GOSPODARKA NARODOWA

5-6
(261-262)
Rok LXXXIII/XXIV
maj-czerwiec
2013
s. 69-96

Daniel WIŚNIEWSKI*

Temporary Brain Drain, Distance to the Frontier, and Welfare at Origin

Summary: The article analyzes the possible impact of a brain drain on the economies of six selected European countries, suggesting that this impact may be positive in the long run due to a combination of factors including temporary migration, an educational effect and increased capability for technology adoption. According to the author, research shows that temporary migration is a widespread trend that involves a significant number of people, especially during an economic crisis. Recent empirical studies also confirm that temporary migration may have a positive effect on the economies of sending countries, improving their total factor productivity (TFP) and speeding up technology adoption, the author says. The article develops a simple two-period model analyzing the possible "brain gain" pattern resulting from return migration. The model is structured so as to show changes in the human capital of both sending and receiving countries in the short and long run. This mathematical structure is then simulated with the use of statistical data from various sources. Each studied country experiences an unexpected shock resulting in either an increase or a decrease of the brain drain, which is then fixed in the subsequent periods. The empirical results indicate that most developed countries are likely to benefit from a brain gain, whereas poorer states usually experience a brain drain in the long run, the author says. The opposite is true of welfare, he adds: the simulations indicate that poorer countries are likely to experience significant economic growth.

Keywords: brain drain, brain gain, return migration, human capital, technology diffusion, total factor productivity (TFP)

JEL classification codes: F22, O15, J61

Artykuł wpłynął do druku 10 maja 2013 r.

Introduction

Recent studies regarding international migration underline the importance of highly skilled workers emigration from less developed countries to modern

* Cergy-Pontoise University, Doctoral Candidate, Warsaw School of Economics, e-mail: dwisniewski7@yahoo.com

economies. Together with a significant development of transport and information technologies the mobility of skilled individuals has become considerably important. Many well-educated people, especially in science and technology, are attracted by advanced economies, higher wages, better standards of living and greater possibility for personal improvement. As a result, developing economies loose a significant share of their best workers, what eventually cause a constraint for faster technological development.

In contrast to this negative picture, the latest studies on this matter seem to indicate that initial brain drain may positively influence the development of source economies. It is documented that emigrants very often decide to return to their countries of origin after certain period, mostly when they begin to grow, or when unemployment in the host countries increases. This point is particularly important nowadays, when the world economy experiences a severe crisis, which has decreased the number of jobs available in most developed countries. In consequence, these highly skilled individuals use their experience gathered from modern states in the entrepreneurial activities at home.

The second outcome related to the brain drain which may positively influence the development of sending country's economy is called in the literature as the incentive effect. In particular, this term describes an increased effort of people to invest in education, due to a greater possibility for migration. It is proved that highly-educated workers have bigger chance to emigrate to a country with higher returns to skills. Therefore, those individuals who aim at emigrating tend to educate more intensively, what positively affects the general level of schooling. Since a vast majority of people decide to stay at home during their lifetime, it has a positive impact on source country's human capital.

Another important gain which may be derived from initial emigration and subsequent return of highly-skilled labor may be obtained from bringing new technologies to the source economy. In such a situation, emigrants who worked abroad may come back to their home countries with sufficient knowledge and resources to begin the development of technologically advanced sectors. It has been observed that returnees are very important channel of technology diffusion form developed to developing countries. Moreover, these experienced returnees increase the Total Factor Productivity of sending economy, what positively affects the capability of the source economy for technology adoption.

Finally, there exist one more positive result from significant emigration of highly skilled workers, which however is not a subject of deeper discussion in this paper, that is obtained from remittances. These amounts of money which are sent from emigrants to their family members, may also be used for development of entrepreneurial activities, or invested in further education. Yet, the literature seems to reject this hypothesis, stating that vast majority of this capital is spent for consumption.

The existing literature confirms the importance of all ingredient of this research, including return migration, possible brain gain and technology diffusion. Therefore, this paper provides a comprehensive discussion about possible effects of these three phenomena, using a stylized overlapping

generation model of human capital accumulation and endogenous growth in the open-economy framework, which is based on the theoretical setting presented by Docquier and Rappoport [2011]. This model considers human capital as the amount of knowledge, skills and experience in particular society. Subsequently, the model will be extended to the case of migration of best-educated individuals to measure the impact of a brain drain for the source country. Finally, this methodology also considers return migration and the brain gain.

The model is, then, calibrated with statistical data from various sources, and the values of parameters consistent with the literature. Moreover, this theoretical framework is used in simulation to display the dynamics of the process of the brain gain. Ultimately, these simulations allow to understand, what is the real impact of initial brain drain which in the future may be reshaped into a significant brain gain.

The analysis is structured as follows: section 2 is devoted to a brief review of the literature of interest including the brain drain, brain gain, return migration and technology diffusion. Section 3 develops a model of human capital accumulation with endogenous growth, and provides theoretical background for further considerations. Section 4, is devoted to analyze the results of simulations of the theoretical model, while section 5 concludes.

Literature Review

Contemporary literature provides various papers regarding brain drain, temporary migration and technology diffusion. In this section, I develop a broad discussion about all these concerns in order to ensure sufficient background for further considerations.

Brain Drain

The matter of the brain drain has significant negative connotations, describing a process of skilled-labor outflow from less developed countries to technologically advanced economies, capable to absorb these individuals. Together with a considerable increase in international migration, driven by the development of transport technologies, the issue of the brain drain has become very important, especially for developing economies suffering from the lack of well-educated labor force.

Nowadays, the term brain drain is usually used to describe emigration of nations' most-skilled and educated individuals. Rapoport and Docquier [2006] defined this phenomenon as 'migration of engineers, physicians, scientists, and other very highly skilled professionals with university training'. Although the brain drain is mainly considered as migration between countries, this process has been also noticed at the domestic markets, for example as the outflow of best-educated from rural areas to towns.

Although it is well documented that international migration has increased from 75 million in 1960 to 190 million in 2005, the overall percentage of people

migrating has slightly changed from 2.5 to 2.9. Nevertheless, if we consider the migration of best-educated individuals from less developed countries to high-income states, we can observe different results. The share of foreign-born individuals in the richest countries has tripled within these 45 years [Docquier and Rapoport, 2011, p. 2]. Simultaneously, the level of schooling of these immigrants is also rising. Therefore, the issue of the brain drain has become of vital importance to economists and policy-makers around the world.

The first stream of economic thought concerning the brain drain emerged at the second half of 1960s, and consisted mostly of welfare analyses in trade-theoretic frameworks. This group was lead by such research projects as Grubel and Scott [1966], Johnson [1967], and Berry and Soligo [1969], and contributed to the literature by stating that the brain drain does not have any impact on the source countries, and underlined the positive effects of free migration to the world economy. This general notion was explained through putting a strong emphasis on remittances, and assets left by emigrants at home country, what compensate the brain drain.

The second group of economists considering this phenomenon was formed during late 1970s under the leadership of Jagdish Bhagwati. Unlike their predecessors, this stream aimed at presenting negative consequences of the brain drain which arise from labor markets rigidities, informational imperfections or fiscal externalities. The papers published by Bhagwati and Hamada in 1974 or McCulloch and Yellen in 1977 emphasized that the emigration of high-skilled individuals is the main contributor in widening economic inequalities between richer and poorer countries. Simultaneously, the methodology of researching the brain drain changed from international trade to endogenous growth framework.

The third approach toward the brain drain crystallized in the late 1990s. In consequence of deeper debate and intensive research on this matter, the economists documented ambiguous impact of skilled-labor emigration on economy. Therefore, the main aim of scholars was to determine under what conditions the net effect on welfare and development is positive or negative. Theoretical literature has shown that, due to certain externalities and under some circumstances, the brain drain may be beneficial for the economy of the source country. Simultaneously, some empirical studies, conducted thanks to a better availability of statistic data, proved theoretical findings and confirmed a more balanced picture of this issue.

Such a long time of scientific research on the brain drain resulted in many interesting findings on this matter. A key paper on human and physical capital accumulation and international trade was written by Lucas [1988]. Although these models were constructed in order to describe economic growth, they subsequently were emplyed in projects on brain drain. The author presented three separate models which became a starting point for numerous research projects. The first model in the paper is devoted to physical capital accumulation and technological change. The second considers human capital accumulation through schooling, whereas the final model describes human capital accumulation as a process of learning-by-doing.

These theoretical models were subsequently confirmed by Barro [1991) and Mankiw et. al. [1992] who proved that the level of schooling across countries is a significant variable in explaining the differences in growth rates between states. In the latter years the main focus of scholars was put on representative agent models in which the level of education differs endogenously among agents. This approach was represented for example by Galor and Zeira [1993] who investigated the impact of distribution of education levels on the economy.

Mayda [2010] evaluated the role of push and pull factors in international migration showing that the impact of push factors on aggregate emigration flows is rather small in comparison to those of distance and pull factors. These conclusions have also evaluated empirically by Docquier, Lohest and Marfouk [2007] who employed the OLS estimator with White's correction for heteroskedasticity. The results for developing countries indicated that high-kill emigration is less sensitive for geographical variables, like for example distance. Additionally, emigration of highly educated increases with the degree of religious fractionalization, and decreases with the level of development at origin.

Simultaneously, some studies were conducted in order to determine the pattern of selection in international migration. Grogger and Hanson [2008] employ the DLM bilateral emigration stocks and rates observed in 2000 and wage distribution by skills and occupations, in order to explain key drivers of international migration. According to their results, migrants are positively selected, meaning that those with better skills and education are more prone to migrate. Moreover, the authors also found that among the migrants there exist a positive sorting effect which implies that best-skilled labor tend to locate in those countries with the highest returns to skills.

Finally, a recent paper by Beine, Docquier and Ozden [2010] considers the size and composition of bilateral migration flows. Taking into account the usual determinants of migration and potential endogeneity biases, they prove that larger diasporas increase the size of migration flows and decrease the education level of new migrants. In fact, this statement is a confirmation of of the existence of joint network externalities and lower migration costs cause by a strong diaspora.

Temporary Migration

Contemporary literature confirms the hypothesis that return migration is an important issue affecting the consequences of international migration. Although it is difficult to measure the scope of this phenomenon from statistical data of the source country, several studies have quantified the share of migrants who come back, after certain period of time, to their countries of origin. According to these estimations, this share varies from 25 to 40 percent of all emigrants.

Similar results have been obtained in several empirical studies on return migration. Dustmann and Weiss (2007) prove that even one half of all immigrants to the UK between 1992 and 2002 returned to their countries of origin within 10 years of their arrival. In their paper, the authors developed a simple model

which captures this idea in order to search for motives that pull the immigrants back to the source country, despite higher wages in the host state. Finally, they concluded that there exist three major incentives which may govern such individuals: (i) differences in relative prices between host and home country, (ii) complementarities between consumption and the location where consumption takes place, and (iii) the possibility of accumulating human capital abroad, which enhances the immigrant's earnings potential back home.

In the paper by Böhning [1984] the scale of return migration has also been studied. According to the results, it is clearly stated that even more than two thirds of all foreigners admitted to Germany within the years from 1950s to 1970s returned back home. Even more striking situation was observed in Switzerland, where more than four-fifth of all immigrants, inhabited this country only temporarily.

The importance of return migration has also been confirmed in the study prepared by OECD [2008] which underlines that a share of 25 to 50 percent of all immigrants to European states has emigrated elsewhere within 5 years. We may only anticipate that most of them returned to their countries of origin. Simultaneous estimations were conducted in France by INSEE (1995) which indicated that 25 percent of guest workers intend to return home. The most important finding, however, was that one third of them were highly skilled workers.

Return migration has also been observed in the United States. Jasso and Rosenzweig [1982] estimated that within 50 years between 1908 and 1957 about 15.7 million individuals immigrated to the US from which 4.8 million emigrated. That is consistent with the other findings, since the return migration ranges around 25 percent. Interestingly, this pattern of return migration of legal immigrants increased during 1970s even up to 50 percent. Similar results were also presented by LaLonde and Topel [1993] who reported that around one third of immigrants to the US between 1890 and 1957 returned home.

Dustmann [1996] provides important characteristics and incentives which influence the propensity of individuals to return to their countries of origin after several years of staying abroad. His empirical study confirmed that the chance of return increase together with age at entry but also decrease with the number of years of residence in the host country. Moreover, the remaining years in home country decrease with longer stay abroad and age at entry. Finally, the results of this study suggest that economic benefits are the larger, the earlier it is certain whether it is only temporary or permanent residence. In other words, the migrants may gain more if they manage to specify their nature of stay as soon as possible.

Apart from influential literature confirming the importance of return migration, there exist also several theoretical and empirical studies which search to model the decision-making of agents about possible emigration and return. These papers aim to specify who and under what circumstances is more predestinated to migrate and return after certain period of time. Simultaneously, these models also discuss the impact of these decisions for the economies of host and source countries.

This approach is successfully applied in the paper by Adda, Dustmann and Mestres [2006] who constructed a dynamic model describing the return migration and filled it with panel data from Germany for the years 1984-2003. The agents in the model make their decisions in each period about extending their stay for another year in the host country or return home permanently. These decisions are taken on a basis of comparisons between the discounted flow of utility related to both options which depend on the capital invested in each country as well as on a series of stochastic shocks.

The return migration has been also presented in partial equilibrium framework. In the paper by Mesnard [2003] a representative worker chooses his own life cycle utility, simultaneously deciding about the duration of migration period and occupation after return. The agent exists in a world with imperfect capital markets in which he aims to overcome liquidity constraints in the home country by accumulating savings in the host country. This methodology allowed the author to prove that migrants do not necessarily return earlier if they acquire enough capital to invest after return in their country of origin.

All these research projects suggest that return migration is a significant process which may influence development of source countries. Moreover, these studies also confirm that it is a sizeable phenomenon which have to be taken into consideration for quantitative assessment of the effects of migration. Nowadays, when the world economy experiences a disastrous crisis causing excessive unemployment, the return migration may be even more prominent. Many foreign workers who face severe conditions on the labor market in the host country, decide to return home. Therefore, it necessary to reconsider the effects of this phenomenon on growth of the sending countries.

Brain Gain

In the recent literature on brain drain and return migration, there have been several studies indicating that emigration of highly-skilled labor together with considerable probability of return to their countries of origin, may positively affect the economic development of the source countries. It is documented that returnees may become an important source of entrepreneurial activities especially in modern technologies.

One of the initial papers which discussed the possibility of a brain gain in relation to initial brain drain in a world of asymmetric information was written by Stark, Helmenstein ans Prskawetz [1998]. The authors proves that migration of high-skill labor may lead to a higher average level of human capital per worker due to educational incentive.

Similar results were presented by Mountford [1997] who considered a possibility of temporary migration as an incentive for individuals to pursue higher education. As has been mentioned above, the probability for migration increases together with higher educational level. Therefore, people willing to emigrate tend to invest more in schooling in order to rise their probability for migration to high-income countries. This kind of mechanism, combined

with uncertainty of migration may lead to the increase of human capital of the source country.

These arguments are emphasized in the paper by Constant and Massey [2002] who compared the notions of neoclassical and new labor economics perspectives on migration. Whereas, the first approach considers emigration as a permanent decision taken in order to maximize the lifetime earnings, the latter perceives this phenomenon as a temporal residence in the host country used in order to overcome market differences at home. This difference result in drawing up two separate models which derive predictions about how some variables are going to influence return migration. The authors also indicated that the return of emigrants may determine a significant technological boost for the economy of sending country.

A great example of positive impact of initial brain drain changed into a significant brain gain due to return migration can be observed in India's IT sector. This phenomenon was documented in the paper by Commander et. al. [2008] in which the authors aimed to measure to what extent the emergence of India's Silicon Valley was correlated with the return of highly-skilled workers experienced in modern economies in the US and Europe. In fact, they found that most of individuals participating in the development of IT sector in India have some work experience from abroad. After certain period, these highly educated individuals returned to India and began to invest in modern technologies.

Similar results were obtained by Mayr and Peri [2009] who proposed a simple tractable overlapping generations model which provides economic rationale for return migration and specify who will migrate and who will return, after some period of time, among agents with heterogeneous abilities. If migration is uncertain, the incentive effect may, to some extent, counterbalance the brain drain. Moreover, if it is coupled with return migration, both may result in a brain gain, even though the returnees are negatively selected. The simulations conducted with plausible parameter values have confirmed these hypotheses.

The issue of the brain gain is also considered in the paper by McCormick and Wahba [2001] which focuses mainly the effects of labor migration on the economies of least developed countries (LDCs). The authors study the linkages between overseas employment, savings and entrepreneurial activity on return. They find important evidence that both overseas savings and the duration of stay increase the probability of becoming an entrepreneur amongst literate returnees to Egypt. Simultaneously, in case of illiterate individuals, only overseas savings have positive effect on the probability of becoming an entrepreneur. The former persons are able to gather some useful experience and knowledge during their stay abroad, what increases their chance for starting their own business. On the other hand, the latter group of people usually accept manual jobs which do not provide much possibility for learning.

Some interesting findings were made by Zucker and Darby [2007] who followed the careers 1984-2004 of 5401 star scientists listed in ISI HighlyCitedSM as the most cited researchers in the world. Although a majority of them reside in the United States and work at most prestigious universities,

a significant number return to their countries of origin and contribute to the overall development of particular scientific field at home. Moreover, the results of this research also showed that very often these star scientists work as a start-ups of modern technology sectors in developing countries.

Methodology

This section is devoted to present a stylized model of human capital accumulation of endogenous growth with a possibility to migrate which is subsequently used as a background for further considerations about the effects of the brain drain. This theoretical framework is based on the model prepared by Docquier and Rappoport [2011] for their literature review.

The model describes a world inhabited by individuals and firms living for two periods: youth and adulthood in an open economy framework. Firstly, it is necessary to characterize the production sector, and derive a wage-setting equation as a function of human capital. Subsequently, I focus on determining human capital accumulation and calculate a skill-setting equation endogenizing this process as a function of economic performance.

The Wage-Setting Equation

In the economy, there are physical K_t and human H_t capital in efficiency units accumulated at each period. All these inputs produce an output which is a Cobb-Douglas production function of the form:

$$Y_t = A_t K_t^{\alpha} H_t^{1-\alpha} \tag{1}$$

where A_t is the Total Factor Productivity of the source country. The human capital in this function combines both low- and high-skilled labor which are treated as perfect substitutes. However, in order to introduce certain distinction between both groups, it is necessary to normalize the number of efficiency units to one for low skilled and $1 + \theta > 1$, where $\theta > 0$ for high-skilled workers. Therefore, I can derive the production function in per capita terms which is of the form:

$$y_t = A_t k_t^{\alpha} h_t^{1-\alpha} \tag{2}$$

and combines of stock of physical capital per worker and the average number of efficiency units of labor h_t.

The returns to physical capital are equalized across nations, what determines the movement of this capital among countries. Moreover, I assume that the physical capital depreciates fully in one period, and that each country is characterized by a given risk premium. Having this information, I can derive an arbitrage condition which denotes the equilibrium amount of capital per worker:

$$R^* = \alpha A_t k_t^{\alpha-1} h_t^{1-\alpha} \tag{3}$$

where R^* is the risk-free international interest factor at time t, equal to one plus the interest rate.

The wage rate per efficiency unit equals to:

$$w_t = \alpha A_t k_t^{\alpha} h_t^{-\alpha} \tag{4}$$

Then, it is necessary to present the relationship between the leading and following economies in per capita terms. In order to achieve this aim, I rearrange the equation (3) and substitute it into equation (2). All these calculations deliver the following form:

$$\frac{y_t}{y_t^*} = \left(\frac{A_t}{A_t^*}\right)^{\frac{1}{1-\alpha}} \left(\frac{h_t}{h_t^*}\right) \tag{5}$$

In accordance to this relationship of two countries, we can observe that economic performance is dependent on the ratio of the efficiency units of labor. Simultaneously, we can indicate that the ratio of productivities is a convex function of the productivity ratio.

Additionally, if we use the equation 4 and substitute it into equation 3, we may obtain the ratio of wages between both economies:

$$\frac{w_t}{w_t^*} = \left(\frac{A_t}{A_t^*}\right)^{\frac{1}{1-\alpha}} \equiv \omega_t \tag{6}$$

what also implies that $w_t = (A_t)^{\frac{1}{1-\alpha}}$.

Although, the ratio of wages between both countries (ω_t) does not directly depend on human capital endowments, they play a key role, since the level of human capital determines productivity. Therefore, the total factor productivity is an increasing function of the average quality of labor. This finding may be explained as the outcome of positive impact of the level of human capital on productivity confirmed by the literature. The quality of average human capital influences the capacity of an economy to innovate and adopt new technologies. It has been also proved that a decrease in human capital may result in an increase of the risk premium, and decline of the domestic wages.

Moreover, I assume that $A_t = \lambda^t A_0 h_{t-1}^{\varepsilon}$, where $\lambda^t > 1$ is a variable capturing possible common trends in technological progress and ε denotes the elasticity of productivity to human capital. Analogically, $A_t^* = \lambda^t A_0^* h_{t-1}^{*\varepsilon}$ for the leading economy. Therefore, the relationship between both countries may be described as $\frac{A_t}{A_t^*} = \frac{A_0}{A_0^*}\left(\frac{h_{t-1}}{h_{t-1}^*}\right)^{\varepsilon}$.

The Skill-Setting Equation

Recent studies seem to confirm that due to imperfect information and return migration, a significant brain gain, associated with the initial emigration of skilled labor, may occur. In fact, greater possibility to migrate may increase the investment in education of low-skilled workers who aim to relocate to a higher--wage country. Yet, once the real productivity is revealed, the low-skilled workers will either migrate and return or will never leave from their country of origin. Therefore, some additional amount of human capital may be acquired which would have never been gained without the possibility of migration

The second positive effect of the initial brain drain is related to the technology diffusion, and diaspora effect. Primary emigration of labor to technologically advanced countries combined with subsequent return of these individuals, may considerably affect the total factor productivity of the source country and speed up the technology adoption. 'This idea was formalized by Dominques Dos Santos and Postel-Vimay [2003] in a setting where growth is exogenous at destination and endogenous at the country of origin thanks to the knowledge embodied in migrants returning from more advance economy' [Docquier, Rappoport, 2011, p. 29].

First, it is necessary to focus on human capital formation. As has been mentioned above, the model consists of two periods in which rational individuals maximize their utility functions. During their youth, the agents may work for a certain wage w_t and decide whether to invest in education. This decision at time t is denoted by x_t, and may have a value of 0 or 1 respectively to negative or positive answer. If an individual wants to obtain education, he has to bear the cost cw_t in which c captures the fixed effect of the agent's ability to learn. For simplicity, the model assumes that c is uniformly distributed between 0 and 1. In the second period, uneducated people obtain the wage w_{t+1}, whereas their educated counterparts may receive $(1 + \theta)\, w_{t+1}$ which is spent for consumption.

The utility function has a logarithmic form and can be written as:

$$U(x_t) = \ln\left(w_t - \hat{\mu}_t - x_t c w_t\right) + \ln\left(w_{t+1}\left(1 + x_t\theta\right)\right) \tag{7}$$

Where $\hat{\mu}_t$ denotes a minimal level of subsistence when young with the assumption that there is no such threshold in other periods. Having in mind that x_t is a binary variable, it is possible to derive the indirect utility function which has a form:

$$V(x_t) = \ln\left(w_t - \hat{\mu}_t - (1 - s)x_t c w_t\right) + \ln\left(w_{t+1}\left(1 + x_t\theta\right)\right) \tag{8}$$

where $0 < s < 1$ denotes government educational subsidies.

Since the least-skilled individuals do not migrate, the indirect utility function for this group remains the same, however, for the educated people that migrate it changes into:

$$V(1) = \ln\left(w_t - \hat{\mu}_t - (1-s)cw_t\right) + \ln\left(qw^*_{t+1} + (1-q)w_{t+1}\right) + \ln(1+\theta) \quad (9)$$

In accordance to this equation, rational agents have an incentive to invest in education only if $V(1) > V(0)$. Therefore, this condition can be rephrased as function of individual's ability to learn:

$$c < \frac{w_t - \mu}{w_t} \cdot \frac{\theta}{1+\theta} \cdot \frac{1}{(1-s)} \equiv \hat{c}_t \quad (10)$$

Since we know that c has a uniform distribution, then the critical value $\hat{c}_t$ is equal to the proportion of people opting for education when young. As can be observed, this proportion increases with wage w_t and the skill premium θ in the home country.

Let assume that returnees are endowed with a productivity gain η per unit of time spent abroad which is described by a fraction of individual's adulthood $0 < q < 1$. Then, I can express the same function with a minimum level of subsistence in more developed countries: $\hat{\mu} = \mu \cdot w^*_t$. Then the proportion of high-skilled people in the economy becomes:

$$\hat{c}_t = \left(1 - \frac{\mu}{\omega_t}\right) \cdot \left(1 - \frac{1}{(1+\theta)\left(1 + \frac{q}{\omega_{t+1}}\right)}\right) \cdot \left(\frac{1}{1-s}\right) \quad (11)$$

which is increasing with q, if $\omega_{t+1} < 1$. This relationship indicate that the brain gain may be achieved if the fraction of time spent abroad q is not too large, and if the differentials in skill prices is neither too small nor too large.

Now we can consider the equation of human capital growth rate in which each person has m children. Then, the average level of human capital can be displayed as:

$$h_{t+1} = 1 + \frac{\theta}{1+m} \cdot \frac{(1-q)\hat{c}_t(1+\eta q)}{1 - q\hat{c}_t} \equiv H(\omega) \quad (12)$$

which constitutes the wage-setting equation for an open economy with migration. In consequence of the balanced growth path, each extensive variable grows at the constant rate, and all intensive variables reach the steady state. Therefore, the equation 13 should finally be subscribed as $h_{ss} = H(\omega_{ss})$.

In accordance to this equation, the return migration may positively affect the productivity of the sending country if, for a given value of $\hat{c}_t$, the skill premium remains $\eta > \frac{1-\hat{c}_t}{1-q}$. This relationship indicates that the greatest positive impact of return migration may be achieved when η and $\hat{c}_t$ are large, and the time spent abroad q is low.

Empirical Results

The model presented above is designed in such a way to describe the effects of the brain drain in the short- and long-run. It posses a possibility to observe, how a particular economy would respond to an unexpected shock of intensive migration. The main advantage of this mathematical expressions, is that the most of the variables included in these equations have their measurable statistical counterparts sufficient for empirical analysis. In order to conduct this analysis, I will simulate the equations (5) and (12).

The migration between Easter and Western Europe increased significantly form a value close to zero in 1980s, when most of movements between these regions were successfully prevented by the Iron Curtain, to even 10-15% of the population in recent years [Mayr and Peri, 2009, p. 17]. After the collapse of communism in Europe, former satellites of the Soviet Union began their accession procedures to the European Union which were finalized in 2004 and 2007. This political change abolished most of existing barriers and unleashed a new era of intensive migration, mostly from the East to the West. Therefore, possible effects of migration for sending and receiving economies become an interesting scientific questions which are addressed in this section.

In order to conduct an evaluation of the effects of migration of most skilled individuals, I choose six European countries of similar size in terms of population. In particular, I select three highly productive countries from Western Europe, namely Austria Belgium and Portugal, and compare them with three Eastern-European states Bulgaria, Czech Republic and Hungary. Simultaneously, I use the United States as the leader country in terms of productivity per capita that all the European states mentioned above aim to follow. This comparison allows to capture the distance to the frontier of both sets of countries examined in this analysis to the leader.

Initially, I examine the effects of emigration of most-educated workers using the actual rates for the brain drain. Then, I employ several simulations to evaluate, how sample countries would respond to an unexpected shock in the value of high-skilled emigration rate.

Parameter Choice

Table 1 shows the choice of common parameters that are employed during simulations. In part, they are obtained from the literature, and in part they have been chosen to match the data. The value of ε describing the elasticity of productivity to human capital has been chosen from the paper by Docquier and De la Croix [2011]. The value of α is based on the literature regarding international migration for example Urrutia (2001). In the case of θ, its value is set on a basis of computations conducted by Rosenzweig [2007] and [2008]. In these papers, the author estimated an average return to schooling between 7 to 10 percent per year. Taking a medium value from this range of 8 percent, and having in mind that the best-educated individuals obtain 15 additional

years of schooling than their unskilled counterparts, this gives the actual value of 1,2.

Subsequently, h^*_{t+1} denoting the human capital growth rate in the leading country (US) is based on the share of individuals with tertiary education (around 45%) and the value of θ. Finally, the productivity gain acquired from the experience gathered abroad ε is set on a basis of estimations conducted by Mayr and Peri [2009]. According to their results, together with a brain drain value of around 15%, young indicviduals obtain a 5% relative gain in wages in comparison to the autarky.

The other variables are gathered from various statistical sources exclusively for each state discussed in the analysis. The share of individuals with tertiary education in the working-age population denoted as h_t, and the rate of the brain drain q, are acquired from the dataset prepared by Docquier and Marfouk [2005] and the World Bank indicators. The number of children per person m, together with the values of the GDP per capita used in order to derive their ratio between the leading and following countries $\frac{y}{y^*}$ come from Eurostat. The educational subsidy of the government s is obtained from the data on the share of public spending in tertiary education provided by UNESCO. Finally, the value of μ is calibrated in order to match the data on the share of educated individuals.

Baseline Case

In this section, I discuss the assumptions and results of the baseline case which subsequently is employed to conduct two separate experiments, describing possible outcomes of unexpected migration shocks. The initial simulations are run with the use of data concerning the brain drain in 2000 for six European countries. I conduct the simulations for five periods, each consisting of 25 years, from 1975 to 2100. The values of the high-skilled workers emigration are changed in comparison to initial value and then fixed in subsequent periods. As a result, this analysis allows to observe, how an unexpected shock influence the human capital growth rate and GDP per capita ratio. The results obtained from these baseline simulations are displayed in the Appendix B.

Firstly, I would like to analyze the richest and most productive states from Western Europe. The primary country considered in this analysis is Austria, in which around 16% of highly-skilled labor emigrated in 2000. In fact the simulations indicate that, a slight increase in the value of q of around 0,01 would cause a slight increase in GDP per capita ratio with the leading economy, from 67.8% to 67.86%, and a boost in the case of human capital growth rate from 16.13% to 16.20% in the long run. Interestingly, these positive patterns are began with the initial loss in both indicators due to a certain adjustment period.

A similar outcome is acquired from the simulations concerning Portugal. In fact, if in the next periods the brain drain would be slightly increased from 16% to 20%, a small positive effect in the human capital growth rate of

0.22% would be accompanied by a noteworthy improvement in productivity of around 10%. Similarly, as in the case of Austria, this unexpected change in the brain drain value would in the short run cause a decline in the human capital growth rate. Yet, in subsequent periods this pattern is overtaken by the reverse result.

In the case of Belgium, I introduced a slightly higher rate of the brain drain of around 4.59%. In consequence, the simulations indicate that this particular state would be challenged by a significant fall of productivity displayed in the GDP per capita ratio. Specifically, this indicator is going to decline from 64% to 55%. Interestingly, this pattern would be followed by the opposite trend in case of human capital growth which, after initial decline, slightly increases in the same period by 0.01%.

In the opposition to these mainly positive effects foreseen for western economies, the outcome for the second group of countries, consisting of less productive and poorer states, remains rather ambiguous. Although, on the one hand, all of them are going to experience a boost in productivity, yet, this pattern is followed by a significant brain drain. Due to the abolition of existing barriers, the most skilled individuals are more prone to emigrate to a higher-wage country. Therefore, the sending economies suffer from this significant drain which has been confirmed in the simulations.

The described situation might be easily observed in the case of Bulgaria which posses a brain drain rate of around, 3.7% in 2000. When I increase the value of this parameter to 6%, this country in the long-run should be benefited from an enormous increase of productivity, reaching even the value of 21%. Nevertheless, this successful occurrence would be accompanied by a decline of the human capital growth rate of around 0.13%. Similar observations are gathered from the simulations regarding Czech Republic. Although I decreased the value of q from 8.5% to 4%, a considerable increase in GDP per capita ratio of around 20% would be bound with a slight decrease of human capital growth of 0.05%. Finally, decreasing the Hungarian brain drain rate from 14.44% to 11% would lead to the same outcomes as in the previous cases. Thus, an improvement in productivity ratio of around 20%, is followed by a slight decline in the human capital growth rate reaching around 0.2% in the long-run.

In general, the results obtained from all these simulations may be considered as reasonable. The most, developed countries are foreseen to experience a brain gain, whereas the poorer states are predestinated to face the opposite. This phenomenon may be explained by the fact that richer countries attract and absorb well-educated individuals from Eastern Europe. In fact, Austria, Belgium and Portugal receive hundreds of workers from the East in which a part of them is well-educated, young, persons searching for a higher wage abroad.

Experiment 1: No Migration

After this comprehensive discussion about the effects of the brain drain in the case of unexpected shock in the rate of high-skilled labor emigration, it is now

necessary to conduct a similar analysis with no possibility of migration. Such an extension is introduced to evaluate the growth of productivity and human capital in the sending and receiving countries of Europe with no migration. It will also be used as a comparison to the case with free migration. Observations of these simulations are displayed in Appendix C.

In the case of Austria, the abolition of migration would bring very positive effects. The increase in GPD per capita ratios of 2.5% would be accompanied with around 3% boost in the human capital growth rate. Similar notions can be stated in the case of Belgium. Although the abolition of migration has no effect on GDP per capita ratio, yet, the human capital growth rate is considerably affected by this extension. In fact, no possibility of migration, positively affects the former indicator which in the short run increases from 17.85 to 18.4%, and the decreases to the long-run value of 18.2%.

The case of no migration, together with no other changes in parameters' values, would not affect the productivity of Bulgaria. Simultaneously, such a change would not prevent this country from experiencing a brain drain. Yet, the whole slope of human capital growth, having negative trend, is moved upward. Consistent results are also obtained for the Czech Republic case. The abolition of migration, together with keeping fixed the values of other variables, does not affect the GDP per capita ratio, and has a slight positive effect on human capital growth rate.

The same situation is observed in Hungary. In the case of no migration the GDP ratio of this country remains the same, and the brain drain is slightly affected. Although, the abolition of migration leads to a significant increase in the human capital growth rate from 8.7 to 9.9% in the short run, yet, in the long run the brain drain is inevitable and reaches only a bit lower value. Finally, in the case of Portugal, the abolition of migration does not affect productivity ratio, although it moves the slope of human capital growth rate slightly upwards.

All in all, these results exhibits certain common patterns that I would like to discuss. In general, the abolition of migration, together with unchanged values for other parameters, would not have any significant influence on GDP per capita ratio or the rate of human capital growth.

Experiment 2: Doubled Migration Rates

The second extension for this analysis concerning the effects of the brain drain, is to study the behavior of both sending and receiving economies in the case, when the rates of high-skilled labor emigration from 2000 are doubled. The aim of this research is to determine, whether the European countries should implement such policy measures that increase the possibility of migration. The outcomes of these calculations are presented in Appendix D.

The increase of the rate of highly-educated individuals from 16% to 32% changes the initial brain gain into a significant drain in the case of Austria. In particular, such a substantial change in emigration rates decreases the productivity of this state by two percent in the long run. Simultaneously, the

growth of human capital decreases from 16.1% to 13.6% in the same number of periods.

In the case of Belgium, the increase of highly-educated labor emigration has no significant influence on the GDP ratio with the leading country. Yet, a higher brain drain changes the increasing growth rates of the human capital into the opposite trend. In fact, if the emigration of skilled-labor would be doubled, together with remaining the same values of other parameters, the mentioned indicator would decline from 17.9% to 17.3% in the long run. Therefore, Belgium is a good example of a brain gain case which occurred after initial loss of human capital.

An increase of highly-skilled labor emigration from 3.76% to 7.34% has a positive impact on Bulgarian economy. Despite, this change does not alter the ratio of GDP per capita, it decreases the negative impact of the brain drain in the long run. After primary decline in the human capital growth rate, the situation stabilizes and results only in a slight negative result which is much smaller than in the baseline case.

In the case of Czech Republic, an increase of the high-skilled labor emigration do not affect the GDP per capita ratio, and fails to reverse the negative impact of the brain drain on the economy. In fact, the rate of emigration of the best works set up to 17%, results in a significant decrease of the human capital growth rate in the long run from 8.08% in the baseline case to 7.8% in the case with doubled value of q.

The doubling of high-skilled workers emigration rate has a slight negative impact on the GDP per capita ratio of Hungarian economy. This impact is also bound with a higher decrease of human capital growth rate. The negative impact of doubled rate of highly-productive individuals emigration is the most prominent in the case of Portugal. A considerable brain gain, observed in the baseline case, turns out into a substantial drain ranging from 6% to 5.5%. Simultaneously, the GDP per capita ratio is smaller than in the baseline case of around 0.44%.

All in all, the increase of emigration rates of best workers display rather ambiguous results. If the initial brain drain in 2000 is not too large, its double value may have a positive impact on the growth rate of human capital as in the case of Bulgaria. Yet, if the emigration of well-educated persons is substantial, then it usually may turn a brain gain into a significant drain as in the case of Austria or Portugal.

Conclusion

The economic consequences of migration of highly-skilled individuals may be evaluated as ambiguous, in the sample of European countries. In fact, if the recent values of this phenomenon would be slightly changed in the future, the most productive countries from Western Europe would experience a considerable brain gain. This outcome results from fact, that the mentioned economies attract

skillful workers from the East and possess sufficient technology to absorb this additional labor force.

On the other hand, less developed states from Eastern Europe are faced with the opposite effect. Abolition of most of existing barriers to migration results in the emergence of negative outcomes, mostly for human capital growth rates. Despite this substantial brain drain that is displayed in the simulations, those poorer countries are also supposed to experience an increase in productivity. After many years of transformation from central-planned to market economies, these countries are going to grow and converge to the Western European states. The accession to the European Union, and cohesion programs employed in this international framework, may successfully contribute to this process.

Interestingly, the abolition of migration do not significantly affect the GDP per capita ratios or the human capital growth rates in the long. Moreover, when the values of highly-skilled workers emigration are doubled, the simulations provide ambiguous results which depend on the initial value of the brain drain in 2000. If q is not too large, then its substantial increase may have a positive impact on human capital growth. However, if these parameters in 2000 exhibit high values, their doubling would certainly reverse a brain gain into the opposite outcome.

All in all, this analysis indicate that various outcomes may be achieved in different states and cases. In fact, each policy measure that would produce a human capital gain should be exclusively prepared for each particular country. The policy-makers, while creating an appropriate proposal, should take into account all accompanied circumstances, and characteristics of the specific economic environment. These ambiguous results of the presented simulations, underlined that initial emigration of the best workers may eventually produce a brain gain.

Bibliography

Adda J., Dustmann C., Mestres J., [2006], *A Dynamic Model of Return Migration*, UCL, London.

Barro R.J., [1991], *Economic Growth in a Cross Section of Countries*, NBER Working Papers, 3120, National Bureau of Economic Research.

Beine M., Docquier F., Ozden C., [2010], *Diasporas*, „Journal of Development Economics", forthcoming.

Benhabib J., Spiegel M.M., [1994], *The Role of Human Capital in Economic Development: Evidence from Aggregate Cross-Country Data*, „Journal of Monetary Economics", 34, 143-173.

Berry A.R., Soligo R., [1969], *Some welfare aspects of international migration*, „Journal of Political Economy", 77, 5, 778-94.

Bhagwati J.N., Hamada K., [1974], *The brain drain, international integration of markets for professionals and unemployment*, „Journal of Development Economics", 1, 1: 19-42.

Bohning W.R., [1984], Studies on International Labor Migration, London, Macmillan.

Bosetti V., Carraro C., Duval R., Sgobbi A., Tavoni M., [2009], *The Role of R&D and Technology Diffusion in Climate Change Mitigation: New Perspectives Using the WITCH Model*, OECD Economics Department Working Papers, No. 664.

Commander S., Chanda R., Kangasniemi M., Winters A., [2008], *The Consequences of Globalisation: India's Software Industry and Cross-Border Labour Mobility*, „The World Economy", 31 (2), 187-211.

Constant A., Massey D., [2002] *Return Migration by German Guestworkers: Neoclassical versus New Economic Theories*, International Migration, 40, 4, 5-38.

De la Croix D., Docquier F., [2011], *Do Brain Drain and Poverty Result from Coordination Failures?*, CREaM Discussion Paper, No. 09/10.

Docquier F., Lohest O., Marfouk A., [2007], *Brain drain in developing countries*, „World Bank Economic Review", 21, 2: 193-218.

Docquier F., Rapoport H., [2011], *Globalization, Brain Drain and Development*, Centre for Research and Analysis of Migration (CReAM) Working Papers, 1108, Department of Economics, University College London.

Domingues Dos Santos M., Postel-Vinay F., [2003], *Migration as a source of growth: the perspective of a developing country*, „Journal of Population Economics", 16, 1: 161-75.

Dustmann C., [1996], *Return migration – the European experience*, „Economic Policy", 22, 214-250.

Dustmann C., Weiss Y., [2007], *Return migration: theory and empirical evidence from the U.K*, „British Journal of Industrial Relations", 45, 2: 236-56.

Galor O., Zeira J., [1993], *Income Distribution and Macroeconomics*, „The Review of Economic Studies", 60, 1, 35-52.

Grogger J., Hanson G., [2008], *Income Maximization and the Strength and Sorting of International Migrants*, NBER Working Paper, No. 13821, Cambridge, Ma.

Grubel H., Scott A., [1966], *The International Flow of Human Capital*, „American Economic Review", 56, 268-74.

Jasso G., Rosenzweig M.R., [1982, 19, August], *Estimating the Rates of Legal Immigrants Using Administrative and Survey Data: The 1991 Cohort of Immigrants to the United States*, Demography.

Johnson H., [1967], *Some Economic Aspects of the Brain Drain*, „Pakistan Development Review", 7, 3: 379-411.

LaLonde R.J., Topel R.H., [1993], *Economic Impact of International Migration and the Economic Performance of Migrants*, [in:] Rosenzweig M.R., Stark O. (eds.), Handbook of Population and Family Economics, 1 (1), Chapter 14, 799-850, Elsevier.

Lucas R. Jr., [1988], *On the Mechanics of Economic Development*, „Journal of Monetary Economics", 22, pp. 3-42.

Mankiw N.G., Romer D., Weil D.N., [1992], *A Contribution to the Empirics of Economic Growth*, „Quarterly Journal of Economics", 107, 407-437.

Mayda A.M., [2010], *International migration: A panel data analysis of the determinants of bilateral flows*, „Journal of Population Economics".

Mayr K., Peri G., [2009], *Brain drain and brain return: theory and application to Eastern-Western Europe*, B. E. Journal of Economic Analysis and Policy, 9, 1.

McCormick B., Wahba J., [2001], *Overseas Work Experience, Savings and Entrepreneurship Amongst Return Migrants to LDC's*, „Scottish Journal of Political Economy", 28 (2), 164-178.

McCullock R., Yellen J.T., [1977], *Factor mobility, regional development and the distribution of income*, „Journal of Political Economy", 85, 1, 79-96.

Mesnard A., [2003], *Temporary migration and capital market imperfections*, „Oxford Economic Papers", 56, 2.

Mountford A., [1997], *Can a brain drain be good for growth in the source economy?*, „Journal of Development Economics", 53, 2, 287-303.

OECD, [2008], International Migration Report: SOPEMI 2008 Edition, Paris.

Papageorgiou C., Savides A., Zachariadis M., [2007, July], *International Medical Technology Diffusion*, „Journal of International Economics", Vol. 72, No. 2, 409-427.

Rapoport H., Docquier F., [2006], *The economics of migrants remittances*, [in:] S.-C. Kolm and J. Mercier Ythier, eds., Handbook of the Economics of Giving, Altruism and Reciprocity, Amsterdam, North Holland, Chapter 17.

Rosenzweig M.R., [2007, January], *Higher education and international migration in Asia: brain circulation*, paper presented at the World Bank Annual Regional Conference, Beijing.

Rosenzweig M.R., [2008, June], *The global migration of skill*, paper presented at the conference on Migration and Development, Lille.

Segerstrom P., [1991], *Innovation, Imitation, and Economic Growth*, „Journal of Political Economy", 94, 1163-1190.

Stark O., Helmenstein C., Prskawetz A., [1998], *A brain gain with a brain drain*, „Economics Letters", 55: 227-34.

Urrutia C., [2001], *On the Self-Selection of Immigrants*, Manuscript, Universidad Carlos III de Madrid.

Zucker L., Darby M., [2007], *Star Scientists, Innovation and Regional and National Immigration*, NBER Working Paper, No. 13547, Cambridge.

Appendix A: Common Parameters

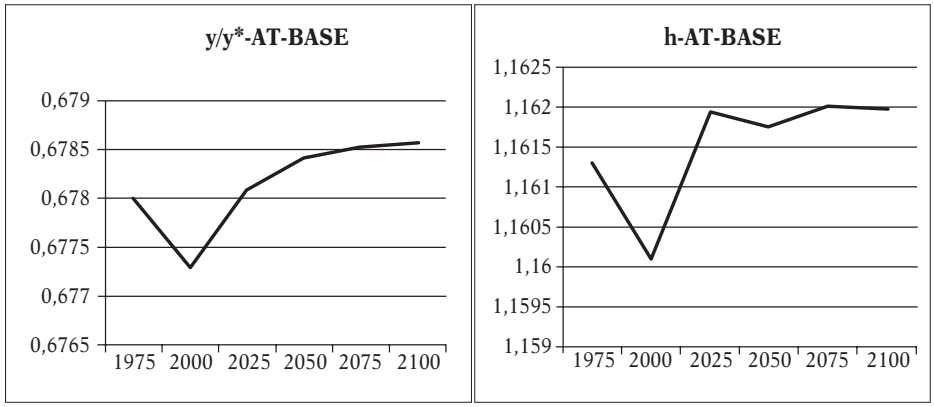
Table 1

Choice of Common Parameters: Baseline

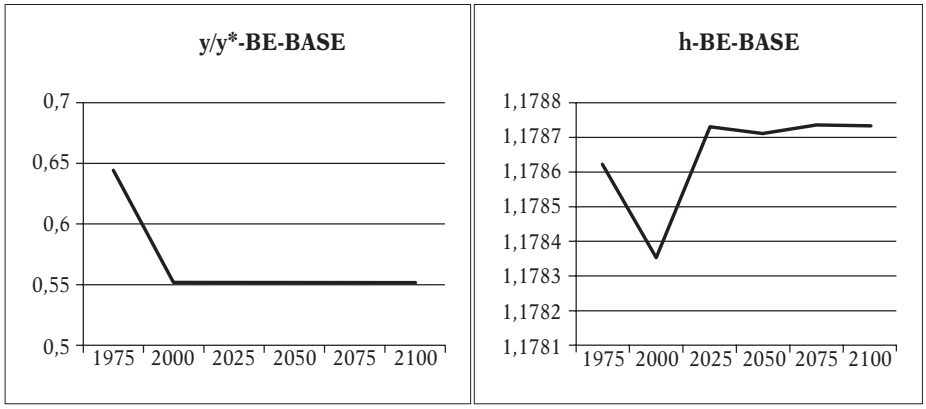
h^*	α	θ	η	ε
1,347	0,3	1,2	0,05	0,28

Appendix B: Basline Case

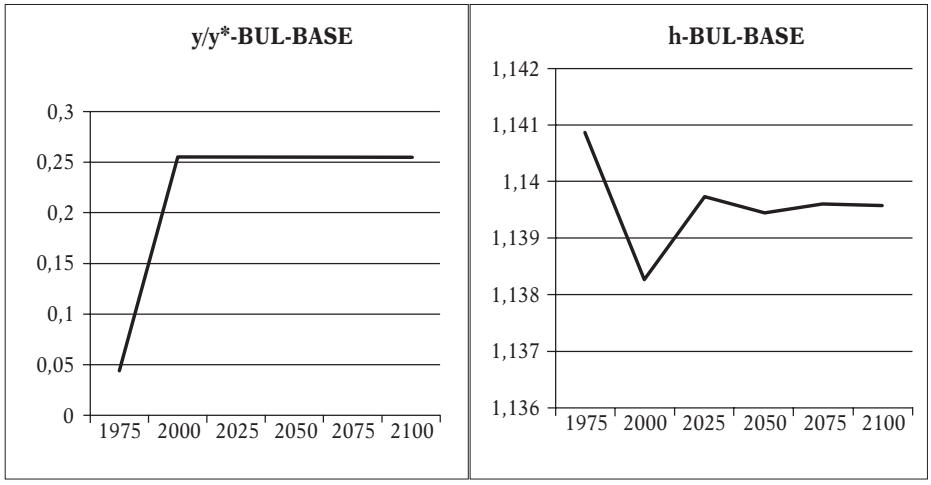
Austria



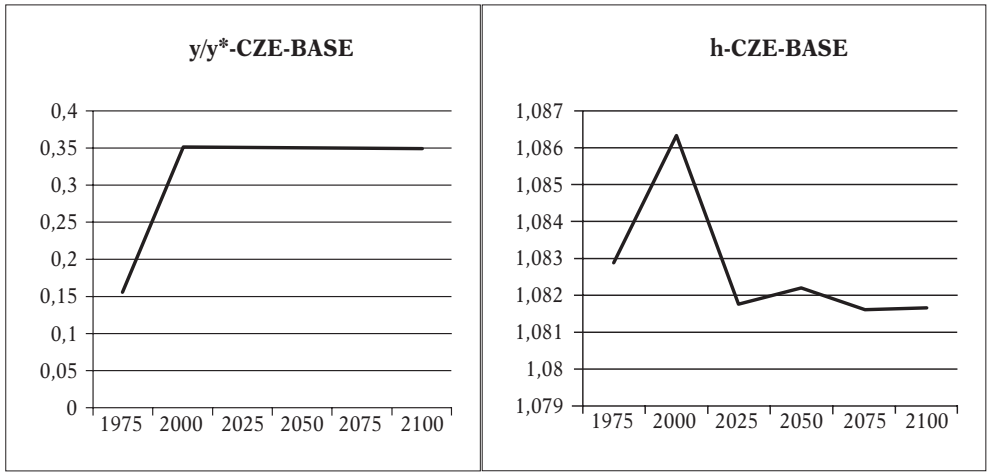
Belgium



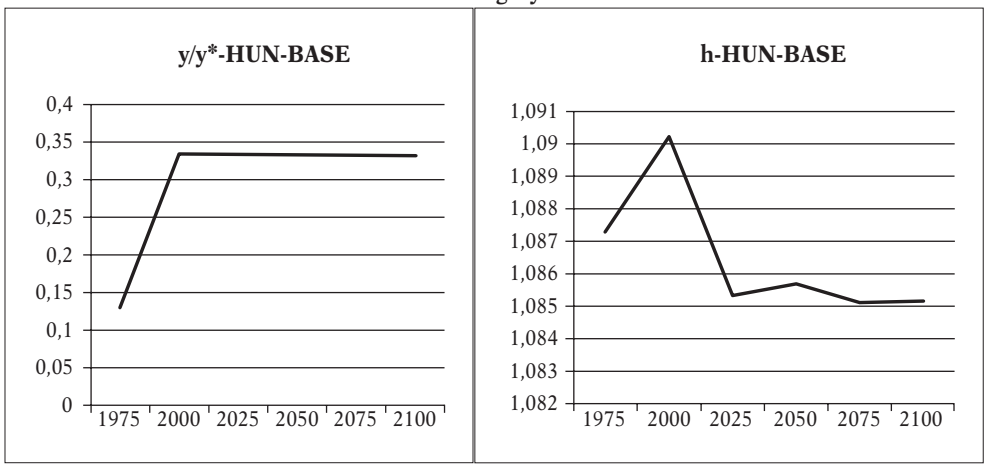
Bulgaria



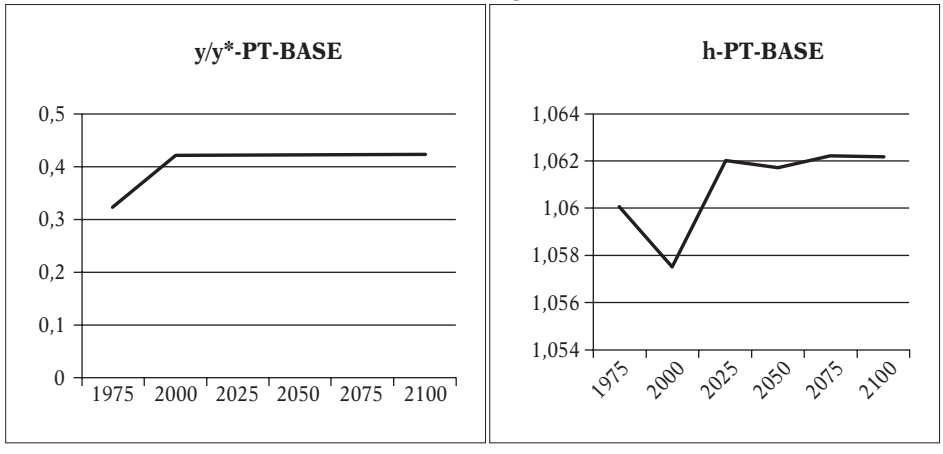
Czech Republic



Hungary

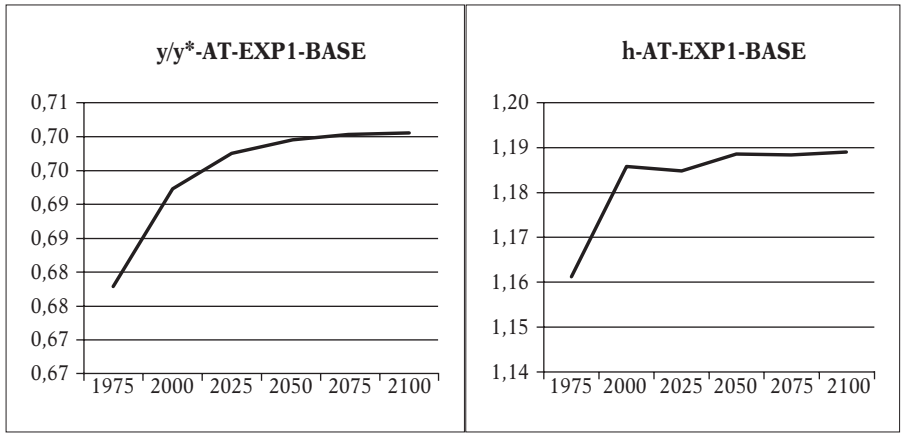


Portugal

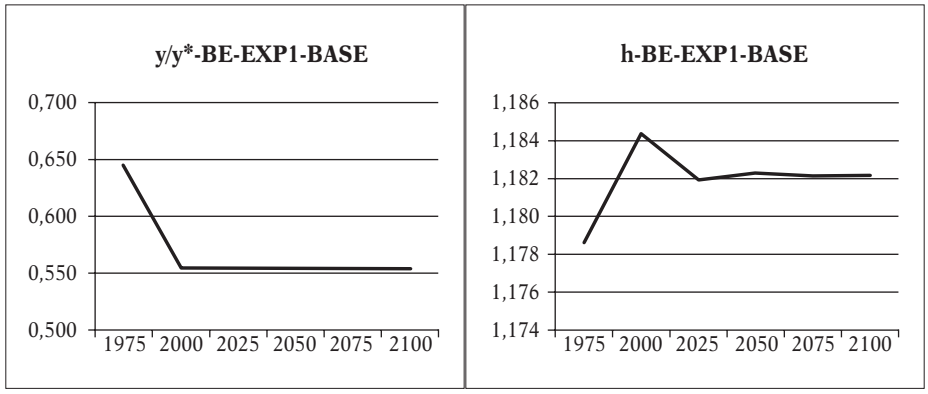


Appendix C: Experiment 1: No Migration

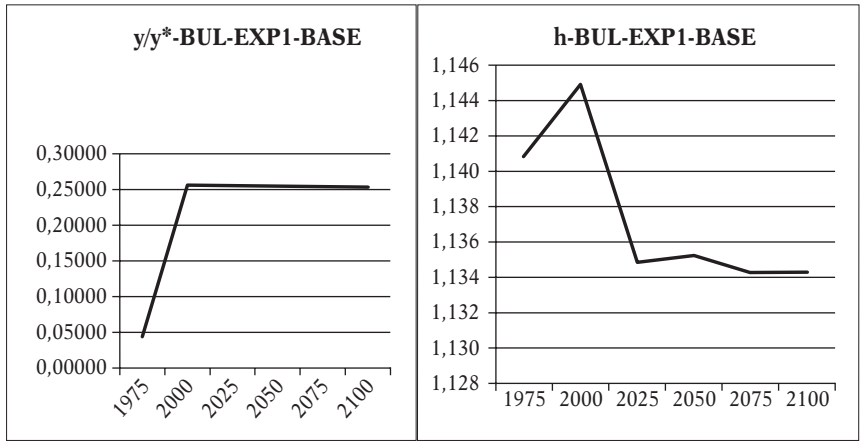
Austria



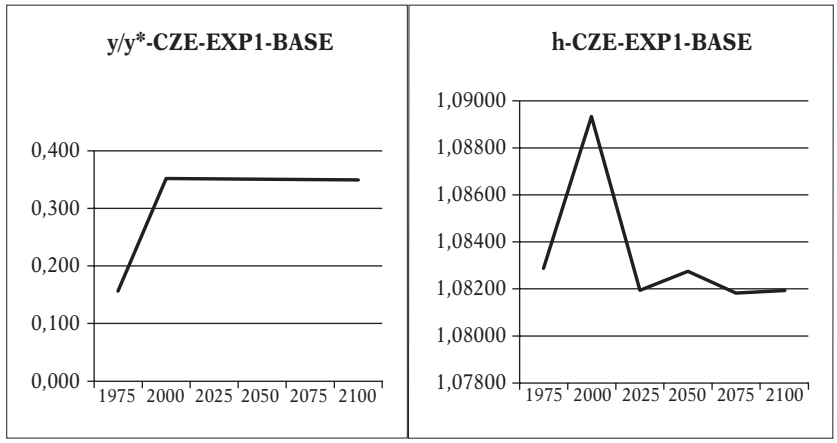
Belgium



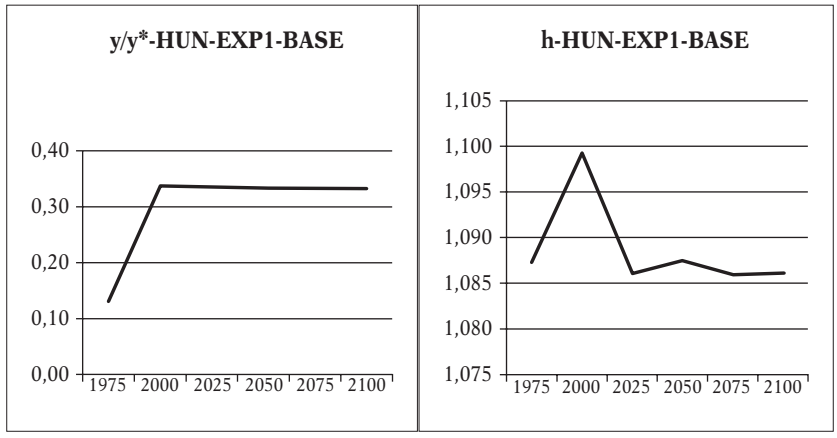
Bulgaria



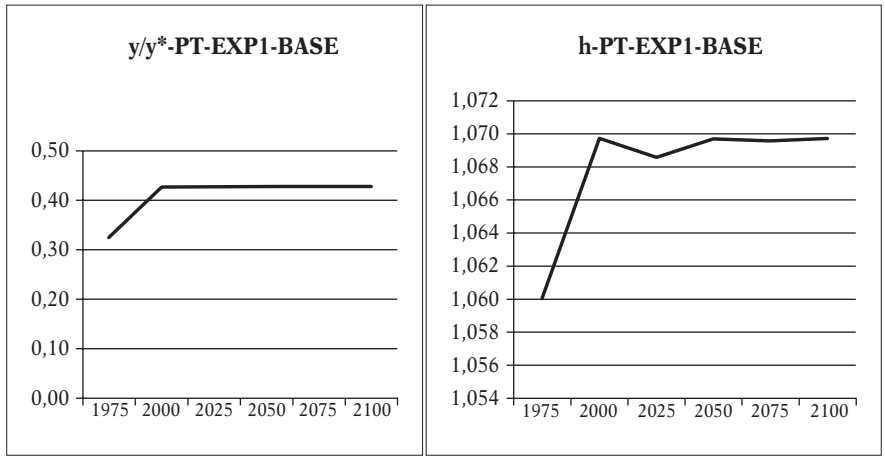
Czech Republic



Hungary

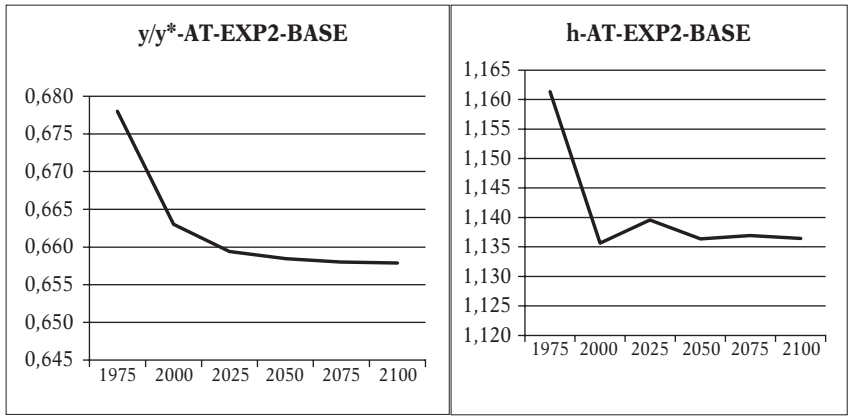


Portugal

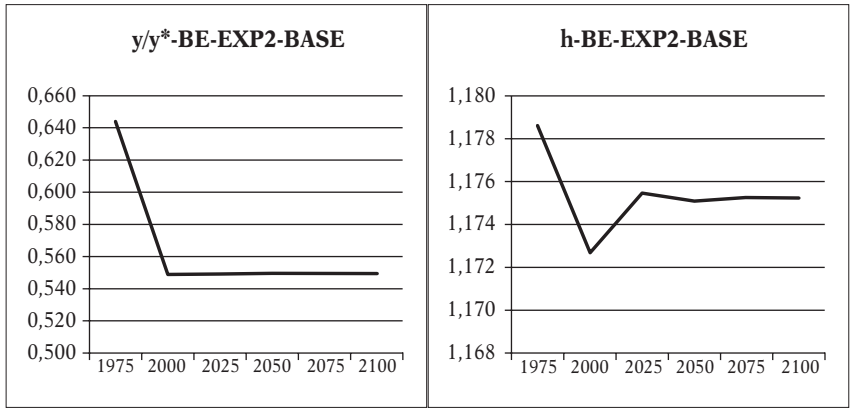


Appendix D: Experiment 2: Doubled Migration Rates

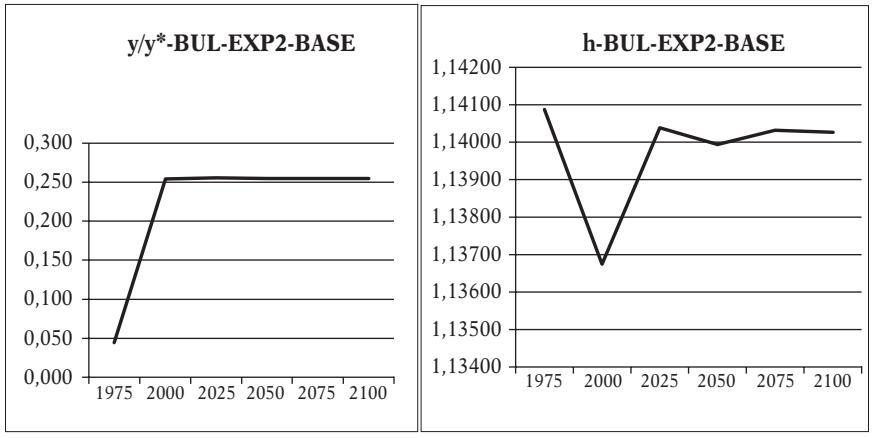
Austria



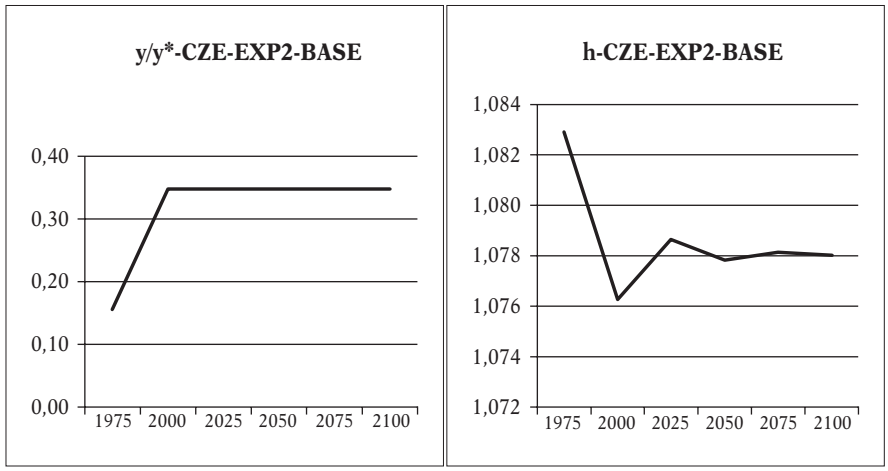
Belgium



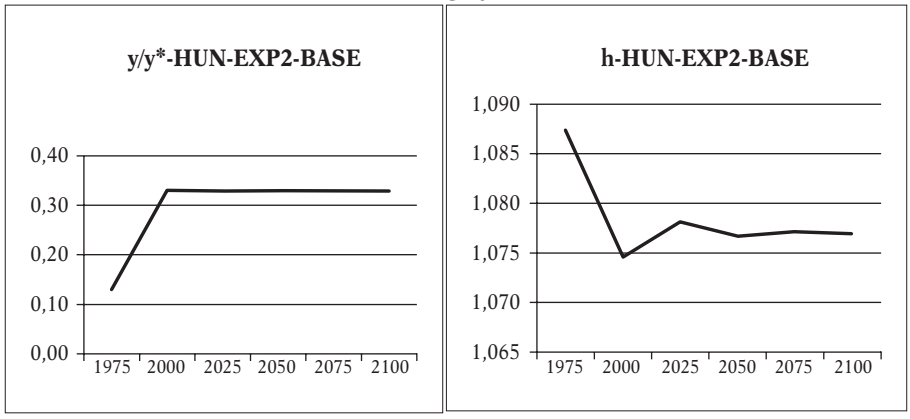
Bulgaria



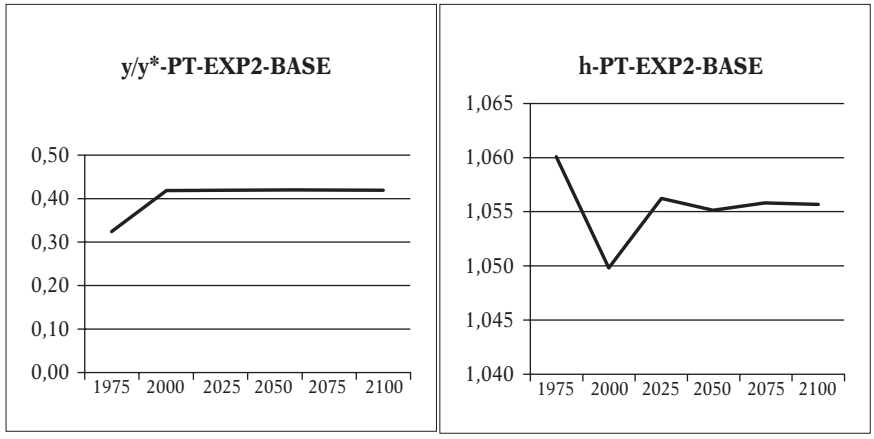
Czech Republic



Hungary



Portugal



TYMCZASOWY DRENAŻ MÓZGÓW, DYSTANS DO KRAJÓW NAJBOGATSZYCH ORAZ DOBROBYT W KRAJACH WYSYŁAJĄCYCH

Streszczenie

Głównym celem tego artykułu jest analiza drenażu mózgów, który może mieć pozytywny wpływ na gospodarki krajów europejskich ze względu na migracje tymczasowe, efekt edukacyjny oraz zwiększone możliwości adaptacji technologii. Współczesne analizy empiryczne potwierdzają, że migracje tymczasowe to powszechne zjawisko, zwłaszcza w czasie kryzysu ekonomicznego, które może mieć pozytywny wpływ na produktywność całkowitą, co w rezultacie prowadzi do zwiększenia możliwości adopcji nowych technologii. Poniższy artykuł rozwija dwuetapowy model generacyjny rozpatrujący możliwy wzrost kapitału ludzkiego wynikający z migracji tymczasowych. Wspomniany model jest zorganizowany w sposób pozwalający zaobserwować zmiany w poziomie kapitału ludzkiego w krajach wysyłających i przyjmujących zarówno w krótkim jak i długim okresie czasu. Następnie ta struktura matematyczna zostaje użyta w symulacji dla sześciu państw europejskich. Każdy kraj doświadcza niespodziewanego szoku gospodarczego wynikającego ze wzrostu lub spadku drenażu mózgów, którego poziom zostaje zablokowany w następnych okresach. Wyniki badań wskazują, że kraje wysoko rozwinięte powinny doświadczyć wzrostu kapitału ludzkiego podczas gdy kraje biedniejsze prawdopodobnie będą nadal cierpiały z powodu drenażu mózgów w dłuższej perspektywie czasowej. Zupełnie inne wnioski można jednak wysnuć w kwestii poziomu dobrobytu. Symulacje wykazują bowiem, że kraje gorzej rozwinięte doświadczą znaczącego wzrostu gospodarczego.

Keywords: drenaż mózgów, migracja powrotna, kapitał ludzki, produktywność, dyfuzja technologii

JEL classification codes: F22, O15, J61