SESSIONI SPECIALI

A MODEL OF THE ROLE OF EDUCATION IN 2015 UN INTERNATIONAL MIGRATION DATA

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Sommario

Le migrazioni a scala globale sono chiaramentelegatea una molteplicità di cause che, oltre ai fattori economici, comprendono i conflitti, i disastri naturali, le condizioni politiche locali. Tuttavia è possibile cercare di evidenziare quali sono le principali variabili che sono alla base dei movimenti migratori tra macro aree del pianeta. Questo studio analizza i dati del rapporto ONU 2015 e li interpreta attraverso un modello gravitazionale, le cui variabili indipendenti sono indicatori della situazione socio-economica di una popolazione. Eliminando progressivamente i contributi meno significativi, si evidenzia che il livello d'istruzione dei migranti è uno dei fattori più importanti.

Abstract

Migration on a global scale is clearly linked to a multiplicity of causes that, in addition to economic factors, include conflicts, natural disasters and local political conditions. However, it is possible to pinpoint what are the main variables that underlie migratory movements between macro areas of the planet. This study analyzes the 2015 UN report data and interprets them through a gravitational model, whose independent variables are indicators of the socio-economic situation of a population. Progressively eliminating the less significant contributions, the level of education of migrants emerges as one of the most important factors.

Keywords

Gravitational model, multiple regression, UN statistical subdivision, migrants' expected schooling

Introduction

The possibility to decide where to live is among the parameters that underlie human freedom (UNPD 2009).Modern transport has made the movement of people easier, cheaper and faster. At the same time, conflicts, poverty, inequality and environmental changesare pushing people to abandon their homes in search of better opportunities for themselves and their families (United Nations 2016).

International migrations is connected to demographic aspects, economics, cultures and policies around the world (Kim and Cohen 2010) and, in many areas, remains one of the few options for people, especially young, to seek a decent life (United Nations 2015). On the other hand, in countries that have witnessed a decline in fertility and a rapidly aging population, international migration has become an increasingly important contribution to economy and society (Kim and Cohen, 2010). In Europe, for example, the population would have declined during the last 15 years without positive migration, while in Africa, Asia, and Latin America, the negative migration rate has marginally contributed to slow down the pace of population growth (United Nations 2016). The 2030 Agenda for Sustainable Development recognizes the positive contribution of migrants for inclusive growth and sustainable development and describes how international migration is a multidimensional reality of major importance for the development of countries of origin, transit and destination (United Nations 2015).

The large number of implications that migrations generate on the planet (Kandemir 2012)make migration a truly interdisciplinary field of research involving demography and economy, as well as geography, ethnology, policyand psychology. Migration,however, has to date less developed mathematical tools that explain it, with respect other factors such as fertility, or mortality (Aleshkovski and Ionstev 2006).

The United Nations (UN) define human migration as the movement of people from one place in the world to another in order to obtain permanent or semi-permanent residence. These movements can occur across borders or within them; they can be voluntary (for work, study or family reasons) or forced (resulting from conflicts or natural disasters); regular (with documentation) or irregular (without documentation); temporary, seasonal or long-term (UNDP 2010).

The number of international migrants in the world, i.e. the number of those who no longer live in their country of origin, has continued to grow rapidly in recent years reaching 244 million migrants in 2015, corresponding to about 3.3% of the world's population (it was 2.8% in 2000), thus exceeding the rate of growth of the world population. (United Nations 2016). The map in Figure 1 represents the global flows at the continent level. The various areas of the world are also classified according to the level of human development index (HDI).

The map shows that most movements take place within continents. Among these, Asia and Europe are the continents with the highest numbers in terms of migrants. Among the flows between continents, those between South and North America and from Asia to Europe are the most relevant.International

migrations represent however only a minority of those who have abandoned their homes. Globally, in fact, many more people move within their national borders rather than going abroad (UNDP 2010). According to the United Nations Development Program (UNDP 2009), the number of internal migrants, i.e. those who moved within their national borders, amounted to about 740 million in 2009, about 4 times higher than that of international migrants. This means that about 1 person out of 7 in the world does not live where he/she was born.

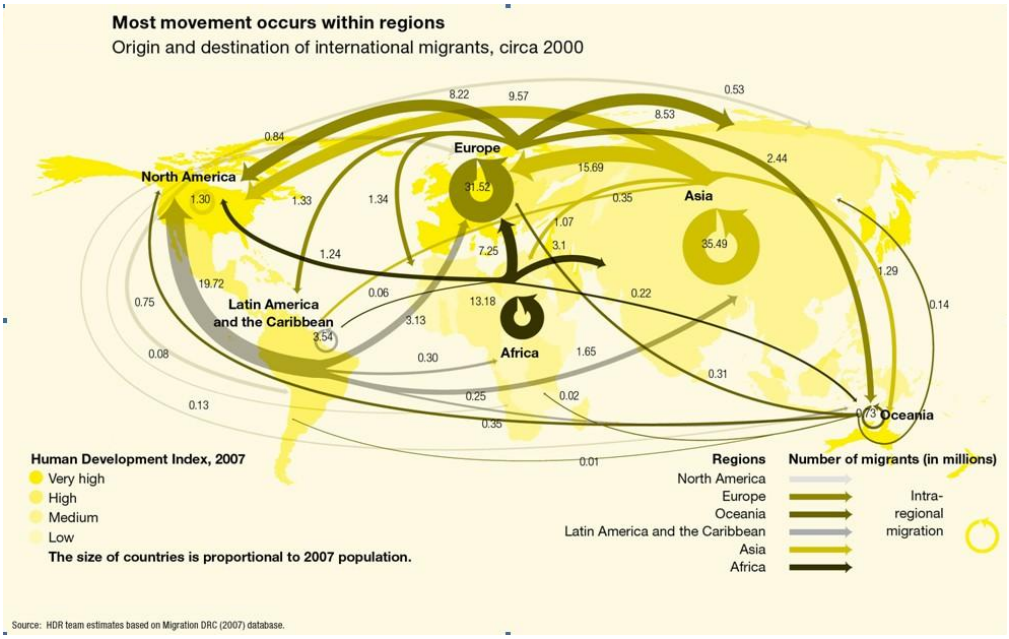

Figure 1, International migration flows (Source: UNDP 2010).

The United Nations High Commissioner for Refugees (UNHCR) indicates also an increased number of involuntary migrants that reached a record level of 65.3 millionin 2015, 5.8 million more than the previous year.These include individuals moving around the world due to persecution, conflicts, violence or human rights violations. Of these, 21.3 million are refugees, 40.8 displaced internally in their countries of origin and 3.2 asylum seekers. Furthermore, climate change and all the consequent natural disasters further increased human mobility and displacement (UNHCR 2009): The International Displacement Monitoring Center (IDMC) in 2014 estimated a number of people displaced from their homes due to disasters caused by natural hazards amounting to 19.3 million.

Migration Models

Migratory models can be defined theoretically or empirically, even ifalso empirical models require some theoretical foundations at the base. (Greenwood 2005). To date, there is no widely acceptedgeneral theory on international migration but only a large number of proposals that have been mostly developed in isolation from one another (Massey et al. 1993).

The early neoclassic theory sees the labor market as the main driver to control migration flows. Authors see this factor either translated into country level policies (Lewis 1954, Ranis and Fei 1961, Harris and Todaro 1970), or as influencing the individual choices of migrants (Sjaastad 1962, Todaro 1969, 1989, Todaro and Maruszko 1987).

Later,Taylor (1986) and Stark (1991) pointed out that families could be interested in diversifying their income risk though migration even if salaries are similar in both the origin and the destination countries. Piore (1979) underlined the role of attractive factors in the destination countries, more than the situation in the countries of origin.A recent account on migration theories and applications can be found in White (ed.) (2016).

Despite all these studies, the "Migration Laws" first developed by E. Ravenstein in 1885, examining migration data in European Countries and the US still appear to be valid in many cases (Aleshkovski and Iontsev 2006). These laws can be summarized as follows:

- Most migrants rarely travel long distances, usually moving a short distance to large cities. Long distance migrations are usually undertaken by people from large cities.
- Most migrations take place from rural areas to urban areas.
- Most migrants include young males between the ages of 20 and 45.
- Each migratory flow produces at least one in the opposite direction.
- Within countries, women migrate more than men.
- Migration increases in volume with the development of industry and transport.
- Much of migration depends on economic reasons.
- Moving towards destination centers (usually large cities) migrants leave "empty places" in their place of origin that are occupied by other migrants.
- The native inhabitants of the cities are less prone to migration than those from the rural areas of the country.

Though still seeing economic reasons behind most migration flows, the laws underline some important social and geographical aspects of the phenomenon. These points have been better outlined by Lee (1966) that sees the migration flows as dependent upon three types of causes: The push factors, the pull factors, and the intervening obstacles (see Figure 2).

According to this model, in every area there are many different factors that induce a person to stay within the area or attract other people to it, and other factors that tend to repel them. These are shown in Figure 2 as "+" and "-" signs. There are others, listed as "0",toward which people are basically indifferent. Some factors influence people in the same way, while others have different effects (for instance, climate can affect most people in the same way, why education is less relevant in families without children). Also, if one considers any two points in space, there are a number of obstacles between them. The most studied is the "distance", meaning not only the number of kilometers between the two points, but also the differences in culture, religion, and life styles. All these factors are mediated by personal perception and in fact, in many cases, the objective value of the factors is less relevant than the way they are perceived. Furthermore, the decision to migrate is not always a choice based on rationality and for some people the irrational component (imitation, friendship, hope…) is the dominant one. It is therefore expected to find numerous exceptions to any form ofgeneralized explanation of the migration phenomenon.

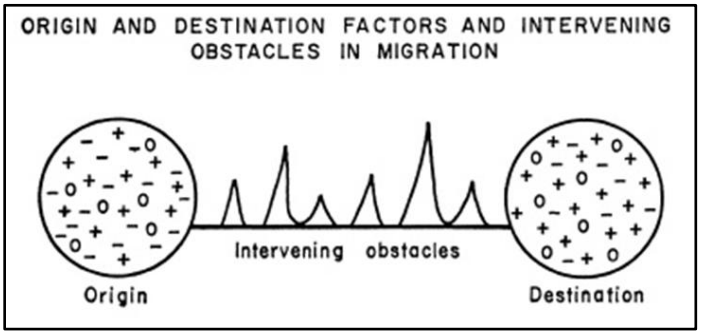

Figure 2, A scheme of push and pull factors according to Lee (1966).

Mathematical formulation

The gravitational model of migration, at the root of the approachused the current study, is a model of urban geography derived from Newton's law of gravitation and, according to Claydon (2012)

constitutes one of the main developments in terms of modeling the phenomenon of migration. It is used to predict the degree of interaction between two areas (Letouzé et al. 2009) and expresses some kind of demographic factor as the product of two indicators of the "mass" of the two areas divided by a function of their "distance". For instance, Steward (1940) formulated it as

$$F_{ij} = G \cdot \frac{P_i . P_j}{D_{ij}^2}$$

Where the demographic force F_{ij} between two countries i and j is assumed to be proportional to the product of their population $P_i$and P_j divided by the square of their distance D_{ij}.

The gravitational model of migration is therefore based on the idea that with the growth of the mass(measured by population, in the Steward's approach) of the two places, there is an increase in the movement between them. Instead, the farther the two places are away, the lower the movement is.

The gravitational model has been extended in two directions. The first is the possibility of using some exponent β of the country "masses" to represent different types of influences (e.g. through positive or negative values of the exponents) as well as adopting a generic exponent α for the distance (and not force it to be the square), i.e.

$$F_{ij} = G \cdot \frac{P_i^{\beta 1} \cdot P_j^{\beta 2}}{D_{ij}^{\alpha}}$$

The second is to assume that the numerator can be the product of more than two terms, thus allowing the model to include most of the push and pull factors devised by Lee. In quite the same way, the denominator may be representative by any measure of the distance, but, being it a constant once i and j are defined, it may also be incorporated in the constant of the formula.

In the end, the generalized gravitational model, after applying the logarithms, may be expressed the following form:

$$\ln F_{ij} = \ln \beta_0 + \beta_{1i} \ln P_{1i} + \beta_{2i} \ln P_{2i} + ... + \beta_{1j} \ln P_{1j} + \beta_{2j} \ln P_{2j} + \cdots + \varepsilon_{ij}$$

Where all the P_{ki} and P_{kj} represent the different factors taken into account in both the origin (i) and the destination (j) areas and ε_{ij} should result in a white noise. The last form is very convenient since it is linear in the parameters $\ln\beta_o$ and β_{kh} to be estimated and thus allowsadopting the well-known least square techniques for their determination, once a measure of the demographic force F_{ij} and of the factors P_{kh} has been defined.

Materials and methods

Migration data set

All the evaluations of the current work are based on UN data, which subdivide the world into 22 statistical regions, represented in Figure 3. They have been defined as belonging to the same continents, and represent aggregation of countries that can be considered as sufficiently "close" to each other (for population, traditions, economy, religion,…) beside been physically adjacent.

Caribbean, Polynesia, Melanesia, and Micronesia were not considered due to the very small migration fluxes, thus reducing the considered regions to 18. For each region, UN data report the number of dwellers coming from each other region and living permanently there in 2015, as well as those leaving in 2010. Two types of models are thus possible. The first to interpret the global movements up to 2015, and the second to describe only the variations that took place between 2010 and 2015. Both types will be dealt with in the next section even if both present some problems. The situation in 2015 may represent also some old flows that took place in condition quite different from the current ones, the difference of the last five years may present negative values in those areas where the number of immigrants has decreased, which constitute a problem from the computational viewpoint. In both cases, however, the migration rate (i.e. number of migrants divided by the population of the origin area) has been used as independent variable to avoid the obvious discrepancies due to the quite different population of the macro regions.

Figure3 – Statistical regions as defined by the UN (From: unstats.un.org).

The regression models

Even if it is evident that regression models as those illustrated above may not have causal or predictive meaning, in this section we try to estimate the parameters of a model that correlates migratory flows with economic, geographical, demographic and development indicators, considered as possible useful factors to explain the trend of global migration. We are well aware that such an approach does not allow to "understand" the phenomenon of migrations, since we limit ourselves to a simple mathematical approach, without investigating all the social, personal, historical, political, natural and psychological factors that push people to abandon the their country of origin to go and live elsewhere.Nevertheless, exactly for the complexity of the phenomenon we deem it useful to understand to which other factors it is more linked, at least at a global scale.

As to the possible independent variables (or regressors) that have been assumed, their choice has been based on a number of criteria derived from the theories presented earlier. They should be representative of:

- Economic factors: as the degree of employment and salaries (as in Neoclassical Theory).
- Demographic factors: as the average age of the population, whose importance emerges for example in the Labor Market theories.
- Geographical factors (distance and boundaries in our analysis), whose importance is recognized by all models.
- Other factors indicating the well-being of the population: life expectancy at birth, inequality coefficient, education. Recent studies on migration are giving increasingly importance to these parameters since the latest analyses link migration flows to more general indicators of the well-being of the population more than to purely economic aspects (UNDP 2009). These aspects are well described by the HDI (a weighted sum of GDP per capita, life expectancy at birth, expectation of education, average number of years of the school attended).

The possible regressorsselected for the models thus were:

1. D_{ij}: representing the distance between the two regions. This value has been one of the most problematic to determine since the UN subdivision into macro areas leads to very large surfaces, and therefore it leaves a certain degree of arbitrariness in establishing the coordinates of each region to be used to calculate the various distances. In the end, we used the direct distance in kilometers between the centers of gravity of two regions.

2. GDP_iandGDP_j: indicate, for origin and destination respectively, the gross domestic product per capita. The data come from the World Bank database and refer to 2015 (World Bank 2017).
3. AGE_i and AGE_j: indicate the average age of the population in the origin and in the destination areas. They refer to 2014 (UNDP 2014)
4. $LifeExp_i$ and $LifeExp_j$: represent life expectancy at birth in the areas of origin and destination, and refer again to 2014 (UNDP 2014). The indicator is defined as the number of years that a newborn can expect to live, if the prevailing patterns of mortality at specific ages at time of birth remain constant throughout the child's life.
5. $SchoolExp_i$ and $SchoolExp_j$: are the expected years of schooling. They represent the number of years of teaching expected for a child entering the educational age (UNDP 2014)
6. $SchoolMean_i$ and $SchoolMean_j$: are the mean years of schooling.They indicate the average school year that a person aged 25 or more has attended during his life (UNDP 2014).
7. $INEQ_i$ and $INEQ_j$: represent the inequality indices within each region (UN 2014).
8. EMP_i and EMP_j: are the employment rates for the population over 15, calculated in 2013 (UNDP 2014)
9. *border*: this factor indicates whether two regions have a common border. It assumesa value of 1 in case the two areas are adjacent, zero if they are not. It stresses the geographical factors: two areas may be relatively close, but for instance separated by a sea or by another area, which represent some of the intervening obstacles pointed out by Lee.

Since all the indicators were reported, in the respective data sets, to the individual states, they have been weighted by the country populations to obtain valuesassociated to the macro areas.

Complete models

The results obtained by using all the independent variables listed above are relatively good: the corrected R-square values (that take into account the number of independent variables used) are 0.61 and 0.54 respectively for the model of 2015 resident and of the 2010-15 flows. This is an acceptable result for social science models, indicating that between 50 and 60% of the variability of the dependent variable is indeed explained by the models. Both models show, additionally, the importance of the distance factor, of the GDP in the destination area and of expected schooling in the origin area. Their

respective parameters are relative large in absolute values (they are negative, as expected, for the distance) and have a high level of significance (as shown by their p-value).

The two models are not fully satisfactory since several parameters have a low significance level. This is possibly due to the fact that most of the input variables are correlated between each other and this suggests adopting a pruning procedure to determine the most important factors in a different way.

Determining the most significant variables

The pruning procedure works as follows: the parameter estimation of the regression is repeated several times (exactly 13 times), each time excluding the input variable that has the least significant parameter. This means that we start with a model with 16 input variables and we go down to a model that has only 4. Clearly, we lose something in terms of model performances, but hopefully gain in model robustness. One can also think to the possibility of further reducing the number of input variables, but, when doing so, the model performance drop down to an unacceptable level.

Following the reduction paths, one sees that the first variables to be excluded are those related to the age and inequality in the origin country and that, at the end of the procedure, the remaining variables are always the common border, the distance, the GDP per capita of the destination and the expected schooling of the origin region. For all the four variables, the parameters are remarkably constant throughout the pruning procedure, their final significance is very high, and they remain in both the 2015 and the 201-15 flow models. The overall loss of model performance, as measured by the adjusted R-square value goes down from 0.61 to 0.57 for the 2015 modeland from 0.54 to 0.52 for the 2010-15 flow model. The obtained four variables models are however not only much more robust, but also easier to interpret and understand: they have two geographical, one economic, and one social input, with coefficients that (except for the border which is a binary variable) have more or less the same weight (in absolute terms, since the parameter of the distance is always negative).

Discussion of model results

The results of the gravitational modelspresented above are similar to those in the literature. The GDP of the destination country has been almost always considered much more significant than the GDP of the country of origin (Mayda 2010, Claydon 2012). This is justified by some (Letouzé et al. 2009, UNDP 2009) by the U-inverse relationship that exists between GDP in the country of origin and the rate of

emigration. These reports stress that the poorest and least developed are very often those with the least chance of moving (a certain level of income and education is necessary to be able to migrate), as well asthose that have reached a satisfactory standard of life. Figure 4 that reports the probability of emigration in relation to the per capita salary in the Mexican families is an example of this trend (Meza and Pederzini 2006).Given the simplicity of the gravitational model, which can describes only linear or exponential links with respect to the variables at stake, the factors that have more complex relations with the rate of emigration, such as that of GDP in the country of origin, may appear less significant in the model.

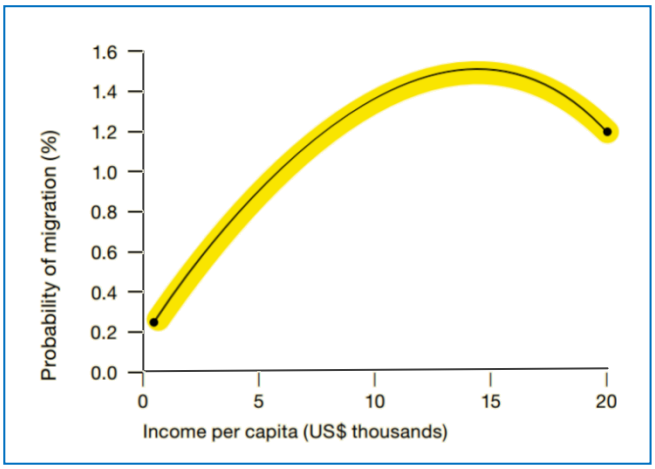

Figure 4– Probability of emigration by income level in Mexican households (Source: Meza and Pederzini 2006)

The strong significance of the distance factor in the regressions carried out and its negative value confirmsthat the increase in the distance between two macro areas leads to a decrease in the number of migrants, as already pointed out by a number of previous studies (Mayda 2010, Letouzé et al. 2009, Claydon 2012).Together with the distance, also the border factoralways remains among the four most significant indicators confirming how much the spatial - geographical aspect, which in part represents the similarity between two areas, is important in the study of migrations.

The last parameter that we find in the final model is that concerning the expectation of education in the area of origin (see also Meza and Pederzini 2009, Rao 2010, Postiglione 2017)which, together with the GDP, constitutesone of the component of theHDI as computed by the United Nations. The factor of education is often cited in the literature to highlight the phenomenon of "migrant selectivity".

According to this concept, the most educated and the most qualified people are those that have the greatest chance to migrate. Immigration policies in fact often favor the arrival of educated people with respect to those with less qualification (UNDP 2009).

Conclusions

The main limitation of the models presented here derives from the subdivision of the World into macro areas. This implies different consequences.

The modelassumes uniformity within areas, where important (political, religious, ethnic, linguistic) differences may be present in the different countries, specifically to allow and/or discourage population movements.Also the data on the distances between macro areas constitute a strong approximation since they do not well represent the physical barriers and the difficulties in moving between macro areas.

Additionally, the model is clearly not able to consider all the personal choices, the traditions, the past history (for instance, the presence of member of the same family/group already abroad). These are in fact almost never quantifiable.

The analysis does not take into account important events that very often cause movements of large numbers of people. These include natural catastrophes or wars. Instead, we focus on indicators that are fairly stable and predictable over time, easily quantifiable at a macro level.

The model does not consider the time variations, but is based only on data related to a given period. To prove its robustness, it would instead be necessary to analyze different data time series. However, it is almost certain, that, at a global scale, migration is not a stationary phenomenon and thus cannot be represented by a fixed set of parameters. Robustness must thus be interpreted as the fact that the most relevant factors remain the same though time, even if their relevance and representativeness change.

The modeldoes not consider the non-linear trends, like the U-inverse trend previously illustrated, and tends to give greater importance to factors with linear or exponential relations.

The strongest evident limitation of the model is that it considers only flows between macroareas and does not take into account the movements within regions and within countries, which constitute the largest portion of migrants. Indeed, in very low development zones, peoplehave the greatest difficulty in moving and traveling over long distances.

The current analysis, despite all these limitations, produced satisfactory results with numerous similarities with thosepresent in the literature concerning different periods and scales. It can thus be considered a good contribution for carrying out more complex elaborations such as the introduction of other variables or some adaptation of the gravitational equation aimed at capturing the non-linear trends that some factors present.

Though aware that the result of this work cannot be used as a forecasting toolnor for causal explanation, we can still consider it as a possible supporting approach in this field of study. In fact, the paper shows how complex the phenomenon of migrations is and underlines the need for an approach that does not limit itself to studying this complex topic from a purely socio-demographic point of view. The need to develop reliable and precise tools to analyze migration is more important today than ever and it is vital that this development be carried forward also in formal quantitative terms. Such models could in fact be extremely useful in addressing and supporting appropriate political choices in a world and in a historical moment in which migrations assume an ever greater and central importance within world societies.

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