Paper V

Migration and Development: a Resource-Based Approach

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Abstract

International migration flows are continuously growing, and an estimated 3% of the world's population lives today away from their country of origin. The social, economic and environmental impacts of these massive movements are significant in the context of global, regional, and national development. Migration interacts with key development issues through the displacement of human and financial resources that are central to development. Such interactions are highly complex, and a quantitative modelling approach is necessary to support the design of national and regional migration policies that are coherent with development objectives and plans. We propose a resource-based approach to analyze migration-related development issues, based on a synthesis of theory and evidence from different fields, which we implement with the System Dynamics (SD) method. The study highlights the dynamic interaction between migration and development, and the inherent elements of complexity that make managing such phenomenon particularly difficult. An extended policy analysis is carried out for two virtual countries – one industrialized and one developing – and general policy insights are derived. In order to support the mainstreaming of migration in the development agenda, our migration model can be dynamically linked to the Threshold 21 model, a broadly based tool that supports the elaboration of national and regional development plans.

Keywords: Migration, System Dynamics, Resource-Based Approach, National Development, Policy Analysis.

Acknowledgment

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Migration and Development: a Resource-Based Approach

1. Introduction

International migration flows are continuously growing, and an estimated 3% of the world's population lives today away from their country of origin (IOM 2005). The social, economic and environmental impacts of these massive movements are significant in the context of global, regional, and national development. Nevertheless, migration is often not explicitly considered in countries' development plans, neglecting a phenomenon that not only can become an important development challenge but that can also represent a significant opportunity for individuals and societies.

Migration is inherently a complex phenomenon, and one that requires to be analyzed from a multidisciplinary perspective. By shifting human and financial resources across borders, migration has sizable impact on development processes, although the complexity and breadth of this issue makes it difficult to properly consider it in conventional development plans. Integrated quantitative models are necessary in order to fully understand this phenomenon and to create coherent policies to harmonize migration with rapid endogenous development. However, often the quantitative models used to support the development planning process either do not consider migration or consider it in an exogenous manner (Pedercini 2003; Bahadur et al. 2005; Bussolo and Medvedev 2007).

In order to provide a comprehensive perspective on migration dynamics and their development impacts, we propose a resource-based migration model representing the socio-economic systems of two virtual countries. Our analysis focuses on the accumulation and cross-border flows of human and physical/financial capital that are intertwined with migration. Such flows, altering the resources' accumulation processes within a country in desirable or undesirable ways, can fundamentally shift a country's development path. A resource-based approach is thus ideally suited to represent the interaction between migration and development. Such an approach is extensively adopted in the field of firms' strategic management (Barney 1991; Peteraf 1993) and Warren recently provides a more quantitative and dynamic perspective for resource-based analysis (Warren 2002) which we adopt as analytical framework. Most recently a resource-based approach is being successfully applied to development issues (Pedercini and Barney Forthcoming).

The model is implemented using the System Dynamics (SD) method, already broadly used to analyze a variety of development issues (Saeed 1987; Arango 2007; Qureshi 2008). SD was initially developed at the Massachusetts Institute of Technology in the early 60s, and provides a powerful framework for building, simulating and analyzing complex models. The method highlights the relationship between structure and behaviour of complex dynamic systems (Richardson and Pugh 1981). The SD method is particularly well suited for this type of application as it enables a proper representation of the accumulation processes of the key resources, and of the elements of dynamic complexity – feedback loops, delays, and non-linearity – that characterize such processes (Forrester 1961). Also, the SD method helps maintaining a certain degree of model transparency, which is essential to support a better understanding of the system (Größler et al. 2000) and to consequently increase policy-makers' confidence in the model.

The model provides an endogenous representation of some of the mechanisms that drive demographic and economic development dynamics as well as migration and remittances flows, combining theory and evidence from different fields. We use Lee's perspective as

initial framework of reference to investigate the migration flows (Lee 1966), and we consider both pull and push factors (Dorigo and Tobler 1983), i.e. conditions in the country of origin and in the country of destination. However, our model does not explicitly consider distance as a factor affecting migration, and therefore does not belong to the category of "gravity" models. Also, we do not consider push and pull factors as separate elements, but we determine drivers of migration based on differentials in conditions between the country of origin and that of destination. Ours is thus a disequilibrium model (Hunt 1993), and is not solved via optimization, but belongs to the broad category of simulation models (Sterman 1996).

The purpose of our study is not that of providing an exhaustive representation of all key mechanisms driving development and migration, but rather that of illustrating the type of insights into the nexus between migration and development that a resource-based approach can offer. We believe that our model can integrate the existing development planning tools and facilitate the mainstreaming of migration in the development agenda. In particular our model can be incorporated in the Threshold 21 (T21) model (Barney 2002), which offers a proper multidisciplinary framework for the analysis of development issues. The T21 model is broadly used by governments and international agencies to create and test alternative development strategies. In particular, T21 is often being used to support policy analysis in the context of Poverty Reduction Strategy Papers (PRSP), Millennium Development Goals (MDG) assessments, or similar exercises in various countries[1]. Our migration model can easily be integrated into the broader T21 model, facilitating a proper representation of migration and of its implications in the context of development planning.

The next section describes the structure of the model; section 3 describes the basic behaviour patterns that the model generates and some preliminary policy insights; and section 4 summarizes our findings and conclusions.

2. Model

2.1 Demographic and economic development mechanisms

For this study, we develop a resource-based migration model considering two virtual countries, a developing one and an industrialized one. The structure that we use to represent both countries is perfectly symmetrical, and we use different parameterizations to characterize each of them. For both countries, we endogenously represent the mechanisms that drive demographic and economic development.

Figure 1 portrays the stock and flow structure that captures the relevant demographic dynamics. Variables inside a box are stocks; variables represented as double arrows are flows; and variables represented otherwise are auxiliaries, i.e. are intermediate calculations to determine flows. To the right of the stock and flow diagram is a legend to interpret the figure. The upper part of Figure 1 represents the population of an industrialized country (pertinent variables names begin with "ind"), while the bottom part the population of a developing country (pertinent variables names begin with "dev"). The model disaggregates the populations of the two countries into three age groups: young (age 0-14); working age adult (age 15-59); and elderly (age 60 and over). Individuals grow old and move from one age group to the other, or can also die at any time. We assume that fertility depends on education (Birdsall 1988) and mortality depends on income (Rodgers 1979).

[1] For information and reports on the projects, please visit www.millennium-institute.org

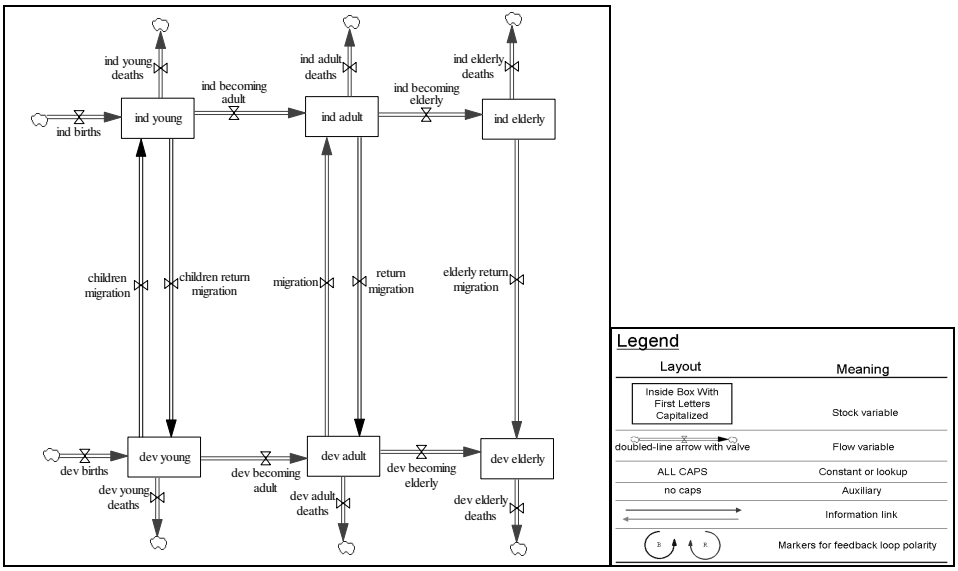

Figure 1: Left: stock and flow structure of population; right: legend for the stock and flow diagram.

The two populations are linked by migration flows. We assume that migrants from the developing country to the industrialized country are primarily working age adults, and that the migration towards the developing country is made of older working age adults and elderly people returning to their home country after having accumulated an adequate asset base, been forced out, or retired from work in the industrialized country (i.e. re-immigration). In cases where emigrants are able to bring their families to the developed country, they may decide, if possible, to stay, so that not all migration is reversed. We do not discuss explicitly in this paper the migration of people originally from the industrialized country to the developing one, although this can happen in the model in case working and living conditions are better in the developing country than in the industrialized one. Under normal circumstances, other than citizens from industrial countries working for their companies in developing countries, there are few who actually migrate. We will thus focus in this analysis on the determinants of the migration flow from the developing to the industrialized country and of the corresponding re-immigration flow.

In order to endogenously represent economic development, we consider physical capital and human capital (including labour, education and skills) as the key drivers of production. Figure 2 illustrates the stock and flow representation of these resources (labour represented by “ind adult” calculated in the population structure), and how they give rise to production. The accumulation of resources over time leads to growth in production and income. We have assume a Cobb-Douglas production function (Cobb and Douglas 1928) and used education as a main determinant of productivity (Mankiw et al. 1995). As labour migrates from a country to the other, the model keeps track of the corresponding flows of education and skills, and of remittances between the two countries. Such flows shift resources from one country to the other, altering their development paths, as described in detail in the following paragraphs.

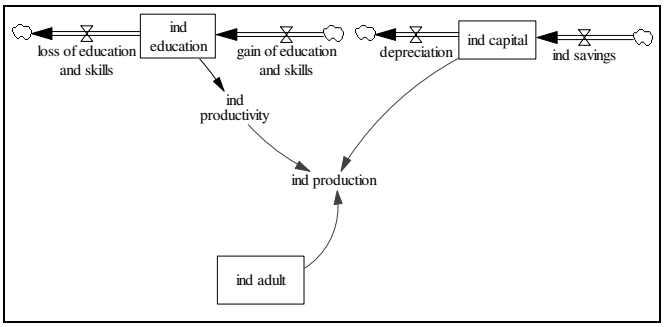

Figure 2: Stock and flow structure of economic resources

2.2 Workers' migration

We consider five main determinants of migration: (1) demographic growth; (2) the difference in labour cost between industrialized and developing countries (i.e. wages or salaries actually paid to immigrants compared to what they would earn at home); (3) the difference in quality of life; (4) the substitutability of labour; and (5) the feasibility/costs of migration. These five factors determine the pressure for migration between the developing and industrialized country, pressure that can be either eased or accentuated by the flows of labour and remittances. The policies implemented to manage such flows determine to a great degree whether in the long run the migration pressure can be reduced. Far from covering all the possible drivers of migration in a country-specific setting, the factors considered are relevant examples of the type of socio-economic factors involved. The following paragraphs describe the main mechanisms that, by acting on the five key drivers of migration considered, lead to reduction or amplification of the initial inequalities among the two countries.

A first element affecting migration is of demographic nature: it has been observed that countries with rapid population growth are characterized by higher emigration (Afolayan 2001). Population growth implies an increasing pressure on the natural resources, and an increasing population density. We thus assume that the faster the population in a country grows, the higher the incentive for people from that country to migrate. In general, developing countries experience a faster population growth rate than industrialized countries. The consequent flow of emigration from developing to industrialized countries rebalances disequilibria in the population growth, as industrialized countries absorb part of developing countries' population growth. As people migrate, the difference in the population growth rates between industrialized and developing countries declines and the incentives to migrate are reduced. This mechanism is a balancing feedback loop (Sterman 2000) that tends to balance the population growth rate between countries, and is highlighted in blue and labelled B1 in Figure 3. In this and the next figures, only the feedback loops in the industrialized country's side of the sketch are highlighted. The same feedback loops in the developing countries side of the sketch are symmetrical to those in industrialized countries and are omitted for simplicity.

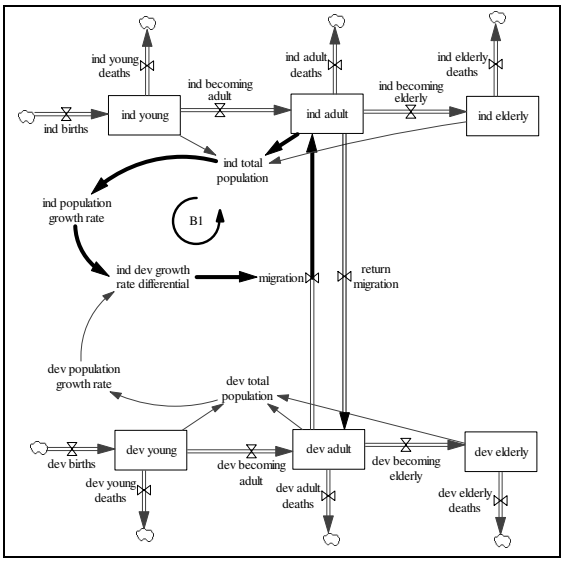

Figure 3: Balancing feedback loop B1: the "Population growth" loop.

A second important determinant of migration is the difference in labour cost, or wages. The difference in the effective cost of labour between industrialized and developing countries is a factor that stimulates migration (Martin and Taylor 2001): a high difference implies that it is advantageous for firms in industrialized countries to hire workers from developing ones; and it is advantageous for workers from developing countries to work in industrialized ones. Labour cost, in turn, is determined by the labour productivity, which we assume proportional to the amount of production per unit of labour. A high production per unit of labour indicates that the contribution of a unit of labour to production is high, and assuming that labour is paid proportionally to its marginal contribution, salaries should be higher. The amount of production per unit of labour depends on the productivity of production factors and on the capital stock. Industrialized countries tend to have a larger capital stock and productivity than developing ones, and thus higher production per unit of labour and higher wages.

In neo-classical production functions, such as the one used in this model, factors of production (including labour and capital) exhibit decreasing marginal returns. This means that, ceteris paribus, a larger labour force provides lower output per unit of labour. Therefore, a country that has a small labour force, abundant capital, and thus higher production per unit of labour attracts workers from countries where labour is more abundant compared to capital. This leads to an expansion of the labour force in the receiving country and thus a decrease in the output per unit of labour and salaries[2]. The loop between migration, labour force, and production per worker is thus a balancing feedback loop that tends to adjust the distribution of labour force according to the countries' needs, and to reduce migration pressure. This mechanism is highlighted in blue and labelled B2 in Figure 4.

[2] In some cases, employers in industrialized countries can offer a wage lower than the marginal productivity to foreign workers who have little bargaining power (this is particularly relevant for illegal immigrants). In such case, immigration would lower the average local salaries even faster.

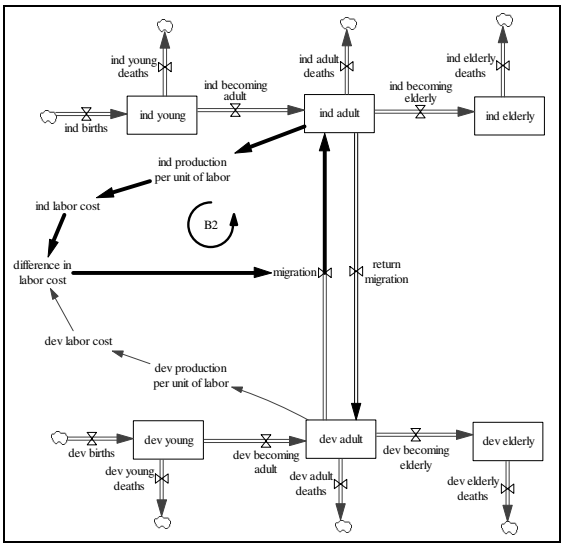

Figure 4: Balancing feedback loop B2: the "Labour cost" loop.

The two balancing feedback loops illustrated so far (B1 and B2) tend to balance initial inequalities among the two countries. However, there exist mechanisms that tend to amplify inequalities over time. A first such mechanism operates through the effect of the differences in quality of life on migration.

The difference in quality of life between developing and industrialized countries is the third determinant of migration considered. In particular, it has been observed that a high level of development in a country stimulates immigration of people from countries with lower levels of development (Nyberg-Sorensen et al. 2002). We assume that production per capita is a major indicator of development and quality of life: the higher the production per capita, the higher the goods and services available for each individual and the better the public infrastructure and social services available. Other factors, such as governance and environmental conditions also importantly affect quality of life and in turn migration (Brown 2008), although these aspects fall beyond the scope of this study.

Assuming that migration principally consists of people in working age, migration towards a country with high per capita output increases the share of workers over the total population in the receiving country. Consequently, income per capita also rises, further stimulating migration towards that country. On the other hand, the country of origin of the workers faces a reduction in output per capita and thus quality of life, creating further push to emigration[3]. The mechanism described above is a reinforcing feedback loop that tends to amplify initial differences in income among countries. It is highlighted in red and labelled R1 in Figure 5. This phenomenon is particularly dangerous if the workers migrating are among the best skilled and most productive in their country origin, causing a so called "brain drain".

[3] This is true under the assumption of full employment in the country of origin, as in the neo-classic production function used. More realistically, this is also true under the assumption that the unemployed left in the country of origin do not have the necessary skills to take on the jobs left by the more skilled emigrated workers.

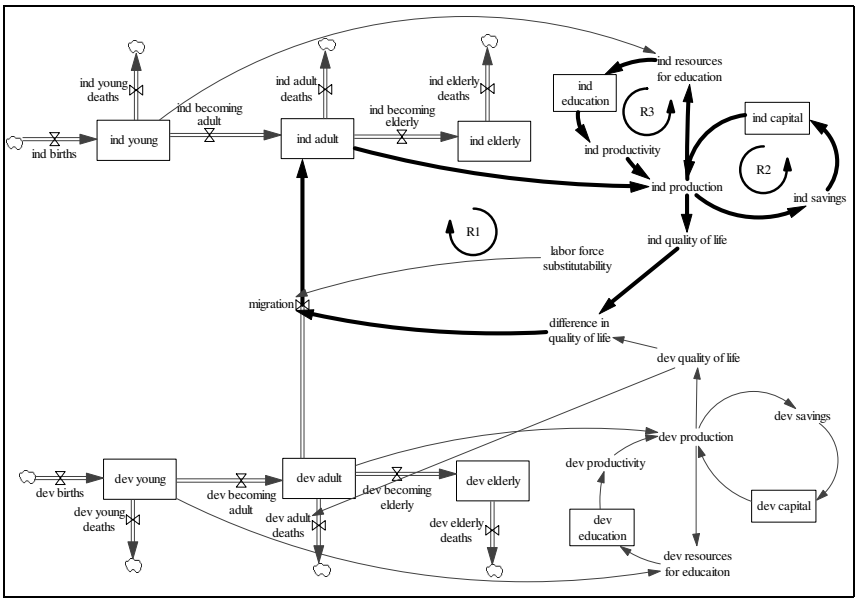

Figure 5: Reinforcing feedback loops R1 ("Labour growth"); R2 ("Capital growth"); and R3 ("Education growth").

In the resource-based approach adopted, production is not only a function of physical and human capital, but also the main determinant of their evolution over time: production generates the savings that are then turned into investment in physical and human capital. These are reinforcing feedback loops (labelled R2 and R3 in Figure 5) that are at the heart of economic growth in both industrialized and developing countries. The stocks of capital and education presented in Figure 5 are the same as those presented in Figure 2: we omit here to represent the flows that affect them in order to emphasize the feedback loops they are part of. These mechanisms are relevant in the context of migration because they tend to amplify any difference in income and resources among the countries. In particular, an increase in production due to immigration leads to a consequent expansion in physical and human capital, leading to higher income and further migration. The same loops are at work in the developing country, where lower income due to emigration leads to less investment in human and physical capital, and thus to a further reduction in income. Feedback loops R2 and R3 therefore further strengthen the action of feedback loop R1, and generate increasing disparities among countries.

Labour force substitutability between different countries is another important element affecting migration. The complementarity of education and skills of migrant workers with the existing technology in the receiving country is central for economic performance (Ben-Gad 2007). Also, high-skilled labour has particularly high incentives to migrate towards countries with high average level of human capital, because such regions experience local externalities and can thus offer a high skill premium (Giannetti 2001). Consistently with these observations, an increasing demand for high-skill migration towards industrialized countries has been noted (Mahroum 2001). In some cases, industrialized economies can exhibit a lack of labour for unskilled jobs: however, we assume that for any job, including unskilled jobs, a higher education of labour is always preferred.

The average level of human capital in a country depends on the amount of resources allocated to education (including training) per young person, which in turn substantially depends on

production. A country that is receiving migration, and thus is increasing its production, also experiences an expansion of the resources available for education, leading to a more skilled and effective labour force. On the other hand, the same mechanism is at work in the developing country, where loss of labour (often the most skilled) leads to a reduction in income, in education, and consequently to less opportunities for migration. As the gap between the education levels of the two economies increases, the labour substitutability decreases, and thus migration is reduced. The mechanism above described is a balancing feedback loop (highlighted in blue and labelled B3 in Figure 6) that tends to slow down migration. Differently from the other balancing feedback loops previously discussed, B3 tends to slow down migration by reducing the compatibility of workers, that is, by increasing the differences between the two countries rather than by reducing them. The mechanism is at the heart of the brain-drain issue, where selective migration impoverishes the people left in the country of origin (Docquier et al. 2005).

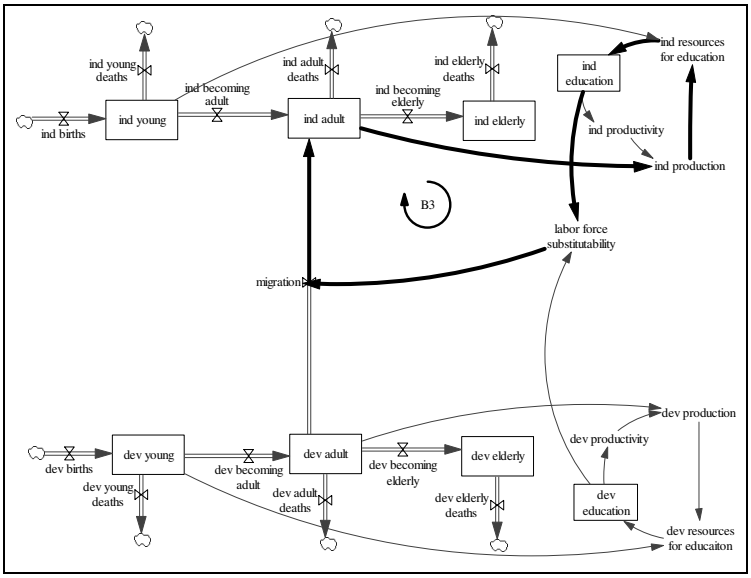

Figure 6: Balancing feedback loop B3: the "Brain-drain" loop.

A fifth relevant factor affecting migration is the cost/feasibility of migration (Sjaastad 1962). This factor is related to both intrinsic characteristics of the countries being involved, such as their distance, climate, geo-political situation, and particular policies put in place, such as restriction to migration and/or fees. Although governments have limited possibilities to significantly affect some of these aspects, they can affect migration flows through specific policies. There exist a wide variety of migration policies, some attempting at directly controlling migration (such as migration quotas), and others targeting the determinants of migration (Farrant et al. 2006). The permeability of the two countries to migration will affect the functioning of the mechanisms illustrated so far: very tight anti-migration policies will tend to slow down such mechanisms, while open pro-migration policies will tend to make them work more rapidly. Examples of such policies, which are exogenously represented in the model, are tested in the following section.

2.3 Workers' re-immigration and children migration

In addition to the flow of workers from the developing to the industrialized country, we also consider the flows of returning workers (i.e. re-immigration), the flow of returning retired workers, and the flows of children migration.

The re-immigration flow, that is, the flow of workers going back to their country of origin after having worked in the industrialized country for a number of years, has different determinants with respect to the migration flow so far considered (Nyberg-Sorensen et al. 2002). Workers tend to go back to their home country after having accumulated a significant amount of wealth; because they were not able to integrate in the industrialized country; or for family related reasons. In our framework, we assume that the average worker returns to its country of origin after a certain number of years.

The flow of workers re-immigration is of particular importance for two reasons. First, by reducing the number of migrant workers in the host country, the amount of remittances sent to the home country is reduced. Returning workers might also bring back some financial resources, but we assume in this framework that the saving of migrants workers are sent back continuously in form of remittances rather than all at once upon the workers' return. Second, and more important, the returning workers bring back to their home country a set of more advanced skills and knowledge. While working in the industrialized country and being exposed to advanced technologies, migrant workers gradually absorb new skills and competences that are scarce in their country of origin (Papademetriou 1991). Upon their re-immigration, these skills and knowledge add to the stock of human capital of the country, and can lead to higher productivity. By increasing productivity and production, the difference in quality of life with respect to the host country is reduced, and thus the need for migration. This mechanism is a balancing feedback loop (labelled B4 in Figure 7) that tends to reduce migration over time.

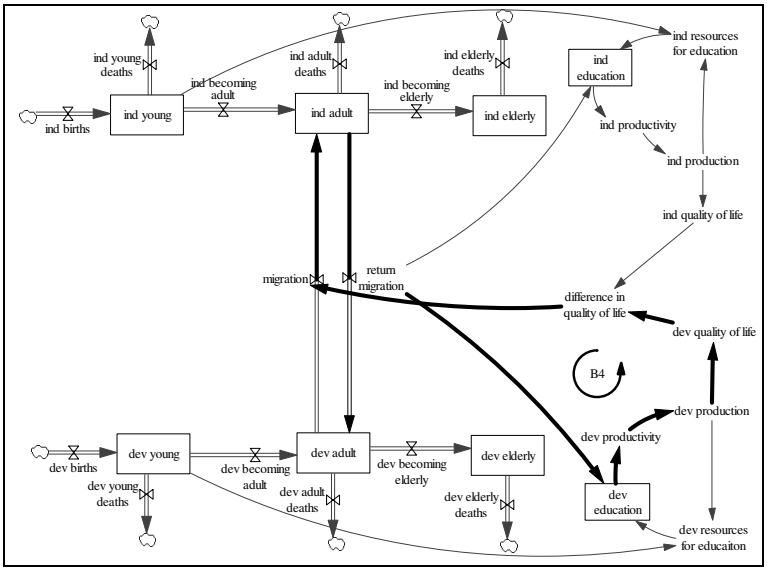

Figure 7: Balancing feedback loop B4: the "Return migration" loop.

The increase in the average education and skills level in the developing country resulting from the return of workers can also increase labour force substitutability, and might generate further migration. This can be the case for example of returning workers who have acquired a high

level of skills, and do not find adequate opportunities upon their return to their country of origin. They can thus more easily re-engage in migration, given the better skills and experience they have acquired. This reinforcing loop is illustrated in Figure 8 and labelled R4.

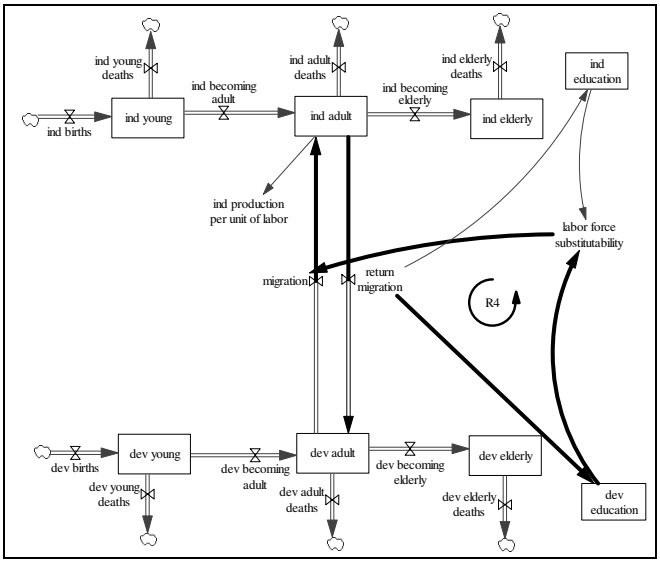

Figure 8: Reinforcing feedback loop R4: the "Second round migration" loop.

Some of the workers migrated to the industrialized country stay there for a longer period than the average (and some for a shorter one), so that they eventually become elderly and retire in the host country. Some of them eventually re-immigrate as elderly in their country of origin, while some remain in the industrialized country. The re-immigration of the elderly has a different effect than the re-immigration of people in their working age: while the return of working age people is associated with an increase in the human capital available for production, the return of the elderly increases the total population without adding to the productive human capital stock. This implies a reduction in the per capita income and thus in the quality of life, leading potentially to further migration. This mechanism is a reinforcing loop and is labelled R5 in Figure 9. The strength of this loop depends in practice on the actual needs of the returning elderly population: if they have accumulated a certain amount of wealth during their working period abroad, they might not require support from their family or the state, and absorb little resources from the local economy.

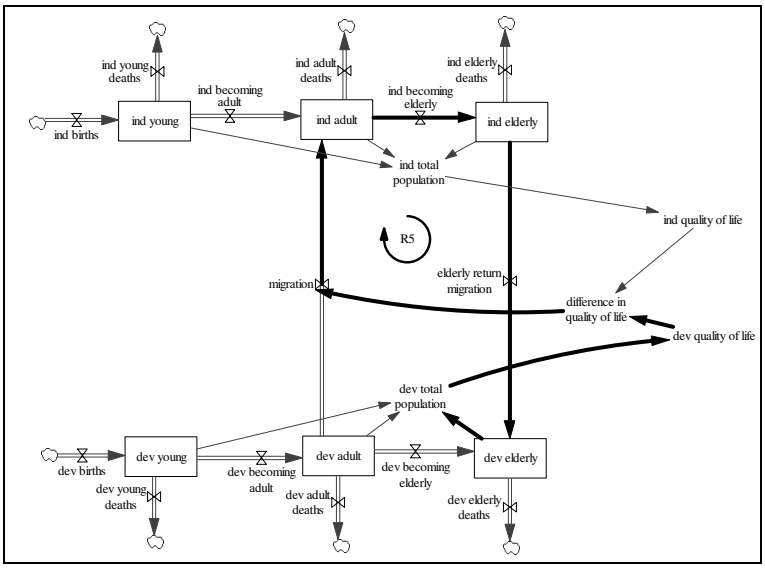

Figure 9: Reinforcing loop R5: the "Social security stress" loop.

As workers migrate to seek job opportunities in the industrialized country, some of them will bring their children along, who will add to the young population in the host country. The flow of children migrating along with their parents is represented as a co-flow of workers' migration, i.e. is determined by the flow of workers' migration. The children of foreign parents who grow up in the industrialized country are assumed to receive the same type of education as those who are born citizens, although their integration is often a complex issue (Melia 2004). These children can move back to their country of origin together with their parents, or become citizens and stay permanently in the industrialized country.

The migration of children along with their parents has various effects. First, the reduction in the number of children in the developing country implies a larger per capita income, and thus a higher quality of life. This in turn can reduce the need of migration. This is a balancing feedback loop mechanism and is labelled B5 in Figure 10. This loop tends to offset the undesirable effects of the reinforcing loop R1 presented in Figure 5: in this case, as workers migrate, they bring along their dependents, without leaving an additional burden to their country of origin.

A second effect of children migration is of similar nature: as children migrate, more resources are available for the education of those who remain in the country, leading to better education, higher productivity and lower migration in the long run. This balancing loop is labelled B6 in Figure 10.

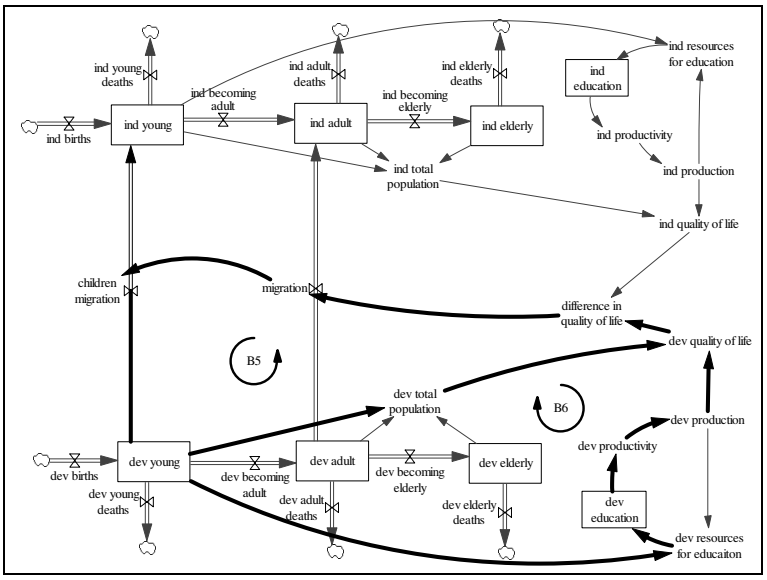

Figure 10: Balancing loops B5 and B6: the "Children resources" and "Education resources" loops.

Finally, the third effect of children migration rolls out in the long run. By growing up in the industrialized country, migrants' children acquire education and skills similar to those of the local children. Some of these children are naturalized, i.e. they become citizens of the host country, and some return to their country of origin, either as children, as working age adults, or as elderly. When they return to their country of origin, either as children or adults (this second case is illustrated in Figure 11) they bring along additional skills and education that increase the country's stock of human capital and thus productivity. This leads to a higher quality of life and reduces the need for migration, creating another balancing loop, labelled B7.

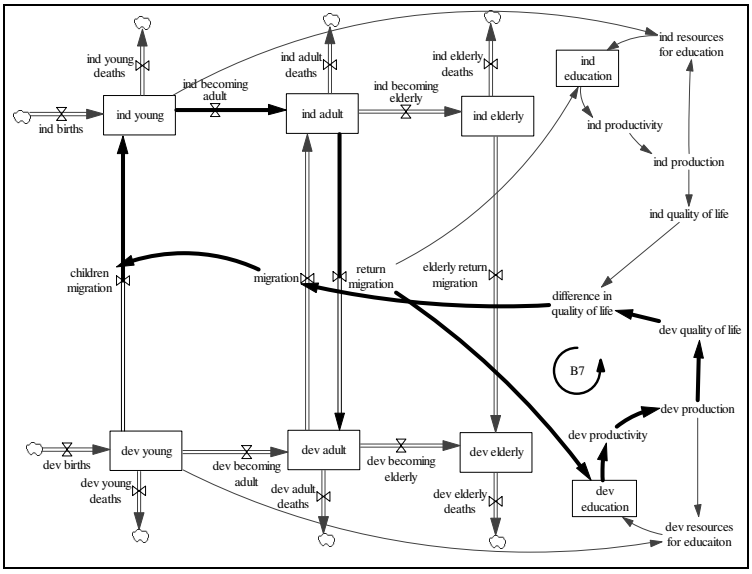

Figure 11: Balancing loop B7: the "Foreign education" loop.

2.4 Remittances flows

So far we have discussed the flows of people across the two countries and their major determinants. In this framework, remittances have the fundamental role of offsetting some of the income losses associated with workers' migration and of balancing the physical capital stocks among the two countries (Taylor 1999). Remittances are determined by the wages paid to immigrants in the industrialized country, which are assumed to be proportional to the share of immigrant workers over the total workforce, and to the average productivity level. Remittances are sent to residents in the developing country who can either save and invest them, or use them for consumption (Ghosh 2006). The part of remittances that is consumed leads to a direct increase in quality of life for the recipients of the remittances – often the family of the migrant – generating a reduction in the push to emigration[4]. The part of remittances that is invested contributes to the accumulation of physical capital, leading to increased productivity and production. This eventually increases the domestic real wages and quality of life, and thereby reduces the appeal of emigration. These mechanisms are two balancing feedback loops, in which migration leads to an improvement of the conditions in the country of origin and thus a reduction in the migration pressure. The two loops are highlighted in blue and labelled B8 and B9 in Figure 12 (in the sketch remittances are represented as a function of production and the emigration flow, for simplicity).

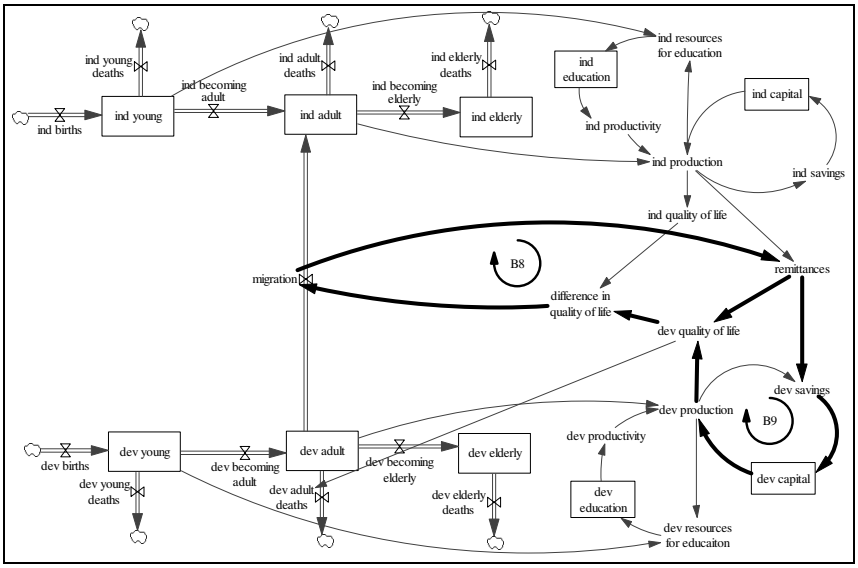

Figure 12: Balancing feedback loops B4 and B5: the "Remittances consumption" and "Remittances investment" loops.

Although loops B8 and B9 are of the same nature, their effect on the system in the long run is quite different. Loop B8 leads to an increase of quality of life due to income generated outside the country. In case the flow of remittances should stop at any moment, the income would be correspondingly reduced. Loop B9 instead leads to an increase in quality of life by increasing the stock of physical capital, and thus by generating a much more sustainable additional

[4] In case information about wages in the industrialized country is limited in the developing country, receiving remittances can actually cause further desire to migrate. This aspect is however not dealt with in the model.

endogenous income flow that is less dependent on the industrial country. This increase in income is further strengthened by the action of the reinforcing feedback loop R2, as previously discussed. Therefore loop B9 leads to a balancing of physical capital among the two countries, which is maintained after the remittances cease to flow.

2.5 Demographic transition

A final mechanism of relevance in the context of the framework presented in this paper is of demographic nature. In case the inflow of remittances and the increase in human capital driven by the returning workers more than offset the initial losses of work force, per capita income in the developing country can be higher than it would be without migration. As a result, mortality is reduced leading to a more rapid population growth. The more rapidly growing population provides further stimulus to migration, closing a reinforcing feedback loop (R6 in Figure 13). This loop tends to partially compensate the balancing effect of loop B1, illustrated in Figure 3.

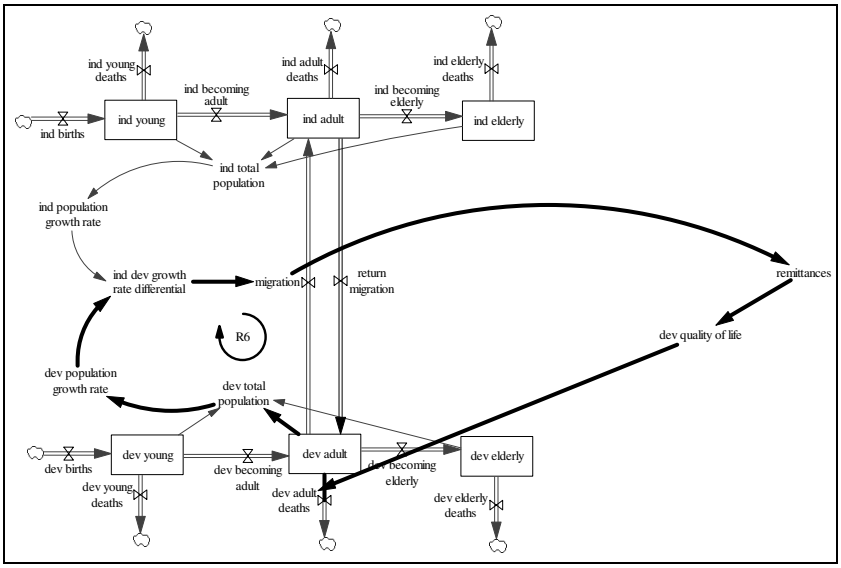

Figure 13: Reinforcing feedback loop R6: the "Deaths reduction" loop.

In the long run, as education in the developing country increases, fertility drops, reducing births and leading to a reduction in the population growth rate. This in turn tends to slow down migration. This mechanism is a balancing loop and is labelled B10 in Figure 14. This phenomenon where an increase in income brings a population characterized by high fertility and mortality towards a new equilibrium characterized by low fertility and mortality, is known as *demographic transition* (Kirk 1996). In the case of a country broadly open to migration, a demographic transition can happen particularly rapidly, as income and education change more rapidly than they otherwise would. This would be, in other words, a *migration-induced demographic transition*, where fertility and mortality drop particularly fast, leading eventually to a new equilibrium in a shorter time. Still, by involving demographic dynamics, the feedback loops B10 and R6 tend to operate with major delays. This implies that these phenomena can build up relevant inertia before their effects on migration being observed.

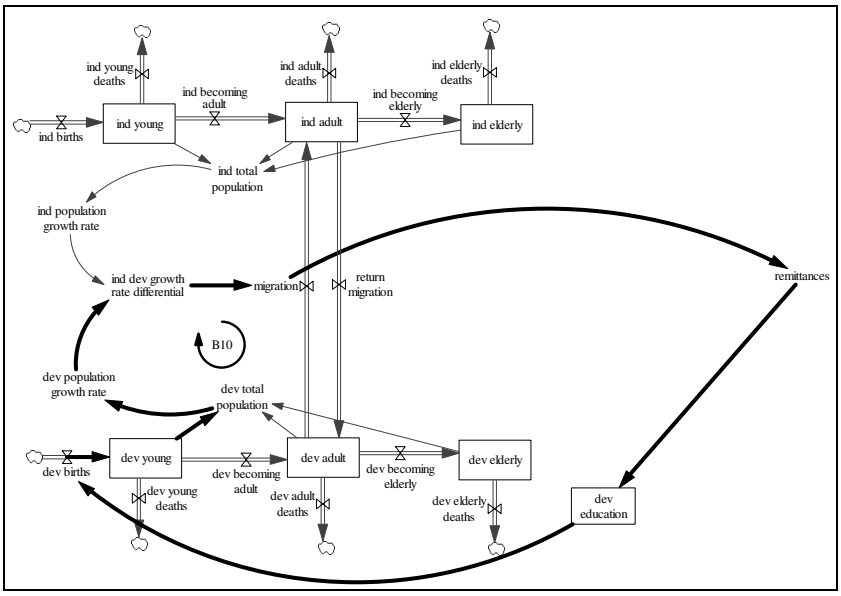

Figure 14: Balancing feedback loop B10: the "Births reduction" loop.

This section illustrates a variety of mechanisms that tend to reduce or amplify the differences in human and physical capital among the two countries through flows of migration and remittances. The overall system's behaviour over time depends on which of these feedback loops is dominant in the various phases of development. This depends on the structural characteristics of the countries being analyzed, and by the public policies set in place. The following section describes the results of a set of selected simulations that illustrate how different loops dominate the system under different policies and conditions, leading to different results. We also draw some preliminary policy insights.

3. Policy Analysis

Based on the model described in the previous section, we simulate ten scenarios exploring different types of migration policies and conditions. We assume that the two countries have initially the same total population, but that the population of the industrialized country is more concentrated in the adult and elderly groups, due to decreasing fertility rates and increasing life expectancy. The population in the developing country is instead more concentrated in the young and adult groups. Also, we assume that the industrialized country has initially 2.5 times as much per capita income as the developing country, and about twice as much capital and education. Productivity, driven by education, is also about twice as much in the industrialized country. We also assume that there are no relevant trade or investment flows between the two countries, in order to isolate the effect of migration on development dynamics from other possible exogenous forces[5]. We simulate all the scenarios for a period of two hundred years, sufficient to appreciate the long term dynamics of the phenomena under study. We assess to which extent each scenario led to changes in the migration pattern and a reduction in the

[5] Foreign investment can exogenously increase capital and production, and generate employment in the developing country. However, this can generate endogenous development only if it brings along substantially higher salaries for local workers allowing more saving, and technology/knowledge transfer. Trade can also allow faster technological adoption and increase productivity in the long run, although it can generate unemployment in the short run. The net effect of trade policies on development are still under debate Rodrik, D., 1998, "Trade Policy and Economic Performance in Sub-Saharan Africa", *NBER Working Paper Series,* (WP 6562), National Bureau of Economic Research, Cambridge..

inequalities between the two countries, using as main indicators the migration rates and the per capita output of the two countries.

In the first scenario we assume that the two economies are completely isolated, with no possibilities of exchanges of labour and remittances. Under the assumption of diminishing returns to resources, income per capita in the two countries should converge. However, we assume that propensity to save is a function of income, which in the developing country is lower, so that saving in human and physical capital are just sufficient to compensate for the natural losses. The country is thus in a poverty trap (Sachs et al. 2004) and inequalities among the two countries tend to amplify. Escaping such a poverty trap is particularly difficult in the case that no cross-country flows of labour and remittances are possible, and the differences in standards of living between the two economies tend to increase, as illustrated by the left graph in Figure 15. In this scenario, the reinforcing feedback loops R2 and R3 are dominating the system, since, by allowing no migration and remittances, all the other feedback loops are cut off. The R2 and R3 loops, however, are more effective in the industrialized country, since the low income in the developing country does not allow for adequate saving. Income in the industrialized country thus grows fast, while that of the developing country remains stable, leading to increasing divergence between the two economies. Eventually, diminishing returns in the industrialized country lead to a slow-down of growth, and income inequalities tend to stabilize again at a higher level. Although income differences increase, and so does the push for migration, migration remains zero (right graph in Figure 15) as a result of the no-migration policy in place. This situation can lead to increasing illegal migration and to the related risks of human tragedies.

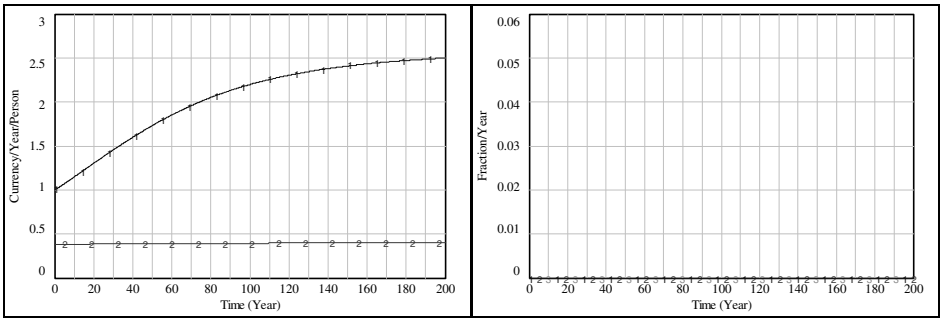

Figure 15: Scenario 1: No Migration. Left-hand graph: per capita output in the industrialized country (line 1) and in the developing one (line 2); right-hand graph: adult emigration rate (line 1), adult re-immigration rate (line 2) and adult net migration rate (line 3).

In our second scenario we allow for exchange of labour between the two countries, but not for exchange of remittances. We also assume that workers stay in the host country for a very long period (on average 60 years), so that only a small portion of them returns to their home country before retiring. The results illustrated in Figure 16 indicate a growth of the per capita income in the industrial country, while the developing one experiences negative growth. The reinforcing feedback loop R1 is in this case dominating the system. The higher quality of life, higher salaries, and lower population growth rate that initially characterize the richer country, attract labour form the poorer country. This impoverishes the poorest economy that is losing the relatively more productive part of its labour force. Migration starts high, and after decreasing in the very first years due to the decreasing population growth in the developing country, it starts increasing again. The increasing differences in salaries and quality of life strengthen the migration flow, accelerating the fall of the poorest economy. A large part of the labour force in the developing country is eventually absorbed by the industrialized one, which

continuously expands. In the long run, the balancing loops B1 and B2 only partially counteract the increasing migration pressure: the fall in income in the country of origin provides a very strong incentive to migrate. Similarly, the balancing loop B3 has a modest effect: the decreasing education level of the poorer country only partially reduces the migration flow, which stabilizes at a high level. Eventually, in this scenario we observe a strong divergence in per capita income between the two countries, with a polarization of the most productive economic activities that benefits the industrialized one.

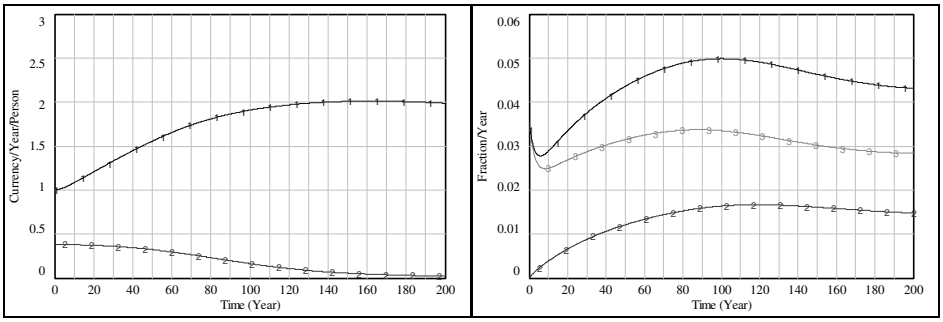

Figure 16: Scenario 2: No Remittances and Late Return. Left-hand graph: per capita output in the industrialized country (line 1) and in the developing one (line 2); right-hand graph: adult emigration rate (line 1), adult re-immigration rate (line 2) and adult net migration rate (line 3).

In our third scenario, we allow for transfers of remittances across the two countries, but we retain the assumption that workers stay in the host country for a very long period. Also, we assume that the remittances are allocated between saving and consumption in the same proportion as the income generated inside the country. Since the propensity to save in the developing country is low, most of the remittances are thus used for consumption. The results in Figure 17 indicate that in this scenario the disparities in income between the two countries tend to reduce only slowly, and migration remains high throughout the scenario, with a tendency to decrease in the long run. In this case, the inequality-boosting action of the loop R1 is partially limited by the balancing loops B1, B2 and B8. Given the initial difference in income, population growth, and labour cost, migration initially starts high. As remittances are sent back, income in the developing country initially increases more rapidly, slowing down migration, loop B8 initially counteracting loop R1. However, since the remittances are consumed and not invested, quality of life and population growth increase, but not domestic productivity, so that production per unit of output falls and income growth eventually slows down. At the same time, population growth in the developing country accelerates, thanks to the increased quality of life. Low productivity and abundance of labour in the developing country cause the balancing loop B2 to offer only a weak response. The country thus becomes dependent on remittances: a large labour force has to be employed abroad in order to obtain sufficient salaries. But in doing so, they further weaken the domestic economy. In the long run the economy of the developing country deteriorates, so that it becomes mainly a reservoir of cheap labour for the industrialized country. Interestingly, income in the industrialized country also tends to decrease in the long run, as the incoming migrant workers are increasingly less skilled, and productivity is, consequently, reduced.

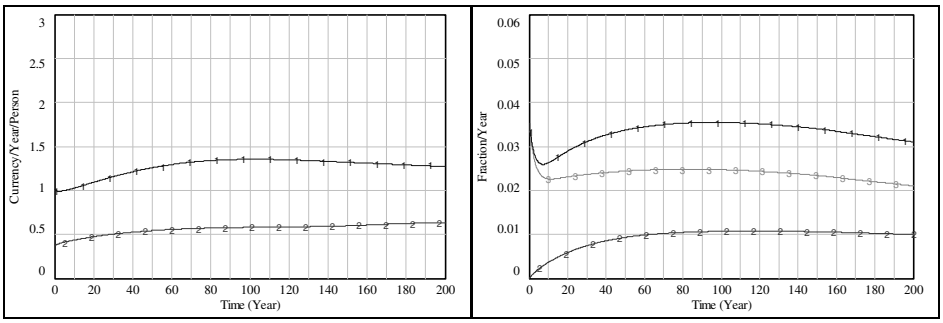

Figure 17: Scenario 3: Remittances and Late Return. Left-hand graph: per capita output in the industrialized country (line 1) and in the developing one (line 2); right-hand graph: adult emigration rate (line 1), adult re-immigration rate (line 2) and adult net migration rate (line 3).

In our fourth scenario, the assumptions remain the same as in the second scenario, i.e. we allow for no remittances, but with the difference that migrant workers stay in the host country for a shorter period (on average 20 years), i.e. a large share of them returns to their home country before retiring. The results portrayed in Figure 18, indicate a limited but steady growth in the per capita output of the developing country and a faster growth in the industrialized one than in the previous scenario. In this case, the negative effects of the R1 loop are being compensated for (with some delay) by the balancing loop B4. The large initial migration leads, after some time, to a large return migration of skilled workers, leading to an increase in human capital, higher productivity, and higher income in the developing country, which reduces migration in the long run. In addition, the higher level of education in the developing country also leads to a reduction in fertility and thus in population growth, which in the long run help maintaining net migration at a lower level than in the previous scenario (loop B10). On the other hand, as education improves in the developing country, the labour force becomes more demanded by the industrialized country, facilitating migration, as described by the loop R4. Interestingly, this also benefits the industrialized country: the higher level of human development in the developing country also implies that resources are available to train the young people, so that those migrating to the industrialized country are more productive.

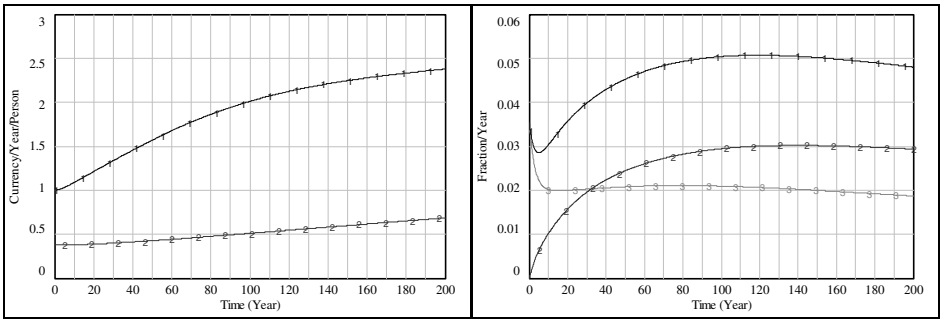

Figure 18: Scenario 4: No Remittances and Normal Return. Left-hand graph: per capita output in the industrialized country (line 1) and in the developing one (line 2); right-hand graph: adult emigration rate (line 1), adult re-immigration rate (line 2) and adult net migration rate (line 3).

In our fifth scenario we allow for transfers of labour and remittances across the two countries, and we assume that the remittances are allocated between saving and consumption in the same proportion as the income generated inside the country. Results in Figure 19 indicate that, in this scenario, the income inequality between the two countries tends to be reduced. In this

case, the loss of labour is compensated by both the loop B4 (as in the previous scenario) and the loop B8. Income in the developing country grows faster than in the previous scenario, thanks to the remittances. On the other hand, the income of the industrialized country grows slower, as part of the value added there is being sent back to the developing country. Consequently, net migration decreases at an increasing rate in this scenario. However, throughout this scenario, remittances account for a large share of the income in the developing country, diminishing only slowly in the long run. This implies that the developing economy is partially dependent on remittances, making it particularly vulnerable: a reduction in migration or remittances would, therefore, considerably hurt the country.

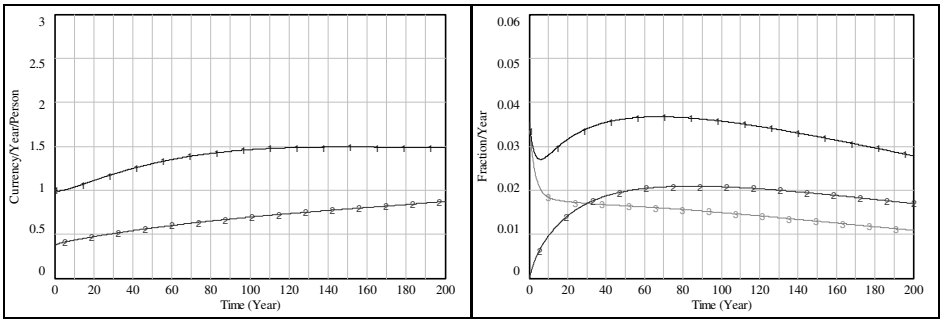

Figure 19: Scenario 5: Remittances are Consumed. Left-hand graph: per capita output in the industrialized country (line 1) and in the developing one (line 2); right-hand graph: adult emigration rate (line 1), adult re-immigration rate (line 2) and adult net migration rate (line 3).

In the sixth scenario we allow for exchanges of both labour and remittances, and we assume that 30% of remittances are invested in physical capital. As Figure 20 shows, under these hypotheses convergence in income of the two countries is almost achieved in the long run, and migration is reduced nearly to zero. In this case, in addition to the loops B4 and B8 (as in the previous scenario), the loop B9 also contributes to increase income in the developing country and to reduce migration. Emigration is initially large, as differences in income and quality of life are significant. As the immigrants generate income in the industrialized economy, they send home part of their savings. Part of these remittances is invested, leading to a more rapid physical capital accumulation in the developing country, and thus to a rise in production. This effect is further amplified by the R2 and R3 loops, accelerating growth in the developing country. Benefitting from the better education of migrant workers, production in the industrialized country also grows faster than in the previous scenario. However, productivity growth in the industrialized country tends to slow down earlier than in the developing one, as diminishing returns kick in. On average, income in the developing country grows faster, and income disparities are almost eliminated. Differently from the previous scenario, in this case quality of life in the developing country is increased also thanks to the additional domestic production generated within the country, and not only by directly consuming the remittances received from the industrialized country. This has two advantages: first, the improvement in quality of life obtained is self-sustained, i.e. a sudden cut of remittances would not cause a sudden drop in domestic income and its contribution to the quality of life. Second, the economy does not become addicted to migration: the improvement of the local economy leads to better job opportunities and salaries locally, reducing the push for migration.

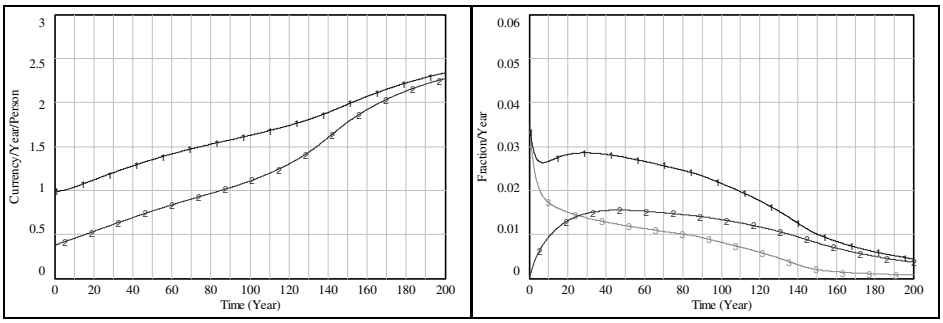

Figure 20: Scenario 6: Remittances Invested. Left-hand graph: per capita output in the industrialized country (line 1) and in the developing one (line 2); right-hand graph: adult emigration rate (line 1), adult re-immigration rate (line 2) and adult net migration rate (line 3).

In the seventh scenario analyzed, we retain all the assumptions of the previous scenario, and we also allow for migrant workers to carry along part of their children. As Figure 21 shows, in this case income convergence happens even faster than in the previous scenario, and net migration also falls more rapidly, becoming negative in the long run. This is due to the combined action of loops B5, B6 and B7. As a direct effect of children migration, the size of the labour force relative to the total population in the developing country does not fall as fast as in the previous scenario, so that per capita income in the developing country is not negatively affected as much. Also, the smaller population of children implies a larger amount of resources available for the education of each of them, who will eventually grow up to become more productive workers. Moreover, the migrants' children who will start working in the industrialized country will send additional remittances and, upon their return, will carry skills and competences that will further increase domestic productivity. Finally, the outflow of children also reduces the population growth faster that in the previous cases, helping to maintain a low net migration rate.

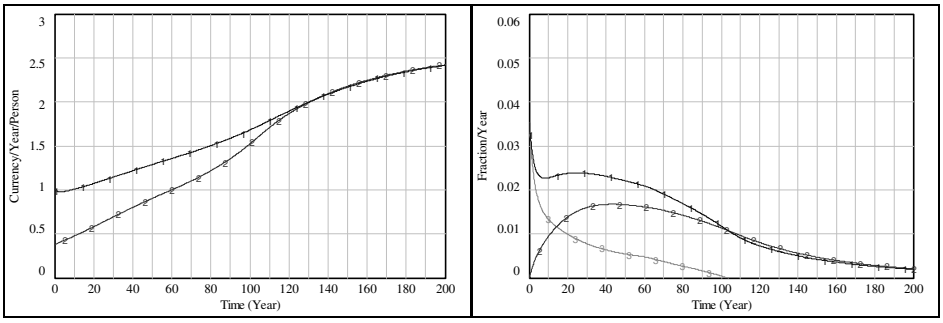

Figure 21: Scenario 7: Children Migration. Left-hand graph: per capita output in the industrialized country (line 1) and in the developing one (line 2); right-hand graph: adult emigration rate (line 1), adult re-immigration rate (line 2) and adult net migration rate (line 3).

Building up on the assumptions of the previous scenario, in the eighth scenario we also allow for naturalization of part of the migrants' children in the industrialized country. As illustrated in Figure 22, this has the effect of slightly slowing down the income convergence, as loop B7 is weakened. In this case, part of the migrants' children coming to working age in the industrialized country is naturalized and thus become permanent part of the industrialized country workforce. This implies that it is less likely that these workers send remittances back home, and, most importantly, such workers are unlikely to return to their country of origin and thus bring back their skills and competences. Still, income convergence is achieved, although

a bit slower than in the previous scenario. Interestingly, in the beginning income in the industrialized country grows slightly faster than in the previous case, but eventually it slows down. Initially the lesser amount of remittances sent back increases income, but eventually the additional workers who retire in the industrialized country reduce the amount of income per capita.

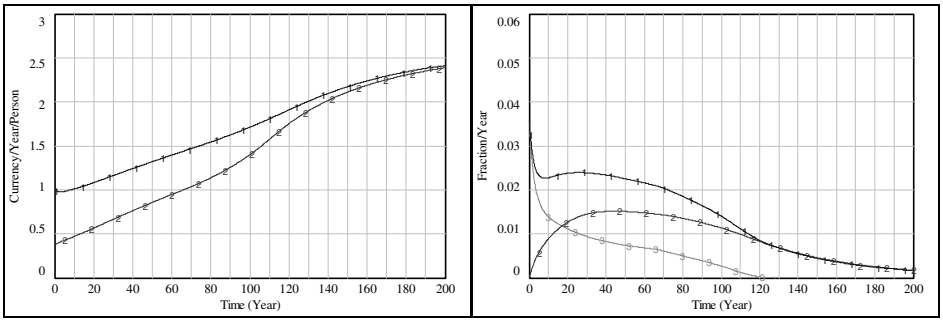

Figure 22: Scenario 8: Children Naturalization. Left-hand graph: per capita output in the industrialized country (line 1) and in the developing one (line 2); right-hand graph: adult emigration rate (line 1), adult re-immigration rate (line 2) and adult net migration rate (line 3).

In our ninth scenario, instead of considering children migration, we start from the assumptions of the sixth scenario (free migration and remittances invested) to test how a more rapid return of migrant workers affects the development dynamics. Specifically we assume that migrants stay an average of 10 years away from their home country. The graphs in Figure 23 indicate that, in this case, income convergence happens at a slower pace than in the sixth scenario, while net migration decreases slightly faster. In this scenario, the B4 loops works faster than in the sixth scenario. On one hand, as the average residence time of migrants in the host country is shorter, they have less time to accumulate skills and competences. As a result, when they return to their home country, each worker contributes to a lesser extent to building up local human capital. On the other hand, the flows of migration are also significantly intensified, so that, eventually, human capital in the developing country grows faster than in the sixth scenario. However, in a context of diminishing pressure for migration, as re-immigration increases, migration raises to make up only for part of the returning workers. This causes the amount of migrants working in the industrialized country at any time to be smaller, and thus the remittances sent back to be less, weakening the loops B8 and B9. The balance between increase in human capital and loss in remittances is close, and sensitive to our assumptions regarding the amount of remittances per migrant worker, the time required to acquire education in the host country, and the actual cost of education in the two countries. In this case the final result is a slightly slower convergence. A convergence based more on education and less on remittances is, however, less fragile and more easily sustainable in the long run.

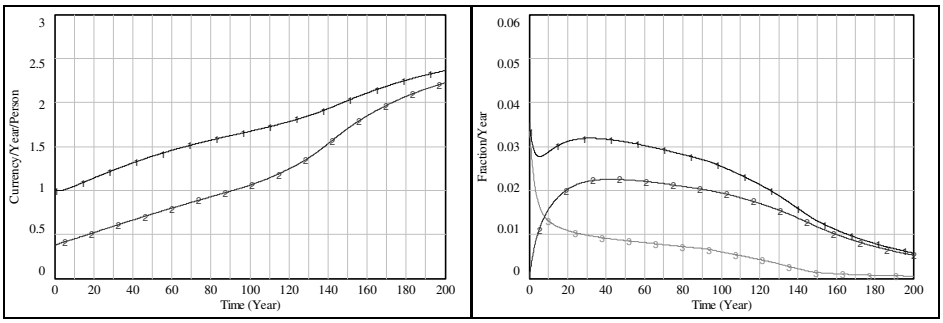

Figure 23: Scenario 9: Accelerated Return. Left-hand graph: per capita output in the industrialized country (line 1) and in the developing one (line 2); right-hand graph: adult emigration rate (line 1), adult re-immigration rate (line 2) and adult net migration rate (line 3).

In the tenth scenario, starting again from the assumptions of the sixth scenario, we test the impact of intensive training for migrants workers in the industrialized country. More specifically, we assume that it takes for migrants workers half of the time to acquire a similar level of skills of local workers than we considered in previous scenarios. The results illustrated in Figure 24 indicate that, in this case, income convergence is slightly faster than in the sixth scenario, and with an important difference: in this scenario the income of both countries grows significantly faster. This is due to a stronger contribution of the loop B4, and to the amplification effect of loops R2 and R3. As migrants worker in the industrialized country acquire skills more rapidly, they tend not only to increase productivity in the host country, but upon their return, to do so also in their home country. Increased productivity leads to more resources available for investment in both physical and human capital, thus leading to faster growth in both countries: a win-win situation.

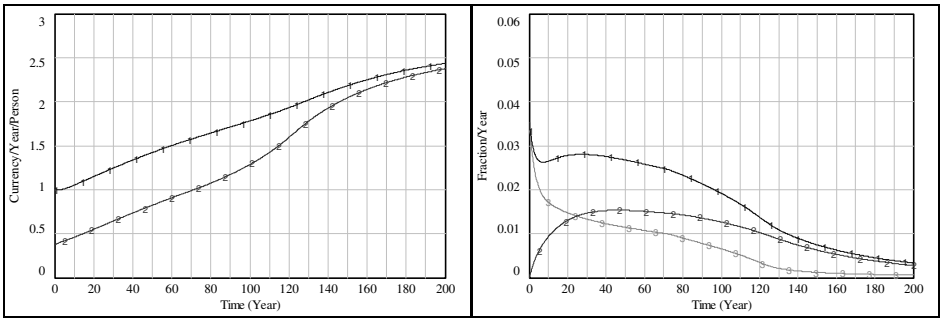

Figure 24: Scenario 10: Intensive Training. Left-hand graph: per capita output in the industrialized country (line 1) and in the developing one (line 2); right-hand graph: adult emigration rate (line 1), adult re-immigration rate (line 2) and adult net migration rate (line 3).

Throughout this section, we analyze ten basic scenarios illustrating migration dynamics under alternative conditions. These conditions are unlikely to exist in this stylized form to a full degree in any economy, as countries are more likely to experience some mix of the conditions and dynamics illustrated above. Nevertheless, by analyzing these scenarios, we can derive some preliminary policy insights. First, we observe that not allowing any migration does not facilitate income convergence. The two countries develop their human and physical capital in an isolated way, and convergence can only happen over a very long period of time. We also observe that, once we allow for migration, two conditions are fundamental for the local economy to sustainably grow and not become dependent on migration: (1) The flow of remittances is at least partially invested; and (2) Migrants should return to their country of

origin while still economically productive. Investment of remittances and return of productive workers generates acceleration in the accumulation of physical capital and human capital. This leads to endogenous economic growth and, eventually, to convergence of the two economies.

We also observe that, when migrant workers bring along their children, income convergence tends to accelerate, which leads to a lower pressure on public services in the developing country and to an increase in the chances for the migrants' children to receive proper education. Naturalization of a part of those children does not seem to substantially harm the process. Our results also indicate that a rapid return of migrant workers leads to a reduction in the flow of remittances, and to an increase in the rate of accumulation of human capital. The balance between the two effects is close, and, although in our example the convergence happens slower than under the assumption of a longer stay abroad, income growth in the developing country is in the long run more sustainable, driven to a larger extent by human capital accumulation. Finally, we observed that facilitating training in the host country accelerates income growth in both countries, leading to a win-win situation.

4. Conclusions

Migration is one of the most challenging phenomena of our century, and one that is inherently complex. Proper quantitative models are required to fully understand this phenomenon and create coherent policies to harmonize migration with a rapid endogenous development. In order to provide a comprehensive perspective on migration dynamics, we develop a resource-based migration and development model representing the socio-economic systems of two virtual countries.

By way of simulation we analyze alternative scenarios, and identify mechanisms that shape migration over time. In particular, we identify a set of mechanisms that tend to bring the system towards equilibrium and others that tend to maintain, or even exacerbate, differences between the two countries. Which mechanism prevails, depends on the inherent characteristics of the socio-economic systems of the country of origin and destination respectively. Notably, such characteristics can be shaped by public policies. We conclude that facilitating the investment of remittances, as well as the training and reintegration of migrant workers in their country of origin, are key factors for the two economies to converge. Family reunion seems also to promote convergence and a reduction of migration in the long run.

The model developed in this paper represents the migration dynamics between two generic countries. In reality, different countries have different structural characteristics that altogether determine the balance of force between the mechanisms behind migration. In order to provide country-specific policy insights, this model should be properly customized to represent the real socio-economic systems of the countries being analyzed. Also, it should be integrated with a broader development framework that can take into account, in a more detailed manner, the socio-economic-environmental impacts of the policies being designed. For this reason, the model has been developed so that it can be incorporated into the Threshold 21 model, a comprehensive framework representing social, economic, and environmental aspects of development. By integrating our migration model with T21, we allow for proper consideration of migration issues in the context of development planning. We thus believe that our model complements the existing tools by providing insights into migration dynamics from a resource-based perspective, and supports the mainstreaming of migration in the development agenda.

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