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Does migration lead to economic convergence in an enlarged European market?

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Abstract

This paper examines the relationship between migration and convergence for the enlarged internal market of the European Union (EU27) for the period 1990–2007. The impact of migration on growth is estimated in two ways: by including the migration rate in a growth regression and examining its impact on the convergence coefficient; and from the actual coefficient on migration, which can be interpreted as the effect of migration on long-term growth. While the first approach gives results in favour of the importance of migration on convergence even when human capital is controlled for, the results of the latter are not statistically significant.

Keywords: migration, economic growth, convergence

JEL: J61, O41, O47

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1. Introduction

Disparities in economic prosperity are one of the main problems in the modern economy. Empirical studies of real convergence can show whether a tendency towards the equalization of living standards is observed, what its determinants are, and the speed of this process. The question is especially important from the perspective of the New Member States (NMS), which upon entry of into the EU were lagging behind considerably.

The research is motivated by the fact that the NMS expected that wage convergence would occur after their accession to the EU. At the same time, the Old Member States (OMS) were increasingly concerned about the possibility that EU enlargement might affect their local labour markets and wages through new channels of imports from low-wage countries, the eastward relocation of production, and inflows of migration.

According to neoclassical theory, migration is expected to speed up the convergence process between countries (Barro, Sala-i-Martin 2004). The flow of labour from low-wage countries to high-wage countries should bring lower wage differentials, and income *per capita* would tend to decrease in immigration countries and increase in emigration regions. However, the impact of migration on convergence rates is unclear when the labour flow is heterogeneous.

Moreover, the movement of labour towards wealthier areas depresses the demand for goods, services and the factors of production in the area lagging behind. Initial inequalities lead to a further accumulation of disparities, as explained by Myrdal's (1957) theory of circular and cumulative causation. A similar effect is shown by New Economic Geography and Krugman's (1991) core-periphery model.

In this paper we test empirically whether migration processes that have been observed within EU27 countries during the period of integration 1990–2007 speeded up convergence and were important for steady-state rate of growth. Neoclassical approach has been applied and several specifications of augmented Solow model have been estimated. Among others, skill heterogeneity of migrants has been introduced in the spirit of new growth models. To our knowledge, this is the first attempt to evaluate the impact of migration flows on convergence after the EU enlargement. Its importance and policy implications are self evident. Moreover, we use a dynamic panel data setting and system GMM, not traditional cross-country regressions, which, as we show, lead to biased estimations.

The paper is organized in the following way. In Section 2, a review of the literature is presented. Section 3 examines the theoretical growth model with migration. In Section 4, the empirical study of the impact of migration on convergence in the EU27 in 1990–2007 is performed. We compare two models: the classical growth model, where growth is explained by the initial value of GDP and the investment rate; and a model with an additional variable – the net migration rate. Due to difficulties in obtaining data, we rely on a demographic function to compute net migration as the difference between the actual population change during a given time and that calculated from natural growth and death rates. The impact of migration on growth is estimated in two ways: by including the migration rate in a growth regression and examining its impact on the convergence coefficient; and from the actual coefficient on migration, which can be interpreted as the effect of migration on long-term growth. This is followed by the conclusion and suggestions for future studies.

2. Literature review

Growth models including the additional variable of migration are relatively scarce in relation to the growth literature *per se* (probably due to a lack of data availability). Some attempts, however, have been made to address the issue. Ozgen et al. (2009) in their meta-analysis of 11 studies that explicitly measure the effect of a net migration on growth conclude that an increase in the net migration rate of one percentage point increases on average the GDP *per capita* growth rate by 0.13%. This positive relationship between net migration and growth is rather in line with endogenous growth theories than with neoclassical growth model. However, they underline that studies using panel data models or IV estimations yield smaller effects while the opposite is the case for regressions controlling for high-skilled migration. The most citied study was conducted by Barro and Sala-i-Martin (2004), who estimate for the US, Japan and five European countries separately the augmented growth regression with the additional net migration variable for 1950–1990. The results are similar for all the countries covered in that migration does not seem to be a major determinant of the convergence process. On the contrary, in the same spirit Ostbye and Westerlund (2006) estimate growth for Norway and Sweden, but argue that migration does have an effect on the rate of convergence. Their study is based on a dynamic panel data setup and they include gross and net migration rates. They conclude that in Norway, where the brain drain is observed, migration is a centripetal force and acts against convergence, while in Sweden it is a centrifugal force and adds to the convergence rate, which is consistent with a brain gain scenario. Kirdar and Saracoglu (2006) examine the phenomenon from the perspective of internal migration in Turkey. Again, their results do not confirm the impact of migration on the speed of convergence even when the endogeneity of migration is taken into account.

Taylor and Williamson (1994) measure the impact of migration on convergence from the historical perspective in 1870–1910, using the slightly different technique of partial equilibrium analysis. They conclude that in the absence of migration, wages, labour productivity levels and GDP would have been much higher in the New World and much lower in the Old World. For example, by 1910 wages in Ireland would have been 31% lower, in Italy – 23% lower and in Sweden – 10% lower. Wages in the United States would have been 12% higher, in Australia and Canada they would have been 22% and 25% higher, respectively. Similarly, Boyer et al. (1994), using a small-scale GE model for the Irish economy, conclude that if there had been no emigration between 1851–1911, real wages would only have been 81% of the actual level, and there would have been no Irish catch-up on Britain. Moreover, Hatton and Williamson (2006) argue that there are strong parallels between the effects of migration in the past and present, and O'Rourke (2004) states that emigration is an effective way for poor countries to raise their living standards.

The theoretical literature on immigration and economic growth suggests that the impact of immigration on native income growth depends crucially on the human capital level of immigrants. This issue is usually studied from the host country perspective because of the fear of a negative influence of migrants on native wages. It has to be kept in mind that in this study detecting such an influence would be an argument for convergence. Borjas (2000) argues that if we assume that immigrants and natives are perfect substitutes in production – immigrants and natives have the same skills and are competing for the same type of jobs – then the impact of immigration is a decrease in wages. If the two groups were complements in production, the immigrants would raise the native wage. Friedberg (2001), however, finds that highly skilled immigration from the Soviet Union to Israel has not affected the structure of wages in the host country because immigrants initially took jobs at wages and skill levels below those they left behind. Card (2001; 2005), reviewing the recent evidence on U.S. immigration, finds no evidence that immigrants have harmed the opportunities of less-educated natives. This marginal effect had earlier been confirmed by the potential but negligent impact of Cubans who increased Miami's population by 7% in May 1980 (Card 1990).

However, Aydemir and Borjas (2006), using data drawn from the Canadian, Mexican, and U.S. censuses, found a statistically significant inverse relationship between immigrant-induced shifts in the labour supply and wages in each of the three countries: a 10 percent labour supply shift is associated with a 3 to 4 percent opposite-signed change in wages. Despite the similarity in the wage response, the impact of migration on the wage structure differs significantly across countries. Immigration narrowed wage inequality in Canada, increased it in the United States, and reduced the relative wage of workers at the bottom of the skill distribution in Mexico.

Further, migration is likely to generate multiple effects on the economy of the sending country. The loss of skilled workers (brain drain) from poor to rich countries has in particular been a traditional major source of concern for their countries of origin. Nevertheless, recent studies (Beine et al. 2008; Docquier, Rapoport 2007) stress that skilled migration also induces positive effects through such various channels as remittances, return migration, diaspora externalities,[1] quality of governance, and an increasing return to education. For example, Beine et al. (2008) estimate that a limited but positive rate of skilled migration is likely to be beneficial to the poorest countries as it fosters human capital accumulation in low income countries.

An extensive overview of the literature on the effects of migration on growth gives inconclusive results.

Our empirical investigation relies on the standard framework of convergence models. Due to our data constraints we cannot detect the impact of skilled versus unskilled migration on the equalization of standards of living, but by employing an additional regressor – a proxy for human capital – we take into account the possible redistribution of human capital due to migration flows.

3. The neoclassical growth model with migration[2]

The neoclassical aggregate production function has the following form:

$$Y(t) = F\big(K(t), L(t), A(t)\big) \tag{1}$$

where:

$Y(t)$ – the total amount of production of the final good at time t,

$K(t)$ – the capital stock,

$L(t)$ – the labour force,

$A(t)$ – technology at time t.

[1] "Diaspora externalities" refers to the phenomenon of facilitating the flow of goods, factors, and ideas between the migrants' host and home countries (see Docquier, Lodigiani 2006).

[2] The theoretical part based heavily on Barro, Sala-i-Martin (2004, pp. 383–392).

We introduce migration, which changes the stock of population and to some degree capital, as immigrants come with accumulated human capital (emigrants take out human capital). The growth rate of the domestic population is now augmented by the migration rate:

$$\dot{L}/L = \frac{dL(t)/dt}{L} = n + m \tag{2}$$

where n is the natural growth rate and $m = M/L$ is the net migration rate. The change in the capital stock is defined as the difference between gross investment and depreciation, augmented by capital brought in by immigrants:

$$\dot{K}(t) = dK(t)/dt = I(t) - \delta K(t) + \kappa M = s\big(K(t), L(t), A(t)\big) - \delta K(t) + \kappa M \tag{3}$$

where s is the saving rate, δ the depreciation rate and κ is the capital that each migrant comes with. We define $k(t)$ as the effective capital-labour ratio (capital divided by per unit of effective labour):

$$k(t) = \frac{K(t)}{A(t)L(t)} \tag{4}$$

Taking logs and differentiating expression (4) with respect to time, we obtain:[3]

$$\frac{\dot{k}(t)}{k(t)} = \frac{d(\ln(k(t)))}{k(t)} = \frac{\dot{K}(t)}{K(t)} - g - n - m \tag{5}$$

where g is the exogenous technological growth rate.

Substituting for $K(t)$ in equation (3) we derive:

$$\frac{\dot{k}(t)}{k(t)} = \frac{s\big(K(t), L(t), A(t)\big) - \delta K(t) + \kappa M}{K(t)} - g - n - m \tag{6}$$

Now, using the concepts of effective capital-labour ratio (4), output per effective labour: $\hat{y} = \frac{Y(t)}{A(t)L(t)} = f(k(t))$ and capital per effective immigrant/emigrant: $\hat{\kappa} = \frac{\kappa}{A(t)}$ equation (6) equals:[4]

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3 $$\frac{\dot{k}(t)}{k(t)} = \frac{d\big(\ln(k(t))\big)}{dt} = \frac{d\left(\ln\left(\frac{K(t)}{A(t)L(t)}\right)\right)}{dt} = \frac{d\big(\ln(K(t)) - \ln(A(t)) - \ln(L(t))\big)}{dt} = \frac{\dot{K}(t)}{K(t)} - g - n - m$$

4 $$\frac{\dot{k}(t)}{k(t)} = \frac{sY(t) - \delta K(t) + \kappa M}{K(t)} - g - n - m = \frac{sY(t) + \kappa M}{K(t)} - \delta - g - n - m = \frac{sf(k(t))A(t)L(t) + \kappa M}{k(t)A(t)L(t)} - \delta - g - n - m =$$
$$= \frac{sf(k(t))A(t)L(t)}{k(t)A(t)L(t)} + \frac{\kappa M}{k(t)A(t)L(t)} - \delta - g - n - m = \frac{sf(k(t))}{k(t)} + \frac{\kappa m}{k(t)A(t)} - \delta - g - n - m = \frac{sf(k(t))}{k(t)} +$$
$$- m\left(1 - \frac{\kappa}{k(t)A(t)}\right) - (\delta + g + n)$$

$$\frac{\dot{k}(t)}{k(t)} = \frac{sf(k(t))}{k(t)} - m\left(1 - \frac{\hat{\kappa}}{k(t)}\right) - (\delta + g + n) \tag{7}$$

If we log-linearize the differential (7) around its steady state,[5] the speed of convergence to the steady state is calculated as:

$$\beta = (1-\alpha)(g+n+\delta) + b + b(1-\alpha)\log(k^{*}/k_{world}) \tag{8}$$

where α is the share of capital in national income, k^* is the steady-state capital intensity and k_{world} is the capital intensity in other economies.

The speed of convergence in the model without migration reduces to:

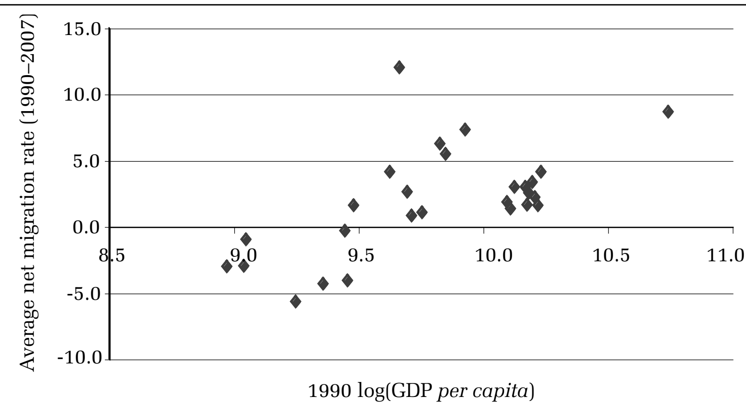
$$\beta = (1-\alpha)(g+n+\delta) \tag{9}$$

The difference between the speed of convergence with and without migration $b + b(1-\alpha)\log(k^{*}/k_{world})$ depends on b, α and the ratio k^*/k. Assuming that in the steady state $k^* = k_{world}$, this difference diminishes to b. This latter is a function of

$$b = \alpha[1-(\hat{\kappa}/k)]dm/d[\log(\hat{y})] \tag{10}$$

where $dm/d[\log(\hat{y})]$ is the sensitivity of international migration to income differentials, and $\hat{\kappa}/k$ is the ratio of effective capital brought by immigrants (taken by emigrants) and that of the receiving country (sending country). The relationship $\hat{\kappa}/k > 1$ describes the situation when migrants have higher human capital than those in the sending countries (brain drain). It slows down the convergence in the sending country if $\hat{\kappa}/k < 1$ migrants are unskilled in relation to those in the sending country. For our analysis, the crucial determinants of the speed of convergence are the sensitivity of international migration to income differentials and the ratio of immigrant to native human capital.

Figure 1
Net migration rate and initial income, 1990–2007



[5] The steady state is defined by the condition $\dot{k}(t) = 0$, then $sf(k(t))/k(t) = (g+n+\delta) + m(1-(\hat{\kappa}/k(t)))$.

Figure 1 shows the positive relationship between average net migration in 1990–2007 and GDP *per capita* in 1990. Due to the constraints of our data, we cannot compute the ratio $\widehat{\kappa}/k$, which would be crucial to determining the coefficient *b*.

Of course, all usual limitations of the neoclassical growth model such as: diminishing returns to labour and capital, constant returns to scale and exogenous rate of technological progress apply to the above framework. The questions of human capital and skill heterogeneity with consequence for productivity, skill-biased technical progress (affecting the capital formation rate, foreign capital inflow rate, and the domestic savings rate) are tied to be answered in the analyses of the impact of migration on growth under the framework of endogenous growth models. Still, at the theoretical ground the consensus about the link between migration and growth has not been reached. See for example Kemnitz (2001) who in endogenous setting shows that immigration increases natives' wages if they possess more capital then the average native. Contrary, following the same approach Torben (2007) argues that immigration is a win-win game for both the immigrant and the natives.

4. An empirical analysis of the impact of migration on convergence in the EU27

We follow the classical approach for measuring convergence phenomena. Sala-i-Martin (1992a) introduced the concept of absolute and conditional beta-convergence. Absolute beta-convergence takes place when the *per capita* income of countries approaches each other in the long run, while conditional beta-convergence means that the *per capita* income of countries approaches a steady state, which does not have to be common to all of the economies. Beta-convergence is usually tested by estimating the relationship between the initial level of GDP *per capita* and its average annual growth:

$$\Delta \ln y_{i,t} = \alpha + \beta \ln\left(y_{i,t-1}\right) + \eta_i + v_t + u_{i,t} \tag{11}$$

where:

$\Delta \ln y_{i,t}$ – the log difference in *per capita* GDP,

$\ln(y_{i,t-1})$ – the logarithm of *per capita* GDP at the start of the period,

η_i – an individual effect for country *i* (*i* = 1,..., 27),

v_t – a time effect (*t* = 1990… 2007),

$u_{i,t}$ – an error term $u_{i,t}, \sim IID(0, \delta^2{}_t)$.

Clearly, the above model can be written equivalently as:

$$\ln y_{it} = \alpha + (1-\beta)\ln y_{i,t-1} + \eta_i + v_t + u_{it} \tag{12}$$

and if extended to include structural factors, we have the case of conditional convergence given by the following equation:

$$\ln y_{it} = \alpha + (1-\beta)\ln y_{i,t-1} + \delta \ln X'_{it} + \eta_i + v_t + u_{it} \tag{13}$$

In the classical application of the Solow model, additional variables $X_{i.t}$ include the logarithm of the investment rate $\ln(s_{i,t})$, and the logarithm of the population growth rate plus 0.05, where 0.05

represents the sum of a common exogenous rate of technical change and a common depreciation rate. The empirical literature on the determinants of economic growth suggests numerous additional explanatory variables, from human capital, investment in R&D to policy variables such as fiscal deficit and degree of openness. Doppelhofer et al. (2004) used the Bayesian approach of 67 potential determinants of growth to detect their robustness. The most strongly related to growth were: Asian dummy, schooling, investment prices and initial GDP.

The estimated coefficient, beta, is the indicator of the convergence process. The speed of convergence is calculated as $\lambda = -\ln(1-\beta)$ and its half-life according to the formula: $t^* = \ln 0.5 / \ln \lambda$. Half-life indicates the period needed for half of the dispersion to disappear.

4.1. Data

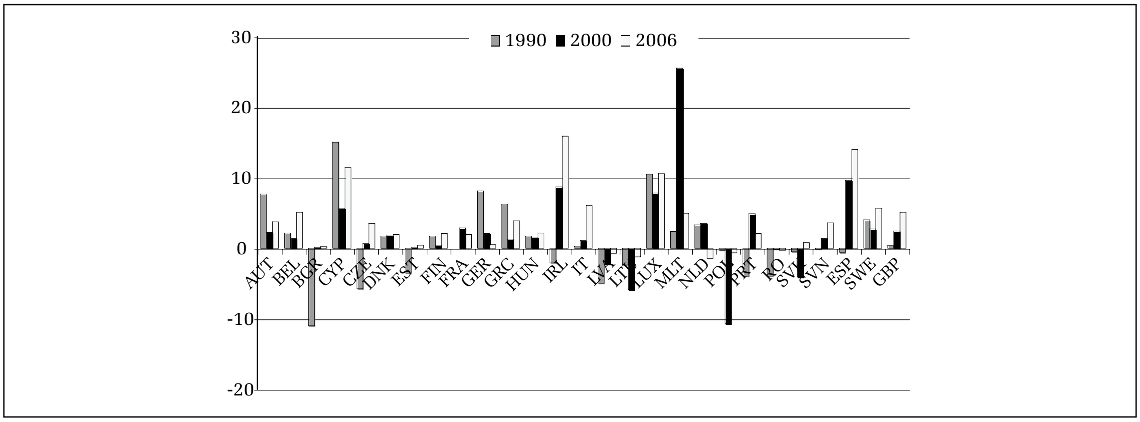
The data used for estimation are from the 27 EU countries with observations from 1990 to 2007, and are taken from the following sources:

- $y_{i,t}$: GDP *per capita* in 2007 international dollars (converted to 2007 price levels with updated 2005 EKS PPPs) from The Conference Board and Groningen Growth and Development Centre, Total Economy Database, January 2008, http://www.conference-board.org/economics/;
- $invest_{i,t}$: investment ratio as percentage of GDP, World Development Indicators (WDI) (April 2008, for 2007 and Cyprus data from Eurostat);
- $school\_sec$: gross secondary enrolment, as a percentage of total, World Bank Group 2007;
- $school\_ter$: gross tertiary enrolment, as a percentage of total, World Bank Group 2007;
- lf_ter: labour force with tertiary education (% of total), World Development Indicators (April 2008);
- $educ\_ex$: education expenditure as percentage of GNI, World Development Indicators (April 2008);
- $R\&D$: research and development expenditure as percentage of GDP, World Development Indicators (April 2008);
- NM: net migration rate, own calculation following the procedure explained below.

The most popular sources on migration are: national statistical institutions, Eurostat, OECD, the United Nations and census data. Unfortunately, they are not consistent. The differences between migration statistics are mainly related to different legislation – the definition of migrants, the duration of stay, the efficiency of registration systems and statistical methodologies. Moreover, the data on immigration reported by receiving countries and those on emigrants reported by sending countries can differ substantially. For example, in 2006 the inflow of Poles into Germany was reported at 163 643 while the outflow of Polish citizens to Germany at 112 492 (source: Eurostat). To avoid these problems, the data on migration were estimated indirectly through the demographic accounting equation:

$$NM_t = (P_t - P_{t-1} + D_t - B_t) / P_{t-1} \times 1000 \quad (14)$$

Figure 2
Net migration rate across EU27 in 1990, 2000 and 2006



where:

$NM_t = I - E$ – the net migration rate per thousand inhabitants,

P_t – population in year t,

P_{t-1} – population in year $(t - 1)$,

D_t – deaths,

B_t – births.

Net migration obtained through the demographic equation is considered to be the part of population change not attributable to births and deaths.

Figure 2 shows the net migrations across EU27 countries for three years: 1990, 2000 and 2006. The negative net migration are characterised for the New Member States, with the exception of Malta, Cyprus and Hungary. The countries with the lowest net migration rate are Poland and Bulgaria.

We are fully aware of the methodological problems related to this calculation (this is estimated migration, not reported), but on the other hand, through this simple calculation we get long time and space cover. Additionally, the correlation between the net migration calculated according to the demographic accounting equation (14) and Eurostat data is 0.98 and between United Nations data – 0.925.[6] Another argument is that if the data are biased, e.g. population statistics underestimate migrations, we should expect that this bias refers both to the positive net migration as well negative net migration rates.

4.2. Results

Our basic regression represents the standard (slim) Solow model, where regressors include only the initial level of log GDP and the logarithm of the investment rate which stands for the effect

[6] The United Nations (Population division) report data for 5 years subperiods. The coefficient of 0.925 refers to the correlation of the data from United Nations and the mean values for 1990–1995, 1995–2000 and 2000–2005 subperiods.

Table 1
Estimation of the growth model: dependent variable ln $y_{i,t}$

Method of estimation	OLS	FE	RE	DIFF-GMM	SYS-GMM
$\ln(y_{i,\,t\text{-}1})$	0.9964*** (0.0038)	0.8639*** (0.0196)	0.9954*** (0.0038)	0.7855*** (0.0920)	0.9684*** (0.0331)
ln($invest_{i,t}$)	0.0652*** (0.0166)	0.1277*** (0.0121)	0.0724*** (0.0101)	0.2032 (0.1582)	0.3279*** (0.1329)
λ – speed of convergence	0.0036	0.1463	0.0046	0.2414	0.0321
Half–life	192.29	4.74	151.48	2.87	21.60
AR(2)				0.183	0.077
Hansen J test				[1.000]	[1.000]

Notes: all computations made using XTABOND2 for StataSE 9.0.
Year dummies included in all models. Constant not reported.
Standard errors in parentheses. Statistically significant at ***1, ** 5, * 10 percent level.
FE stands for estimation with fixed effects; RE stands for random effects.
DIFF-GMM first-differenced estimator; SYS-GMM system estimator. Results are reported for two-step GMM estimator.
ln($invest_{i,t}$) in GMM estimations treated as endogenous variable and instrumented by its lags.
Instru ments used for DIFF-GMM (column (4)) are $\ln(y_{i,t-2})$, $\ln(invest_{i,t})$, and all further lags.
Additional instruments used for levels equations in SYS-GMM (column (5)) are: $\Delta\ln(y_{i,t-1})$, $\Delta\ln(invest_{i,t-1})$.
The figures reported for Hansen test and Arellano-Bond test are the p-values.

of the saving rate. The estimated coefficient on lagged income is the indicator of the convergence process. In our model, the explanatory variable is the lagged value, so it is a dynamic model. Therefore, the standard panel data estimators – OLS levels (pooled), Within Groups (Fixed Effects) – cannot be used. Nevertheless, it may still be useful to compare the results to those obtained by GMM. Our results for the model (14) are reported in Table 1.

The first two columns report OLS and Within Groups estimates. It is well known that OLS levels give an estimate of autoregressive parameter that is biased upwards and Within Groups give

Figure 3
Relationship between GDP *per capita* in 1990 and the average annual growth rate of *per capita* income between 1990 and 2007

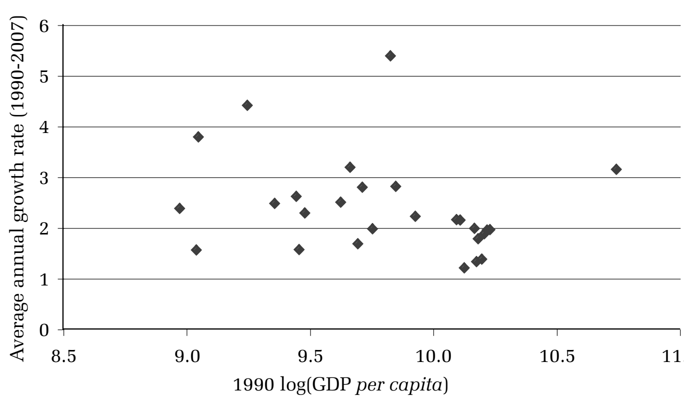


Table 2
Estimation of the growth model with net migration rate: dependent variable ln $y_{i,t}$

	1	**2**	**2 (A)**	**2 (B)**	**2 (C)**
$\ln(y_{i,\,t\text{-}1})$	1.0100*** (0.0181)	0.9684*** (0.0331)	0.9782*** (0.0363)	0.9669*** (0.0557)	1.019*** (0.0443)
$\ln(invest_{i,t})$		0.3279*** (0.1329)	0.1900 (0.1149)	0.2461 (0.1712)	0.0727 (0.0481)
$\ln(1{+}nm_{i,t})$			0.1783 (0.1177)	0.0338 (0.1388)	-0.0505 (0.2011)
λ – speed of convergence		0.032	0.022	0.034	
Half–life		21.59	31.52	20.57	
AR(2)	0.109	0.077	0.069	0.108	0.106
Hansen J test	[1.000]	[1.000]	[1.000]	[1.000]	[1.000]

Notes: all computations made using XTABOND2 for StataSE 9.0.
Results are reported for two-step GMM estimator. Standard errors in parentheses. Statistically significant at ***1, ** 5, * 10 percent level. The figures reported for Hansen test and Arellano-Bond test are the p-values. Year dummies included in all models. Constant not reported.
ln(*invest*) treated as endogenous and instrumented by its own lags: $t-2$ or earlier in the first differenced equation and $t-1$ first differences in the level equation.
(A) net migration rate treated as exogenous (not instrumented)
(B) net migration rate treated as predetermined
(C) net migration rate treated as endogenous.

an estimate that is biased downwards (Blundell, Bond 1998; Bond 2002). In our case, it means that the speed of convergence of OLS is biased downwards and of Within Groups biased upwards. For both GMM estimations, we take into account the endogeneity of the explanatory variables (lagged GDP and investment rate) by using lagged values as instruments. The third column reports a two--stage first-differenced GMM estimator using the full set of instruments. The DIF-GMM appears to give a downwards-biased estimate of the coefficient on the lagged dependent variable that is consistent with the finite sample biases expected in the case of a highly persistent series (Bond 2002). The final column reports the system GMM estimator which uses lagged levels and lagged first-differences as instruments. The system GMM parameter estimates appear to be reasonable. Interpretation of the values of Hansen and correlation tests gives no evidence of misspecification of the model. The Hansen test indicates that the null hypothesis cannot be rejected at any conventional significance level so the instruments used in the estimation are not correlated with the error terms and over-identifying restrictions are justified. Moreover, the autocorrelation AR(2) suggests a lack of second-order correlation in the differenced residuals. The estimated autoregressive parameter of 0.9684 implies an average speed of convergence of 3.2% per year, and consequently a half-life of 21.6 years. Furthermore, the results indicate that the investment rate has a significant positive effect on the steady-state level of *per capita* GDP, even after controlling for unobserved country--specific effects and allowing for the likely endogeneity of investment.

Table 3
Estimation of the growth model with additional human capital proxy: dependent variable ln $y_{i,t}$

	1	**1A**	**2**	**2 A**	**3**	**3 A**	**4**	**4 A**	**5**	**5A**
$\ln(y_{i,t-1})$	0.9642*** (0.1545)	1.0428*** (0.0430)	1.0212*** (0.0412)	0.7468*** (0.0753)	0.6852*** (0.1621)	1.0161*** (0.0335)	0.7704*** (0.2044)	0.7012*** (0.1478)	1.0810*** (0.0478)	1.1224*** (0.0572)
$\ln(invest_{i,t})$	0.1297*** (0.0941)	0.1015 (0.0840)	0.0507 (0.0510)	0.0688 (0.0600)	0.3466*** (0.1422)	0.1114 (0.0546)	0.1918*** (0.0728)	0.1929*** (0.0731)	0.0485 (0.0467)	0.1613 (0.0962)
$\ln(school\_sec)$	0.0190*** (0.1045)	0.1358 (0.0919)								
$\ln(school\_ter)$			-0.1560 (0.0194)	-0.15801*** (0.0693)						
$\ln(educ\_ex)$					0.0372 (0.0619)	-0.0417 (0.0722)				
$\ln(lf\_ter)$							-0.0167 (0.0281)	-0.0252 (0.0289)		
$\ln(R\&D)$									-0.0733 (0.0407)	-0.0821 (0.0403)
$\ln(1+nm_{i,t})$		-0.0612 (0.1739)		0.2730 (0.2274)		-0.1524 (0.1654)		0.0374 (0.0692)		-0.1852 (0.1387)
Speed of convergence λ	0.036			0.292	0.378		0.261	0.355		
Half-life	19.01			2.37	1.83		2.66	1.95		
AR(2) test	0.426	0.303	0.290	0.204	0.299	0.152	0.231	0.361	0.021	0.021
Hansen J test	[1.000]	[1.000]	[1.000]	[1.000]	[1.000]	[1.000]	[1.000]	[1.000]	[1.000]	[1.000]

Notes: all computations made using XTABOND2 for StataSE 9.0.
Results are reported for two-step GMM estimator. Standard errors in parentheses. Statistically significant at ***1, ** 5, * 10 percent level. The figures reported for Hansen test and Arellano-Bond test are the p-values. ln(*invest*), school enrolment, tertiary labour force, public spending on education *per capita*, R&D and net migration rate treated as endogenous variables and instrumented by their own lags.

It is worth noting that from the results of equation (12), presented in Figure 3 and in the first column of Table 2, absolute convergence is not detected. There is no negative relation between the initial GDP *per capita* and its average annual growth rate; the coefficient on lagged GDP is higher than 1, indicating infinite half-life and divergence of income levels.

The impact of migration on growth is estimated in two ways: by including the migration rate in the growth regression and examining its impact on the convergence coefficient; and from the actual coefficient on migration, which can be interpreted as the effect of migration on long-term growth. Accordingly, if migration speeds up convergence, then the speed of convergence estimated from the equation augmented by net migration should be smaller than the estimated speed of convergence from the slimmer equation without net migration among the regressors. Consequently, the coefficient on lagged GDP and half-life should be higher. In view of the convergence scenario, the coefficient on migration should be negative.

Table 2 reports results for the growth equation with the net migration rate as an additional explanatory variable. All calculations are made *via* system GMM estimator, which has been proved to give unbiased estimation, as discussed above. Column (2) reports the results of the estimated equation without the net migration rate, as in the last column of Table 1. In column (3), the endogeneity of net migration is not taken into account. The parameter on lagged GDP is slightly higher than that in column (2), indicating a lower speed of convergence when net migration is controlled for (intuitively, net migration influences the convergence rate beta). Nevertheless, the coefficient on migration is not statistically significant. In the fourth column, the net migration rate is treated as predetermined, and in the last column the endogeneity of migration is taken into account by instrumenting by its proper lagged values. When net migration is endogenised, its impact becomes higher. The coefficient on lagged GDP *per capita* in column 5 is greater than 1. We interpret this as meaning that when migration rates are allowed to vary (slimmer equation without net migration), the convergence phenomenon is observed, while otherwise not.

Migration changes not only the number of workers but also the distribution of human capital. To quantify the effect of migration on the homogenous labour force, we add a regressor which proxies human capital. First, we estimate the augmented Solow model, where the logarithm of the secondary-school enrolment rate is included as an additional explanatory variable. Whether we treat school enrolment as exogenous, predetermined or endogenous has no effect on the final conclusion.[7] The estimation of the growth model with human capital proxied by secondary school enrolment is presented in Table 3.

The speed of convergence in the equation without the migration variable (model 1) is higher than in the equation with the migration rate (migration is held constant) (model 1A). However, at the same time for none of the regressions from Table 4 is the coefficient on the net migration rate statistically significant. Further, in Table 3 estimations of the growth model are presented with additional human capital this time proxied by tertiary school enrolment, tertiary labour force, public spending on education *per capita* and expenditure on R&D.

The results are now less clear. For tertiary school enrolment and tertiary labour force, migration does not add to the speed of convergence (equation without net migration rates). Again, none of the coefficients on net migration rates are statistically significant and additionally those on human capital proxies are also insignificant and often of wrong sign. These results might imply

[7] The detailed results are available from the author upon request.

Table 4
Estimation of the growth model with net migration rate of senders and receivers: dependent variable ln $y_{i,t}$

	1	2	3	4	5	6
$\ln(y_{i,\,t\text{-}1})$	0.946***	1.154***	0.455	0.977***	0.887***	1.097***
	(0.041)	(0.218)	(0.235)	(0.090)	(0.069)	(0.069)
$\ln(invest_{i,t})$	0.196	0.079	0.057	0.052	0.153	0.196
	(0.120)	(0.077)	(0.056)	(0.075)	(0.095)	(0.126)
$\ln(1+nm_{i,t})\_receivers$	0.067	-0.019	0.727	2.329	0.113	0.322
	(0.296)	(0.297)	(0.688)	(1.487)	(0.515)	(0.978)
$\ln(1+nm_{i,t})\_senders$	0.365*	0.162	0.347	0.165	0.213	-0.322
	(0.168)	(0.177)	(0.348)	(0.194)	(0.204)	(0.316)
$\ln(school\_sec)$		0.043				
		(0.174)				
$\ln(school\_ter)$			0.118			
			(0.083)			
$\ln(educ\_ex)$				-0.156		
				(0.092)		
$\ln(lf\_ter)$					-0.016	
					(0.041)	
$\ln(R\&D)$						-0.054
						(0.057)
Speed of convergence λ	0.056		0.788	0.023	0.120	
Half-life	12.42		0.88	29.58	5.78	
	0.083	0.454	0.546	0.265	0.331	0.878
AR(2) test	0.065	0.439	.	0.050	0.419	0.066
Hansen J test	[1.000]	[1.000]	[1.000]	[1.000]	[1.000]	[1.000]

Notes: all computations made using XTABOND2 for StataSE 9.0. Results are reported for two-step GMM estimator. Standard errors in parentheses. Statistically significant at ***1, ** 5, * 10 percent level. The figures reported for Hansen test and Arellano-Bond test are the p-values. ln(*invest*), school enrolment, tertiary labour force, public spending on education *per capita*, R&D and net migration rate treated as endogenous variables and instrumented by their own.

that the current human capital variables, as used in Table 4, may not have a significant effect on the steady-state level of *per capita* GDP after controlling for unobserved country-specific effects and investment. One possible explanation for these findings is that they affect growth through the rate of investment. The same lack of effect of school enrolment on the growth rate has been found by Bond et al. (2001). However, in some of the specifications investment loses its statistical significance.

One possible explanation of the lack of statistical significance of the migration coefficient might be the asymmetric effects of immigration and emigration flows on convergence.[8] To check this, we estimate the convergence equation dividing the net migration variable for subgroups of countries: receivers with positive value of net migration rate and senders with negative value of net migration rate. The results are presented in Table 4.

Similarly to the previous estimations, most of the coefficients of net migration are statistically insignificant. The one exception is the net migration rate for the senders in column (1). It indicates the positive link between the migration and growth, which is in line with neoclassical framework. Additionally now, for all specifications the speed of convergence in the equation without the migration variables (corresponding models from Table 3) is higher than in the equation with the migration rate indicating its impact on the convergence process.

5. Conclusions

This paper examines the relationship between net migration and convergence for the enlarged internal market of the European Union (EU27) for the period 1990–2007. The effect of migration is measured by including net migration rate as the explanatory variable in the growth regression. There are two aspects of interest: the change in the speed of convergence in relation to the reduced form of the equation (when the net migration rate is not controlled for) and the actual coefficient on migration, which can be interpreted as the effect of migration on long-term growth.

The implied speed of convergence in the reduced form of the equation is estimated to be 3.2% yearly (which is in accordance with the growth literature). Conditioning on net migration rates, the speed of convergence decreases to 2.2% when migration is treated as an exogenous variable, and drops to zero when migration is instrumented by its lags. In view of these results, it can be said that migration is an important source of convergence. However, at the same time we were not able to detect its statistically significant effect on long-term growth. One possible explanation of the lack of statistical significance of the migration coefficient might be the asymmetric effects of immigration and emigration flows on convergence. This problem could be solved be employing gross migration rates instead of net migration, but due to the constraints of our data this was not possible in this study. Additionally, we divide the net migration rates for subgroups of countries: receivers and senders, without impact on the results.

The results stand when we expand the model by controlling for the level of human capital measured by secondary school enrolment. This means that the migration effect is also visible for countries with the same endowments of human capital. In the case of immigration countries, the negative effect on GDP *per capita* of additional labour is not overcome by additional human capital,

[8] We want to thank an anonymous referee for pointing this out.

and in emigration countries the loss of human capital does not overcome the positive effect on GDP *per capita* of loss of population. Bearing in mind the fact that the results were mixed when human capital was measured by other variables (tertiary school enrolment, tertiary labour force, public expenditure on education, expenditure on R&D) the last conclusion has to be treated with caution. It might also indicate that the relationship between migration with heterogeneous labour flows and growth is ambiguous. This is a challenge for future theoretical and empirical studies, and could not be achieved without reliable and complete data. Additionally, also the new generation of models is important for meeting this challenge successfully for better understanding of complex nexus migration – growth.[9]

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