

BASS MODEL-BASED APPROACH TO MIGRATION

Francesca Bitonti



1. Introduction

International migration has a long history and, in the recent past, has further enhanced under the influence of globalization. Unsurprisingly, the topic has become the focus of a great deal of disciplinary and inter-disciplinary social sciences with the aim of interpreting and synthesizing population movements. Sociological, economic, geographical, and multidisciplinary approaches have been employed to explain migration (Bijak, 2006). Following the literature review proposed by Bijak (2006), it is possible to draw a general overview of the main contributions to migration theory from different areas of knowledge.

Sociological theories of migration mainly focus on the push-and-pull factors approach of Lee (1966), according to which attracting or repelling causes, as better living and working conditions on the one hand, and humanitarian crises, conflicts, unemployment, and poverty on the other, modulate migration flows between origin and destination countries. Macroeconomic theories generally explain migration through the lens of labour market differences between countries in terms of nominal or real wage differentials (Lewis, 1954), expected income (Harris and Todaro, 1970), and labour demand characteristics at the destination (Piore, 1979). At the microeconomic level, migration decisions are explained as a result of rational cost-benefit analysis (Stark, 2003; Massey *et al.*, 1993; Sjaastad, 1962). Human geography, instead, describes migration choices in relation to the geographic distance between origin and destination, allowing spatial interactions between regions (Stewart, 1941; Zipf, 1946; Isard, 1960; Clark, 1982). The gravity theory of migration, in analogy to Newton's law, especially concerns the notion of mass – defined as population sizes, employment, and income – and distance, measured according to different metrics. Apart from the discipline-specific theories of migration, there have also been several attempts to propose a unified explanation for population flows, combining economic, political, sociological, and psychological determinants of migration. Nonetheless, these approaches are far from constituting an all-inclusive theory of migration and seem hardly possible to be operationalized in practical applications (Bijak, 2006).

With the exception of some sociological concepts, the majority of migration theories focus on structural explanations of migrant behaviour, disregarding the social forces influencing individual conduct and changes in behaviour. Indeed, in their seminal work, MacDonald and MacDonald (1964) described how the organization of migration flows may occur in several ways, spanning from chain migration to its complete opposite, which they termed “impersonally organized migration”. The former results from the establishment of social ties between actual and potential migrants, while the latter accounts for movements originating from political and economic instabilities or from individual motivations. In my thought, these two extremes of migration arrangements theoretically concern diffusionism, when referring to chain migration, and structuralism, in relation to the impersonal organization of movements. For this reason, the work proposes a multi-perspective approach, combining diffusionist and structural theories, which provides explanations for a novel Italian emigration process started in the early 2000s. The diffusionist theory is briefly described in the next section 2, while the recent Italian emigration process is presented in section 3. The unifying theoretical framework proposed here will be applied to real-world data via the formulation of a specific methodology introduced in section 4. In particular, an ad-hoc extension of the benchmark model of diffusion studies, i.e. the Bass diffusion model, will provide a practically viable technique to apply the multidisciplinary framework of migration to analyze an actual phenomenon. The results of the application are reported in section 5, while the general conclusions of the work are drawn in section 6.

2. Combining structural and diffusionist approaches to migration

The diffusionist framework is used in the social sciences to explain the spread of new ideas and practices, also called “innovations”, among the members of a given population (Rogers, 1962; Strang and Meyer, 1993). The ground idea of diffusionism is that the interplay of social influence mechanisms, such as interpersonal information exchange, social norms, and emulative processes, shapes individual conduct and, eventually, the macro-level dynamics. From a demographic standpoint, innovation could be any innovative idea or behaviour having implications on the population dynamics, namely fertility, mortality, and migrations (Vitali and Billari, 2017). In this sense, examples are contraceptive adoption, solo living, smoking behaviour, novel migration practices, and the like. Diffusionism gained momentum in demography with the necessity to explain the decline in marital fertility that occurred across Europe during the past century. This approach challenged the classical demographic transition theory, which argued that modernization and structural changes in society were the main drivers for

variations in fertility (Casterline, 2001). After this introduction to the demographic debate, the diffusionist vision has been the theoretical background for several studies on fertility choices and family planning and the promotion of public health campaigns aimed at contrasting the spread of diseases and health-damaging behaviours (Alvergne *et al.*, 2011; Bengtsson and Dribe, 2014; Lesthaeghe, 2010; Ramseyer Winter, 2013; Svenkerud *et al.*, 1998; Vitali *et al.*, 2015). Recently, structural and diffusionist arguments have not been considered as distinct nor in opposition anymore. Rather, they are conceptualized as strictly embedded explanations of demographic changes (Cleland, 2001). This strand of thought gives additional strength to my research objective of analyzing and conveying meaningful insights into international migration processes integrating diffusionism with structural explanations.

3. The new Italian emigration

In recent years, Italian emigration has considerably grown compared to the 80s and 90s. The current emigration presents specific peculiarities, configuring a situation different from the past, which in literature is known as “the new Italian emigration”. Among the novelties, an increased share of women and well-educated individuals leaving the country has been recorded (Colucci, 2018; Fondazione Migrantes, 2020; Strozza and Tucci, 2018). Furthermore, although the Southern regions continue, as in the past, to contribute to the outgoing movements, recently, the more advanced northern Italy has become the main outflow area (Bonifazi, 2018; Strozza and Tucci, 2018). The destinations preferred by Italian migrants mainly converge to some E.U. countries (Bonifazi, 2018). Finally, the new Italian emigration appears to be paired with a change in attitude towards international migration. The globalization and the availability of new communication technologies could have overcome several of the barriers hindering movements in the past, allowing Italians, especially the youngsters, to approach international mobility in a novel and more confident way (Tirabassi, 2018).

Overall, the interaction among the global economic downturn, the E.U. integration process (De Rose and Strozza, 2015; Livi Bacci, 2014; Pugliese, 2018), and the change in attitudes toward outward mobility appears to have shaped a new migration behaviour that has diffused across Italy. The novel aspects characterizing Italian emigration define an innovative migrant behaviour that diffuses among the population through particular communication channels and according to established social dynamics, but also in accordance with the economic cycle of origin and destination countries.

4. Methods and data

Even though the diffusionist framework has found applications in several population studies, it is hard to find implementations of a specific diffusionist model to describe demographic dynamics. Here, I propose to exploit the Bass model (Bass, 1969), extensively employed in market research studies to analyze the diffusion of new ideas, products, and behaviours in a given population. According to the model, the pace of diffusion is driven by two forms of communication: the *external* one, such as mass media advertisement or awareness and prevention health campaigns, and the *internal* one, including social influence, word of mouth, and imitation. These two drivers of diffusion shape two categories of adopters: the innovators, mainly influenced by the external source, and the imitators, who adopt in response to their interaction with prior adopters. The Bass model consists of a first-order differential equation:

$$Y'(t) = \left(p + \frac{q}{m} Y(t) \right) (m - Y(t)) = p(m - Y(t)) + q \frac{Y(t)}{m} (m - Y(t)) \quad (1)$$

where the variation of adoption $Y'(t)$ over time is proportional to the residual susceptible population $(m - Y(t))$, with m being the constant overall susceptible population, and $Y(t)$ the cumulative adoptions at time t . Rearranging the left-hand side equation (1) it is possible to notice that the instantaneous adoptions $Y'(t)$ is the result of the sum between the *external* component governed by parameter p and the *internal* one modulated by q . Parameter p is the so-called coefficient of innovation, representing the effect of the external influence. Parameter q is the coefficient of imitation and reflects the inter-personal influence individuals can exert on each other. The external component is mainly active during the first phase of the diffusion process: the individuals adopting earlier (“innovators”) create the initial group of adopters who, with the passing of time, inform or show the benefits gained from the adoption of the new behaviour, stimulating (through an “avalanche effect”) the adoption by the other adopter category (“imitators”), influenced by human interaction mechanisms. The basic Bass model and its extensions have found empirical applications not only in the realm of marketing studies but also in the demographic field: e.g. to analyze the diffusion of oral contraception (Sharif and Ramanathan, 1981), to clarify the dynamics in vaccination propensity and address public health policy (Kahana and Yamin, 2021; Onofrio *et al.*, 2012), and to study the diffusion of disease-related information during an epidemic outbreak (Gündüç, 2019). In the present work, I propose an extended version of the traditional Bass model to capture both structural and diffusionist explanations to the new Italian emigration:

$$\frac{dY_{it}}{dt} = p_{it}(m - Y_{it}) + \frac{q_{it}}{m} Y_{it}(m - Y_{it}) \quad (2)$$

where the coefficients p and q depend on the structural characteristics of the destination countries, the emigration flow is directed to:

$$p_{it} = \alpha_0 + \alpha_1 U_{it} + \gamma_2 D2_i + \gamma_3 D3_i + \dots + \gamma_n Dn_i + \epsilon_{it} \quad (3)$$

$$q_{it} = \beta_0 + \beta_1 U_{it} + \delta_2 D2_i + \delta_3 D3_i + \dots + \delta_n Dn_i + \epsilon_{it} \quad (4)$$

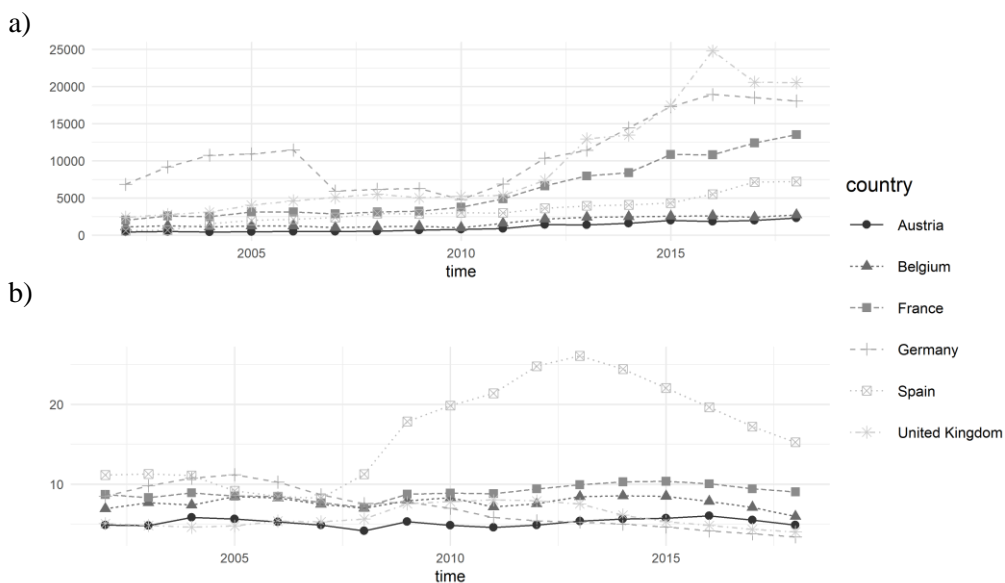
$i=1, \dots, n$ are the destination countries at each time interval t , U_{it} is the unemployment rate for destination country i at time t , $D2_i + \dots + Dn_i$ are $n-1$ dummy variables identifying the $i=2, \dots, n$ destination countries respectively, lastly, the erratic component is defined as $\epsilon_{it} \sim N(0, \sigma^2)$. The extended version of the Bass model has been fitted using an ad-hoc numerical optimization algorithm minimizing the mean squared error (MSE) in the R software, which automatically estimated all the model parameters for several destination countries at once. The main advantage of the proposed model is to parsimoniously provide the time-varying parameters p and q for each destination country considered. With the same interpretative, rather than forecasting, objective found in many applications (Bunea *et al.*, 2020; Furlan *et al.*, 2016; Guidolin and Mortarino 2010), this work intends to combine the diffusionist paradigm with the traditional structural perspective of the new Italian emigration process. Note that the proposal is that of a “toy model”, i.e., a simplistic model used to provide insights into whether some mechanism might explain complex real-world phenomena. Typical examples of toy models are the Lotka–Volterra model in population ecology and the Schelling model of segregation in the social sciences. Toy models usually do not perform well in prediction and empirical adequacy, rather, they serve other epistemic goals.

Annual counts of Italian citizens who cancelled their Italian residence due to transfer of residence abroad from 2002 to 2018 towards the main E.U. destination countries (Austria, Belgium, France, Germany, Spain, and United Kingdom – pre-Brexit) were retrieved from the Italian National Institute of Statistics (Istat) repository. Data on unemployment rates come from the World Bank online database¹. Overall, the emigration flows illustrated in Figure 1.a appear to grow with time. The 2007-2011 period characterized by the global financial crisis records a stagnation of the movements for all the countries considered. After those years, annual emigrations have recorded a steady increase through time, which is more marked for the United Kingdom, Germany, and France. Annual

¹ Istat data are available at: <http://dati.istat.it/>; World Bank data are available at: <https://data.worldbank.org/>

unemployment rates (Figure 1.b) have registered an increase between 2007-2009 for each destination as a consequence of the global economic downturn. The upward trend started to reverse some years later, with Germany and the United Kingdom being the first economies to recover.

Figure 1 – a) Annual emigration counts toward the main E.U. countries. Source: Istat repository. b) Annual unemployment rates for the main E.U. destination countries. Source: World Bank online database. Period: 2002–2018.

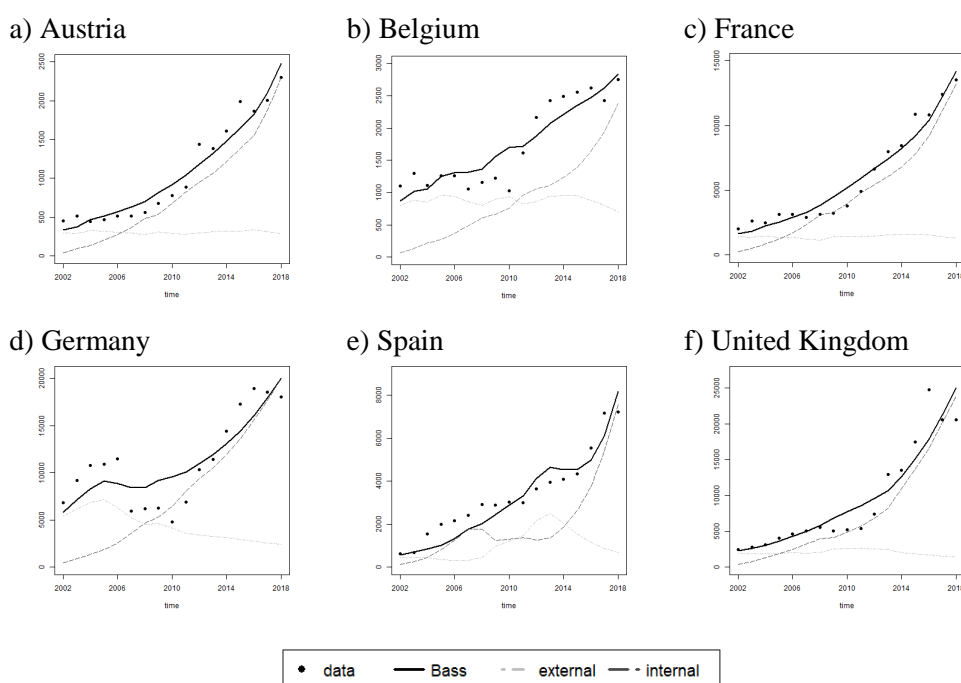


5. Results

The main objective of this work was to gain possible diffusionist insights into a modern migration process like the new Italian emigration, besides the traditional structural explanations. Figure 2 shows the fit of the extended Bass model (in black solid line) to the annual Italian emigration counts (in black dots) towards the main E.U. countries. Besides the fluctuations in the data, due to some issues intrinsic to the national data collection process and corrections during routine surveillance activities, the model seems to capture the trend of the flows quite well. For each destination, the internal driver of migration (in dark gray dashed line) seems to have outnumbered the external one (in light gray dashed line) before 2010 approximately. In particular, the inter-human influence has grown exponentially

while the mediatic component has remained constant or at least decreasing. The increasing weight of the internal driver of migration suggests that word of mouth and imitative behaviours of those who have already emigrated could have guided potential migrants in their choice to emigrate abroad. On the other side, the little variations in the external component seem to confirm that the diffusion process has overcome its “initial phase” where adoptions are mainly led by mediatic sources of information.

Figure 2 – *Extended Bass model fitting the new Italian emigration towards the main E.U. countries. Time: 2002-2018. Annual counts, different y-axis scales. Source: author’s elaboration.*



The fit of the model with the inclusion of an economic covariate connects the structural conditions with the temporal dynamics of coefficients p and q . The unemployment rates have indeed contributed configuring a specific pattern of diffusion for each destination country, letting p and q vary with time. The inclusion of a structural variable within a diffusionist model allowed us to relate the sociological motives to emigrate with the actual economic conditions of each country. Indeed, whether the diffusion of new attitudes towards international emigration and the emulative behaviours to emigrate pertain to Italy as a whole,

information about economic and living conditions differ according to the specific destination. In this sense, the extended Bass model provides country-specific diffusion processes, both in terms of mediatic information spread (modulated by p) and contagious mechanisms leading to emigrate (mediated by q).

Finally, the adjusted version of the R-squared for the complete model ($adj-R^2 = 0.912$) results to be greater than the one for the model estimated without the inclusion of the structural covariate ($adj-R^2 = 0.900$). This outcome provides further support to the proposal of theoretical integration between different types of migration determinants.

6. Conclusions

The diffusionist framework, originally rooted in social sciences, has been applied to gain novel insights into innovative ideas and practices leading to demographic changes. However, studies of migration have not usually taken a diffusionist perspective, even when considering sociological aspects of movements. The main discipline-specific theories of migration have generally focused on the structural (e.g. political and economic) explanations of migration, disregarding diffusionist drivers, such as mediatic and inter-human information diffusion and imitative behaviours. Here, I attempted to integrate both structural and diffusionist perspectives to explain human movements, employing a practically viable methodology. In this sense, I challenged the existing multidisciplinary theories to migration which have proved to be not operationalizable in practice (Bijak, 2006). In particular, I introduced an extended version of the benchmark model of diffusion studies, i.e. the Bass model, including structural variables in a pure diffusionist framework. The application focused on a novel emigration process recently occurring in Italy, the so-called new Italian emigration. This flow presents peculiar characteristics configuring a situation markedly different from the past. Its aspects of innovation let the new Italian emigration be well-suited to be analyzed through the lens of the diffusion of innovations theory. Estimating simultaneously a parsimonious model for several flows divided by destination, I disentangled the two components of the model, namely the mediatic (or *external*) and the interhuman (or *internal*) information channels modulating the diffusion of the novel migrant behaviour. The different trends in the two diffusionist mechanisms detected for each country revealed that for the destination countries considered, the increasing weight of the internal driver of migration, i.e. word of mouth and imitative behaviours of those who already have emigrated could have guided potential migrants in their choice to emigrate abroad. The general prevalence of the internal component over the external one could find an explanation in terms of the

interplay between the integration of the European Union, the availability of advanced means of communication and transportation, and the global economic crisis. These structural dynamics could have boosted the interpersonal diffusion of a novel confident behaviour toward international migration: the first fostering cross-border movements and labour mobility, the second logistically facilitating connections and shortening the psychological distance between homeland and host country, and the latter by acting as an economic push factor to emigrate. As a result, what in the past was accounted for international mobility today resembles an inter-regional one.

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SUMMARY

Classical migration studies distinguish chain migration, where social relationships and social networks channel between different places, from the impersonally organized migration. Whereas the former is mediated by interpersonal information exchange or imitative behaviours, the latter is mainly guided by economic motives or political instabilities.

Objectives: Despite the theoretical distinction between the two types of migration mechanisms, at the current stage of literature development, no practically viable methodology has been proposed to analyze population flows while disentangling the social from the impersonal drivers of migration. The aim of this paper is to fill this gap by introducing an “all-inclusive” methodology which can be operationalized in practical applications. The work refers to the diffusion of innovation theory and to the structuralism (or adaptation), both used in research on fertility, to better characterize the two sources of migration. In particular, the diffusionist paradigm captures the social influence conveyed by specific communication channels (mediatic and interpersonal), which drives the diffusion of migratory practices among individuals. On the other end, the structural vision explains the movements occurring as an adaptation to variations in economic or political cycles.

Methods: Here an extended version of the traditional Bass diffusion model is proposed. The Bass model is widely applied in market research to analyze the diffusion of new products, ideas, and behaviours. The version introduced in the present work aims to analyze population movements while distinguishing between sociological and structural motives to migrate.

Results: The fit of the model has been carried out to study the so called new Italian emigration towards the main destination countries. The preliminary results highlight the underlying dynamics governing the new Italian emigration flow and provide novel insights.