policy aiming to control population growth. As is well known, beyond a few remaining cases, most countries in the world share the same cultural background and have reproduction rates below 2.2 per woman, that is, below the reproduction rate that maintains the population constant. The United Nations forecast that the world population will reach a peak around 9 billion and then will start to decrease. Population dynamics is therefore going to be under control and, on the contrary, depopulation is becoming a serious problem in some high-income economies. The second direction (reduction of GDP per person) cannot be a program of any political party that aims to win elections. Although the reduction of living standards cannot be a straightforward goal, the literature on drivers of life satisfaction with its rationales for the Easterlin paradox (Easterlin and O'Connor, 2022) and the wisdom of spirituality of many religious thoughts (not last the Laudato Si encyclical) clarifies that there is no linear positive relationship between per capita GDP and happiness and that we can significantly increase the quality of our life by reducing those parts of GDP that actually harm and cultivating those virtues and attitudes that are invisible and not counted in GDP.

Given what was considered above, most of the work must be done in the other two directions of making our economy more environmentally efficient and sustainable. The drive toward renewable energy is the main policy measure needed

to reduce greenhouse emissions per energy used. As is well known, even in a life cycle assessment perspective where we consider emissions from input extraction to final waste disposal, we find that wind and solar produce from 100 to 200 less emissions per gigawatt hour of electricity than coal, oil and gas. Other advantages of renewables are the more efficient use of energy (much less energy power dispersed), lower air pollution impact, lower prices, more independence from gas and oil countries and lower exposure to inflation shocks as the last two both caused by fossil fuel prices (at end 70es with the oil price shock and in these years with the gas price shock). The fourth indicator of the Kaya identity (energy used per unit of GDP produced) clearly indicates the direction of circular economy that is, the decoupling between creation of economic value and use of energy. A main pillar of circularity is the increase in the share of reuse, recycle and regeneration in inputs used for new production.

3. The ecological collective action problem

Global warming is one of the most complex environmental problems, also from a theoretical point of view. If we use the 2x2 taxonomy based on appropriability/renewability for classifying environmental goods we have four classes of environmental goods with problems of increasing complexity. For environmental goods that are renewable and appropriable such as wood there are exact rules that ensure non decreasing stocks based on the compatibility between cut rates and growth rates. Non appropriable renewable goods are subject to the tragedy of the commons (Hardin, 1968) and to the problem of overexploitation that can solved with limited use rights and can be preserved in the most virtuous examples simply due to the social norms of local communities (Ostrom et al. 1999). Raw materials are typically appropriable non-renewable goods which economists tend to be much less optimistic about their risk of exhaustion. This is because when scarcity begins prices go up thereby stimulating research and technological progress in productive processes that save the given raw material. As far as technological progress identifies substitutes to the given raw material exhaustion is not a problem. While in the fossil era the exhaustion challenge was on oil (with grim predictions who always underestimated technological advances in extraction and substitution) the focus is now on materials needed for the wind and solar infrastructure. Again, progress in the circular economy and discovery of new processes saving the use of such materials can lead us out of new fears of scarcity.

The problem of climate change and global warming is the most difficult to handle. Climate is not just non-renewable and non-appropriable but is also a global public good. The additional complexity here is that, while with local public goods there is a superior (local) authority who can sanction non cooperative behavior, this is not the case when the public good is global. Everything is therefore left to the non-

enforceable willingness to cooperate of sovereign entities. This is the reason why when the US under the Trump government left the Paris Agreement no authority having enforcement power could sanction and prevent them from doing so. The further complexity is given by the weakness of political leaders negotiating in the cooperation game of emission reduction with political leaders of other countries. Political leaders do not represent only their own will but have been elected by their citizens and, therefore, have the weakness of depending on polls and on domestic public opinion. They can therefore be personally convinced that ecological cooperation and reduction of carbon emissions is the right thing to do, but they can pay the cost of doing it if attacked by opposition and opinion of their voters that do not want to pay the cost of ecological transition.

All these factors contribute to explain the limits of COP meetings in solving the ecological dilemma…and explain why the same international institutions are aware that solutions are almost impossible to work without participation of citizens (as in UN Goal 12 of responsible consumption and saving). For all these reasons several contributions in the literature model the climate game as a social dilemma (Carraro and Siniscalco, 1993; Wang et al., 2009; Heitzig et al., 2011; Heugues, 2013; Nordhaus, 2015; Mielke and Steudle, 2018).

Following Becchetti and Salustri (2016) we can model the multi-player ecological game considering the presence of n players whose strategy set is made by the following two actions: choose the ecologically responsible (V) or the standard (A) action.

As a consequence of their choice their payoff is

$$U_i(V) = [(j+1)/n]b + a - c \quad (2)$$

$$U_i(V) = (j/n)b \quad (3)$$

where j is the number of individuals who choose the ecologically responsible action, b is the "political" benefit (positive externality of the solution of global warming) of the responsible choice accruable in terms of its own payoff, a is the social preferences (warm glow) of the ecologically responsible choice for the individual who chooses it, and c is the cost differential between the ecologically responsible and the standard action. We assume that there are no income constraints in the model ($Y_i > c$ for all i) so that the ecological choice is economically feasible for all players.

As is clear from the scheme the effect of b (the positive 'political' effect on the individual reward of the ecological action) crucially depends on the share of participants in the game choosing that action. If all participants choose it, the share is equal to 1 and the entire 'political' benefit b is gained. If the individual is the only one to choose that action on a very large number of players, the share tends to zero and the 'political' effect is nil. This is what happens at the extreme if only one Earth inhabitant makes the ecological choice on the planet. In the absence of this 'political'

benefit, the individual chooses ecological action only if a-c>0 and the problem reduces to a classic case of charity giving where the decision to give is taken when the benefit driven by other preferences is higher than the cost of giving. As is well known, the literature tells us that the two main rationales for other-regarding preferences are altruism (the presence in my utility function of the utility of another individual) and warm glow (the enjoyment proportional to my giving irrespective of the effect of my action).

Given the game characteristics, ecological games end up in the classical prisoner's dilemma. The dominant strategy is choosing the standard non ecological action so that the Nash equilibrium of the game is that where all players choose the non-ecological strategy and the global warming problem is not solved. The paradox is obviously that this Nash equilibrium is Pareto dominated by the opposite equilibrium where all players choose the ecological action, and the ecological problem is solved.

In technical terms in the two player game the Prisoner's dilemma occurs when the cost differential between the ecological and the non-ecological action is neither too high (in such case it is optimal for all players to choose the non-ecological action, and this becomes both the Nash and the Pareto superior equilibrium) nor too low (in such case it is nonetheless optimal to choose the ecological action, and this becomes both the Nash and the Pareto superior equilibrium). The boundaries of the Prisoner's dilemma region (as shown in Figures 1-3) depend on values of b and a and get larger when these values grow. Another typical feature of the game is that, as the number of players grows, the Prisoner's dilemma region grows larger, and this occurs for a downward extension of the area. This implies that the increase in the number of players makes it less likely that a reduction in the cost differential between the two actions makes the ecological choice the Nash equilibrium.

Becchetti et al. (2016) outline in an experimental setting a policy measure that could eventually lead to the cooperative equilibrium of the game. More specifically, they devise a balanced budget mechanism by which the government levies a small lump sum tax on all players choosing the non-ecological action redistributing total tax revenues in equal parts among players who choose the ecological action. The policy measure obviously has the property of transferring large sums to those choosing the ecological action when they are a few, thereby creating an incentive for an increase in their number. The other main advantage of the policy measure is that it is budget balanced, a property not shared by mechanisms used in Italy (Conto energia, superbonus) and in many other countries, and based on a lump sum subsidy to players choosing the ecological action that is eventually paid by all taxpayers. These alternative approaches have the problem of not keeping under control public expenditure if the number of players choosing the ecological action grows.

The experiment on the balanced budget policy measure is run for 20 rounds where the policy measure is introduced after the 10th rounds. During the first 10 rounds we record a typical behavior of human populations: the share of cooperative players choosing the ecological action is very high at the beginning (around 90%) but it progressively declines in the following rounds gradually converging to a share just below 20%. This result is almost a stylized fact in behavioral economics where several experiments suggest that human populations have a large share of conditional cooperators (I cooperate only if the other cooperate) and a smaller share of unconditional cooperators. Back to our benchmark model, we can conveniently assume that for the latter a-c>0 depending on different rationales that can account for their other regarding preferences.

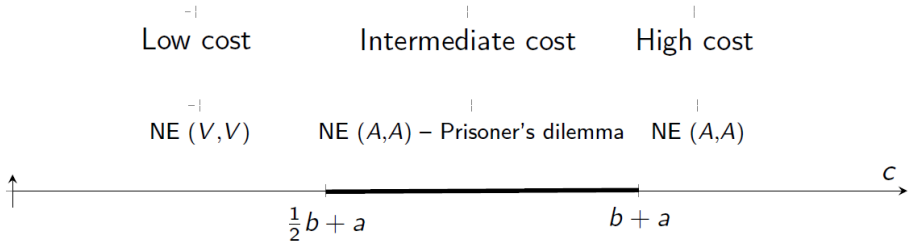
The introduction of the balanced budget policy measure from the 11th round makes joint cooperation the Nash equilibrium and therefore produces a jump up in the share of players doing the ecological choice. The policy measure devised in the experiment is different from what was enacted in many countries and in Italy in the last years. It is a balanced budget and, therefore, by definition, sustainable in terms of government debt. With Conto Energia and Superbonus (the two main Italian energy subsidies of the last decades the logic was reversed and the measures were not budged balanced. In both cases, "players" making the ecological choice (installation of solar panels producing energy from renewable sources in the first case, house retrofit to reduce net emissions in the second case) were subsidized, and the total cost of subsidies was paid by taxpayers. The obvious consequence of this approach was that, with the growth of players doing the ecological choice the taxpayers bill (or alternatively the government deficit) grew substantially so that the measure was in the end not sustainable and had to be suspended. More specifically on the superbonus, the measure could have been made sustainable even without having the properties of that described in our experiment with the definition of an yearly expenditure threshold and with all new potential recipients exceeding that threshold being postponed to the next year government budget.

Figure 1 – *The two-player ecological game.*

		P2	
		V	A
P1	V	$b+a-c, b+a-c$	$\frac{1}{2}b+a-c, \frac{1}{2}b$
	V	$\frac{1}{2}b, \frac{1}{2}b+a-c$	$0, 0$
PD conditions (i.e. (A, A) is NE but is inefficient)			
$\frac{1}{2}b+a<c<b+a$			

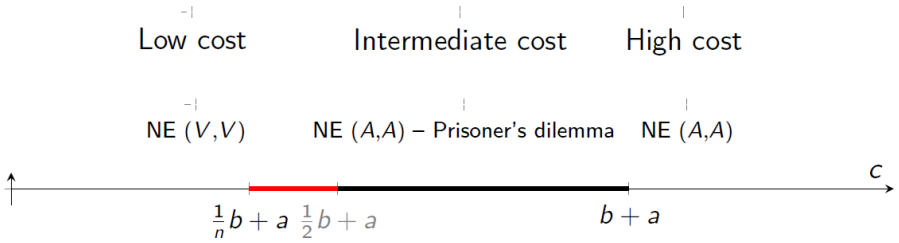
Source Becchetti and Salustri (2016).

Figure 2 – *The Prisoner's dilemma interval in the two-player ecological game.*



Source Becchetti and Salustri (2016).

Figure 3 – *The Prisoner's dilemma interval in the multiplayer ecological game.*



Source Becchetti and Salustri (2016).

The recent literature investigates in depth the social dilemma of ecological transition trying to understand which factors can affect the decision to act ecologically or can change the structure of the game. Magli and Manfredi (2022) reviewed this literature and discussed how a recent strand of contributions argued that the increasing severity of the problem can elicit coordination, since the negative effects of lack of coordination have increasingly suffered in the short and not in the long run. However, the consequence can also be, on the opposite an enhanced conflict on increasing scarce environmental resources leading to climate wars. Therefore, the conclusion of Magli and Manfredi on this more optimistic perspective is critical.

Trying to provide an answer to these research questions Becchetti and Salustri (2023) show in an empirical analysis on EU citizens on European Social Survey data that the willingness to take ecological action is crucially affected, on the positive side, by the perceived severity of the problem and the perception that government in

other countries will take ecological actions. The last variable answers the typical critique ("what about India and China ?") that ecological effort is useless if effort in most virtuous countries is not accompanied by that of all other countries (emphasizing again the coordination problem in the global warming challenge). The results of this paper show that social capital is a key variable affecting the impact of these two factors (perceived severity of the problem and expectations about ecological effort of others). More specifically,ecological action of individuals in countries with higher social capital is much more positively affected by perceived severity and much less so by expectations on action of other countries. In synthesis these findings support the hypothesis that higher social capital eases the transition from conditional to unconditional cooperation in climate games.

The solution of the climate change collective action problem can arise also from new forms of energy production from renewables that can modify the game theoretic structure of the dilemma. One of these new forms is renewable energy communities that should account, according to EU targets, for around 16% of energy produced from renewable sources and already represent an important form of energy production in other countries (such as the US) in the rural regions less inhabitated (Reis et al. 2021; Eu Commission 2018; Campann et al. 2016).

Renewable energy communities are made by households, local administrations and profit and not for profit organizations, that create a society to promote, develop, and implement renewable energy projects in a specific geographic area or community. By doing this renewable energy communities can have three sources of economic gains. First, their members do not have to buy the energy they produce. Second, they can sell the energy they produce and do not consume the market. Third, they are remunerated by the government with a subsidy for the share of energy produced and self-consumed. The rationale for this subsidy is the flexibility service to the electricity grid that is going to be overcharged with the growth of renewables. This is why a world of prosumers producing and consuming in place the energy they need is a value reducing a potentially negative congestion externality that deserves to be paid. Becchetti and Salustri (2023) show that, based on existing regulatory features, renewable energy communities transform the ecological game structure from the standard collective action problem of multiplayer prisoner dilemmas into a stag-hunt game and eventually, under reasonable parametric conditions, a cooperation game where making ecological choices is the Nash equilibrium and private and social optimum coincide thereby eliminating the failure of the market.

4. The statistical challenge: the development of circularity indicators

The climate challenge leading to the new era of ecological transition requires a parallel revolution of statistical indicators. By definition, the move from productivity to circularity implies a move from the goal of creating economic value by increasing

good and services sold per unit of time to the goal of creating economic value in an environmentally sustainable way. This radical change in turn implies the move from entirely financial/economic indicators, traditionally used at micro and aggregate level, to a new generation of composite indicators creating a bridge between traditional financial/economic and environmental indicators. The change in indicators needs to be paralleled by a change in skills in accounting, economic, and financial profession where, in the new transition scenario, the impact of economic choices on the ecosystem must be evaluated along the six DNSH dimensions (with more specific reference to water footprint, air pollution, and carbon emissions).

Table 1 – *Co2/per unit of GDP ranking of Italian regions, 2019.*

Region	Co2 Emissions (kg) 2019	GDP (PPP) 2019	Co2/GDP Ratio
Bolzano / Bozen	3507491840	25796599808	0.136
Lazio	29245026304	201726803968	0.145
Trentino-Alto Adige / Südtirol	7674959360	47287103488	0.162
Campania	18659567616	110967996416	0.168
Liguria	9170577408	50174603264	0.183
Lombardia	74458587136	399339814912	0.186
Trento	4167467776	21490499584	0.194
Toscana	23819608064	122085793792	0.195
Marche	8329537536	42624000000	0.195
Veneto	37110632448	166407585792	0.223
Abruzzo	7428625408	32901199872	0.226
Valle d'Aosta / Vallée d'Aoste	1177827200	4868499968	0.242
Piemonte	34146744320	137827500032	0.248
Emilia-Romagna	40445800448	162860498944	0.248
Friuli-Venezia Giulia	11297149952	39292502016	0.288
Umbria	6905760256	22960900096	0.301
Calabria	11723196416	33323700224	0.352
Sicilia	31388049408	89189703680	0.352
Basilicata	5507922944	12656799744	0.435
Puglia	35778920448	75769200640	0.472
Molise	3175282944	6478899712	0.490
Sardegna	18511435776	35085799424	0.528

Source: Becchetti et al. (2022).

Table 2 – *Per capita disposable income / PM10 ranking of Italian provinces (euro per mg/mc), 2019.*

Province	Ranking	Per capita disposable income / PM10	Province	Ranking	Per capita disposable income / PM10
Sud Sardegna	1	1690	Reggio nell'Emilia	55	699
Bolzano	2	1389	Ravenna	56	690
Verbano-Cusio-Ossola	3	1365	Piacenza	57	690
Trieste	4	1228	Fermo	58	689
Savona	5	1188	Pescara	59	680
Cuneo	6	1180	Lodi	60	672
Siena	7	1156	Foggia	61	661
L'Aquila	8	1095	Vercelli	62	660
Gorizia	9	1049	Messina	63	650
Aosta	10	1046	Ferrara	64	648
Belluno	11	1013	Asti	65	642
Bologna	12	990	Vicenza	66	628
Genova	13	987	Torino	67	628
Pistoia	14	985	Verona	68	621
Lecco	15	979	Treviso	69	615
Trento	16	977	Lecce	70	612
Massa-Carrara	17	972	Teramo	71	611
Udine	18	970	Latina	72	607
Ancona	19	969	Mantova	73	597
La Spezia	20	937	Avellino	74	594
Macerata	21	936	Terni	75	593
Chieti	22	925	Venezia	76	593
Viterbo	23	901	Pesaro e Urbino	77	591
Biella	24	877	Bari	78	586
Varese	25	869	Sassari	79	586
Sondrio	26	863	Trapani	80	584
Imperia	27	854	Catanzaro	81	578
Isernia	28	851	Alessandria	82	568
Campobasso	29	848	Padova	83	568

Table 2 – *Per capita disposable income / PM10 ranking of Italian provinces (euro per mg/mc), 2019 (continued).*

Province	Ranking	Per capita disposable income / PM10	Province	Ranking	Per capita disposable income / PM10
Firenze	30	843	Cremona	84	565
Arezzo	31	840	Rimini	85	563
Livorno	32	837	Brescia	86	562
Pisa	33	831	Barletta-Andria-Trani	87	562
Rieti	34	828	Reggio di Calabria	88	561
Monza e della Brianza	35	824	Cosenza	89	557
Pordenone	36	783	Brindisi	90	554
Milano	37	780	Pavia	91	549
Potenza	38	777	Taranto	92	547
Como	39	765	Siracusa	93	533
Parma	40	765	Vibo Valentia	94	531
Perugia	41	756	Rovigo	95	529
Lucca	42	755	Catania	96	520
Novara	43	754	Agrigento	97	514
Prato	44	748	Oristano	98	501
Enna	45	734	Caltanissetta	99	469
Modena	46	731	Palermo	100	466
Bergamo	47	723	Crotone	101	435
Grosseto	48	722	Salerno	102	431
Nuoro	49	722	Cagliari	103	429
Benevento	50	718	Frosinone	104	427
Forlì-Cesena	51	716	Napoli	105	416
Ascoli Piceno	52	704	Ragusa	106	403
Roma	53	704	Caserta	107	400
Matera	54	700			

Source: Becchetti et al. (2022).

To give a very simple example on how this could be, we present two ranking of Italian regions based on the ratio of Co2 emissions/GDP and per capita disposable

income/PM10, where PM10 is the standard particulate matter indicator that measures an important dimension of air quality. The first ranking is a direct measure of the capacity of a given area to create climate change sustainable economic value, that is economic value with the minimum possible flow of carbon emissions. The leading area in Italy from this point of view is the area of Bolzano, while at the bottom of this ranking we find the Sardinia region whose Co2 emissions/GDP ratio is almost four times higher. The interpretation of the indicator is that the Sardinia economy is far behind the region of the Bolzano in terms of capacity to create a decarbonized circular economic system. The result is affected both by the low absolute capacity to create economic value in the region, but also by the 'old economy' characteristics of that region (i.e. the scarcity of electric railways as a means of local transportation, the dependence on high-emission industrial sectors, etc.).

In the second circularity ranking we paradoxically find that a region of Sardinia (South Sardinia) jumps at first place in terms of per capita disposable income/PM10. The apparent paradox is explained by the fact that, when the environmental indicator used in the composite circularity indicator is quality of air, the geographical advantage of having strong winds and a large portion of the geographical area bordering the sea is an important advantage in terms of dispersion of particulate matter.

5. The statistical challenge: environmental impact indicators

The green taxonomy is the 'Linneus type'[2] approach chosen by the EU to measure adherence to the path of ecological transition. The taxonomy identifies activities admissible and not admissible with ecological transition for each industrial sector, in a detailed classification separately considered for each of the six DNSH domains.

The DNSH standard can be defined as a green Pareto improvement standard since an investment or an economic activity is DNSH consistent if it improves substantially the situation in at least one of the six DNSH dimensions (mitigation, adaptation, quality of air, use of water, circular economy, biodiversity) without producing significant negative effects on the other five, exactly as a Pareto improving choice in economics is something improving wellbeing of at least one individual without worsening that of all other individuals.

This approach has the limit of requiring considerable work in an attempt of examining all possible activities in each industry. The task is even more daunting given the accelerated pace of green technological innovation, so the risk that it this

[2]Carl Linnaeus was a Swedish botanist, zoologist, and physician who formalized the modern system of naming organisms (binomial nomenclature) and is therefore recognized as the father of "modern axonomy"

approach is of never has an end and, while being always in progress, it does not classify as admissible new emerging green technologies that can have more significant positive effects on environmental sustainability.

The alternative 'GIFT' approach proposed by Becchetti et al. (2020) is based on the idea of measuring the impact of a given investment/economic activity with respect to estimated counterfactual changes that define threshold changes that delimit the borders of admissible regions.

The first step of the approach consists of selecting indicators for each of the six domains as shown in Table 3. The obvious candidate for the first dimension is net Co2 emissions, while the identification of the indicator measuring the second dimension (adaptation) is naturally more complex and is found in an index of environmental vulnerability. This type of indicator is increasingly used and popular in the sense that regulatory banking authorities impose the measure of climate risk as a fundamental factor to calculate lending capital requirements. This implies that borrowers with activities and investments more exposed to climate risk and vulnerability (with lower adaptation capacity) are classified as riskier based on this indicator and therefore require a higher bank capital buffer. Adaptation indicators will therefore be increasingly used and popular in the next years. The obvious candidate to measure the third dimension is the water footprint (i.e., the overall water used to create a given product in a life cycle perspective). Two natural candidates for the circular economy dimension are production of nonrecyclable waste and consumption of primary minerals (both on the negative side). PM2.5 and PM10 are the main indicators measuring particulate matter in the fourth dimension, accompanied by indicators measuring other air polluting substances. Land use for anthropic activities and net deforestation balance are two standard measures for the last dimension of DNSH (biodiversity).

In Table 4 we illustrate similarities and differences between the GIFT and the green taxonomy approach emphasizing how the GIFT approach has the advantage of providing a ready-to-use flexible tool that can adapt to all ongoing changes in green technology. In Table 5 we resume results of an experiment on costs of use of the GIFT approach as a percentage of net sales for different firm sizes. The fixed cost of GIFT evaluation is obviously higher in percent for smaller firms, and higher if firms do not dispose of an in-house life cycle assessment. In any case the cost is never lower than 0.01 percent of net sales (for the lowest size class), while falling to 0.0005 percent for the highest size class. We can also consider that a good GIFT evaluation can produce indirect positive reputation effects in corporate non-financial reporting that can balance its cost, and that standardization of evaluation and procedures could further reduce costs evaluated in 2020.

Table 3 – *Similarities and complementarities between GIFT and EU taxonomy (Source: Becchetti et al., 2022).*

Similarities between GIFT and EU Taxonomy	Complementarities between GIFT and EU Taxonomy
• Environmental improvement and fulfilment of the DNSH principle with respect to 6 environmental objectives: 1. Climate change mitigation. 2. Climate change adaptation. 3. Sustainable use and protection of water and marine resources. 4. Transition to a circular economy. 5. Pollution prevention and control. 6. Protection and restoration of biodiversity and ecosystems. • Compatibility check with sustainability criteria of EU Taxonomy before assessing an investment through the GIFT.	• The GIFT applies a generic DNSH logic and does not define sustainability criteria for specific activities. • The GIFT aims to assess the environmental performance of investments (variation of environmental burdens compared to a counterfactual) through LCA-based KPIs. • While work for the EU Taxonomy is ongoing, the GIFT offers a ready-to-use and flexible tool (which can be adapted to adhere to future developments of the EU Taxonomy).

Table 4 – *GIFT Key Performance Indicators (Source: Becchetti et al., 2022).*

Area	KPI (unit)	Methodological references
1. Climate change mitigation	I1. Net emission of GHGs (kg $CO_{2,\ eq}$)	Calculation of life cycle GHG emissions to and removals from the atmosphere, and characterisation of their overall Global Warming Potential over 100 years (GWP100) based on the IPCC model, as described in the EU Environmental Footprint (Zampori and Pant, 2019).
2. Climate change adaptation	I2. Climate change vulnerability proxy (dimensionless)	Characterisation of the vulnerability of the analysed system through the quali-quantitative assessment of its exposure (E), sensitivity (S) and adaptation capacity to extreme climatic events (adapted from GIZ (2014)).
3. Sustainable use and protection of water and marine resources	I3. Water scarcity footprint ($m^3_{eq.}$)	Calculation of the overall water consumed from a life cycle perspective, corrected for its scarcity according to the AWARE model, as described in the EU Environmental Footprint (Zampori and Pant, 2019).
4. Transition to a circular economy	I4a. Consumption of fossil fuels and non-regenerative biomass (MJ) I4b: Consumption of primary minerals (kg) I4c: Generation of non-recyclable waste (kg)	Calculation of a) consumption of fossil fuels and non-regenerative biomass, b) consumption of primary minerals, c) production of non-recyclable waste, adopting a LCA perspective aligned to the EU Environmental Footprint (Zampori and Pant, 2019).
5. Pollution prevention and control	I5a. Emission of particulate matter (disease incidence) I5b. Photochemical ozone formation (kg NMVOCeq.) I5c. Acidification (mol H+eq.) I5d. Freshwater eutrophication (kg Peq.)	Calculation of life cycle emissions of pollutants of concern (e.g., PM2.5, NMVOCs, NOx, SOx, NH3) and characterisation of the impacts associated with emission of particulate matter (UNEP (2016a) model), photochemical ozone formation (LOTOS-EUROS model), acidification (Accumulated Exceedance model), freshwater eutrophication (EUTREND model), as described in the EU Environmental Footprint (Zampori and Pant, 2019).
6. Protection and restoration of biodiversity and ecosystems	I6a. Direct land use for anthropic activities (m^2a) I6b. Net deforestation balance (m^2)	Calculation of a) direct land use (green areas excluded) associated with the investment, b) difference between direct deforestation (positive value) and direct reforestation and afforestation (negative values), adopting a LCA perspective aligned to the EU Environmental Footprint (Zampori and Pant, 2019).

Note: KPIs were defined with reference to a primary environmental area. Because of the interconnected nature of cause-effect mechanisms, these KPIs partly address the six areas and can have an influence on more than one area.

Table 5 – *Costs (in EUR) associated with the application of the GIFT approach for different sizes of companies (Source: Becchetti et al., 2022).*

Type of company	A. Cost for conducting a LCA study [a] [b]	B. Cost for quantifying GIFT's KPIs for an investment [b], [c]	C. Other costs (digital platform, audit, certification) [b], [c]	D. Total costs in case no LCA is available (D = A+B+C) [% of D vs. net sales]	E. Total cost in case LCA is available (E = B+C) [% of E vs. net sales]
Type I: - Net sales: < EUR 100 million	10′000–18′000	1′800–3′000	1′000–1′500	12′800–22′500 [0.013%–0.023%]	2′800–4′500 [0.003%–0.005%]
Type II: - Net sales: EUR 100–1′000 million	12′000–20′000	2′000–3′500	1′000–1′500	15′000–25′000 [0.003%–0.005%]	3′000–5′000 [0.001%–0.001%]
Type III: - Net sales: > EUR 1 billion - Products/ services offered: < 100	20′000–30′000	2′800–4′000	1′000–1′500	23′800–35′500 [0.002%–0.004%]	3′800–5′500 [0.0004%–0.001%]
Type IV: - Net sales: > EUR 1 billion - Products/ services offered: > 100	30′000–50′000	3′500–5′000	1′000–1′500	34′500–56′500 [0.003%–0.006%]	4′500–6′500 [0.0005%–0.001%]

Notes:
[d] EUR 100 million for type I, EUR 550 million for type II, EUR 1 billion for types II and III.
[a] LCA study needed to quantify GIFT's KPIs.
[b] Estimations from ESGeo, the ESG service provider involved in the pilot project.
[c] The cost implies that the ESG evaluator makes at least 100 evaluation per year.

6. Conclusions

The industrial revolution promoted and supported by the neoclassic economic paradigm has produced an astounding increase in global population, life expectancy and living standards under the goal of corporate profit maximization that stimulated the production of the highest possible number of goods and services that could be sold on the market. This successful drive has neglected that economic actions occur within an ecosystem providing fundamental services for life and the same productive activity. The consequences have been the progressive depletion of natural capital and environmental resources. The problem can be in some way accommodated in presence of appropriable and renewable/non-renewable environmental goods, while it becomes more serious and difficult to tackle when dealing with a non-renewable/non-appropriable environmental resource such as climate.

In our paper, we show that climate is a global public good whose preservation requires the solution of a collective action problem that can typically be formalized as a multiplayer Prisoner's dilemma. We therefore show that the socially optimal choice where everyone chooses the ecological action is not attained due to a coordination failure problem, while the less desirable outcome where everyone chooses the less expensive ecological action is the Nash equilibrium of the game.

In the paper we discuss conditions and policies under which the paradox can be addressed.

More specifically, we show that balanced budget policy measures based on subsidizing the ecological, while taxing the non-ecological choice can bring to the socially optimal ecological equilibrium and be sustainable in terms of government budget, at the same time. We also discuss how green subsidies historically enacted do not almost always correspond to these measures. We also show and discuss how social capital, the perceived severity of the ecological problem, and the expectation about moves of other countries/players significantly affect the decision to act ecologically in the game. We also explain how some bottom-up approaches to energy production, such as that of renewable energy communities, can modify the structure of the game, transforming it from a prisoner's dilemma into a stag hunt, and eventually a cooperative game in which the coordination failure problem is solved. Our conclusion on this point is also that, as renewables become mainstream, industrial competition in renewables can foster coordination. The question "what about China and India?" discouraging effort of individuals and countries most concerned about transition can change into "how can I catch up leaders in ecological transition? "Provided that industrial activities in this sector will become more and more profitable as the demand for renewables grows due to their economic convenience.

In the second part of the paper, we argue that entering the era of ecological transition requires a deep change in our statistical measures. If the change implies

the move from the goal of productivity to that of circularity, statistical indicators for ecological transition need to be bridges between standard economic/financial/accounting indicators and environmental indicators requiring a good knowledge of natural sciences.

To illustrate this in more practical terms we discuss an approach to evaluate impact consistent with the Do No Significant Harm standard, evaluating the effect of investment in the six standard (DNSH) domains and compare it to the EU green taxonomy approach. We also show that monitoring ecological transition requires the construction of a new set of hybrid composite indicators based on the ratio between economic and environmental variables. We apply them to Italian regions and provinces to identify those whose economy is more in line with the new circularity target.

Our conclusion is that success in tackling the global warming challenge requires fundamental ingredients such as higher levels of civic virtues and social capital, policy measures that reward ecological choices, new hybrid indicators to measure circularity, and with them, necessarily the development of proper competences requiring the match between standard economic and financial skills with knowledge of the natural sciences.

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HOW WOMEN'S WORK HORIZON IS CHANGING: AN ANALYSIS OF OCCUPATIONS ACROSS GENERATIONS[1]

Barbara Boschetto, Elisa Marzilli

Abstract In 2022, despite the gradual improvement of the female employment rate, the Italian labour market still shows a significant gender gap. Although the growth in women's educational attainment has increased their participation in the labour market and maintained it even during the economic crisis of 2008-2013 and the health crisis of 2020, it has not yet translated into better professional qualifications for them. There is a double disadvantage for working women: "horizontal" and "vertical" segregation. However, a more detailed analysis of data on occupations by gender and age suggests that something is gradually changing. This study analyses the different gender composition of the workforce in specific occupational groups, comparing different generations (25-39 years, 40-54 years and 55-69 years), with the aim of identifying and quantifying the change occurred in women's employment over the last two decades.

1 The background

In 2022, in an economic and social context deeply affected by the recent pandemic emergency and the related economic crisis, the Italian labour market still shows a significant gender gap, despite the gradual improvement in the female employment rate. Women have a lower employment rate (51.1% compared to 69.2% of men) and a higher unemployment rate (9.4% compared to 7.1%), but their disadvantage is also strongly reflected in an analysis of the characteristics and type of work they do, as well as their educational and life paths. The growth in women's educational attainment has increased their participation in the labour market, making it more sustainable during the period of crisis that characterised a large part of the decade 2004-2014 and during the recent Covid-19 health emergency. However, they still face significant barriers to full employment. Although women have surpassed the average educational attainment of men (65.3% of women with diploma compared to 60.1% of men, 23.1% of women and 16.8% of men with tertiary education) and are increasingly participating in the labour market, this has not yet translated into an

[1] This article is a joint effort by the authors. In particular, Barbara Boschetto edited paragraphs 1, 2 and subparagraph 3.2, and Elisa Marzilli edited paragraph 3.1. Conclusions are written jointly.

advantage for them in terms of higher occupational qualifications. In addition, girls are still under-represented in scientific fields of study: the share of young women (25-34 years) graduating in STEM (science, technology, engineering and mathematics) is half that of men (17.6% compared to 33.7%) (Istat, 2022). Although the gender gap significantly reduces with increasing educational attainment, it never disappears: in 2022, the employment rate of female graduates aged 15-64 is 77.7%, for men is 84.7%. The reason could be the disciplines chosen by women, less expendable on the labour market. This is partly probable, but the data show that, with the same degree, 87.3% of women is employed compared to 90.4% of men in the health field and 79.3% compared to 89.3% in the STEM field, confirming that gender biases and stereotypes persist even with equal starting conditions and favour gender segregation. At the same time, reconciling work and family life remains particularly difficult for women (Truc, 2022). The birth of children is a critical and very delicate period for the situation of women on the labour market, much more than for men, and the responsibility of taking care of younger children limits their employment even more. While the employment rate of women aged 25-49 without children reaches 76.6% in 2022, the employment rate of mothers with children under 6 years is still 55.5% (Istat, 2023a). Moreover, part-time work is not always a reconciliation tool of work and care, especially when it is not chosen by the worker (involuntary part-time) but imposed by the employer (Maestripieri, Insarauto, 2020). In 2022, 31.8% of women works part-time compared with 8.3% of men (involuntary part-time is 16.5% for women and 5.6% for men). The presence of children requires the use of work-life balance strategies to minimize the loss of employment and underemployment of women. In the light of the above, it is interesting to examine the data on occupations by gender to see if anything is really changing on the employment horizon for women. In the last two decades, female employment on the one hand, has been supported by numerous gender policies[2] and a greater diffusion of tertiarisation and flexibility of the labour market, on the other it has also been affected by the effects of the economic crisis and the health emergency (Lugli, 2021). The aim of this work is to identify the changes that have recently occurred in the women's labour market. It analyses the different gender composition in specific

[2] Numerous strategies for gender equality conducted at international level (Millennium Development Goals in 2000, Agenda 2030 in 2015), require the Italian state and some large companies to develop inclusive gender policies, with the aim of involving women at risk of marginalization in the labour market. Policies for reducing the gender gap have aimed to promote women's participation in the labour market, reduce the wage gap between men and women, eliminate barriers to women's advancement or cultural practices that preclude women from equal opportunities. The main policy instruments have included: parental leave reserved for mother, father or both parents (mandatory or optional); care services such as daycare centers and preschools; gender budgeting on company boards; obligation for large companies to report on the status of male and female staff and wages; support for female entrepreneurship.

occupational groups, comparing the incoming generation of workers (25-39 years) with the outgoing generation (55-69 years), the more educated workers with the less educated ones and the workers belonging to different geographical areas. The gender gap by occupation will be analysed not through the traditional groups of the Classification of Occupations[3], but rather through an ad-hoc-aggregation of occupations, that allows us to overcome the classification criteria of CP[4] partially. Since a temporal comparison with this group typology was made for the first time on this occasion, the analysis is mainly descriptive, however logistic models were developed to support the descriptive evidence, the main results of which are reported.

2 Occupational segregation by gender

Occupational gender segregation refers to the unequal treatment of men and women in employment. Rather than discrimination, the word segregation focuses on the factor of distinction/separation that exists between men and women in the workplace. There have been numerous studies aimed at measuring segregation, both nationally and internationally, in order to understand its causes and consequences (INAPP, 2022; Save the Children, 2023). The economic literature distinguishes two forms of occupational segregation: horizontal segregation, referring to the concentration of employment female representation in a limited number of sectors and professions, and the vertical segregation, referring to the female concentration at the lower levels of the hierarchical scale within the same occupation (Rosti, 2006).

Horizontal segregation is linked to the persistence of gender stereotypes that influence women themselves in their study paths and professional choice (Barigozzi, Montinari, 2022). It translates into gender prejudice which considers women more suitable for certain jobs (teachers, secretaries, cleaners, hairdressers, nurses, shop assistants, cashiers, etc.) and whereby derives the feminisation of some productive and service sectors (social services, teaching, textiles, commerce, administration).

[3] The ISTAT Classification of Occupations (CP), which is linked to the International Classification of Occupations ISCO-08, is the tool for classifying labour market occupations into specific occupational groupings, which is useful for the communication, dissemination and integration of statistical and administrative data on occupations, while ensuring comparability at international level. Since 2023, ISTAT has adopted the CP2021 Classification of Occupations, the result of a revision of the previous version (CP2011) and further alignment with ISCO-08.

[4] This ad-hoc-aggregation allows us to overcome the classification criteria of the CP partially, which group together in the same level those occupations that require the same level of skills, and distinguish occupations by area of competence only in the subsequent levels. Traditional professional groups, without an ad-hoc-aggregation, could have hidden important aspects of the gender changes that have occurred in recent years. In the second CP's major group, for example, scientific professions and those related to teaching coexist, but among the former there is a clear male prevalence while among the latter there is a clear female prevalence, so it is preferable to keep them separate. Ad-hoc aggregation keeps not only some occupations but also some areas separate.

These jobs are often characterised by low pay, low skills and poor career prospects, but are more compatible than others with the management of family responsibilities (close to home, with flexible working hours, with routine tasks that do not require transfers and overtime, etc.) (Wiswall, Zafar, 2018). In 2022, this phenomenon is still widespread: about half of women's employment is concentrated in just 20 occupations, while men's employment is concentrated in 54 occupations. The most common occupations for women are general business and secretarial workers, salespersons, carers, domestic workers, nurses and cleaners, and primary school teachers. Among specialist occupations, there are those related to education - nursery and primary school teachers, secondary literature teachers, specialists in the education and training of the disabled people - and women practicing law. Among technical occupations, we find only health and care occupations, but also executive office occupations, such as general affairs, secretarial and accounting occupations. Skilled occupations in trade and services are more common among women, such as shop assistants, cashiers, bartenders, hairdressers and personal care workers, Finally, in unskilled occupations, women are more employed as domestic helpers, office and industrial cleaners and servants. Compared to women's employment, men's employment is certainly more varied. Vertical segregation refers to the difficulty for women to gain access to top positions within organisations or to skilled and specialised professions that are more often reserved for men, such as entrepreneurs, judges, engineers, doctors, academics, etc. The existence of vertical segregation highlights the existence of a *glass ceiling* that hinders women's career progression and excludes them from top positions with greater responsibilities. In the debate on gender segregation, this study contributes to highlighting the quantitative aspects of the phenomenon both in terms of horizontal and vertical segregation, using data on occupations, also offering a temporal comparison over 18 years. The focus is conducted on four specific occupational fields, two with a traditional male prevalence (managerial and scientific) and two with a female prevalence (healthcare and education) in which, however, women are historically confined to the lowest levels.

3 Analysis of occupations

3.1 Four fields under observation: small but significant progress for women

This study is based on data from the ISTAT Labour Force Survey and, more specifically, on the variable "occupation". In particular, this study considered a specific aggregation of occupations into 12 groups from the Classification of Occupations - CP2011 (Table 1), excluding the armed forces[5]. The specific

[5] It was preferred to exclude the armed forces because of the recent entry of women into this sector.

aggregation groups occupations starting from the II and III digit of the CP2011 occupational classification, prioritising the field of competence according to the logic of *job families* (Table 1). Up to now, the 2022 average has been used to give the most recent picture of the distribution of employment by occupation. From now, in order to provide a longer time comparison and at the same time make the estimates stronger, on the 2004-2005 averages, the first two years of the latest *historical series*, and the 2021-2022 averages, the first two available years of the *new series*[6], will be used.

Table 1 – *Ad hoc aggregation of occupations into 12 groups (percentage composition on two-year average 2021-2022).*

Group	Description	%	Group	Description	%
1	P.A. managers and entrepreneurs	2.8	7	Clerks	12.5
2	STEM	8.2	8	Sales and restaurant workers	14.5
3	Health occupations	6.6	9	Building, metal workers	14.8
4	Teachers and researches	5.8	10	Agriculture, food, textile workers	7.5
5	Legal-financial occupations	7.2	11	Transport and storage	5.7
6	Socio-cultural occupations	6.2	12	Low-skilled professions (cleaners, carers)	8.2
				Total	100

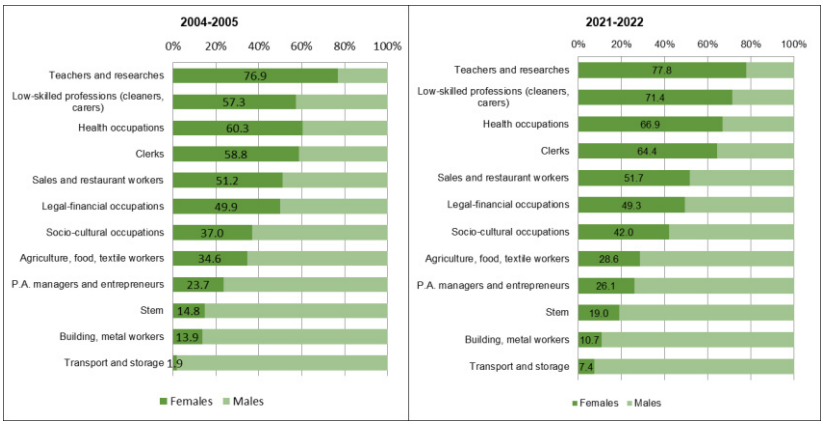
Source: ISTAT, Labour Force Survey.

The comparison over time allows analysing the dynamics that have taken place in the work, and more specifically in occupations, over the last 18 years, capturing aspects of growth and progress as well as stagnation and critical issues. Although the overall employment rate of women increased by 3.2 percentage points, it is important to check whether this increase was accompanied by an improvement in the quality of their employment, particularly in terms of overcoming traditional gender segregation. In fact, the number of women in employment has increased not only in traditionally female-dominated occupations such as carers, clerks or nurses (in particular, care and cleaning services have moved into second place in terms of

[6] All countries of the European Union, since January 2021 implemented the new Regulation (EU) 2019/1700 of the European Parliament and of the Council. For the Labour force survey, it introduces changes in the definition of household and employed persons, using a new questionnaire. Details of the changes introduced from 2021 are at link https://www.istat.it/it/archivio/252689. The data collected from 2021 are new data series, while those collected up to December 2020 represent the old series. The proposed time comparison thus contains a break in the historical series, but the comparison between old and new series, for the overlap period 2018-2020, shows a completely similar trend in the estimates between the two series and with that of the period 2021-2022.

female presence like Figure 1 shows), but also in some occupations usually reserved for men. This is the case, for example, of occupations related to transport and storage, of socio-cultural technical occupations, of STEM occupations, and of managerial profiles, although the increase in the latter is lower than the average increase.

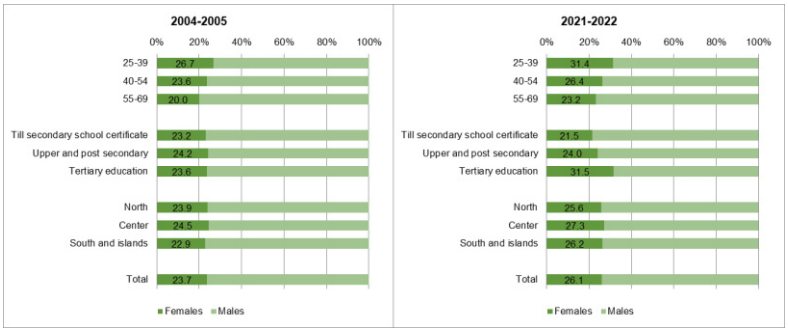
Figure 1 – *The 12 groups of occupations by sex. Two-year average 2004-2005 and 2021-2022 (percentages).*



Source: ISTAT, Labour Force Survey.

Public administration managers or entrepreneurs in small and large business companies: over the last 18 years, there has been a significant decline in the number of people employed in the most highly qualified occupations, profiles traditionally dominated by men. In the 2021-2022 biennium, their share of total employment is 2.8% (5% in 2004-2005) and among them, the share of men is significantly higher than that of women (73.9% *vs* 26.1%).

Figure 2 – *Managers and entrepreneurs by sex, age classes, level of education attained and territory. Two-year average 2004-2005 and 2021-2022 (percentages).*

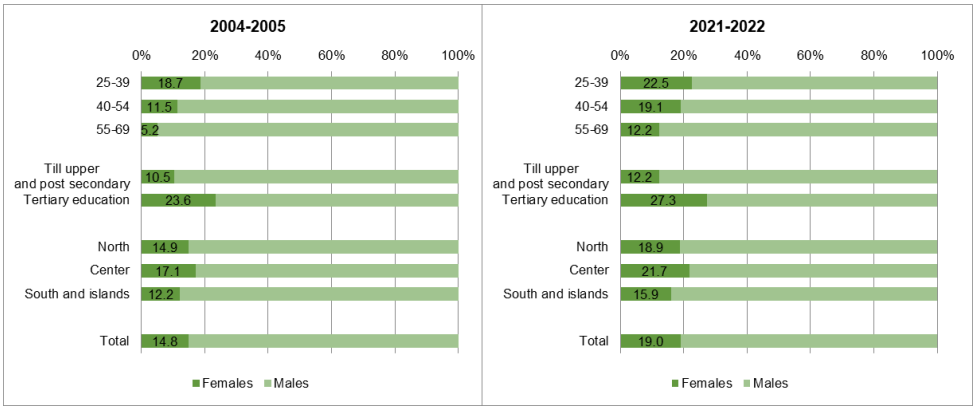


Source: ISTAT, Labour Force Survey.

In a context of persistent male dominance, very small positive signs for the female component should be noted. In fact, the increase in the share of women is lower than their average growth: from 23.7% in 2004-2005 to a presence of 26.1% in the most recent period (Figure 2). The largest increases were among younger women aged 25-39, from 26.7% to 31.4%, and among women with tertiary education, from 23.6% to 31.5%. Finally, the increase, which is widespread in all regions, is proportionally greater in the South (from 22.9% to 26.2%).

STEM: data on women is still not very encouraging, with women still under-represented in scientific professions. Some studies suggest that women make up around 30% of the world's researchers, and less than a third of female students choose to study subjects such as maths and engineering at university (UNESCO, 2017). In Italy, only 20% of girls chooses to study STEM subjects in 2021, confirming them as traditionally male occupations, as remarked by the main European indicators on Specialised and Technical Human Resources - HRST (Istat, 2023b). The origin of this gap depend on several factors. Firstly, certain stereotypes linked to the perception of a greater inclination of women towards humanistic subjects and men towards scientific subjects. Secondly, a labour market that favours the recruitment of young men, but also the lack of support measures - especially for freelancers - to ensure continuity of employment in the event of maternity leave. Moreover, in male-dominated disciplines, women may find it more difficult to form networks or be less willing to compete (Casarico, Lattanzio, 2020).

Figure 3 – *STEM occupations by gender, age classes, highest educational attainment and territory. Two-year average 2004-2005 and 2021-2022 (percentages).*



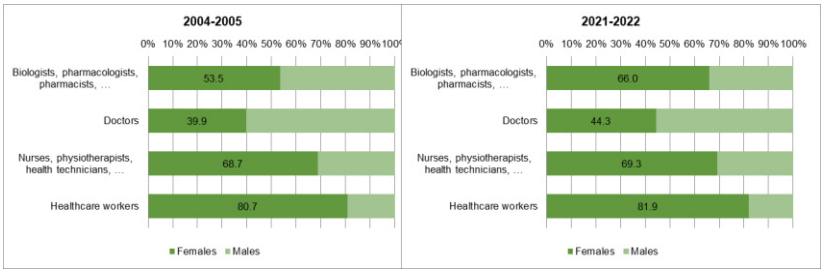
Source: ISTAT, Labour Force Survey.

In this background, it is not surprising that in the 2021-2022 two-year average, only one fifth of those employed in STEM (8.2% of the total employment) are women (19.0%). However, it is important to note how the comparison over time

reveals interesting progress in terms of overcoming segregation. Firstly, the female share of the total has increased by 4.2 percentage points compared to the past, from 14.8% in 2004-2005 to 19.0% in 2021-2022 (Figure 3). The increase is more significant among middle-aged and older women, in fact at the beginning of the period their share was negligible (5.2% among women over55). In addition, the share of women in tertiary education has increased to 27.3% (from 23.6% in the past). At territorial level, the Centre has the highest share of STEM employed women (21.7%) and the highest growth (+4.6 points) compared to the other geographical areas. Overall, STEM employed women are better educated than men: the share of tertiary educated women is higher not only in professional STEM occupations (93.2% vs. 83.8%) but also in technical occupations (42.2% vs. 18.5%), confirming a higher proportion of over-educated women.

Health and life occupations: they account for 6.6% of total employment. Although the health sector as a whole consists of female-dominated occupations (66.9% women), there are significant differences within it. While women represent the great majority of healthcare workers in 2021-2022 (81.9%) and around two-thirds of specialists in life sciences (66.0%) and technicians in health and life sciences such as nurses (69.3%), they are still a minority among medical doctors (44.3%) (Figure 4). In 2021-2022 the medical doctors (general practitioners, surgeons, pathologists, dentists...) are 1.2% of total employed people.

Figure 4 – *Health occupations by typology and sex. Two-year average 2004-2005 and 2021-2022 (percentages).*

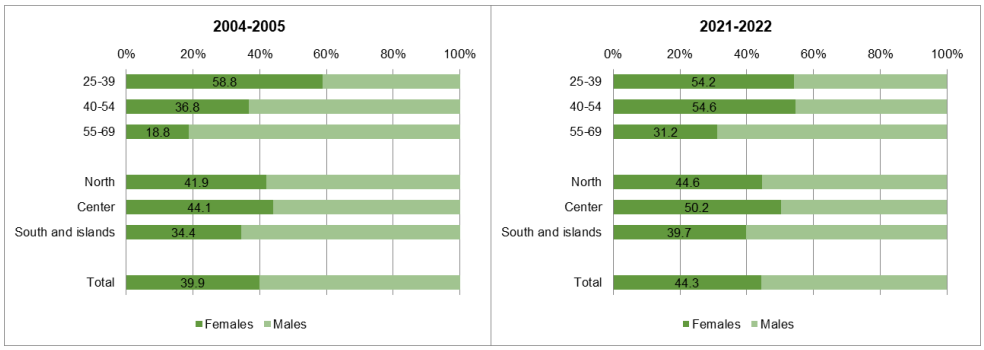


Source: ISTAT, Labour Force Survey.

The medical occupation has traditionally been almost exclusively male. However, there was already a paradigm shift at the beginning of the observation period: among youngest doctors (25-39 years), the proportion of women was already higher in 2004-2005. Today, although women are still a minority, there has been an overall increase of 4.4 percentage points compared to the past, while other professions of the same field have remained essentially stable. In addition, women have overtaken men in the youngest age group (under 55), where their share is around 54.0% (Figure 5). The most significant progress over time was made by

women in the middle age group (40-54 years), whose share increased by almost 18 percentage points to 54.0%, and to a lesser extent by older women (12.4 points), reaching 31.2%. At territorial level, the increase occurred mainly in the Centre, where the share of women increased by more than 6 percentage points. In Western society, the progressive "feminisation" of health occupations has become an important reality that is changing the face of modern medicine. In Italy, too, the presence of female doctors is growing, and the overtaking has already taken place in almost all specialisations, surprisingly even in those that used to suffer from a more typically masculine connotation, first surgical specialisations.

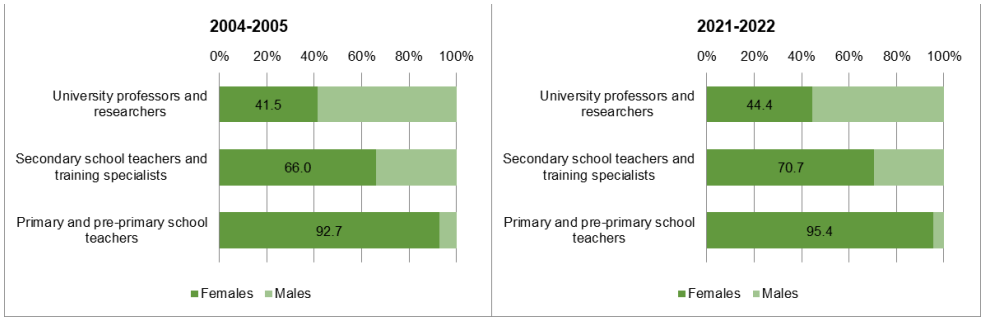
Figure 5 – *Medical occupations by sex, age classes and territory. Two-year average 2004-2005 and 2021-2022 (percentages).*



Source: ISTAT, Labour Force Survey.

Education, training and research occupations: women show a clear advantage in this field that accounts for 5.6% of total employment. Although this sector as a whole is clearly dominated by women (77.8%), there are some clear differences within it: while women account for almost all primary and pre-primary teachers (95.4%) and the great majority of lower and upper secondary teachers (70.7%), they are still a minority among university teachers and researchers (44.0%) (Figure 6). In the academic field, women are not only less present, but also less likely to reach positions of responsibility; they fail to achieve the desired and elevated roles during their university careers. However, even in this sub-group there are signs of improvement. Although men are still the majority in 2021-2022, it is important to highlight the situation of gender parity achieved in the younger generation (25-39 years), where the share of women is 51.2%. The most significant progress over time is recorded for older women (55-69 years), whose share increased by 16 points to 42%, and in the North, where the increase was 6.6 points and the share reached 43.3%.

Figure 6 – *Teachers and researchers by typology and gender. Two-year average 2004-2005 and 2021-2022 (percentage).*

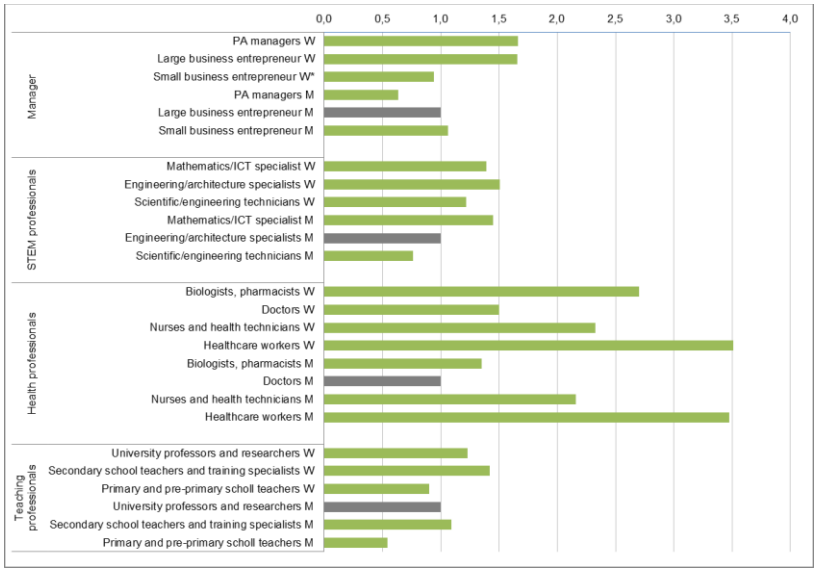


Source: ISTAT, Labour Force Survey.

3.2 Comparison over the time: logistic model

Multinomial logistic regression models were used to support the descriptive analysis in order to show the different probability of being employed in the analysed occupations, in the recent period (2021-2022) compared to the past (2004-2005). To examine the interaction between occupation, gender, and period, the model was applied to the four groups of occupations (dependent variables) stratified by gender. The time variable has been used as independent variable, adjusted for other potential confounders, including age, geographical area and citizenship (Figure 7). Among managerial occupations, the profiles showing a higher propensity to be employed in the last two years are female PA managers and female entrepreneurs of large enterprises, with an odds ratio of 1.66 times more than male entrepreneurs of large enterprises, taken as the reference category (95% CI: 1.46-1.89 the former and 1.49-1.84 the latter). Among the STEM specialists, the propensity to be employed as female engineers is 50% more than male engineers are (odds ratio 1.51, 95% CI: 1.38-1.65) and it is greater for male maths and ICT specialists (odds 1.45, 95% CI: 1.36-1.55). In the Health occupations the healthcare workers in 2021-2022 have a propensity three times and half more than the male doctor in the 2004-2005 to be employed, both for women (odds ratio 3.51, 95% CI: 3.26-3.) and for man (odds ratio 3.48, 95% CI: 3.08-3.93). Female pharmacists and biologists (odds 2.70), female nurses (odds 2.33) and female doctors (odds 1.50) have also greater propensity than male doctors to be employed. Among teaching professionals, the women teachers of secondary school and university professors and researchers show greater propensity to be employed (odds 1.42 and 1.23) than male university professors.

Figure 7 – *Probability of being employed in some professional groups. Ods ratio. 2021-2022 vs 2004-2005.*



Source: ISTAT, Labour Force Survey.

4. Conclusions

Data from the Labour Force Survey show that in the recent period, compared to the past, women have a higher probability of being employed in more specialised profiles. It happens not only in some occupational fields where female component always held lower profiles (health and training), but even in those areas whose occupations have always been the prerogative of men (managerial profiles and stem occupations). However, data shows that our country remains severely disadvantaged in terms of female employment, especially in the skilled profiles. It is therefore ever more urgent to strengthen and incentivise tertiary education for both sexes, especially in the technical-scientific field, in order to close the gap with other European countries, improve human capital and invest in highly specialised sectors that are strategic for competitive growth in the knowledge society. The tentative signs of improvement in the female component appear insufficient for many of the skilled sectors highlighted in this analysis. There is therefore an urgent need for institutions and companies to introduce equality and diversity management policies: the set of practices and policies aimed at valuing diversity within a working environment, whether it be gender, sexual orientation, ethnic origin, culture, physical ability, etc., as well as systems for evaluating companies and institutions themselves

on their ability to promote diversity. Finally, the reconciliation of work and family life and, last but not least, social policies to promote a culture of equality and combat gender bias should be strengthened: indeed, data show that for women, education alone is not enough to achieve equal treatment with men in the labour market.

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TOURIST DESTINATION LOYALTY: A CASE STUDY OF ROME

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Abstract. Destination loyalty is the intended behavior of the customer who can put into effect the pleasant sentiments they have for a destination that allows them to revisit, repurchase the services, and refer the destination favorably to their surroundings. This circumstance is fairly common in the management of many touristic destinations, and it has been developed into a topic that is available for many innovative analyses. This study investigates the factors that affect and shape the loyalty between foreign tourists and the city of Rome. In order to assess destination loyalty, a data collection was implemented. The main objective is to identify not only key factors increasing destination loyalty of foreign visitors, but also the main aspects demotivating repeated visitations, in connection with the socio-economic characteristics of tourists. The results of this study could represent important entry points for public decision makers and tourism operators to improve the attractiveness of the city of Rome, with the goal of increasing destination loyalty and tourist arrivals.

1. Introduction

Borders between countries have been removed in many industries due to globalization, and various sectoral changes and advances have occurred. In contrast, the tourist industry has welcomed several innovations due to these adjustments to its creative organizational structure. Additionally, the ease of travel has expanded tourism activities, and with these increased activities has come increased competition among destinations for a larger slice of tourism revenue. As a result, tourist destinations aimed to draw more visitors to have more income until the realization that having loyal customers would bring more benefits than gaining more new customers (Pfeifer, 2005). Thus, the term "loyalty'' started to take center stage in the travel industry. In the context of tourism, destination loyalty refers to a traveler who returns from a destination, shares his/her great experiences, and encourages his/her friends and acquaintances to do the same (Almeida-Santana & Moreno-Gil, 2018). Although there is a wealth of research into customer loyalty in the larger marketing

sector, it has received scant attention in tourism literature (Oppermann, 2000). Since 1956, more than 3,000 publications have been written on the subject of "customer loyalty" (Cossío-Silva et al., 2019), yet only a small number of researchers have looked into the issue of repeat visitation and have developed preliminary tourist loyalty typologies. Moreover, limited attention has been spent in research on the perspective of tourists in terms of their relationship with destinations, while past studies have focused mainly on how destinations establish relationships with tourists. When it comes to the recent international scenario in the tourism sector, Europe emerges as the most popular continent with nearly 900 million international arrivals recorded worldwide in 2022, closely followed by Asia and the Pacific regions (UNWTO, 2023). In this context, it becomes essential to delve into the specific case of Italy, where a total of 109 million total arrivals were observed in 2022, according to ISTAT. Interestingly, Italy witnessed a considerable reliance on domestic tourists, with the international market accounting for nearly half of the total arrivals. This emphasizes the need not only to attract more international tourists, but also to implement effective destination strategies aimed at cultivating a loyal tourist base. It is noteworthy that Italy plays a prominent role in the European tourism landscape (Celardo & Iezzi, 2017), ranking as the fourth most visited country in Europe in 2022, according to EUROSTAT. By examining regional preferences, the statistics provided by ISTAT shed light on the popularity of specific destinations in Italy, with the Lazio region securing the fourth position in terms of total arrivals. Furthermore, when analyzing the number of nights spent by tourists in various cities across Italy, Rome emerged as the frontrunner, underscoring its significant contribution to the national economy. Finally, an examination of arrivals in Rome in 2021 by origin reveals that a majority of tourists came from Italy, followed by 20% from other European Union countries. Notably, the United States accounted for the highest number of nights spent in Rome, closely followed by France, according to ISTAT. These insights collectively emphasize the need to explore and implement effective strategies to enhance destination loyalty and capitalize on the potential of international and domestic tourism markets. Thus, the objective of this study is to analyze destination loyalty and to explain the background factors that affect repeated visiting, implementing a field survey on 1,000 tourists in the context of the city of Rome (Italy).

2. Literature Review

Customer loyalty has become a significant consideration for businesses, as they recognize the importance of retaining existing customers rather than solely focusing on acquiring new ones. Oliver (1999) defines loyalty as the commitment to repeat

purchases or endorsements despite external factors or competition. Customer loyalty significantly impacts the performance of service companies and it is often seen as a key competitive advantage. Studies have shown that a small increase in client retention can lead to substantial profit growth (Lam & Shankar, 2014; Bowen & Chen, 2001).

Shifting our perspective from businesses to destinations, it becomes apparent that while customer loyalty focuses on individual preferences and satisfaction, destination loyalty examines the broader allure and enduring attractiveness of a specific place to a diverse range of visitors. McKercher and Wong (2004) describe destination loyalty as the extent to which tourists demonstrate a strong attachment, preference, and commitment to a specific travel destination, leading to their intention to revisit and recommend it to others. Although destination loyalty research draws on concepts from product and service loyalty literature, it recognizes the unique characteristics of the tourism industry. Factors such as familiarity with the destination, overall satisfaction, visitor sociodemographic traits, and motivations influence the desire to return (Kastenholz et al., 2006; Oppermann, 2000). Contentment alone does not guarantee loyalty, as travelers may prefer to explore new places (Oppermann, 1999). Studies on this topic can be categorized into expectation-dissonance paradigm and cognitive psychology approaches, both focusing on tourist satisfaction (Castro et al., 2007). Another key element that is connected to destination loyalty is the "image", which has a significant interest in conceptualization (Chon, 1990; Gallarza et al., 2002; Moreno-Gil & Martín-Santana, 2015), and it can be defined as a comprehensive perception involving both cognitive and affective evaluations (Baloglu & McCleary, 1999; Carballo et al., 2015). While the cognitive component of destination image pertains to the beliefs and information that tourists hold regarding the attributes of a destination, the affective component of the image, on the other hand, relates to the emotional feelings and responses represented by the various characteristics of a place. Although several studies have identified the image as one of the determinants of destination loyalty (Bigne et al., 2001; Chen & Tsai, 2007; Faullant et al., 2008; Loureiro & Gonzalez, 2008; Prayag & Ryan, 2012; Prayag, 2008), there is still no consensus on the strength and the direction of these relationships. Many authors predominantly focus on measuring cognitive image (Chen & Tsai, 2007; Chi & Qu, 2008; Prayag & Ryan, 2012) or utilize general image attributes (Bigne et al., 2001; Campo-Martínez et al., 2010; Loureiro & Gonzalez, 2008), while paying less attention to measuring affective image attributes (Zhang et al., 2014). The inclusion of the affective component, as suggested by Prayag and Ryan (2012), could provide a better understanding of the relationship between image and loyalty. Destination image plays a crucial role in the overall consumption experience, satisfaction, and repeat visitation. A positive destination image creates favorable expectations and experiences for tourists,

leading to higher levels of satisfaction and an increased likelihood of repeat visitation (Bigne et al., 2001). When tourists perceive a destination positively based on its image, they are more likely to develop a sense of loyalty and exhibit behaviors such as repeat visits and positive recommendations (Machado et al., 2009). It encompasses impressions, information, beliefs, values, and emotions associated with a destination (Jenkins, 1999; Bigne et al., 2001).

Another factor that influences people's decisions to travel for leisure is motivation, which has been widely examined in earlier studies (Sun et al., 2013). "Push" and "pull" factors can be used to categorize these motives (Crompton, 1979; Dann, 1977). Internal motives (push), according to Dann (1977), are connected to the desires of tourists and include the desire to escape, rest, acquire prestige, engage in sports, and socialize. The attraction of the location and its historical, cultural, or natural features, however, are pull forces. Thus, it is clear that individuals' motivation to travel can directly affect many factors in the process until they return home, either negatively or positively (Petrick, 2002a; Petrick, 2002b). Looking at prior research, it can be said that also socio-economic profile has a high influence on loyalty (Petrick & Backman, 2001; Petrick, 2005). Age and income are the basis of these differences. According to Correia, Zins, and Silva (2015), older tourists are more likely to seek to revisit a destination than younger ones. On the other hand, when it comes to income, these authors argue that tourists with higher incomes are less likely to be loyal. Lastly, word of mouth (WOM) has a significant impact on destination choice and subsequently, destination loyalty. WOM is the earliest form of communication, and it serves as a non-commercial means of verbal communication among consumers interested in a particular company, product, or service (Woodside & Deloizer, 1976). Positive WOM communication about a destination can enhance its reputation and credibility, influencing potential tourists to consider visiting.

3. Data and methods

In order to achieve the proposed objectives, fieldwork was implemented through a structured questionnaire that included socio-demographic, behavioral, motivational, and image variables. The questionnaire used was adapted from Almeida-Santana and Moreno-Gil (2018)[1]. The questionnaire combined sixteen closed questions. The numerical scales used are from 1 to 10, with 1 being the minimum value and 10 being the maximum. Concerning the destination image, its three components were evaluated (cognitive, affective, and overall image). For the

[1] The structure of the form was not changed, but some adaptations were implemented to the questionnaire in order to take into account the specific nature of the destination analyzed.

assessment of the cognitive component of the image, 26 items were used; a 6-item semantic differential scale was used for the measurement of the affective component of the image; a Likert scale from 1 to 10 was used to measure the overall image. With regard to motivation, 20 items were used. The target population of this study consisted of potential tourists, aged 18 and over, who visited the city of Rome. The survey was implemented through computer-assisted personal interviewing (CAPI). A non-probabilistic sample of 1,000 individual tourists' was selected in a period between February and June 2023, with respondents participating in the survey on the basis of their voluntary engagement. The data collection was implemented by administrating an online questionnaire (implemented on the Google Forms platform), in three different famous zones in the city center of Rome, including *Piazza di Spagna*, *Pantheon* and *Colosseum*, to meet with the target and ask their personal contribution to the study. After completing the fieldwork and having implemented quality controls on data, we performed (1) chi-squared tests and (2) a binomial logit analysis with the R software. Two groups of tourists were differentiated, those who are loyal[2] to the destination and tourists who are not.

4. Results

Regarding the first section of the questionnaire dedicated to socio-economic characteristics, an equal distribution of 50% male and 50% female respondents participated in the study, indicating a balanced demographic distribution among the respondents. The largest age group among the participants was in the 18-24 range (38%), followed by the 25-34 age class (33%). Notably, tourists from the United States constituted the largest proportion, representing 8% of the total visitors, followed by Germany (7.5%) and Spain (7%). When examining prior travel experiences, 47% of the respondents had visited Italy before the interview, with a significant 85% of them having already explored Rome. Milan and Florence also emerged as popular cities among the participants. Respectively, 69% and 63% of respondents who had already visited Italy went to these destinations. As for the motivation part of our analysis, it is clear that much of the core of tourist motivation stems from the desire for new cultures and places to explore, relaxation or a break from responsibilities, and last but not least, entertainment in general. The affective component of Rome's image, on the other hand, is perceived as a moderately authentic and healthy destination. However, there is room for improvement in terms of sustainability. Moreover, Rome is not viewed as a quiet or gloomy destination;

[2] A tourist can be defined as being loyal to a specific destination if at least one or more visits to the same destination are observed.

instead, it is seen as an active and stimulating destination, capable of instilling happiness and joy among its visitors. Concerning the cognitive component of the image, while Rome is perceived as less clean and equally crowded compared to respondents' preferred destinations, it excelled in other appealing aspects such as lifestyle, climate, family-friendliness, gastronomic variety, and historical-cultural attractions. The overall image of Rome was highly positive, with ratings predominantly falling within the range of 8 to 10. A substantial majority of respondents (95%) expressed a willingness to recommend Rome to others, further indicating their satisfaction. Moreover, a significant proportion of participants indicated a strong likelihood of revisiting the city within the next two years. These findings underline Rome's allure as a desirable tourist destination, attracting a diverse range of visitors and fostering destination loyalty. In the analysis of factors influencing the revisit intentions of tourists in Rome, Chi-squared tests have been implemented on loyalty and (1) age, (2) income, (3) no. of trips made in 2021-2022 outside the country of residence, (4) use of social media and (5) level of studies. The estimation of the Chi-squared tests shows that age, income, and past experience are associated with destination loyalty (*p-value* < 0.01). In line with Correia et al. (2015) and Almeida-Santana and Moreno-Gil (2018), the greater the age of the respondents, more likely they are to be loyal to a destination. In line with the previous references, it was observed also a strong relationship between the average income level and loyalty, where a greater purchasing power facilitates repeated visits to the destination. The results also show that the greater the number of holidays of more than four days (past experiences), the greater the probability there is a loyal tourist. The variables of social media usage and level of study were found to be not significant, even if in the literature (Gruen et al, 2006; Almeida-Santana & Moreno-Gil, 2018) the use of social media has proved to be significant for destination loyalty. In order to fulfill the objective of this study, three binomial logit models have been estimated, with loyalty as the dependent variable and motivation (20 items), cognitive image (26 items) and affective image (6 items) as independent variables. The motivation to know new and different places has, as expected, a negative influence on loyalty (Table 1), where repeated tourists tend to have a low need to search for something new. In fact, non-loyal tourists are travelers who mainly prefer to constantly discover new destinations, rather than revisit the same place. Attending cultural events affects loyalty in a positive way, indicating that tourists who actively engage in cultural activities during their visit are more likely to develop loyalty towards the destination. This suggests that cultural events can enhance the overall experience and create a sense of attachment to the location. The positive influence of sharing the holiday experience with friends on loyalty indicates that WOM communication plays a significant role in destination loyalty. When tourists share positive experiences with others, it not only reinforces their own connection with the

destination, but also potentially attracts new visitors. On the other hand, enjoying and spending time with family and friends affects destination loyalty negatively, indicating that tourists who prioritize social interactions during their trips may have lower levels of loyalty. This suggests that when tourists prioritize personal relationships over the destination itself, their loyalty may decrease at the same time. This result highlights that the destination's ability to provide an enjoyable experience for both tourists and their companions is crucial for fostering loyalty.

Table 1 – *Estimated binomial logit model of destination loyalty and motivation items.*

Items	β	S.E.	p-value
To know new and different places	-0.137	0.511	0.008
To attend cultural events	0.255	0.045	< 0.001
To tell friends about the holiday experience	0.143	0.035	< 0.001
To enjoy and spend time with family and friends	-0.127	0.044	0.004

Only the significant items after a backward elimination have been reported in this table.

With respect to the determining factors related to the image of the destination, only the cognitive image resulted in affecting destination loyalty, while all 6 items of the affective image were not significant. Concerning the cognitive image, there is an inverse relationship between loyalty and the items “Rome offers greater personal security” (Table 2) and “Rome is cheaper for holidays”. The greater the value that the tourists apply to these attributes, the lower the probability of them to show loyalty. This means that while security is not a determinant in the revisiting choice of tourists, affordability represents for loyal visitors a key factor of retention. On the other hand, there is a positive relationship between loyalty and the items “Rome is more accessible”, “Rome offers greater political and social stability”, “Rome is less crowded” and “Rome is more exotic”. Even if security is negatively associated with loyalty, political and social stability of the destination emerged as an influencing factor of tourists’ fidelization. Accessibility also emerged as one of the key factors of the image influencing the loyalty for the city of Rome, together with the suggestive and evocative atmosphere of the city.

Table 2 – *Estimated binomial logit model of destination loyalty and cognitive image items.*

Items	β	S.E.	p-value
Rome offers greater personal security	-0.148	0.039	< 0.001
Rome is cheaper for holidays	-0.099	0.036	0.006
Rome is more accessible	0.153	0.043	< 0.001
Rome offers greater political and social stability	0.125	0.040	0.002
Rome is more exotic	0.236	0.043	< 0.001

Only the significant items after a backward elimination have been reported in this table.

5. Conclusions

This study proposes valuable insights into the drivers influencing destination loyalty within the specific case of Rome. These factors were analyzed through a questionnaire administered to a non-probabilistic sample of potential tourists, with a large sample size that allowed consistent conclusions to be drawn. The results allowed us to identify the existence of variables and items influencing loyalty that could be taken into account by managers and public decision-makers in designing marketing strategies for the city of Rome. The analysis of socio-economic characteristics revealed significant correlations between age, income, and past travel experience with destination loyalty. Older tourists with higher incomes demonstrated a greater propensity for loyalty. Additionally, tourists who had engaged in multiple trips outside their home country exhibited higher levels of loyalty too. These findings align with existing research, highlighting the impact of demographic and economic factors on tourist behavior. The study also shed light on motivational factors, indicating that tourists with a preference for novelty and new experiences may exhibit lower levels of loyalty. Conversely, those who actively participated in cultural events and shared their holiday experiences with others, displayed a stronger inclination towards destination loyalty. These findings underscore the importance of providing unique and culturally enriching experiences to foster loyalty, as well as the significant role played by WOM communication in shaping perceptions and loyalty. The examination of cognitive and affective components of the destination image revealed intriguing findings. Rome was perceived as an active and stimulating destination, capable of evoking happiness and joy among its visitors. Its historical and cultural attractions, lifestyle, and gastronomic variety were regarded as particularly appealing. However, respondents also noted concerns about crowding and cleanliness compared to their preferred destinations. These findings suggest the need for effective crowd management strategies and initiatives to enhance cleanliness perception, ultimately contributing to tourists' satisfaction and loyalty. The results of multivariate analyses further supported the influence of motivation and image on destination loyalty. Notably, tourists who prioritized personal relationships over the destination themselves displayed lower levels of loyalty, underscoring the importance of providing enjoyable experiences for both tourists and their companions. Perceptions of personal security, cost, accessibility, political and social stability, crowd levels, and the evocative nature of Rome were found to significantly impact destination loyalty. These findings emphasize the necessity of addressing these factors to increase loyalty among tourists. In conclusion, this study provides valuable insights into the complex dynamics of tourist destination loyalty in the context of Rome. Even if the study involved a non-probabilistic sample of tourists, making it impossible to extend the results of the analyses and limiting the

implications of the research, the outcomes of this study represent a key starting point for future research in the field of destination management. The findings underscore the importance of nurturing loyalty among visitors, as it offers numerous benefits for both the destination and its stakeholders. By capitalizing on Rome's strengths and addressing areas of improvement, the city can position itself as a premier tourist destination, fostering long-term success and growth in the competitive global tourism industry.

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THE NONPROFIT SECTOR IN ITALIAN INNER AREAS[1]

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Abstract. The Nonprofit Institutions (NPIs) provide social and economic support to local communities by offering services, goods and resources and fulfilling the purpose of building public benefit. Moreover, the nonprofit sector is a significant actor to cope with social and economic vulnerability, especially in fragile territories where it plays a key role in enhancing empowerment of local population and fostering communities' development. Half of Italian municipalities host the "Inner areas" which are fragile territories, far away from main centres of supply of essential services and too often abandoned to themselves, due to their rural identity according to the European classification of degree of urbanization. The Inner areas are manly located in South of Italy, which represent the 44.8% of total: 1,718 municipalities overall (67.4%) where Region such Basilicata, Sicily, Molise and Sardinia show higher incidence (more than 70%). The paper aims to describe the spread of NPIs in Italian Inner areas, within central and peripheral contexts, by highlighting their role in terms of services offered and human resources employed, in connection with the local socioeconomic development and level of vulnerability. The analysis is based on the integration of the data gathered by the Statistical Register of Nonprofit Institutions with the main indicator provided by different data sources (Permanent Census of the population, ASIA Statistical Register of active enterprises, Frame SBS Register), allows studying territories by providing important insights to sectorial and territorial planning and reducing costs and statistical burden, as well. Socioeconomic characteristics of communities and level of vulnerability, in association with data on nonprofit sector are considered. The analysis of the provision of social services by non-profit institutions, including cultural and environmental amenities, human welfare services, along with their role in local employment, will allow to explore to what extend nonprofit sector's performance contribute to build a resilience process at local level, by fostering community economic development and enhancing the quality of life for its residents.

[1] Although the contribution is the joint responsibility of the authors, sections 1, 2 and 3 are attributed to Valeriana Leporanico, section 4.1 is attributed to Sabrina Stoppiello, section 4.2 to Stefania Della Queva, section 4.3 to Manuela Nicosia.

1. Introduction

The National Inner Area Strategy represents (SNAI) an innovative national policy of development and territorial cohesion that aims to counteract the marginalization and demographic decline of the Inner areas of our country. The Map of Inner areas, of reference for SNAI and included in the Partnership Agreement (AP) 2014-2020, is a tool that looks at the entire Italian territory in its articulation at municipal level, identifying the municipalities which have access to essential services[2], called Poles and Inter-municipal Poles and representing all the other municipalities based on their distance from them (in terms of actual road travel times), classifying them in four bands to increasing relative distance (Belt, Intermediate, Peripheral, Ultra-peripheral) and, therefore, with a greater potential discomfort in the use of services. Municipalities classified as Intermediate, Peripheral and Ultra-peripheral represent the whole of the Inner areas of our Country (Figure 1). (Dip. politiche di coesione. 2022. *Criteri per la Selezione delle Aree Interne da sostenere nel ciclo 2021 – 2027).*

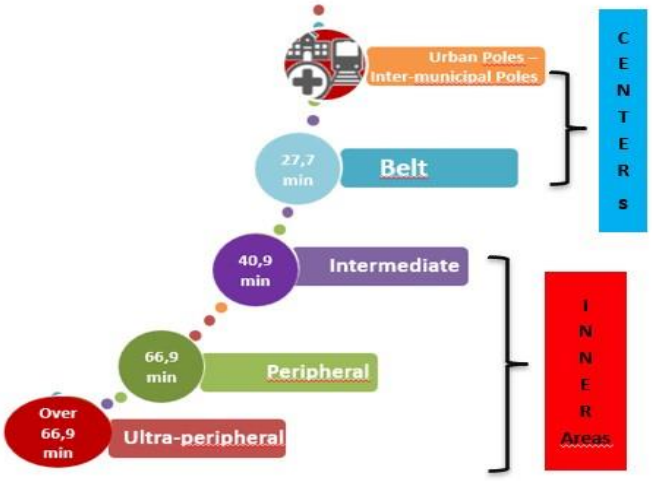
1.1 Distribution of municipalities according to the classification of Inner areas

The IA 2020 Map, included in the new 2021-2027 Partnership Agreement, has followed the approach already defined for the IA Map 2014 considering new census data and more timely distance estimation procedures (SNAI 2020). The new mapping of the Inner areas counts: 182 Common Pole, 59 Inter-municipal Pole; 3,828 Common Belt (48.4%) placed at relatively small distances from a Pole or an inter-municipal Pole (lower than the median of the distribution of distances equal to 27.7 minutes); 1,928 Intermediate Municipalities (24.4%) which represent the first cluster of Inner areas (distance between the median and the 3 quartile someone equal to 40.9 minutes); 1,524 Municipalities Peripherals (19.3%), that is, whose distance is between the 3 quartile and the 95th percentile equal to 66.9 minutes; 382 Municipalities Ultra-peripherals (4.8%), which have a distance from the nearest common pole or inter-municipal pole greater than the 95th percentile (Figure 1). At the territorial level, the municipalities of the Inner areas are mainly present in the regions of the South of Italy (44.8% of the national total), with significant effects in Basilicata, Sicily, Molise and Sardinia.

In the Inner areas, which extend for a total area of more than 177 thousand km^2 (almost 59% of that of the entire country), reside a little more than 13 million people, that is less than 23% of Italians, with a population density of 75.7 inhabitants per km^2 (Table 1).

[2] Essential service centres are those municipalities able to provide simultaneously: schools with a full range of secondary education, at least one-grade one emergency care hospitals and at least one Silver category railway station.

Figure 1 – *Spatial distribution municipalities - SNAI Classification 2021.*



Source: Istat..

Table 1 – *Number of municipalities, population, area and population density - SNAI Classification 2021. Absolute values and km²*.

SNAI Classification	Municipalities	Population	% Population	Surface	% Surface	Population density
A - Urban Poles	182	20,470,301	34.6	24,455	8.1	837.1
B - Inter-municipal Poles	59	1,576,586	2.7	3,728	1.2	423.0
C - Belt	3,828	23,756,465	40.1	96,344	31.9	246.6
D - Intermediate	1,928	8,059,454	13.6	75,838	25.1	106.3
E -Peripheral	1,524	4,653,355	7.9	79,394	26.3	58.6
F -Ultra-peripheral	382	720,052	1.2	22,310	7.4	32.3
Total	**7,903**	**59,236,213**	**100.0**	**302,068**	**100.0**	**196.1**
A+B+C - Centres	4,069	45,803,352	77.3	124,527	41.2	367.8
D+E+F - Inner areas	3,834	13,432,861	22.7	177,541	58.8	75.7

Source: Permanent Census of the population. December 31 2020.

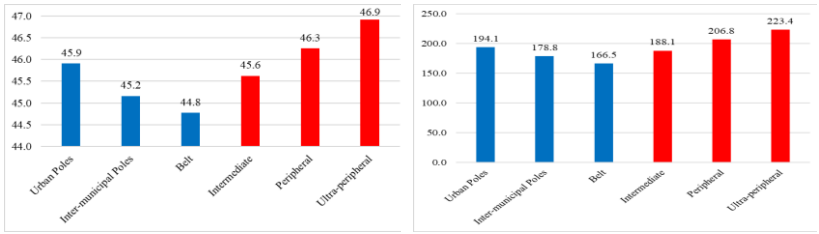
In particular, in the municipalities classified as Intermediate represent just over a quarter of the national territory and there resides 13.6% of the population (about 8 million inhabitants); in the Peripheral Municipalities resides 7.9% of the national population (about 4.6 million residents), on an area that covers more than a quarter of the national territory (26.3%, over 79 thousand km2); the Ultra-Peripheral Municipalities (the most disadvantaged category) represent just 1.2% of the population and 7.4% of the national territory.

2. Demographic dynamics: analysis of the main structural indicators.

In the long term, the dynamics of the population in the Inner areas, with its effects on the depopulation of the most marginal and isolated municipalities, is one of the elements that helped to launch the appropriate National Strategy. Between 1951 and 2020, the Municipalities of the Centres recorded a growth of 4.9 residents per thousand while the Inner areas each year lost an average of 1.3 residents per thousand inhabitants. In total, in the last seventy years the Inner areas have lost 8.8% of the population (from 14,730,499 residents in 1951 to 13,432,861 residents in 2020), which therefore tends to move to the Centres that are able to offer more services. In this context policies to combat these phenomena affecting such a large part of the Italian territory.

Depopulation is accompanied by the progressive ageing of the population of the Inner areas: the population resident in the municipalities of Belt is on average younger than the other areas of the rest of Italy while the least young are resident in the municipalities Ultra-peripheral with an average age of about 47 years (Figure 2). Italy now has a stable population structure of regressive type, with a clear prevalence of elderly population compared to the young: in 2020, the old age index of Italy is 182.6 and is significantly higher in the Inner areas than the Centres (196.1 against 178.8). In the classes of the peripheral and Ultra-peripheral Municipalities the resident elderly population is more than double that of the young (206.8 and 223.4, respectively) while the lowest value is observed in the municipalities of Belt (166.5).

Figure 2 – *Middle age and old age index in Italy.*



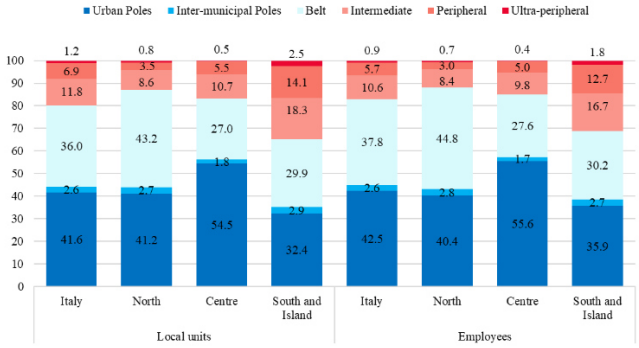
Source: Permanent Census of the population. December 31 2020.

3. Productive system: Local units and employees by SNAI area

Although accounting for 69.8% of the area, in the Inner areas of the South is located just 34.9% of the local units of active enterprises (nationally the Inner areas cover 58.8% of the area and host 19.9% of local units). In terms of employees, the

Inner areas account for 17.2% at national level and 31.2% in the South and Island (Figure 3).

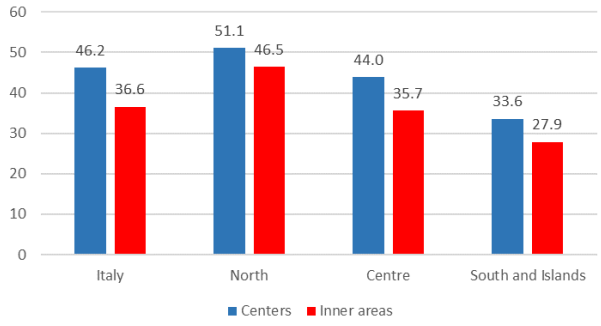
Figure 3 – *Local units and employees by SNAI areas. Year 2020 (percentage value).*



Source: Our data processing from Istat - Statistical Register of active enterprises 2020.

The productivity of the enterprises, expressed in terms of value added for employee, decreases appreciably moving towards the Inner areas both in Italy and in the macro regions. The enterprises located in the Inner areas of Southern of Italy show the lower value of productivity compared to the other macro regions (Figure 4).

Figure 4 – *Productivity index by SNAI area and macro regions, in thousands. Year 2020.*



Source: Our data processing from Istat- Frame SBS Register.

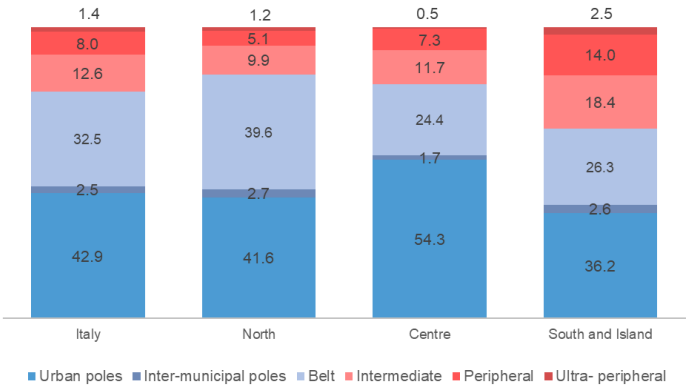
4. Nonprofit sector in Centres and Inner areas

4.1 Nonprofit Institutions by SNAI areas

The nonprofit sector plays an important role in spreading solidarity by stimulating social relationship, trust and social capital. Nonprofit Institutions provide support to difficult or vulnerable people and build proximity relations, which provide crucial resources for both individuals and communities. The nonprofit sector can thus become a factor of cohesion and socio-economic development at local level. As manner of fact, the associations create a virtuous circle of reciprocity by fostering the participation between their members. Wherever relationships are based on solidarity, a virtuous process is triggered by leading to the growth of the social capital and creating a fertile ground for the development of a valuable asset: trust (Bassi 2000; Sciolla e Maraviglia, 2016).

According to this prospective, the paper aims to explore the presence of nonprofit sector in the Inner areas (AI) of Italy, defined as municipalities far away from essential services, peripheral contexts where situation of vulnerability and social and economic disadvantage can find place. The analysis is based on data from the NPIs Statistical Register[3], which provide yearly updated data on the structural characteristics of the sector at municipality level.

Figure 5 – *Nonprofit Institutions by SNAI areas and macro regions. Year 2020 (percentage values).*



Source: Our data processing from Istat – NPI Statistical Register.

[3] The Statistical Register is by through integrating several administrative and statistical sources. According to international definitions (SNA 1993, 2008), Nonprofit Institutions are «legal-economic units with or without legal personality, private in nature, which produce marketable or non-marketable goods and services and which, according to applicable laws or their own bylaws, do not have the power to distribute, even indirectly, profits or other gains other than remuneration of work performed to the persons who established them or to their members».

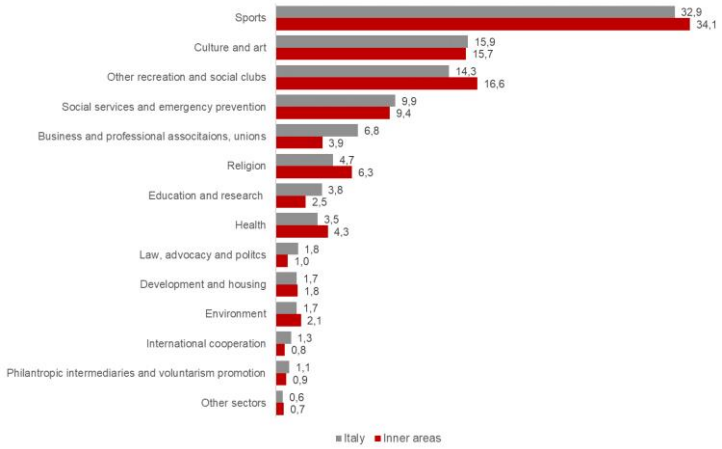
At the 31st of December 2020, the nonprofit organizations active in Italy were 363,499 with 870,183 employees. At the geographical level, 50.2% of NPIs is located in Northern Regions, 22.2% in the Centre, 18.2% in the South of Italy and 9.4% in the Islands. The distribution of employees presents the same concentration, with 57.2% of them in the North of Italy and 20.0% in the South.

As shown in Figure 5, the quota of NPIs gradually decreases from the Centres to the Inner areas, where is located 22.1% of NPIs. In particular, 12.6% in the intermediate municipalities, 8% in the peripheral ones and only 1.4% in the ultra-peripheral. The composition between Inner areas and Centres is different by looking to macro regions. In the Inner areas of Southern Italy NPIs account for the 34.9%, which is higher if compared to the national level (22.1%) and to other macro regions, as well (19.5% in the Centre of Italy, 16.2% in the North). Looking to the sector through the legal form of NPIs, although it reflects the composition at national level, the presence of social cooperatives is a bit higher in the Inner areas (4.3% compared to 4.1% at national level, 4.5% in peripheral municipalities). Moreover, NPIs with "other legal form" (which include ecclesiastical bodies, social enterprises, institutions providing education, health, or social assistance services) account in the Inner areas for 8.9%, compared to 8.1% at national level.

4.2 Nonprofit Institutions by SNAI areas and sector of activity

The nonprofit sector covers a huge quantity of activities, providing specific services able to face the local population's needs.

Figure 6 – *NPIs in Inner areas and Italy by sector of activity. Year 2020 (percentage values).*



Source: Our data processing from Istat – NPI Statistical Register.

NPIs in the Inner areas are mainly active in Culture, Sports and recreation activities (66.4% compared to 63% at national level). Within the main sector, NPIs active in Sport are prevalent by accounting for 34.1% (compared to 32.9% in Italy) followed by NPIs active in Other recreation and social clubs which account for 16.6% (14.3% in Italy). Moreover, in the Inner areas NPIs active in Religion show a higher quota (6.3%) if compared to the national level (4.7%) as well as NPIs active in Health (4.3% compared to 3.5%) (Figure 6).

Table 2 – *NPIs by sector of activity and Inner areas/Centres and macro regions. Year 2020 (percentage values).*

	South and Island		Centre		North	
	Total	Inner areas	Total	Inner areas	Total	Inner areas
Culture	14.2	14.7	16.8	16.7	16.3	16.3
Sports	36.0	37.4	33.6	36.1	30.8	29.1
Recreation	10.1	11.7	12.8	16.1	17.3	22.7
Health	3.5	4.4	3.5	5.2	3.4	3.7
Social services, emergency prevention	11.7	11.5	9.5	7.6	9.0	7.8
Environment	1.7	1.9	1.8	1.8	1.7	2.4
Religion	3.9	4.2	4.9	7.4	5.1	8.2
Other sectors	18.7	14.2	17.2	9.0	16.3	9.7
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Our data processing from Istat – NPI Statistical Register.

Other sectors include Education and research, Development and housing, Law, advocacy and politics, Philanthropic intermediaries and voluntarism promotion, International cooperation, Business and professional associations, unions, other sectors.

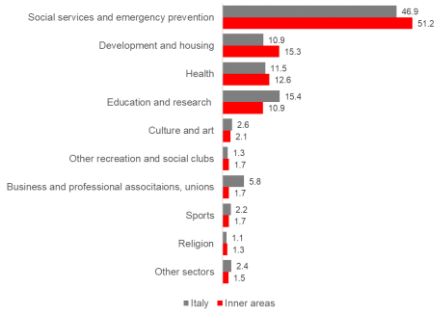
Looking at the macro regions, NPIs active in Sports are much more in the Inner areas of the Centre of Italy (36.1% compared to 33.6%) and in the South (37.4% compared to 36.0%). The nonprofit sector contributes to fil the gap of health services of the Inner areas by providing service of health assistance (NPIs account for 5.2% and 4.4%). In some contexts, according to data comparison at European level and among Italian regions as well, the development of the sector goes together with the public intervention growth (Memo 2023, 18). In other cases, NPIs represent a key resource within the welfare state services, by generating employment (including job placement of disadvantaged persons). Indeed, within their role of subsidiarity and integration, Nonprofit Institutions carry out activities that strongly affect the quality of life and the country's social cohabitation (Barbetta, 1996).

Beside the attention to the community wellness, in the Inner areas of North of Italy the nonprofit sector plays an important role in creating opportunities of socialization and participation to the recreation activity of social clubs (22.7%) (Table 2). Along with the fulfilment of expression needs, in the Inner areas of North NPIs take part in protecting the environment (2.4% compared to 1.7% of the North), according to the "reforming strength" which nonprofit organizations represent with its collective action to common goods protection (Cotturri, 2013).

4.3 Human resources of NPIs in Centres and Inner areas

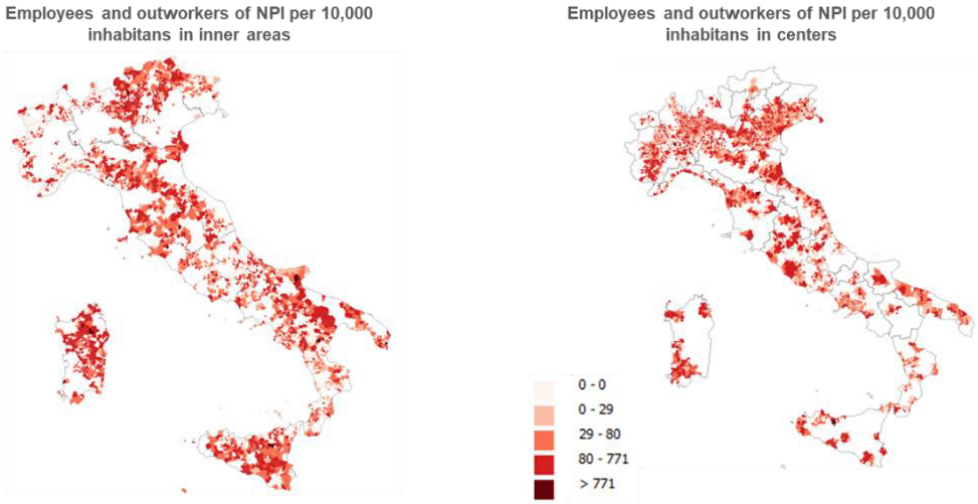
In order to qualify the impact of the nonprofit sector in the local employment by SNAI area, the distribution of paid Human Resources (including employees and outworkers) can be analysed (Figure 7).

Figure 7– *Employees and outworkers of NPIs by sector of activity. Year 2020 (percentage values).*



In the Inner areas compared to Italy, a concentration of paid human resources is observed in more structured sectors. The employees and outworkers in Social services and emergency prevention in the Inner areas represent more than 50% of the total of human resources in NPIs, showing a higher quota compared to the national one (51.2% and 46.9%). Moreover, the percentage of NPIs employees in the Inner areas present higher value in sectors such as Development and housing (where job placement in enterprise or social cooperative represents the most provided service) (15.3% compared to 10.9% at national level) and Health as well (12.6% compared to 11.5%).

Figure 8 – Employment in NPIs in Centres and Inner areas. Year 2020.



Source: Our data processing from Istat – NPI Statistical Register.

The number of paid human resources per inhabitants shows the different role of nonprofit at local level, by distinguishing between Inner areas and Centres (Figure 8). In the Inner areas higher values can be observed in Lombardia (with 150 paid human resources per 10 thousand inhabitants), in Sardegna (with 122 paid human resources per 10 thousand inhabitants) and in Trentino Alto-Adige (with 120 paid human resources per 10 thousand inhabitants). Lower values can be observed in the Southern Regions Inner areas such as Calabria (36 paid human resources per 10 thousand inhabitants) and Campania (51 paid human resources per 10 thousand inhabitants).

5. Final remarks

The relational capital, as result of the interaction between local socioeconomic actors, is a driving factor in local development processes when is closely related to the environmental, social and economic characteristics of the local context (Trigilia 2011; Camagni 2009, 118-132). According to the literature about the role of Inner areas in local development (Barca, 2015), these territories differ from the poles not only for the disadvantages but also for the opportunities to be carried out. Despite the character of peripherality of inland areas, which is not only geographical but also related to the socio-economic and political connections (Noguera and Copus, 2016) (Mantino eand Lucatelli, 2016), the presence of nonprofit sector is thus a positive factor for the quality of life of these places. The challenge to explore these contexts

through official statistical data on nonprofit sector represents an important step in the process of recognizing these places. The analysis of nonprofit sector within the Inner areas, along with the socioeconomic characteristics of local communities, allowed to better describe the role of the sector in the community economic development. The provision of social services by non-profit institutions, including cultural and environmental amenities, human welfare services, plays an important role in enhancing the quality of life for residents. Moreover, the contribution of nonprofit sector in local employment allowed to explore to what extend nonprofit sector's performance contribute to build a resilience process at local level. Nonprofit sector represents an important resource at local level, where is necessary to deal with socio-economic vulnerability, and can have a strategic role for the empowerment of local population and for the development of the territory, as well. From this point of view, Nonprofit Institutions are part of the "territorial capital" from which the National Strategy for Inner areas (SNAI 2020) intends to start from for the development of Inner areas. The paper represents the first step of a preliminary analysis to be study in-depth in order to explore the role of NPIs in association with the other socio-economic actors.

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OCCUPATIONAL CHARACTERISTICS AND TRAJECTORIES OF YOUNG IMMIGRANTS' DESCENDANTS IN ITALY[1]

Alessio Buonomo, Giuseppe Gabrielli, Rosa Gatti, Salvatore Strozza

Abstract. Immediate immigrants' descendants represent a significant part of the Italian population with a migratory background at a young age, and they are increasingly entering the Italian labour market for the first time. We aim to test the downward path that can be framed in terms of the segmented assimilation theory, investigating the descendants' access to employment and their working characteristics. This is a first attempt at analysing these under-researched issues due to the still young average age of immigrants' descendants. Paying attention to youths aged 18–29 years, we use information from the ad hoc ISTAT labour force survey module of 2021 on the integration of migrants and their descendants into the labour market and perform descriptive analyses on employment/unemployment status and occupational characteristics. To touch upon compositional effects, multivariate analyses will deepen the study of factors linked to over-education by using the two-step Heckman procedure. Second generation immigrants have the highest probability of employment exclusion. This is not the same for the other migratory generations, who seem to have a similar path to the Italians. Among workers, second generation immigrants have a highly skilled position and an educationally relevant job more frequently than the other groups.

1. Introduction

Over the past three decades, the number of first-generation foreigners residing in Italy has considerably increased. This is posing major challenges to their integration and social cohesion. However, their employment conditions are particularly unfavourable: they are often forced to accept any kind of job, even when it is well below their level of education (Reyneri and Fullin, 2011); they are penalised in terms of income and professionalism; they are unable to get out of those employment niches where they can find work because they are left vacant by Italians.

[1] This article is the result of a common reflection of the authors, whose names are placed in alphabetical order. Sections 1 and 2 are to be attributed to Rosa Gatti, section 3 to Salvatore Strozza, section 4 to Alessio Buonomo, and section 5 to Giuseppe Gabrielli.

In some ways, we are faced with what in other contexts has been called the ethnic penalty (Kalter and Kogan, 2006; Heath and Cheung, 2007).

In the last two decades, the immediate descendants of immigrants (henceforth DI) have become more and more numerous and are increasingly entering the Italian labour market for the first time. Most were born in Italy and have been socialised to the Italian language, culture, and society through school attendance. By investigating the DIs' access to employment and their working conditions, we aim to test the downward mobility tendency that can be framed in the terms of the segmented assimilation theory elaborated in the American context (Gordon, 1964; Portes and Zhou, 1993; Portes, 1995, 1996; Alba and Nee, 1997). To the best of our knowledge, the occupational characteristics and trajectories of DIs are under-researched in Italy due to their still young average age.

In this article, the following research questions are posed:

RQ1. What are the labour market outcomes for the DIs compared to their parents and their Italian counterparts?

RQ2. Can different kinds of career path be detected between the DI group and the other groups observed in the Italian context?

RQ3. Is it possible to identify whether some DIs constitute a group at risk of downward assimilation? Will the relative professional positions be reproduced across the generations?

To examine these questions, the strategy of this study is to use data from the ad hoc 'Labour force survey module of 2021 on the integration of migrants and their descendants into the labour market, which provides information on the employment status, job search, job type and characteristics, and attitudes towards the labour market of the young working-age population.

Since our main research interest is to investigate employment and occupational differences according to migratory generations, we pay particular attention to fractional generations that are close to Rumbaut's (2004) classification.[2]

2. Theoretical Background

The integration of immigrants and their descendants has been mainly studied in the United States through assimilation theories. According to classical assimilation theory (Alba and Nee, 2003), ethnic groups will progress towards assimilation following a single pattern, assuming that hostility towards immigrants tends to diminish gradually over time (with increasing residence time for the first generation

[2] The availability of information on the age at arrival for foreign-born people is useful to identify fractional generations of foreigners. This definition, however, only approximates Rumbaut's classification because it does not consider the parents' country of birth.

and the transition from the first to the second generation; for the latter, in fact, schooling is a powerful assimilation vector). Alongside the classical model of assimilation (Alba and Nee, 2003), studies developed since the 1960s have shown the presence of different modes of long-term incorporation for immigrants and their children. The distinction between the various forms of integration has revealed a persistent and differentiated ethnic segregation that penalises ethnic minorities, especially in the labour market. Referring to the black minority in the United States, Gordon (1964) identified several dimensions of integration, emphasising that cultural assimilation does not necessarily go hand in hand with greater socioeconomic success; nor does it imply a decrease in hostility towards a particular group. In some cases, socioeconomic success may coexist with a low level of cultural assimilation, whereas in an alternative model, lasting socioeconomic downgrading may go hand in hand with cultural assimilation. The latter model has been called downward or segmented assimilation (Portes and Zhou, 1993; Portes, 1995, 1996; Portes and Rumbaut, 2001). The term 'downward' or 'segmented' assimilation refers to a significant and persistent socioeconomic inferiorisation of certain groups, a situation that may be accompanied by strong linguistic and cultural assimilation. One of its main features is a lasting penalty in the labour market: second generations belonging to these groups seem to face more difficulties.

This suggests the existence of specific and enduring discrimination against immigrants and their immediate descendants (Silberman and Fournier 2008). Segmented assimilation (Portes and Zhou, 1993) challenges traditional assimilation theory by stating that "the process [of integration of newcomers] is neither simple nor inevitable" (Portes and Rumbaut, 2001, p. 45). According to the segmented assimilation theory, the majority of children of immigrants achieve either middle class or working-class status, but there are still others who are at risk of joining "those at the bottom of society, a new rainbow underclass" (Portes and Rumbaut, 2001, p. 45). Indicators of this path towards downward assimilation include early school dropout, long-term unemployment, poverty, crime, and incarceration, among others. Difficulties in finding a way to integrate push the children of immigrants towards the formation of an oppositional culture (Zhou, 1997).

With regard to labour market inclusion, a common explanation of the labour market outcomes of children of immigrants refers to the ethnic penalty theory (Kalter and Kogan, 2006; Heath and Cheung, 2007). According to this hypothesis, ethnic minorities perform poorly in the labour market due to their ethnic/racial characteristics that impose social barriers to their integration into the labour market.

The persistent disadvantages based on racial/ethnic discriminatory practices may challenge the so-called meritocratic society, hinder social mobility, and strengthen the social reproduction of existing inequality structures (Gracia et al.,

2016). According to this hypothesis, DIs would fail to overcome barriers to their social economic success under equal conditions.

Later studies have highlighted the complexity of the processes and factors to be considered in order to explain the different paths followed by various populations of immigrant origin. The segmented assimilation theory, developed mainly by American scholars, has also been used by some researchers to investigate the integration of children of immigrants in Western European countries (Silberman, Alba, and Fournier, 2007; Vermeulen, 2010). The main focus of these studies has been on "the theory's two alternative 'modes of incorporation': downward assimilation, and upward mobility" (Thomson and Crul, 2007, p. 1032).

More precisely, the main question in the European context has not been how some children of immigrants are assimilated into the underclasses, but whether or not the process happens at all (Vermeulen, 2010, p. 1218). In the French case, Silberman and Fournier (2008) show a downgrading of children of immigrants at least in the medium term, with specific differences among DI groups depending on parental origin. The ethnic penalty observed in recruitment is milder for Turks than for African groups linked by colonial relations with France. Similar results are observed by Meurs et al. (2006), who highlight a higher exposure to unemployment for the second generations than the first, with considerable heterogeneity between the different ethnic groups. In the Swedish case analysed by Behtoui (2013), with the same education, gender and age, children of immigrants are not able to obtain a position in the labour market to the same extent as children of natives. In fact, young people with an immigrant background run a higher risk of falling into the inactive and unemployed (job-seeking) groups and earning lower wages than those with a native background. Analyses conducted by Gracia et al. (2016) showed that second-generation Moroccans and Turks are systematically disadvantaged in the Dutch labour market compared to their native counterparts, albeit with differences between males and females. The labour market disadvantage of the second generation is not related to educational attainment and job skills. Furthermore, the findings suggest that the intersection of ethnic and socioeconomic factors is particularly powerful in explaining this disadvantage. Schnell and Fibbi (2015) also demonstrated that the socioeconomic status of parents is crucial in determining the path of (un)success in the transition from education to employment of Turkish and Balkan DIs in Switzerland. They are less likely to follow a path of upward social mobility due to unfavourable structural conditions (the socioeconomic status of their parents). In light of the research conducted in other European countries, in the next sections we will consider the Italian case and check whether the results are in line with those shown above.

3. Data and Methods

The source of the data is the Labour Force Survey, conducted in Italy by ISTAT. In particular, we used the 2021 ad hoc module on the Labour market situation of migrants and their immediate descendants. The sample is weighted in order to make it representative of the observed universe. The overall unweighted sample amounted to 127,097 individuals; we selected only the 12,686 individuals aged between 18 and 29 years old, distinguished on the basis of the migratory generation.

The 2021 ad hoc module allows us to have additional information relating to the migration history and other specific aspects of international migrants and to identify the children of immigrants by migratory generation. The survey only considers legally resident foreign citizens, excluding irregulars or those who have a residency permit but do not have legal residency. Despite the aforementioned limitations, the Labour Force Survey remains one of the most reliable sources of information for foreign labour forces.

To verify whether there are differences in the risk of over-education between natives, immigrants and descendants of immigrants aged between 18 and 29, we decided to use the two-step Heckman procedure. This fits a maximum-likelihood probit model with sample selection (Heckman, 1976; Winship and Mare, 1992).

$$y_j^{select} = \left(z_j\gamma + u_{2j} > 0\right);\ y_j^{probit} = (x_j\beta + u_{1j} > 0)$$

The procedure estimates a selection equation (which should contain at least one variable that is not in the outcome equation) to analyse whether the subsample of employed people is selected and, if so, to compute an additional covariate to correct for the existing distortion of this selection.

In particular, the selection equation has a dummy dependent variable that assumes a value of 1 in the case of employed respondents and 0 otherwise (unemployed and inactive people). According to International Labour Organization guidelines, employed people conducted at least one hour of paid work in the week of the interview or had a job or business from which they were temporarily absent.

The outcome equation has over-education as a dependent dummy variable (over-educated vs. not over-educated). To determine over-education, it is necessary to measure differences between the profession and the educational level of workers. To this end, information on individual professional levels according to the International Standard Classification of Occupations (ISCO-88) was compared to individual educational levels according to the International Standard Classification on Education (ISCED-97). The major groups 2 to 9 of the ISCO-88 classification are arranged with the ISCED-97 classifications. In particular, group 2 (intellectual, scientific and highly specialized professions) corresponds to a Bachelor's degree or

post-graduate education, while group 9 (unqualified occupations) corresponds to basic literacy (primary school). Ultimately, group 1 (legislators, executives, and entrepreneurs) and group 9 (military professions) are not associated with any level of education. For this reason, they are excluded from the analysis.

In both models, the main independent variable is the migratory generation. According to Rumbaut's (2004) classification, the following modalities have been defined: Italians (born in Italy with both parents born in the country, referent category); second generation (G2 = born in Italy with both parents born abroad); second mixed generation (G2mix = born in Italy with one parent born abroad); 1.75 generation (G1.75 = born abroad but arrived before the age of 6); 1.5 generation (G1.5 = born abroad but arrived between ages of 6 and 12); 1.25 generation (G1.25 = born abroad but arrived between ages of 13 and 17); and first generation (G1 = born abroad and arrived after age of 17).

Just two different predictors are included in the selection equation. First of all, educational level concerns three modalities—low (compulsory education or less), intermediate (high school degree), high (academic degree or higher educational level)—with the first as the referent category It has also been used to define the over-education of respondents, but there is no theoretical reason to include it in the outcome model. Secondly, marital status relates to three modalities—single, married, separated/divorced—with the first as the referent category. It acts above all on the decision/need to be employed, although the coefficients have also been verified that are not significant in the outcome model. Thus, the fundamental assumption of the Heckman procedure (having at least one variable in the selection model only) has been respected. The other independent variables considered in the selection equation are gender (woman vs. man as the referent category), age (discrete variable) and age squared, and Italian geographical area of residence (three modalities—North, Centre, South—with the first as the referent category). These last covariates are considered as independent variables in the outcome model, together with the distinction between full-time (referent category) and part-time work and between employed (referent category) and self-employed.

4. Results

Despite being an increasingly consolidated presence in Italy, the G2 still represent a very young component of the Italian population (Table 1). Their average age (21 years old) among youths (18–29 years) is clearly the youngest among the migratory generations considered. This information invites us to interpret the results of this group with caution, since many of them constitute an inactive population as, more frequently than the others, they have not yet finished their studies compared to other migratory generations. Specifically, Table 1 summarises the employment (and

unemployment) status of our sample. As traditionally observed in Italy, the highest employment rates are recorded among who were older upon arrival (G1.5, G1.25 and G1). Furthermore, these migratory generations are distinguished by the lowest unemployment rates. Considering professional skills and age upon arrival in Italy, the older the immigrant upon arrival, the lower the percentage of high-skilled jobs. Conversely, Italian-born DIs (both G2 and G2mix) have the highest percentages of people employed in highly skilled jobs compared to foreign-born respondents. However, as expected, Italians form the highest percentage of the whole sample (11%). A final characteristic considered in Table 1 is over-education. The lowest percentages of over-educated are recorded among DIs born in Italy (G2 and G2mix).[3] This interesting result prompted us to examine over-education more deeply and to consider it as a dependent variable in our analyses.

Table 1 – Employment/unemployment status, professional skills, and overeducated job of foreign population by migratory generation and Italian population aged 18-29 years. Italy, 2021, weighted data (percentages, absolute values, and median ages)

Indicators	G2	G2mix	G1.75	G1.50	G1.25	G1	Italian
			Employment and unemployment indicators				
Unemployment rate	38.9	26.3	29.8	19.7	25.3	18.1	21.7
Employment rate	22.2	32.8	34.9	51.3	43.3	48.7	38.2
			Professional skill				
Low-skilled job	21.0	19.0	44.9	40.5	29.5	32.0	15.8
Middle-skilled-job	72.2	74.5	50.3	54.9	66.8	66.2	73.3
High-skilled-job	6.9	6.4	4.8	4.6	3.7	1.8	10.9
Total	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*
			Overeducation				
% of overeducated job	16.6	15.7	37.2	26.1	20.5	26.7	13.6
			Absolute values, and median ages				
Unweighted total count	344	731	331	526	395	335	10,024
Median age at interview	21	23	25	25	24	25	23

Source: our elaborations on LFS data, ad hoc module 2021.

The Heckman procedure shows that the specification Wald test results, at the bottom of Table 2,[4] indicate a good model fit, whereas the selection equation is

[3] Interestingly, the differences by migratory generation are reduced when perceived over-education is considered (this information is available in Labour Force Survey data, but not shown here for reasons of space). The mismatch between the perceived and actual situation should be further investigated in future analyses.

[4] For the robustness check, we also considered a Heckman model applied with weighted data. However, the results of the analyses (not included here but available on request) do not show relevant differences compared to the analysis with unweighted data.

(weakly) significant ($p<0.01$ both for ρ and for the LR test). In addition, ρ is negative, so the coefficients would be underestimated without the correction.

The multivariate results summarised in Table 2 partially confirm the descriptive analyses presented in Table 1. The differences between the two analyses can be explained by the association between the migratory generation variable and the socio-demographic and occupational characteristics of the sample. In other words, the effect of migratory generation is related to the other control variables included in the model.

Before considering the differences by migratory generation, let us examine the other control variables included in the Heckman model. In general, they are in line with the expected findings. However, it should be noted that the results in this case refer to the entire sample considered—i.e., both the migratory generations and the Italian population (as summarized in Table 1, Italians are clearly prevalent in our sample, accounting for around 80 per cent of the respondents). In the selection model, women have a lower propensity to be employed than men. The age at interview shows a bell shape in the propensity to be employed (age has a positive and age squared a negative significant coefficient). Respondents residing in Central and Southern Italian regions are less likely to be employed than those residing in Northern regions. As the level of education increases, the coefficients increase significantly, while being married, compared to being single, decreases the propensity to be employed.

The coefficients of the control variables in the model outcomes (over-educated occupational position) are less significant. In this case, the variables relating to sex and age at the interview are not statistically significant. The coefficients for the area of residence are opposite to the selection model just described, although they are significant. Therefore, as expected, the probability of being over-educated is higher for residents in Central and Southern Italy than their Northern counterpart. Finally, being employed with a full-time contract and being self-employed decrease the probability of being over-educated.

Moving on to our key variable (migratory generation), in the selection model relating to employment status compared to Italians only two of the migratory generations considered have significant coefficients. Firstly, G2 takes on a (strongly) significant negative coefficient—in other words, this cohort has the lowest probability of being employed in the sample. Secondly, G1.5 has a higher (weakly) significant probability of being employed compared to Italians. In the outcome model relating to the over-educated occupational position, all migratory generations have positive coefficients. In other words, the Heckman's model confirms what has already been observed in Table 1: the Italians have the lowest probability of being over-educated. However, multidimensional analysis indicates that the result is not statistically significant for G2 and G1.25.

Table 2 - Heckman procedure: probability of being employed (selection equation) and probability of having an overeducated job (outcome equation). Italy, 2021 (coefficients, standard errors, and p-values)

Variables	Selection model (employment)			Outcome model (overeducation)		
	Coef.	Std. Err.	p-val	Coef.	Std. Err.	p-val
Migratory generation (Ref. Italians)						
G2mix	-0.090	0.055		0.219	0.093	**
G2	-0.251	0.085	***	0.103	0.186	
G1.75	-0.081	0.080		0.659	0.120	***
G1.5	0.123	0.063	*	0.399	0.101	***
G1.25	0.083	0.071		0.141	0.110	
G1	-0.019	0.074		0.333	0.111	***
Sex (Ref. Man)						
Woman	-0.361	0.025	***	0.001	0.096	
Age at interview	0.713	0.062	***	-0.162	0.235	
Age squared	-0.011	0.001	***	0.002	0.004	
Area of residence (Ref. North)						
Centre	-0.221	0.034	***	0.180	0.063	***
South	-0.630	0.028	***	0.372	0.120	***
Educational level (Ref. Low)						
Intermediate	0.098	0.036	***			
High	0.225	0.054	***			
Marital status (Ref. Single)						
Married	-0.233	0.055	***			
Separated/ Divorced	0.125	0.263				
Employment type (Ref. Full-time)						
Part-time				0.350	0.066	***
Employment status (Ref. Employee)						
Self-employed				-0.212	0.072	***
Constant	-10.299	0.726	***	1.804	3.444	
Athrho				-0.618	0.364	*
Rho				-0.550	0.254	***
N	12,686			4,567		

LR test of independent equations. (rho = 0): chi2(1) = 2.87 Prob > chi2 = 0.0900. Wald chi2(13) = 205.6 pval = 0.0000.

Note: Statistical significance of the relationship is marked by * if p<0.1, ** if p<0.05, *** if p<0.01.
Source: our elaborations on LFS data, ad hoc module 2021.

5. Discussion and Conclusion

This is one of the first attempts to investigate the employment status and occupational characteristics of DIs in Italy by using recently released data. The analyses compare native-born adults with a migratory background (second generation), adults

born abroad arriving at different young ages (middle generations: 1.25, 1.5, and 1.75), adults born abroad who arrived at adult ages (the first generation), and Italians (born in Italy with both parents born in the country).

This distinction allowed us to have a comparative approach among groups and to verify whether disadvantages across generations persist, hindering social mobility and supporting a downward assimilation process in the labour market. However, due to the still young ages of DIs, our analyses are confined to young adults where we observe a cross-cutting picture that might change in the future. Moreover, different results may emerge when considering other occupational characteristics and distinguishing by country of origin. Considering employment status (RQ1), the second generation has the highest probability of employment exclusion (Meurs et al., 2006). However, while in the international literature foreign-born and young immigrants (the middle or 1.5 generation) tend to be more at risk of economic exclusion than the second generation (Thomson and Crul, 2007), this is not observed in our analyses, where fractional generations seem to have a similar path to the Italians. This is likely due to the young age observed and will need to be investigated further in the future. As far as career paths are concerned (RQ2), G2 and G2mix in Italy, at least at a young age, show highly skilled positions and an educationally relevant job position more frequently than the other DIs. It is therefore observed that the ethnic penalty among employed young adults (Heath and Cheung, 2007) diminishes across migratory generations, moving from G1.25 to G2 (RQ3). According to other results (Behtoui, 2013), young people who arrived at an older age (G1.5 and G1.25) suffer more than other groups from unfavourable ethnic characteristics which limit the possibility of enhancing their professional skills.

Two main concluding remarks seem to emerge from our analyses. Firstly, the second generation runs a higher risk of falling into the category of inactive and unemployed people (Behtoui, 2013). Future analyses will determine whether they are able to reduce this gap when older. Secondly, the outcomes of middle generations seem to reinforce the social reproduction of the existing inequality structures of the first generation (Gracia et al., 2016). Our findings stimulate policy recommendations to counteract and prevent racial-ethnic discriminatory practices, to remove social barriers to labour market inclusion and social mobility of immigrant descendants, and to promote equal opportunities for them in accessing the labour market. These recommendations go in the direction of creating a more equitable society.

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INSIGHTS INTO ALCOHOL CONSUMPTION: DOES EDUCATIONAL MISMATCH AFFECT DRINKING BEHAVIORS IN RUSSIA?

Silvana Robone

Abstract. Our study innovates over the previous literature on socioeconomic determinants of drinking behaviours by investigating the impact of horizontal educational mismatch (field of schooling not matching with the job) on alcohol consumption. We conduct a longitudinal gender-specific analysis on individual data from the Russia Longitudinal Monitoring Survey (RLMS-HSE) (2011-2014) and estimate correlated random effects probit for alcohol use controlling for state dependence. Our results indicate that educational mismatch is related to drinking behaviors in Russia; in particular, horizontal mismatch tends to trigger alcohol consumption in women, while it increases the probability of becoming a heavy drinker for men.

1. Introduction

Excessive alcohol consumption is an issue of global importance, contributing to the main risk factors for population health. This results in a pronounced increase in alcohol-related deaths, infectious and non-communicable diseases, mental disorders, injuries and significant deterioration of maternal and child health. For instance, Europe is known as the heaviest drinking region in the world, with 10.9 litres of pure alcohol per person. This amount is twice as much as the world's average (European Alcohol Policy Alliance, 2016).

Although the EU countries have shown a persistent decline in the overall per capita alcohol consumption over the past decades (WHO, 2018), this was mainly determined by the trends related to the Southern European countries (e.g. decline in France from 23.95 to 11.50 and in Italy from 17.75 to 7.56 litres of pure alcohol per capita from 1964 to 2014). Meanwhile, Central-Eastern and Eastern Europe remain consistent in consuming the highest levels of alcohol in comparison with the rest of the EU (WHO, 2012; Malisauskaite and Klein, 2018).

Epidemiological research on drinking behaviours has been well-developed, providing evidence that age, gender, educational level, income, ethnicity and other

sociodemographic characteristics significantly affect alcohol consumption (Slade *et al*., 2016). In addition, employment status and occupational characteristics have also been found to determine people's drinking habits (Popovici and French, 2013; Hasegawa *et al*., 2013; Hong *et al*., 2017). However, the possible influence of educational mismatch on drinking habits has never been considered before. Educational mismatch has been observed in both developed and developing countries (Davia *et al*., 2017); for instance, it has been reported that about 30 % of EU adults experience various forms of educational mismatch in the labour market (Morgando et al., 2026). The educational mismatch is likely to occur due to labour market imbalances (e.g. excess labour demand, risk and uncertainty etc.) and/or institutional factors (e.g. technological change, short-term recessions etc.). It is expected to increase in the EU due to a slowdown in job growth, a high unemployment rate and an expansion of low-quality jobs accompanied by tertiary education's prevalence. Our study aims at bridging this gap in the literature by assessing the influence of educational mismatch on alcohol consumption. In particular, we focus on *horizontal* mismatch, which occurs when the field of study of completed education and the actual occupation of an individual do not match.

Previous literature has linked different types of educational mismatch with negative labour market and health-related outcomes, e.g. diminishing returns to education and traps to career progression, deterioration of job satisfaction and mental health (Montt, 2017; Meroni and Vera-Toscano, 2017; Bracke et al., 2014). However, to the best of our knowledge, horizontal mismatch has never been investigated in the context of research on drinking habits. We assume that horizontally mismatched categories of employees may perceive higher levels of stress due to a lack of knowledge and skills (i.e. human capital) required to deal with challenging job requirements, and previous studies indicate that stress and social anxiety are positively related, as an example, to heavy drinking (Rutledge and Sher, 2001; Siegrist and Rodel, 2006).

To fill the existing gap in the literature, we conduct a longitudinal gender-specific analysis of the data from the Russia Longitudinal Monitoring Survey (2011-2014) and estimate a dynamic probit model for alcohol use, controlling for unobserved heterogeneity and state dependence. It is worth mentioning that most of the recent studies on sociodemographic and work-related determinants of drinking behaviours have been applied to the context of developed economies (Allen *et al*., 2017), ignoring low- and middle-income countries (LMICs). Our study aims at filling this gap by focusing the analysis on the Russian Federation. The choice of Russia as a "testing ground" for our analysis seems quite reasonable since the Russian population is characterized by a relatively high level of alcohol use/consumption (e.g. alcohol per capita (15+) consumption of 11.7 litres of pure alcohol in Russia vs 9.8 liters for the WHO European Region in 2016) (WHO, 2018). Moreover, Russia

also revealed the highest alcohol-attributable years of life lost score (YLL) in 2016 (WHO, 2018).

Our results indicate that educational mismatch is related to drinking behaviours in Russia; in particular, horizontal mismatch tends to trigger alcohol consumption in women, while for men, it increases the probability of becoming a heavy drinker.

2. Data

We analyse individual data from the Russia Longitudinal Monitoring Survey (RLMS-HSE) (2011-2014)[1]. Our unbalanced sample of the economically active Russian population consists of respondents aged 19-54.[2] Our final sample includes 14,002 observations (i.e. 7,674 and 6,328 observations for women and men, respectively) spread over 4 years.

We consider two dependent variables. The first one is *alcohol use*, a dummy variable based on question "Do you consume alcoholic beverages in general?", and which is equal to one in the case of a respondent giving a positive response, zero otherwise. The second one is *heavy drinking*, a dummy variable which combines data on the quantity consumed (for four types of beverages - beer, dry wine, fortified wine and vodka - mapped into pure alcohol in grams) and the frequency of consumption (how many times per month the respondent consumes the alcoholic beverages). We create gender-specific distributions of alcohol consumption and identify those respondents who exceed the 80th percentile as heavy drinkers (as in Arabadzhyan, 2019). Our dummy variable takes the value of one if the respondent is classified as a heavy drinker, zero otherwise.

Our main explanatory variable, *horizontal mismatch*, is a dummy variable constructed by mapping the International Standard Classification of Occupations (ISCO) code of the respondent's profession with the ISCO code of the qualification

[1] The RLMS-HSE consists of a series of nationally representative annual surveys which contain a wide range of data on health, education, work and welfare related topics collected at both individual and household levels. Although the RLMS-HSE covers the time span of 1994-2022, we are restricted to use the 21st-24th waves since the variables required for construction of the horizontal mismatch dummy are present only in these waves.

[2] Alcohol consumption is strictly prohibited in Russia for those who are younger than 18 years old. Since retired respondents are not the target group of our analysis, we exclude them by cutting the sample at the age of 54 in order to adjust for the differences in retirement age for women and men in Russia in 2010-2014 (i.e. 55 vs 60 years, respectively).

(major) obtained during his/her studies at a two-digit level.[3] If these two codes differ, the respondent is classified as horizontally mismatched (Sellami *et al*., 2018).

Since we assume that the manifestation of the effect of educational mismatch on alcohol use cannot be immediate, we use a one-year lag of horizontal mismatch in our analysis; this also allows us to address possible issues of endogeneity. Indeed, the estimation of the effects of educational mismatch on alcohol use and heavy drinking may raise concerns about the presence of endogeneity bias, unless one can establish that the relationship is unidirectional (Robone et al., 2011).

Table 1 – *Description of variables used as controls*

Variable name	Description
Born in 1960s	This is a set of dummy variables for birth cohorts (being born in the 1950s is used as a reference category)
Born in 1970s	
Born in 1980s	
Born in 1990s	
Gender	Dummy variable for gender (Female=0, Male=1)
Single	Dummy variable for marital status (Never married, divorced/separated, widowood=1, Otherwise=0)
Young children	Dummy variable for presence of children yourger than 18 years old (Yes=1, Otherwise=0)
Years of education	Total number of years of completed education
Middle income group	Dummy variable for self-reported income group (Medium=1, Otherwise=0)
High income group	Dummy variable for self-reported income group (High=1, Otherwise=0)
Rural area	Dummy variable for type of settlement (Urban=0, Rural=1)
Non-Russian	Dummy variable for ethnicity (Russian=0, Otherwise=1)
Smoker	Dummy variable for smoking (Non smoking=0, smoking=1)
Not working (t-1)	Dummy variable for the status of being out of the labour market (one-year lagged) (Not working=1. Otherwise=0)
Non-tertiary sector (t-1)	Dummy variable for non-tertiary sector of employement (one year lagged) (Non-tertiary sector=1, Otherwise=0)
Unofficial job (t-1)	dummy variable for unofficial employement (one-year lagged) (Officially employed=0, Otherwise=1)
Year dummies	A set of year dummies (2011, 2012, 2013, 2014) where a year of 2011 is taken as the reference category
Regional dummies	A set of regional dummies (Centre, North-West, South, North Caucasus, Volga, Ural, Siberia, Far East) where Centre is taken as the reference category

[3] The International Standard Classification of Occupations (ISCO-88) defines occupational categories as follows: 1-Managers, 2-Professionals, 3-Technicians and Associate Professionals, 4-Clerical Support Workers, 5-Services and Sales Workers, 6-Skilled Agricultural, Forestry and Fishery Workers, 7-Craft and Related Trades Workers, 8-Plant and Machine Operators and Assemblers, 9-Elementary Occupations.

Similarly to previous literature, we include a set of sociodemographic covariates in our econometric specification, such as age, marital status, presence of children, education, income, ethnicity, and type of settlement, along with year and regional dummies (Slade *et al*., 2016). In addition, we include work-related controls, such as working in the informal sector or not working in the tertiary sector. Moreover, since our sample is characterized by a considerable number of respondents who report a "not working" status, we construct the corresponding control variable - which equals one if the respondent does not work at the moment of the survey and zero otherwise - and introduce it in our models.[4] Table 1 describes the variables used as controls in our regression model.

Table 2 - *Descriptive statistics stratified by gender*

	Women (n=8,555)				**Men (n=5,524)**			
Variable name	Mean	SD	min	max	Mean	SD	min	max
Born in 1960s	0.264	0.441	0	1	0.244	0.429	0	1
Born in 1970s	0.284	0.451	0	1	0.271	0.444	0	1
Born in 1980s	0.27	0.444	0	1	0.296	0.456	0	1
Born in 1990s	0.117	0.322	0	1	0.135	0.341	0	1
Single	0.320	0.466	0	1	0.290	0.454	0	1
Young children	0.506	0.500	0	1	0.453	0.498	0	1
Years of education	13.087	2.759	8	21	12.359	2.597	8	21
Middle income group	0.616	0.486	0	1	0.622	0.485	0	1
High income group	0.041	0.198	0	1	0.051	0.22	0	1
Rural area	0.295	0.456	0	1	0.296	0.457	0	1
Non-Russian	0.135	0.342	0	1	0.141	0.348	0	1
Smoker	0.168	0.374	0	1	0.560	0.496	0	1
Not working (t-1)	0.299	0.458	0	1	0.286	0.452	0	1
Non-tertiary sector (t-1)	0.138	0.345	0	1	0.260	0.439	0	1
Unofficial job (t-1)	0.028	0.165	0	1	0.048	0.214	0	1
Horizontal mismatch (t-1)	0.444	0.497	0	1	0.494	0.500	0	1
Alcohol use	0.708	0.455	0	1	0.769	0.422	0	1
Heavy drinking	0.021	0.144	0	1	0.085	0.278	0	1

Table 2 displays descriptive statistics stratified by gender since the previous studies have provided evidence in favour of substantial disparities in alcohol

[4] The not working respondents include the unemployed, the students and those who are not disabled, not on a maternity leave and other type of leave.

consumption with respect to gender (Erol and Karpyak, 2015; Slade *et al*., 2016). Around 44% of female and 50 % of male respondents are mismatched by field of study. The shares of alcohol users among women and men equal 71% and 77 %, respectively, while it goes down to 2% and 9% when we consider heavy drinkers.

3. Estimation Strategy

We estimate panel data probit for alcohol use, stratifying the analysis by gender. To purge the data from unobserved heterogeneity, we apply the Mundlak (1978) correction - which accounts for correlated individual effects - by including the function of within-individual means of time-varying regressors in our model. In addition, since a substantial share of variability in drinking behaviours seems to be determined by state dependence/addiction (Knight *et al*., 2002), we control for state dependence and address the issue of the initial condition by including both the one-year lag and the initial value of our dependent variables in the model, following the procedure proposed by Wooldridge (2005). The general specification of our models can be expressed as follows:

$$y_{it} = \beta mm_{it-1} + \gamma sec_{it} + \lambda work_{it-1} + \delta y_{it-1} + \eta y_{it=0} + \theta_i + \theta_t + \alpha_i + \varepsilon_{it} \quad (1)$$

$i = 1, \ldots, N$ (number of individuals in the sample)
$t = 2, \ldots, T$ (number of waves of the survey)

where: y_{it} is the outcome of interest (alcohol use, heavy drinking); mm_{it-1} is the explanatory variable (horizontal mismatch observed in the previous period); sec_{it} is the set of socioeconomic controls; $work_{it-1}$ is the set of work-related covariates observed in the previous period; y_{it-1} is the respondent's drinking behavior observed in the previous period; $y_{it=0}$ is the initial value of the respondent's drinking behavior; θ_i and θ_t are regional and year dummies, respectively; α_i is an individual-specific and time-invariant random component; ε_{it} is a time and individual-specific error term which is assumed to be normally distributed, uncorrelated with α_i and uncorrelated across individuals and waves.

4. Results

Table 3 reports the results obtained from the panel probit model described in Section 3, considering as dependent variables alcohol consumption and heavy drinking behaviours. Our results indicate that birth cohorts do not differ in terms of

alcohol use in the female sub-sample, while in the male sub-sample, the youngest cohort (born in the 1990s) tends to be the most prone to alcohol use and the least prone to heavy drinking. Moreover, age does not appear to affect significantly the heavy drinking behaviours. Respondents of both gender groups are less likely to consume alcohol if they are single, perhaps, due to being at lower risk of adopting positive attitudes towards alcohol from their partners. While female respondents with young children are more prone to alcohol use, no effect is observed for the same variable in the male sub-sample. Both gender groups reveal a positive and statistically significant relationship between years of education and alcohol use, but a negative (although not statistically significant) relationship with regard to heavy drinking.[5] Women who are settled in rural areas are less likely to be involved in drinking when considering both alcohol consumption and heavy drinking. In addition, the protective effect of migrant status against alcohol use can be observed in both gender groups, indicating that foreign respondents are less prone to consume alcohol than the natives. Finally, the positive and statistically significant effect of smoking on alcohol use and heavy drinking is found for both women and men. While work-related variables do not seem to contribute to female alcohol use in Russia, men employed in the non-tertiary sector tend to be more likely to consume alcohol.

As far as the educational mismatch is concerned, the positive and statistically significant coefficient for horizontal mismatch for women indicates that those who were horizontally mismatched in the previous period are more at risk of consuming alcohol in the current period than their matched counterparts; however, no statistically significant effect is reported for men for this variable. On the contrary, being horizontally mismatched increases the chance of heavy drinking for men, while it has no statistically significant effect for women.

To provide some information about the magnitude of the impact of horizontal mismatch on the drinking behaviours of the respondents, we have computed average partial effects for the model described in Section 3. The effects are computed for an individual with average characteristics and are stratified by gender. Women who were horizontally mismatched in the previous period were about 2% points more likely to consume alcohol, while men were about 2% points more likely to become heavy drinkers. The magnitude of these results is small but not negligible. The full set of results on average partial effects is available upon request.

[5] Our result is in line with previous literature showing that higher education (such as having a university degree) is positively associated with drinking more frequently or increasing the quantity of alcohol used (Bingham et al., 2005; Casswell et al., 2003; Jacobsen, 1989), but negatively associated with the likelihood of developing an alcohol use disorder (Sher and Gotham, 1999). White et al. (2006) noted that college attendees who remain in their parents' home experienced notably lower alcohol use frequencies than their counterparts living off campus. Therefore, it is possible that individuals attending college/university get involved in social drinking and they keep this habit even later on in their life.

Table 3 – *Probit model, estimated coefficients and standard errors for alcohol consumption and heavy drinking*

	Alcohol use		Heavy drinking	
	Women (n=8,555)	Men (n=5,524)	Women (n=8,555)	Men (n=5,524)
	coef/se	coef/se	coef/se	coef/se
Horizontal mismatch (t-1)	0.111*	0.006	-0.183	0.256**
	-0.064	-0.097	-0.158	-0.107
Born in 1960s	0.022	0.354**	0.295	0.106
	0.104	0.156	0.247	0.185
Born in 1970s	-0.037	0.442**	-0.009	0.129
	0.112	0.172	0.262	0.195
Born in 1980s	-0.145	0.272*	0.129	-0.059
	0.111	0.161	0.255	0.194
Born in 1990s	-0.050	0.546***	-0.102	-0.691***
	0.123	0.188	0.287	0.267
Single	-0.096*	-0.236**	-0.443	0.026
	0.058	0.107	0.289	0.120
Young children	0.152**	0.322	0.033	-0.063
	0.062	0.202	0.128	0.098
Years of education	0.019*	0.042**	-0.031	-0.009
	0.011	0.016	0.023	0.018
Middle income group	-0.032	0.016	0.144	-0.084
	0.070	0.071	0.104	0.080
High income group	-0.123	0.016	0.212	-0.169
	0.109	0.149	0.230	0.181
Rural area	-0.133**	-0.134	-0.388***	-0.163
	0.063	0.088	0.144	0.103
Non-Russian	-0.295***	-0.300***	-0.089	0.163
	-0.079	-0.113	-0.173	-0.115
Smoker	0.588***	0.937***	0.947***	0.503***
	-0.080	-0.191	-0.142	-0.094
Unofficial job (t-1)	-0.186	0.2	0.553***	-0.248
	-0.140	-0.174	-0.213	-0.227
Non-tertiary sector (t-1)	0.016	0.359**	-0.251	-0.022
	-0.076	-0.162	-0.187	-0.094
Not working (t-1)	0.121	0.194	0.325*	0.297**
	-0.128	-0.178	-0.174	-0.13
Outcome (t-1)	0.409***	0.661***	0.145	0.522***
	-0.076	-0.119	-0.215	-0.148
Outcome (t=0)	1.429***	1.751***	1.638***	1.338***
	-0.111	-0.207	-0.275	-0.206
Constant	-0.682***	-1.306***	-3.133***	-2.298***
	-0.229	-0.312	-0.526	-0.36
Log-pseudolikelihood	-3690.072	-1867.988	-657.66	-1207.101

Note: Coefficients were also estimated for regional and year dummies, and within-individual means of time-varying regressors (available on requests). Robust standard errors are clustered at an individual level. *p<0.10, **p<0.05, ***p<0.01

5. Discussion

Our paper contributes to previous literature by estimating the impact of horizontal educational mismatch on alcohol consumption and heavy drinking. Our findings provide evidence that horizontal mismatch tends to trigger alcohol use in women, while for men, it increases the probability of becoming a heavy drinker. Overall, our results suggest substantial gender differences related to the quantity and frequency of alcohol consumption in Russia.

Our study has some limitations. Firstly, we cannot control for neighbourhood effects (e.g. access to alcohol in the respondent's settlement area, drinking habits of the respondent's personal and professional network) due to the lack of data. These effects have been shown to be important determinants of drinking behaviors (Tucker et al., 2013). Secondly, our heavy drinking variable is constructed based on respondents' self-reported data on alcohol consumption, and this may cause measurement error and downward bias in our estimates (Livingston and Callinan, 2015). Moreover, we are not able to control for a specific company's characteristics (due to the data limitations), which may be related to the potential employment of mismatched employees and alcohol consumption. Finally, in our study we do not provide a theoretical or sociological explanation for the empirical relationship we find between horizontal mismatch and alcohol use and heavy drinking. The investigation of the factors which might mediate this relationship is left for future research.

We assume that our results can be generalized to the countries of Eastern Europe which experienced the Soviet regime in the past since their populations tend to reveal similarities in drinking habits (Malisauskaite and Klein, 2018) and labor force characteristics concerning educational level (Morgado et al., 2016). Furthermore, this study can be extended to a comparative analysis between the Eastern European countries and the Western developed economies. Moreover, it would also be important to understand the exact transmission mechanisms between educational mismatch and drinking behaviours. In the future, we plan to perform some mediator analysis to investigate the possible role of variables such as mental health and job satisfaction as a transmission mechanism between educational mismatch and drinking behaviours.

Our study provides some guidelines for policymakers. We believe that the Russian system of higher professional education requires reforms to remove the low-quality educational institutions from the market of educational services and revise entry requirements to the educational institutions. In addition, the outcomes of the Russian post-secondary and higher professional education system should align with the requirements of the Russian labor market. This may help avoid the expansion of horizontally mismatched employment in the labour market. Finally, human

resources managers in the companies are suggested to make more considered decisions while recruiting and appointing personnel.

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LABOUR COSTS AND THEIR COMPONENTS IN 2020: CHARACTERISTICS AND DYNAMICS IN ITALY AND IN EURO AREA COUNTRIES[1]

Francesca Ceccato, Marilena Angela Ciarallo, Paola Conigliaro

Abstract. This article presents information on the structure of labour costs in the Euro area, focusing in particular on the situation in Italy. The analysis is based on data from the four-yearly Labour Cost Survey (LCS) with reference to the year 2020 considering both the level of the costs and their structure per unit of labour input (employees and hours worked). Labour costs indicators support governments and social partners in defining social policies and in promoting the competitiveness of enterprises. These indicators must enable comparisons across countries.

1. Overview

Labour costs are a crucial factor in every country, for defining social and fiscal policies, for fixing social security contributions and benefits and for the abilities of enterprises to compete. For this reason, the interest in labour costs data and indicators comparable across countries and over time, is growing among governments, social partners, national and international institutions.

The term labour costs covers a wide range of meanings and uses, depending on whether the perspective is that of enterprises, households, governments or social partners. Setting standards for labour statistics involves most international organisations.

The ILO Bureau of Statistics, for instance, began collecting labour statistics in the early 1920s, and published the main results in the International Labour Review from its first issue in 1921. The 100 year-old International Conference of Labour Statisticians (ICLS) makes recommendations on selected topics in the field of labour statistics in the form of resolutions and guidelines, which, once approved by the ILO, become part of the set of international standards on labour statistics. One of the first relevant guidelines are contained in the resolutions concerning statistics on labour costs (ILO, 1966) that includes the International Standard Classification of Labour

[1] The article is the result of the joint work of the authors. §1, 3 are attributed to Marilena Ciarallo, §2.1, 2.2 is attributed to Paola Conigliaro and § 2.3 to Francesca Ceccato.

Cost comprising 10 major costs groups (among which direct wages and salaries, remuneration for time not worked, employers' social security expenditure, cost of vocational training, taxes as regarded as labour cost, etc.). The Eurostat classification also breaks down wages and salaries and employers' social security contribution into a number of detailed sub-items. There is also specific mention of wages and salaries in a number of other United Nations guidelines (1983, 1997) while the Canberra Group (2001) provides a list of components of labour costs from the perspective of the household income.

In the Labour Market Domain, Eurostat has been working over the years to develop standards for the European Union to produce statistics on wages, earnings, labour costs, in particular in relation to businesses.

They constitute a hierarchical system of multi-annual, yearly and quarterly statistics, designed to provide a comprehensive and detailed picture of the level, structure and short-term development of labour costs in the different sectors of activity in the European Union and some other countries.[2] The main statistics produced in this context are the Labour Cost Survey (LCS), the Labour Cost Index (LCI) and the Labour Cost Levels (LCL). These last one provides annual updates on average hourly costs (total costs and main components), obtained by applying the quarterly indicator to the LCS data of the latest available year.

In the next paragraphs, we are going to focus on the Labour Cost Survey (LCS) results for the year 2020 in order also to capture the possible impact of the pandemic crisis on the main variables collected. In fact, most EU government have introduced new schemes in the working arrangements between employers and employees in order to mitigate the economic impacts of the pandemic.

1.1. Labour Cost Survey

The Labour Cost Survey (LCS) is a 4-yearly survey (since 1996) providing detailed data on the structure (composition) and level of labour costs, number of employees, hours worked and hours paid (Eurostat, 2023(a)). The data are broken down by economic activity and enterprise size and refer to business units with 10 and more employees and all economic activities, except agriculture, fishing, public administration, private households, extra-territorial organizations (NACE rev.2

[2] All statistics are based on harmonised definitions of labour costs which are specified in Regulations (EC) 530/1999 (EC, 1999) and 1737/2005 (EC, 2005). European Union Regulation 450/2003 (EC, 2003) concerning the quarterly labour cost index established the base for EU member states to provide LCI data.

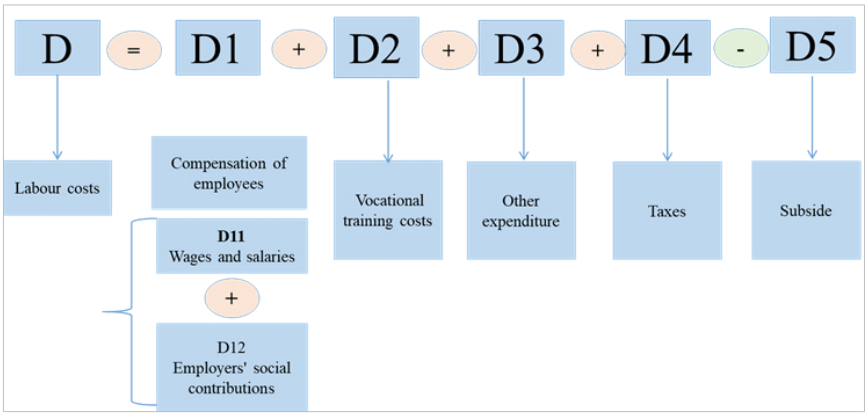
sections B to S[3]). Section O (Public administration and defence; compulsory social security) is considered optional in Regulations, then the figures reported in international comparisons do not take Section O into account.

In addition, the survey supply very detailed information on components making up Wages and salaries and Employers' social contributions (Figure 1).

In particular Labour costs include: compensation of employees (D1) with wages and salaries (D11) in cash (split in direct remuneration, bonuses and allowances paid in each pay period; payments to employees' savings schemes, payments for days not worked) or in kind; employers' social contributions (D12); vocational-training costs (D2); other expenditures (D3); taxes relating to employment regarded as labour costs (D4), less any subsidies received.

Information on the volume of labour input (hours worked and hours paid) complete the source for the calculation of indicators on labour productivity.

Figure 1 – *The structure of labour costs – Main components*



[3] According to the Nace Rev.2 classification: Section:B - Mining and quarrying, C - Manufacturing, D - Electricity, gas, steam and air conditioning supply, E - Water supply; sewerage, waste management and remediation activities, F - Construction, G - Wholesale and retail trade; repair of motor vehicles and motorcycles, H - Transportation and storage, I - Accommodation and food service activities, J - Information and communication, K - Financial and insurance activities, L - Real estate activities, M - Professional, scientific and technical activities, N - Administrative and support service activities, O - Public administration and defence; compulsory social security, P - Education, Q - Human health and social work activities, R - Arts, entertainment and recreation, S - Other service activities.

2. LCS 2020 – Some key indicators and main results

Official Statistics provide large information about observed phenomena and a set of key indicators useful for cross and longitudinal comparisons. Hours worked, hours paid and number of employees are some of the indicators adopted to define the labour input. As said above, the LCS process produces all of them in fine detail allowing calculating indicators on average labour costs (and their main components) per hour worked and per employee. Data are also available broken by economic activity, size of enterprises and institutions and geographical area of reference. This chapter first presents values for key labour input indicators, then those for costs, wages and salaries and employers' contributions.

The analyses refer to the levels reached in 2020 for each of the indicator considered, and the changes registered when compared to the 2016 values. The cross-country comparisons cover 19 Euro area countries (2015 - 2022) and do not include Section O, as mentioned above.

On the other hand, the intra-national analyses compare Italian values by sector of activity. It consider also Section O, as Italy has provided it since 2012 edition. For this reason the figures quoted for total Italy, in analysing the Italian situation, may be slightly different from those appearing in international comparisons.

2.1. Number of employees

In 2020 there are almost 11 million employed in Italy (in NACE Rev. 2, Sections B to S), of whom 24.4% work in Industry except construction (B-E), 40.3% in the Services of the business economy (G-N), 3.7% in Construction and 31.6% in Other services. Full-time employment is by far the most common type of contract: 19.6% of all employees have a part-time contract, with a significantly higher incidence in the service sector (23.7%) than in the industrial sector (8.5%). In particular, in Section I - Accommodation and food service activities, more than half of employees (56.8 %) have a part-time contract. The number of employees has risen between 2016 and 2020 by 5% (Figure 4, page 8), although the pandemic crisis interrupted the growth recorded in the years 2017-2019. Growth is more pronounced in sections of Construction (+16.2%), in Professional, scientific and technical (+15.7%). Water supply, sewerage, waste (+11.3%) and in Administrative and support service (+11.1%).

The Euro area (excluding section O) registers a growth of 7.3%, with values above 30% for Malta and Greece.

2.2. Hours paid (HP) and hours worked (HW)

Hours paid are fully or partly paid by the employer. They include both hours worked and hours not worked (for holidays, sickness, leave, hours paid in the reference period even if worked in another period). They do not include hours paid in full by external bodies and hours worked to recover hours paid in another period (working time account). The number of HP in 2020 is 1,686, 5.5% less than in 2016.

Hours worked are the hours actually worked by employees during the reference period. In Italy in 2020 (NACE Rev. 2, Sections B to S) each employee works on average 1,398 hours (82.9% of HP). Compared with 1,498 HW in 2016, they fell by 6.6% (-7.4%, when excluding Section O). The decrease is also explained by a non-negligible use of short-time working allowances (the Italian acronym is CIG), necessary to cope with the closures imposed by the pandemic emergency.

The figures in the NACE Rev. 2 sections breakdowns show that in Section O there has been no noteworthy change in HW and HP compared with 2016. A sharp reduction in both HW and HP is particularly evident in Section I – Accommodation and food services, with a decrease from 1,351 to 883 HW (-34.6%) and from 1,548 to 1,034 HP (-33.2%).

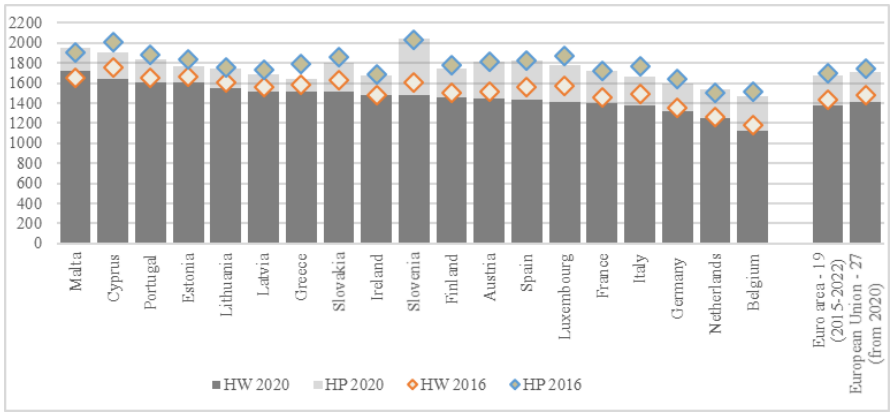
Major decreases, although of varying magnitude, have occurred in the arts and entertainment, manufacturing, construction, transport and storage, wholesale and retail trade, vehicle repair sectors. In other sectors, however, the levels are close to 2016 levels: electricity, waste disposal, water management, insurance and finance, information and communication. In the education sector both HW and HP have increased (+5.8% and +3.5% respectively).

The decline in number of HW and HP recorded for the country as a whole is the result of a combination of decreasing trends in the Sections and their weights in terms of employees. However, it is also due to a series of conditions (composition effect) such as geographical area or company size, which are not presented here.

In the Euro area (19-countries, excluding Section O), the average number of HW is 1,371 (-4.5% compared with 2016) and the average number of HP is 1,673 (-1.8%). The ratio between the number of HW and HP is 82%. Italy ranks 16th among Euro area countries in the number of HW and 15th in the number of HP (Figure 2).

Malta is the country with the highest number of HW in 2020 (1,726), and it is also the only country in the Euro area to record an increase compared to 2016 (+4.2%). The lowest number of HW per employee is recorded in Belgium (1,127, 4.6% less than in 2016, when the number of HW was still the lowest. The largest decrease in the number of HW is recorded in Luxembourg (-9.8%), while the largest decrease in HP is in Greece (8.2%). In the European Union (27 countries), the average number of HW per employee in 2020 is 1,413 (-4.5%t compared with 2016) and the average number of HP is 1,709 (-1.9% compared with 2016).

Figure 2 – *Number of hours paid (HP) and hours worked (HW) per employee in Euro area. 2016 and 2020*



Data source: Eurostat- Number of employees, hours worked and paid, by working time and NACE Rev. 2 activity [LC_NNUM1_R2__custom_6160558] – Last update 23.03.2023 (Eurostat, 2023(b)).

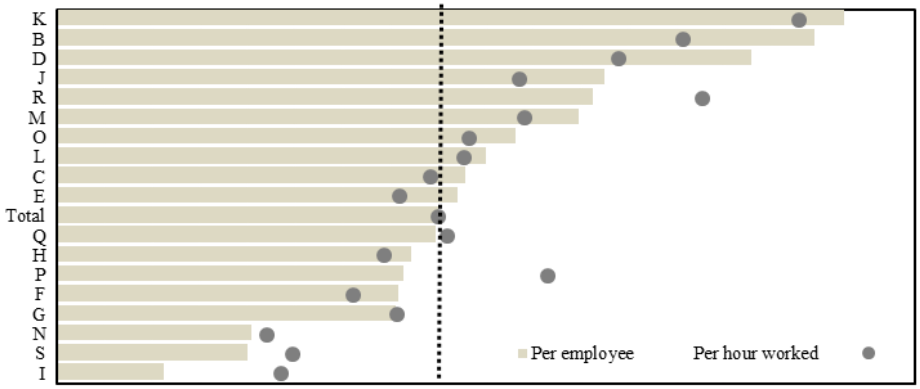
2.3. Labour costs indicators: 2020 and 2016 variation

Labour costs are strictly dependent on the labour input that enterprises or institutions necessitate to produce goods and/or services. The comparison of labour costs indicators calculated with number of employees or hours worked at the denominator may lead to considerations that take into account different but interrelated aspects. In fact, employees and hours worked, as explained above, represent the labour input but measured differently. This is true especially in a particular year such as 2020 when there was a high use of CIG: the number of employees, in fact includes staff temporarily absent for CIG, other than for vacations, leave, maternity leave while hours worked represent the effectively work contribution to the production process. For this reason, the hours actually worked are recognized as the best quantity to effectively measure labour input even in case of strict work reduction.

In what follows, the results obtained comparing the labour cost per employee and the labour cost per hour worked, by economic activities, put in evidence that in 2020 the first one shows more variability respect to the latter, when presenting data in terms of index numbers (with the national average cost equal to 100) (Figure 3). The heterogeneity is very high: it is noted that in section P – Education, the hourly cost is higher than the national average, while the cost per employee is lower; the high value of hourly cost is determined by the low number of hours counted as worked due to non-availability of data on hours worked by teachers outside the school. In contrast, in sections C - Manufacturing and E - Water supply, sewerage, waste

management and remediation activities, the hourly cost is lower than the national average while that per employee is higher, to indicate a high average number of hours worked.

Figure 3 – *Average annual labour costs per employee and per hour worked, by Nace rev.2 section. Italy. Year 2020. Index numbers, Total=100.*

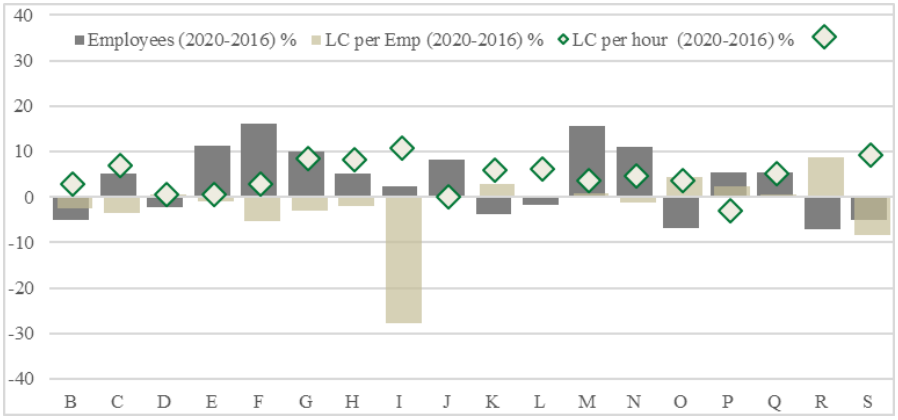


Data source. Labour Cost Survey - LCS 2020 – Italian data (Istat, 2022)

The results become more complex to interpret when presented in variation with a previous wave in 2016, because the labour costs indicator could be affected, in addition to the labour input effect, also to price effect at its numerator. The latter depends on a plurality of factors, occurring between the two survey waves: the employer may have paid different wages and contribution items to the employee, or the composition of the labour force (in terms of white and blue-collar workers, or women and men, or temporary and permanent jobs, etc.) may have affected the mean wages or contributions. These are some aspects that cannot be quantified separately in this analysis, but they are implicit in the results.

Thus, due to a plurality of factors, in 2020 labour costs per hour worked increase (+5.3% respect to 2016) and labour costs per employee decrease (-1.7%) The sectors that register the wider differences in trends between the two indicators are those showing the largest fall in per capita hours worked (Figure 4). In several cases, the lower costs for employers correspond to increased use of the CIG. The largest deviations can be observed in the Accommodation and food service activities (-27.8% labour costs per employee and +10.5% labour costs per hour worked) and in Art, entertainment and recreation (+8.7% and +35.3% respectively).

Figure 4 – *Employees, labour costs per employee and per hour worked by Nace rev.2 section. Italy. Percentage difference between averages on 2020 and 2016.*



Data source. Labour Cost Survey - LCS 2020 – Italian data (Istat, 2022)

In the EU labour costs per employee grow by 6.2% between 2016 and 2020, while in the Euro area by 4.6%. Labour costs per HW increase by 11.4% in the EU and by 10.1 in the Euro area.

The average hourly labour costs indicator is the best one to consider labour input because it is more flexible when the employment situation changes, as occurred in the pandemic year when employment was supported by the national insurance. In these cases, in fact, the hours worked decrease rapidly, while the employees, guaranteed by the social security system, decline more slowly. Focusing on the hourly indicator, it is interesting to measure the contribution of the main components of labour costs-that make up its numerator: wages and salaries and employers' social contributions.

In 2020, there are significant differences among European countries in terms of both labour costs per hour worked and the structure of labour costs.

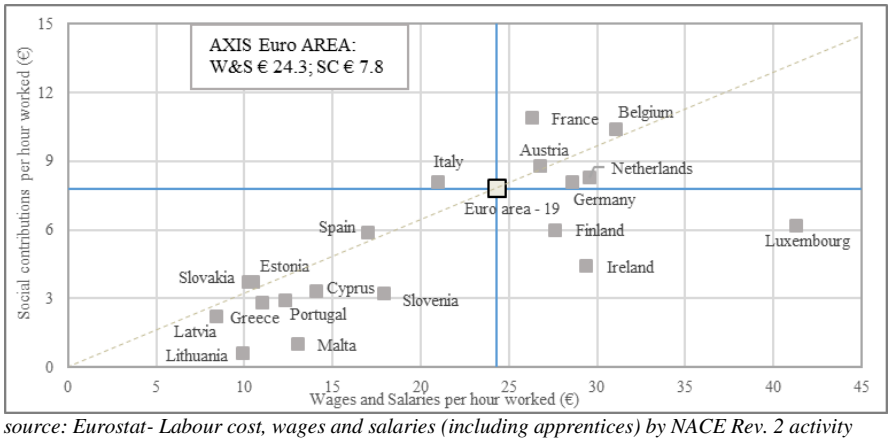
Figure 5 shows the amount in euros of wages and salaries (x axis) and social contributions (y axis) for Euro area countries. In 2020, the average value for the Euro area is 24.3 and 7.8 euros respectively. The diagonal dashed line corresponds to the incidence of contributions on total costs again for the Euro area average (24%).

The lowest hourly wage is in Latvia (8.4 euros), the highest in Luxembourg (41.3 euros). Conversely, the lowest contributions in euro are the prerogative of Lithuania (0.6 euros) and the highest in France (10.9 euros) and Belgium (10.4 euros).

The incidence of social contributions on labour costs ranges from a minimum of 6% in Lithuania (followed by Malta with 7.4% and Luxembourg with 13.1%) to the

maximum for France (28.2%). In addition to France and Belgium, also Slovakia, Estonia, Spain, Italy and Austria show an incidence of social contributions on labour costs higher than 24%.

Figure 5 – *Wages and salaries and social contributions in Euro-area 19 countries. Year 2020, values in euros*



Data source: Eurostat- Labour cost, wages and salaries (including apprentices) by NACE Rev. 2 activity [LC_NCOSTOT_R2__custom_6856023]– Last update 23.03.2023 (Eurostat, 2023(b)).

Looking in detail at the case of Italy (including Section O), in 2020 the average labour costs per hour worked amount to 29.4 euros: 21.2 are wages and salaries, 8.1 are social contributions and 0.1 intermediate labour costs. The incidence of social contributions on labour costs (considered the total amount at national level) is 27.7%. Examining wages and contributions by section of economic activity, there are no notable deviations from these proportions. The only exceptions is section R - Arts, entertainment and recreation where social contributions account for around 24% of hourly costs. In this sector, average gross wages - influenced by the presence of professional sportsmen and women and highly-paid performers - do not match proportional social contributions, because for the part of the wages and salaries exceeding the maximum threshold, only the solidarity social contribution is due and not a social contribution for pensions. On the other hand, in section F – Constructions social contributions exceed 30% of hourly costs, as the effect of the important role played by the high insurance premiums against accidents at work.

The monetary value of wages and salaries and contributions per hour worked also varies widely according to the sector of economic activity.

The lowest hourly wages and social contributions are in section N - Administrative and support service (13.5 euros and 5.2 euros respectively), the

highest in the section K - Financial and insurance sector (36.6 euros and 14.7 euros respectively).

3. Some concluding remarks

Labour Cost Survey confirms that also in 2020 wages and salaries is the main component of labour costs in all Euro area countries, followed by social contributions paid by employers. There are large differences between countries in terms of hourly labour costs and the share of different items in total costs. These differences are the result of a combined effect of aspects that characterise the different countries (economic, regulatory, demographic, etc.). The particular pandemic situation that occurred during the period considered also led to further differences between countries, as both the evolution of the pandemic phenomenon and the measures taken to combat it differed. Furthermore, the schemes introduced by individual country governments to mitigate the impact of the pandemic on businesses and employees had different effects on labour input and labour costs indicators. In the case of Italy the suspension of redundancies and the massive use of CIG, was the main scheme introduced. The impact of this scheme in LCS results for the year 2020 compared to 2016, has been a decrease of labour costs per employee (-1.7%) and an increase of labour costs per hour worked (+5.3%). Employees involved in CIG in fact remain within the scope of LCS and were counted among employees but the volume of hours worked had a reduction. This gap between the two indicators is wider in some sector of activity where the introduction of such measurement has been more intensive. The issue of labour costs reduction has long been the focus of attention of social partners and governments. The availability of statistics on the subject has a long history, and the methodologies and statistical processes for producing them are also constantly evolving. At the EU level, a modernisation of Labour Market statistics on Businesses, which include also Labour costs statistics, is ongoing in order to provide a modernised legal basis that will allow answering needs that are not addressed by the current data. In particular the scopes of the LCS survey will be extend to the section ‘O’ of the NACE classification in order to extend coverage and comparability across Member States.

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REMOTE WORKING AND NEW FORMS OF WORK: EVIDENCE FROM INAPP-PLUS

Paolo Emilio Cardone

Abstract. When the pandemic hit in the spring of 2020, many private companies and public administrations had to resort to working-from-home (WFH) arrangements for their employees. While remote working was rather uncommon before the pandemic, this became the prevalent work arrangement for a large fraction of the working population. Aim of the analysis is to investigate the workers transition to teleworking evaluating the impact of demographic and jobs' characteristics on the probability of having worked from home, partially or totally, during the second wave of the pandemic. The data used in this study are from the last Ninth Survey on Labour Participation and Unemployment (PLUS), thus a sample survey on the Italian labour market supply developed and administered by the National Institute for the Analysis of Public Policies (INAPP). Remote working experience is considered positive by 55% of workers and less than 10% believe it was negative. Fitting a logistic regression model, it is possible to estimate the different attitudes among workers more accurately. The probability to work from home is slightly higher for males, older workers, white-collar, high-skilled, well-educated, industrial and service sector employees. There is also a clear disadvantage for those who have a low-medium education level and for low-skilled workers. Moreover, many respondents would choose new ways of working such as from small village and from countryside/mountain.

1. Introduction

The outbreak of the COVID-19 Pandemic at the beginning of 2020 led to radical changes in many aspects of individuals' lives. Social policies, based on limiting contacts and physical distancing, implied suspension, reduction and converting several activities to remote mode, including work.

The COVID-19 crisis has caused far-reaching changes in a very short time-period. Public health measures designed to stem the spread of COVID-19 have included active encouragement of homeworking for those in a position to do so. With many workplaces in enforced closure from spring 2020, remote working became the

customary mode of working for many employees with previously limited or no experience of working in this way[1].

When the pandemic hit in the spring of 2020, many private companies and public administrations had to resort to working-from-home (WFH) arrangements for their employees.

In the effort to identify the negative effects of social distancing measures and mobility restrictions, the recent literature has focused on *jobs that can be performed at home*.

Predictions that remote working would become a dominant mode of work date as far back as the 1980s and the beginnings of the information revolution (Toffler, 1980).

While remote working was rather uncommon before the pandemic (according to data from the 2018 European Labour Force Survey, roughly 10% of employees and 30% of self-employed used to work from home at least sometimes), this became the prevalent work arrangement for a large fraction of the working population during the pandemic: the Eurofound (2020) survey suggests that 48% of employees worked remotely at least some time in 2020. This shift did not take place homogeneously: the extent to which each firm adopted this strategy depends on the type of industry (Barbieri et al., 2020; Dingel and Neiman, 2020).

Moreover, in a cross-country study, Boeri et al. (2020) report that the percentage of jobs that can be performed remotely differs among European countries, from 23.95% in Italy to 31.38% in UK. These jobs are mainly concentrated in services: professors, engineers, lawyers, architects are just some examples of the occupations included in this category.

Adams-Prassl *et al.* (2020) show how working from home protected workers not only from the health risks of the COVID-19 pandemic, but also from the economic shock caused by the pandemic. They show how the "food preparation and serving" sector appears to be the least suitable for smart working, and how this sector was the one that suffered closures and multiple interruptions of work during the pandemic, causing the closure of many activities and the loss of jobs by its workers.

The evidence on the wide variations in the numbers of workers who were able to work from home were also studied and confirmed by Felstead and Reuschke (2020).

Depalo and Giorgi (2020) highlight how the increase of smart working was heterogeneous among sectors: those characterized by greater teleworkability and which actually worked remotely in 2020 are the information-communication and financial-insurance activities sectors. On the contrary, smart working in the hotel and

[1] In this analysis, the terms “teleworking” and “working from home” are used interchangeably. An appropriate definition of teleworking is “the remote provision of labour that would otherwise be carried out within company premises” (European Commission, 2020).

restaurant sector, where teleworkability is extremely limited, was below 2%, remaining at the low levels of 2019, before the pandemic.

It also emerged from the Smart Working Observatory[2] (Crespi, 2018), that the main reasons that induce workers to work-from-home are the improvement of well-being and work-life balance.

If the effects of remote working on productivity are not yet clear how explained by the OECD (2020), smart workers have a higher level of gratitude for the company that allows them to use this way of work and they reciprocate by working more (Falk and Kosfeld, 2006). In other words, they work more efficiently because they feel an obligation towards the company or too much because there is no clear separation work-life balance.

Aim of this study is to evaluate the impact of jobs' characteristics on the probability of having worked from home (partially or totally) during the second wave of the pandemic.

2. Data and methods

The analysis is carried out using microdata from the last Ninth Survey on Labour Participation and Unemployment (PLUS), a sample survey on the Italian labour market supply developed and administered by the National Institute for the Analysis of Public Policies (INAPP)[3].

The primary objective of the INAPP-PLUS survey is to provide reliable statistics on phenomena rarely or marginally explored by other surveys on the Italian labour market. The questionnaire was submitted to a sample of residents aged between 18 and 74 years, according to a stratified random sampling over the Italian population[4]. The survey has been released in 2021 (March – July) on a sample of 46.282 individuals but note that in this research only respondents who work were analysed.

We therefore exclude those who are not employed, pensioners and students from our empirical analysis: this results in a sample of 19.025 observations.

Respondents are asked a series of questions to investigate work arrangement during the second wave of the pandemic.

[2] The Smart Working Observatory of the School of Management of the Politecnico di Milano, founded in 2012, represent the point of reference in Italy on digital innovation: https://www.osservatori.net.

[3] The INAPP-PLUS data are available by accessing to the section: https://inapp.org/it/dati/plus.

[4] The stratification of the INAPP-PLUS survey sample is based on population strata by NUTS-3 region of residence, urbanisation degree (i.e. metropolitan or non-metropolitan area), age group, sex, and employment status (i.e. employed, unemployed, student, retired, or other inactive).

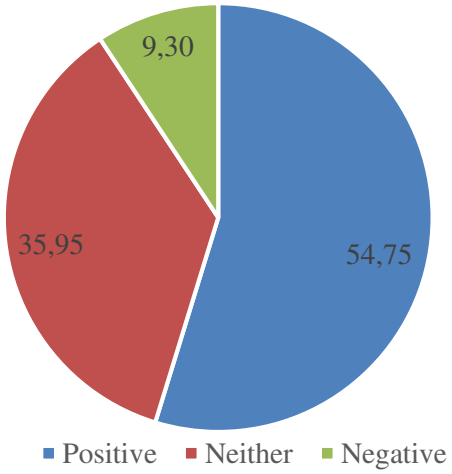
After a set of questions, *SM6* (questionnaire p.25) asks "*Nell'ultimo mese quanti giorni ha lavorato da remoto?*" ("*How many days have you worked remotely in the past month?*"), with two possible answers: "*Never*" or "*At least one day*".

3. Results

We first briefly present descriptive findings on the choice of remote work[5].

The working remotely experience is considered positive by 54,75% of workers and less than 10% (9,30%) believe it was negative (figure 1).

Figure 1 – *Opinion on remote work experience (% values).*



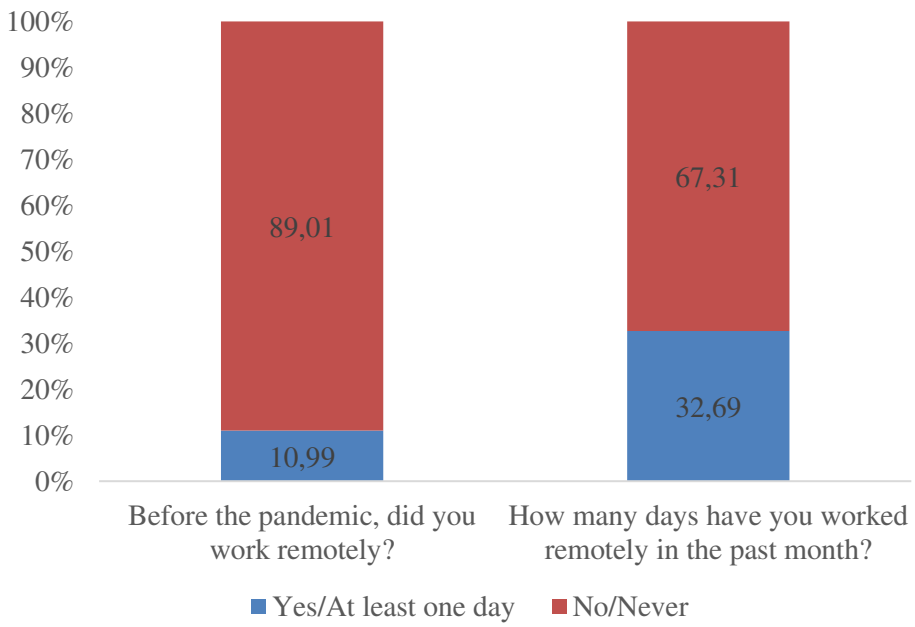
Source: own elaboration on Inapp-Plus 2021.
Note: Design weights are applied.

In Italy, before the pandemic, 2.458.210 employees (10,99%) worked remotely; in 2021 agile workers rose to 7.262.999 and the share of total employment rose to 32,69% (figure 2).

As shown in figure 2, during 2021 the share of remote workers tripled compared to the pre-pandemic period.

[5] Preliminary findings were presented at the Conference of the Italian Association for Population Studies (Demography Section of the Italian Statistical Society) "*Popdays 2023*" held in Roma Tre University (02/02/2023).

Figure 2 – *Share of remote workers, before the pandemic and in 2021 (% values).*



Source: own elaboration on Inapp-Plus 2021. Note: Design weights are applied.

Moreover, the incidence of remote workers grows with the increase in the demographic size of the municipality, from 26,8 per cent in small villages to 48,3 per cent in metropolitan areas (table 1).

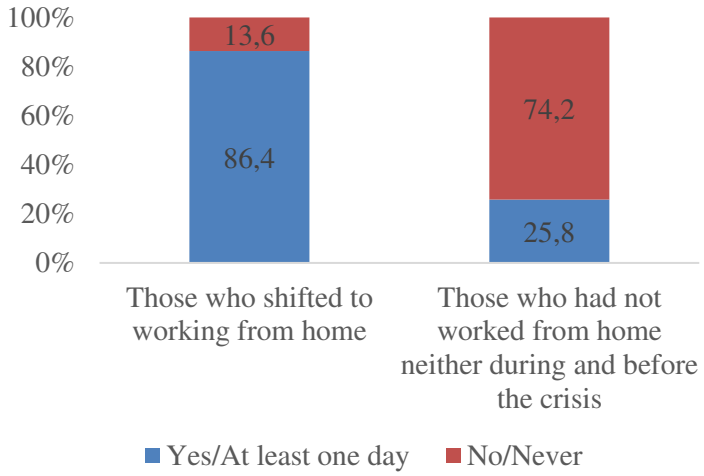
Table 1 - *Days worked remotely in 2021, by demographic size of municipalities (% values).*

How many days have you worked remotely in the past month?	Never	At least one day	Total
< 5˙000 inhabitants	73.23	26.77	100
5˙000 - 10˙000 inhabitants	72.45	27.55	100
10˙000 - 30˙000 inhabitants	72.07	27.93	100
30˙000 - 100˙000 inhabitants	66.85	33.15	100
100˙000 - 250˙000 inhabitants	61.84	38.16	100
> 250˙000 inhabitants	51.69	48.31	100

Source: own elaboration on Inapp-Plus 2021. Note: Design weights are applied.
Pearson chi2(5) = 545.5562; Pr = 0,000

Those who shifted to working from home (exclusively or partially) were very likely to indicate wanting to telework after the crisis (86,4%). Meanwhile, 74,2% of those respondents who had not worked from home neither during and before the crisis, indicated they would prefer never to telework (figure 3).

Figure 3 – *Share of workers that would like to work remotely (% values).*



Source: own elaboration on Inapp-Plus 2021. Note: Design weights are applied.

Finally, the increase in remote work has sparked a debate on worker relocation further away from large urban areas. The last two questions of the "remote working" section asks: "*If you could work remotely, would you move to a small village?*" and "*If you could work remotely, would you move to an isolated place in contact with nature (countryside, mountain, etc.)?*". Respectively 34,5% and 41,5% of respondents would choose these new ways of working.

They are the *south-workers*, people that work mainly remotely for employers located elsewhere, in Northern Italy or abroad.

In this context, many workers are reconsidering their priorities and would like to be able to work from anywhere. This may represent a positive input for Southern economies, which could attract talent both among those who were part of the "brain drain" and among people who are not originally from the South.

Using a logistic regression model it was possible to estimate the different attitudes among workers towards remote working (partially or totally), during the second wave of the pandemic, more accurately (Liu, 2016).

The model includes socio-demographic characteristics (age, gender, education level) and work-related (work, type of work and Ateco[6]).

In order to achieve this goal, the dependent variable of this study is the "*Remote Working*": we recode respondents' answers (*SM6*, questionnaire p.25) into a binary outcome variable which receives a value of 1 if the respondent worked remotely at least one day and takes a value of 0 if the respondent does not worked remotely.

Concretely, in the study analyzed variables are:

- *Gender*. Categorical. Dummy variable: Female, Male (reference cat.).
- *Job*. Categorical. Nine values. 8-Elementary occupations (reference cat.); 1-Managers; 2-Professionals; 3-Technicians and associate professionals; 4-Clerical support workers; 5-Services and sales workers; 6-Skilled agricultural, forestry and fishery workers, Craft and related; 7-Plant and machine operators and assemblers; 9-Armed forces.
- *Age group*. Categorical. Six intervals. From 18 to 24 (reference cat.); 25 to 29; 30 to 39; 40 to 49; 50 to 64; 65 to 74.
- *Education*. Categorical. Four levels. Elementary School; Middle School; High School; University (reference cat.).
- *Work*. Categorical. Dummy variable: Public (reference cat.), Private.
- *ATECO*. Categorical. Twentyone values. A: Agriculture, Forestry and Fishing (reference cat.); B: Mining and Quarrying; C: Manufacturing; D: Electricity, Gas, Steam and Air Conditioning Supply; E: Water Supply; Sewerage, Waste Management and Remediation Activities; F: Construction; G: Wholesale and Retail Trade; Repair Of Motor Vehicles and Motorcycles; H: Transportation and Storage; I: Accommodation and Food Service Activities; J: Information and Communication; K: Financial and Insurance Activities; L: Real Estate Activities; M: Professional, Scientific and Technical Activities; N: Administrative and Support Service Activities; O: Public Administration and Defence; Compulsory Social Security; P: Education; Q: Human Health and Social Work Activities; R: Arts, Entertainment and Recreation; S: Other Service Activities; T: Activities of Households as Employers; Undifferentiated Goods-and Services-Producing Activities of Households for Own Use; U: Activities of Extraterritorial Organisations and Bodies.

Thus, we fit the logistic model which estimates the probability of having smart working or not, and includes all the above mentioned variables:

[6] ATECO is the classification of economic activities and it is the national version of the European nomenclature, Nace Rev. 2 (Statistical classification of economic activities in the European Community).

$$logit(p) = \alpha + \beta_1 Gender_i + \beta_2 Job_i + \beta_3 Age\ group_i + \beta_4 Education_i + \beta_5 Work_i + \beta_6 ATECO_i \quad (1)$$

Table 2 shows odds ratios of logistic model and this means that the coefficients (*Beta*, not showed) in logistic regression are in terms of the log odds because the coefficients can be expressed in odds by getting rid of the natural log[7].

Firstly, we test the goodness-of-fit using a postestimation tool, the Hosmer-Lemeshow statistic[8].

Logistic model for "*Smart Working*", goodness-of-fit test:
Number of groups = 10
Hosmer-Lemeshow chi2(8) = 10,88
Prob > chi2 = 0,2086

This fitted model says that, holding covariates at a fixed value, the odds of working-from-home for female over the odds of working-from-home for male (reference category) is 0,85. In terms of percent change, we can say that the odds for female are 15% lower than the odds for male. In other words, the chance to work from home is slightly higher for male rather than female.

Regarding the job, the odds of working-from-home for the first four categories are higher over the odds of working-from-home for the "Elementary occupations" (reference category). In particular, the odds for "Professionals" are more than three times higher than the odds for "Elementary occupations" (OR=3,27) and the odds for "Managers", "Technicians and associate professionals" and "Clerical support workers" are double or more (OR=2,08, OR=2,29 and OR=1,99).

Table 2 - *Logistic regression model. (follows)*
Number of obs = 18.412 *LR chi2(39) = 4268,66* *Prob > chi2 = 0,0000*
Log likelihood = - 9937,0439 *Pseudo R2 = 0,1768*

		ODDS	S.E.	z	P>|z|
• Gender	Male	1 (base)			
	Female	0.85***	0.03	-4.58	0.000
• Job	Managers	2.08***	0.30	5.09	0.000
	Professionals	3.27***	0.35	11.17	0.000

[7] This is done by taking the exponential for both sides of the equation, because there is a direct relationship between the coefficients produced by logit and the odds ratios produced by logistic: a logit is defined as the natural log (base *e*) of the odds.

[8] This test follows a chi-square distribution with the degrees of freedom equal to the number of groups minus 2. A not significant *p-value* indicates that the model fits the data well since there is no significant difference between the observed and expected data. In this case, the Hosmer-Lemeshow chi-square test has a value of 10,88 with the degrees of freedom equal to 8. The associated *p-value* is 0,2086 which is not significant. Therefore, the model fits the data well.

Table 2 - *Logistic regression model. (continued).*

		ODDS	S.E.	z	P>|z|
	Technicians and associate professionals	2.29***	0.24	7.98	0.000
	Clerical support workers	1.99***	0.20	6.93	0.000
	Services and sales workers	1.03	0.12	0.28	0.782
	Skilled agricultural, forestry and fishery workers, Craft and rel.	0.57***	0.08	-3.81	0.000
	Plant and machine operators and assemblers	0.50***	0.11	-3.23	0.001
	Elementary occupations	1 (base)			
	Armed forces	0.75	0.18	-1.22	0.221
•Age group	18-24	1 (base)			
	25-29	1.93***	0.15	8.77	0.000
	30-39	2.67***	0.20	12.95	0.000
	40-49	3.59***	0.29	16.01	0.000
	50-64	3.18***	0.23	15.91	0.000
	65-74	2.93***	0.39	8.16	0.000
• Education	Elementary School	0.15*	0.16	-1.82	0.069
	Middle School	0.31***	0.03	-10.63	0.000
	High School	0.47***	0.02	-17.91	0.000
	University	1 (base)			
• Work	Public	1 (base)			
	Private	1.37***	0.10	4.44	0.000
• ATECO	A: Agriculture, Forestry and Fishing	1 (base)			
	B: Mining and Quarrying	1.93	0.79	1.60	0.109
	C: Manufacturing	1.24	0.19	1.42	0.157
	D: Electricity, Gas, Steam and Air Conditioning Supply	3.16***	0.60	6.07	0.000
	E: Water Supply; Sewerage, Waste Manag. & Remediation Acti.	4.68***	1.16	6.23	0.000
	F: Construction	1.81***	0.29	3.71	0.000
	G: Wholesale & Retail Trade; Repair Of Motor Vehicles & Mot.	1.18	0.19	1.06	0.288
	H: Transportation and Storage	1.61***	0.27	2.86	0.004
	I: Accommodation and Food Service Activities	0.78	0.14	-1.36	0.175
	J: Information and Communication	5.62***	0.87	11.14	0.000
	K: Financial and Insurance Activities	3.11***	0.48	7.31	0.000
	L: Real Estate Activities	1.41*	0.29	1.67	0.096
	M: Professional, Scientific and Technical Activities	1.91***	0.29	4.32	0.000
	N: Administrative and Support Service Activities	2.89***	0.63	4.83	0.000
	O: Public Administration & Defence; Compulsory Social Secur.	3.34***	0.56	7.24	0.000
	P: Education	2.17***	0.35	4.82	0.000

Table 2 - *Logistic regression model. (continued).*

	ODDS	S.E.	z	P>|z|
Q: Human Health and Social Work Activities	0.51***	0.08	-4.26	0.000
R: Arts, Entertainment and Recreation	1.50**	0.28	2.23	0.026
S: Other Service Activities	2.12***	0.32	5.00	0.000
T: Act. of HH as Empl.; Undiff. Goods-Serv.-Prod. Act. of HH	1.41	0.58	0.83	0.406
U: Activities of Extraterritorial Organisations and Bodies	4.63***	1.39	5.09	0.000
NA	0.08***	0.30	3.46	0.001
constant	1.22***	0.02	-12.80	0.008

*Source: own elaboration on Inapp-Plus 2021. Notes: ***p<0,01 **p<0,05 *p<0,1*

On the other side, the odds for "Skilled agricultural, forestry and fishery workers, Craft and related" and "Plant and machine operators and assemblers" are lower than the odds for "Elementary occupations". Please note that the odds for "Services and sales workers" are not significant (*p value* > 0,05). This is an important finding because the Italian National Institute of Statistics (ISTAT) considers categories 1, 2 and 3 as high-skilled workers; categories 4, 5 and 6 as medium-skilled workers; categories 7 and 8 as low-skilled workers (for this last group there is a clear disadvantage). The chance of working-from-home is lower for those who have a low-medium education level ("University" reference cat.). Moreover, the probability is higher for those working in the private sector than in the public administration (reference category): in terms of percent change, the odds for private sector (OR=1,37) are 37% higher than the odds for public administration. Older workers were more likely than prime-age (25–29 and 30-39) and younger employees (18-24, ref. cat.) to have worked from home. Lastly, the odds of working-from-home is higher for almost all Ateco sectors over the odds of working-from-home for "Agriculture, Forestry and Fishing" ("A" reference category).

4. Conclusions

This study contributes to the wider debate surrounding "the working-from-home revolution". In this paper we estimate probability of having worked from home (partially or totally) during the second wave of the pandemic. We exploit survey data where the workers were interviewed in 2021 (March – July), immediately after the second wave. When this second wave of pandemic hit in the spring of 2021, many private companies and public administrations had to resort to working-from-home (WFH) arrangements for 32,5% of their employees. This working remotely experience is considered positive by 55% of workers and less than 10% believe it

was negative. Employees living in cities and metropolitan areas were significantly more likely to report working from home than those in less populous settlement types. It now appears very likely that the experience of working from home during the COVID-19 crisis will lead to a growth in teleworking when the crisis abates. Interestingly, the preferences for teleworking expressed in the survey were very much shaped by whether or not individual employees had recourse to this type of work during the crisis. The more regular their experience of teleworking, the more likely they were to indicate a preference for teleworking post-crisis and at greater frequency (86,4% vs 25,8% for those who have never worked remotely). Which categories of employee respondents were more likely to telework during the crisis? In this regard, we also fit a logistic regression model and main findings suggest that those working from home were disproportionately male workers, olders, white-collar, high-skilled, well-educated, industrial and service sector employees. Moreover, a new phenomenon has emerged as result of these changes: *south-working*. An emerging form of remote work that allows employees to work from anywhere, so that the worker can choose to live in a preferred geographic location, in particular in internal or remote areas and the Southern regions of Italy, in which the educated face continuous pressure for internal migration from South to North. This prospect is also particularly relevant to intermediary cities, which are considered a good compromise between access to urban services, quality of life and affordability. South-workers are employees of companies that produce income in their city/region of work and spend their money in the territories where they choose to live or stay in the medium and long term. In this way, some internal and rural areas can benefit from south-working in terms of taxpayers and repopulation. This south-working phenomenon may have repercussions on the development strategy of internal or remote areas which will finally be able to repopulate with activities, projects and people. This could be a great opportunity for these territories. It is important to create the best conditions to be able to host and offer them everything they need to work and live in the area in the best possible way. It requires an amount of infrastructural investment, such as internet, roads, services (schools, hospitals, etc.). Despite its limitation, we hope this paper provides a first "lay of the land" of the history of south-working, although it is still an "early-stage" phenomenon. We also hope this study can open the door to a new discussion about the evidence on a new geography of jobs in italian regions, its consequences for territories development, wellbeing, opportunities, challenges and the policy responses from the institutions.

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HUMAN RESOURCES RECRUITMENT IN ITALIAN PUBLIC SECTOR POST COVID 19: DEMOGRAPHIC CHARACTERISTICS, GENDER COMPOSITIONS, EDUCATION FOR A NEW PUBLIC EMPLOYER BRANDING. FOCUS ON ISTAT EXPERIENCE

Michele Camisasca, Ilaria Screpante

Abstract. The present study aims to examine the attractiveness of the Public Administration to young generations and technical-scientific professional profiles, with specific reference to the case of Istat. After observing the characteristics of public sector workers, attention is focused, in a comparative perspective, on the competitive procedures managed by FormezPA in the biennium 2021-2022 and by Istat, considering the specificity of the organization and the required professional profiles. In particular, the analysis concentrates on the demographic, educational, and professional characteristics of the applicants. The obtained results allow for reflection on the public sector's ability to attract new professionals, providing insights for the evaluation of the adopted recruitment policies.

1. Introduction

The prolonged freeze on turnover of public sector workers, resulting in an aging reference population, and the concurrent need to modernize the Public Administration (PA) as a whole, are the main factors driving the recruitment of new professionals and skills. These needs have been further accelerated with the adoption of the National Recovery and Resilience Plan (PNRR). The purpose of this study is to observe the attractiveness of the public sector in relation to technical-scientific expertise through the analysis of competitions initiated for the recruitment of specialized professionals, leveraging the informative potential inherently contained in the application forms. The analysis of this information allows for useful insights into the attractiveness of an organization, the effectiveness of recruitment processes, and their distortions. The attractiveness will be observed by comparing the selection procedures initiated by FormezPA for the recruitment of technical-scientific competencies in the period 2021-2022[1], as outlined in paragraph 3, with the selection carried out by the Italian National Institute of Statistics (Istat) in 2022 for the hiring of personnel with technical-statistical skills, as described in paragraph 4. The

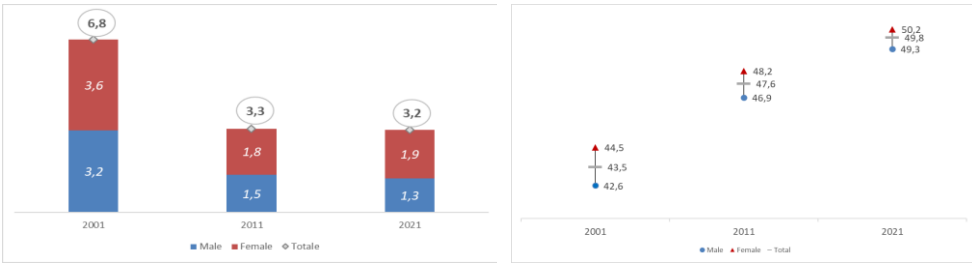
[1] FormezPA is, today, the only entity that makes available data and information on competition participants/winners, through the creation of a data warehouse of the selections managed and the dissemination of data in aggregate form.

compared procedures differ in various aspects (employment contract type, required educational qualifications, etc.), however, the aim is not to compare them but, as mentioned earlier, to assess the PA's ability to present itself as the employer of choice for scientific professionals, currently scarce in central administrations and local authorities, albeit present within those administrations with easily identifiable scientific institutional purposes.

2. Public administration: an aging workforce

The PNRR makes a double bet on the PA, on one hand supporting a reform plan for the public sector (simplification and digitization of products and processes; development of streamlined organizational and recruitment procedures; enhancement of skills), and on the other hand entrusting the implementation of the Plan to individual Administrations, each responsible for their respective areas of competence, requiring them to undergo a "revolution" in activity management (setting mandatory timelines for achieving objectives; monitoring activities; financial management of relevant investments; coordination of implementing entities; reporting, etc.). This second aspect represents the most complex factor, demanding a high level of management capacity from the involved administrations to handle this "new normal" and the cultural change required to govern it. However, the current state of the public administration, characterized by a decrease in workforce and a general increase in the average age of workers, sets the context for the interventions, actions, and challenges faced by individual institutions. In 2021, there were a total of 3,238,968[2] public employees in Italy, which has decreased by approximately 37,000 units over the past 10 years [3].

Figure 1 – *PA employees (a) by sex (a) and average age (b) (Years 2001-2021; Absolute values).*



Source: own elaboration on State General Accounting Department data.

[2] See Rgs, Annual Accounts, 2022.
[3] Adjusted for changes in the composition of the S13 list.

Furthermore, the freeze on turnover, which underlies the reduction in the number of public employees, along with changes in pension access provisions, are the main factors that have led to a significant increase in the average age in public employment. From 2001 to 2021, the average age for the overall personnel has increased from 43.5 to 49.8 years, (Figure 1a and b), with significant differences among different sectors.

If in 2001, in all sectors, no male and female reached the average age of 50 years, and in fact were quite far from it, in 2021, everyone has crossed this threshold, with except for women in the Healthcare sector who are just below it. Observing also the median age, in the same years, the trend is confirmed. In particular, the median age increases from 43.3 year in 2001 to 51.2 years in 2021. Comparing the average with median age it is possible to observe as the public employees in 2001 belonged to the younger age groups (average age 43.5 *vs* median 43.3) while across twenty years the employees belonged to the older age groups (average age 49.8 *vs* median 51.2). The same trend, *mutatatis mutandis*, is confirmed also for male and female.

Given the large number of personnel in the older age groups, which provides an implicit representation of future retirements, the entry of new personnel into the PA would allow not only to maintain the personnel replacement rate at levels that enable the functioning of administrations but also the entry of younger individuals and new skills necessary to support the ongoing changes in the public sector. All this, together with the PNRR, represents a great opportunity for the renewal of the PA, which requires careful planning that takes into account present and future needs and allows them to be met through fast and effective competition procedures. For the first time, the process of modernizing the PA - which has its origins in the 1990s - attributes central importance to "people" and invests in generational turnover within the public sector. All these elements have led to the implementation of innovative recruitment policies compared to the past, both in terms of the number of positions offered through competitions, the methods of conducting competition procedures, and the type of candidates sought. Regarding this last aspect, the most novel element is the attempt to incorporate highly specialized technical personnel, especially those with scientific and mathematical skills, into institutions. However, this challenge has proved to be particularly difficult, resulting in a significant lack of coverage for the advertised positions in the mentioned areas, especially in sectors that have been accustomed for years to dealing with legal, administrative, and accounting professions.

3. PA modernization: centrality of recruitment amid uncertainty

In the biennium 2021-2022, after the acute phase of the pandemic events, the focus shifted to launching competitions for the recruitment of specialized personnel

within the Public Administration. Referring to the 124 competition procedures managed by FormezPA (from January 1, 2021, to June 30, 2022), nearly 40,000 positions were advertised, both for legal-administrative profiles and technical-scientific profiles, predominantly for hiring in central administrations (over 76%). The advertised positions, slightly over half of them being fixed-term (21,167, accounting for 53%), mostly pertain to extraordinary recruitment for personnel to implement the Pnrr, characterized—compared to the past—by a high demand for technical profiles (22.9%). For all the published calls during the reference period, in fact, the majority of sought-after professional figures correspond to highly specialized profiles (engineers, computer scientists, statisticians, architects, geologists, economists, cultural experts), thus requiring a university degree as a minimum access requirement (over 78% of the procedures are aimed at graduates).

In order to get a clear picture of the audience actually involved, the demographic and educational characteristics of the candidates participating in the selections and, consequently, of the successful and eligible candidates were analyzed.

In general, the sheer number of applications submitted (over 2 million) seems to highlight the continuing high level of interest in the civil service[4]. There were, however, many "multiple" applications, i.e., applicants who applied for more than one procedure; while 641 thousand were "unique" applications (applicants for only one competition)[5]. In particular, almost 265,000 candidates submitted applications for participation in multiple selection processes, accounting for 41% of the total candidates (of these, approximately 45% participated in two competitions; 32.7% in 3 or 4 competitions, and 23.4% - almost 60,000 candidates - submitted applications for more than 5 competitions). Multiple applications constitute an important factor to consider, given - as described below - the number of withdrawals recorded, which partly involved individuals who emerged as winners in multiple processes.

From the analysis of the demographic characteristics of the target audience, the average age of the competition participants stands out, approximately 40 years, especially in relation to the overall objective of countering the trend of an increasing age among public workers. However, from the distribution of candidates by age groups, a significant percentage of young candidates is evident: over 29% of the candidates are under 30 years old, and over 41% are aged between 30 and 40 years. With regards to gender, there is a notable prevalence of women: 365,000 women (58%) applied for at least one competition, compared to 276,000 male candidates. The gender breakdown of candidates confirms the greater inclination of women to find potential employment opportunities within the Public Administration, a preference also confirmed by the current composition of public workers.

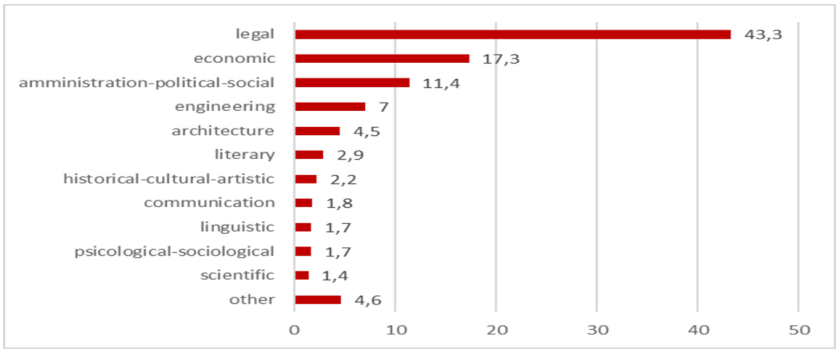
[4] The number of applications is adopted as an indicator of PA attractiveness; see OECD, *Public employment and management 2021: the future of the public service*.
[5] Cf. FormezPA, Annual Report 2022.

Information on the candidates' residence shows significant territorial differences: the majority of candidates reside in the Southern regions (over 68%); approximately 24% come from the Central regions, with the Lazio region being the most represented, housing around 20% of the candidates. This primacy can be attributed primarily to the fact that the majority of central administrations are located in that region.

Regarding educational qualifications, as mentioned earlier, over 80% of the candidates hold a university degree. For the purpose of this analysis, it is also interesting to focus on the thematic areas of the presented university degrees.

The preponderant field is "Legal" (over 43%), followed by "Economics" (17.3%). Degrees in computer science, statistics and mathematics, on the other hand, seem to represent the "great absentees" among the profiles considered by FormezPA, included under the generic heading "other fields" as they are present with frequencies of less than 1%[6] (Figure 2).

Figure 2 – *Candidates by subject area of undergraduate study (%).*



Source: own elaboration on FormezPA data

The analysis of educational qualifications with respect to gender, on the other hand, while highlighting the prevalence of women with high educational qualifications (63% of the candidates hold a master's or specialist or old-school degree), confirms the negative record, already highlighted at the national level, on the low presence of female graduates in Stem (Science, Technology, Engineering and Mathematics) disciplines, who account for only 13%[7].

[6] Data on the educational characteristics of the participants in the selections by profile of "Computer Scientist/Statistician" also highlight that the majority of those involved turn out to have a degree in engineering (See FormezPA Report, 2022).

[7] In 2021, 24% of young adults (aged 25-34) with a tertiary degree have a bachelor's degree in scientific and technological fields, commonly known as STEM (Science, Technology, Engineering, and Mathematics) degrees. The percentage rises to 33.7% among men (one in three graduates) and drops to 17.6% among women (one in six graduates), highlighting a significant gender gap. There are territorial differences for STEM graduates, particularly

With respect to the candidate population, the analysis of the main characteristics of the winners/awardees confirms the trends described, with the exception of the average age of those involved, which, for the winners/awardees, drops to 36 years old compared to the 40 years average age of the candidates. Women continue to represent the largest component (approximately 58.5%); the most common educational qualification is a master's degree, with the legal field remaining predominant (almost 60%). The presence of graduates in STEM disciplines, on the other hand, is quite limited: 3.5% of the eligible candidates have a degree in engineering, 2% in architecture, and only 0.3% in mathematics/statistics[8].

As a result, it is precisely for these professional areas that the needs of the administrations have not been fully met: for the profile "Computer Statistician" the vacancies are more than 37% of the total available; for the profile "Engineer/Architect" we observe a failure to fill positions for more than 70% of the total. If we take the Cohesion South competition as an example, for about 2,800 fixed-term positions (3 years), we note that the total filling of posts was achieved only for the profiles "Legal Administrative Expert" and "Expert in Territorial Design". There were 1,245 vacancies left for the "Technical Expert" profile (engineers and architects), 722 for the "Management, Reporting and Control Expert" profile, and 12 for the "Expert Computer Analyst" profile[9].

The failure to achieve the objectives of the recruitment process for technical-scientific skills within central and local administrations leads to an overall reflection that cannot be limited solely to the scarcity of such professional profiles in the job market and the resulting competition from the private sector. These reasons, as we will see in the next paragraph, are not confirmed when observing the competition for the recruitment of personnel at Istat.

4. The specificity of recruitment of specialized profiles: the Istat case

In March 2022, Istat launched a public competition for the permanent recruitment of 100 research institution technical collaborators (CTERs), aimed at individuals with secondary school diplomas possessing appropriate statistical and digital skills, with the aim of placing new staff in the Institute's statistical production and technical support structures. The competitive procedure ended in December 2022, with the publication of the final ranking list.

In accordance with the recommendations of the OECD[10], the selection procedure was guided by the criteria of specificity and speed of the process. Regarding the first

among males: the percentage ranges from 30.8% in the South to 36.4% in the North. (Istat, Levels of Education and Occupational Returns - 2021).

[8] See FormezPA, Annual Report 2022.

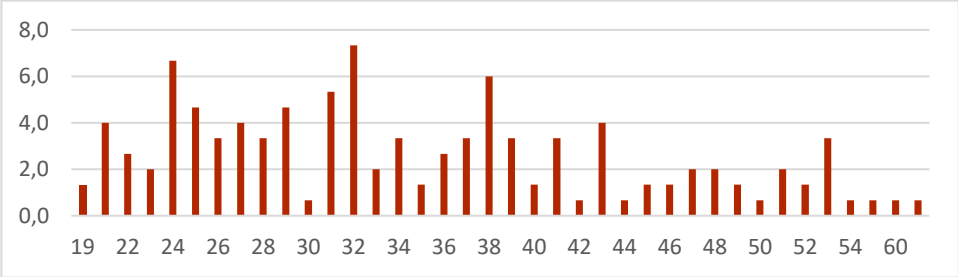
[9] See FormezPA, Annual Report 2022

[10] See OECD, Recommendation of the Council on Public Service Leadership and Capability, OECD/LEGAL/0445

criterion, a more suitable recruitment system has been outlined to assess the required specialized skills, giving priority to sector-specific selection tests (focused on subjects related to the required specializations: computer science, statistics, public and digital communication, old and new media, organization and activities of Istat), which are more capable of identifying the necessary abilities and competencies. As for the second aspect, priority has been given to the speed of the competition procedure and the subsequent hiring process, considering the general tendency of individuals with specialized skills to abandon the recruitment process when competitors offer job positions more quickly. The competition was conducted online, allowing for a reduction in completion times, cost management, logistical facilitations for candidates, and the efficient handling of a large number of participants. Approximately 17,000 applications were submitted; the number of candidates attending the written test exceeded 1,600; 100 candidates were successful and 50 were eligible.

The winners and eligible candidates are mostly young: they have an average age of less than 35 years. In particular, 55% of them are between 19 and 35 years old, with higher frequencies at 32 and 24 years old (7.3% and 6.7% respectively) (Figure 3).

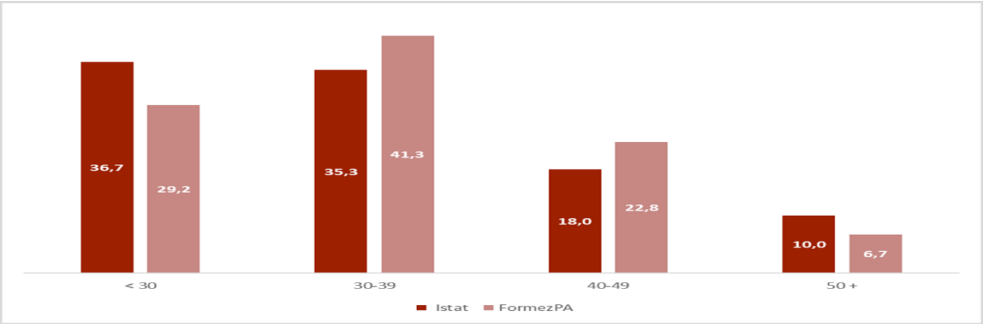
Figure 3 - *Winners/eligible candidates by individual age (%).*



Source: own elaboration on Istat data

Comparing the data from the Istat competition with FormezPA, there is a higher presence of young individuals among the winners/eligible candidates at Istat compared to those observed by FormezPA (Figure 4). In the case of the Istat competition, the most numerous age group is the youngest one, from 19 to 29 years old, while for the procedures managed by FormezPA, the largest number of candidates falls between the ages of 30 and 39.

Figure 4 – *Winners/eligible candidates by age groups (%).*



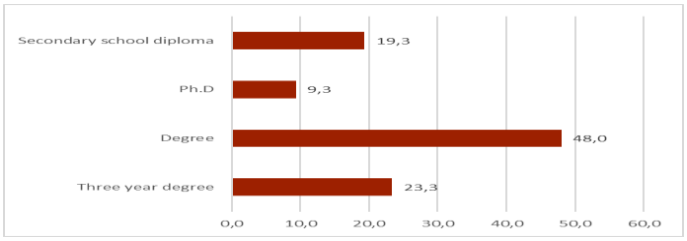
Source: own elaboration on Istat data and FormezPA data

Regarding gender, the winners/eligible candidates at Istat are predominantly men (66%), in contrast to the composition of all public employees and the previously mentioned FormezPA data (42% men). This divergence is partly attributed to the predominant fields of study in different procedures: in the case of Istat, as described below, there is a prevalence of graduates in STEM disciplines, in which the number of female graduates is lower compared to males. On the other hand, in the case of FormezPA competitions, STEM disciplines are marginally represented.

Regarding geographical origin, information about the residence of the winners/eligible candidates of the Istat competition highlights a predominance of Central Italy (slightly less than 53% of the individuals), influenced, however, by a strong presence of residents in the metropolitan area of Rome. This data is striking both when compared to the evidence from the data released by FormezPA (where 61% of the eligible candidates reside in the South of Italy) and in relation to the expected possibility for new hires at Istat to be assigned to the territorial offices of the organization, present throughout the national territory. However, considering that the central headquarters of the Institute is located in the city of Rome, there is undoubtedly a strong correlation between the work location and the residence of the individuals involved. Lastly, it is worth noting that Northern Italy continues to show the least interest in public employment, with 11.3% of the winners/eligible candidates in the Istat competition and only 8% in the FormezPA competitions.

Regarding educational qualifications, as previously mentioned, the Istat competition required candidates to have a high school diploma. However, the analysis reveals that over 80% of the winners/eligible candidates hold a higher educational qualification than what was required for the competition. In particular, when examining all the educational degrees presented by the individuals, it emerges that the majority of winners/eligible candidates (48%) have a master's degree, specialist degree, or an equivalent degree under the old education system (Figure 5).

Figure 5 – *Winners/eligible candidates by educational qualification (%).*

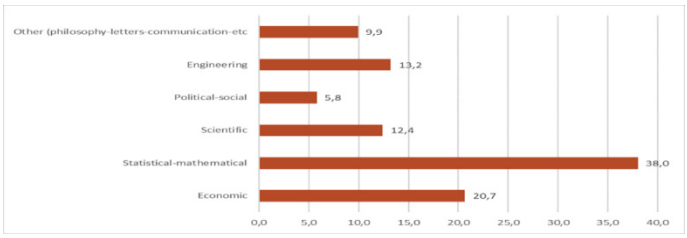


Source: own elaboration on Istat data

In absolute values, 86 individuals among the winners/eligible candidates have completed their university studies, and out of these, 14 have obtained a doctoral degree. The high level of education compared to what is required for the CTER (Technical-Scientific Researcher) position is also confirmed by the description of the main professional experiences of the candidates. Many of the winners/eligible candidates have gained experience in research (in public institutions, universities, and private organizations); many have had teaching experiences in secondary schools (mainly in scientific fields); many come from data analyst roles in the private sector. In particular, about 30% have reported previous experiences in other public administrations, and over 37% come from private research organizations and institutions.

Furthermore, concerning the thematic areas of the degrees obtained by the winners/eligible candidates, there is homogeneity among the individuals. The most frequent university study field is "statistics-mathematics" (38%), followed by the "economic" field (figure 6). However, there is no representation of the legal field among the winners/eligible candidates; none of them hold degrees in legal disciplines.

Figure 6 – *Subject areas of degrees awarded (80% of winners/eligible).*



Source: own elaboration on Istat data

In particular, it is interesting to highlight the preponderance of scientific profiles: overall, graduates in Stem disciplines accounted for more than 63% of Istat competition winners/eligible candidates ("statistical-mathematical", "engineering" and "scientific" fields). This is a very important figure, both with regard to the

achievement of the expected results of the competition and with regard to the overall trend of national competitions, in which, on the contrary, the recruitment of specialized professional profiles showed - as described - significant criticalities.

5. Recruitment in the Public Administration: a branding issue as well

The analysis carried out so far shows how the factors influencing the dynamics of public employee recruitment are diverse and heterogeneous. An allusion to how the Public Administration presents itself cannot be overlooked. Therefore, it is necessary to ask whether the Public Administration, as a preferred employer, is doing enough to enhance the attractiveness of public work. Probably not. Too little attention is paid to promoting a brand that appeals to potential candidates with values, motivation, and pride in contributing to the public good. There is almost no definition and dissemination of the factors that contribute to attracting and retaining qualified employees, which, according to the OECD, are areas that need investment in order to develop an effective and reliable public service[11]. Private organizations have long understood the importance of building a positive image of their activities, which is a minority approach in the public sector. The public sector is not accustomed to considering competition in the job market as a foundational element of organizational success[12]. The interest of Public Administrations in branding, understood as a strategy aimed at making the organization's identity attractive, is indeed a relatively recent phenomenon[13], connected to changes in the role of the State and the increased involvement of third parties in public action, as well as the scarcity of certain specific professional skills, there is emerging interest in forms of branding related to human resources management. This is because a positive perception of the institution encourages high-quality and high-quantity applications. The modernization of the Public Administration, therefore, requires the development of common branding strategies for the entire public sector, while at the same time differentiating them based on the individual institutions involved. The starting point is understanding what candidates might find attractive in working for a particular organization (*attraction*) and using it to communicate an employer brand.

In the case of Istat, the construction of an attractive reputation as an employer is now a key element in the organization's recruitment strategy. In this regard, interesting insights emerge from Irma De Marco's research[14], launched in April 2023 and conducted on a sample of students from public and private universities, aimed

[11] See OECD, cit.
[12] R. Ingrassia, *L'employer branding nelle organizzazioni pubbliche*, 2017.
[13] A. Wareaas, *Can public sector organizations be coherent corporate brands?*, Marketing Theory, 8, 2008.
[14] I. De Marco, "*Employer branding in Public Administration. The Istat case study*" graduate thesis in Public Administration Economics and Management, Bocconi University.

at identifying possible dimensions of attractiveness of the Istat[15]. The initial data highlights Istat's excellent placement as the reference institution for statistical production in our country. In fact, 96% of the respondents stated that they were aware of the Institute and its activities. Among them, 72% have used Istat data, and 14% have participated in initiatives/activities organized by the organization, such as training internships, seminars, and conferences. 70% of the interviewees believe that working at Istat can be interesting due to the relevance of the Institute's activities to their educational background, as well as their expectations regarding the development of skills and competencies in a research-oriented organization. When evaluating the attractiveness of the organization, dimensions such as *development value* (attractiveness related to growth opportunities within the organization and future career prospects), *application value* (attractiveness linked to the opportunity to apply one's knowledge), and *interest value* (attractiveness of an organization associated with the job content, innovative work methods, and the stimulating nature of the work environment) prevail.

The findings described in the survey are also confirmed by the evidence from the Istat competition experience, which shows a high participation of technical-scientific profiles. In contrast to the overall disinterest observed at the national level in the procedures managed by FormezPA, there is a greater engagement of young individuals, a high involvement of people with STEM degrees, even for positions that require qualifications lower than a university degree, and full coverage of available positions. The Istat experience highlights that the specificity of the organization seems to have attracted an audience that identifies with the core activities of the Institute. This audience exhibits diverse professional experiences but shows great homogeneity in terms of educational profiles. On the other hand, the disinterest towards other Public Administrations appears to stem from an image of a public sector founded solely on administrative and legal professions and tasks, as evidenced by the predominant educational and training profiles among candidates in competitions managed by FormezPA, rather than a wider variety of roles and functions that characterize current public institutions.

6. Conclusions

The need to meet specialist requirements has compelled the Public Administration to engage with the private sector. The initial results achieved through procedures for recruiting technical profiles necessary for the implementation of the

[15] The questionnaire is structured in 4 sections and captures information about the respondent and study background, knowledge of Istat, and interest in working at the Institute. As of July 2023, about 600 students from 18 public and private universities had participated in the survey. The sample consists of 55.3 percent females and 44.7 percent males. The average age of the respondents is 22 years old. The most represented degree programs are Economics and Statistical Science.

National Recovery and Resilience Plan (PNRR) have not been positive. However, these difficulties cannot be solely attributed to the lack of such professionals within our society, and it is overly simplistic to identify competition from the private sector as the sole cause of the lack of attractiveness of the public sector.

To achieve the objectives of public sector renewal, it is necessary to develop proactive branding and recruitment strategies that effectively communicate the purpose, activities, and reliability of a work environment capable of meeting the recognition needs of the various professional profiles present within it. To overcome the emerged challenges and improve the planning capacity of the public sector, it is also crucial to understand the relevant contexts and analyze the data available to administrations. This includes data concerning internal personnel as well as ongoing selection procedures, which can provide valuable information for adopting data-driven strategies. In this way, recruitment processes can be aligned with the real functional needs of administrations and the changes taking place in the public sector during this transition period.

Acknowledgment

We would like to thank Dr. Antonella Bianchino (Istat) for helpful suggestions and support in the data analysis of the research *Employer branding in Public Administration. The Istat case study*.

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INCOME DISTRIBUTION IN LOMBARDY DURING THE PANDEMIC TRANSITION: A TERRITORIAL STUDY[1]

Simona Ballabio, Elena Sorba, Alberto Vitalini

Abstract. The COVID-19 pandemic has had a disruptive impact not only in terms of health emergency, but also from a social and economic perspective. At least in the short term, the effects in terms of economic fragility on the population seem to be inevitable both as an increase in the incidence of fragility and as an increase in the intensity of fragility. However, these risks are not evenly distributed among different territorial areas. In general, variability at different levels is an important key to interpreting social phenomena, especially for the implementation of effective territorial policies.
The work proposes to analyze the impact of the pandemic crisis on the economic fragility of the Lombardy population at the municipal level, using income data from tax returns provided by the Italian Revenue Agency for the period 2014-2021.
The analysis shows that the municipalities most affected by the crisis triggered by the spread of COVID-19 are those with a constant or positive pre-pandemic economic trend, i.e. those with a more vibrant economy. By contrast, the risk of increased economic fragility is less high in municipalities characterized by a negative trend, i.e. less economic dynamism. Furthermore, the analysis shows that the risk of increased economic fragility is less in small municipalities, characterized by a larger aging population, which seems to play a protective role. The prevailing manufacturing specialization helps to explain the variability observed at territorial level. In particular, heavy manufacturing municipalities seem to be the least affected.

1. Background

In 2020, the COVID-19 pandemic has had a strong impact not only in terms of a health emergency, but also in social terms due to the economic shock triggered by the containment measures. The containment measures taken to limit the spread of the virus, such as lockdowns and imposed closures, led to a contraction of production and employment, resulting in increased poverty and inequality both within and

[1] The work is the joint responsibility of the authors. Paragraphs 1 and 4 are attributed to Elena Sorba, paragraphs 2.1, 2,2, and 3.2 to Simona Ballabio, paragraphs 3.1 to Alberto Vitalini.

between countries (Palomino *et al.*, 2020). The level reached by absolute poverty in 2021 (7.5%) in Italy is among the highest since the year this indicator began to be measured. In particular, in the North, there has been a sharp increase in households in absolute poverty: 6.7% in 2021 compared to 5.8% in 2018 (Istat, 2022a). Initially, the crisis reproduced pre-existing inequalities, affecting those with precarious jobs, especially women, young people and foreigners, but it also affected many self-employed in traditional activities (Brandolini, 2021; Istat, 2021; Carta and Philippis, 2022).

The long-term consequences are not yet fully foreseeable (Martin *et al.*, 2020) but seem inevitable in terms of an increase in economic and social fragility, with effects especially on lower incomes and with clear territorial and spatial differences (Almeida *et al.*, 2021). Also in consideration of the fact that the effects are triggered on non-homogeneous distribution of economic performance in the pre-pandemic period (Mussida and Parisi, 2020).

The Italian economic and social framework is characterized, also in 2021, by the negative repercussions of the crisis resulting from the health emergency, but also by the outline of the recovery of economic activity (Istat, 2022b). The economic effects produced by the crisis triggered by COVID-19 have not yet been completely reabsorbed: in 2021, Italian GDP grew by 6.6 percent, recovering two-thirds of the exceptional contraction that occurred in 2020 (Bank of Italy, 2022).

Within this framework, the aim of the paper is to explore, with a purely descriptive purpose, the impact of the pandemic crisis in terms of the greater economic fragility of the population at a territorial level in Lombardy. In particular, the focus is on the variations in income between the pre-pandemic period and the period following the outbreak of the pandemic due to COVID-19, keeping track of economic trends in previous years. That is, we examine the impact of the COVID-19 pandemic outbreak on per capita income in both 2020 and 2021 at the municipal level in Lombardy, in terms of income trend change. In essence, we ask whether, at the level of individual municipalities in Lombardy, the impact of COVID-19 on income changes in 2020 was positive, negative or absent. Similarly, we ask whether in 2021 the situation has recovered, worsened or remained unchanged. In order to determine whether any negative effects of COVID-19 also persist in the year following the year of the outbreak of the health emergency, we look at whether the municipalities that were negatively impacted in the first year of the pandemic, that is, in the year most affected by the containment measures, have recovered their pre-pandemic trend in the following year or continue to be characterized by a slower growth trend. Similarly, we assess whether municipalities that were not negatively impacted by COVID-19 in the first year were also spared in 2021 or experienced a delayed negative impact in terms of declared per capita income.

The analysis of per capita income data at territorial level can provide important information for the implementation of public policies aimed at mitigating the economic effects of the pandemic. For example, the municipalities that suffered the greatest negative impact may need targeted interventions to stimulate economic and social recovery. Moreover, the focus on Lombardy's municipalities could be used as a basis for comparative analyzes with other Italian regions or other countries, in order to assess territorial and spatial differences in the impact of the pandemic on the economic fragility of populations.

2. Data and Methods

2.1. Operationalizing the concept of pandemic crisis impact

The data used are taken from tax returns provided by the Italian Revenue Agency for the period 2014-2021. These data offer the possibility of analysis at a fine territorial level, the municipal level, but they also have limitations. The use of declared income does not take into account the income support measures provided by the government and does not take into account tax evasion, which is a non-marginal phenomenon in Italy. As context data, some demographic statistics and classifications defined by the Italian National Institute of Statistics (Istat) were used, using the municipalities of Lombardy defined at administrative boundaries referring to 2021 as the unit of analysis.

The impact of COVID-19 is measured in terms of the change in income in 2020 and 2021 compared to the pre-pandemic period. To assess the impact of COVID-19 on income, we could limit ourselves to looking at the 2019/2020 and 2019/2021 change. However, the economic trend that characterized the various territories in the pre-pandemic period is not evenly distributed; some territories are characterized by negative income variation, others by no variation and still others, most of them, by more or less pronounced growth. If only the annual variation is considered, there is a risk that the impact of Covid is not correctly assessed because the annual variation may be in line with the previous trend. For example, if the trend is - 0.5% per year and a similar decrease is observed between 2019 and 2020 and between 2019 and 2021, we cannot automatically attribute this decrease to the effect of the pandemic crisis (because no discontinuity is observed). To control this, we compared the 2019/2020 and 2019/2021 rate of change with the average annual rate of change of the previous five years by simply subtracting the two values. We thus obtain a difference of percentage points. If the difference is positive the impact of Covid is considered positive, if the difference is zero the impact is zero, if the difference is negative the impact is negative. In order to observe the income impact of Covid

during the year in which the Prime Ministerial Decree imposed the containment measures, and in order to observe the impact of the pandemic during the only year for which declared incomes are available after the pandemic but are not subject to economic activity closures imposed to limit the spread of the virus, we separately considered the 2019/2020 variation and the 2019/2021 variation. For the trend, the period following the readjustment after the great recession triggered in 2008 was considered.

For an exploratory analysis and visualization of the spatial distribution of the effects of the pandemic crisis, an impact typology was constructed with essentially heuristic value. As a first step, a two-mode classification was determined for both 2020 and 2021, in both cases with respect to 2019:

1. neutral or positive impact: municipalities with no change in income trend or with positive trend change. For example, municipalities with an average rate of change for 2014-2019 of 0.5% and a 2019/2020 rate of change of 0.5% or more.
2. negative impact: municipalities with a negative trend change. E.g., municipalities with an average rate of change for the period 2014-2019 of 0.5% and a 2019/2020 rate of change of 0.1%, a difference of -0.4 percentage points.

In a second step, by combining the values of the two previous classifications built on the two different years, a typology consisting of four types was determined:

1. no or positive impact: municipalities with no or positive trend change in both 2020 and 2021;
2. negative impact reabsorbed: municipalities with negative trend change in 2020 but no trend change in 2021;
3. lagged negative impact: municipalities with no or positive trend change in 2020 but negative in 2021;
4. negative impact that persists: municipalities with negative trend change in both 2020 and 2021.

2.2. Analysis tools

To show the distribution of impact among the municipalities of Lombardy, according to the classifications presented in the previous paragraph, we used choropleth maps. Instead, to describe the characteristics of the municipalities that modulate the probability of being more exposed to a negative impact that either

persists or is delayed, or at the opposite protected, we will use a decision tree strategy (or classification tree). The tree classifies cases into homogeneous groups, based on the values of independent variables (predictors) that predict the values of a dependent variable (target). In particular, we will use SPSS Answer Tree and CHAID (Chi-squared Automatic Interaction Detection) growth methods as statistical tools. At each step, CHAID chooses the independent (predictor) variable that has the strongest interaction with the dependent variable. For each node, the tree shows the number and percentage of members of the target group. The subdivisions of the municipalities are made in order of importance. The categories of each predictor are merged if they are not significantly different from the target variable. The target variable is divided into four modes and corresponds to the impact classification taking into account both 2020 and 2021.

The independent variables, in line with the literature, are:

- province;
- population size class (dummy: 1. up to 5,000 inhabitants, 2. more than 5,000);
- altitude zone (1. mountain, 2. hill, 3. plain);
- prevalent tourist vocation (1. non-tourist, 2. non-lacustrine tourist, 3. lacustrine tourist);
- prevalent manufacturing specialization (1. nonmanufacturing, 2. made-in-Italy, 3. heavy manufacturing;
- per capita income trend in 2014-2019 (1. negative, 2. stable or positive up to 2% (3rd quartile), 3. above 2%);
- per capita income 2019 (1. below I quartile (€14,494) , 2. between I and III quartile (€17,603), 3. above III quartile);
- incidence of foreigners no-eu (1. below I quartile (3.5%), 2. between I and III quartile (8.1%), 3. above III quartile);
- incidence 65 and older (1. below I quartile (21.1%), 2. between I and III quartile (26.6%), 3. above III quartile);
- incidence of self-employed taxpayers (1. below I quartile (11.3%), 2. between I and III quartile (15.6%), 3. above III quartile).

3. Results

3.1. Municipal distribution

In Lombardy in 2020, the pandemic due to COVID-19 had a general negative impact on declared per capita income. Approximately 9 out of 10 municipalities were negatively impacted, if only in terms of a slowdown in the growth trend (Fig. 1). In

2021, the geography of the effects of COVID-19 changes profoundly: the percentage of municipalities affected by a negative income trend change compared to the pre-pandemic period drops to around 40% (fig. 2).

Figure 1 – *Choropleth map of the impact of COVID-19 at municipal level in 2020.*

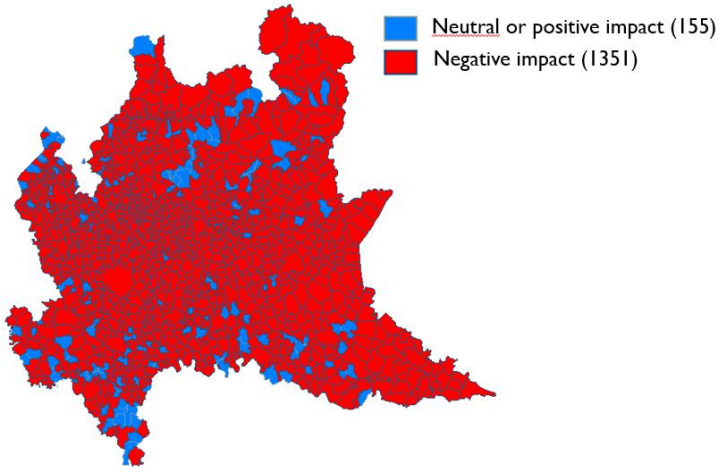
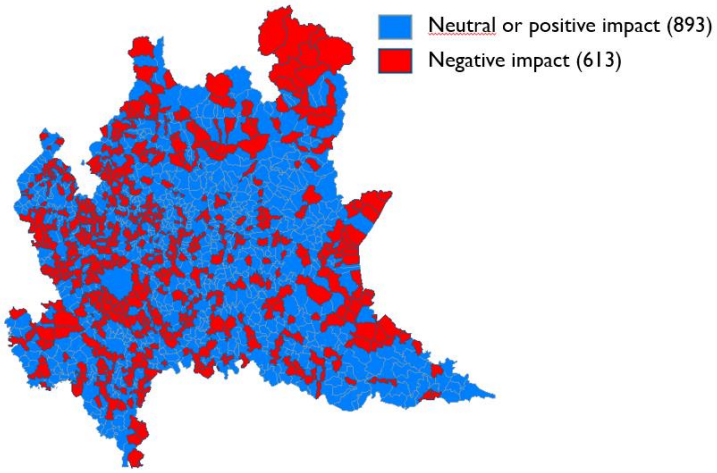


Figure 2 – *Choropleth map of the impact of COVID-19 at municipal level in 2021.*



Considering the two years together, it can be seen that about 9% of the municipalities do not appear to have suffered any negative impact, while half of the Lombardy municipalities, although having suffered a negative impact in the year of the restrictions and closures determined for the containment of the virus, already recovered in 2021 a trend of per capita income in line with or above the pre-pandemic period. Approximately 40% suffer a negative impact in 2020 that persists into 2021,

when the containment measures are relaxed, and very few municipalities (21) suffer a delayed negative impact.

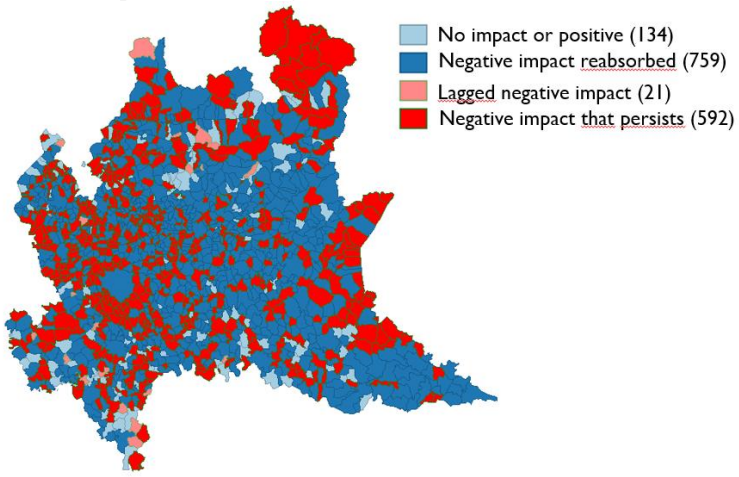
Observation of the choropleth map reveals a territorial trend towards a concentration of negative impact of the COVID-19 pandemic. In particular, a concentration is observed in four distinct areas of the regional context, characterized by specific connotations of the economic structure. Although the relationship between the consequences of Covid-19 on declared income (associated with the municipality of residence) and the economic system is certainly also influenced by the phenomenon of work commuting, which in Lombardy involves a significant share of workers, especially in some areas.

The first area affected by the negative impact is concentrated in the Milan hinterland, with the exclusion of Milan. This area is characterized by the presence of numerous industrial and commercial activities, which have undergone severe contractions due to the containment measures adopted to limit the spread of the virus.

The second area affected by the negative impact of the pandemic concerns the lake municipalities bordering Lake Garda, in the province of Brescia. This area is highly dependent on tourism and the hotel industry, sectors that have suffered heavy losses due to the health crisis.

The other areas affected are the upper Valtellina and, in a widespread manner, the provinces of Varese and especially Como (Fig. 3). Even in these areas, the negative impact of the pandemic has been significant, resulting in increased economic fragility and reduced income.

Figure 3 – *Choropleth map of the impact of COVID-19 of the impact of COVID-19 at municipal level taking both 2020 and 2021.*



In terms of the percentage of municipalities affected, there seems to be a relationship between the negative impact of the pandemic crisis and the province they belong to, with a rather high incidence of negative impact in the provinces of Milan and Como. This is also confirmed by looking at the number of people affected by province: in the Como area, almost one in two of the people reside in municipalities with a negative impact of the pandemic crisis on income. Moreover, two out of five of the people living in Sondrio, Milan and Pavia reside in municipalities that have been affected by the negative impact of the health crisis on per capita income. In contrast, the municipalities that were spared by the crisis triggered by COVID-19 in terms of income are mainly concentrated in the provinces of Bergamo, Cremona and Brescia: here, about four out of five residents reside in municipalities that were not affected by a negative impact or the negative impact recorded in 2020 was reabsorbed.

Table 1 – *Municipalities with lagged or continuing negative impact by province and population. Absolute values and percentages.*

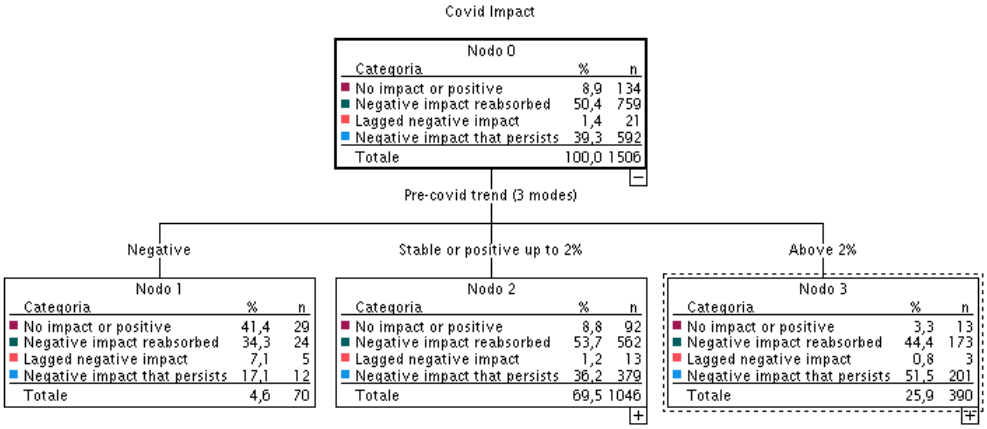
Provinces	Lagged negative impact		Negative impact that persists		Total population	
	a.v.	%	a.v	%	a.v	%
BERGAMO	4	1.6	68	28.0	273.697	24.8
BRESCIA	0	0.0	63	30.7	336.777	26.8
COMO	1	0.7	74	50.0	290.126	48.7
CREMONA	0	0.0	36	31.9	86.067	24.5
LECCO	0	0.0	33	39.3	118.272	35.5
LODI	1	1.7	26	43.3	79.870	35.1
MANTOVA	0	0.0	23	35.9	111.888	27.6
MILANO	1	0.8	81	60.9	1.297.873	40.2
MONZA E BRIANZA	0	0.0	21	38.2	300.103	34.5
PAVIA	9	4.8	69	37.1	214.380	40.1
SONDRIO	3	3.9	34	44.2	75.080	42.0
VARESE	2	1.4	64	46.4	335.404	38.2
Total	21	1.4	592	39.3	3.519.540	35.3

3.2. Application of the decision tree

The application of the decision tree shows that municipalities with a positive trend in per capita incomes in the pre-pandemic period are more affected, i.e. the probability of having suffered a negative effect is much higher in correspondence with the most lively economic realities. Conversely, the risk of an increase in

economic fragility is less high in municipalities with a negative trend, i.e. municipalities that were already starting from a more difficult economic situation.

Figure 4 – *Decision tree for impact classification: Node 0.*



Among municipalities with a constant or positive but less than 2% income growth trend in the pre-pandemic period, the variability of the phenomenon is primarily explained by population size class: the risk of an increase in economic fragility is less high in smaller municipalities (up to 5,000 inhabitants), with the difference depending on the level of population aging. The municipalities with a higher incidence of elderly people are more likely to have suffered a delayed negative impact, in all likelihood the higher incidence of pensions may, at least initially, have helped to stem the negative effects of the economic crisis triggered by the spread of the virus, at least in terms of income reduction.

In municipalities with more than 5,000 inhabitants, the likelihood of having been negatively impacted varies according to the prevailing specialization of the local labour system (LTS) to which the municipality belongs. The least affected municipalities are those in heavy manufacturing, which experienced a less significant negative impact than other sectors of the local economy.

On the other hand, as regards the municipalities with a more lively pre-pandemic economy, with a positive income change of more than 2%, it is mainly the provinces of Bergamo and Brescia that are least affected by a negative impact. Rather, in these provinces most of the municipalities, although affected by a slowdown in income growth in 2020, recovered or improved their previous trend in 2021.

Figure 5 – *Decision tree for impact classification: exploding Node 2.*

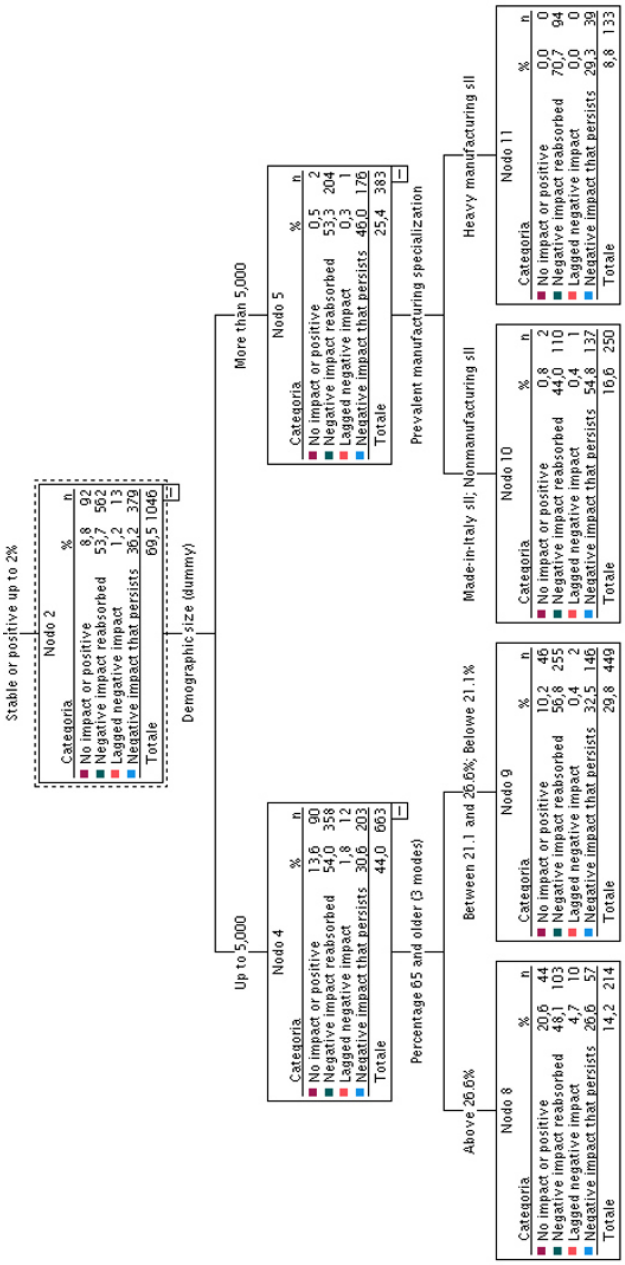
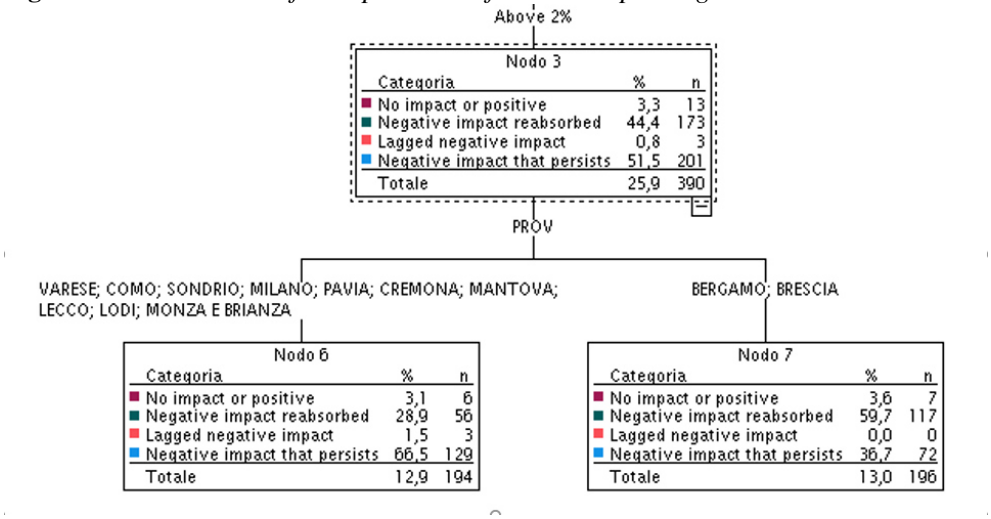


Figure 6 – *Decision tree for impact classification: exploding Node 3*



4. Conclusion and some further developments

Analyzes showed that the impact of the COVID-19 pandemic on income does not seem to have been evenly distributed across the territory. Some provinces were more affected, in particular the province of Como and also that of Milan. Other provinces, however, were less affected, in particular the provinces of Cremona, Bergamo and Brescia.

An important factor that seems to be able to modulate the distribution of the impact seems to be the pre-pandemic period. The most affected areas are those that are economically more vibrant.

A protective factor with respect to impact seems to be, in smaller municipalities, the degree of aging of the population. In all likelihood, at least initially, the high proportion of elderly people receiving retirement income mitigated the income impact of the economic crisis triggered by COVID-19. In municipalities with a population over 5,000 inhabitants, the protective role seems to be played by specialization in heavy manufacturing.

The main limitation of the work, besides the use of declared income that does not take into account the income support measures provided by the government and tax evasion, is not having considered the intensity of the impact. An in-depth study of the dynamics at the territorial level would be desirable, also in explanatory terms, taking into account not only the presence of the impact but also the strength of the effects on the variation of the income trend.

It would also be interesting to relate the impact of COVID-19 on income to some measures of poverty and to investigate the effects of the crisis triggered by COVID-19 on the unequal distribution of income at the municipal level, using measures such as the Gini index.

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AN ANALYSIS OF LABOUR COST POLICIES THROUGH STATISTICAL REGISTERS[1]

Sara Gigante, Silvia Pacini

Abstract. The RACLI Register, now being included in the Labour Register, with information on employment, hours, wages and social contributions at job level for the subpopulation of jobs in the private non-agricultural sectors' enterprises is a useful tool for the monitoring and evaluation of the labour market policies. This micro level employer employee longitudinal database allows deep analyses in particular for the evaluation of contributions reduction' measures thanks to the recent estimation of social contributions (total and distinguished by employer and employee social contributions) and the track of all related cost items at job level. These analyses are reliable thanks to a metadata driven process based on an integrated dynamic metadata system designed and implemented to achieve the dual purpose of interfacing with the administrative sources and their continuous changing over time and with the system of statistical production (surveys and registers). This paper aims to illustrate the potential of the register as a suitable instrument for conducting studies on the implementation and effects of labour market policies and to explore the impact on wages in addition to those linked to employment. First results, according to the characteristics of jobs, workers and employers, for the reference years 2016–2020 are presented.

1. Introduction

The evolution of the statistical register and, among them, of the register on wages, hours and labour costs (RACLI[2]) on the employees of enterprises in the private non-agricultural sectors allows deepened analyses on the labour market also related to the monitoring of the expected or actual impact of targeted policies. This

[1] Authors' opinions do not necessarily reflect Istat's official policy. The paragraphs are attributed as following: 1 and 54 to Silvia Pacini; 2, 3 and 4 to Sara Gigante.

[2] The RACLI register is the forerunner of the Labour Register for the subpopulation of dependent jobs in the enterprises of the private non-agricoltural sectors and release information since the reference years 2014. In the recent years the Labour Register development is in progress and the RACLI register will be embedded in it (Baldi *et al*., 2018).

is possible thanks to the RACLI register's statistical unit, the job, defined as the connection between an employee and an employer starting with an activation date and ending with a closing date, whose longitudinal coherence from the year 2014 has been granted through a control and correction treatment process. At this level of detail, the information available are related to different measurements of labour input, as employment stocks and flows and hours paid and worked, as well as variables on wages and, recently since the reference year 2016, also on labour cost. In the last years, indeed, a complex estimation methodology of social contributions, separately charge to employer and employee, have been implemented throughout the reconstruction of the statistical information starting from very detailed administrative micro codes. As illustrated in paragraph 2, this successful operation has been requiring the design, implementation - still in progress -, and recurring updating of a complex metadata system. It covers and connects the input sources metadata to the statistical output metadata through the process metadata, making possible the estimation of target statistical variables and the profiling of policies aimed at the labour cost's reduction, respecting data confidentiality that is a building blocks of the process itself. Paragraph 3 describes a brief introduction to the experimental analysis of the impact of the labour policies based on a reduction in employer social contributions, while the methodology and the results are described in paragraph 4. Some conclusions are briefly summarized in paragraph 5.

2. What makes the RACLI register a useful tool for studying labour policies?

The purpose of this article is to demonstrate the register's potential as a useful tool for doing research on the implementation and effects of labor market. According to the literature, the availability of an adequate information base is required: good information systems, mostly powered by administrative archives, are a critical support (Trivellato, 2009). To begin, it is necessary to emphasize the register's census-like aspect as well as the availability of reliable information at the job-individual-firm level referring to multiple dimensions. Indeed, the register's goal is to provide a relational system as well as a standardized technological and methodological foundation, allowing for a multidimensional and consistent picture of the private labour market and organizing the outputs in a dynamic, performing, controlled, and documented structure from which micro-data and aggregate statistics can be obtained. What is more, because social systems are complex (Marchesi *et al*., 2011) it is challenging to identify the processes that led to the results (the

program is a "black box"[3]). The RACLI register, reflecting the nature of the topic to which it refers, is capable of naturally representing a complex system, especially when placed in a system of interactions with other registers (the interactions between items generate information, and the whole is greater than the sum of its parts). First of all, the register is not a static structure but rather a complex organization in constant motion, susceptible to continuous stressful events arising both from the suppliers' side (administrative data flows and socioeconomic realities) and from the users' side (different research scopes and goals that are not totally programmed). Change is not an incidental aspect but rather a necessary component of the process that has to be appropriately incorporated into the architecture. It continuously needs to collect and update information, potentially providing researchers with valuable insights into employment trends and the effectiveness of various labour market interventions. It can also provide a valuable tool in computational Social Science and Social Cognition, as it allows for the analysis of complex systems and their interactions. By studying the relationships between different registers, researchers can gain a deeper understanding of the underlying processes that contribute to the observed results and uncover hidden patterns and dynamics that may not be apparent when studying individual components in isolation. This approach may help shed light on the "black box" nature of certain programs and provide insights into how they operate. To achieve these goals, the register must equip itself with suitable technological and organizational tools adaptable to the register's and the theme's complexity by: (a) making the Register's fundamental structure both stable and flexible; (b) ensuring underlying consistency across all processes; (c) activating economies of scale and facilitating resource transversal usage; and (d) serving data quality and data management.

The dynamic integrated system of metadata designed and partially created in the register, in particular, is at the heart of the employment information system, acting as the pivot on which the Register's different functions rely. It is intended to serve two functions: (a) interaction with the changing external environment (administrative information flows and, more broadly, the socioeconomic environment); and (b) communication with the internal statistical production system (surveys and registers). The system aids in data protection, tracking administrative sources, and process quality control. It ensures accurate interpretation of estimates and enables contextual and automated modifications to procedures and information systems (a metadata-driven process), responding to the dynamic nature of the input. Operationally, the procedures "read" from the metadata system both the extraction path of the different information needed for the process as well as their

[3] In mathematical models, the system is a black box, i.e. it is not known a priori either what it contains or how it behaves. It is possible to study its behaviour solely by analysing the responses it produces in the face of the demands it receives.

usage, and return the estimates and associated quality indicators (process and output). The metadata creation process involves horizontal integration of available input metadata, vertical integration of administrative sources, and information transformation. The theoretical unit of the system (item) is defined as the combination of period, source, variable, and modality. Horizontal metadata integration involves combining several types of information to provide a complete representation of each item. Vertical integration of administrative sources requires combining and harmonising metadata from several inputs. Transforming information requires making metadata actionable and accessible by converting it from passive to active for metadata-driven activities. The meta-information pertaining to the input, process, and output metadata must be connected in a cohesive way, allowing all processes to refer to this single information source. It is critical to emphasise that, due to the system's complexity, updates cannot be fully automated; instead, theme experts must process them. In addition, it is necessary to maintain margins of flexibility that can absorb shocks through semi-structured parts of the system. Furthermore, leveraging the entire system allows for the derivation of complicated variables (e.g., compensation of employees - D.1 definition of the System of National Account), the extraction of data and metadata for insights (e.g., evaluation of youthful recruiting policies, recourse to social shock absorbers, short-time work schemes), and the extraction of subpopulations of interest (e.g., disadvantaged workers). The system is designed, built, and functioning in its fundamental elements, but experimentation and innovation are ongoing, necessitating continuous learning and improvement.

3. Introduction to the exploratory study on labour cost reduction measures

Both social progress and full employment are goals shared by the European Union (European Union, 2012). To encourage a renewed process of convergence towards improved living and working conditions, the European Pillar of Social Rights, which was established in April 2018, specifically lays out 20 fundamental principles and rights that fall into three main categories: (a) equal opportunities and access to the labour market; (b) fair working conditions; and (c) social protection and inclusion. Governments can mediate on the labour market through labour market institutions (e.g., minimum wages, employment protection legislation, etc.), aggregate fiscal policy (changes in public expenditure and taxation), particular labour market policies, and social protection programs. In particular, European and national labour policies are increasingly focusing on a broader variety of people who face disadvantages and hurdles to entering or re-entering the labour force. Young people, over-50 workers, female workers, non-EU workers, and those seeking

employment are targeted, including those without secondary education or equivalent qualifications. They may be in specific situations, travel across EU Member States, or seek employment after long periods of unemployment. In Italy, the social contribution reduction, offered to firms with specified features for workers belonging to categories judged deserving of special protection and/or to ensure job stability, plays a particular function in the labour market policy. In particular, hiring incentive schemes aim to reduce labour costs for employers and increase job opportunities for workers. Classified among the active labour market policies (ALMPs)[4], hiring incentives have non-excludable stated goals to encourage labour demand and shift from insecure to more secure contractual forms; they can result in significant inert costs if they support employment that would have been created anyway, as well as travel expenses if they eliminate jobs elsewhere. Additionally, workers hired with a short-term hiring subsidy may be replaced by new subsidised hires after the subsidy expires, causing job turnover rates to increase without adding to employment (the "revolving door" effect) (Brown *et al.*, 2011). Considering that the RACLI register has already been used in research on the minimum wage (Istat, 2023) and employment quality (Gigante *et al.*, 2019), this paper also intends to explore the effect on salary aspects in addition to those linked to employment. Hence, in this exercise, the impact is measured in terms of job length and other quality indicators (in terms of the features of the employment relationship relevant to the year of activation and future years). The study that follows examines the impact of labour cost reduction measures in Italy between 2016 and 2020 on newly activated jobs and includes a counterfactual analysis. The census availability of economic and social information on domain units, the ability to precisely identify individuals who have benefited from a policy and the longitudinal structure of the information allows for a counterfactual approach; in order to "avoid (..) conceptual misconceptions, it is crucial to adopt the definition of effect according to the counterfactual logic, now affirmed in the social sciences" (Trivellato, 2008). According to counterfactual paradigm (Morgan *et al,* 2007), the effect of an intervention is defined as the difference between what is seen in the presence of the intervention and what would have been observed if the intervention had not been there. since it is impossible to witness the effect of an intervention at the individual level by definition, the study extracted a group of non-beneficiaries who were the most similar to the beneficiaries, essentially emulating the value that the outcome variable would have had if the treated group had not been included. The goal of this exercise is to investigate the

[4] That are publicly funded interventions aimed at improving the functioning of the labour market by inducing changes in labour supply and demand, as well as their matching process. The Organisation for Economic Coordination and Development database classifies ALMPs into six broad categories: (i) training; (ii) employment incentives; (iii) direct job creation; (iv) start-up incentives; (v) public employment services and administration; (vi) sheltered and supported employment and rehabilitation.

overall impact of the policies on labour market enacted through a reduction in employer social contributions[5]. The main Italian labour policies (in terms of number of workers involved) based on reduction of social contributions in the period 2016–2020 are the *Jobs Act* (since 2014)[6], the structural incentive for youth employment[7], reduced labour costs for apprenticeships[8], incentives for hiring over 50s[9], contribution relief for employment in disadvantaged areas[10].

Table 1 – *Main professional/individual features of jobs with or without a reduction in employer social contributions. Years 2016-2020, absolute and percentage values.*

Year	Reduction	N. jobs (th)	Part time	Fixed term	Women	At least graduates	<30 years	Employer contribution*
2016	No	14,041	29.3	32.9	40.6	13.2	17.4	47.9
2016	Yes	3,318	37.4	12.6	41.4	13.7	37.9	24.9
2017	No	15,630	30.7	38.7	40.7	13.1	19.6	48.1
2017	Yes	3,138	36.6	13.7	42.8	14.8	38.5	25.6
2018	No	16,617	31.3	40.0	40.6	13.3	19.7	48.2
2018	Yes	2,923	36.1	15.5	43.2	14.8	42.6	28.3
2019	No	17,842	31.8	35.7	40.7	13.8	19.2	48.1
2019	Yes	1,848	35.4	22.9	44.7	14.3	61.4	26.6
2020	No	14,670	30.6	33.1	40.8	14.5	17.9	47.4
2020	Yes	3,594	36.8	21.8	39.1	14.7	36.2	41.2

**Calculated as percentage of gross wages.*

4. A non-parametric observational strategy for a counterfactual analysis

As a starting point, a descriptive study of the implementation of labour cost reduction measures between 2016 and 2020 indicates that beneficiaries[11] have a

[5] Theoretically, once the integrated metadata system is fully updated, the availability of information on required contribution items at the job level allows for the precise identification of each policy intervention

[6] L. 183/2014 (Job Act) contains two main measures: the introduction of the contract with increasing protections for new permanent employees and a contribution deduction for permanent employee.

[7] L.205/2017 (budget low) introduces a reduction of social security contributions charged to private employers for hiring with permanent employment contracts from January 2018 under certain age limits.

[8] The social contributions charged to employers for apprentices is equal to 10% of the gross wages.

[9] L. 92/2012 recognizes an incentive to employer for hiring individuals aged 50 or over who have been unemployed for over twelve months.

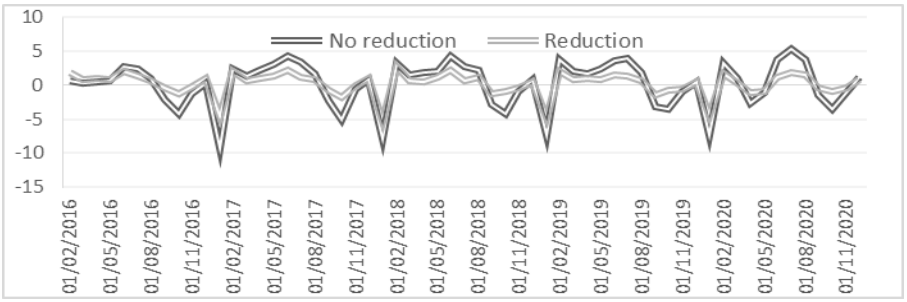
[10] In accordance with DL.104/2020, employers in the private sector in regions with a per capita GDP not surpassing 90% of the average of the 27 nations now comprising the European Union and an employment rate below the national average would have their payments reduced.

[11] The worker characteristics (gender, age and education level) are from the Istat Population Register.

lower frequency of fixed-term contracts and a larger incidence of part-time positions. They are concentrated in all years among employees under the age of 30 and with at least a university degree, and among women up to 2019. The median reduction in labour cost is greater than 21 percentage points until 2019, then drops to 6.2 percentage points in 2020.

Monthly employment fluctuations (Figure 1) were more contained in firms that benefited from labour cost reduction plans for at least one job between 2016 and 2020 (1.3 million) than in firms that did not (853 thousand).

Figure 1 – *Monthly jobs' number changes in firms having or not at least one job with a reduction in employer social contributions. Years 2016-2020, percentage values.*



It is crucial to remember that, in the absence of appropriate treatment, these basic descriptive statistics on the group of beneficiaries and non-beneficiaries may be impacted by: (a) selection bias: the two groups may not be equal; and (b) distortion from spontaneous dynamics: the outcome variable may vary independently of public intervention. In order to "avoid these conceptual misconceptions, it is crucial to adopt the definition of effect according to the counterfactual logic, now affirmed in the social sciences", the counterfactual analysis is performed using a non-experimental design and a non-parametric approach. The procedure is divided into four steps:

1. *Identifying outcome variables:* 1a. In the year of activation, differences in various job quality indicators (percentage closure incidence, hourly wage, labour cost per hour paid, percentage incidence of fixed term and part time); 1b. Differences in hourly and annual wages after 12, 24, 36, and 48 months; 1c. Differences in the number of jobs persisted after 12, 24, 36, and 48 months.
2. *Identification of the beneficiaries:* the availability of information on mandatory contribution items at the job level, with the assistance of the integrated dynamic metadata system, enables the precise identification of the jobs for which the employer requests to take advantage of a contribution relief policy.

3. *Variables for matching:* the pre-treatment variables (X) on which the matching strata were generated are related to the worker and the characteristics of any previous employee jobs. The following were specifically considered: X_1 Territory (province of work); X_2 Age (in 10-year classes); X_3 Educational Level (in 5 classes); X_4 Gender (females vs. males); X_5 Country of Birth (Italy vs. abroad); X_6 Presence of a previously dependent job (a dummy variable in the private sector); X_7 Hourly wage of previously dependent jobs (in 3 classes). With these attributes held constant, a random match between the two groups was formed.
4. *Statistical matching procedure*: it is based on a highly severe profiling (1:1 coupling) and starts from the total number of activated jobs with a reduction every year (Table 2).

Table 2 – *Activated job beneficiaries and matched non-beneficiaries composition according to the matching covariates. Years 2016-2020. Percentage values.*

Dimension	Activated jobs with reduction	Matched jobs	Dimension	Activated jobs with reduction	Matched jobs
Year			Geographic area		
2016	23.1	24.7	North East	19.7	21.0
2017	17.6	18.4	North West	19.4	20.8
2018	18.5	19.6	Center	17.3	18.4
2019	17.3	18.5	Islands	12.6	11.6
2020	23.6	18.8	South	31.0	28.1
Country of birth			Age		
Italy	82.9	82.7	15-29	50.4	52.5
Abroad	17.0	17.3	30-49	33.5	32.4
NA	0.0	0.0	50 and +	16.1	15.2
Sex			Previous jobs' hourly wage		
Female	43.2	43.7	1 Quantile	13.0	10.3
Male	56.8	56.3	5 Quantile	1.5	1.7
Previous jobs			Education		
At Least One	71.6	72.5	Primary	39.6	39.6
			Secondary	40.3	40.4
			Tertiary	11.4	11.3
None	28.4	27.5	N/A	8.7	8.7

The matching technique identified 'twins' for 99% of the jobs in 2016 (on 1.1 million beneficiaries) and 2019 (on 869 thousand), 98% in 2018 (on 927 thousand), 97% in 2017 (on 883 thousand), and 74% in 2020 (on 1.2 million). In the year of activation, the group hired with a reduction had a lower number of jobs closed within the same year (-18 percentage points), lower hourly wages (nearly less than 1 €/hour

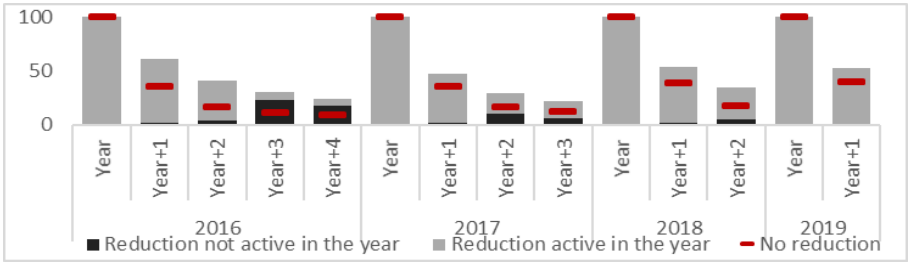
and equal to -0.20 €/hour excluding apprentices[12]), a lower frequency of part time and fixed term contracts. They are mostly employed in the service sector and in small firms (+8.8 percentage points).

Table 3 *– Differences between beneficiaries and not beneficiaries in the year of activation in various indicators. Years 2016-2020, absolute and percentage values.*

Reduction	% Closures	Median hourly wage	Median hourly wage – excluding apprentice	Median hourly labour cost	% Permanent	% Part time	% in firms<=10
Yes	42.4	9.3	9.8	11.3	58.9	35.1	46.8
No	60.5	10.0	10.0	14.0	19.8	41.2	38.0
Diff	-18.1	-0.7	-0.2	-2.8	+39.1	-6.1	+8.8

The labour cost reduction policies implemented between 2016 and 2020 had the effect of steadying jobs activated by the reduction. After one year, between 48% (for positions activated in 2017) and 61% (for positions activated in 2016) of all jobs activated with a labour cost reduction are still active, representing a difference of +12 percentage points and +26 percentage points, respectively, compared to non-beneficiaries (Figure 2). With time, the incidence of jobs without reductions appears to approach that of jobs activated with reductions that are no longer active in the year. The incidence of jobs with reduction active (which is directly tied to the length of the various measures) falls after two (2017) or more years.

Figure 2 – *Jobs with or without reduction per benefit active in the year, year of activation and after 12, 24, 36 and 48 months. Years 2016-2020, percentage values.*



The difference in hourly wage follows a different pattern: beneficiaries' hourly wages are lower even 48 months after being hired compared to jobs activated without

[12] The apprenticeship is a youth employment and training contract established by Legislative Decree No. 81/2015 with the goal of bridging the gap between education and the labor market. Apprentice salaries are lower than those of other contracts since the employer has to provide also training.

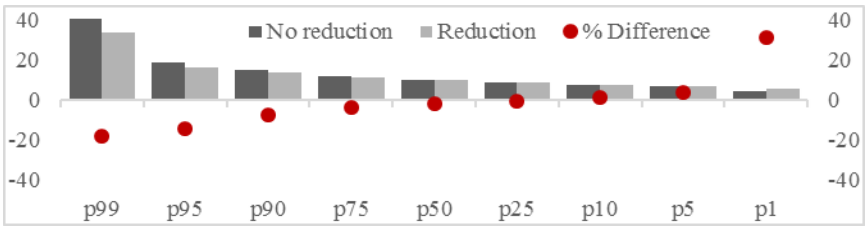
benefits, and the gap widens over time (Table 4). In terms of yearly wages, observing a panel of jobs always active from hiring to 2020 will prevent the difference in annual wages between the two groups from being skewed by the variance in duration associated with the introduction of the policy.

Table 4 – *Differences between beneficiaries and not beneficiaries in hourly and annual wages per activation year and after 12, 24, 36 and 48 months. Years 2016 - 2020, absolute values.*

ACTIVATION YEAR	YEAR	YEAR+1	YEAR+2	YEAR+3	YEAR+4
Hourly wage – excluding apprentices					
2016	-0.39	-0.55	-0.67	-0.79	-0.87
2017	-0.27	-0.62	-0.89	-0.97	
2018	-0.20	-0.41	-0.53		
2019	-0.19	-0.36			
2020	0.04				
Yearly wages– excluding apprentices - only always active jobs					
2016	-447	-1,980	-2,059	-2,048	-2,733
2017	-167	-3,080	-3,414	-3,739	
2018	517	-1,315	-1,366		
2019	2,058	2,026			
2016	1,733				

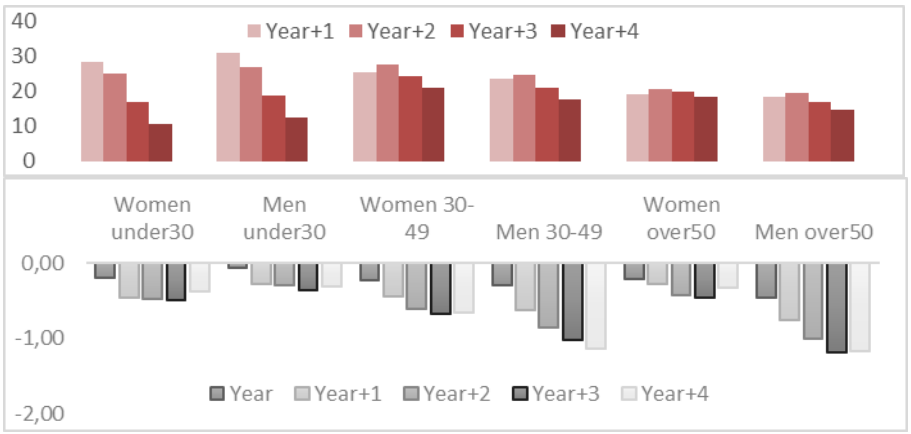
The hourly wages in the two categories might also be compared throughout the whole distribution (Figure 3). As a result, positions with reduced labour input and/or lower hourly compensation appear to endure for the beneficiaries. Excluding apprentices, the group of beneficiaries obtains higher hourly wages only in the first tenth (+1% at the 5th percentile) and a lower wage for the remainder of the distribution (-2.2% in the median and -14% at the 95th percentile) in the year of activation.

Figure 3 – *Distribution of hourly wages (right axis) for beneficiaries and not beneficiaries and percentage difference (left axis) in the activation year. Years 2016-2020, absolute and percentage values.*



Considering only activations in 2016, for young people under 30, the greater stability of jobs activated with reductions is noticeable in the first 24 months (mostly for males) and diminishes significantly in the subsequent ones, while for people over 30, the advantage in terms of length is lower but more durable over time (Figure 4). During the period, the differences in hourly wages between beneficiaries and non-beneficiaries grew more slowly among women and men under 30 than among men over 30.

Figure 4 - *Differences in the percentage of active jobs (top) and hourly wages (bottom) between activated positions in 2016 with and without reductions by gender and age after 12, 24, 36, and 48 months from the reference years. Years 2016-2020. Absolute values and percentage point*



These evidences suggest that the introduction of labour cost reduction may have led to a shift in job opportunities towards lower-paying positions for the beneficiaries. It is important to further investigate the reasons behind this trend and the relationship between the duration of the benefit and the duration of jobs in order to understand the long-term impact of these reductions on job stability and assess its long-term implications for income inequality.

5. Conclusions

Given the relevance of the availability of data to monitor the implementation and the effects of labour market measures, the RACLI data and metadata system has been designed also to follow the implementation of demand-side market measures and to classify them according to different statistical definitions. The analyses shows some evidences of the employer contribution reduction acts between the years 2016 and

2020, and deepened analyses will be possible as soon as a complete classification of administrative interventions and their statistical ongoing will be realized. This ongoing work will be always subject to continuous revisions, integrations and updating as a consequence of its complexity due to different aspects among which the variability of the Italian labour market policies and the way they are applied have a relevant role together with the evolution of administrative sources and statistical products. A further evolution of the register with the estimation of employee social benefits will make it possible other labour policies analyses.

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THE PRODUCTIVITY OF ITALIAN FIRMS: A SPATIAL ANALYSIS

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Abstract. This paper focuses on the total factor productivity (TFP) of Italian manufacturing firms over 2008-2020 and analyses the role played by different factors in determining it. Starting from the consideration that TFP in Italy presents a strong territorial component, we employ a hierarchical (multi-level) model to evaluate to what extent firms' productivity performance is influenced by location. In this context, the analysis allows to disentangle individual, firm-level, features from higher-level, provincial (NUTS-3), ones. At the firm-level, we single out the firm's age, size and the technology content of production; at the higher level, we consider a number of indicators relative to the quality of local infrastructure, services, administration and the level of social capital. The results show that territorial elements matter, especially for firms located in the South. We also detect a non-linear relation between the technology content of production and productivity: moving away from "low-technology" sectors, TFP becomes higher for "middle-low technology" sectors, but gets lower as technology improves.

1. Introduction

Starting from the mid-1990s, the growth of total factor productivity (TFP, or productivity) has known a long phase of decline in most EU-15 countries. Several authors link the phenomenon to structural changes, especially to the shift of activity from manufacturing to services, which traditionally has lower productivity (Van Ark et al., 2008). However, productivity growth remained far higher in the United States, where tertiarization followed different paths compared to those of European countries (Van Ark et al., 2008, D'Adamo et al., 2021, Bauer et al., 2021) and was accompanied by the massive introduction of information and communication technologies not only in advanced sectors -like finance- but also in traditional ones such as commerce, transportation, and accommodation. By contrast, this occurred to a far lower extent in European countries. For the EU-15 members, the main causes of productivity stagnation are generally found to lie in: partial -or incomplete-

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adoption of the ICT revolution; low investment in innovation, infrastructure, and human capital (cfr. Rodriguez-Pose, Ganau, 2022); market rigidities preventing the reallocation of resources to more productive units; limited knowledge and information diffusion (cfr. Corrado et al., 2009); and small business size.

While these features are seemingly common to all old EU members, it can be easily argued that they are all the more prominent for Italy and represent important determinants of the country's productivity stagnation (among others, cfr. Barra, Ruggiero, 2022 and Fabiani et al., 2005). In addition, Italy's well-known economic dualism, characterized by productivity differences between an efficient North and a less developed South, represents an additional drawback.

This study aims at analysing the evolution of TFP in the manufacturing sector across Italian provinces from 2008 to 2020. The provincial dimension of TFP is relatively underexplored, in favour of regions. However, these can be overly aggregated and limit the ability to fully understand the impact of different territorial characteristics on productivity. Hence, TFP is explored at the provincial level, with particular attention for the well-known geographical disparities of the Italian economy. The focus of the research lies on the territorial and structural features within which firms operate. Based on a typical hypothesis of economic geography, which posits that territorial characteristics influence firm performance, various external elements related to the territory, such as infrastructure availability and local administration efficiency, are analysed. Alongside, some internal firm characteristics, such as age, size, and specialization, are also considered. By using information both at the individual (firm) and province level, we develop a multilevel approach that allows firms' performance to be influenced by the context within which it operates.

The structure of the study is as follows: in the following paragraph, we present the data and the chosen methodology. In paragraph three we show and comment the results of our estimates, followed by a brief concluding discussion (paragraph four).

2. Data and methodology

Data comes from the "Aida" database, provided by Bureau Van Dijk. Over a ten-year frame, "Aida" reports economic and financial information for more than one million Italian companies. Data are extracted from firms' balance sheets and financial statements, whether consolidated or not, filed with the Chambers of Commerce. For each company, "Aida" also provides a wide range of indicators, including demographic and commodity data (year of establishment, industry sector, administrative procedures, number of employees, and so on).

For each active company in the 2-digit ATECO sectors ranging from 10 to 33 (manufacturing), the following variables are selected: value-added, wage costs (as a

proxy for the number of employees, which has many missing data), costs for raw materials (as a proxy for the cost of intermediate goods), and the nominal value of total tangible assets. The time-period goes from 2008 to 2020. The data is deflated using the annual average calculated from the monthly producer price index for each 2-digit ATECO sector between 10 and 33 provided by the Italian National Institute for Statistics (ISTAT). Salaries, instead, are deflated using the annual average of ISTAT's sector-specific deflators defined by collective bargaining. The sample is then cleaned of outliers by eliminating the 1st and 99th percentiles from each deflated variable. This results in an unbalanced panel of 132,486 year-observations.

TFP is estimated using the dynamic, multi-stage semi-parametric method by Olley, Pakes, 1996, that proxies a firm's (unknown) productivity by its (known) investment decisions[2]. The model has the advantage of accounting explicitly for firms' entry or exit decisions, allowing not to drop the firms that do not operate over the entire time-period. Moreover, compared to traditional methods (pooled OLS, fixed effect estimation), it helps reduce potential distortions due to endogeneity and selection issues. The first arise because productivity -which is known to the firm, but not externally- contributes to determining the demand for inputs. Instead a selection bias occurs because a firm's decision to enter/exit the market is linked to its expected productivity. In other words, assuming that a firm's profits are positively linked to its capital stock, for a given level of productivity, firms with bigger capital stocks are more likely to remain in activity than firms with smaller ones.

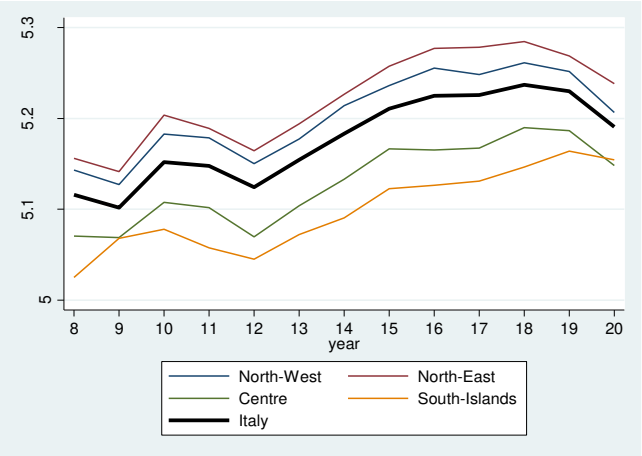
At the beginning of each period the incumbent firm decides whether to remain/exit the market. If it exits, it receives a sell-off payment and does not reappear. Instead, if the expected discounted value of profits is higher than the liquidation payment, it remains in activity. Conditional on the decision to remain and on its beginning-of-period state variables (age, capital stock and TFP), in the first step the firm selects optimal inputs, including investment. This allows to estimate the variable inputs' coefficients and the joint effect of all state variables on inputs. The second step separates the effects of age and capital on investment from those on output. This is done by estimating (*via* probit regression) the firm's probability of survival conditional on its state variables. In the final step TFP is estimated via a production function that includes a second order polynomial term accounting for the survival probability. This leads to the identification of all inputs' coefficients.

TFP levels (in logarithms) are obtained by running Stata's *opreg* command within the STATA software. Between 2008-2020, average TFP in the manufacturing sector in Italy generally grows, at least until 2019, with some fluctuation in 2008-2013, due to adjustments following the Great Recession. At the same time, the variance falls,

[2] A full discussion of the features and methodological issues related to this method is beyond the scope of the present paper. References can be found, among others, in Olley, Pakes, 1996 and in Van Biesebroeck, 2007. A good description is in Yasar et al., 2008.

indicating greater homogeneity among firms. The distribution of productivity is moderately skewed; the skewness index is positive and grows over time, indicating a concentration of observations below the mean. This, combined with the high kurtosis (leptokurtic distribution), indicates a significant presence of outliers, especially on the lower end. Both the skewness index and kurtosis reject the hypothesis of a normal distribution.

Figure 1 – *Average TFP (in log) by Italian macro-regions, 2008-20.*



Source: Authors' elaboration on BvD data, 2008-20

Figure 1 shows the trend of TFP in Italy's four (NUTS-1) macro-regions: North-West, North-East, Centre, and South-Islands. The graph confirms Italy's well-known territorial differences and highlights a general pro-cyclical pattern of TFP, which declines during crisis years (2008-09 and 2010-12) and grows during recovery. In fact, an exogenous shock, such as the one that occurred in 2009, instantly reduces demand and production, while adjustments on the input side (labour and raw materials) may be slower. The evolution of productivity during the period in exam is quite similar in the four areas, which differ for their levels. The two Northern groupings show almost identical trends. They are followed, at some distance, by the Centre, that also shows a rather similar evolution. Instead, the South follows a partially different trend, especially during crisis years 2008-10 and 2018-20, indicating a different impact of these periods on the region. Finally, it is worth noting that, due to higher average productivity growth in the North, the difference in TFP levels between the four areas is larger in 2018 than in 2008; however, the difference falls in 2019 (and even more so in 2020).

2.1 The econometric model

Fig.1 shows a seemingly strong territorial component of firm-level TFP. The possibility that firms' performance may depend also on context-specific features is now analysed. This is done by means of a hierarchical, or multi-level, model. As known, the fundamental assumption of these models is that individual performance depends on the context in which individuals operate. In other words, it is assumed that individual decisions (level 1) are influenced by the socio-economic environment in which they are taken (level 2), thus surpassing the rather restrictive assumption of traditional approaches, according to which there is no correlation among observations in different subgroups (Fazio and Piacentino, 2010; Aiello et al., 2014).

The model is expressed as follows:

$$y = X\beta + u + \varepsilon \tag{1}$$

where $\boldsymbol{y}$ is an n x 1 vector of responses, $\boldsymbol{X}$ is an n x p matrix containing the fixed effects regressors, $\boldsymbol{\beta}$ is a p x 1 vector of fixed-effects parameters, $\boldsymbol{u}$ is a q x 1 vector of random effects distributed according to a normal distribution with expected values $(0, \tau_{00})$, and $\boldsymbol{\varepsilon}$ is an n x 1 vector of errors distributed according to a normal distribution with expected values $(0, \sigma^2)$.

The first term in equation (1) constitutes the fixed part of the model, while the remaining part is the random component. The model is evaluated using two statistics. The first one is the inter-class correlation index (ICC), which measures the portion of total variance explained by the variance between the groups:

$$ICC = \frac{\tau_{00}}{\tau_{00} + \sigma^2} \tag{2}$$

The second statistic is given by the log-likelihood ratio *log-LR* which compares different specifications of the model. Under the null hypothesis, this statistic is distributed according to a chi-square (χ^2) distribution with degrees of freedom determined by the differences in the number of parameters among the specifications (Fazio and Piacentino, 2010).

The specification of equation (1) estimated in this study is:

$$TFP_{ipt} = \gamma_{00} + \sum_{i}^{3} \beta_{i} X_{ipt} + \sum_{h}^{6} \lambda_{h} Z_{hpt} + u_{0pt} + \varepsilon_{ipt} \tag{3}$$

where *TFP* is the logarithm of the total productivity of the *i-th* company located in province *p* in year *t*; γ_{00} is the average intercept of the regression lines; ***X*** is a vector of three variables that measure specific firms' characteristics; ***Z*** is a vector of six provincial variables that measure territorial features.

In particular, vector ***X*** includes:

- ✓ "*Years of activity*".
- ✓ "*Firm size*", measured by the number of employees.
- ✓ *"Technology intensity*", according to the OECD classification (2011):
  - High technology (HIT)
  - Medium-high technology (MHT)
  - Medium-low technology (MLT)
  - Low technology (LOT).

Vector ***Z*** (specific to each province) includes:

- ✓ "*Quality of local roads*" measured by the number of accidents. The hypothesis is that road accidents are a proxy for infrastructure quality: all else being equal, a better road network reduces the likelihood of accidents.
- ✓ "*Quality of personal services*" measured by the intensity of hospital migrations. The hypothesis is that hospital migrations is a proxy for the quality of the personal services available locally, a high availability reducing the likelihood of seeking treatment elsewhere.
- ✓ "*Local innovative capacity*" measured by the provincial propensity for patenting. The hypothesis is that patents are a proxy for creating a dynamic and innovative environment within the territory.
- ✓ "*Efficiency of local administration*" measured through the capacity to collect local taxes. The hypothesis is that collection capacity proxies administrative efficiency and hence the quantity and quality of the services potentially provided by local administrators. Greater collection capacity means more funds, resulting in more expenditure and hence more services.
- ✓ "*Gender equity in local administration*" measured by the number of women in local administration. The hypothesis is that women's involvement in politics acts as a proxy for social capital.
- ✓ "*Social security*" measured by the number of thefts in the territory. The hypothesis is that the number of thefts is a proxy for the quality of the social context, particularly for the perceived level of security.

All estimations are carried out using the "mixed" command of STATA software. The model is fitted by restricted maximum likelihood (REML).

3. Results

Results are reported in Table 2. As is common practice, we first estimate a null (or "empty") model with no regressors, to serve as a benchmark for the other models. “Model one" includes a subset of the firm-related ***X*** vector of variables that describe individual firms’ characteristics, i.e. "years of activity" and "firm size". "Model two" adds "Technology intensity". Finally, "Model three" introduces the entire ***Z*** vector containing all the indicators related to the territorial context.

Table 2 – *Estimations.*

VARIABLES	model 0	model 1	model 2	model 3
Time	0.00806***	0.0127***	0.0127***	0.0101***
	(0.000100)	*(0.000128)*	*(0.000128)*	*(0.000306)*
Years of activity		0.0306***	0.0368***	0.0354***
		(0.00190)	*(0.00185)*	*(0.00203)*
Firm size		-0.00471***	-0.00233***	-0.000853
		(0.000895)	*(0.000884)*	*(0.000943)*
HIT			-0.0731***	-0.0848***
			(0.00445)	*(0.00461)*
MHT			-0.0366***	-0.0506***
			(0.00685)	*(0.00709)*
MLT			0.257***	0.253***
			(0.00357)	*(0.00371)*
Quality of road infrastructure				-0.00416***
				(0.00127)
Quality of personal services				-0.0154***
				(0.00276)
Local innovative capacity				0.0184***
				(0.00124)
Efficiency of local administration				0.0245***
				(0.00724)
Gender equity in local adm.				0.0428***
				(0.00321)
Social security				-0.0134***
				(0.00201)
Constant	5.114***	5.011***	4.905***	4.713***
	(0.00173)	*(0.00550)*	*(0.00564)*	*(0.0325)*
ICC	*0.362*	*0.375*	*0.367*	*0.370*
Log-LR	*-500011****	*-357894****	*-353962****	*-314718****
Akaike criterion	*1000032*	*715802.7*	*707944.3*	*629469.2*
Observations	1,027,017	789,733	789,733	686,425
Number of groups	132,486	118,770	118,770	113,410

All variables are in logarithms. Standard errors are reported in parentheses. ***″p<0.01, ** p<0.05, * p<0.1

All the statistics indicate an improvement in the model’s goodness of fit following the introduction of different groups of regressors. The highly significant log-

likelihood ratio test (log-LR), as well as the Akaike criterion, fall with the introduction of the various groups of regressors, showing that the goodness of fit improves. Moreover, the LR test (not reported in the table) indicates the presence of significant differences in the intercepts, which fall with the introduction of the regressors, confirming that each subsequent version of the model is nested within the previous one and justifying the use of a hierarchical model.

Coming to the estimation of the coefficients, they are generally highly significant and have the expected sign. Since data is in panel form, each firm represents a cluster with multiple observations over time; therefore, the first coefficient ("*Time*") estimates how much TFP within the firm is correlated over time.

"Years of activity" has a positive and statistically significant effect. In other words, the experience gained by companies helps improve their productivity. This can be seen as evidence of an ongoing process of formal and informal knowledge accumulation. "Firm size" has a negative and statistically significant coefficient in models 1 and 2, where we do not consider the provincial variables; it becomes no longer statistically significant when territorial features are introduced (model 3).

The introduction of "*Technology intensity*" (model 2) opens new scenarios. The three technology levels (HIT, MHT, and MLT) show highly significant coefficients. (Results should be read with reference to LOT, omitted to avoid multicollinearity). Results show that firms belonging to "medium-low technology" sectors (MLT) achieve higher levels of TFP compared to firms in "low-technology" ones (LOT). Instead, firms operating in "high" (HIT) or in "medium-high technology" (MHT) sectors obtain TFP performance below that of "low-technology" firms. This could be explained by Italy's traditional specialisation in the so-called "made in Italy" sectors (medium-low technology textiles, clothing, leather, footwear), all heavily contributing to the country's strong position in international markets and all showing relatively high average TFP levels.

The introduction of the $\boldsymbol{Z}$ vector of socio-economic local features (model 3), does not alter the overall picture described above. All territorial variables' coefficients are highly significant and have the expected signs, although they have very low values[3].

In conclusion, the hierarchical model adopted seems to account for TFP adequately; in particular, provinces account for over one third of the total variability.

Model 3 is then estimated separately for each macro-region Results are reported in Table 3.

[3] The coefficients of the territorial variables shown in the Table should be interpreted bearing in mind that, for three of them -namely "Quality of road infrastructure", "Quality of personal services" and "Social security"- higher values imply worse territorial features.

Table 3 – *Estimations by Italian macro-regions.*

VARIABLES	North-West	North-East	Central	South
Time	0.00614***	0.0116***	0.00924***	0.0109***
	(0.000634)	*(0.000633)*	*(0.000826)*	*(0.00130)*
Years of activity	0.0306***	0.0532***	0.0208***	0.0267***
	(0.00373)	*(0.00401)*	*(0.00420)*	*(0.00481)*
Firm size	-0.00715***	0.00213	-0.00188	0.0105***
	(0.00165)	*(0.00174)*	*(0.00216)*	*(0.00243)*
HIT	-0.102***	-0.0539***	-0.0980***	-0.0982***
	(0.00826)	*(0.00858)*	*(0.0104)*	*(0.0126)*
MHT	-0.122***	-0.0280**	0.00719	0.00143
	(0.0127)	*(0.0131)*	*(0.0155)*	*(0.0193)*
MLT	0.246***	0.327***	0.204***	0.187***
	(0.00723)	*(0.00730)*	*(0.00763)*	*(0.00830)*
Quality of road infrastructure	0.00190	0.000850	-0.0123***	-0.0118***
	(0.00186)	*(0.00285)*	*(0.00348)*	*(0.00376)*
Quality of personal services	0.0186***	0.00298	-0.0411***	-0.0269***
	(0.00466)	*(0.00683)*	*(0.00739)*	*(0.00780)*
Local innovative capacity	0.0203***	0.0186***	-0.00259	0.00340
	(0.00380)	*(0.00354)*	*(0.00329)*	*(0.00287)*
Efficiency of local administration	0.172***	-0.00992	-0.0207	0.0402***
	(0.0174)	*(0.0183)*	*(0.0152)*	*(0.0146)*
Gender equity in local adm.	0.0688***	0.0726***	0.0561***	0.0205**
	(0.00911)	*(0.00670)*	*(0.00890)*	*(0.00871)*
Social security	-0.0112***	-0.0287***	-0.00723	-0.0421***
	(0.00394)	*(0.00344)*	*(0.00523)*	*(0.00688)*
Constant	3.980***	4.736***	5.016***	4.948***
	(0.0809)	*(0.0860)*	*(0.0747)*	*(0.0726)*
ICC	*0.390*	*0.385*	*0.342*	*0.313*
Log-LR	*-106690****	*-84049****	*-60747****	*-46551****
Akaike criterion	*213412.2*	*168129.2*	*121525.9*	*93134.2*
Observations	250,134	205,907	124,390	84,013
Number of groups	38,378	31,793	22,154	16,564

All variables are in logarithms. Standard errors are reported in parentheses. ***″p<0.01, ** p<0.05, * p<0.1

A first, unexpected indication concerns the model's goodness of fit: the Log-LR likelihood index, although highly significant for all macro-regions, shows a better fit for the South, followed closely by the Centre and, quite at a distance, by North-East and by North-West; the Akaike information criterion confirms. At the same time, the ICC index shows lower residual variability among provinces in the South compared to other macro-regions, especially the two northern groupings. In other words, the territorial regressors explain a greater component of TFP variability in the South than elsewhere. This confirms that location has a different impact on productivity depending on the area to which provinces belong (cfr. Chapman, Pipitone, 2022).

Coming to the coefficients, they are in general significant and follow those for Italy as a whole. Over time, TFP improves within companies, especially in the North-East and in the South (much less so in the North-West). The "*Years of activity*" have a positive impact on TFP in all macro-regions. Instead "*Firm size*" is statistically significant only in the North-West and South, but with an opposite effect: negative in the first case, positive in the second one. In the former, the presence of large-scale companies is often linked to mature, heavy industry sectors; the South instead is characterized by smaller firms, for which an increase in firm size yields positive effects on TFP. As for the coefficients of "*Technology intensity*", they are generally significant and have the same sign as the ones highlighted for Italy. Companies in MLT sectors present higher levels of TFP in all macro-regions, particularly in the North-East. On the other hand, both HIT and MHT companies record lower TFP (with respect to LOT sectors), especially in the North-West. In the Centre and South, the coefficients for MLT firms are not statistically significant.

Also the coefficients of territorial indicators are generally in line with those for Italy as a whole, even if with some difference across macro-regions. The coefficient for the "*Quality of road infrastructure*" (measured by the number of road accidents) is negative and statistically significant only in the central and southern areas, where infrastructure is historically lower than elsewhere. This highlights the importance of infrastructure both in terms of firm efficiency and of regional development. A similar argument applies to the "*Quality of personal services*" (measured by hospital migration), that also shows a negative and statistically significant effect on TFP only for the Centre and South. The low quality of local services affects all those operating in a region, by raising costs and reducing efficiency.

Instead, "*Local innovative capacity*" (proxied by the propensity for patenting) has a positive and statistically significant effect only in the two northern, economically more advanced, macro-regions. This implies that patenting may produce positive effects on TFP only if associated with a local production system that is able to capture the positive effects of research and innovation.

The impact of "*Efficiency of local administration*" on TFP is less clear and less pronounced than that of the other variables. It has positive and statistically significant effects in the North-west and South, but loses significance in the other two.

On the other hand, "*Gender equity in local administration*" and "*Social security*" play a statistically significant role in all macro-regions. Although with different intensities, women involved in local administration give an important contribution to the efficiency of territories, generating positive effects on firms' TFP. Finally, lower social security reduces TFP everywhere, but more in the South.

4. Conclusion

The study examines the TFP of Italian manufacturing firms, clustered by provinces and by the technology content of their specialization, during 2008-2020.

The estimation of a multilevel econometric model confirms, that the choice of a hierarchical model is appropriate. This indicates that, in general, a company's performance in terms of TFP is related to the territorial context in which it operates (in our case, provinces). Second, contrary to expectations, the model shows that "medium-low technology" (MLT) sectors are associated with higher levels of efficiency, while TFP is lower in higher technology sectors. This implies a non-linear relation between the technology content of production and productivity: moving away from "low-technology" (LOT -our reference sector), TFP is initially higher but becomes lower as technology improves. This is an interesting result that deserves further inspection; we leave it to future research. Finally, when considering macro-regions individually, the model shows a better fit for the South (and even more so for the Islands) suggesting that territorial elements count differently across the country. In particular, it is the quality of local administration, of infrastructure, and the level of social security that matter most for southern firms, generally more than what occurs for firms located elsewhere. Another result is that, among all the territorial features that were considered, only the number of women involved in local administration cuts across all macro-regions with a positive and significant impact on TFP. We leave also this result to further research.

From the perspective of economic policy implications, these results suggest that there remains -potentially substantial- room for public intervention aimed at addressing Italy's dualism. One possible area of intervention lies in the traditional approach focused on tackling the diseconomies generated by deficiencies in infrastructure and public administration, even with reference to the considerable availability of European funds aimed at recovery and resilience. Last, as the literature acknowledges a significant lack of territorial connections among provinces in the South, implying a lower diffusion of spillovers and networks across firms (cfr. Chapman, Pipitone, 2022), intervention should be targeted at removing the obstacles that hinder the formation of clusters allowing the higher-productivity territories to act as drivers for neighbours.

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BEHAVIORAL FACTORS, SDG AWARENESS AND SUSTAINABLE POLICIES IN ACADEMIA

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Abstract. *Behavioral factors, SDG awareness and sustainable policies in academia.* Successful implementation of sustainable activities in academic institutions requires an understanding of individual and organizational behavior as psychological factors can undermine technical solutions. We extend the Theory of Planned Behavior (TPB) by incorporating SDG awareness to investigate how psychological factors influence the sustained activities of academic unit heads in European countries. The model is estimated using Partial Least Squares-Structural Equation Modeling (PLS-SEM). The results support the use of behavioral models to explain the decision-making process at the academic level. In particular, subjective norms, perceived behavioral control, and SDG awareness play an important role in shaping sustainable activities in science. In contrast, moral attitudes do not influence academic decisions.

1. Introduction

Sustainability is a pressing issue in society, and higher education institutions (HEIs) have a crucial role to play in ensuring sustainable development. HEIs are uniquely positioned to transform people and society, shaping labor skills essential for the future low-carbon economy (Murga-Menoyo, 2014). Universities have embraced sustainability principles by redesigning curricula, greening campuses, and building local, regional, and international networks to influence student behavior (Adams et al., 2018). However, progress has been criticized for being technologically opportunistic and lacking coordination, leadership, and coherence (Ramos et al., 2015; ISCN Secretariat, 2014; Butt et al., 2014; Martin et al., 2013). The potential role of universities in achieving sustainable development has yet to be fully explored and exploited (Chankseliani & McCowan, 2020). To address this gap, this study implemented the Theory of Planned Behavior (TPB) by adding the role of SDG awareness to classical variables of moral attitude, subjective norms, and perceived behavioral control.

The study aims to understand whether academic environmental awareness and cognitive components play a significant role in behavior and whether it effectively

achieves improvements. The TPB is a widely used theory to explain human behavior (Ajzen, 1985). Previous studies have used TPB to predict human intention and behavior related to sustainability in higher education institutions (Davis et al., 2008; Wu & Wu, 2008; Chen et al., 2010; Thoo et al., 2021). However, previous studies mainly looked at a sample of students or non-academic staff to predict outcomes at the individual level. This study contributes to this gap by implementing the TPB by adding the role of SDG awareness to the classical variables of moral attitude, subjective norms, and perceived behavioral control. This method allows us to isolate the effect of awareness of the SDGs in academia and to understand better the impact on intention and positive behavior in a sustainable policy. In conclusion, this study highlights the importance of understanding the role of psychological and behavioral factors in promoting sustainable policies in academic institutions. The results indicate that SDG awareness plays a significant role in achieving positive behavior.

The rest of this paper proceeds as follows. Section 2 presents the theoretical framework, introduces the positive behavior analyzed, and formulates the research hypotheses accordingly. Section 3 illustrates the specified PLS-SEM model and describes how the constructs are measured, data collected, and hypotheses tested. Section 4 presents the results. Section 5 discusses the main results and their implications.

2. Background

The topic of management decisions related to sustainable activities at the university level is a recent area of research, and the factors driving "green" academic policies are still under discussion and analysis (Ghasemy et al., 2020). Previous literature on this subject has demonstrated that management decision-making processes are complex, influenced by various factors (Matthews et al., 1994). Higher education institutions face additional external forces that affect management decisions due to their crucial role in promoting sustainable development through teaching, research, operations, and knowledge transfer activities (Muller-Christ et al., 2014). Therefore, finding a single framework to explain this behavior is challenging. Khan et al. (2020) suggests studying the pro-environmental behavior of organizations in a context where the Theory of Planned Behavior (TPB) proposed by Ajzen (1991) holds. According to TPB (Ajzen, 1991), attitudes, subjective norms, and perceived behavioral control can predict the intention to perform a particular behavior (Mondéjar-Jiménez et al., 2016). The central assumption of this model is that intention strongly influences behavioral performance. TPB is an extension of the Reasoned Action Theory (TRA) of Fishbein and Ajzen (1975) and Ajzen and Fishbein (1980) and is a prominent framework in studies predicting outcomes at the

managerial level (Papagiannakis & Lioukas, 2012; Sánchez-Medina et al., 2014). Additionally, this theory is also useful for studying academic management intentions and behaviors regarding environmental issues (Khan et al., 2020).

Our paper defines positive behavior as sustainable activities implemented by the academic unit that lead to significant behavioral changes at the academic level. By adding this variable, we disentangle the effect of the university policy by focusing on the specific awareness of the SDGs, thus capturing the specific effect. Given the complexity of the management decision-making process, this study proposes the following hypotheses:

RH1: The moral attitude, social norms, and perceived control behavior of decision-makers positively influence both academic unit intentions and positive behavior toward sustainable activities.

RH2: The awareness of the SDGs of decision-makers positively influences academic unit positive behavior toward sustainability by mediating intentions.

3. Data and methods

The DECODE Sustainability project provides data on how academics perceive sustainability initiatives at their academic units. A Europe-wide sample distribution is utilized, with 50% of respondents from Northern European countries, 27% from Southern Europe, and 23% from Eastern Europe. Questions are asked to cover the economic, social, and environmental dimensions of sustainable development affected by SDGs as described by the UN. Environmental dimension is the most prevalent, followed by social and economic dimensions. Most of respondents are Deans or Directors/Heads of Academic Units (82%). A preliminary cleaning of the dataset was conducted, with 58.72% (495) of the questionnaires completed by answering all questions. The questions most helpful in constructing the latent variables predicted by the theory of planned behavior were identified based on the literature (Mondèjar-Jiménez et al., 2016), resulting in a final dataset of 104 observations. The number of observations guarantees a powerful application of PLS-SEM. The geographical distribution of the responses reflects the distribution of the full set of respondents. We cannot control for the field of study, and it could of course be an in-depth for future analysis. The analytical framework that is best suited for studying theory development in this context is SEM modeling with the PLS path approach (Monecke & Leisch, 2012; Rigdon, 2012). SEM models consist of two main parts: the measurement (inner) model and the structural (outer) model. The structural model describes constructs and links between them, while the measurement model specifies the relationship between constructs and indicators (manifest variables) (Keith, 2006; Kline, 2011). SEM combines regression and

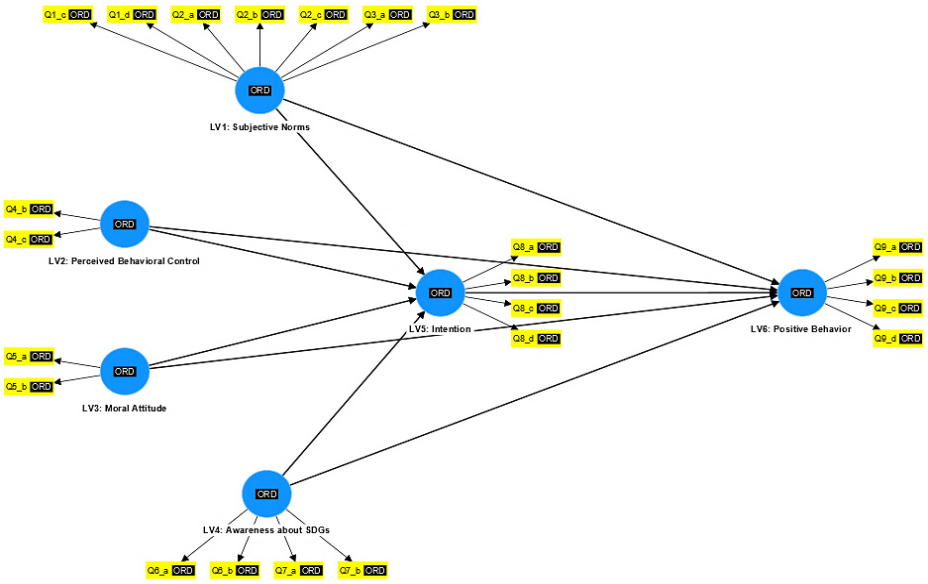
factor analysis, making it useful in examining latent unobserved and observed variables. It combines path and factor analytic techniques in one predictive model (Keith, 2006). PLS-SEM can be considered a variance-based approach to SEM and is useful for predicting and explaining target constructs (Mateos-Aparicio, 2011). PLS-SEM models have two attractive key advantages in behavioral and socio-economic studies: a) they work efficiently with small sample sizes and complex networks; b) they relax assumptions about the underlying data concerning classical regression methods (Cassel, Hackl, Westlund, 1999). According to operational rules discussed in the literature, the sample size should be equal to the greater of ten times the number of formative indicators that represent the single construct in the structural model (Barclay, Higgins, & Thompson, 1995).

In recent years, the Partial Least Squares-Structural Equation Modeling (PLS-SEM) approach has gained increasing popularity in various disciplines, including psychology, sociology, education, and economics (Khine, 2013). PLS-SEM has been successfully applied to various fields such as strategic management (Hair et al., 2012a), marketing (Hair et al., 2012b), tourism (do Valle & Assaker, 2016), human resource management (Ringle et al., 2018), and hospitality (Ali et al., 2018). In the area of higher education research, there has been an increase in the number of publications using PLS-SEM since 2015, indicating the growing theoretical contributions and rigorous models (Ghasemy et al., 2020). Previous studies have applied SEM models to study leadership and policy application in academic areas (Ronald & Rosser, 2000). There have also been examples of PLS-SEM applications for policy evaluation, such as the study by Ibrahim and Al-Matari (2022). Table 1 presents a list of the Latent Variables (LVs) in the structural model and their corresponding indicators in the measurement model. The latent variables are classified into two groups: endogenous and exogenous factors, based on whether they have any predecessors in the model. Figure 1 illustrates the structural model used in this study and the relationships between the latent variables. This model includes two endogenous variables, Intention and Positive Behavior, which are discussed in detail in the subsequent sections. As a result of this study, two models have been proposed:

$$LV_6 = \beta_1 2LV_1 + \beta_2 2LV_2 + \beta_3 2LV_3 + \beta_4 2LV_4 + \beta_1 6LV_5 + z_2 \quad (1)$$

where LV_g are the latent variables $g \in 1, \ldots, 6$, β_{gn} are the generic coefficients,and z_g denotes the error terms assumed to be centred around zero, i.e. $E(z_g) = 0$. Figure 1 shows the complete inner and outer components of the model, which correspond to the RHs that have been specified in the previous section. We use SmartPLS 4 software to evaluate the model.

Figure 1 – *The specified inner and outer models.*



4. Results

In this section, a two-stage analysis is performed to examine the results of the PLS-SEM model. To evaluate the measurement models, we first estimate the indicators and construct reliability as well as the convergent and discriminant validity of the constructs. In a second step, we evaluated the structural model for its ability to predict endogenous constructs based on its goodness-of-fit, cross-validated redundancy, and path coefficients.

4.1. Measurement model

We evaluate reflective measurement model considering reliability and validity (Table 2). In this kind of model latent constructs cause the measured variables and the error results in an inability to fully explain these measures. Following Hair et al. (2011), item reliability is determined by considering standardized outer loadings, which are greater or slightly less than 0.70. Nevertheless, indicator loadings between 0.40 and 0.70 are also acceptable if the average variance extracted (AVE) of the construct is higher than 0.50 (Hair et al., 2012b; Kahn et al., 2020). We have found that all indicator loadings are between 0.650 and 0.871 (see Table 2). However, two indicators for subjective norms and one for the construct of perceived behavioral

control are eliminated since we found that the AVE was less than 0.5. Thus, after deleting the three indicators mentioned above, our study fulfills the criteria of indicator reliability and convergent validity. To assess convergent validity, we refer to the AVE, defined as the overall mean of the squared loadings of the indicators associated with the construct. Our study found that AVE values are equal to or greater than 0.50 (between 0.50 and 0.67). To evaluate internal consistency, we use composite reliability (CR). According to previous literature, CR values should ideally be higher than 0.70 (Ali et al., 2018; Hair et al., 2011). As a result, we can conclude that the composite reliability of the six constructs is also satisfied, as these values range from 0.774 to 0.878. Therefore, we can conclude that this study fulfils internal and convergent consistency criteria. To determine discriminant validity, we used the Fornell-Larcker criterion (Fornell & Larcker, 1981). It compares the correlation between the latent variable and the square root of the AVE values (Chin, 2010). Moreover, the square root of the AVE of each construct is more significant than its strongest correlation with any other construct, as shown in Table 2. As a final step, we evaluated the impact of multicollinearity by looking at constructs and indicators' variance inflation factor (VIF). Following Hair et al. 2019, the VIF values of all constructs should not exceed 3.0 to be considered valid. The estimate of VIF for each construct and indicator in our study ranges between 1,138 and 2,378 points. Based on the criteria referenced above, we can conclude that the measurement model chosen for our study matches our research goals. Therefore, we can move on to the evaluation of the structural model.

4.2. Structural model

Validation tests performed in the previous section ensure the goodness of the estimated model. In this section, the significance of the emerging relationships will be analyzed. Standard errors have been computed by bootstrapping with 5000 sub-samples (with replacement). It protects against geographical effects and various types of confounding due to selection bias. We consider a relationship statistically significant at 1% level (p-value < 0.01). In this sense LV4 (Awareness about SDGs) emerges as the most significant variable with or without the mediation of LV5 (Intention). The mediating effect is significant 0.318 (0.001) and it implies an improvement of R-square from 20.6% to 45.5% of the information explained. The detailed analysis of direct, indirect, and total effects (Table 4) reveals that LV1 (Subjective Norms) and LV3 (Moral Attitude) have a significant total effect but neither the direct nor the indirect effect individually are significantly highlighting the significant role of Intention. In general, 4 out of 5 relationships have a significant role in the model.

Table 1 – *Latent variables and manifest variables.*

LV1: Subjective Norms	Q1. Which professional development opportunities does your academic unit offer to its educators: a) Didactical/pedagogical skills-buildings b) Content knowledge on sustainability or SDG topic c) Opportunities to engage in multidisciplinary teaching teams d) Support for sustainability-related program management
	Q2. Which professional development opportunities does your academic unit offer to its educators: a) Multidisciplinary research skills & methodologies b) Content knowledge on sustainability or SDG topic c) Opportunities to engage in multidisciplinary teaching teams
	Q3. Which professional development opportunities does your academic unit offer to its academic staff: a) Community or service-learning methods for educators b) Citizen science research methods for researchers
LV2: Perceived Behavioral control	Q4. The sustainable strategy of our academic unit is influenced by: a) Our institution's sustainability strategy b) National or regional strategies c) SDGs & the UN's 2030 agenda
LV3: Moral Attitude	Q5. What are the key obstacles that stand in the way of your academic staff to undertake sustainability initiatives? a) Lack of knowledge about sustainability related topics b) Lack of competencies
LV4: Awareness about SDGs	Q6. Academic staff in our unit are: a) Well-aware of our unit's sustainable ambitions b) Participating in our unit's sustainability related decision making
	Q7. Students at our academic unit are: c) Well-aware of our unit's sustainable ambitions d) Participating in our unit's sustainability related decision making

Table 1 – *Latent variables and manifest variables (continued).*

LV5: Intention	Q8. Attention to sustainability or SDGs is likely to increase in the next five years in our academic unit's: a) Teaching b) Research c) Social engagement d) Operation and administration
LV6: Positive behavior	Q9. Over the last three years our academic unit has made good progress towards embedding sustainability in the following activities: a) Teaching b) Research c) Social engagement d) Operation and administration

Table 2 – *Reflective model: reliability measurements.*

Construct	Composite Reliability	AVE
LV 1 Subjective Norms	0.877	0.505
LV 2: Perceived Bheavioral Control	0.803	0.671
LV 3: Moral Attitudes	0.774	0.634
LV 4: Awareness about SDGs	0.861	0.608
LV 5: Intention	0.878	0.643
LV 6: Positive Bheavior	0.803	0.506

Table 3 – *Estimated direct, indirect, and total effects. Notes: Significance level: *** p-value<0.01; ** p-value<0.05; * p-value<0.10.*

	Direct Effect		Indirect Effect		Total Effect	
	Estimate	Sign	Estimate	Sign	Estimate	Sign
LV1 → LV5	0.2				0.2	
LV1 → LV6	0.183		0.064		0.247	***
LV2 → LV5	-0.003				-0.003	
LV2 → LV6	-0.045		-0.001		-0.046	
LV3 → LV5	-0.06				-0.06	
LV3 → LV6	-0.182		-0.019		-0.201	**
LV4 → LV5	0.300	***			0.300	***
LV4 → LV6	0.283		0.096	*	0.379	***
LV5 → LV6	0.318	***			0.318	***

5. Discussion and concluding remarks

This paper applies the theory of planned behavior to analyze the effect of awareness of the SDGs on positive behavior in terms of sustainable academic policies. The estimated structural equation model allows us to isolate the impacts of SDG awareness from other factors (latent variables) that might influence the achievement of a good outcome. In this sense, high awareness is necessary to achieve positive behavior. In contrast, perceived behavioral control is not significant in any of the estimated models. Furthermore, the mediating effect of intention is effective in describing the observed variance in positive behavior: the improvement in the model is about 20%. Although policies and funding programs for research and innovation are prime instruments to support the green transition, behavioral aspects play a significant role in this story. For an environmental policy to be effective, voluntary, or educational components (moral, awareness) are much more effective than coercive components (perceived behavioral control). The policy proposal is quite straightforward: simply funding instruments will be ineffective if there is a lack of environmental awareness and collaboration among academic unit leaders. In our recommendation, policymakers should integrate an investment plan to achieve green transition at the academic level, with an educational program for academic staff and deans. By educating deans and staff, the university can become more aware of their environmental impact and work towards a greener future. Achieving a more sustainable development model at the academic level requires a combination of drastic transformation, not only in terms of hard assets (like technologies and infrastructures) but also in terms of culture and values, behaviors, and practices.

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QUALITY ASSESSMENT OF STATISTICAL INFORMATION SERVICES. AN EXPLORATORY ANALYSIS WITH RASCH MODEL

Giuseppe Lecardane

Abstract. The quality has now assumed a primary position in the field of research and statistical information. Quality aspects of the statistical organization and production is essential to collect valuable information and identify service dimensions.
The exploratory analysis with the Rasch method concerns the qualitative and functionality assessment of service and territorial structures through satisfaction degree expressed by thematic referents.
Rasch model has proved to be useful for diagnostics of service quality and allows valid and reliable information on the production and organizational process with analysis of strengths and weaknesses.
Qualitative survey results show organizational skills of the statistical offices and referents to produce the data. In other words, it is argued that perceived quality depends on organizational variables of a soft type (organizational climate, human resources, knowledge) rather than a system one (structures and/or processes).
The objective of the study is exploratory to define specific measures aimed at improving the statistical function within the National Statistical System.

1. Introduction

Qualitative process evaluation of the services offered from a complex system, such as that of statistical information, is a key point towards improving the quality and effectiveness of the service provided to users.

The analysis of the process and the choice of an appropriate statistical methodology constitute excellent tools for evaluating the data production chain which guarantees continuous monitoring and the possibility of promptly intervening with corrective actions.

Istat has always maintained a policy for the quality of statistical data with a strong orientation towards the production process. Strengthening processes is one of the possible ways to improve the quality of the final data.

Based on these premises, this work is the result of some lines of intervention of the Istat research project "Experimentation for new methods of collecting environmental data" (Lecardane, G. 2022) [1] aimed at measuring and evaluating the perception of thematic managers/referees environmental data of the municipal environmental statistics offices on the organizational and production process of the statistical function within the territorial structures according to Istat directives on environmental data.

In the first part of the work, some main results of the quality survey will be analysed: the profile of the environmental thematic referent, the organizational and instrumental endowment of the service, the methods of acquisition, control, sending and archiving of statistical data.

We proceeded with the analysis of the evaluative perception of the environmental thematic referents regarding the organizational and production process of the statistical function within the territorial structures involved.

Due to the latent nature of the phenomenon, there is a need to identify appropriate statistical tools for an objective measurement of perception and to implement a synthesis of the answers through a questionnaire provided to the representatives of the public and private entities that collaborated in the Istat survey for environmental statistics.

Knowing the opinion of the representatives on the reliability of the data produced and transmitted to Istat is certainly important information, although not the only one, which can allow you to identify critical elements in the system and implement appropriate corrective actions.

The objective of the study is exploratory and proactive to identify specific measures aimed at improving the statistical function within the National Statistical System.

2. A survey on the production activity of statistical information

To study the functioning of the statistical production process, an evaluation questionnaire was prepared as a tool for critical reading of the data production.

The questionnaire, designed and used for the survey, was administered to officials and technicians of the public and private offices participating in the collection of urban environmental data, with the assignment of thematic referents and heads of the

[1] Research project Istat RD, Specific projects, ID 1095, Experimentation for new ways of collecting environmental data of cities - PPMO 2017/19 (Project ID: 1905 and 1400. ODS/164/2018 of 13/09/2018, ODS/141 /17, from 2017 to 2012). Project Manager and Coordinator: Lecardane Giuseppe. Project aimed at experimenting with new methods of data acquisition with the ARCAM online platform and analysis of the organizational processes of the municipal statistics offices for the archiving and transmission of environmental data to Istat.

statistics offices. The experimental phase involved the recognition and selection of nine municipal statistical offices (Table 1) among the regions of northern and southern Italy participating in the project (Abruzzo, Basilicata, Friuli-Venezia-Giulia, Molise, Sicily and Veneto) and the collaboration of almost seventy officials and technicians with the role of manager, referent and collaborator of the Istat environmental surveys.

Table 1 – *Statistical offices of the capital municipalities in the regions adhering to the project*

Regions	**Capital municipalities**
Abruzzo:	Chieti
Basilicata:	Matera
	Potenza
Friuli-Venezia-Giulia:	Udine
Molise:	Campobasso
Sicilia:	Caltanissetta
	Palermo
Veneto:	Padova
	Rovigo

Based on the topics structured in the evaluation questionnaire, the organizational and functional system of the service, the structure of the office, the human and instrumental resources involved, the production process of statistical information on environmental issues (acquisition, treatment, review, validation and transmission of data), as well as the evaluation of the quality perceived in the organizational aspects of the office/service.

Even if the outcome of the survey is not exhaustive of the entire structural and organizational of the local public system, the results nonetheless provide some important indications on the production process of the local statistical structures involved in the production of the statistical data and on possible corrective actions to be realize.

3. Exploratory analysis of service quality and the Rasch model

The analysis allows the quality and functionality assessments of territorial structure services through the satisfaction degree expressed by thematic respondents of the municipal statistics offices. Theme of quality has now assumed a primary position in the field of research and statistical information. Having a good knowledge

of functional and statistical quality in organizational and production terms is essential for gathering valuable information and identifying critical issues on which to intercede. The choice of the methodology for the estimation mainly depends on the categorical-ordinal nature of the results or *outcomes* (taken from questionnaires, tests, etc.). Attitude of the subjects to provide answers/judgments towards aspects of reality can be summarized with the term of *latent* results (latent trait). In the literature, the estimation of latent results is performed to evaluate skills, perceptions, abilities or more generally attitudes on different aspects of reality often not directly observable but which can be inferred from a set of items that measure *latent traits*. Among the many multidimensional methodologies used for the estimation of latent variables, Rasch model allows a particularly valid analysis, satisfying all the ideal properties of a quantitative and objective measure (Bergmann, Foster, et al.).

Rasch methodology (Rasch, 1980 and Wright 2000) is part of the *item response theory* models (Pearlin et al., 1990) for the estimation of *outcome* or *latent trait* measures. *Latent trait* is measured through the subjects responses to a series of items that represent manifestations of different agreement or disagreement degree: an "ability" towards the *latent trait* is defined as any "propensity" β_i of an individual i (in terms of satisfaction, ability, aptitude, etc.) respect on a *latent trait* and with δ_j the difficulty of the subjects to answer on a item j (j=1,…,m).

The model estimate, for each respondent, a parameter of ability and, for each level of response, a parameter of difficulty. Furthermore, it is possible to state that a subject is *able* not in absolute sense but in relative to the other subjects and to the questionnaire examined. Same criterion is re-proposed in terms of difficulty in the answer. Rasch is a logistic model and assumes that the probability for a subject to answer a question (items of the questionnaire or the test, etc.) depends on the difference of two parameters: ability/characteristics of the respondent β (direct function) and the difficulty of the question (item) δ (test or questionnaire) answering the items in increasingly difficult ways (inverse function), with a non-linear and logistic model. The measure is not proportional to the probability of response but to its transformation (*logit*):

$\text{Logit}(p) = \log(p/(1-p)) = \beta_i - \delta_j$ p = probability of correct answer to an item, β_i = answering ability of the interviewee i, δ_j = item difficulty j.

The comparison between ability of an individual and difficulty of an item allows us to predict the probability of choosing an answer mode. Items with two categories and more the answer x on item j (x = 0, 1, …, k_j) implies a positive answer to each previous modality 0, 1, 2, ..., x-1; the difficulty of answering to category x in item j (δ_{jx}) is considered as overcoming the difficulties of previous steps (δ_{jw} with w = 0, …, x); the parameter that expresses the difficulty of item j step w (δ_{jw}) can be expressed as the sum of a component defined as *location* of the item (δj) with a component is the differential effect of step w respect on *location* (τ_{jw}): $\delta_{jw} = \delta_j + \tau_w$;

the classic *Dichotomous Rasch Model* (Rasch, 1960) is extended to items with *kj* possible answers in the *Rating Scale* (Andrich, 1988) in which the differential effect is identical for each item ($\delta_{jw} = \delta_j + \tau_w$). In the *Partial Credit* version, difficulties of each step are different between items ($\delta_{jw} = \delta_j + \tau_w$) and the probability in a subject *i* to answer in *x* mode in item *j* depends only on the difference between two parameters β_i e δ_j:

$$\pi_{ijx} = \frac{\exp \sum_{w=0}^{x} (\beta_i - \delta_{jw})}{\sum_{q=0}^{kj} \exp \sum_{w=0}^{x} (\beta_i - \delta_{jw})} \quad x = 0, \ldots, k_j \text{ with } \sum_{x=0}^{kj} \pi_{ijx} = 1 \text{ and } \delta_{j0} = 0 \qquad (1)$$

[1] probability that the *i-th* subject answers *x* and not *x-1* on the item (*odds*) is a function of the β_i person's *ability and difficult parameter* in according to a function logistic:

$$\frac{\pi_{ijx}}{\pi_{ij(x-1)} + \pi_{ijx}} = \frac{\exp \sum_{w=0}^{x} (\beta_i - \delta_{jx})}{1 + \exp(\beta_i - \delta_{jx})} \qquad x = 1, \ldots, k_j \qquad (2)$$

From [2] we deduce the relationship between the *logit* scores and the subject's *ability* and *difficulty* parameters of the item in real terms

$$\ln\left(\frac{\pi_{ijx}}{\pi_{ij(x-1)}}\right) = \beta_i - \delta_{jx} \qquad (3)$$

[3] shows that the *ability* and *difficulty* of the items are estimated in the same measurement unit (*logit*) and that subject *i* has a greater probability of answering *x* rather than *x-1* on item *j* only if the his *ability* is higher than the *difficulty* of category *x* for item *j*; if for this subject the difference were zero, he would have the same probability of answering *x* and *x-1* on item *j*. The estimation of the parameters with Rasch model in the *Partial Credit* version is obtained through the maximization of *likelihood function* based on the response vector of the individuals on each item, conditionally on the overall score obtained on all the *m* items (Wright, Masters, 1982).

4. Results of Rasch Analysis

The study provides interesting aspects on the activities, processes, resources and information products of structures involved to verify qualitative levels of territorial

statistical function. Table 2 lists items examined and the evaluation in terms of degree of judgment expressed by respondents useful for applying the model. Tables 3, 4 and 5 show the percentages of the ten items evaluated by thematic referents regarding the organizational aspects and collaborative degree with internal and external personnel to the service. Evaluations of interviewees on the functional and operational structure of the office are concentrated to a positive degree of judgment. However, some critical issues, judged below sufficient, are reported in staff training (34%), in assignment of personnel with statistical skills (32 %) and in organizational structure (18%). When asked whether there has been a change in the structure and processes compared to the previous three years, almost all subjects (over 70%) agree that the condition has remained almost unchanged. Finally, on the collaboration received from colleagues or other personnel in the statistical activities, the results are concentrated on good levels of cooperation, even if some difficulties for external personnel in other administrations (16% of respondents judge it not positive). The estimate carried out using the Rasch model and elaborated using the statistical package Winsteps & Facets Rasch Software - Rasch measurement computer program. Tables 6a and 6b show the statistics of the items: parameter estimate of the average *difficulty* of the items or *measure*, variability degree of the estimate or *standard error*, *infit* and *outfit* indices for measuring the goodness of fit to the model (*average and standardized*). Values are arranged in descending order of the estimate *measure*: from items with greater *difficulty* in answering and which require greater *ability* of the subjects (*positive values*) to more "*simple*" items with less *ability* to answer (*negative values*). Model sets *logit*=0 the *average difficulty* of the items.

Table 2 – E*valuation of perceived quality in the organizational aspects of the statistics office*

ITEM CODE	Item	Score	Judgement
66	IT and technological equipment	5	Excellent
67	Statistical staff assignment	4	Good
68	Staff training	3	Sufficient
69	Relationships with staff	2	Insufficient
70	Processes and workloads	1	Poor
71	Organizational structure		
72	Circulation, clarity of information		
73	Quality of statistical products and services offered		
74	Timeliness of response to users		
89	Overall office quality		

Table 3 – *Evaluation of the quality perceived in the organizational aspects of the office/service (percentage values)*

Organization of the office/service in terms of	Poor	Insufficient	Sufficient	Good	Excellent
IT and technological equipment	0,0	8,9	26,8	55,4	8,9
Statistical staff assignment	23,2	8,9	39,3	25,0	3,6
Staff training	10,7	23,2	37,5	28,6	0,0
Relationships with staff	5,4	1,8	28,6	53,6	10,7
Processes and workloads	10,7	8,9	26,8	53,6	0,0
Organizational structure	3,6	14,5	34,5	45,5	1,8
Circulation, clarity of information	3,6	5,4	37,5	50,0	3,6
Quality of statistical products and services offered	5,4	3,6	37,5	50,0	3,6
Timeliness of response to users	1,8	3,6	35,7	55,4	3,6
Overall office quality	1,8	1,8	21,4	69,6	5,4

Table 4 – *Evaluation of the change in the organizational aspects of the office/service compared to three years ago (percentage values)*

Organization of the office/service in terms of	Much worsened	Worsened	Unchanged	Improved	Much improved
IT and technological equipment	0,0	0,0	55,4	39,3	5,4
Statistical staff assignment	1,8	10,7	64,3	21,4	1,8
Staff training	1,8	8,9	64,3	25,0	0,0
Relationships with staff	1,8	1,8	69,6	23,2	3,6
Processes and workloads	3,6	19,6	53,6	21,4	1,8
Organizational structure	1,8	12,5	57,1	25,0	3,6
Circulation, clarity of information	1,8	3,6	69,6	21,4	3,6
Quality of statistical products and services offered	1,8	5,4	62,5	30,4	0,0
Timeliness of response to users	1,8	1,8	67,9	28,6	0,0

Table 5 – *Evaluation of degree of collaboration (percentage values)*

Evaluation of degree of collaboration with	Poor	Insufficient	Sufficient	Good	Excellent
Staff	3,6	1,8	21,4	58,9	14,3
Executive	3,6	1,8	14,3	67,9	12,5
Other operating units	5,4	5,4	35,7	50,0	3,6
Other public and/or private administrations	5,4	10,7	33,9	48,2	1,8
ISTAT	0,0	0,0	17,9	57,1	25,0

Table 6a – *Item fit statistics in the Rasch model*

INPUT: 66 Person 10 Item MEASURED: 66 Person 10 Item 5 CATS MINISTEP 3.69.1.4

Item statistics: MEASURE ORDER Person Reliability: 0,89 Item Reliability: 0,92

Entry	Total	Meas	Stand.	INFIT		OUTFIT		Item	Description
Num	Score	ure	Error	Mnsq	Zstd	Mnsq	Zstd		
2	155	1,63	0,21	0,87	-0,6	0,81	-0,8	67	Statistical staff assignment
3	159	1,46	0,21	0,81	-1	0,95	-0,2	68	Staff training
5	181	0,45	0,22	0,88	-0,5	0,66	-1,5	70	Processes and workloads
6	180	0,29	0,23	0,68	-1,6	0,7	-1,3	71	Organizational structure
8	192	-0,14	0,24	0,78	-1	0,91	-0,3	73	Qual. stat. prod. serv. offered
7	193	-0,2	0,24	1,07	0,4	0,7	-1,3	72	Circul., clarity of inform.
9	199	-0,55	0,25	0,66	-1,7	0,64	-1,6	74	Tim. of response to users
4	203	-0,8	0,25	1,34	1,5	1,14	0,7	69	Relationships with staff
1	204	-0,87	0,26	2,09	3,9	1,92	3,2	66	IT and tech. equipment
10	210	-1,28	0,27	0,89	-0,4	0,66	-1,6	89	Overall office quality
MEAN	*187,6*	*0,00*	*0,24*	*1,01*	*-0,1*	*0,91*	*-0,5*		
S.D.	*17,8*	*0,92*	*0,02*	*0,41*	*1,6*	*0,37*	*1,4*		

Table 6b – *Item fit statistics in the Rasch model*

INPUT: 66 Person 10 Item MEASURED: 66 Person 10 Item 5 CATS MINISTEP 3.69.1.4

Item statistics: MEASURE ORDER Person Reliability: 0,89 Item Reliability: 0,92

PT-MEASURE		EXACT MATCH		Item	Description
CORR.	EXP.	OBS%	EXP%		
0,85	0,79	62,5	59,0	67	Statistical staff assignment
0,79	0,78	66,1	60,1	68	Staff training
0,76	0,74	64,3	63,8	70	Processes and workloads
0,78	0,73	74,5	63,7	71	Organizational structure
0,73	0,71	69,6	66,8	73	Qual. stat. prod. serv. offered
0,69	0,71	78,6	67,2	72	Circul., clarity of inform.
0,75	0,69	78,6	67,1	74	Timeliness of response to users
0,68	0,68	60,7	68,0	69	Relationships with staff
0,46	0,67	58,9	69,0	66	IT and tech. equipment
0,64	0,66	82,1	70,4	89	Overall office quality
MEAN		69,6	65,5		
S.D.		7,9	3,6		

Results of the Rasch analysis show good model reliability indices (*Reliability index*: ratio between the *variance explained* by the model and the *total variance*. For values >0.8 index is *good*) with *item reliability* indices equal to 0.92 and *person reliability* equal to 0.89 (*good* reproducibility characteristics of the model) as well as a *good extension* of the *logit measure* of the item *difficulty* (from -1.28 to 1.63).

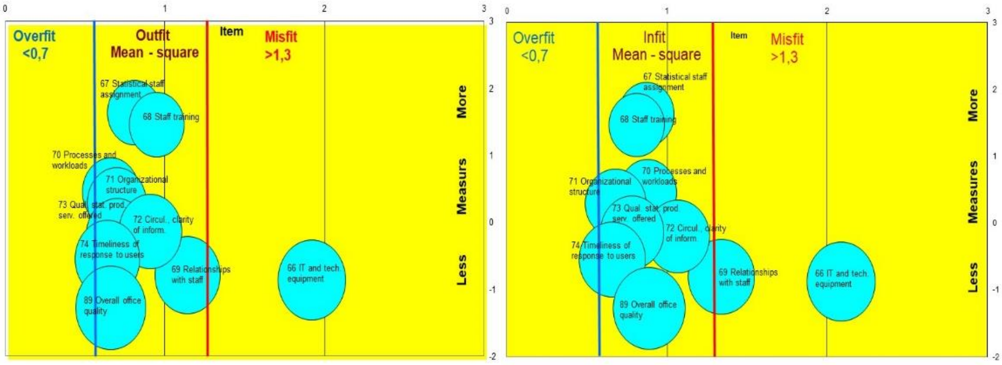
The *goodness of fit* to the *Rasch model* is evaluated in terms of *infit* (Unweighted Mean Square statistic) and *outfit* (Weighted Mean Square statistic) with *expected value* equal to 1 and defined on the comparison between *observed responses* (for

individual to each *item*) and *expected responses* based on the model. In practice, it is necessary to verify whether and to what extent the estimates obtained (*units* and *items*) distort the initial methods of *response*, a direct expression of the individual's responses to the items. Therefore, it is necessary to verify the existence of *systematic errors* that invalidate the good approximation of the starting data in the model. Two types of errors can be identified: *Misfitting*, unpredictable responses in contrast with the individual's *ability level* and the item's *difficulty* degree, i.e. *too positive responses* to *too difficult items* or *unsatisfactory responses* to *too difficult items*. easy, given the *ability* of the subject; *Overfitting*, answers too systematically linked to the *individual's ability* and the *item difficulty* without any effect of the *random component*. In essence, responses that are *too predictable* and therefore "*suspicious*" of being determined by *unknown external factors*. There is a *good fit* for values between 0.7 (*overfit*) <*Good Model*<1.3 (*misfit*). If *Overfit*, item responses are *too predictable* therefore "*suspicious*" and statistically *without any effect* of the *random component*; if *Misfit* responses are *not predictable*, in contrast to the *ability* of the *individual* and the *difficulty degree* of the *item*.

Figure 1 shows the results of the diagnostic tests for the *goodness of fit* (*infit* and *outfit*) to the model according to the items examined. It is observed that almost all the items are concentrated within the range of *good adaptability* to the *Rasch model* conditionally on the subject's *ability levels* and on the probability of choosing response methods. Only item 66 " *IT and technological equipment* " is *out of range* with a value greater than 1.3 (*misfit*), therefore, based on the model, item could be poorly worded or extraneous to the construct. Ultimately, the items for which respondents evaluate a general *dissatisfaction* with the *organizational aspects* of the office/service are: item 67 " *Statistical staff assignment* " (1.63) and item 68 "S*taff training*" (1.46), confirming the previously obtained results. Instead, items for which the respondents consider themselves *most satisfied* with the *quality of the service* are the following: item 89 "*Overall office quality*" (-1.28), item 66 " *IT and technological equipment* " (-0.87) even if in the presence of *misfits* and item 69 " *Relationships with staff*". *Item-Subject* map (Fig. 3) shows on a *logit scale* the joint distribution of the *subjects ability* (left side) who respond according to a decreasing scale of required *ability* (*more–less ability*) and positioning of the *items* (right side) on a decreasing scale of *difficulty*. Most of the *subjects* (*X* is represented by a single subject) and the *items* are concentrated in the central part of the graph, showing a substantial balance in *ability* of the respondents and in *difficulty level* of items.

Furthermore, the *Item-Subject* map reveals a *dissatisfaction* and *difficulty* level of the *respondents* in items "*Statistical staff assignment* (item 67)" and "*Staff training* (item 68)" as they differ strongly from the remaining group and higher levels close to *2 logits*. These items would require important corrective interventions.

Figure 1 – *Bubble chart, OUTFIT and INFIT of the items (percentage values)*




```
      XXXXXXXXXXX   |
                   S|
               XX   |
 2                  +
                    |T  67 Statistical staff assignment
                X   |   68 c) Staff training
                    |
 1            XXX   +S
             XXXX   |
                   M|   70 Processes and workloads
               XX   |   71 Organizational structure
 0           XXXX   +M
             XXXX   |   72 Circulation and clarity of informations
                        73 Quality of statistical products and services offered
              XXX   |   74 Timeliness of response to users
             XXXX   |   66 IT and tech. Equipment
                        69 d) Relationships with staff
-1             XX   +S
               XX   |   89 Overall office quality
                X   |
              XXX  S|T
-2              X   +
               XX   |
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                X   |
-3             XX   +
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-4              X   +
 Less ability               Easy Item
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5. Conclusions

Knowing expectations and perception of statistical referent of one's own structure on the data production and dissemination methods is a prerequisite for improving the relationship between relationship between benefits provided and needs satisfied. The analysis and evaluation of statistical activity, within public and private structures, is an important tool to identify critical points to be corrected and strengths to be promoted and extended to other realities. The transversal reading of the present work offers numerous points of reflection both in terms of knowledge and proposals on

several fronts. The use of the Rasch model has proved useful in methodological terms for in-depth diagnostics of service quality. In fact, the model allows to obtain valid and reliable information on the production and organizational process highlighting any strengths and/or weaknesses. Results of the qualitative survey show appropriate organisational capacity of the statistical offices and statistical referents from data production to analysis. However, the analysis reveals the need to:

- strengthening of structures and services;
- substantial training investment in the staff with suitable qualifications for the production and control of statistical data;
- improvement in the ability to interact with other statistical data providers in terms of engagement and collaboration.

Essentially, the perception of the service quality depends partly on the structural endowment but, in a decisive way, on the human factor in terms of training (acquisition of technical, methodological and specialist knowledge) and interaction (collaboration and participation). In other words, it is argued that perceived quality increasingly depends on organizational *soft variables* (organizational climate, human resources, knowledge) rather than system (structures and/or processes).

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PSYCHOSOCIAL RISKS: WORK-RELATED STRESS RISK ASSESSMENT IN ISTAT AS A GOAL FOR THE WORKERS' WELL-BEING[1]

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1. Introduction

Psychosocial risks represent an emerging challenge in the field of health and safety at work, as they have significant repercussions on the health of individuals, companies and national economies. (Iavicoli *et al.*, 2009). Technological evolution, digitization, increased competitiveness and economic instability are some of the factors that contribute to a stressful work environment[2]. It is essential to face these factors to ensure the mental health and well-being of workers, as well as to promote greater productivity and organizational sustainability. The psychosocial risk factors, and in particular the work-related stress, are issues that impact transversally in all organizations and are part of those aspects that every organization that want to operate in a sustainable way have to monitor carefully. Work-related stress and psychosocial risks, in fact, are linked to at least two of the objectives[3] of the Agenda ONU 2030 that the Italian Alliance for Sustainable Development carries forward in Italy. In particular, Goal 3 related to the themes of "*Good Health and Well-Being*" and Goal 8 related to "*Decent Work and Economic Growth*" with the sub-objective of creating healthy and safe work environments in all contexts. Work-related stress is defined by the European Agency for Safety and Health at Work[4] as "*the perception of imbalance felt by the worker when the demands of the work environment exceed individual capacities to cope with them*". The risks assessment for the health and safety of workers is carried out in accordance with the requirements of current legislation, in particular of art. 28 of Legislative Decree 81/2008 and subsequent amendments[5]. For the work-related stress risk assessment, the European Framework Agreement contents and the technical indications approved by the Permanent

[1] This article is the result of the common contribution of all and, therefore, the individual contribution is considered equal and equivalent to that of the other co-authors.

[2] European Agency for Safety and Health at Work, 2000.

[3] 17 Goals to Transform Our World, https://www.un.org/sustainabledevelopment/

[4] European Agency for Safety and Health at Work, 2002.

[5] ITALIAN LEGISLATIVE DECREE n. 81, 2008 April 9.

Consultative Commission for Occupational Health and Safety must be taken into consideration. The National Institute of Statistics - Istat, public administrations, research institutes and, more generally, companies pay great attention to the matter of organizational well-being. In compliance with the current legislation, these subjects are required to carry out an assessment of work-related stress risk in order to ensure the full psychophysical and relational (social) well-being of all workers who are part of the organization, as well as any other risk for health and safety at work (Camisasca *et al.*, 2023).

The purpose of the paper is not only to deal with the work-related stress risk assessment in ISTAT workplaces and to identify prevention and protection measures, but also to analyse and identify improvement measures for the entire organization and the individual structures to create healthy, safe and sustainable work environments, even in low-risk conditions, through a bottom-up process that strongly involves the workers in an original and innovative way.

2. Materials and methods

The Department of Medicine, Epidemiology, Occupational and Environmental Hygiene developed and published in May 2011 on a specific INAIL online platform, a Methodology for the assessment and management of work-related stress risk (Di Tecco *et al.*, 2018). This Methodology was modified and further developed after testing it on an extended sample. Companies can use it to carry out their risk assessment in compliance with the Legislative Decree 81/2008 and subsequent amendments. The method offers validated tools and specific resources that companies can use following a sustainable and integrated approach, articulated in phases, which involves the prevention figures and the workers. The "objective" INAIL methodology adopted to carry out the preliminary assessment is a scientifically validated methodology that has been widely used for several years in Istat, with an analytical and structured methodological process. The approach to the objective preliminary assessment is implemented by using "checklists", and consists essentially of two moments:

a) the analysis of "sentinel events" ("e.g. work-related injuries, sick leave absences, turnover, legal actions / disciplinary sanctions, reports from the Occupational Physician, specific and frequent formal complaints from workers");
b) the more specific analysis of content indicators ("e.g. work environment and work equipment; work load and work pace; working hours and shifts; correspondence between workers' skills and required professional requirements") and of context indicators ("e.g. role within the organization;

decision-making and work control; interpersonal conflicts at work; career path; communication (e.g. uncertainty about required performance)"). The Employer has the obligation to "hear" and therefore involve the workers and/or the Workers' Safety Representatives choosing procedures subject to "the adopted evaluation methodology".

The INAIL methodology provides for the risk calculation a weighted score on the different work areas with different characteristics, from which we can obtain the individual contributions of the three areas by adding the three areas of Sentinel Events, Work Content and Context Areas. The results obtained refer to the risk level shown in Figure 1, which has been updated and reweighted by INAIL over the years, revalued and standardized on the basis of the experience of thousands of companies of the INAIL sample.

Figure 1 – *The scores obtained in the 3 Areas are added together (left) to make a total risk score, which is then used to verify the positioning of the Homogeneous Group in the Table of Risk Levels (right).*

Final checklist score	Risk bands					
	Irrelevant		Medium		High	
	FROM	TO	FROM	TO	FROM	TO
Sentinel Events Area Score	0		6		16	
Content Area Score	0	23	24	43	44	100
Context Area Score	0	37	38	53	54	100
Final Score	0	58	59	90	91	216

FROM	TO	RISK LEVEL	NOTES
0	58	IRRELEVANT	The analysis of the indicators **does not highlight** particular organizational conditions that can determine **the presence of work-related stress**. The result is reported in the Risk Assessment Document and the periodic monitoring plan is carried out.
59	90	MEDIUM RISK	The analysis of the indicators **highlights** organizational conditions that can determine **the presence of work-related stress**; Corrective action must be taken and **the effectiveness of the intervention must then be verified**.
91	216	HIGH RISK	The analysis of the indicators **shows a HIGH level of work-related stress risk**, such as to require the use of **immediate corrective actions**.

Source: INAIL, (Di Tecco et al., 2018).

2.1. Application of the "objective" INAIL methodology to the ISTAT case study

The preliminary "objective" methodology proposed by INAIL was used in ISTAT to carry out the survey, which began in March 2022 and continued until after September 2022 with the aim of updating the work-related stress risk assessment. The preliminary assessment included the adoption of a work plan divided into progressive phases:

1. Definition of the organizational partition
2. Definition of the survey plan
3. Definition of sentinel events
4. Compilation of checklist

The phases of the work plan involved the Evaluation Group, established by the Employer and made up of the Prevention and Protection Service, the Occupational

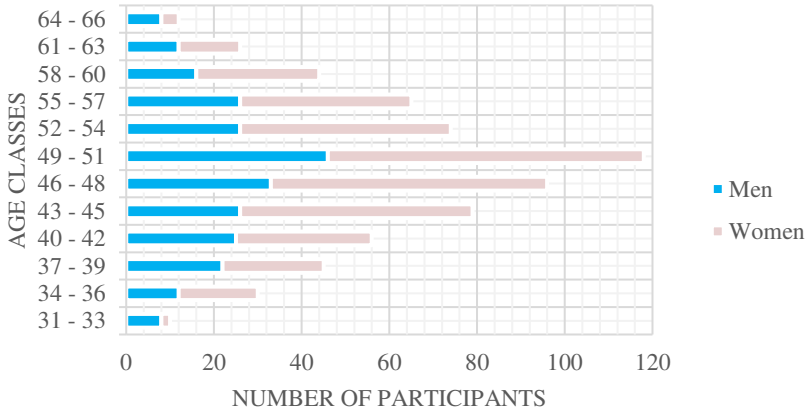
Physician, the Workers' Safety Representatives and the personnel of the Human Resources Directorate, with the aim of realizing all the activities of the work-related stress risk assessment. The Evaluation Group operated according to the work plan, including a design phase and an operational phase, in which the entire organization was divided into homogeneous organizational partitions characterized by the same organizational parameters that, in Istat, are services and staff structures. After the definition of the survey plan, the actual survey phase was carried out and all the indicators provided by the INAIL checklist were acquired objectively. Some of the indicators are objectively described in the official documentation of the Institute, others indicators, relating to sentinel events, derive from Human Resources Directorate and finally, the most important part relating to work context and content indicators derives directly from workers and Workers' Safety Representatives, through numerous collective interviews conducted on site with the compilation of checklists for each of the identified organizational partitions with strong confrontation between workers. The entire process of the work-related stress risk assessment was accompanied by moments of communication and information / training of personnel to encourage their involvement through official communications and information actions published on the news Intranet page, and specific mail addressed to individual structures (Directorates).

2.2. Sample composition

The workers involved in the sample of the work-related stress survey, randomly extracted, were 655 (~ 45%) out of a total of about 1470 workers of the Roman offices and distributed among 57 homogeneous organizational partitions. In order to be considered more significant for the purposes of the survey, it was chosen that the organizational partition should be identified by homogeneous groups with more than 4 workers. Below, we will provide an accurate analysis of the sample of workers who participated in the work-related stress survey. As shown in the diagram on the left, the sample consisted of 40% of Men and the remaining 60% of Women with well-represented organizational partitions and in line with the overall distribution of employees where the female population exceeds the male one. The diagram on the right, instead, shows the distribution of the sample that participated in the survey. The adherence was very high, 75% of those summoned participated spontaneously (without further reminders), massively and actively aware of the importance of the survey. Figure 2 shows the distribution of the participants divided by gender and age classes. It can be seen that in almost all age classes there is a female prevalence except for the two small classes of distribution at the extremes of the diagram, 31-33 and 64-66 (each 2%), where there is a less significant male prevalence on a small

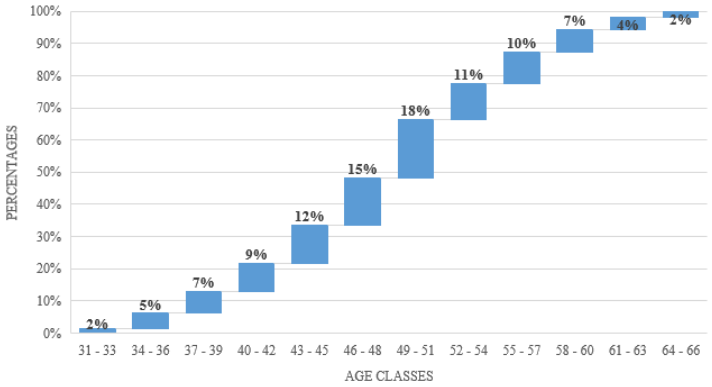
sample. The intermediate age class is still prevalent for both genders as can be seen in Figure 3, the prevalent age group is 49-51 (18%), followed by age classes 46-48 (15%) and 43-45 (12%) and so on.

Figure 2 – *Distribution of the participating sample by gender and age classes (Absolute Values).*



Source: Data processing of the sample conducted by the Istat, 2022.

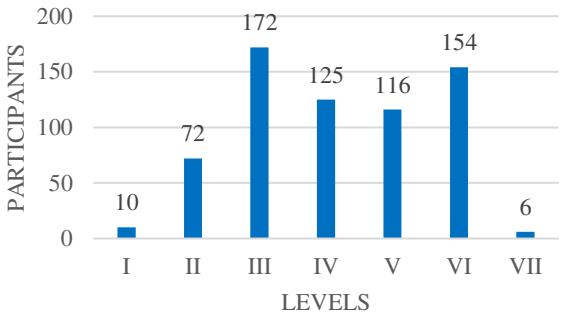
Figure 3 – *Distribution of Work-Related Stress survey participants by age classe (Values %).*



Source: Data processing of the sample conducted by the Istat, 2022.

Figure 4 shows, in absolute values, the distribution of participants in the Work-related Stress survey divided by professional level; while Figure 5 shows the distribution of percentage values of participants per level on the total of the sample.

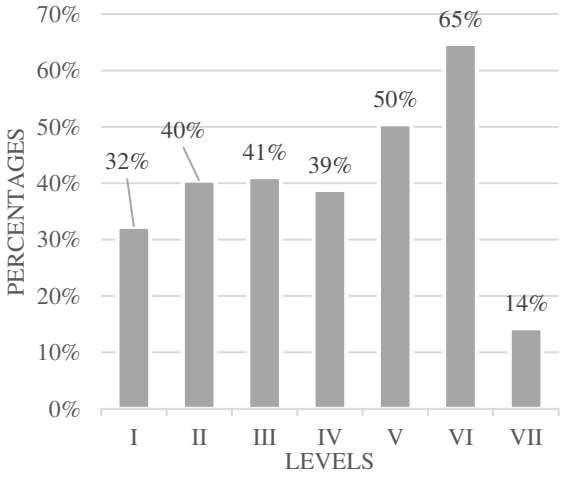
Figure 4 – *Distribution of the participating sample by gender and age groups (Absolute Values).*



Source: Data processing of the sample conducted by the Istat, 2022

The most represented levels in absolute value are III followed by VI and IV and so on. For almost all levels, in percentage terms, participation is above 40%, with the exception of those (levels I and VII) where the total number of workers is very small. The percentage values of the sample of workers on the total per level are homogeneous for the different levels of workers summoned as shown in Figure 5. The sample ensured a good representativeness at all levels and a high participation in the survey.

Figure 5 – *Distribution of Work-Related Stress survey participants by age class (Percentage Values).*

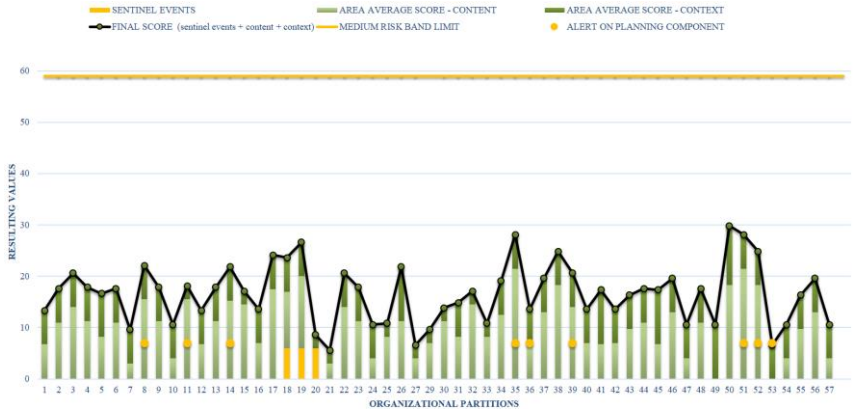


Source: Data processing of the sample conducted by the Istat, 2022.

3. Results

Through the objective INAIL methodology, it was possible to assess indicators derived from sentinel events, from work content and context factors of the INAIL methodology on 655 workers and 57 homogeneous organizational partitions. Consequently, for each organizational partition shown on the x-axis in Figure 6, the risk level was calculated by summing the scores of the three areas.

Figure 6 – *Representation of overall scores of the work-related stress assessment in Istat.*



Source: Data processing of the sample conducted by the Istat, 2022.

The resulting values show the weight of the distribution of the work content, work context, and sentinel events areas. The evaluation results show an overall irrelevant risk level for all the Institute partitions, in line with the previous surveys well below the critical threshold (set at 58 - the Medium risk band limit). For higher values, with a Medium Risk result, the Legislation would have required corrective actions and the adoption of mandatory focused measures. However, a detailed analysis of Figure 6 provides useful and interesting insights, as indicated by the Yellow dots, which highlight the presence of alerts that contribute to a greater risk factor, such as in the example within the work content area. In many cases, in fact, the significant "subsections" of interest may have provided indicators that carried greater weight respect to the risk, as in the case of Task Planning. The Sentinel Events carried significant weight only in three partition (18, 19, and 20), however the overall value of the assessment remained at an irrelevant risk level. Even in the worst cases, within organizational partitions with higher levels, the values remained well below the threshold of Medium risk. It is noteworthy that, on average, the work content area is usually higher than the work context area. Furthermore, the frequency analysis

(Table 1) is an additional evaluation parameter adopted by ISTAT completely original and innovative because it is not present in the INAIL reference methodology.

Table 1 – *The checklist indicators and the corresponding frequencies from which it is possible to identify transversal improvement actions to be adopted for the entire Institute.*

Question No.	Indicator	Absolute Value	Percentage
53	Systems to evaluate managers/heads in relation to the management of their staff	57	100%
19	Adequacy of the human resources necessary for the performance of the tasks	49	86%
55	Work depends on tasks previously performed by others	47	82%
17	Performing the task requires performing multiple tasks at the same time	26	46%
29	Regular working time of more than 8 hours	24	42%
21	Frequent and unpredictable variations in the amount of work	24	42%
14	Work is frequently interrupted	11	19%
30	Overtime is routinely done	9	16%
34	Shift work	8	14%
18	Clear definition of tasks	4	7%
58	Tools are set up for the decisive participation of workers in company choices	4	7%
43	Meetings between managers and workers	1	2%
15	Adequacy of the instrumental resources necessary to carry out the tasks	1	2%
50	Overlap of different roles among the same people (shift manager/supervisor/quality manager...)	1	2%

Source: Data processing of the sample conducted by the Istat, 2022. Data on a representative sample of 57 total homogeneous partitions of the survey.

This new parameter involves an analysis of the indicators that are most represented in terms of frequency. The purpose of this analysis was to identify improvement measures applicable to the entire organization. From the analysis of the transverse improvement actions frequency, we can highlight that the evaluation of managers is a comprehensive theme, while the resource adequacy is a critical issue. The lack of resources emerged prominently in the assessment and has become more intense; for this reason, a strong recruitment activity is currently underway, in line with the rest of the Public Administration. Additionally, the theme of work dependence on others requires a strong synergy and coordination of activities because, understandably, processes that rely on upstream and downstream operators pose a significant challenge. The analysis of the indicators frequency has allowed

the identification of improvement proposals not foreseen in the INAIL methodology, focusing on issues related to planning, resources, and professional growth. The improvement actions, shown in Table 2, stem directly from the frequency analysis and are very interesting because they represent beneficial actions for the entire organization, aimed at a cross-functional improvement and a continuous pursuit of organizational well-being for all Istat workers.

Table 2 – *Checklist indicators and corresponding transverse improvement actions to be adopted for the entire Institute.*

Indicators	Improvement actions
Adequacy of the human resources necessary for the performance of the tasks	▪ Empower human resources.
Work depends on tasks previously performed by others	▪ Respect and improve planning and timing; ▪ Ensure continuity and punctuality in the delivery of data.
Performing the task requires performing multiple tasks at the same time	▪ Improve the planning of secretarial activities; ▪ Prioritize tasks and increase resources.
Regular working time of more than 8 hours	▪ Enhance the number of resources and the efficiency of work processes.
Frequent and unpredictable variations in the amount of work	▪ Strengthen organizational meetings on important issues.
Work is frequently interrupted	▪ Make available hours for help desk activities.
Overtime is routinely done	▪ Strengthen the resources of the secretariat.
Clear definition of tasks	▪ Explain the tasks in the structure.
Shift work	▪ Empower human resources.
Meetings between managers and workers	▪ Increase structured and regular meetings at apical level.
Tools are set up for the decisive participation of workers in company choices	▪ Promote preparatory meetings with the group to which you belong.
Criteria for career advancement are defined	▪ Enhancement of the criteria of merit and career progression; ▪ standardization of procedures and criteria that are transparent and stable over time; ▪ Expand the number of open competitions and reduce their completion time.
The presence of a training plan for the professional growth of workers	▪ Enhance the offer.

Source: Data processing of the sample conducted by the Istat, 2022.

The improvement measures suggested by the workers themselves can be implemented by all organizational partitions regardless of having obtained irrelevant levels of risk. Among the improvement actions identified as applicable to the entire structure, we find: the establishment of objective criteria for career development, the strengthening of human resources, the enhancement of specific training, the improvement of task planning with adherence to timelines, the definition and simplification of procedures and avoiding unnecessary overtime. Other specific improvement actions have emerged in individual organizational units or among homogeneous groups of workers, and each individual Department / Directorate / Service can voluntarily adopt them. These actions are aimed at researching continuously the physical, mental, and social well-being of all workers within the organization. The identified improvement actions have become the primary goals for the Institute's Management, they have been discussed and shared through focused meetings between the Management and the Employer, and they are included in the three-year improvement plan for 2023-2025.

4. Final considerations and conclusions

The final considerations resulting from the evaluation of work-related stress risk have highlighted an irrelevant risk level for all partitions of the Institute. This indicates that the prevention and protection measures implemented have been effective in ensuring a healthy and safe work environment for employees, in line with previous surveys. However, the analysis of indicators has allowed the identification of additional improvement proposals, particularly regarding the activity planning, the resources allocation and the professional growth opportunities. These suggestions can further optimize organizational policies and practices in order to promote employees' well-being and foster a sustainable company culture.

In conclusion, the evaluation of work-related stress risk and the adoption of preventive measures are fundamental to ensure a healthy, safe and sustainable work environment. The bottom-up approach used in this study, based on the INAIL methodology, has allowed an accurate assessment of risk factors present in different Istat organizational partitions and the identification of specific improvement proposals. All the process has highlighted the importance of an active worker involvement in managing psychosocial risks and in creating sustainable organizations.

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GENDER GAP OF ITALIAN REGION: A SYNTHETIC INDEX PROPOPOSAL[1]

Daniela Fusco, Maria A. Liguori, Margherita M. Pagliuca

Abstract. Gender stereotypes are deeply ingrained in our culture and are a root cause of gender inequalities. Gender stereotypes can limit ability and aspirations to choose a field of study or training, pursue a professional career, and make simple life choices, like picking a hobby. Although inequalities still exist, the EU has made significant progress in gender equality over the last decades. There are numerous indices built for measure gender gap. In 2013, European Institute for Gender Equality (EIGE) released the Gender Equality Index (GEI), created to assess the levels of gender equality in Europe based on EU policies. This index is currently based on seven domains: work and money, knowledge, time, power, health, trust and safety, quality and life satisfaction. Our work intends to identify a measurement of the gender inequalities in the Italian region and the changes caused by COVID-19 pandemic.
Starting from the domains proposed by the GEI, integrated with some of the indicators of the Sustainable Development Goals (SDGs), eight dimensions were identified and a ninth of a more specific nature was added, called "Gender-based violence".

1. Introduction

Equality between women and men is a fundamental value of the European Union and is vital to its economic and social growth. The Gender Equality strategy 2020-2025 (EC, 2020) presents policy objectives and actions to make significant progress by 2025 towards a gender-equal Europe.

However, actually, gender gaps remain and, in the labour market, women are still over-represented in lower paid sectors and under-represented in decision-making positions. To study the phenomenon, already in 1995, the UNDP developed the Gender-related Development Index (GDI), which considered three domains: life

[1] Authors contributions: Daniela Fusco Abstract, paragraphs 1, 4 and References; Maria A. Liguori paragraph 2, tables and Appendix; Margherita M. Pagliuca paragraph 3.

expectancy and health, knowledge and standard of living. In 2013, EIGE released the Gender Equality Index (GEI), created to assess the levels of gender equality in Europe based on EU policies (EIGE, 2013). It does so by encompassing the universal caregiver model outlined by Fraser (1997), in which gender equality, as 'equal sharing of paid work, money, knowledge, decision-making power and time', is seen as central (Plantenga et al., 2009).

With 65.0 out of 100 points, Italy ranks 14th in the EU on the Gender Equality Index. Its score is 3.6 points below the EU's score (EC, 2023).

Since 2010, Italy's score has increased by 11.7 points, raising its ranking by seven places. This is one of the largest long-term improvements compared to other Member States. Since 2019, Italy's score has increased by 1.2 points; however, its ranking has remained the same (14th). Both long and short-term improvements are mainly due to a better performance in the domain of power.

During the last years, women, mostly mothers, have borne the brunt of the upheaval, including the more acute socioeconomic consequences of the COVID-19 crisis (EIGE, 2022). For the first time in a decade, gender inequalities in employment, education, health status and access to health services have grown in all European countries.

Starting from the domains proposed by the GEI and integrating with some of the indicators of the Sustainable Development Goals (SDGs), this work intends to identify a measurement of the phenomenon from 2018, in order to measure the changes in gender inequalities with the arrival of the pandemic and how they differ in the Italian regions, capturing the presence of gaps both in favour of men and women.

2. Methodology

Following the OECD indication for the composite indicator construction (OECD, 2008), the definition should give the reader a clear sense of what is being measured by the indicator. These are the steps:

1. Theoretical framework. Provides the basis for the selection and combination of variables into a meaningful composite indicator under a fitness-for-purpose principle.

2. Data selection. Analytical soundness, measurability, municipalities' coverage, and relevance of the indicators to the phenomenon being measured and relationship to each other.

3. Imputation of missing data.

4. Normalization. To render the variables comparable.

5. Weighting and aggregation. Select appropriate weighting and aggregation procedure(s) that respect both the theoretical framework and the data properties.

6. Uncertainty and sensitivity analysis. To assess the robustness of the composite indicator in terms of e.g., the mechanism for including or excluding an indicator, the normalisation scheme, the imputation of missing data, the choice of weights, the aggregation method.

Being gender inequality a multidimensional concept, we added to the 8 domains, a ninth one, gender-based violence (Table 1). Starting from 134 indicators analysed, at the end, 51 indicators was been chosen (Appendix).

The work of selection the indicators, for each domain, involved finding a delicate balance between the need to satisfactorily measure the nine domains and: data availability (only regional indicators classifiable by gender have been taken into consideration); feasibility (the availability of obtaining and processing updated data in a simple way has been taken into account); timeliness of the data to ensure an adequate time comparison; thematic appropriateness.

Our model of measurement is formative, since indicators are considered as causing the gender gap (rather than being caused by it, such as in the reflective approach), so, the correlations between basic indicators are not very relevant. According to this approach, indicators are not interchangeable.

In order to capturing the different forms of inequality rather than the single levels, we didn't use absolute levels of indicators, but we have calculated relative indices (female-to male ratios).

Each indicator is calculate for male, female and total, while the ratio female on male gives the gap. Therefore, the gap is plus then one if it is in favour of female, minus then one if it is in favour of male.

Table 1 – *Number of indicators per Domain.*

Domains	Number of indicators analysed	Number of indicators chosen
Knowledge	17	6
Work and money	27	13
Power	6	4
Health	23	4
Well-being		5
Trust and safety	6	5
Quality and life satisfaction.	28	5
Time	15	3
Gender-based violence	12	6
Total	134	51

Table notes: authors' elaboration

In order to construct our gender inequality index, we follow the composite indicators approach computing a composite index for each single domain.

For this research, the Adjusted Mazziotta–Pareto Index (AMPI) is applied. The AMPI is a non-compensatory (or partially compensatory) composite index that allows comparability of the data across units and over time (Mazziotta and Pareto, 2016; 2017). It is a variant of the Mazziotta–Pareto Index (MPI), based on a re-scaling of the individual indicators by a Min–Max transformation, in contrast with the classic MPI where all the indicators are normalized by a linear combination of z-scores (De Muro *et al*., 2011) and a re-scaling of the basic indicators in a range (70; 130). It is the best solution for a multi-year analysis.

Given the original matrix X_{ij}, where $i=1,...,n$ are the units of analysis (the Italian regions) and $j=1,..,m$ are the basic indicators, we calculate the normalized matrix as follows:

$$r_{ij} = \frac{\left(x_{ij} - Min_{x_j}\right)}{\left(Max_{x_j} - Min_{x_j}\right)} \; x \; (60 + 70)$$

where x_{ij} is the value of the indicator j in the unit i and Min_{xj} and Max_{xj} are the goalposts for the indicator j. Let Inf_{x_j} and Sup_{x_j} be respectively the minimum and the maximum values of indicator j across all regions and all time periods considered, and Ref_{x_j} be the reference value for indicator j. Then the "goalposts" are defined as: $Max_{x_j} = Ref_{x_j} + \Delta$, and $Min_{x_j} = Ref_{x_j} - \Delta$, where $\Delta = (Sup_{x_j} - Inf_{x_j})$ /2. The adjusted MPI is given by:

$$AMPI^{\pm} = \mu_{r_i} \pm \sigma_{r_i} * cv_i$$

where r_i is the normalized value of the indicator, μ_{r_i} , σ_{r_i} and $cv_i = \sigma_{r_i} / \mu_{r_i}$, are the mean, the standard deviation and the coefficient of variation of the unit i and the sign ± depends on the kind of phenomenon measured. If all the composite indices are positive, i.e., increasing values of each index correspond to positive variations of the gender gap in a specific domain, $AMPI^-$ is used, otherwise $AMPI^+$

3. Results: Quality and life satisfaction

To experiment the methodology we have chosen the domain "Quality and life satisfaction". The choice depended by the availability of all simple indicators at same time and the low number of the indicators.

The means and the standard deviations for each simple indicator (Table 2) show how the indicators have moved over the years by sex. On average, in Italy, for all domain indicators, men have higher values than women.

Table 2 – *Domain Quality and life satisfaction: Means and Standard deviation for each indicator at national level.*

Quality and life satisfaction					
	2018 M(SD)	2019 M(SD)	2020 M(SD)	2021 M(SD)	2022 M(SD)
Indicator			**Female**		
Positive judgement of future perspectives	26.93 (2.63)	27.84 (3.25)	26.25 (2.38)	29.66 (2.56)	27.57 (3.12)
Free time satisfaction	65.29 (5.41)	66.83 (5.59)	68.54 (4.56)	56.23 (4.35)	64.19 (5.44)
Life satisfaction	41.97 (8.21)	44.24 (7.44)	45.20 (6.81)	45.92 (5.85)	46.00 (6.06)
Friends relationships satisfaction	23.37 (5.31)	22.58 (3.74)	22.54 (6.80)	18.79 (3.71)	21.31 (4.90)
Family relationships satisfaction	33.66 (6.22)	33.09 (4.68)	33.33 (6.29)	31.89 (5.31)	32.17 (6.67)
	2018 M(SD)	2019 M(SD)	2020 M(SD)	2021 M(SD)	2022 M(SD)
Indicator			**Male**		
Positive judgement of future perspectives	30.29 (3.08)	31.08 (3.39)	29.81 (3.16)	32.91 (3.31)	30.21 (2.81)
Free time satisfaction	68.97 (4.36)	70.94 (4.13)	72.49 (4.05)	60.05 (3.47)	68.53 (3.92)
Life satisfaction	45.43 (8.35)	46.84 (7.25)	48.15 (6.83)	48.90 (5.36)	49.60 (6.11)
Friends relationships satisfaction	25.00 (4.34)	24.62 (2.84)	23.26 (4.42)	20.01 (2.93)	23.66 (4.01)
Family relationships satisfaction	34.58 (6.17)	34.40 (4.57)	33.50 (5.65)	32.84 (5.28)	33.71 (5.87)

Table notes: authors' elaboration

As we expected, almost all the indicators of this domain suffer a decrease in the 2021 year. Except for the "Positive judgement of future perspectives" that grow up in 2021 particularly for women (+10.3% respect to year 2018). Also the indicator "Life satisfaction", with a bigger standard deviation, grow during the pandemic: from 41.97 (2018 y.) to 45.20 (2021 y.) for women and from 45.43 (2018 y.) to 48.15 (2021 y.) for men. For both men and women, in 2021 the "Satisfaction for free time" presented the lowest values (56.23 for female and 60.05 for male), even if this indicator is generally higher for men.

"Satisfaction for Friends relationships" decreased in the years up to 2021, in 2022 there was a change in trend, while the level of "Family relationships satisfaction" has been almost stable over the years.

Figure 1 – *Domain Quality and life satisfaction: Box plot, male and female per year.*

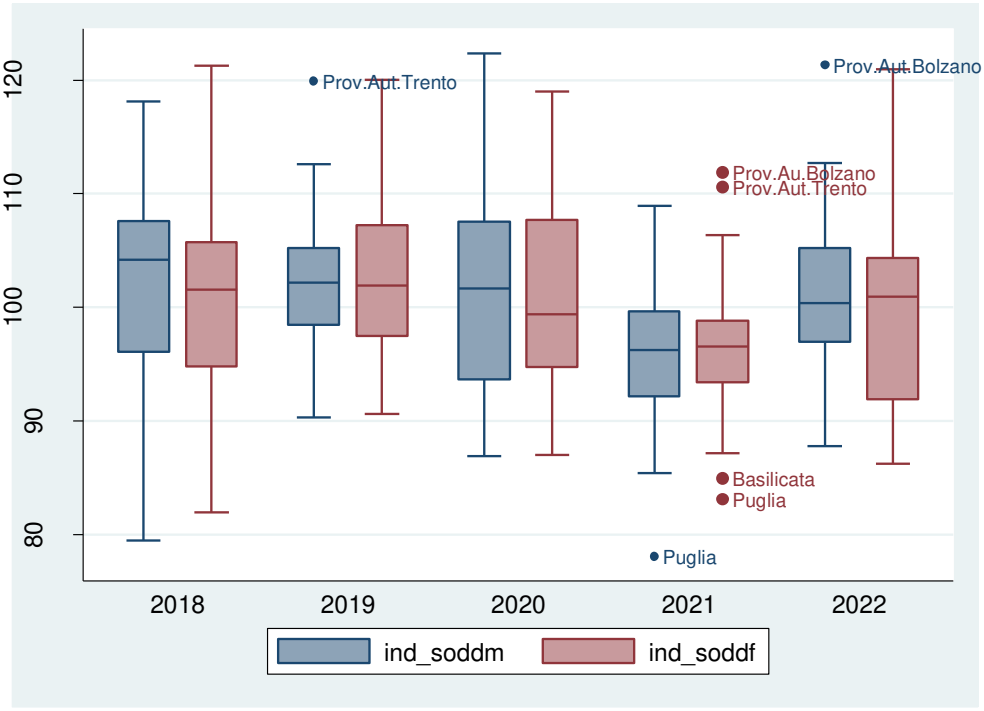

Figure notes: authors' elaboration

The box plot (Fig. 1) underline significant results for the synthetic indices calculated by sex. Males are represented with blue colour, females with pink colour; the "whiskers" are the maximum and minimum, the rectangle is the variability (interquartile difference), the points are the outliers. In 2018, there is a high variability and male satisfaction levels are higher. Over time, the differences between women and men are reduced, except in 2020. It is clear a less variability of the phenomenon in 2021 with low average values. In Puglia region, both for male and female, the values are particularly low in the same year (also in Basilicata for women), whereas in the provinces of Trento and Bolzano the "Quality and life satisfaction" is particularly high for women. Instead, in 2020, the year of greater uncertainty, greater variability is observed with higher average values for males respect to females.

In 2022 the average values start to increase again, even if with greater variability, more marked for women. In this year women have higher levels of satisfaction.

Table 3 – *Domain Quality and life satisfaction: regional synthetic index.*

Regions	Quality and life satisfaction index				
	2018	**2019**	**2020**	**2021**	**2022**
Abruzzo	90.8	93.6	95.4	103.2	93.3
Basilicata	101.5	98.6	100.6	72.1	75.6
Calabria	96.0	98.9	100.1	101.8	100.7
Campania	102.1	93.1	102.4	97.1	93.8
Emilia-Romagna	101.9	97.1	103.7	102.4	105.3
Friuli-Venezia Giulia	92.9	105.2	96.8	89.2	96.2
Lazio	97.9	97.7	104.2	95.3	96.7
Liguria	97.4	102.5	100.4	96.9	98.9
Lombardia	106.4	102.5	99.4	89.2	98.5
Marche	99.9	96.3	108.6	97.6	93.9
Molise	99.5	86.4	94.5	110.1	81.2
Piemonte	102.8	104.9	98.0	103.4	98.4
Provincia Autonoma di Bolzano/Bozen	110.3	105.1	109.4	107.0	103.4
Provincia Autonoma di Trento	104.1	100.8	99.4	101.2	110.5
Puglia	90.0	98.9	91.9	102.1	98.6
Sardegna	87.3	97.8	95.9	92.8	104.6
Sicilia	96.9	91.2	95.1	92.5	95.2
Toscana	98.8	102.2	98.0	99.1	96.9
Umbria	83.4	88.7	94.3	99.7	98.9
Valle d'Aosta/Vallée d'Aoste	96.7	103.7	98.9	113.6	96.5
Veneto	101.4	93.1	105.6	98.9	91.4
North	103.1	100.6	101.2	96.5	98.8
North-est	101.1	97.0	104.1	99.8	98.6
North-west	104.5	103.1	99.1	93.9	98.8
Center	97.5	98.5	102.0	97.4	96.9
South and islands	95.7	94.9	97.2	97.2	96.2
South	96.5	95.9	98.2	99.3	95.4
Islands	94.2	93.1	95.3	92.8	97.6
Italy	**100.0**	**98.5**	**100.2**	**97.0**	**97.8**

Table notes: authors' elaboration

The synthetic results, where Italy in 2018 is used as a benchmark value, show different context between both Regions and Macro-regions (Table 3). All values upper 100 highlight situations in which the gap against women is lower than in Italy.

It is interesting to note that, at the macro area level, the differences of the index values flatten out towards 100 over the years. During the first wave of pandemic, 2020, there was a reduction of the gap in favour of women (except in North-west).

In South, the gap continued the reduction in favour of women in 2021, but in 2022 it was grow up to the disadvantage of women.

The worst female situation for Quality and life satisfaction is in Basilicata for 2021 (72.1) and 2022 years (75.6). This result is mainly influenced by the indicator Friends relationships satisfaction, particularly low (0.63, 2021 y, and 0.68, 2022 y). While, the best performances are achieved by Valle d'Aosta in 2021 (113.6, with Positive judgement of future perspectives equal to 1.04, Friends relationships satisfaction equal to 1.3 and Satisfaction with family relations equal to 1.00), Trento in 2022 (110.5), with simple indicator high in mean, and Bolzano in 2018 (110.3), thanks to high values for the indicators Friends relationships satisfaction (1.19) and Satisfaction with family relations (1.03). Unusual the situation of Sardinia where the gap has gone from being in favour of men in 2018 year (87.26) to being in favour of women in 2022 (104.61) thanks to results obtained for the indicators Positive judgement of future perspectives (1.00), Friends relationships satisfaction (1.10) and Satisfaction with family relations (1.03).

4. Conclusions and final remarks

Following the EU regulations, gender equality was included as one of the three crosscutting missions of the National Plan, alongside those dealing with generational and regional disparities (Donà, 2022). As Italy's Recovery and Resilience Plan was, in terms of resources, the largest national plan under the RRF, it has the potential to be a 'turning point' for gender equality in Italy. This underline the importance of a measurement of the phenomenon at regional level. The choice of the most suitable model was not easy.

The selection of the 51 indicators was a complex choice, weighted considering:

- Data availability. Only regional indicators classifiable by gender have been taken into account;
- Feasibility. The availability of obtaining and processing updated data in a simple way has been taken into account;
- Timeliness of the data to ensure an adequate time comparison;
- Thematic appropriateness.

The idea is the construction of a composite index for each domain because the loss of information deriving from the calculation of a single index, which further summarizes the domains, would lead to the exclusion of the possibility of undertaking this choice. Moreover, the normalization process implements an "implicit" weighting which is also difficult to quantify. Specifically, the min-max normalization depends on how wide the gap between the maximum and minimum value is from a temporal point of view and by how big the regional gap is for each

single indicator. This is a relevant issue especially if an indicator is analysed from a temporal point of view because even significant advances in percentage terms (of the elementary indicator) could translate into very small advances of the normalized indicator. However, the construction of a regional ranking, alongside the reading of individual domains, could represent an important information input for monitoring the phenomenon over time. The results obtained for the domain Quality and life satisfaction show the goodness of the chosen approach. This allows proceeding with the calculation of the other domains and the synthetic index as next steps.

Appendix

Simple indicators	**Domains**
Adequate nutrition	Well-being
Alcohol consumption	Well-being
Overweight or obesity	Well-being
Smoking	Well-being
Sedentariness	Well-being
People with high level of IT competencies	Knowledge
Reading books and newspapers	Knowledge
Early leavers from education and training	Knowledge
People having completed tertiary education (30-34 years old)	Knowledge
STEM graduates	Knowledge
People with at least upper secondary education level (25-64 years old)	Knowledge
Young people neither in employment nor in education and training (NEET)	Work and money
Cultural employment	Work and money
Share of employed persons with temporary jobs for at least 5 years	Work and money
Share of over-qualified employed persons	Work and money
Involuntary part time	Work and money
Share of employed persons who feel their work unsecure	Work and money
Proportion of time spent on unpaid domestic and care work	Work and money
People at risk of poverty	Work and money
Job satisfaction	Work and money
Employment rate (20-64 years old)	Work and money
Gender pay gap	Work and money
Pensions	Work and money
Pension expenditure	Work and money
Share of members of Regional Assemblies	Power
Share of members of Managers Regional Assemblies	Power
Share of members of Municipal councils	Power
Share of members of Municipal commettee	Power
Mental health	Health
Life expectancy at birth	Health

Simple indicators	**Domains**
life expectancy without limitations at age 65	Health
Healthy life expectancy at birth	Health
Safe walking alone at night in the city/ area where you live	Trust and safety
Relatives/friends you can count on to help you	Trust and safety
Victims of blows	Trust and safety
Victims of sexual violence	Trust and safety
Victims of stalking	Trust and safety
Positive judgement of future perspectives	Quality and life satisfaction.
Leisure time satisfaction	Quality and life satisfaction.
Life satisfaction	Quality and life satisfaction.
Satisfaction with friends relations	Quality and life satisfaction.
Satisfaction with family relations	Quality and life satisfaction.
Volunteered the time to an organization	Time
Civic and political participation	Time
Persons aged 3 and over practising sports	Time
Households for women	Gender-based violence
Anti-violence centers	Gender-based violence
Female victims of blows	Gender-based violence
Female victims of stalking	Gender-based violence
Female victims of family violence	Gender-based violence
Female victims of sexual violence	Gender-based violence

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UNPACKING DETERMINANTS OF WATER CONSERVATION BEHAVIOUR AND SPATIAL HETEROGENEITY IN THEIR COEFFICIENTS

Rashad Mammadli

Abstract. Water scarcity issues around the world require a thorough understanding of the factors that influence water consumption and conservation behaviour to address the problems on the demand side. This study investigates the determinants of water conservation behaviour through a comprehensive empirical analysis and explores spatial heterogeneity in their coefficients at a regional unit scale with a specific focus on Italy. Ordinal logistic regression with sequential analysis provides that various socio-demographic, behavioural, and social factors including trust in public institutions have a significant impact on water conservation. Furthermore, the findings of the geographically weighted regression reveal statistically significant spatial variations in the relationship between water saving and its four factors including gender, household size, energy saving, and trust in public institutions. The study concludes that targeted interventions tailored to specific regions are essential for effective water-saving interventions which have important implications for policymakers in promoting this type of conservation behaviour.

1. Introduction

Insufficient access to clean water is a prevalent and persistent issue that affects populations worldwide, and these problems are expected to deteriorate further in the forthcoming decades as water scarcity becomes increasingly widespread due to population growth, water pollution, climate change, and the overexploitation of natural resources (Gregory & Di Leo, 2003).

Prior research has found that water consumption or conservation is affected by multiple parameters, such as socio-demographic characteristics including income (Fielding et al., 2012), age (Aprile & Fiorillo, 2017), household size (Russell & Knoeri, 2012), and education (Gregory & Di Leo, 2003). Psychosocial factors, such as habits (Straus et al., 2016), subjective norms (Russell & Knoeri, 2020), and pro-environmental behaviour (Dolnicar et al., 2012), influence residential water use and saving as well. Furthermore, the altitude of the geographic location (Romano et al., 2016), ownership structure (Kontokosta & Jain, 2015), and water prices (Romano et

al., 2016) are also significant in determining this behaviour. A major limitation of previous research is the limited number of potential determinants included in the models and the reliance on small sample sizes (Dolnicar et al., 2012). Additionally, the impact of socio-demographic variables on water consumption behaviour differs significantly across different geographic regions. Therefore, it is crucial to conduct determinant analysis using localized data to evaluate the relevance of the results of previous studies to the local conditions of target region (Kontokosta & Jain, 2015).

The present study aims to address the limitations in two steps. First, it investigates the factors of water conservation using a large sample from Italy. Then, it explores spatial heterogeneity at a regional unit scale in the relationship between water-saving behaviour and its determinants. In addition to exploring the impact of previously known factors, the effects of two domains of subjective well-being, charitable donations, trust in others and trust in public institutions are tested to go beyond the existing empirical research and determine new implications for policy measures.

2. Materials and Methods

The present research utilizes data from the Aspects of Daily Life (AVQ) survey, which is an annual, multipurpose survey conducted by the Italian National Institute of Statistics (ISTAT) since 1993. This survey gathers information from approximately 50,000 individuals residing in 20,000 households about their daily activities, behaviours, and difficulties. I use the 2021 wave and focus solely on respondents aged 16 and above as well as exclude the rows with non-available information in education, civil status, region of residency, and the judgment of the cost of the water variables. Furthermore, as the models include both individual and household level variables, only the first individual from each household in the dataset is retained, resulting in a sample size of 18,633 observations. In order to address the presence of missing data, comprising approximately 1.21% of the entire dataset, the k-nearest neighbours (kNN) imputation technique is performed as the results of Little's test indicate that there is no significant evidence that the data is not missing completely at random (MCAR).

To evaluate water conservation behaviour, a survey question, that asks participants about the frequency with which they attempt to avoid wasting water, is exploited. Responses are provided on a 4-point frequency scale, which is reordered for this study. A score of 1 indicates "never," a score of 2 indicates "sometimes," a score of 3 indicates "habitually," and a score of 4 indicates "always." Table 1 presents some descriptive statistics of the selected variables.

Table 1 – *Descriptive Statistics.*

Variable	Category or Description	% *or* mean
Age	16 – 34	4.6%
	35 - 44	11.4%
	45 - 54	19.3%
	55 - 64	21.0%
	65 and more	43.7%
Gender	1 = Female	37.7%
Civil status	1 = Married	49.8%
Education	1 = Higher education (bachelor's degree and above)	15.6%
Income (judgement)	Insufficient (Scarce)	30.1%
	Adequate	68.2%
	Excellent	1.6%
Household size	Number of household members	2.29
Health Status	5-point scale: 1 = "very bad"; 5 = "very good"	3.60
Satisfaction with Life	0-10 scale: 0 = "not at all"; 10 = "very satisfied"	7.18
Sat. with Environment	4-point scale: 1 = "not at all"; 4 = "very satisfied"	2.84
Sat. with Water Services	4-point scale: 1 = "not at all"; 4 = "very satisfied"	3.06
Drinking tap water	1 = Yes	43.4%
Cost of Water (judgement)	Low	1.9%
	Adequate	57.9%
	High	40.2%
Ownership structure	1 = Rent	13.6%
Reading labels	4-point scale: 1 = "never"; 4 = "always"	2.87
Organic food	4-point scale: 1 = "never"; 4 = "always"	2.46
Local food	4-point scale: 1 = "never"; 4 = "always"	2.87
Energy Saving	4-point scale: 1 = "never"; 4 = "always"	3.63
More sustainable transports	4-point scale: 1 = "never"; 4 = "always"	2.05
Churchgoing	1 = Regularly (at least once in a month)	31.6%
Waster Sorting[1]	3-point scale: 1 = "never"; 3 = "always"	2.91
Volunteering	1 = Yes	8.4%
Trust in others	1 = "most people are trustworthy"	26.8%
Trust in public institutions[2]	10-point scale: 0 = "not at all"; 10 = "totally trust"	5.88

To allow for addressing the questions raised in Section 1, this paper estimates the determinants of water conservation behaviour in Italy using two different modelling approaches. The first approach involves sequential analysis using ordinal logistic regression to identify significant factors, while the second approach utilizes geographically weighted regression (GWR) to investigate the spatially heterogeneous effects of each independent variable at a regional unit scale of Italy.

[1] It is a composite indicator constructed as an as an arithmetic mean of the four same scale variables which are sorting habits for paper, glass, plastic, and organic. Cronbach's alpha is 0.85.

[2] It is a composite indicator constructed as an as an arithmetic mean of the seven same scale variables which represent trust in Italian Parliament, European Parliament, regional government, municipalities, political parties, justice system and law enforcement. Cronbach's alpha is 0.91.

In the first approach, the proportional odds model for Ordinal Logistic Regression, as described by McCullagh (1980) is exploited:

$$logit\big(P(Y \leq i)\big) = \log\left(\frac{P(Y \leq i)}{P > i}\right) = \beta_{i_0} + \beta_{i_1} x_1 + \cdots + \beta_{i_{n-1}} x_{n-1} + \beta_{i_n} x_n \quad (1)$$

where Y is an outcome variable with I categories, so that, $P(Y \leq I) = 1$; i is a specific category of Y; $\beta_{i_o}, \beta_{i_o}, \beta_{i_1}, \ldots \beta_{i_{n-1}}, \beta_{i_n}$ are model coefficient parameters with n predictors. The odds of being less than or equal a $i - th$ category is $\frac{P(Y \leq i)}{P > i}$.

Before constructing GWR model, variable importance and feature selection methods using Bayesian Networks and Random Forest algorithms are implemented both for robustness check and for reducing the dimensionality of the data and improving the model's performance by eliminating irrelevant features.

In the final stage, a geographically weighted regression (GWR) model is employed to examine the association between water conservation behaviour and predictor variables across various geographic regions in Italy. GWR is a method that expands the traditional regression framework by allowing for local variations in the coefficients. It accounts for the geographic location of each observation by assigning a diagonal matrix of locally weighted regression coefficients, in which each diagonal element is a function of the location of the observation, enabling a diverse relationship between the dependent variable and predictors across different spatial units (Fotheringham & Charlton, 1998):

$$y_i = \beta_0(u_i, v_i) + \sum_{k=1}^{p} \beta_{ik}(u_i, v_i) x_{ik} + \varepsilon_i \quad (2)$$

where β_i is the value of the kth parameter at location i, and (u_i, v_i) are the geographical coordinates of that location. Diagonal elements of a weight matrix are determined using a Gaussian weighting function as a kernel density function:

$$w_j(i) = \exp\left[-\left(\frac{d_{ij}}{b}\right)^2\right], j = 1,2, \ldots, n \quad (3)$$

where d_{ij} is the distance between regression point i and data point j and b is bandwidth.

3. Results

Prior to conducting the analysis, the presence of multicollinearity among the independent variables is assessed using the Variance Inflation Factor (VIF). The VIF for civil status variable is the highest at 1.995, indicating a moderate level of collinearity with the other independent variables. However, it is below the

recommended threshold of 5, which means that collinearity is not substantial enough to significantly affect the analysis.

Sequential analyses with OLR are performed to explore the determinants of water conservation behaviour. Three models are constructed. In the first step, only socio-demographic characteristics, various domains of well-being, and water-related variables are included (Model 1). The pro-environmental behaviour variables are entered into the regression in the second step (Model 2). Finally, Model 3 which also includes the social capital variables is performed. Table 2 presents the results of the ordinal logistic regression analysis with the dependent variable being ordered categorical. The coefficients indicate the log odds ratio of the odds of a higher category of water conservation, given a one-unit increase in an explanatory variable.

At the first step of the regression, demographic, well-being and water-related variables do not account for a significant amount of variance in water conservation behaviour. The inclusion of pro-environmental behaviours leads to a significant increase in the explanatory power of the model, with 50% of the variance in self-reported frequency of water-saving behaviour explained ($Nagelkerke\ R^2 = 0.4969$).

In the realm of socio-demographic characteristics, age and gender significantly contribute to explaining water conservation behaviour. The variable of age exhibits a positive correlation ($p<0.001$) with water conservation efforts, indicating that older individuals tend to be more inclined towards minimizing water wastage compared to their younger counterparts. This finding aligns with previous studies conducted by Aprile and Fiorillo (2017), and Gregory and Di Leo (2003), while standing in contrast to the results obtained by Fielding et al. (2012) and Russell and Knoeri (2020). Similarly, the marginal effect of being female presents a positive sign and is statistically significant at the 1% level, indicating that females save water more than males. This finding is consistent with previous research (Aprile & Fiorillo, 2017). However, contrary to the various prior findings, education, income, household size, ownership structure and perceived health have not significant effect on water saving. Considering the well-being variables, those who report higher satisfaction with life are also more likely to report a higher frequency of water conservation ($p<0.01$).

Even though in Model 1, as the judgment on the cost of water ($p<0.01$) increases from lower to adequate, and from adequate to higher ($p<0.001$), individuals are more likely to conserve water, which is in line with expectations and supported by previous research (Romano et al., 2016), their marginal effect reduces to statistical insignificance in Model 2. Drinking tap water is also has a non-significant effect.

With regard to pro-environmental behaviour (PEB), all domains of PEB except consuming organic food and waste sorting habits, have a statistically significant positive effect on water-saving habits, which is in align with the prior findings (Dolnicar et al., 2012). The statistically insignificant effect of organic food could be the result of the motivation behind consuming naturally, as a study by Idda et al.

(2008) shows that the primary motivations for organic food in Italy are food safety and taste rather than environmental safeguard.

Table 2 – *Determinants of Water Conservation Behaviour.*

Variables	Model 1		Model 2		Model 3	
	Odds Ratio	S.E.	Odds Ratio	S.E.	Odds Ratio	S.E.
Age	0.055***	0.010	0.047***	0.012	0.045***	0.012
Gender: female	0.298***	0.039	0.147**	0.046	0.142**	0.047
Civil status: married	0.153***	0.046	0.093	0.053	0.092	0.053
Education: higher	0.059	0.047	-0.046	0.055	-0.042	0.056
Household size	-0.063***	0.018	-0.024	0.021	-0.027	0.021
Income	-0.150***	0.032	-0.062	0.037	-0.060	0.038
Ownership structure: rent	-0.063	0.049	-0.007	0.057	-0.019	0.058
Health Status (perceived)	0.080***	0.023	0.016	0.027	0.016	0.027
Satisfaction with life	0.122***	0.011	0.036**	0.013	0.028*	0.013
Satisfaction with environment	0.034	0.023	0.032	0.028	0.029	0.028
Satisfaction with water services	0.030	0.027	0.003	0.031	-0.013	0.031
Drinking tap water	0.062	0.034	0.019	0.040	0.032	0.040
Cost of water: Adequate	0.315**	0.110	0.176	0.133	0.129	0.134
Cost of water: High	0.409***	0.111	0.172	0.134	0.132	0.136
Reading labels			0.136***	0.022	0.134***	0.022
Organic food			0.003	0.026	0.009	0.026
Local food			0.118***	0.024	0.118***	0.024
Energy Saving			2.254***	0.029	2.257***	0.029
More sustainable transportation			0.116***	0.019	0.119***	0.019
Waste sorting			0.095	0.053	0.089	0.053
Churchgoing: regularly					-0.013	0.043
Charitable giving					-0.104	0.060
Volunteering activities					0.016	0.077
Trust: most people are reliable					0.004	0.046
Trust in public institutions					0.028**	0.010
AIC	*30,884*		*21,569*		*21529*	
Pseudo R^2 *(Nagelkerke* R^2*)*	*0.02*		*0.4969*		*0.4976*	

****p < 0.001, **p < 0.01, *p < 0.05*

In the final step, the addition of social capital variables does not considerably increase the power of the model to explain variance in water saving behaviour ($Nagelkerke\ R^2 = 0.4972$). In comparison with Model 2, the signs and significance of the coefficients of all variables remain the same with modest variations in values.

Contrary to the findings by Aprile and Fiorillo (2017), regular church attendance is not statistically significantly correlated with more frequent water-saving behaviour. Similarly, charitable giving and volunteering activities in the last 12 months, and trust in others also have statistically insignificant coefficients which are somewhat unexpected as Brekke et al. (2011) argue that people who act more prosocially tend to make higher contributions to public goods, including the

environment; and Tam and Chan (2018) demonstrate that an individual-level generalized trust in others can help elicit more pro-environmental behaviour. In contrast to trust in others, individuals become more likely to save water as their trust in public institutions increases ($p<0.01$), which is in line with previous findings on the relationship between pro-environmental behaviour in general and general trust.

Concerning feature selection (Table 3), following the robust approach suggested by Cugnata et al. (2016), the BN structures are estimated using eight algorithms, including constrained-based algorithm which utilizes conditional independence tests to assess edges in $\mathcal{G}$, a score-based algorithm which uses heuristic search algorithms to evaluate a goodness-of-fit based on AIC or BIC, and hybrid approaches, provided by Scutari (2016). For direct connections, a weight of 1 is assigned to the arcs linking pairs of nodes, 0.5 for indirect connections, and 0 for unlinked arcs. Then weights for each arc through the eight algorithms are summed up. For the purposes of this paper, a robust BN is defined as the one containing the largest set of arcs scoring 4 or more, corresponding to an arc found in half or more of the algorithms considered. Finally, a Markov blanket of water conservation behaviour, as well as any variable on the path leading to this behaviour through directed or undirected arcs in the robust network are selected. As for feature selection with Random Forest, variable importance techniques with Mean Decrease Accuracy (MDA) and Mean Decrease Gini (MDG) are employed. Later, the scores in decreasing order for both MDA and MDG are ranked, and the variables which have higher importance score than the average scores of all variables are selected.

Table 3 – *Robust Variable Selection.*

Variable	OLR	BN	MDA	MDG	Total
Age	1	0	1	1	3
Gender	1	1	1	0	3
Civil status	0	0	0	0	0
Household size	0	0	1	1	2
Health Status (perceived)	0	0	1	1	2
Satisfaction with life	1	0	1	1	3
Satisfaction with environment	0	0	0	1	1
Satisfaction with water services	0	0	0	1	1
Reading labels	1	1	1	0	3
Organic food	0	1	1	1	3
Local food	1	1	1	1	4
Energy Saving	1	1	1	1	4
More sustainable transportation means	1	1	1	1	4
Trust in public institutions	1	0	0	1	2

Finally, the study utilizes a scoring system in which a score of 1 is assigned to variables that are selected by Bayesian Network, and Random Forest (both MDF and MDA) techniques, as well as to the explanatory variables which has a statistically

significant coefficient in the third OLR model, while a score of 0 is assigned to the remaining variables. Then, the scores are summed up and 11 variables with a total score of 2 or more are selected for inclusion in the GWR model.

Table 4 presents the output of the GWR model along with the results of global OLR model with the selected variables. F2 test, which examines the SSR improvement of GWR over OLS through the difference between their residual sums of squares (Leung et al., 2000), provides that GWR demonstrates significant improvement in explanatory power over the OLS, while it underperforms the OLR model based on the comparison with their AIC values.

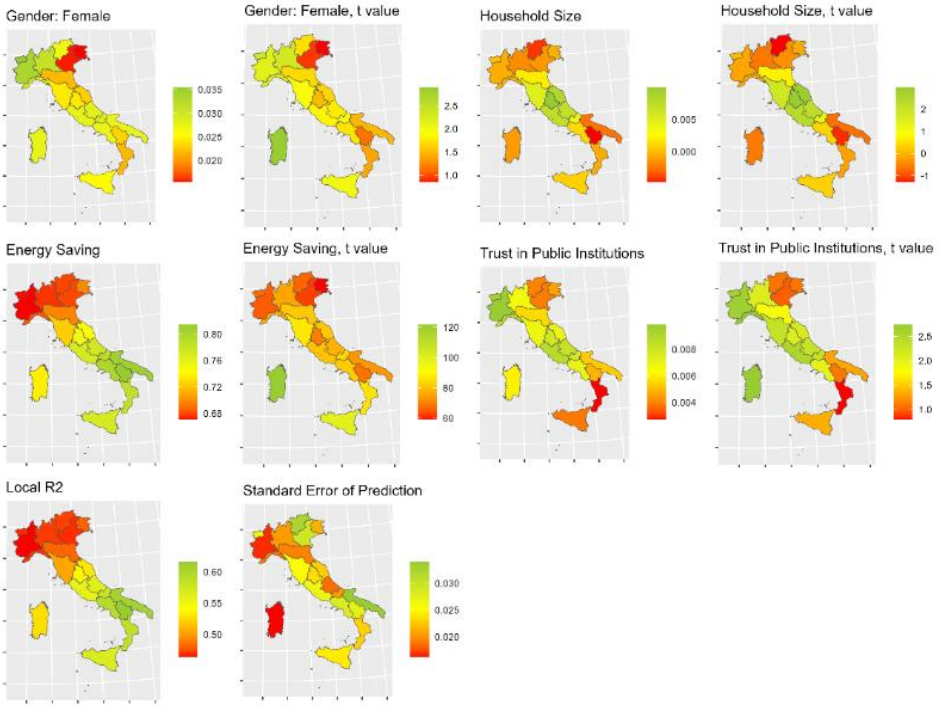
Table 4 – *Results of the geographically weighted regression (GWR) model.*

Variable	Min	Median	Mean	Max	F3 Test	Global (OLR)
Intercept	0.324	0.528	0.534	0.744	1.000	
Age	-0.001	0.007	0.006	0.012	1.000	0.049***
Gender: Female	0.015	0.028	0.026	0.035	0.000	0.112**
Household Size	-0.005	-0.000	0.001	0.010	0.000	-0.004
Health Status (perceived)	-0.023	0.003	-0.000	0.015	1.000	0.012
Satisfaction with life	-0.001	0.003	0.003	0.008	1.000	0.027*
Reading labels	0.004	0.038	0.034	0.045	0.770	0.132***
Organic food	-0.009	0.004	0.004	0.020	0.134	0.003
Local food	0.027	0.033	0.037	0.055	1.000	0.119***
Energy Saving	0.671	0.737	0.733	0.814	0.000	2.261***
More sustainable. trans.	0.017	0.024	0.024	0.033	1.000	0.116***
Trust in public institutions	0.003	0.007	0.006	0.010	0.000	0.026**
Local R^2	0.464	0.527	0.524	0.616		0.497
AIC	*31,163*					*21,516*
F2 test (Leung et al., 2000)	*2.807*	*p<0.001*				

****p < 0.001, **p < 0.01, *p < 0.05*

F3 statistics, which verifies the significance of the spatial heterogeneity in each GWR estimate (Leung et al., 2000), indicates that the coefficients of gender, household size, energy saving, and trust in public institutions vary significantly across space (Figure 1). The coefficients of three variables are consistently positively associated with water conservation, while, the estimate of household size takes both negative and positive values in different regions of Italy. In particular, it has a negative impact in most regions of North Italy including Trentino-Alto Adige, and Lombardy, as well as in Basilicata, Apulia, and Sardinia, however, these results are not significant. While it positively and significantly influences water saving in Central Italy. The highest positive effect is observed in Umbria.

Figure 1 – *Spatial Heterogeneity in the GWR coefficients vary significantly over the space.*



The correlation between being female and water conservation is the highest in the Northwest Italy, specifically in regions such as Valle d'Aosta, Piedmont, and Lombardy, while it is lowest in the central regions including Tuscany and Umbria, and Sicily, and not significant in the remaining areas. When it comes to energy-saving behaviour, it emerges as the strongest positive predictor of water conservation across the country, with the highest impact observed in south-eastern regions such as Apulia, and Basilicata, and the lowest impact observed in North Italy. Conversely, trust in public institution more are more likely to be a stronger predictor in some northern regions, namely, Piedmont, Valle d'Aosta, and Liguria, and slightly less strong or has not significant effect in southern and north-eastern regions.

Gutiérrez-Posada et al. (2017) suggest three possible scenarios when comparing the global and GWR estimates. The first is when the global model estimates are significant but the variation in parameters under GWR is not, indicating that the factor being studied does not have a spatially heterogeneous effect and the global model parameter is representative at local level. This scenario includes age, reading labels, local food and more sustainable transportation means. The second context is

when the variation in GWR coefficients is significant, but the global model coefficient is not, indicating spatial variability leads to an average general effect near zero. Household size belongs to this group. The third scenario is when both the global estimator and the F3 statistic are significant, showing that the global estimates have failed to capture spatial non-stationarity. This scenario encompasses gender, energy saving, and trust in public institutions. In the second and third scenarios, GWR is necessary to understand the spatially heterogeneous processes and propose customized policy implications at the local level (Gutiérrez-Posada et al., 2017).

4. Discussion and Conclusion

The present study investigates the factors affecting water conservation behaviour and spatial heterogeneity in their estimates by utilizing the 2021 Aspects of Daily Life survey data from Italy. The findings from the ordinal logistic regression provide some support for the predictive ability of socio-demographic, behavioural, and social capital variables on explaining the frequency of paying attention to not wasting water. The profiles of water savers suggest that individuals who save water more often are female, and comparatively older, have higher subjective well-being, and engage in other sustainable behaviours as well. These results are consistent with past research. However, unlike previous findings, income, education, and household size are found to be non-significant predictors for water saving behaviour. Furthermore, the results of the geographically weighted regression confirm the existence of spatial heterogeneity in four determinants of water conservation behaviour, namely gender, household size, energy saving, and trust in public institutions.

From a theoretical standpoint, the current study contributes significantly by exploring a wide range of potential factors simultaneously and testing their roles in explaining water conservation behaviour. Furthermore, as described in Sections 1, the models investigated include additional potential explanatory variables that had not been previously examined. Regarding these variables, trust in public institutions and satisfaction with life, have positive coefficients, whereas trust in others, charitable donations and volunteering activities have a non-significant relationship with water conservation. Finally, by applying GWR and obtaining spatial heterogeneity in the coefficients at a regional unit scale, the study provides further empirical contributions to the debate on the determinants of water-saving behaviour.

The study's findings have important policy implications as well. In general, to change behaviour and habits, upstream and downstream interventions are suggested in which according to Martínez-Espiñeira and García-Valiñas (as cited in Russell & Knoeri, 2020), the latter including educational programs in schools is more effective in promoting desirable habits for water conservation. Furthermore, it is worthwhile

to state that spatial non-stationarity across the regions of Italy in the estimates of four determinants requires flexibility in the implementation of national policies or the design of regionally heterogeneous or customized policies at local level. It is particularly important for the determinants encompassed in the second and third scenarios described by Gutiérrez-Posada et al. (2017) as discussed in Section 3.

One of the limitations of the present research is that the measurement of water conservation behaviour relies on self-reported data, which may be subject to social desirability bias. Although some studies find no evidence of this bias affecting the accuracy of the measurements of sustainable behaviour (Milfont, 2009), and others provide evidence that stronger self-reported water conservation habits are associated with lower water consumption (Straus et al., 2016), caution is still needed when interpreting the results. Second, while the study uses regions as spatial units for GWR, smaller units such as provincial or point unit scales may provide more insights into spatial disparities in the GWR estimates. Finally, the cross-sectional nature of the study may limit the ability to establish causality. Therefore, future research that addresses these limitations, such as using actual behaviour as a dependent variable to address social desirability bias (Dolnicar et al., 2012) or employing a longitudinal design to address reverse causality (Russell & Knoeri, 2020), is necessary.

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THE EFFECT OF GREAT RECESSION ON EUROPEAN LIFESPAN INEQUALITY

Gianni Carboni

Abstract. This paper investigates the impact of the Great Recession on Lifespan Inequality across 26 European countries, aiming to clarify the contrasting views between pro-cyclical and counter-cyclical mortality patterns within business cycles. By analyzing mortality data from 2004-2019 and categorizing countries based on the GR's severity, our study employed a Difference-in-Differences methodology to estimate the year-to-year Average Treatment effect on the Treated and the Overall Treatment Effect. We leveraged Callaway and Sant'Anna's (2021) Difference-in-Differences strategy, in order to perform causal effect estimation through their doubly-robust estimators (and also employing their did R library). The findings demonstrate a significant, negative short-to-medium-term impact of the Great Recession on Lifespan Inequality, especially in countries most affected, signifying a beneficial outcome in mortality distribution. These findings were confirmed through two robustness checks, analyzing the effects in separate groups and over the full period. Beyond offering a nuanced perspective on the relationship between economic downturns and Lifespan Inequality, this study underscores the overarching political implications. As economic downturns loom larger and more recurrent, the integration of public health, economic policy, and social justice becomes paramount, especially in strategies promoting equality, inclusivity, and sustainable growth.

1. Introduction

Discussions have reignited about the ties between business cycles and mortality rates, an idea first highlighted by Ogburn and Thomas (1922), who noted that mortality increases (decrease) during economic growth (crisis), a concept named the pro-cyclical pattern. Although overshadowed for a while, this research area was revived by Eyer (1977), coining the "Thomas effect".

However, some scholars suggest that unemployment periods degrade individual health, hinting at a counter-cyclical pattern. This disagreement arises from the simultaneous existence of pro-cyclical (macro-level) and counter-cyclical (micro-level) trends. We propose that these diverging outcomes could stem from differences

in the effects on employed and unemployed populations during studies, potentially leading to an overall benefit at the macro level.

Ruhm (2000) reaffirmed Thomas's notion that major causes of death rise with economic growth and fall with recessions. Research across continents has consistently found the 'Thomas Effect', though counter-cyclical patterns have been noticed in France, Sweden, and Australia.

Despite these findings, some remain sceptical of the pro-cyclical connection.

The 2008 Great Recession (GR) allowed a fresh investigation of this, and numerous studies affirmed the pro-cyclical trend, including a causal study by Salinari and Benassi (2022).

Several key reasons emerge for this behavior: the reduced cost of time during a crisis, the health benefits of economic downturns like reduced pollution and stress, and the decreased mobility reducing accident rates and infectious diseases. However, in the long-term or in growing economies, the association may reverse, as seen in India and China.

Our research builds upon Salinari and Benassi's (2022) work, addressing criticisms around the potential existence of an ecological fallacy, i.e., the notion that better average lifespan can coexist with worsened disparities within countries. In this hypothetical situation, it is conceivable that individuals with initially lower mortality rates could possibly benefit from the crisis, thereby consolidating their pre-existing advantage over those with higher initial mortality rates, who might face additional deterioration. This hidden mechanism, undetectable through Life Expectancy (LE), could misattribute a beneficial effect to the Great Recession (GR), disguising inherent harm. An ecological fallacy could thereby challenge the prevailing concept of pro-cyclical mortality trends.

To gain a deeper understanding of economic crises' effects on inequality, our study shifts focus from mortality levels to mortality distribution within countries. We adopt Lifespan Inequality (LI) as our measure, quantifying lifespan variations within a population, to examine the GR's impact on LI in Europe. By investigating whether GR reduces (rises) LI, signifying decreased (increased) dispersion and enhanced (weakened) equality, we aim to uncover if a pro-cyclical link between economy and mortality exists not only "absolutely" but also benefits inequality reduction. In the realm of public health, in fact, the implications of economic downturns extend beyond mere mortality figures. It is imperative to discern whether such crises, while potentially resulting in generalized health benefits, also play a role in bridging the gap of health inequalities. If the GR not only led to reduced mortality rates but also acted as a levelling force, diminishing disparities in health outcomes, then it would offer a more profound testament to the 'Thomas Effect'. This study, thus, seeks to delve deeper into this dimension. By juxtaposing overall mortality

benefits with shifts in health inequalities, our research aims to unravel a more holistic view of economic crises' impact on public health.

2. The link between mortality and Lifespan Inequality in the existing literature

Before diving into the nitty-gritty, we should clarify LI's role in tracking life length variations within countries. LE refers to the expected years left for a population at a certain age, usually birth. However, it can hide significant disparities. As conceptual example, overlooking LI while considering only LE might reveal that, despite males generally having lower LE and higher mortality rates, they can outlive females in specific cases (Bergeron-Boucher et al. 2022).

Between 1950 to 2015, LI consistently decreased globally, aligning with the global LE increase; however, there are considerable population and temporal variations (Németh 2017). Some studies point to a positive association between mortality and LI, others suggest a negative correlation (Vigezzi et al. 2022).

In demography and epidemiology, the focus is often on how mortality shocks influence LI, but rarely in the context of economic crises. We know, however, that changes in mortality rates can happen independently from economic cycles, like during drug crises, wars, or natural disasters (Wilmoth et al. 2011; Case and Deaton 2020). Vigezzi et al. (2021) noted that in mortality crises, relative LI often increases but absolute variation decreases, quickly reverting post-crisis.

At the end of the story, there's a lack of research on LI fluctuations in economic cycles.

On the other hand, there have been efforts to explore the link between social health inequalities and the GR, yet these studies mainly looked at socioeconomic health inequality indicators (Heggebø et al. 2019), but rarely used LI as a health inequality measure nor used a causal approach, with some interesting exceptions.

For example, Khang et al. (2005) found no surge in geographic inequalities in mortality post-economic crisis in South Korea. Laliotis and Stavropoulou (2018) identified a non-linear response of mortality to unemployment during Greek crises.

Most literature shows an increase in health inequalities during crises (Bacigalupe and Escolar-Pujolar 2014), though these findings are not definitive. The link between crises and mortality inequality is complex, influenced by the crisis type, socioeconomic indicators, and age groups studied. Bacigalupe and Escolar-Pujolar also state that multidisciplinary efforts can bridge knowledge gaps in understanding crisis and health equality relationships.

In summary, there's a gap regarding the effect of economic crises like the GR on LI dynamics, especially in European context. Our study aims to fill this gap by examining the GR's effects on LI using a causal approach (Difference in Differences – DiD – methodology), focusing on European countries to deepen understanding of how major economic crises may shape LI patterns.

3. Data, peculiarities of the European context, and methodology

We sourced LI metric data from the Human Mortality Database (HMD).

The study focuses on 26 European[1] countries excluding Romania, Luxembourg, Malta, and Cyprus due to data issues and small size. It spans 2004-2019, starting later than the possible 2001 to avoid interference from the 2000-2001 economic crisis (our focus is only on GR).

A key research facet is differentiating countries based on GR impact. Following the categorization proposed by Tapia Granados and Ionides (2017), we used unemployment rate changes from 2007-2010 to classify countries into three groups: Group 1 (GR not experienced or mild, unemployment rate change <2%), Group 2 (moderate GR, rate change 2%-4%), and Group 3 (severe GR, rate change >4%). Group 1 was the control group, while groups 2 and 3 were treatment groups.

The study aims to estimate the impact of the GR on LI in Europe by comparing the control group (Group 1) to the combined treatment groups (Groups 2 + 3).

Note that the outcome should be seen as a conservative measure since some countries belonging to Group 1 might have mildly affected countries.

Lastly, the unemployment rate helped identify the crisis's onset in 2009. Comprehensive checks by Salinari and Benassi (2022) confirmed the validity of this framework.

We leveraged the age at death standard deviation, designated LI_x, as the LI measure, formally:

$$LI_x = \sqrt{\sum_{j=x}^{\omega} \frac{d_j}{l_x} \left(j + a_j\right)^2 - (x + e_x)^2}\,. \tag{1}$$

This was rooted in Shkolnikov and Andreev's formula (2010). Here, ω is the maximum age at death observed in the life table, d_x represents the count of observed deaths between the age interval of x and $x + 1$, l_x denotes the count of individuals who have survived up to age x. The term $x + a_x$ represents the age at death, the variable on which we are computing the LI, for individuals who die at age x (with a_x denoting the lifespan at age x for those individuals), and e_x represents the average life expectancy at age x. In accordance with the standard approach used on studies concerning lifespan inequalities, we have opted for LI at birth. From now on, therefore, we will refer to LI as LI_0.

The assignment mechanism $W(i)$ connects each country i to a treatment indicator (0 or 1), establishing whether it underwent a GR or not. For every country i at time t, we define the counterfactual $LI_t^{W(i)}$, showing LI's distribution at t for countries exposed or not exposed to the GR. To infer the unobserved potential outcome, we

[1] Europe is here intended as a continent.

employ the Parallel Trend Assumption (PTA), which suggests that the missing counterfactual distribution (the one of treated countries during the post-treatment period) are identical to those observed in untreated countries in the same periods. Using this, we can calculate the Average Treatment effect on the Treated (ATT), namely:

$$ATT = E(LI_t^1 - LI_t^0 | W = 1) = \\ E(LI_t - LI_{t-1} | W = 1) - E(LI_t - LI_{t-1} | W = 0) \quad (2)$$

In terms of estimation of ATT, our study explores Callaway and Sant'Anna's (2021) novel DiD strategy that accommodates treatment effect heterogeneity and different initiation timings. The ATT becomes dependent on the treatment's starting year and the estimation period, yielding $ATT(g,t)$ or the Group-Time Average Treatment Effect. In our case, nevertheless, the advantage of using this methodology does not lie in this, since all countries start being treated in the same year (2009). Rather, the real feature that motivated us to use Callaway and Sant'Anna's technique is the estimation method, which differs from the more traditional approach (the so-called Two-Way Fixed Effects). We are referring to the Doubly-Robust (DR) estimation. We therefore estimate $ATT(2009,t)$ via DR estimators.

We also integrate a measure capturing the Overall Treatment Effect (OTE) as an arithmetic mean of all $ATT(2009,t)$ calculated post-treatment.

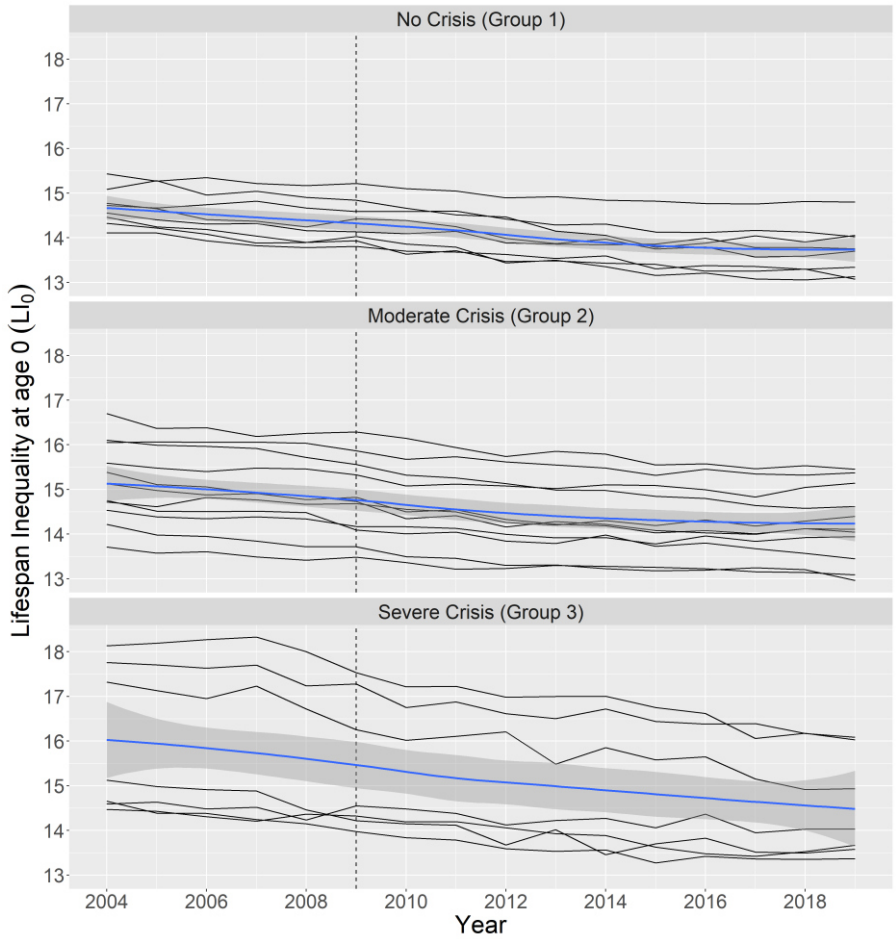
Confidence intervals on both $ATT(2009,t)$ and OTE are constructed through bootstrapping as suggested by Callaway and Sant'Anna (2021). We use their R did library for our analysis.

Lastly, we performed two robustness checks following $ATT(2009,t)$ estimation between Group 1 and Groups 2 + 3. First, we separately assessed the average treatment effect on Group 1 versus Group 2, and Group 1 versus Group 3 (Robustness Check 1, RC1). Second, we aimed to validate the year-over-year findings by examining estimations across the full period computing OTE (Robustness Check 2, RC2). We anticipate comparable causal effects across these checks and variations in the effect's strength based on whether Group 2 or 3 is the treatment group.

4. Results

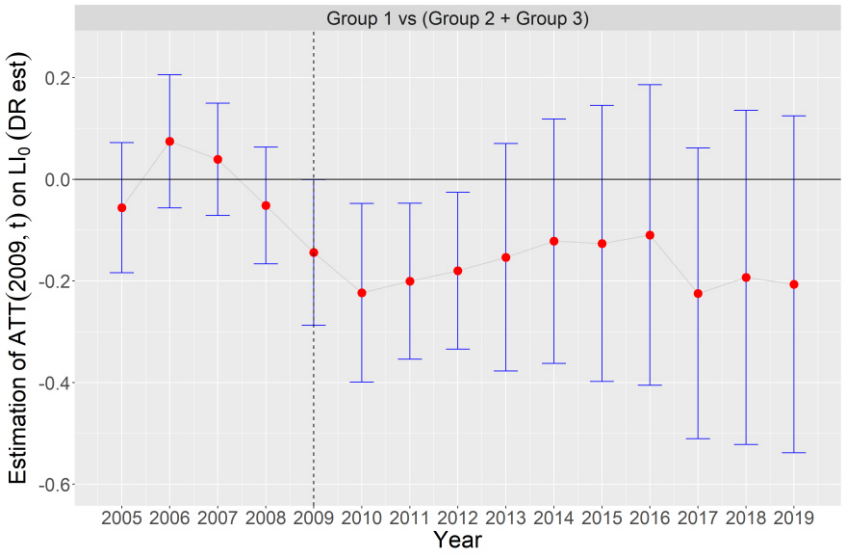
Our study aims to examine a specific phenomenon over time, as shown in Figure 1. The consistent time trends across all groups reaffirm the non-rejection of PTA and reflect common patterns in life expectancy. Differences in LI levels among the groups, non-random across European nations, justify the use of DiD strategy. Group 3, though smaller and variable, will offer valuable insight for robustness checks.

Figure 1 – *Progression of Lifespan Inequality at birth from 2004 to 2019 across 26 European nations.*



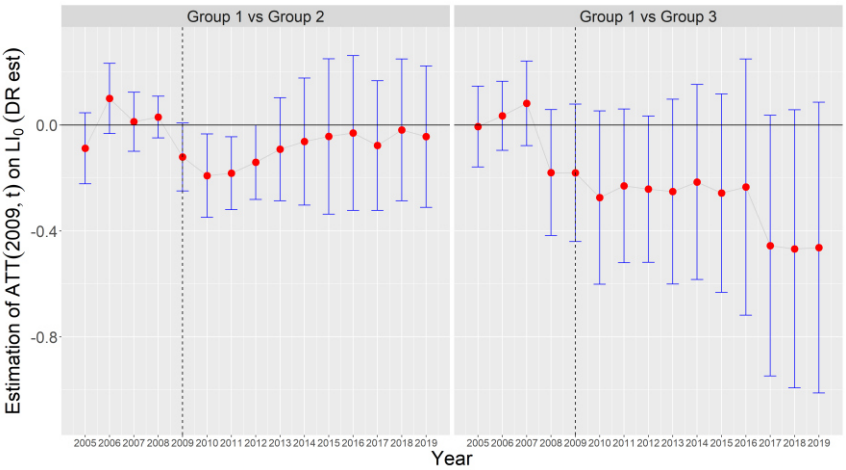
Note that countries are categorized into three groups (No Crisis, Moderate Crisis, Severe Crisis), determined by the unemployment rate shift during pre-crisis and crisis periods.
The year 2009, marked by a vertical dotted line, signifies the crisis onset.
The blue dashed line, an estimate of local polynomial regression (LOESS), provides a visual estimate, with the 95% confidence interval shown as a surrounding grey area.
Source: Author's computation on Human Mortality Database (HMD - www.mortality.org).

Figure 2 – *The year-to-year Effect of the Great Recession on the European Lifespan Inequality.*



Estimation of ATT(2009,t) with Doubly-Robust estimator.
Source: Author's computation on Human Mortality Database (HMD - www.mortality.org).

Figure 3 – *Robustness check of the year-to-year effect of the Great Recession on the European Lifespan Inequality (RC1).*



Estimations of ATT(2009,t) with Doubly-Robust estimator, according to the level of severity of the crisis.
Source: Author's computation on Human Mortality Database (HMD - www.mortality.org).

Our key finding, illustrated in Figure 2, demonstrates a significant, negative, three-year impact of GR on LI, suggesting benefits in mortality distribution for affected countries. The PTA, although untestable, doesn't reject this view, evidenced by non-significant ATT in pre-crisis years, and consistently negative post-treatment ATT. This trend cannot be purely coincidental, as its probability is less than 0.001.[2]

Robustness was assessed through a repeated analysis in which we considered Groups 2 and 3 as the treatment group separately (RC1), with results aligning with our primary outcome (Figure 3). The treatment effect was stronger in Group 1 vs Group 3 and sustained over time, while Group 2 began reverting to pre-crisis levels after three years. Regardless, no positive effect was observed post-treatment. Statistical insignificance in Group 1 vs Group 3 could be due to Group 3's smaller size and higher variability. In any case, this circumstance was also deepened through the second robustness check.

An additional robustness check (RC2), in fact, was performed to evaluate GR's long-term impact on mortality inequality (our OTE), as shown in Figure 4. Results confirm our initial finding of a significant negative effect in the primary comparison and a relationship between crisis intensity and effect magnitude. Group 3 demonstrated (weak) statistical significance, supporting our primary outcome. The non-significant comparison of Group 1 and Group 2 also substantiates our findings: although the annual effects in the primary comparison (Group 1 vs. Group 2 +3) and first RC1 test (Group 1 vs. Group 2) are significant, their brief duration limits overall significance. However, the second RC1 test (Group 1 vs. Group 3) showed greater intensity and duration (albeit not yearly significant), thus appearing significant over the entire period.

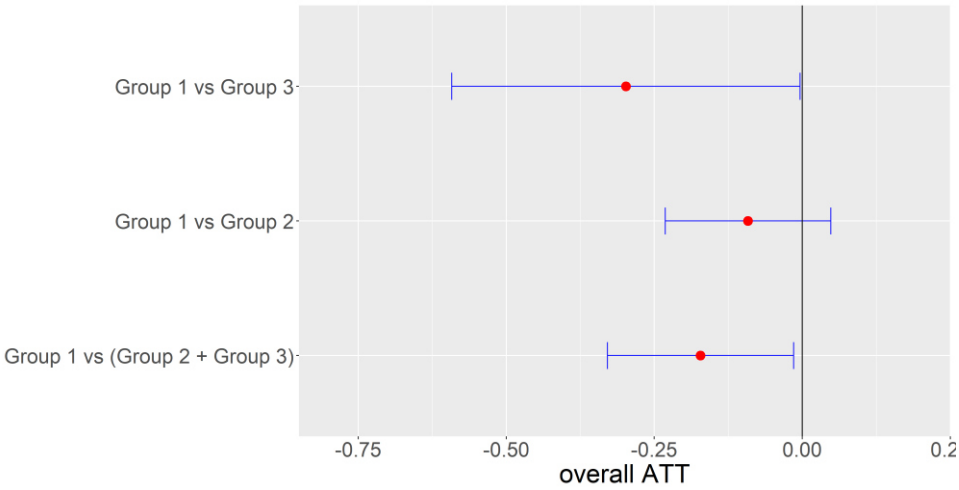
To conclude this Results section, despite group variations, GR reduced Lifespan Inequality in Europe.

5. Conclusions

Our study identifies a statistically significant, short-to-medium-term negative impact of the Great Recession on Lifespan Inequality in Europe, particularly in severely affected countries. This aligns with Salinari and Benassi's (2022) findings. "Negative" here refers to its mathematical implication, indicating beneficial health outcomes via reduced survival rate disparities. The robustness of this result was confirmed through two checks, comparing different groups of countries and analyzing the full period.

[2] Which is the result of 0.5^{11}. 0.5 is meant as the probability of obtaining a negative (positive) sign effect, such as a fair coin toss; 11 is the number of post-crisis years observed. This value is an approximation, which can be interpreted as a rough p-value, at least from an intuitive perspective.

Figure 4 – *OTE (2004-2019) of the Great Recession on the European Lifespan Inequality (RC2).*



Estimations of the overall ATT with two different models, according to the level of severity of the crisis.
Source: Author's computation on Human Mortality Database (HMD - www.mortality.org).

Our findings offer a fresh perspective on the business cycle's impact on mortality patterns, a subject often overlooked in favor of absolute mortality studies. Unlike others, our study directly addresses mortality variability, bypassing the need and risk of selecting a mediating variable connecting economic crisis and inequalities (since a potentially infinite number of socioeconomic variables could be addressed). This protects us from arbitrary choices and further technical complications, allowing to sharply focus on the causal effect of the crisis on inequalities in mortality.

Our research supports a positive correlation between mortality and lifespan inequality (thus, a negative link between LE and LI), resolving contradictions in existing literature. On top of that, we adopt a causal approach, establishing a causal link between Great Recession and Lifespan Inequality, which has withstood robustness tests, enhancing its significance.

To conclude, the realization that economic downturns can foster not only improved public health levels but also more equitable health distributions carries profound policy implications. Such insights necessitate a recalibration of economic policies, prioritizing social justice and well-being alongside pure economic growth. Given the conventional emphasis on economic growth as a prime governmental objective, these findings advocate for public health and welfare strategies that enshrine equality at their core. The intent should be to mitigate health disparities and champion universal healthcare access. Recognizing the causal interplay between economic conditions and health equity underscores the need for equitable, inclusive,

and sustainable growth paradigms, linking economic cycles intrinsically to health disparities.

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YOUTH AND FEMALE UNEMPLOYMENT: A CRITICAL ISSUE FOR INNER AREAS IN PUGLIA (ITALY). NEEDS AND OPPORTUNITIES IN THE SILVER ECONOMY AGE

Annamaria Fiore

Abstract. The National Strategy for Inner Areas (SNAI) represents an Italian national policy for development and cohesion on a territorial basis. Its methodology makes it possible to classify Italian municipalities according to their accessibility to essential services (health, education, mobility), as well as providing a reference grid on which differentiated policies can be developed for territories. The National Institute of Statistics have already shown that the population of inner areas is on average older; also, the old-age index is significantly higher. In addition, the inner areas have also suffered a heavy demographic decline, especially in the South of the country. In this paper, the author uses SNAI's taxonomy to look not at demographic indices, but at two other social phenomena that also heavily impact the demographic ageing of these areas: youth and female unemployment. I focus on Apulian municipalities. Usually, these phenomena are considered in their negative side-effect also because they pose a severe challenge to the sustainability of welfare and health systems, in terms of public budgets, workforce, competitiveness and quality of life, whereas the objective of the paper is to open up greater awareness of the opportunities that the silver economy can bring, especially for decision-makers in the territories most at risk of ageing and depopulation.

1. Introduction

Advanced economies face a far-reaching demographic transition. This macro-trend consists of several sub-components: declining birth rates, ageing population, and depopulation of some areas. Demographic change has serious effects on several socioeconomic dimensions: on the labour market, the healthcare systems, and social exclusion, to mention just a few (Martinez-Fernandez et al., 2012; European Commission, 2020). In this contribution, I will focus on Italy and the regional case of Puglia, showing how demographic decline, associated with female and youth unemployment, differs across the municipalities according to the classification of the National Strategy for Inner Areas, SNAI (DPS, 2012; Urso, 2016).Once the phenomenon has been represented in this territorial detail, I will present the implications that the ageing of the population may open for innovative business opportunities. These prospects could be exploited precisely by females and young

people, categories particularly weak in the labour market in the inner areas of Puglia, once considered the sectors in which their employment prevails and their greater contribution to the development of innovative start-ups than the national average. By processing data taken from the special section of the Business Register dedicated to start-ups, ARTI finds that female-led start-ups in Puglia account for 14% of the total (compared to 12.6% at the national level), while young people are prevalent in the management of innovative start-ups in almost one in five cases (19.1% vs. 16.4%; ARTI, 2022).The paper aims to open greater awareness of the opportunities besides threats that the silver economy can bring, especially in the territories most at risk of ageing and depopulation.

2. Demographic decline: OECD and Italy

Since the seventies, OECD countries witnessed a demographic decline, particularly evident in Italy when you consider both the constantly decreasing share of the young population and the continuously increasing share of the elderly population; this has repercussions on the labour market, where the share of the working age population, always higher in Italy than the OECD average up to 2004 thenceforth has reversed the trend, becoming consistently lower (Table 1).

Table 1 – *Labour force statistics. OECD and Italy, 1970-2021.*

Indicator	Definition	Year	OECD	Italy
Young population	People aged less than 15 out of the total population, %	1970	28.8	24.6
		2021	17.6	12.8
Elderly population	People aged 65 and over out of the total population, %	1970	9.3	10.9
		2021	17.6	23.7
Working age population	People aged 15 to 64 out of the total population, %	1970	61.9	64.5
		1992	65.7	69.1
		2004	66.5	66.5
		2021	64.8	63.5

Source: OECD - Labour Force Statistics: Summary tables (2023).

However, Italy is very differentiated internally in several respects. While this variety has always been a much-appreciated characteristic of our country, this leads to criticalities in territory governance. To offer diversified possibilities for territorial analyses, ISTAT disseminates statistical information according to different criteria of territorial units: extension, antimetrical band altimetry, degree of urbanisation, and littoral or coastal areas. The growing need for sound information for policy making and available at a territorial level ever closer to the individual citizen has led to a different classification of Italian municipalities, in addition to strictly geographical (geo-morphological) and/or anthropological (urban settlement) criteria. A new taxonomy, set up for the first time in Italy during the 2014-2020

Cohesion Policy programming cycle, considers as a classification criterion accessibility to essential services: thus, the municipalities are categorized according to their 'peripherality', measured by the actual distance from the centres of integrated supply of essential services (school, health, and transport services railway). This leads to the subdivision of municipalities into central or inner areas. Consequently, the National Strategy for Inner Areas (SNAI; Italian: Strategia Nazionale per le Aree Interne), an Italian policy developed in 2013 and promoted by the Agency for Territorial Cohesion (Dipartimento per la Coesione Territoriale) and then by the Minister for Territorial Cohesion, aims at enhancing the territorial reactivation of remote municipalities. The subsequent strategic document suggests a series of policies and actions to counteract, or at least to mitigate, the demographic decline and the territorial marginalization process. With the new Partnership Agreement 2021-2027, an update of the Map was carried out while maintaining the methodology for the classification of Italian municipalities into six categories: Poles, Intermunicipal Poles, Urban Belts (Central Areas); Intermediate, Peripheral, Ultra-peripheral (Inner Areas). Recent studies proved significant differences between Central areas and Inner areas in average age, and old-age index (Bianchino et al., 2022) as well as criticalities in employment, demographic ageing, depopulation and commuting in inner areas (Acampora et al. 2023).

Table 2 – *Classification of Apulian municipalities according to SNAI, 2014-2020 and 2021-2027.*

Programming cycle	Metric of Inner Areas	Municipalities	Population
2014-2020	n.	138	1,017,709
	%	53.7	25.5
2021-2027	n.	148	1,437,004
	%	57.6	36.6
Change	Absolute	+10	419,295
	%	+7.2	41.2

Source: Author's elaboration on Istat - Classification of municipalities according to Inner Area characteristics (administrative geography as of 30 September 2020).

3. Inner Areas in Puglia: demographic decline and unemployment

Puglia is a region in South-Eastern Italy. In the Map of the SNAI developed for the 2014-2020 Cohesion Policy programming cycle, 138 out of 257 Apulian municipalities were classified as Inner Areas (53.7%), involving 25.5% of the total population. These percentages increased in the 2021-2027 programming cycle up to 57.6% of municipalities and 36.6% of the population (Table 2).

As underlined in the previous section, Inner Areas in Italy present a significant depopulation. This is confirmed in the Apulian case: in general terms, if the population of Puglia decreased by 4.6% in the decade 2012-2022, the population decrement in Central Areas was -5.2%, whereas in the Inner Areas was -7.5%, with a peak of over 30% recorded in a municipality in the province of Foggia. Another relevant difference is in the average age (45.3 vs. 46.5 years). In both cases, the differences tested by a Wilcoxon rank-sum test used to compare two independent samples are significant (Table 3).

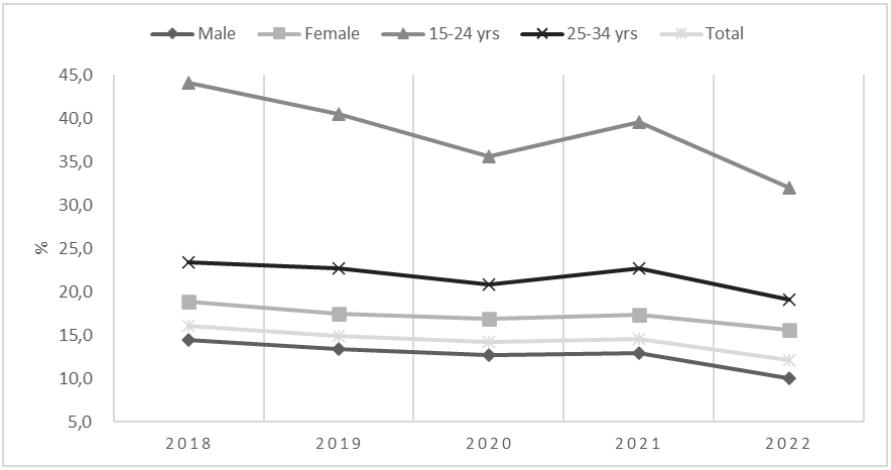
Table 3 – *Demographic decline and average age of Apulian municipalities.*

Indicator	Central Areas	Inner Areas	Wilcoxon rank-test	p-value
Demographic change 2012-2022, %	-5.2	-7.5	3.644	0.0003
Average age, 2020	45.3	46.5	-4.058	0.0000

Source: Author's elaboration on Istat – Demo.

In the last five years, Puglia experienced a decreasing unemployment rate: it passed from 16.1% in 2018 to 12.1% in 2022, constantly lower than in the South (from 18.4% to 14.3%), but still distant from the Italian average (from 10.6% to 8.1%). Differences emerge when considering age group and gender: for young people aged between 15 and 24 is never less than 32%, and the gap between male and female unemployment is at least 4 percentage points, with a tendency to increase rather than decrease over time (Figure 1).

Figure 1 – *Unemployment in Puglia, 2018-2022.*



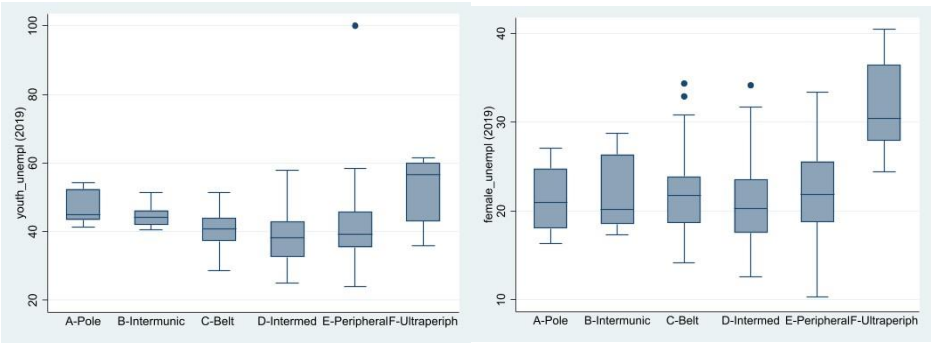
Source: Istat - Labour Force Survey.

Moreover, youth and female unemployment rates were particularly by the pandemic crisis between 2020 and 2021: while the absolute difference in unemployment rates for men was only 0.2 percentage points, the difference in unemployment rates for females was twice (0.4) and 3.8 percentage points for young people aged 15 to 24. These data could be potentially limited by a significative presence of a shadow economy, in Italy in general (according to the late estimates, 174 billion euros, representing 10.5% of GDP; Istat 2023b), and in Southern Italy in particular (CGIA Mestre, 2021). Moreover, the shadow economy is concentrated in the sector of other services to persons (Istat, 2023b), where females are especially employed (Toffanin, 2016).

3.1. Youth and female unemployment

For our purpose, it is of relevance to establish if there are different patterns in unemployment rates across SNAI areas. I calculated youth (15-24 years) and female unemployment rates for all Apulian municipalities utilizing the most recent data available on the occupational status at this territorial level (2019), dividing the number of persons looking for jobs by the total labour force and then multiplying by 100. Youth and female unemployment rates show different patterns according to SNAI areas, as shown in box plots in Figure 2.

Figure 2 – *Youth (left panel) and female (right panel) unemployment rates in Apulian municipalities according to SNAI areas, 2019.*



Source: Author's elaboration on Istat - Census of the Population and Housing – Education and training, economic activity status, and school or workplace municipal dataset

As regards the youth unemployment rate, it shows a sort of U-pattern: relatively high in the Pole municipalities (46.9%), then it decreases up to 38.8% in the Intermediate municipalities, and then it increases again up to 52.3% in the Ultra-peripheral municipalities. This means that more than half of 15–24-year-olds are actively seeking employment in some municipalities. In a very small municipality in

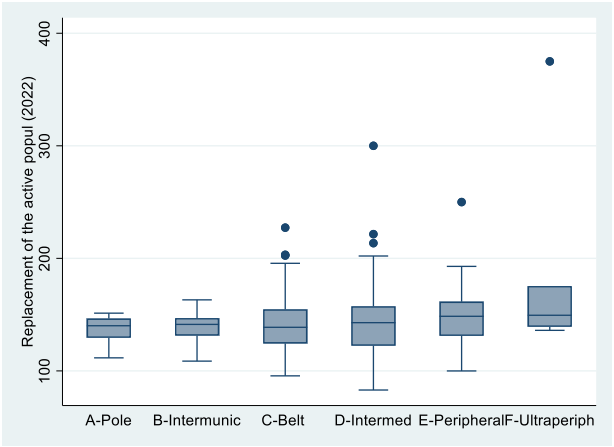
the province of Foggia, Celle San Vito, young unemployment reaches 100% (the outlier in the corresponding box plot).Female unemployment is quite similar in Pole and Intermediate municipalities (20.9% and 21.9%, respectively), but then it increases in the Peripheral and especially in Ultra-Peripheral municipalities: 22.2% and 31.7%. Considering both indicators together, they give a picture of social disadvantages experienced by the municipalities most distant from essential services (i.e., school, health, and transport services railway). Especially in the case of the high youth unemployment rate, this exacerbates the phenomenon of depopulation: young people, in the absence of job opportunities in their areas of residence, are more likely to migrate in search of work opportunities, further impoverishing marginal areas, and depriving them of new energies for development possibilities. This trend was recently confirmed in a note by the National Institute of Statistics: in 2020, the South and the Islands lost as many as 42 young residents (25-34 years old) per 100 population movements in extra-regional internal flows (+22 in the Centre-North) and 56 out of 100 in foreign ones (-49 in Centre-North). The phenomenon is accentuated in provinces with low employment and the inner areas: in Puglia, the situation is particularly critical in the provinces of Taranto, Brindisi, and Foggia. Overall, almost 6,500 young people left Puglia in 2020 (Istat, 2023a).

4. Ageing population: threat or opportunity?

In the previous section, it has been shown the greater risk of demographic decline and the more critical social situation due to higher youth and female unemployment in the Inner Areas of a Southern Italian Region, Puglia. Still, the old-age dependency ratio (proportional ratio of the population aged 65+ to the working-age population aged 15-64) is structurally greater in the Inner Areas of Puglia (Wilcoxon rank-test: $z = -4.442$, p-value = 0.0000) and, in general, it increased of two percentage points in the last five years (author's elaboration on IPRES open data). Usually, these phenomena are considered for their negative side effects since they pose severe challenges to the sustainability of welfare and health systems (Grubanov-Boskovic et al., 2021), in terms of public budgets, workforce, competitiveness, and quality of life (European Commission, 2015). Criticalities surge in labour markets as well: for example, the constant ageing of the labour force can hinder the adoption and absorption of new technologies in an era of rapid technological transition. In only five years, in Puglia, the ageing of the labour force (percentage ratio between the most mature potentially active population aged 40-64 and the youngest population aged 15-39) increased from 122.2 in 2018 to 134.9 in 2022 (IPRES open data). Moreover, the replacement rate (percentage ratio between the population potentially leaving the labour force aged 60-64 and the population entering the labour force aged 15-19) increased by 13%, from 118.1 to 133.4 over the same five-year period (IPRES

open data). There is evidence of greater difficulty in replacing the labour force in the Inner Areas than in the Central Areas (Figure 3).

Figure 3 – *Replacement rate of active population in Apulian municipalities according to SNAI areas, 2022.*



Source: Author's elaboration on IPRES open data – Population structure indices of Apulian municipalities Time series 2017-2022 .

At the same time, the demographic transition can offer opportunities for the creation of new jobs and growth, usually referred to as the Silver Economy. In 2007, with the resolution "Opportunities and challenges of demographic change in Europe", the Council of the European Union defined a clear policy position and referred to the "silver economy" as an opportunity for Europe and its regions (European Council, 2007). In the background paper "Growing the Silver Economy in Europe" the European Commission defines it as "the existing and emerging economic opportunities associated with the growing public and consumer expenditure related to population ageing and the specific needs of the population over 50" (European Commission, 2015). Recent studies underline the potential of the silver economy connected not only with general new employment opportunities but as a specific attractiveness factor for the younger working-age population, such as in the healthcare sector (Grubanov-Boskovic et al., 2021; Ghio et al., 2022). Although the new employment opportunities associated with the silver economy are usually related to personal care professions, the range of new growth possibilities is much broader, even if not explored yet in the literature. First, the silver economy addresses an audience of consumers with solid wealth positions, good propensity to consume, and specific needs. A greater share of the national wealth is held by the elderly population, which thus sees its purchasing power increase compared to other

segments of the population: the wealth owned by elderly households out of total household wealth in Italy passed from 20.2% in 1995 up to 39.9% in 2016 (Censis-Tendercapital, 2019). Second, the new emergent needs of elderly people are varied: financial security (retirement plans); cultural consumption (museums, cinema); technology (internet, online services); and leisure (wellness, cruises). With this aim, it is interesting to analyse the sectors where the two population segments under study are mostly active (Table 4).

Table 4 – *Female and young people employment in Puglia: top 5 sectors.*

Female		Young people	
NACE sectors	% out of the total regional employment	NACE sectors	% out of the total regional employment
Arts, entertainment and recreation; other service activities; activities of household and extra-territorial organizations and bodies [R-U]	63.7	Information and communication [J]	8.3
Public administration, defence, education, human health and social work activities [O-Q]	55.1	Wholesale and retail trade, transport, accommodation and food service activities [G-I]	7.3
Real estate activities [L]	46.6	Agriculture, forestry and fishing [A]	7.0
Professional, scientific and technical activities; administrative and support service activities [M-N]	41.9	Construction [F]	6.1
Information and communication [J]	36.8	Industry (except construction) [B-E]	6.0
Total - all NACE activities [TOTAL]	35.8	Total - all NACE activities [TOTAL]	5.4

Source: Author's elaboration on Eurostat - Employment by sex, age, economic activity and NUTS 2 regions (NACE Rev. 2)

The sectors are different but complementary: as expected, females especially work in households (maids, cooks, waiters, caretakers, babysitters, secretaries, etc.), in education, and social work activities; young people are particularly active in ICT sectors and in accommodation and food services. These job specializations, if appropriately exploited, can therefore lead to an integrated and comprehensive offer of innovative services for the elderly population. This assumption is particularly true

if we consider that in Puglia both females and, above all, young people show a relative specialisation compared to the Italian average for ICT professions (where it exhibits percentages of 30.6% and 4%, respectively) and their propensity for innovative entrepreneurship, as already emphasised in the introduction (ARTI, 2022). The emergent needs of elderly people pave the way for various innovations where people usually marginalized from the job market (young people, females) can find important prospects and interesting niches for the opening of new market segments: just to cite some examples, they range from food for specific needs palatability, particular deficiencies to e-health and wearable devices; from transport and communication to leisure and lifelong learning experiences and technologies for living environments (ambient assisted living). Most of these products and services also incorporate high-added value in research and development.

5. Policy suggestions for Inner Areas in the silver economy era

In this paper, the centrality of demography in defining society's current and future needs has been featured, trying to combine three strands of literature, so far insufficiently explored in conjunction: the demographic decline, the social weakness of the Inner Areas in a Southern Italian region, the silver economy opportunities to relaunch these areas themselves. Demographic change is a relevant issue for regional policy-makers since it solicited a differentiated territorial approach – particularly concentrated in Inner Areas - to mainstream ageing in all policy fields, and to achieve a society for all ages. An interesting essay describes national and regional models of the silver economy in the European Union (Klimczuk, 2016) but in no case the challenge of an ageing population is addressed through policies supporting the employment of weaker groups (young people, females), and to direct them towards innovative and potentially profitable market niches. Even in Northeast Asia where, to date, the most notable steps towards establishing strategies for using the ageing of society as an opportunity to direct innovation capacities, investment, and R&D towards the growing elderly consumer group have been taken (especially in Japan and South Korea), none considers the aspect of employment of weaker groups (Gschwendtner, 2020). Inner Areas are critical not only for demographic reasons (decline, ageing) but also for social vulnerability measured in this paper with two indicators: youth and female unemployment. However, the high unemployment rates observed could be limited by the significant presence of the shadow economy in sectors where mainly women and young people work (personal services, agriculture, construction, catering; Istat 2023b). Although examples of innovative businesses of the silver economy boosting female and young employment are not yet widespread, the pieces of evidence collected in this paper could lead to some policy suggestions to be implemented at some experimental degree. As will be shown, these do not imply measures of relevant financial endowments but are based on specific features

of the Apulian labour market and some of its comparative advantages: propensity for innovative entrepreneurship by females and young people (ARTI, 2022), the relative concentration of employment in sectors particularly interested in services to be developed for the silver economy (Eurostat dataset). Notwithstanding this, if adequately and structurally supported over time, these policies should lead to a virtuous circle, creating an attractive factor in those areas most at risk of depopulation, the Inner Areas: by the way, the ones most densely populated by the older population. In the first phase, more young people and females could be attracted by favourable innovative policies, and therefore, the number of current inhabitants would grow in the very short term in the Inner Areas by an additional factor. In the second phase, the population increase would be further supported by new births due to the potential formation of new families in the longer term by a multiplicative factor. Examples of policies to be adopted include: female and young entrepreneurship and innovative start-up measures specifically addressed to the silver economy needs; special rewards in more general policies when they are targeted to the older population; targeted training activities; regional departments explicitly dedicated to the senior citizens as it is already the case for youth policy. However, even in a very recent special issue completely devoted to the silver economy in a journal of management, silver entrepreneurship is conceived as the choice of becoming an entrepreneur over the age of 50, but never as innovative start-ups developing products and/or services directed to the needs of older people (Greco et al., 2022). At the national level, a first measure in this direction, foreseen by the Delegated Law for the Support of the Elderly approved by the Council of Ministers on 10 October 2022 was the establishment of CIPA, the Inter-Ministerial Committee for Policies in Favour of the Elderly Population at the Presidency of the Council of Ministers to promote the coordination and integrated planning of national policies in favour of the elderly, the taking care of frailty and non-self-sufficiency by providing for an improvement in senior housing and RSAs. The suggested measures do not have the force to initiate a solution to the problem, but rather to contribute to it, and to address a cultural change. At all levels, as underlined by Confartigianato in the latest issue of Itinerari Previdenziali (2023), "market opportunities and policies at the local, regional and national level, as well as at the European level, should become a research objective for those who see the old age of the population as a challenge and not a threat". Therefore, the silver economy does not simply represent one of the 'markets', but rather a 'transversal economy', embracing an entire society, a different way to conceive the economy.

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CAN THE MEASURE OF DEVELOPMENT BE IMPROVED?[1]

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Abstract. Over the past few decades, the concept of development has undergone a significant transformation, from a primarily economic perspective to a more holistic, multidisciplinary approach. This shifted the focus from conventional economic indicators such as Gross National Product to a more comprehensive evaluation, epitomized by the Human Development Index (HDI). Nevertheless, the structural changes brought by globalization have exacerbated socioeconomic disparities within countries, underscoring the urgent need for further reforms. The primary objective of this study is to enhance the HDI by introducing an economic inequality coefficient that improves its sensitivity to disparities. To achieve this, the HDI is deconstructed into its three core components, and three distinct coefficients of economic distribution—namely, the Gini Coefficient, Theil Index, and Atkinson Index—are each integrated into the HDI through four distinct computational approaches. A rigorous analysis, commencing with a correlation study, followed by a comprehensive robustness examination, was conducted to identify the most effective and dependable index, christened the Just Human Development Index (JHDI). Notably, the incorporation of the Gini Coefficient into the normalization formula of the Income Index (referred to as JHDI-G1) exhibited the highest correlation value when compared to all other alternatives and the traditional HDI. This assessment was made in reference to five chosen validation indices: the Inequality-Adjusted HDI, Gender Development Index, Gender Inequality Index, Multidimensional Poverty Index, and Ecological Footprint per capita. These findings highlight the tangible potential for better consideration of inequalities in development measurement. This achievement is primarily attributed to the integration of the Gini Coefficient, a method that maintains the ease of HDI calculation while significantly enhancing its sensitivity to economic inequalities.

[1] Both the authors equally contributed to data collection, data analysis, and the drafting of the article.

1. Introduction

The evolution of the concept of development and the associated metrics is a highly relevant subject within the realm of scientific research. Throughout history, the understanding of development has undergone profound transformations, transitioning from a predominantly economic viewpoint, cantered around Gross Domestic Product (GDP), to a more comprehensive approach that encompasses the holistic well-being of individuals. The term "development" initially emerged during the latter half of the 19th century as a synonym for economic growth, which referred to achieving sustained increases in income per capita to enable a nation to expand its output at a rate surpassing the population growth rate, as defined by Todaro and Smith (2015). In this perspective, welfare was equated with consumption, implying that higher purchasing power among citizens led to greater levels of satisfaction. State policies, aiming to foster growth focused on bolstering industrial production and encouraging the shift of investments from agriculture to the manufacturing sector. GDP, as a measure of economic growth, account for the monetary value of all final goods and services produced within a nation's borders during a specified period, typically a year, while excluding various factors crucial for development. These calculations do not incorporate non-monetary aspects like health, education, environmental quality, and overall quality of life, included the externalities affecting the environment and the sustainable management of natural resources. Moreover, GDP only acknowledges formal employment, neglecting the value of unpaid labour, as discussed by Fleurbaey and Blanchet (2013). A few decades after the Second World War, numerous non-European countries embarked on decolonization processes and experienced economic growth, which, however, did not translate into improved living conditions for the population. Despite the increased GDP rates, poverty and social vulnerability persisted, failing to diminish. This evidence led many scholars to reconceptualize the term 'development,' viewing it more as a process of 'redistributing growth' with a focus on eradicating poverty and inequality. One of the seminal contributions in this direction came from economist Dudley Seers, paving the way for the formulation of the so called "*basic needs approach*". This development model emerged as an alternative to GDP and emphasized the satisfaction of people's fundamental needs as the foundation for evaluating a country's level of development. Todaro and Smith (2015) underline how this new conception revolutionized the measurement framework, introducing new indicators such as access to adequate food, safe and healthy housing, education, and healthcare services. While the Basic Needs approach offers a broader perspective in contrast to GDP, it also faces limitations, especially regarding the intricacy of measuring, given the complexity of quantifying fundamental requirements. Conventional statistics and indicators might come up short in encompassing the complete spectrum of

individuals' necessities and defining a universal set of needs applicable to all societies. One of the most significant contributions to alternative theories of economic growth was formulated in the late 1990s by economist and Nobel laureate Amartya Sen. According to Sen, poverty is not a phenomenon that can be adequately measured solely by income levels or utility; rather, what holds utmost importance is "*what a person is, or can be, and does, or can do*." Sen's approach underscores that well-being isn't solely contingent on the characteristics of consumed commodities, as in the utility approach, but rather on the agency individuals have in using and realizing the potential of these commodities, as articulated in Sen's work (1999).

1.1. Human Development Index and Measures of Inequalities

The human development index of Amartya Sen has represented a turning point in development measurement methodologies, managing to combine in its computation indicators of both economic and social. HDI is a composite index that measures development according to three fundamental dimensions:

- Life expectancy: influenced by factors such as access to health care, food, environmental conditions and drinking water.
- Literacy rate: considering adult literacy and the rate of schooling.
- GDP per capita: average income of a country divided by its population.

Each indicator is normalized using a specific scale and assigned a value between 0 and 1, where 1 represents the highest level of human development. Then the indicators are aggregated using the geometric mean resulting in a measure of a country's human well-being. Since the late 1990s, the conception of human development and the formulation of HDI have given rise to several formulations of approaches to measure development, such as the Capabilities Approach or all composite indices aimed at measuring dimensions such as Poverty and Gender. In recent years, due to the growing gap between different social classes and between different regions of the world, it has been necessary to highlight the extent of inequalities within development indices. A first contribution in this sense came from Hicks, who conceived a first version of the human development index considering an inequality coefficient. In accordance with the standard of well-being conceived by Amartya Sen, Hicks used the GINI coefficient to measure the economic distribution within the population. The index constructed by Hicks foresees the application of the coefficient GINI to the three dimensions of HDI, then the results are the normalize with the following formula: Having as a final formula:

$$IAXi = \frac{(\text{actual Xi value} - \min \text{Xi value}) * \bar{\lambda}(1 - \text{Gi})}{\max \text{Xi value} - \min \text{Xi value}} \quad (1)$$

where G_i is the Gini coefficient for each *i* dimension (i=1,2,3) (Hicks, 1997).

Hicks' proposed index has faced numerous critiques over the years, especially concerning its consistency within subgroups. It's conceivable that welfare increases in one region while remaining stagnant in another, ultimately resulting in an overall decrease in general welfare. The practical challenges in applying this interpretation of the Inequality-Adjusted Human Development Index (IHDI) prompted a re-evaluation, spearheaded by scholars Foster, Lopez-Calva, and Szekely during their 2005 study in Mexico (Foster et al., 2007). The revamped approach to addressing inequality introduces a novel inequality coefficient, the Atkinson coefficient, into the calculation. This coefficient is applied to the three indicators of the HDI, then the results are aggregated with a mathematical average that provides the values of the Inequalities Adjusted Human Development Index (IHDI). The main strength of IHDI lies in its comprehensive calculation, which considers inequality in all three dimensions: life expectancy, education, and income. This approach allows the derivation of new values, allowing a comparison between HDI and IHDI to reveal the extent of "loss of human development due to inequality." It highlights disparities and inequalities within a given country. However, the methodology used does not offer any understanding of the specific dimensions in which individuals experience inequality, thus limiting the ability to identify which indicator is most affected by this phenomenon. The theoretical issues that the following paper aims to raise concern in particular the growing income inequalities that have occurred in the last twenty years. According to the 2022 World Inequality Report, the poorest 50% of the population collectively collect 8.5% of global income, equal to an average income of €2,800 per year or €230 per month per person. The average 40% of the population earns 39.5% of total income, with their income closely reflecting the global average at €16,500 per year (€1,375 per month). By contrast, the richest 10% of the population captures 52% of total income, exceeding the global average by more than five times, with an average income of 87,200 euros per year per adult (7,300 euros per month). The research question to which the following analysis seeks an answer is whether, in the light of the above data, it is still feasible to discuss improvements in human development without considering economic inequality? Starting from this evidence, the present work aims to reshape the formulation of the HDI into a new index of development called "Just Human Development Index" (JHDI). The necessity to address the increase in income inequalities within countries suggest that inequalities should not be accounted on all three dimensions of the HDI but considered as a "penalty function" solely within the income indicator. The aim, therefore, is not to change the HDI in its entirety, but rather to replace the income indicator with a “fairer” measure to capture the current trends in income concentration.

2. Methods

2.1. Selection of income inequality coefficients

Economic inequality coefficients to embed were selected on the basis of the work of De Maio (2007). Among the coefficients addressed in the paper, Coefficient of Variation (CoV) was excluded because of its limited use in literature while for Kakwani progressivity index, Robin Hood index (also known as Pietra Ratio), and the Sen Poverty Measure, the exclusion was due to the lack of available data. Therefore, the research focused on the following coefficients: Gini Coefficient (GC), Generalised Entropy index (GE), and Atkinson Index (AI). In both GE and AI, the sensitivity parameters (α and ε, respectively) were set at 2 because the higher the value, the more sensitive these indices become to inequalities at the bottom of the income distribution.

2.2. Selection of databases

Secondly, for the data collection two open-access databases were identified on the web: the World Bank Database (WB-DB)[2] and the United Nation University-World Income Inequality Database (UNU-WIID)[3]. The former includes only the Gini Coefficient, while the latter includes Gini Coefficient, Theil Index, and Atkinson Index. The latest available HDI values (2021)[4] have been downloaded from the United Nation Development Program website and then disaggregated into its components: Life expectancy at birth Index (LEI), Education Index (EI), and Income Index (II). The values of the original variable which the components were calculated from have also been considered.

2.3. Alternative methods to embed an inequality coefficient.

Four methods of embedding were developed and tested to identify the most performative coefficient. The first method (JII1) embeds the coefficient as a penalty function of the Income Index (II) during its normalization step with the following formula:

$$JII1i = \frac{\ln(\hat{I}i * ICr) - \ln(100)}{\ln(75000 * ICi) - \ln(100)} \quad (2)$$

where IC_r is the reference value chosen for each Inequality Coefficient (GINI=0.25; Theil=0.15; Atkinson=0.15) and $\hat{I}_i$ is the i-th country yearly Gross National Income (GNI) per capita value capped at 75000$. The JII1 was then reaggregated with LEI and EI by geometric mean.

[2] Link to the World Bank Database (last access: July 14th, 2023)
[3] Link to the UNU-WII Database (last access: July 14th, 2023)
[4] Link to the HDI Database (last access: July 14th, 2023)

The second method (JII2) embeds the coefficient with a calculation similar to that used to compute the Education Index from the Mean Years of Schooling and the Expected Years of Schooling:

$$JII2i = \frac{1}{2} * \left(\frac{\hat{I}i}{75000} + \frac{ICr}{\mathrm{ICi}}\right) \quad (3)$$

where IC_r is the reference value chosen for each Inequality Coefficient (GINI=0.25; Theil=0.15; Atkinson=0.15) and $\hat{I}_i$ is the i-th country yearly GDP per capita value capped at 75000$. The JII2 was then reaggregated with LEI and EI by geometric mean.

The third and fourth methods are based on the normalization of the Inequality Coefficient with a min-max method:

$$JII3i = 1 - \frac{ICi - ICmin}{ICmax - ICmin} \quad (4)$$

where IC_{max} and IC_{min} are fixed for GINI at 0.8 and 0.2 (Theil: 1 and 0.1; Atkinson: 0.8 and 0.1), respectively, while IC_i is capped at 0.2 (Theil and Atkinson: 0.1). The difference between the two methods relies on the fact that JII3 was considered as a fourth dimension and thus aggregated to LEI, EI, and II by geometric mean, while in JII4 the min-max normalization underwent two consecutive steps of geometric mean aggregation: it was firstly aggregated solely to II and only then to LEI and EI.

2.4. Selection of validation indices

To evaluate the capacity of the different alternatives, several indices have been selected. Four indices related to inequalities and poverty with reliable, open-access, and recent data have been identified: the Inequality-Adjusted Human Development Index (IHDI) is related to the inequalities in human development, the Gender Inequality Index (GII) and the Gender Development Index (GDI) consider gender inequalities, and Multidimensional Poverty Index (MPI) is related to poverty. In addition, a validation index linked to the environmental impact of countries was selected to verify which HDI alternative has the higher ability to take this paramount factor into consideration. The selected index was the Ecological Footprint per capita that documents "the extent to which human society stays within or exceeds the regenerative capacity of the planet" (Kitzes *et al.* 2008).

2.5. Statistical analysis

Statistical analysis was carried out on SPSS Ver. 27.0.1.0. A Shapiro-Wilk test assessed the non-normal distribution of variables. A multivariate analysis was performed with the Spearman's rank correlation test. Correlation of the alternatives was computed against the validation indices reported in sector 2.4. Obtained correlations were converted into absolute values and then cumulated to identify the 4 alternatives that correlate the most. Finally, a robustness analysis, composed by an

uncertainty and sensitivity analysis, was carried out on the more correlated variants to evaluate how uncertainty in the input factors propagates through the structure of the composite indicator and affects the composite indicator values (uncertainty analysis), and assess the contribution of the individual source of uncertainty to the output variance (sensitivity analysis) (Nardo *et al.*, 2005). Uncertainty analysis was realized by studying the index's behavior from the inclusion and exclusion of individual indicators. In the sensitivity analysis, the modification of the results on the variation of an added random noise was studied. Lastly, the HDI and the most performative alternative were compared in the ranking capacity and the division of countries into the 4 categories of the HDI.

Table 1 – *Correlation analysis by Spearman's rank-order correlation coefficient.*

	IHDI	GII	GDI	MPI	EF pc	Cumulative Correlation
HDI	-0.925**	0.984**	0.637**	-0.928**	0.849**	4.324
JHDIG1-WB	-0.925**	0.985**	0.646**	-0.930**	0.851**	4.337
JHDIG2-WB	-0.912**	0.977**	0.600**	-0.901**	0.812**	4.202
JHDIG3-WB	-0.925**	0.985**	0.613**	-0.922**	0.817**	4.263
JHDIG4-WB	-0.910**	0.974**	0.590**	-0.899**	0.809**	4.183
JHDIG1-UNU	-0.927**	0.987**	0.634**	-0.927**	0.854**	4.328
JHDIG2-UNU	-0.928**	0.987**	0.613**	-0.921**	0.829**	4.278
JHDIG3-UNU	-0.932**	0.989**	0.605**	-0.922**	0.823**	4.271
JHDIG4-UNU	-0.922**	0.982**	0.587**	-0.906**	0.821**	4.217
JHDIT1-UNU	-0.927**	0.988**	0.631**	-0.926**	0.853**	4.325
JHDIT2-UNU	-0.913**	0.973**	0.590**	-0.887**	0.812**	4.176
JHDIT3-UNU	-0.927**	0.985**	0.597**	-0.911**	0.820**	4.240
JHDIT4-UNU	-0.916**	0.975**	0.577**	-0.884**	0.815**	4.167
JHDIA1-UNU	-0.926**	0.987**	0.630**	-0.925**	0.853**	4.321
JHDIA2-UNU	-0.912**	0.973**	0.586**	-0.882**	0.807**	4.161
JHDIA3-UNU	-0.932**	0.989**	0.603**	-0.920**	0.823**	4.266
JHDIA4-UNU	-0.922**	0.982**	0.587**	-0.901**	0.821**	4.213

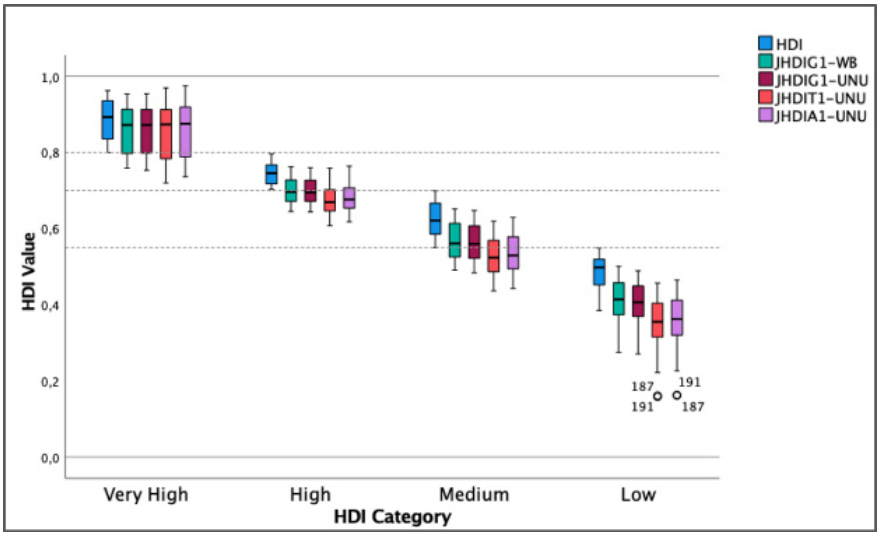
Abbreviations: IHDI:Inequality-Adjusted Human Development Index; GII=Gender Inequality Index; GDI=Gender Development Index; MPI=Multidimensional Poverty Index; EF pc= Ecological Footprint per capita. $^{**}= p<0.01$

3. Results

The identification of the income inequality coefficient and the embedding method that can give to the Human Development Index a better correlation in respect to the individual indicators it is composed of, and 5 external validation indices is the main goal of this study. Table 1 shows the results of the correlation analysis. From the 16 alternatives tested, the 4 variants higher in correlation were selected: JHDIG1-WB, JHDIG1-UNU, JHDIT1-UNU, and JHDIA1-UNU. It is worth noting that only JHDIG1-WB showed a higher correlation than the HDI and all of the more correlated variants use the formula (2) of calculation.

Figure 1 depicts the differences in rank classification between the HDI and the 4 high-correlation variants. According to UNDP Report 2014, the plot is divided into the 4 categories of human development (Very High>0.8; 0.7<High<0.8; 0.55<Medium<0.7; Low<0.55) and the 4 variants' boxplots are depicted in relation to the country's classification of the original HDI. In comparison to the original HDI, all the variants showed lower median values for each HDI category, and the differences are progressively larger for lower values of HDI. Table 2 shows the uncertainty analysis of the HDI variants obtained by summing the absolute ranking differences after alternatively excluding one of the indicators of the original set. The assessment of the degree of influence of each indicator inside the calculation of the HDI and its alternatives reflects the statistical reliability of the indices.

Figure 1 – *Boxplots of the rank classification of the HDI and the 4 high-correlation variants (dotted lines represent the cut-off values for the 4 HDI classification groups).*



HDI: Human Development Index.

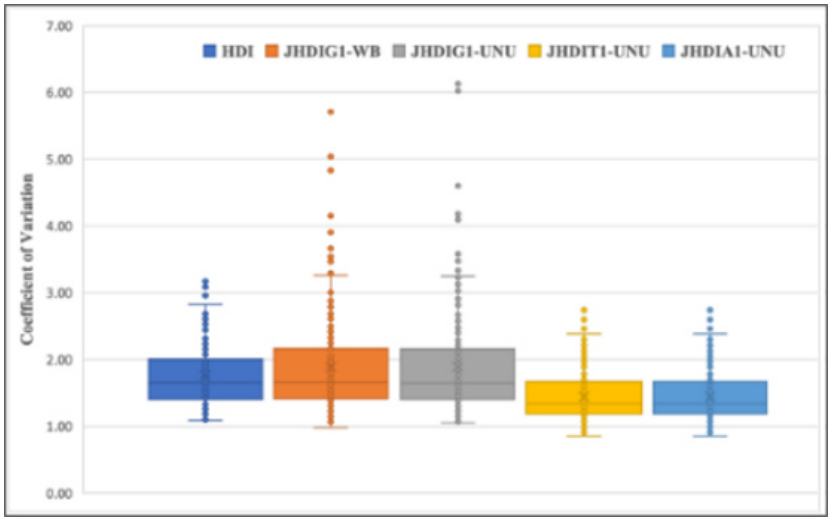
Table 2 – *Mean, root mean squared, and range of variation in country's ranking shifts obtained by excluding alternatively one indicator of the original set.*

Excluded indicator	HDI	JHDIG1-WB	JHDIG1-UNU	JHDIT1-UNU	JHDIA1-UNU
Mean of the absolute ranking differences					
LEI	5.19	10.95	5.81	7.01	6.82
EI	8.42	11.54	7.97	8.69	8.53
II	7.38	11.13	7.38	7.38	7.38
Mean	**7.00**	**11.21**	**7.05**	**7.69**	**7.58**
R.m.s.	**1.34**	**0.24**	**0.91**	**0.72**	**0.71**
CoV	**19.21**	**2.18**	**12.91**	**9.39**	**9.43**
Root mean squared of the absolute ranking differences					
LEI	4.90	7.44	4.82	6.07	5.96
EI	6.74	9.43	6.34	7.11	6.81
II	6.75	8.67	6.75	6.75	6.75
Mean	**6.13**	**8.51**	**5.97**	**6.64**	**6.51**
R.m.s.	**0.87**	**0.82**	**0.83**	**0.43**	**0.38**
CoV	**14.16**	**9.62**	**13.94**	**6.49**	**5.91**
Range of the absolute ranking differences					
LEI	30.00	35.00	25.00	39.00	41.00
EI	36.00	44.00	29.00	40.00	41.00
II	34.00	39.00	34.00	34.00	34.00
Mean	**33.33**	**39.33**	**29.33**	**37.67**	**38.67**
R.m.s.	**2.49**	**3.68**	**3.68**	**2.62**	**3.30**
CoV	**7.48**	**9.36**	**12.55**	**6.97**	**8.53**

LEI: Life Expectancy Index; EI: Education Index; II: Income Index; R.m.s.: Root Mean Squared; CoV: Coefficient of Variation.

On the other side, the sensitivity analysis, showed in Figure 2, verifies the intrinsic robustness of the indices through the study of the modifications that occur when a random disturb is added to each individual indicator. The minimum median value for the CoV was observed in JHDIT1-UNU and JHDIA1-UNU (1.337), followed by JHDIG1-UNU (1.648), HDI (1.650), and JHDIG1-WB (1.658).

Figure 2 – *Boxplots of the coefficients of variation of the HDI and its alternatives obtained by adding a random disturb for each individual indicator.*



4. Discussion

The results of the correlation analysis clearly demonstrate that embedding formula (2) exhibited the highest correlation with the validation indices for all the tested coefficients. As anticipated, this was likely due to the application of these coefficients as a penalty function to Gross National Income per capita (GNI pc) when calculating the Income Index. Furthermore, as a testament to its robustness, the GINI coefficient consistently showed the highest correlation, irrespective of the database used, even though differences in country rankings were observed between the World Bank (WB) and United Nations University (UNU) databases. The uncertainty analysis identified the Gini coefficient from UNU and the WB database as having the lowest means and the lowest coefficients of variation, respectively. On the other hand, the sensitivity analysis revealed an overall very low variability, ranging from 1.34% (JHDIT1 and JHDIA1) to 1.66% (JHDIG1-WB). These results indicate that HDI variants exhibit similar or, in some cases, even greater robustness than the traditional HDI, confirming the solidity of the first embedding method. From these findings, several observations can be made. Firstly, among the top ten positions in the new JHDI, Hong Kong completely disappears, despite being ranked 4th in the traditional HDI. This suggests a significant conclusion: including an income distribution coefficient within the economic welfare indicator as a "penalty function" disproportionately disadvantages high-income countries without effective redistribution policies. This effect is further evident in the new JHDI's top ten

positions, which are predominantly occupied by European countries, particularly those in Scandinavia and Northern Europe. These countries are characterized by high levels of "social protection," where contributory systems based on substantial wages provide efficient public services and welfare states. Conversely, the rankings for the lowest positions remain virtually unchanged, indicating that countries with the lowest Human Development Index also exhibit the poorest income distribution. This deduction appears to corroborate the development patterns in African countries in recent years, where economic growth, if it occurred, did not translate into well-being for the entire population but rather concentrated within the highest income brackets. This is also consistent with the challenges faced by African countries, including the fragility and poor structure of their state apparatus, which struggles to function as an efficient administrative entity and faces difficulties in planning public policy interventions, particularly in remote areas. The strength of this study lies in its focus on reshaping a widely accepted index rather than developing a new composite indicator, which is a common approach in contemporary literature. Therefore, the Just Human Development Index (JHDI) stands out as a readily applicable tool, given the abundance of available data and its ease of calculation. However, one limitation of this study is the omission of decile ratios and derived inequality coefficients, such as the Palma ratio, from the testing framework. Additionally, other means of aggregation, such as the Mazziotta-Pareto Index (Mazziotta & Pareto, 2018), were not explored. Thus, incorporating an inequality coefficient as a penalty function not only maintains the ease of calculation and the robustness of the HDI but also enhances its correlation with inequality. This approach may have significant political implications by highlighting that human development remains incomplete if economic growth is not balanced by income distribution policies (Cingano, 2014).

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THE STRUCTURAL AND ECONOMIC PROFILES OF ENTERPRISES WITH GREATER LONGEVITY[1]

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Abstract. In this paper, after dividing the companies of the FRAME SBS into long-lived and non-long-lived companies and having described their characteristics, the probability of survival of the companies over time is estimated as the structural and economic conditions change. In particular, the COX semiparametric regression model is used to compare the probabilities of survival and identify the profile of long-lived and non-long-lived companies.

1. Introduction

Since the 1960s several studies have been conducted with the aim of implementing statistical models to forecast and evaluate company performance. Initially, these studies were based on univariate approaches through which the statistical indices of companies close to bankruptcy were compared with those of "healthy" companies (Beaver, 1967). Subsequently, multivariate approaches were proposed in the literature such as the Z-Score model (Altman, 1968) which, through a combination of financial statement indices and using discriminant analysis, assigned a score to healthy and unhealthy companies, with some "variants" such as those based on the application of logit models (Ohlson, 1980) or on the comparison of different approaches. In this sense, particularly interesting is the study by Balcaen and Ooghe in which 43 corporate bankruptcy prediction models are examined, grouped into 4 categories: univariate models (1), models based on risk indices (2), AMD models (21) and models probabilistic (19) (Balcaen and Ooghe, 2006).Previous studies have mainly focused on the prediction of the risk of corporate insolvency or default since this is the greatest risk that can typically arise in the entrepreneurial sphere. However, the variability of profits and financial balances, which insolvency depends on, "are not the only measure of corporate success. They are an end. [...] survival is an unquestionable, perhaps the ultimate, mark of

[1] The paper is the result of the joint study of the three authors, paragraphs 2.1 and 3 are attributed to A.M.M. Carucci, paragraphs 2.2 and 2.3 to R.A. Palumbo, paragraphs 1, 4 and 5 to G. Vannella.

success". (Cassis, 1997). Understanding the factors that drive family companies' longevity is essential not only to improve the strategies of existing companies, but also to inform investors' decisions to support start-ups, taking on the responsibility of long-term allocation of resources (Dossena, 2022).On the other hand, studies have rarely been conducted to predict company longevity and to analyse what could be the structural characteristics of companies that would discriminate long-lived vs. non-long-lived companies.Furthermore, a major obstacle to company forecasting models has always been the difficulty of easily finding detailed economic and structural information on a large sample of companies (note that the classic company surveys are based on samples and the administrative source of public budgets is not exhaustive).The enormous coverage of FRAME SBS (therefore FSBS) and ASIA (Active Enterprise Statistical Archive) data in terms of number, structure variables and economic variables, combined with the availability of information in historical series, constitutes a particularly interesting information base for the description of the system over the years and for the evaluation of its evolution in the last decade. In this paper, using this database, the profiles of the companies active since 2012 (the first year of data availability) have been outlined, identifying the structural and economic determinants of these companies and which, consequently, the main factors that led companies not to survive in the period under review.The factors that have influenced the longevity of companies have been identified through regressive models and, in particular, the Cox-hazard statistical model (Cox, 1972) helps evaluate how different characteristics of companies, considered jointly, have influenced their survival probability.

2. Data

2.1. General aspects

Since 2012, the statistics on the economic results of companies and the estimates of the National Accounts have been produced by Istat on the basis of FSBS data (AA.VV., 2020; LUZI, 2016).

It represents the most important integrated system of administrative and statistical data which, starting from the units included in the ASIA database, brings together information deriving from administrative sources and from Istat structural surveys on companies, thus creating an exhaustive archive (in terms of enterprises) with economic and structural variables. This richness of information is particularly useful to analyse the health of Italian companies.

The information of the statistical archive is available in aggregate form on the Istat data warehouse, in the business and competitiveness section or, after appropriate request, as microdata file. In this paper we chose to measure the health

of the production system considering the companies for the period 2012-2019. This choice is subject to the availability of the FRAME SBS (2012 is the first year of data) and the pandemic event. In fact, 2019 is the last year for which the FRAME SBS appears to be less subject to the effects of business closures due to the pandemic event itself.

Starting from the data relating to the years 2012-2019, two sets of companies have been identified:

- Enterprises present in both groups and therefore defined as "long-lived" (hereinafter LLE)
- Enterprises present in 2012 and not present in 2019, "not long-lived" (hereinafter NLLE).

For each enterprise was awarded:

- the flag=1 for «long-lived» companies
- the flag=0 for «not long-lived» companies.

The enterprises present in the 2012 FRAME SBS archive and simultaneously present in the 2019 FSBS are 60% of the total initial enterprises (long lived) while over 1.7 million enterprises stopped their activity before 2019 (Tab. 1).

Table 1 – *Long lived and not long lived enterprises.*

	Number of enterprises	
	Absolute value	Percentage value
NLLE	1737350	39.9
LLE	2613668	60.1
TOTAL	4351018	100

Elaborations on ISTAT data

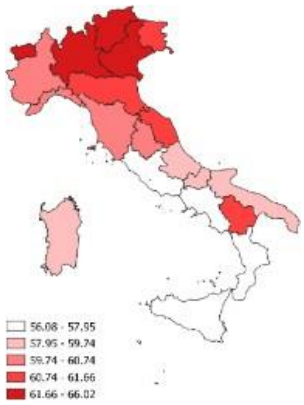
In order to measure the age of the company, the proxy variable was calculated, starting from the ASIA data, expressed in terms of months of life up to 2019 or to the possible date of activity cessation.

2.2. Some elements of analysis: the structure of long-lived and non-long-lived enterprises

To understand which indicators could be chosen for the multivariate analysis, we carried out a descriptive analysis that could support this choice and then examined the distribution of LLEs/NLLEs in relation to the various structural characteristics of the companies. For the sake of conciseness, only the most significant findings are reported below. First, the territorial aspect was particularly relevant (Fig. 1), the presence of LLEs decreases moving from the

North-East to the North-West and from the North to the South. The region with the highest incidence of LLEs is Trentino Alto Adige with 66% of enterprises while the region with the lowest incidence is Lazio (56%).

Figure 1 – *Long -lived enterprises in Italy. Percentage incidences.*

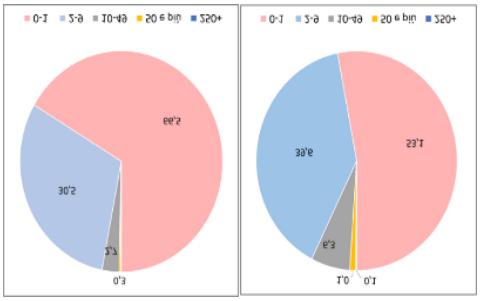


Elaborations on ISTAT data.

The second most interesting aspect was the size of the companies measured in terms of number of employees (Fig. 2), the growth of which tends to increase the longevity of the company. Companies with only one employee represent just over 50% of LLEs and 66.5% of NLLEs; on the other hand, those with 2-9 employees represent almost 40% of LLEs and about 30% of NLLEs and finally the class with 10-49 employees represents 6.3% of LLEs and 2.7% of NLLEs. On average, LLEs employ 4.5 people and NLLEs 2.5. With reference to the sector of economic activity (Fig. 3), 45% of LLEs are in the other services sector, 32.4% in trade commerce sectorand just over 10% in the construction and industrial sectors.

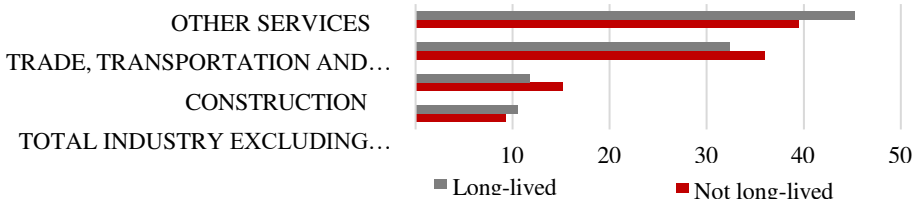
Figure 2 – *Long and not long-lived enterprises by size.*

NLLE *LLE*



Elaborations on ISTAT data

Figure 3 - *Long and not long-lived enterprises by activities*



Elaborations on ISTAT data.

2.3. Usable variables and chosen indicators

Therefore, in order to identify potentially discriminating statistical indicators, the main economic-company variables in the FSBS were analysed, which, given its explanatory purposes, does not contain the aggregates of the balance sheet.

A set of potentially discriminating statistical financial indicators was constructed, the main results of which are reported below (Tab. 2).

Indicators of productivity and remuneration of work:

- Revenue from sale of goods and services/Employees
- Value added/Persons employed
- Gross Operating Margin/Employees
- Value added/Employees
- Wages and salaries/Employees

expressed in euro per employees, indicate to some extent how much economic production activity over a given period can be attributed to each employed person, and also how it changes, as well as the average salary cost per employee.

Indicators of propensity for international trade:

- Exports of goods/(Revenues from sale of goods and services+Others operative revenues)
- Imports of goods/Purchases of raw materials, supplies and consumable.

expressed as a percentage, they measure the propensity to international markets.

- Other cost and value added indicators
- Personnel costs/ (Purchases of goods and services+Costs for use of third- party assets+Personnel costs+Other operative revenue) explains how much of the costs is absorbed by personnel costs
- Value added/Revenue from sale of goods and services describes the increase in value that business activity brings to the transformation processes of

goods and services on the value of sales. It also indicates how large the margin is to remunerate internal production factors.

Table 2 - *Economic indicators: productivity and remuneration of work.*

Productivity and remuneration of work	*NLLE*	*LLE*
Revenue from sale of goods and services/Employees	211188	290446
Value added/Employees	45965	66504
Gross Operating Margin/Employees	16895	30489
Value added/Persons employed	26714	48741
Wages and salaries/Employees	20989	25915
Propensity for international trade	*NLLE*	*LLE*
Exports of goods/(Revenue from sale of goods and services+Others operative revenues)	0.06	0.13
Imports of goods/Purchases of raw materials, supplies and consumables	0.11	0.21
Other indicators	*NLLE*	*LLE*
Personnel costs/ (Purchases of goods and services+Costs for use of third-party assets+Personnel costs+Other operative revenue)	0.15	0.13
Value added/Revenue from sale of goods and services	0.22	0.23

Elaborations on ISTAT data.

In particular, the LLEs, compared to the NLLEs, have significantly higher observed average values of the indicators of productivity, remuneration of work and of propensity for international trade, not relevant differences for the other economic indicators.

These results appeared completely convincing also on the theoretical side, as the longer-lived companies can have a greater "yield" of the workforce both in terms of average turnover per employee and profitability per employee and employee compared to the less long-lived ones, as well as the longest-lived companies can be characterized by higher remuneration for the work employed. Similarly, the companies with greater longevity had higher incidence on both foreign turnover than total turnover and foreign purchases than total turnover, as this increased ability to move across all markets, both domestic and foreign, allows companies to have greater elasticity.

On the other hand, the small difference between the LLEs and the NLLEs with reference to the value added/turnover indicator raised some concerns, as one would have expected a greater difference in the profitability of the turnover between the two sub-populations.

3. Methodology

To evaluate the factors that influence the longevity of companies, the statistical Cox-hazard regression model was used to estimate how different structural and economic characteristics of companies, considered jointly, influence their survival probability (COX, 1972).

The Cox model is widely used in applied statistics (for example in medical statistics) as it is considered a valid tool in the development of survival analyses and for the evaluation of the impact of predictive factors on a specific outcome. A great advantage of the Cox model is given by the possibility of taking into account two observable situations (presence or absence of the event) and more covariates.

The fundamental element of Cox regression is time. It is also useful to underline the semi-parametric nature of the model which does not require a particular assumption for the "time" variable, but requires the covariates to be parametric.

The mathematical formulation of the model is as follows

$$h(t) = h_0(t) \cdot e^{b1x1+b2x2+\cdots+bkxk} \quad (1)$$

in which h(t) is the hazard function, the incidence rate of the event (estimated by the model) at time t; *h0(t)* is the baseline risk (i.e., the incidence rate of the event when the risk factor is absent); *x1, x2, ..., xk are* covariates or risk factors *e b1, b2, ..., bk* regression coefficients.

One of the most important outputs of the Cox model, obviously in addition to the coefficients of the covariates, is the Hazard Ratio (HR), coefficient of expansion or contraction of the risk corresponding to a unit increase of the k-th covariate. We consider the ratio between h(t) and H0(t). In very simple terms, the HR measures the relative risk of an event occurring at a generic time instant t. Nonetheless, it must be interpreted with great caution. An HR=2 does not mean that the event will occur faster, but it does mean that the risk is double the baseline.

$$\frac{h(t)}{h_0(t)} = e^{b1x1+b2x2+\cdots+bkxk} \quad \begin{matrix} < 1 \; if \; bi < 0 \\ = 1 \; if \; bi = 0 \\ > 1 \; if \; bi > 0 \end{matrix} \quad (2)$$

4. Results

The Cox model was applied to the LLEs and NLLEs as a function of the time variable measured in terms of months of life, as previously indicated,

contextually considering structural variables and economic indicators.

The main structural variables used are qualitative and related to the location of the firm, its size and the economic activity as defined in Tab. 3. Economic activity was also analysed in terms of more detailed classification by NACE section.

Table 3 – *Covariates: structural variables.*

Territory	North, Centre, Southern Italy
Size class of persons employed	1, 2 – 9, 10-49, 50-250, more than 250 employees
Economic activities	Industry, Construction, Trade, Other services

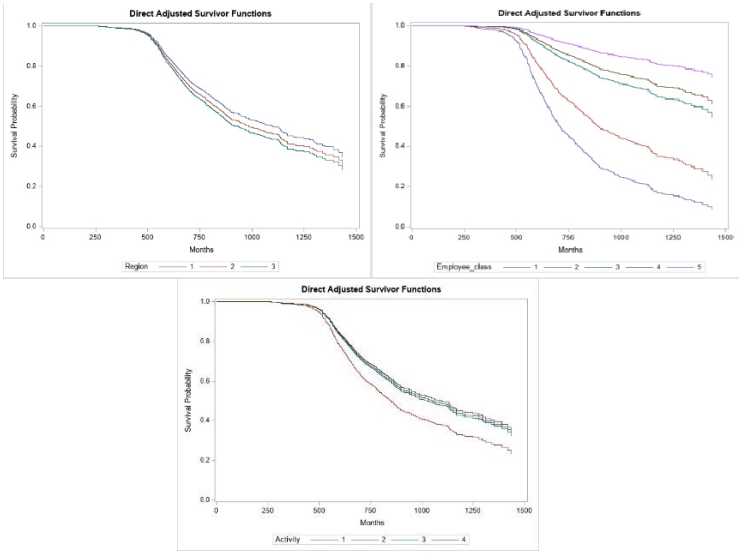
The main economic indicators are shown in Tab. 4 and aim to describe the company's productivity, profitability, propensity for international trade and cost structure. These indicators were standardized before being included in the model.

In the first case a model is proposed with only the covariates distribution, class of employees and macro-class of economic activity, in the second the economic activity has been broken down into NACE sections and in the last one only the quantitative variables have been included (Fig. 5) The survival of companies is certainly different between geographical divisions, companies in the North have by far a greater probability of survival than companies in the Centre and the South. The distance between the curves tends to increase with the age of the firm. In terms of size, the probability of survival is higher in companies with more employees and the distance between the curves increases significantly as the age of the firm increases. Among the economic activities we note an almost homogeneous trend between the curves except for the construction sector that records a lower probability of survival and whose gap widens in correspondence with the older companies compared to the other sectors.

Table 4 – *Covariates: economic indicators.*

Value added per employed	Value added/Employees
Personnel costs per employee	Wages and salaries/Employees
Export on revenue	Exports of goods/(Revenue from sale of goods and services+Others operative revenues)
Personnel cost on total cost	Personnel costs/ (Purchases of goods and services+Costs for use of third-party assets+Personnel costs+Other operative revenue)

Figure 5 – *Survivor functions by territory, size and economic activity.*



Elaborations on ISTAT data

Table 5 – *Parameter estimation, Cox regression first model.*

	Parameter estimate	Pr>ChiSquare	HR
Territory = North	-0.14434	<.0001	0.866
Territory = Centre	-0.00823	0.0001	0.992
Size class of persons employed = 1	1.94105	<.0001	6.966
Size class of persons employed = 2 – 9	1.41899	<.0001	4.133
Size class of persons employed = 10 – 49	0.82189	<.0001	2.275
Size class of persons employed = 50 – 250	0.51705	<.0001	1.677
Economic activities = Industry	0.08932	<.0001	1.093
Economic activities = Construction	0.43692	<.0001	1.548
Economic activities = Trade	0.22483	<.0001	1.252

Elaborations on ISTAT data.

The HR, proposed in Tab. 5, confirms the trend of the survival functions, since the higher the risk ratio, the lower the probability of survival. The value 1 can be considered as a boundary value as values lower than 1 indicate a positive relationship with the probability of survival, while values greater than 1 indicate a negative relationship with survival. Given the heterogeneity of the economic

activity we carried out an in-depth analysis of the companies classified according to the NACE economic activity. The highest probability of survival is recorded in sections L - real estate activities, Q - health and social assistance, B - extraction of minerals from quarries and mines and S - other service activities while the lowest probability of survival is found for businesses of sections N - rental, travel agencies and business support services, I - accommodation and restaurant service activities and J - information and communication services (Tab. 6).

Table 6 – *Parameter estimation, Cox regression second model.*

	Parameter estimate	Pr>ChiSquare	HR
Territory = North	-0.13583	<.0001	0.873
Territory = Centre	-0.00978	<.0001	0.99
Size class of persons employed = 1	2.09959	<.0001	8.163
Size class of persons employed = 2 – 9	1.51578	<.0001	4.553
Size class of persons employed = 10 – 49	0.87135	<.0001	2.39
Size class of persons employed = 50 – 250	0.5635	<.0001	1.757
Economic activities - B	-0.23552	<.0001	0.79
Economic activities – C	0.14092	<.0001	1.151
Economic activities – D	0.28577	<.0001	1.331
Economic activities - E	0.03128	0.1118	1.032
Economic activities - F	0.47546	<.0001	1.609
Economic activities - G	0.17071	<.0001	1.186
Economic activities - H	0.12863	<.0001	1.137
Economic activities - I	0.67311	<.0001	1.96
Economic activities - J	0.62333	<.0001	1.865
Economic activities - L	-0.43094	<.0001	0.65
Economic activities - M	0.01496	0.0003	1.015
Economic activities - N	0.73529	<.0001	2.086
Economic activities - P	0.5147	<.0001	1.673
Economic activities - Q	-0.25532	<.0001	0.775
Economic activities - R	0.45583	<.0001	1.577

Elaborations on ISTAT data.

In terms of economic indicators, the probability of survival increases significantly with the increase in average wages and less significantly with the increase in value added per employee and the propensity to export, while it decreases with the increase

of the weight of personnel costs on total costs (Tab. 7).

Table 7 – *Parameter estimation, Cox regression third model.*

	Parameter estimate	Pr>ChiSquare	HR
Value added per employed	-0.02832	<.0001	0.972
Personnel costs per employee	-0.30630	<.0001	0.736
Export on revenue	-0.08427	<.0001	0.919
Personnel cost on total cost	0.04221	<.0001	1.043

Elaborations on ISTAT data.

5. Conclusion

The results of this study have highlighted the possibility of building company diagnostic models on the basis of the SBS Frame data. Even in the absence of balance sheet data, the application of Cox-type regressive models has highlighted a particularly interesting forecast potential, especially due to the incomparable information capillarity in terms of "surveyed" companies represented by the frame.

In particular, it was possible to estimate how company longevity can be explained with the diagnostic model presented, highlighting how it can depend on variables such as the territory to which they belong, the number of employees, the sector of activity as well as a set of statistic balance sheet indices including the added value per employee, the average cost of personnel, the incidence of the value of exports on turnover, the incidence of personnel costs on total costs.Since there were no data prior to 2012, it was possible to estimate the average age of the company only as a proxy from the date of commencement and cessation of activity without taking into account any corporate "transformations" and the absence of financial information. Nevertheless this analysis, easily replicable for the future, can constitute a valid tool for entrepreneurs and public decision makers. We have also tried to outline the ideal characteristics of companies operating in the area and, conversely, the factors that need to be corrected for existing companies so that their continued operations can be facilitated. Finally, future research could enhance the diagnostic capacity that emerged by implementing the results with the identification of the cut-off levels to discriminate companies based on the probability of survival through the use of a ROC model that checks for first and second kind errors at the same time.

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ANALYSING THE LABOUR MARKET THROUGH A WEB DATA SOURCE: THE SKILL DYNAMIC BASED ON ONLINE JOB ADVERTISEMENTS

Elena Catanese, Francesca Inglese, Annalisa Lucarelli, Giuseppina Ruocco

Abstract. Online advertisements in job portals and company sites have great potentials for job market analyses, providing detailed information on the jobs and skills required by employers. This new source of data – available thanks to advances in web crawling technologies, machine learning and big data techniques – represents an important use case of the ESSnet Web Intelligence Network project, whose main objective is to foster the integration of web data in official statistics. At European level, Online Job Advertisements (OJAs) are centrally collected, and stored in a Data Lab jointly developed by European Centre for the Development of Vocational Training (CEDEFOP) and Eurostat for producing new statistics on job vacancies. OJAs data provide a lot of information on job position characteristics and requirements by enterprises not collected through the official surveys on job vacancies. The objective of this work is to present the potentialities of OJA data in the analysis of the labour demand. In particular, the paper shows some analyses on Italian skill demand, over a period of four years (2019-2022), focussing on relevant changes at national and macro-regional level, by economic activity sectors and major occupational groups.

1. Introduction

The increasing amount of Online Job Advertisements (OJAs) in job portals and company sites has great potential to get detailed and timely insights into labour market trends. Advances in web crawling technologies, machine learning, and big data techniques, have given a boost to the growing interest of the National Institutes of Statistics in data acquired from the web for their use for statistical purposes. OJAs represent an innovative data source for the analysis of job market as it provides relevant information on job characteristics (e.g. occupation, location, type of contract, working time and salary), characteristics of the employer (e.g. economic activity sector), job requirements (e.g. education, skill and experience) and concerning the advertisement itself (e.g. job portal, publishing and expiring date of the ads). To exploit the potentialities of the information contained in OJAs, some considerations are necessary for their correct use: job vacancies and job advertisements cover different populations; they refer to different statistical concepts and to different measures of job openings. Therefore, it is a new data source that does not replace traditional surveys, but can

complement them to produce additional indicators, thus enriching the current official statistical production. The use of this new data source for the analysis of the labour market can be, in part, a response to overcoming the information gaps in existing statistics. More information and granularity represent today a necessity for EU policies and for decision-making in democratic societies. The Italian National Institute of Statistics (Istat) cooperates with several European countries on a project for the development of a Web Intelligence Network (WIN). The WIN project started from the results of the two previous projects (the ESSnet Big Data and ESSnet on Big Data II) implemented between the year 2016-and 2020. The main goal of this initiative within the European Statistical System (ESS) is to foster the integration of web data in official statistics. OJAs is one of the use case of the project, based on the joint work of Eurostat and CEDEFOP, finalized to collect, explore, process and analyse the OJAs for statistical purposes. CEDEFOP OJA system and ESS DataLab are the reference frameworks to analyse job market trends, based on the information contained in the OJA data. The objective of this work is to present the OJA potentialities for analysing in deep the labour demand. To this scope, it focuses on skill analysis, in particular on skill changes observed over a period of four years – from the first quarter 2019 to the fourth quarter 2022 – and broken down by geographical area, economic activity and occupation. Skill and occupation, as well as other variables, are extracted from OJAs through text analysis and classified using keyword lists (ontologies) and machine learning models. The keywords lists are based on the existing standard classification, namely ESCO (European Skills, Competences, Qualifications and Occupations). The paper is organised as follows. Section 2 reports some information on OJAs source compared with traditional sources (Job Vacancy Survey and the Excelsior Information System). Section 3 highlights the definition of OJAs and the conceptual differences between OJAs and Job Vacancies Statistics (JVS) based on official surveys. Section 4 describes OJA data pipeline and the standard classifications used for classifying the skill and occupation variables. Section 5 is dedicated to the skill analysis. In this section, we first highlight the importance of this type of data in providing an up-to-date picture of the skill requirements by employers, then, we present some results on skill demand dynamics broken down by macro-regional area, economic activity sector and major occupational groups. Finally, section 5 concludes the work, with main findings and challenges.

2. OJA: a non-traditional data source

OJAs are web data collected from many online sources, such as: job portals, company sites, social networks, employment websites, employment agencies, job search engines, online newspapers, public employment services, and employers organizations. Unstructured data in textual form – extracted from online sources through complex procedures – are transformed into information that can potentially be

used for statistical purposes. This new data source allows to overcome some limitations of traditional data (limited timeliness and granularity) and to enrich the current official statistical production. In Italy, in the context of the official statistics covering the demand side of the labour market, two main official sources supply information on the unmet labour demand. In particular, Istat has carried out since 2003 the quarterly Job Vacancy Survey (VELA), which produces estimates of the job vacancy rate. The survey covers all enterprises with one or more employees in all economic activities, from sections B to S, according to the international Classification of Economic Activities (NACE Rev.2). Activities in agriculture, forestry and fishing, those of households as employers, as well as activities of extraterritorial organizations and bodies and public administration and defence are excluded (NACE sections A, T, U and O). Data on job vacancies represent the stock of vacant posts at a given reference date. In particular, the time of recording is the last calendar or working day of the quarter. The quarterly job vacancy rate estimates are published at national and NACE section level. Istat's job vacancy rate production is based on the requirements of an EU framework regulation (No 453/2008). The European job vacancy rate is included in the list of the Principal European Economic Indicators (PEEIs) on the labour market. The other official source on labour demand is the Excelsior Information System produced by Unioncamere and ANPAL. Data are collected through the monthly surveys and with web techniques. They provide updated, systematic and reliable knowledge of the consistency and territorial, dimensional and economic activity distribution of the labour demand expressed by companies, as well as the main characteristics of the professional figures required (type of contract, level of education and qualifications, professions and elementary figures). Although it captures a third of the total number of companies present in the Business Register (the Statistical Archive of Active Companies - ASIA), it manages to cover the majority of the country's stable employment stock. Among the most relevant information collected by the Excelsior System: the number of contract activations expected for the following quarter detailed by economic activity, territorial area occupation, type of contract and education. Compared to the official Istat survey, the Excelsior system does not collect information on vacancies for which a concrete search is in progress (as defined in the EU regulation, see section 3). It focuses only on the possible future intentions expressed by companies to hire new workers, which is a different and less strong measure of the actual search of personnel by the enterprise. OJA web data source enables an enrichment of the labour demand information with respect to the official surveys under EU Regulation (as the Istat one) as the Table 1 shows. OJAs from web data collect high detailed information on the characteristics of the position to be filled by the employers (profession, education, skill, territorial area, type of contract, working hours and salary), in addition to the economic activity section – the only detail required by the EU Regulation –. Information is also at high frequency (daily basis) and not only

at a quarterly basis. Furthermore, while the count of job vacancies is measured at a point in time, making it a stock variable, the count of job advertisements is measured per unit of time, making it a flow variable.

Table 1 – *JVS from EU official survey vs OJAs from web data source - enrichment from OJAs.*

JVS from OFFICIAL SURVEY on the basis of EU Regulation	OJAs from WEB DATA
National, by NACE Rev.2 economic activity sections	National, by NACE Rev.2 economic activity sections
Stock of vacancies	Stock of vacancies
Not available	Flow of OJAs collected on each day of the month
Region on voluntary basis	Geographical area/ region / province / city
Occupation on voluntary basis	Occupation, education, skill, contract type, working hours, salary
Quarterly	Daily

3. OJA definition: a different concept from Job Vacancies

OJAs are one of the methods, increasingly widespread, to notify a job vacancy. OJAs refer to advertisements published on job portal revealing an employer's interest in recruiting workers with certain characteristics for performing a specific work. OJAs cannot be assimilated to Job Vacancies (JV) as defined by the EU Regulation. On the basis of the EC Regulation No 453/2008, a job vacancy is defined as: "a paid post that is newly created, unoccupied, or about to become vacant: a) for which the employer is taking active steps and is prepared to take further steps to find a suitable candidate from outside the enterprise concerned; and (b) which the employer intends to fill either immediately or within a specific period of time." The active search for a suitable candidate must have already started but not yet ended at the reference time at which job vacancies are collected. The active steps to find a suitable candidate include: (i) notifying the job vacancy to the public employment services; (ii) contacting a private employment agency/head hunters; (iii) advertising the vacancy in the media (for example the Internet, newspapers, magazines); (iv) advertising the vacancy on a public notice board; (v) approaching, interviewing or selecting possible candidates/potential recruits directly; (vi) approaching employees and/or personal contacts; (vii) using internships. The above definition of a job vacancy in the EU regulation framework makes it clear that the concept of OJAs does not correspond to that of JV, due to different factors. In particular, online job vacancies could cover all those job vacancies, as defined by the EU Regulation, for which the active steps carried out by the employers to find a suitable candidate include also the advertising on internet job portals. But, not all job vacancies are advertised on-line: although there is a general trend towards more job vacancies being advertised on-line, many of them continue to be filled through traditional channels, such as newspapers, employment agencies,

noticeboards, or personal contacts. Moreover, job portals used by employers may not be fully covered by web scraping and other data ingestion activities, and thus not all jobs advertised online may be fully captured. OJA data are generally drawn from multiple job portals: job boards, which publish original ads uploaded by employers; job search engines, which republish ads from other portals; hybrid job portals, which are a combination of both. In addition, new job portals may appear while existing portals may decline in importance. However, even if the whole set of advertisements published on all online portals were considered, they do not refer to total job vacancies that actually exists at a specific reference date. This is due to different reasons: for example, delay in the communication between enterprises and the online portals could cause the presence on portals of job vacancies that are closed (because, for example, a suitable candidate has already been found). In addition to this, either some OJAs may not represent a job vacancy in the scope of the official survey (these include non-existent vacancies, referred to as "ghost vacancies", international jobs, and non-payed student internships) or may be published without any direct correspondence with existing vacancies. Such "fictional" ads may be posted for example for attracting new talents as a recruiting strategy, or improving the image of a company. An additional and a background fact to take into account is that there is no one-to-one correspondence between advertisements and vacancies, as one advertisement may contain more than one vacancy. All the above factors imply that the stock of job vacancies measured by the OJAs could be higher or lower than the corresponding JV data measured by the current official job vacancy surveys. Furthermore, the number of vacancies collected by the official survey is the stock of vacancies, for which businesses are actively seeking suitable candidates at a specific reference date. OJAs represent a flow of new vacancies but usually do not contain information on when the recruitment activity started and ended.

4. OJA data: pipeline and variables classification

At European level, OJAs data are centrally managed: the European Center for the Development of Vocational Training (CEDEFOP) has implemented a system to collect and extract statistical information from OJAs for all European countries [1].

OJA data pipeline starts with web data scraping and includes all phases of processing, cleaning, standardizing, and classifying. A set of validation rules applied to the OJA dataset checks the consistency and plausibility of the statistical output. Consistency is checked in relation to Eurostat's standard classifications (ESCO and NACE Rev. 2). In addition, the stability of the ads distribution within categories of a classification is analysed over time and across data releases. These rules, applied to validate each record or a variable distribution, are complemented by other structural validation rules, to check the correct naming of datasets and variables, empty fields, etc. The statistical output produced by CEDEFOP is integrated and stored in a Data

Lab and disseminated on a quarterly basis with data available at a daily level. Starting from the third quarter of 2018, a new issue of OJA data is released each quarter. All Member States involved in the ESSnet can access the Data Lab, explore OJAs for statistical analysis and contribute to the quality assessment. This cooperative approach fosters the production of experimental indicators, as well as the improvement of the accuracy of the information produced. The text analysis of OJAs provides several details about the job position to fill, such as the salary, the workplace, the reference period and the main classification variables describing the occupation, skills, education level and economic activity. ESCO classification has been conceived to harmonise the core concepts and language about occupations and skills available for different stakeholders, dealing with employment education and training issues. ESCO is divided in two main pillars: occupations, skills/competences. The latest version allows describing 3008 occupations. The skill pillar provides a comprehensive list of knowledge, skills and competences relevant to the European labour market. It contains 13,890 concepts structured in a hierarchy, which contains four sub-classifications: Knowledge, Language skills and knowledge, Skills, Transversal skills. In addition, ESCO is linked to other official classifications and frameworks, such as the International Standard Classification of Occupations (ISCO), corresponding to the top four levels for the occupations pillar. In this case, ESCO describes the occupations classified at level 5 and lower.

5. Skill demand: needs, analyses and results

5.1. Skills from OJAs: an enrichment for the labour demand analysis

OJAs can provide valuable information on labour market dynamics, like the changing demand in skills and new occupation profiles, for instance for data scientist and computer scientist or for highly qualified profiles, covering important informative gaps. These could lead to the production of new timely indicators on the changes in the labour demand and so monitor the labour market dynamic for some sectors at least. Since not all new jobs are advertised (online, or at all), online data may also provide a distorted picture of the labour market. This type of data can provide an up-to-date picture of the skills that employers require, at higher detail than traditional surveys. The collection of reliable online job advertisement data is part of "Skills intelligence", one of the actions of the European Skills Agenda. A new European Regulation – that establishes a common framework for European Labour Market statistics on Businesses (regarding earnings, labour costs, gender pay gap and job vacancies) – is in the process of being approved, allowing the use of innovative sources to obtain detailed information on labour shortages by occupation and region. Generally speaking, collection of this type of information through surveys would entail additional costs for NSIs and increased statistical burden for enterprises. Experimental statistics may reduce this burden and should be based on a harmonized framework amongst

European countries, at least for the main variables: skill, occupation, territorial areas, type of contract and education. In addition, policy-makers and researchers by means of OJA based indicators may support the National Recovery and Resilience Plan (NRRP), to promptly monitor the offer of professional trainings and to analyse the causes of the mismatch between labour supply and demand. Furthermore, skill demand variations allow monitoring many phenomena such as: job creation and destruction, employment shifts, emerging occupations and skills needs, and new working patterns/relations.

Table 2 – *Description of the skills included in the sub-classification "Skill" of the ESCO classification skills/competences pillar.*

Skill	Description
Assisting and caring	Providing assistance, nurturing, care, service and support people, and ensuring compliance to rules, standards, guidelines or laws
Communication, collaboration and creativity	Communicating, collaborating, liaising, and negotiating with other people, developing solutions to problems, creating plans or specifications for the design of objects and systems, composing text or music, performing to entertain an audience, and imparting knowledge to others
Constructing	Building, repairing, installing and finishing interior and exterior structures
Handling and moving	Sorting, arranging, moving, transforming, fabricating and cleaning goods and materials by hand or using handheld tools and equipment. Tending plants, crops and animals
Information skills	Collecting, storing, monitoring, and using information; conducting studies, investigations and tests; maintaining records; managing, evaluating, processing, analysing and monitoring information and projecting outcomes
Management skills	Managing people, activities, resources, and organisation; developing objectives and strategies, organising work activities, allocating and controlling resources and leading, motivating, recruiting and supervising people and teams
Working with machinery and specialised equipment	Controlling, operating and monitoring vehicles, stationary and mobile machinery and precision instrumentation and equipment

In general, the labour demand changes can by analysed at ISCO (occupation) or ESCO (skill) level, disaggregated at NUTS (Nomenclature of Territorial Units) and NACE level. The skill considered in this work are those included in the skills/competences pillar of the ESCO classification and, in particular, in the sub-classification "Skill" (as described in Table 2).

5.2. Skill dynamic

In this section, we present descriptive analyses on Italian skill demand changes based on CEDEFOP OJA data, for the period from the first quarter 2019 to the fourth quarter 2022. The amount of skill, demanded by the employers by means of the online channels and collected in the CEDEFOP OJA system, was measured at the last day of

each quarter. The skill demand changes was assessed by utilizing raw data, i.e. by means of the year on year variations (that is, the percentage changes between the skill demand of each quarter compared to that of the same quarter of the previous year). CEDEFOP OJA time series start from the third quarter of 2018. Therefore, they are too short to be seasonally adjusted. The following figures show changes in the demand for skills at Italian national level and by macro-regions in the period 2019-2022.

Figure 1 – *Skill demand from OJA year on year percentage changes – Italy 2020Q1-2022Q4 – Source: CEDEFOP.*

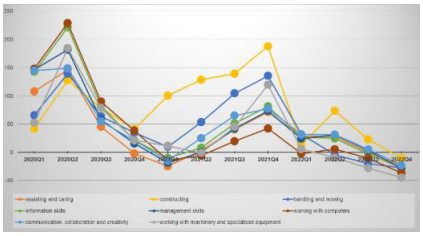
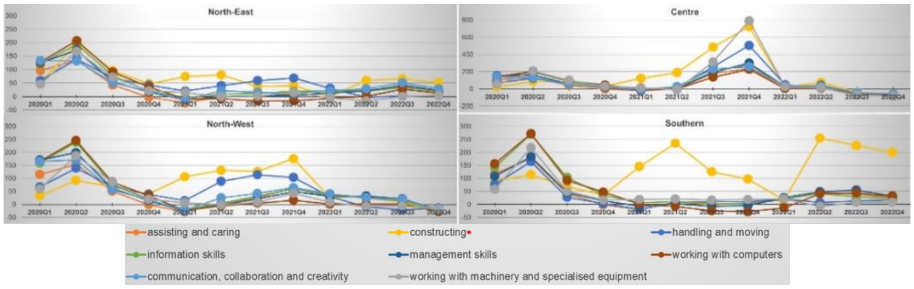


Figure 2 – *Skill demand from OJA year on year percentage changes – Italian macro regions 2020Q1-2022Q4 (skill colours same as Figure 1). Source: CEDEFOP.*

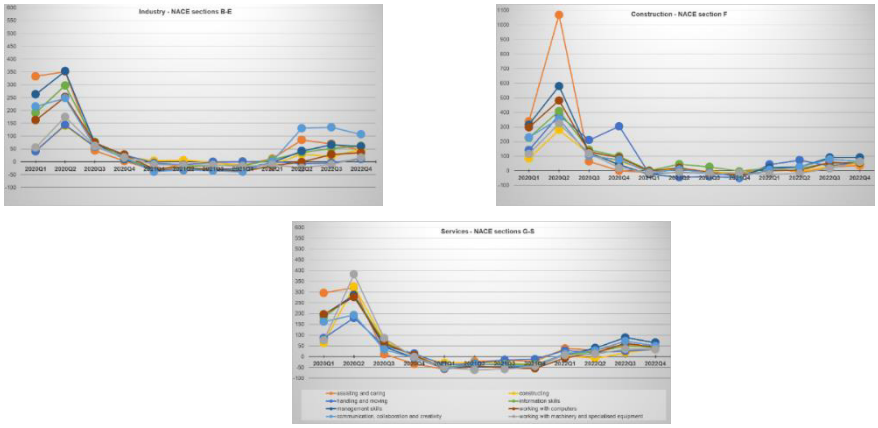


The national level analyses (Figure 1) show a first peak in demand for skills "working with computers" and "information skills" in the second quarter 2020 (see Table 2 for skill description). Moreover, the upward trend in the demand for "constructing skills" (building, repairing, installing and finishing interior and exterior structures), during the year 2021, could be attributed to the bonus effect in the construction NACE economic activity sector. Consistently with the period under analysis characterized by the pandemic crisis, a similar trend is also observed in the demand for "handling and moving skills".

The dynamic of the skill demand shows marked differences at macro-region break down (Figure 2). In the Centre of Italy, the demand for skills in the construction sector shows a higher increase than the national average, approximately four times higher. In Southern Italy, the demand for skills in the construction sector shows a higher increase

too – even if to a lesser extent than in the Centre – with a peak occurring two quarters earlier. A peak is also observed in the second quarter of 2022, with an upward trend. In the North-East, on the other hand, the signal for an increase in constructing skills is much weaker than the national average and concerns the first two quarters of 2021. While in the North-West on the other hand, the signal for an increase in constructing skills is halfway between that of the South and the North-East with a peak in the fourth quarter 2021 later than that one observed for the South. Furthermore, while at national level the increase in demand for constructing skills is also followed by an increase in other kind of skills, this is not the case in the Southern Italy, where an increase in constructing skills is the only one observed. At national level, the increase in demand for constructing skills is also followed by a rise in other kind of skills, this is not the case in the Southern Italy, where an increase in constructing skills is the only one observed. The evidence emerging from the analysis gives information consistent with the period under analysis characterized by the pandemic crisis.

Figure 3 – *Skill demand from OJA year on year percentage changes – Italian NACE economic activity sectors 2020Q1-2022Q4. Source: CEDEFOP.*



5.3. Skill and NACE economic activity sections

This section analyses the dynamic of skill demand by economic activity sector (according to NACE Rev.2 classification). In particular, the dynamic of skills is analysed separately for the industry sector (NACE sections from B to E), for the construction sector (section F) and for the service sector (sections from G to S). As Figure 3 shows, similar trends are observed in the three sectors in the central observation period from the first quarter 2021 to the first quarter 2022, with a slight prevalence of skills with negative trend in the services sector during the year 2021. This could be due to the long term effect of the Covid emergency, which affected economic activities in the service sector the most. In all the three sectors, the research

for skill "assisting and caring" shows a very high increase, reaching almost the maximum[1], which could be due to the emergency period effect too.

In the tails of the observation period, the differences between the three sectors are greater than those observed in the central period. A peak is observed in both industry and construction sectors in the second quarter 2020 in relation to the demand for "management skill", in line with the needs emerged during the Covid crisis of reorganizing work activities and resources and developing new strategies. While in the service sector, in the same quarter, the skill demand for "working with machinery and specialised equipment" shows the highest positive changes. Furthermore, during the last three quarters of 2022, the specialization in "communication, collaboration and creativity" is of particular interest for the industry sector. In this case too, the increasing requirement of this skill should be considered as a long term effect of the emergency period.

Figure 4 – *Skill percentage composition increase by occupation – 2019Q3 and 2022Q3. Source: CEDEFOP.*

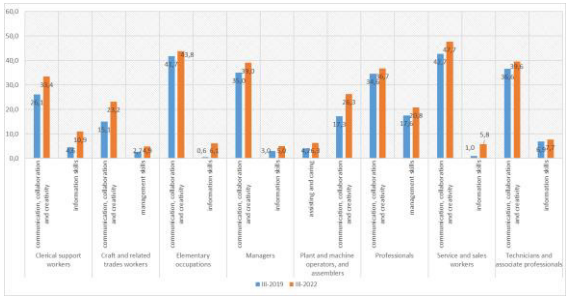
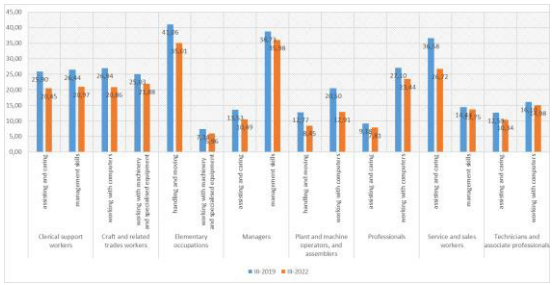


Figure 5 – *Skill percentage composition decrease by occupation – 2019Q3 and 2022Q3. Source: CEDEFOP.*



[1] In the construction sector, in the second quarter 2020, a strong peak is observed, which could be due to changes in the recruitment channels used by enterprises in this sector.

5.4. Skill and occupation

The analysis took also into account changes in the percentage composition by skill of each of the major occupational groups, which occurred between the third quarter 2019 (prior to the health emergency period) and the correspondent quarter in 2022. For the construction of the next figures, we select two skills in each occupation with the higher increase (Figure 4) and with the higher decrease (Figure 5) in percentage point.

As Figure 4 shows, the skill "communication, collaboration and creativity" was the skill with the largest increase across all occupational groups, except for the Elementary occupation and Professional occupation groups. For these two groups, the greatest increase was for the information skill and management skill. These last two skills represent the second largest increase in the percentage composition of all other occupational groups. The widespread increase in the weight of the skill "communication, collaboration and creativity" should be also due to the impact of the pandemic period. As described in Table 2, it implies an increase in the search for candidates with ability in communicating, collaborating, relating and negotiating with other people, developing solutions to problems, creating plans or specifications for the design of objects and systems, etc.

The demand for skills that showed a decrease between the two periods across occupations (Figure 5), were "assisting and caring" and "working with computers". This evidence is in line with the effects of the health emergency phase, which led to an increased demand for these skills and a subsequent return to normal levels in the years after the health emergency.

6. Conclusions

In this paper, we have highlighted the potentialities of OJA data by analysing a core variable in the analysis of the labour demand: changes in the skill demand by enterprises. OJAs is a new data source that does not replace traditional surveys but can be used to enlarge the availability of information in the labour market. OJA data represent a source with great potentialities for the production of new indicators, enriching the official job vacancies statistics. In particular, the demand for skill indicators broken down by geographical area, occupation and economic activity, analysed in this paper, could improve the matching between the two sides of labour market – labour demand, on the one hand, and labour supply on the other – by means of a better orientation of the professional training programme. Furthermore, new granular and detailed information on changes in labour demand could address the funds provided by the National Recovery and Resilience Plan (NRRP) for requalification and professional training in a more efficient way. The results presented showed a consistency of the OJA indicators with the economic framework during the health emergency phase. For example, the upward trend in the demand for "construction skills" during 2021 due to the bonus effect in the construction sector; the

peak both in industry and construction sectors in the second quarter of 2020 in the demand for "management skills", in line with the needs that emerged during the Covid crisis to reorganise activities and labour resources and to develop new strategies; finally, the widespread increase in the weight of the "communication, collaboration and creativity" skill among the main occupational groups in the whole period. This evidence highlights the usefulness of these indicators in describing the dynamics of labour demand, given their timeliness and granularity. Although the potential of the OJA data source is evident, many methodological challenges need to be addressed to ensure good quality statistics based on it. The WIN project is moving in this direction by working on various aspects that can help improving the quality of OJA data, such as: selection of reliable websites and improvement of their stability over time; data cleaning; definition and application of validation rules; and improvement of classified variable accuracy. The quality of OJA data is an essential prerequisite for the production of reliable statistics and for analyses as accurate as possible. Moreover, when using OJA data for statistical purposes some specific critical aspects must be taken into account, because OJA data are a non-probability sample and suffer from coverage issues.

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EXPERIMENTAL STATISTICS: A NEW COMMON LANGUAGE FOR UNCOMMON DATA

Arianna Carciotto

Abstract. In recent years, the data deluge from unofficial sources has forced national statistical institutes in developed countries to think differently. Direct surveys are no longer able to satisfy the growing demand for data for very small territorial areas with rapid publication frequency. The use of administrative sources and social networks is producing new studies and analyses towards a new paradigm of official statistics. International research groups are already working hard to provide high quality data which, however, are not yet "mature" to become official statistics. The Italian case and other international cases represent a complete state of the art of experimental statistics.

1. Introduction

Official statistics is experimenting a deep change, a real revolution, which will entail modifications with regard to many aspects. The national statistical institutes (NSIs) of developed countries are no longer able to face a more and more increasing demand for timeliness data and information on very specific domains of analysis, for instance small territorial areas. Since traditional direct survey is often not sufficient to meet such demand for detailed information, in the last decades, many NSIs have been integrating data from direct surveys with information from administrative sources. This is often done by implementing “statistical registers”, that are microdata files whose records can be thought of as, at least approximately, representative of the population units. Although use of administrative sources may result in sensible improvement of the estimates because of the high target population coverage, it is often not able to meet the new information needs.

On the other hand, the advent and the massive use of social networks allow citizens to have huge amount of information usually not covered by administrative sources. Retrieving information from the new data sources is appealing but implies important issues to deal with: 1) people not used to comprehend statistical data may incur wrong interpretations; 2) data are not guaranteed to be representative of the phenomenon of interest and the ensuing analysis may be strongly biased.

These issues are often not sufficiently investigated by literature on big data and innovative data sources that mainly focuses on IT aspects (Daas et al., 2015). On the other hand, it is well known that, from the official statistics perspective, these aspects must be adequately considered and dealt with (Cheung, 2012; Daas et al., 2012a; Glasson et al., 2013; Groves, 2011).

In the recent years, NSIs are taking up these challenges, putting efforts to find up-to-date solutions. In this context, *experimental statistics* (ES) have been receiving increasing attention. They are based on using "non-conventional" data to meet new information needs in a timely way. Using non-traditional information sources and innovative tools implies the need to find a new "common language" and shared validation procedures to guarantee comparability among different institutions, in particular NSIs.

The word "experimental" refers not only to new analyses but also to new methodologies, data sources and tools that still need to be verified in terms of compliance with standard quality requirements and harmonisation rules. Despite of the experimental nature, their potential is very high. In fact, they fill in the information gaps in a timely way, serve as a driving force for developing new analyses and indicators, and ensure a valuable information support to policy makers (Carciotto, Signore, 2021).

Users play an essential role for ES evolution. In fact, their feedback allows to properly assess the product relevance and functionality. In fact, because of their experimental nature, not all the ES will shift towards official statistics. It is necessary to consider that an experimental statistic could not meet the requirement needed to become official in a structural way or in the long period. In this case, it should remain experimental, to go on with its "maturation" process through testing. Indeed, thanks to possible new data and further technological development in the future, this statistic may become an essential resource to define and model the multidimensional phenomena.

Essentially, the theme under investigation in this paper can be set as follows. ES are statistics that are in the testing phase and not yet fully developed. The experimental label is typically used where: i) the statistics remain subject to testing of quality, volatility and ability to meet user's needs; ii) new methods are being tested and are still subject to modification or further evaluation; iii) there is partial coverage (for example, of subgroups, regions or industries) at that stage of development; iv) there may be potential modification following user's feedback about their usefulness and credibility. ES are published to involve potential users and stakeholders at an early stage in assessing their quality and suitability. Users should be aware that such statistics potentially have a high degree of uncertainty. For this reason, when released, the limitations of experimental products have to be clearly explained in the methodological note. Moreover, when ES are alternative versions of existing official

statistics, users can become familiar with them and understand the potential benefits of new methods and approaches.

This paper is structured as follows: Section 2 illustrates the ES state of the art in the international context, Section 3 focuses on some experiences at Istat, the Italian NSI; Section 4 provides some general conclusions.

2. International context

In recent years, Eurostat is increasingly interested in developing ES as well as in fostering their production within the NSIs. In fact, on Eurostat website two specific sections are devoted to ES: one for those regularly produced by Eurostat itself, the other one for the ESS (European Statistical System) – Experimental Statistics Hub where links to the NSIs that produce ES can be found.

On its website, Eurostat defines ES as those that "*use new data sources and methods to better respond to our users' needs in a timely manner*". To confirm its interest in this area, in 2018 Eurostat organised an EMOS – European Master in Official Statistics named "Experimental statistics: new methods for new data" aimed, among others, at understanding benefits and risks related to the production of ES. More recently, Eurostat has launched some *grants* to finance ES development within the "Single Market Programme". The focus has been put on some specific sectors, such as the foreign trade and the use of AI (artificial intelligence) and ML (machine learning) tools for official statistics. The scope is to develop new statistics and indicators, or new methods and tools, to improve the analysis of the phenomenon under investigation.

From the ESS NSIs' point of view, there is no univocal definition for ES and no shared rules for producing and managing them. Moreover, not all the NSIs produce ES, as this is not mandatory. In some cases, ES are defined in terms of differences with official statistics. Specifically, while the latter is mainly based on "direct" measures (data from surveys, in some cases administrative data), ES are produced through "indirect" measures and carried out with innovative methods (multi-source statistical models, data integration tools, big data analysis, etc). An important aspect of official statistics is related to the "closeness" between what has to be measured and what is actually (directly) measured. This is particularly true when the information is extracted from accurately designed (possibly sample) surveys. On the other hand, data based on traditional statistical surveys as well as on administrative sources often do not ensure adequate timeliness and, in addiction, survey data can be affected by sampling and measurement errors.

Differently from official statistics, ES typically do not fit *a priori* statistical concepts and definitions "by design". Instead, they require more complex

elaboration and interpretation processes in order to be shifted to the current official statistics. Moreover, quality requirements have to be carefully checked before using outputs from ES. On the other hand, new concepts and information needs can emerge from ES production process, so the ES may drive official statistics toward a wider informative horizon.

Below approaches and experiences on ES production in some international institutions are reported.

2.1. Austria

Statistics Austria regularly manages experimental projects that offer new possibilities to produce statistics on many topics, using innovative methods and alternative data sources. Given the ongoing digitalisation, ES allow to enlarge the field of analysis. Users' feedback and interactions with Academia are deemed very useful.

Since ES results may be different from official ones in terms of "maturity" and quality, they are identified with an ad hoc logo to specify their provisional nature and possible interpretation difficulties. Innovation, that is the development of new statistical methods and the use of new data sources, is considered essential for an efficient and high quality data production process.

After testing and ensuring quality in a proper way, the main objective is to use ES within official statistics in order to improve data quality, reduce data collection costs and burden on respondents. On the website, ES are available only when they have reached the official statistics status.

2.2. Germany

According to DESTATIS (the German NSI) definition, ES are those based on innovative methods and new data sources. The degree of "maturity" and results quality are different from official statistics, mainly with regard to harmonisation, coverage and methodology.

In any case, great attention is paid to ES potential in providing new and interesting methods of analysis. One of the NISs' main objectives is to promote development and innovation: not only in terms of techniques and methodologies, but also in terms of analysis integration, using new data sources and methods. For transparency purposes, the results of innovative projects, which are still in an experimental stage, are published in the experimental section of the website.

Users are invited to leave feedback on methods and procedures since not all the experimental studies may be useful. Some ES will remain experiments while others will be included in official statistics production.

On the website, a useful section is dedicated to "workshop reports". These are reports on projects that have tested new methods for data collection or analysis aimed at improving official statistics in terms of quality or timeliness. In the same section, the evaluation and feasibility studies, carried out for some specific ES, are published.

2.3. Lithuania

Unlike official statistics, ES do not have a release calendar but are produced taking into account needs and real possibilities. Moreover, ES are not included in the official statistical program, they are not comparable among countries and methodologies are not consolidated but still under test. While official statistics is based on surveys and administrative sources, ES use also mathematical forecasting methods and alternative data sources.

On the website, Statistics Lithuania specifies the reasons for developing ES. The main intention is to meet the increasing users' needs. In fact, in some cases, the specific experimental statistic can be more accurate than the corresponding official one. In other cases, ES can meet information need that is not available in official sources (as a remarkable example, the estimation of the non-observed economy is mentioned). In any case, the main strength is the timeliness of release.

2.4. Poland

The stakeholders' increasing information needs have pushed to strengthen the information production process, including the development of ES. They have the scope of innovating methodological studies and filling in specific information gaps. The statistics published include results from innovative research that makes use of experimental methods and new methodological approach, still under development. The experimental results are not considered official statistics yet. The research work on ES is carried out within Statistics Poland objectives and statute as well as within projects financed by external funds.

2.5. Spain

ES are mainly aimed at meeting users' needs through innovation within statistical production. On the INE (the Spanish NSI) website, the projects under development are published: they are innovative in relation to data sources, methods, analysis' scope or modalities of data dissemination.

These are considered experimental since they have not reached the requested "maturity" yet, in terms of reliability, stability and data quality, to be included in official statistics. *"However, the available results are offered to users for their use and evaluation due to the relevance that these may have and as a means to improve the products themselves by seeking the views of the information's final recipients."*

Besides some ES, some official statistics defined as former experimental are available on the website.

2.6. The Netherlands

ES are included in the website section devoted to innovation. They are defined as *beta* products under development. Statistics Netherlands works regularly to update its statistical products and processes and carries out research on new data sources and methods, like those related to artificial intelligence. The main scope is to create new statistics or improve the existing ones as well as to develop new techniques aimed at integrating NSI's and other institutions' (Academia, private companies and public institutions) data.

On the website, some indications are given about the method to develop ES. Innovations are released together with a *proof of concept* to explain the potential of the new method or data source. The successful proofs of concept can be further developed to build up new ES that will be named beta products.

During the development of *beta* products, the data source stability is evaluated, methods are validated and the operational requirements are analysed. An innovation is considered as completed *"once the experimental statistic has been successfully converted into a full-fledged, one-time publication or an official statistic*". Of course, not all the experiments become final products.

2.7. Switzerland

ES are produced using new methods and/or new data sources. They are consistent with the Federal Statistical Office innovation strategy. Through their publication, it is possible to involve users at a very early stage in order to develop and strengthen the output.

Experimental projects are aimed at meeting users' needs in terms of efficiency, quality and timeliness.

ES have a high potential for further development, mainly with respect to methodology that remains under evaluation. For this reason, they are clearly identified with a logo to be easily identified.

The experimental projects can be: i) under development; ii) shifted to standard production; iii) stopped for specific reasons and possibly reactivated; iv) concluded without being shifted to standard production.

2.8. United Kingdom

ES are official statistics that are still in a testing phase and are not fully developed yet. Users have to be aware that ES potentially have a high degree of uncertainty. Their limits are clearly explained when released.

The experimental label is used when: i) the statistic remains subject to test of quality, stability and ability to meet users' need; ii) new methods still subject to change or further evaluations are being tested; iii) there is partial coverage; iv) there could be potential changes after users' feedback about their usefulness and credibility.

The main reasons why the Office for National Statistics releases ES are: 1) involving the potential users and stakeholders in a preliminary step to evaluate their quality and suitability; 2) when they are alternative versions with respect to existing official statistics, they can help users become familiar and understand the impact of new methods; 3) they can provide useful information to users only if they are well explained and understood.

When the evaluation process is completed, the experimental label is removed and the statistic is published as official statistics. This occurs when statistical methods are deemed robust, there is a good coverage, users' feedback shows that these products are useful and reliable as well as when the development stage has ended.

2.9. United States

ES are innovative statistical products based on new data sources or new methodologies that users can utilise when other relevant products are not available. For this reason, the US Census Bureau asks for feedback from users and stakeholders on quality and relevance of these new products.

The development of experimental data is an important step towards the creation of new and regularly released statistical products. When resources are available, the experimental data that have the required quality standards and meet users' demand can be regularly produced and included as permanent products in the same web section dedicated to ES.

Experimental data cannot ensure quality standards defined for official statistics. For this reason, they are clearly identified (ad hoc logo and dedicated web section) and released supported by methodology and research documents.

2.10. European Central Bank

The majority of ECB and ESCB (European System of Central Banks) statistical information has high quality levels in terms of harmonisation, coverage and methodological soundness.

At the same time, there are some cases where it is necessary to find a compromise with regard to one or more quality dimensions. For this reason and to increase the transparency of data releases, the ECB has developed ES.

According to the ECB website, experimental data are data collected and produced by ECB whose quality is somehow lower with regard to the other statistics produced.

However, they are considered sufficiently reliable to be useful for ESCB objectives and can therefore be interesting for external users too. ES include, for example, those statistics that are not fully developed in terms of coverage or harmonisation in the Euro zone. While they are of immediate value for analysts, they are still in a test phase and are subject to improvement. There may be cases where some data keep their experimental status since the data source needed to improve their quality is not available or requires very high costs.

2.11. OECD

On the OECD website there is not a specific area for ES. They are published together with official statistics, even if they have a clear experimental feature. Just to cite some examples of ES published: "Household distributional results in line with national accounts, experimental statistics", "Experimental Statistics: Distributional information on household income, consumption and saving", "Experimental Statistics: Supplementary socio-demographic information.

Comparing ES management across the different institutions analysed shows that there is no rigorous common definition of ES. However, most Institutions agree on some key elements to qualify statistics as *experimental*: innovation, new data sources, new methods, new tools, new analyses, processes/outputs not full "mature". Some institutions (e.g., Eurostat, NSI Italy, NSI Spain, US Bureau of Census) have adopted specific dissemination strategies (such as, ad hoc logo and graphical standards) to clearly distinguish ES from Official Statistics. Finally, almost all statistical institutions consider users' feedback as essential to promote ad further improve ES.

3. The Italian case

Istat has been producing ES since 2018. As for many other NSIs, ES are strongly related to product and process innovation, with particular regard to the use of new data sources, methods and tools to better and rapidly meet the increasing users' need. These statistics are defined experimental because they still need to be tested in terms of compliance with quality requirements and harmonisation rules, as well as they still require to be fully transformed into technological and organisational solutions.

Some ES are based on the use of new data sources held by private subjects. Istat can have access to privately held data only through specific bilateral agreements with private companies, within collaboration and research protocols. These partnerships can be useful not only to produce ES but also to enable the mutual exchange of knowledge at expert level. Collaboration with private companies may result in the incorporation of new sources into the regular production process, when feasible. A

sensible example is the use of scanner data for the production of statistics on consumer prices.

It is important that privately held data can be accessed for statistical purposes in a sustainable way. The Italian statistical law does not include specific provisions on access to privately held data, since it was enacted in 1989, at a time which predates the demand for access to this kind of data (Markelevičius et al., 2023). On the other hand, the increasing attention paid in the last years to privacy issues and the recent legislation on data protection pose big challenges to the use of private data for statistical purposes.

In many cases, outcomes from ES available to users are also included in official documents and institutional reports, underlying that their nature is experimental. Among others, important examples are the "Use of the Open Street Map to calculate indicators for road accidents on the Italian roads" in the 2023 SDGs Report (Istat, 2023) and the analysis of the impact of the Ukrainian invasion on the "Social Mood on Economy Index" in the 2022 Annual Report (Istat, 2022). The latter index is regularly updated and has had many applications in different scientific contexts (Carnazza, 2023; Catanese et al., 2022; Righi et al., 2022).

A special mention deserves the experimental statistic "Municipality indicators", published for the first time in 2018. It has become increasingly important to measure wellbeing at a municipality level not only in academic research but also for economic programming by central Government and local authorities. Municipality indicators framework is a multi-source system where experimental data sources are enhanced by other more consolidated informative sources. The municipality indicators capture the territorial structural features from demographic, social, environmental and economic points of view. Moreover, they provide measures that reflect the level of wellbeing reached by local communities. This experimental statistic has been a precious data source to measure many multidimensional phenomena at the Municipality level. This possibility is more important considering the deep change the official statistics is living, in particular in the area of population census. Measuring wellbeing at a Municipality level has produced many scientific papers. These ones have influenced policy makers with regard to the description of the territorial socio-economic context for a more aware socio-economic planning (see also: Fioroni e Quondamstefano, 2021; Arlotti e Bernardi, 2022; Perchiunno et al., 2023; Montorsi e Gigliarano, 2021; Ciacci et al., 2021; Bonardo e Quondamstefano, 2020; Scaccabarozzi et al., 2022; Pratesi et al., 2021; Mazziotta, 2019).

The municipality indicators system has been promoted within the partnership among Istat, the National Association of Italian Municipalities (ANCI) and the Union of the Italian Provinces (UPI).

A valuable contribution to the development of ES is the use of open data made available by other institutions of the Italian National Statistical System (Sistan). For

instance, the municipality indicators incorporate information provided by the Ministry of the Interior, the Ministry of Economy and Finance, the Ministry of Enterprises and Made in Italy, and the Higher Institute for the environmental protection and research (ISPRA).

Another remarkable example is the experimental project "Use of the Open Street Map to calculate indicators for road accidents on the Italian roads". The project is aimed at building a set of innovative indicators measuring different aspects of the vehicle traffic on the Italian road network, with special focus on the road safety. Integration of different data sources such as Istat surveys, Geographic Information System (GIS), Open Street Map (OSM), provides a multidimensional framework to perform analyses of accidents with regard to roads, vehicle and persons involved. The outcome of the project can help decision makers to introduce policies to improve road safety and reduce social costs.

Finally, it is worth mentioning the experimental project "Municipal demographic projections - January 1st, 2022-2042". Demographic projections aim at studying the probable future of a population in terms of total size and structural components. This product can be used by policy makers to analyse population aging trends and to develop forecasting models. Data are available at different levels of aggregation and can be downloaded directly from the information system available on the Istat website. This project can provide useful input for policies on health services, social security, environment, education and transport.

4. Conclusions

Experimental statistics is statistics which is not, or not yet, official. This means that the ES production process has not (yet) been "certified" by the institution(s) responsible for the validation process (typically NSIs). The experimental nature of the statistics may refer to any step of the statistical production process. In fact, innovative approach and methods can be introduced in different phases such as sampling design, data collection, treatment of non-sampling errors, data modelling, data dissemination, etc. In order for an experimental statistical product be validated and promoted to the "official status", some quality requirements have to be verified. The validation process involves different quality dimensions such as *relevance*, *timeliness*, *comparability*, *accuracy*. If the quality level is judged as too low with respect to some of these elements, the ES can still be made available to the users but with suitable warnings that make them aware of the experimental nature of the statistical product.

It is quite hard to define in general and in quantitative manner the requirements that allow experimental statistics to be shifted into official statistics. Setting

requirements depends on the specific information need and has to take into account the different options which are available. This often involves evaluating the trade-off between different quality dimensions. For instance, gathering data from the web, may imply sensible advantage with respect to an ad hoc well designed survey in terms of costs and timeliness. On the other hand, data from the Internet may not be guaranteed to be representative of the population under investigation, so that outcome from analyses based on these data may be affected by strong bias.

In any case, the huge availability of data from "non traditional" sources makes it possible to investigate new phenomena or to sensibly improve statistical analyses of already studied fields.

At an international level, ES have become a not replaceable scientific tool to face, as rigorously as possible, the data deluge (including junk data) citizens have to undergo daily. Therefore, testing and experimenting a number of data sources that, if properly processed, may be integrated within official statistics seems to be essential. This process is the same in many NSIs and international organisations that, thanks to inter-institutional research groups, are able to exchange experiences and good practices. This process is aimed at sharing methodologies and unconventional data processing analysis. In this context, it is also necessary not only to find common criteria to standardise the shifting process from experimental to official statistics but also to promote comparability among NSIs that produce ES on similar topics. On the other hand, NSIs are called to face the challenges related to the trade-off between i) the reduction of data collection costs and burden on respondents and ii) the huge investments in terms of human resources and IT tools that the increasing production of experimental data will inevitably imply.

In the near future, valuable updating and progress at a national and international level will be increasingly frequent in this field. Istat has already developed many different experimental projects that have been deemed remarkable by Academia, institutions and, mainly, local authorities. As a result of the availability of open data and methodologies that are more and more manageable by everyone (thanks to generalised software), ES will be hopefully able to be integrated within official statistics, providing a tool to analyse complex realities.

To this aim, NSIs will have to develop shared rules and procedures to transform ES into official statistics, putting efforts to reach comparability and suitable quality standards. In some cases, ES will be able to replace the traditional production process based on direct surveys or administrative sources. An example can be the use of data from satellites to improve agricultural statistics. Another important application could be the use of fiscal data from electronic invoices to timely produce statistics on economic transactions.

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