WILL TRANSITION COUNTRIES BENEFIT OR LOSE FROM THE BRAIN DRAIN?

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Abstract

We analyze the theoretical effects on growth and welfare in transition economies of emigration of educated and uneducated labor, of higher emigration probability, etc. Using a Grossman-Helpman growth model, we show that the prospects of labor market integration with the EU raises the expected returns to education, stimulate human capital formation and thus raise the growth rate in the candidate countries. However, given these expected returns, emigration of educated workers tends to lower growth and welfare of those remaining. Thus, while the brain drain reduces welfare, effects of labor market integration could nevertheless be positive. Emigration of low skilled workers also reduces growth via adverse effects on education. Higher tuition fees, common in transition countries, counteract positive growth effects of market determined wages.

INTRODUCTION

Emigration of skilled workers like scientists and engineers has increased over time (1). The main increases in these flows have been from Asia and Central and Eastern Europe into North America, Australia and Western Europe. Flows of well-educated workers are also likely to increase in the near future as the European Union is enlarged to include a number of candidate countries (CCs) in Eastern Europe. Most EU countries will then open up their labor markets to the new member countries' workers. In this connection, discussion has focused a great deal on the level of education of the workforce in the CCs and consequences of emigration of the best educated. Many citizens in the CCs fear that brain drain will reduce growth and welfare in their home countries.

Emigration from the CCs and other transition countries before 1989 had a strong political component as the lack of political freedom, besides prospects of higher incomes, was a principal factor behind emigration. The social and economic openness after the fall of communism and the freedom of movement changed the balance in favor of economic migration (2). Empirical studies conducted after 1990, show that for some CEECs, the propensity to work abroad has not changed dramatically after the fall of communism. Chompalov (2000) finds that the brain drain from Bulgaria increased after 1989, but, to the best of our knowledge, other empirical analyses of brain drain from candidate countries are not available. The Central and Eastern European countries (CEECs) remain a major potential source of skilled labor for the Western countries. The modest flows of skilled workers after the transition to market economies started can be explained by regulations and poor labor market performance in the EU countries. However, the approaching EU enlargement, in which, labor market integration is a major issue, makes the welfare effects of a brain drain a highly topical issue on the agenda.

The discussion of the brain drain has also been stimulated by studies, notably Barro (1991), showing that level of schooling across countries is a significant variable for explaining growth rates. Hall and Jones (1999) extend the studies by including differences in social infrastructure across countries. Bils and Klenow (2000) elaborate further on Barro (1991) by studying the dual relationship between schooling and growth. In their model, expected growth rate reduces the effective discount rate that leads to an increase in demand for schooling. Their overall conclusion contradicts that of Barro by showing a very weak direct relationship between schooling and growth but a strong effect of growth on schooling.

In light of these results and the potential for East-West migration after the accession of the CCs to the EU, we shall expand on the issue of the brain drain and growth. A particular feature to be analyzed is the fact that the CCs during the 1990s introduced tuition fees in higher education while education before 1990 was financed by taxes. New private universities emerged at impressive rates. In Poland, for instance, 63% of academic institutions are now privately owned, in Romania 60% and in Slovenia 82%. Moreover, budget deficits and the increased competition from private universities force state institutions to find new ways to maintain infrastructure in human capital formation.

Significant changes in education policy of the CCs affect not only the balance between skilled and unskilled workers but also the propensity to emigrate to the West. Besides changes in different types of labor, the tuition fee plays an important role in our model, since it allows for an analysis of education policy in face of a brain drain problem.

In the centralized system, rewards to flexibility and mobility of labor were almost non-existent. One of the first signals of change in the education policies of transition countries is the increasing inequality of earnings between skilled and unskilled. Clark (2000) investigated the returns and implications of human capital investments for Russia during the second half of the 1990s, concluding that the university premium is increasing in the private sector. While the issue of wage differentials between skilled and unskilled workers, to the best of our knowledge, has not been studied extensively in the transition countries, it is very likely that most transition countries have experienced increased wage differentials. As shown in Ivaschenko (2000), distribution of income became increasingly unequal in 25 transition countries during 1989-98, suggesting that wage differences increased (3).

The brain drain is a research issue of a long-standing interest. Recently, Mountford (1997) studied the conditions for the brain drain to have positive growth effects in the source economy. His paper shows that when educational decisions are endogenous and if successful migration is not a certainty, a brain drain may increase productivity. Migration to a high wage country raises the return to education, which favors human capital formation and can outweigh the negative effects of the brain drain. Beine, Docquier and Rapoport (2001) specify an OLG model with the same counteracting forces and find that the brain drain may favor the sending country if the domestic human capital is stimulated enough (4). Using a cross-section of 37 developing countries, they also find that the possibility of such a positive effect of the outflow of skilled labor cannot be rejected.

Our approach is inspired by the growth model in Grossman and Helpman (1991a,b), which is extended to analyze effects of migration of workers of different skill levels. Like Mountford and Beine *et al*, we allow for the effect that emigration of skilled workers stimulates education, but this positive growth effect cannot fully counteract the negative growth effect as skilled workers leave the country. However, this does not mean that labor market integration necessarily lowers economic growth and welfare in the new member countries. We need also to consider that opening up the labor markets raises the probability of emigration to high wage countries in Western Europe, which in turn raises the returns to higher education and thus stimulates more education and raises the growth rate. Only if a large enough number of skilled workers emigrate, will welfare fall.

We find that emigration also of unskilled workers lowers growth and welfare. While these workers do not enter the growth generating R&D departments, an outflow lowers the relative wage of R&D workers who react by cutting down on education. This reduces human capital formation and growth.

THE MODEL

Consumer Behavior

Consumers share a common inter-temporal utility function that is maximized:

$$U \equiv \int_0^{\infty} e^{-rt} \log u(t) dt \qquad (1)$$

where ρ is the subjective discount rate and $\log u(t)$ is each consumer's static utility at time *t*. The instantaneous utility is given by:

$$\log u(t) \equiv \int_0^1 \log \sum_j (l)^j d(j,t,w) dw \qquad (2)$$

where $d(j,t,w)$ denotes the quantity consumed of a product of quality *j* produced in industry w at time *t*. $l > 1$ represents the extent to which innovations improve product quality.

Each consumer allocates expenditure E to maximize $\log u(t)$ given the prevailing market prices. Solving this budget allocation problem yields a unit elastic demand function

$$d = E/p \qquad (3)$$

where *d* is quantity demanded and p is the market price for the product in each industry with the lowest quality adjusted price. The quantity demanded for all other products is zero. Given this static demand behavior, each consumer chooses the path of expenditure over time to maximize (1) subject to the usual inter-temporal budget constraint. Solving this optimal control problem yields:

$$\frac{dE(t)}{dt} / E(t) = r(t) - r \qquad (4)$$

that is, a constant expenditure path is optimal if and only if the market interest rate equals ρ. We will restrict attention to steady state properties of the model. Then ρ is the equilibrium interest rate throughout time and consumer expenditure is constant over time. We let *E* denote aggregate steady state consumer expenditures.

Product Markets

Labor is, in our model, of two kinds: R&D workers, L_r , and production workers, L_p . We assume that both are in fixed supplies but we shall allow for endogenous determination of the length of R&D workers' education implying that human capital supply is endogenous. One unit of production workers is required to produce one unit of output, regardless of quality. Hence, every firm has a constant marginal cost equal to one. We treat the wage rate of production workers as the numeraire and let *w* denote the relative wage of R&D workers.

Consider the profits earned. With the previous state-of-the-art producer charging a price of 1, the lowest price such that losses are avoided, the new quality good producer earns instantaneous profits

$$p\,(p) = \begin{cases} (p-1)E/p, & p \leq l \\ 0, & p > l \end{cases} \tag{5}$$

where p is the quality leader's price. These profits are maximized by choosing $p = l$. Therefore, this quality leader earns as a reward for its innovative activity the profit flow $(1-1/\,l\,)E$, and none of the other firms in the industry can do any better than break even by selling nothing at all.

R&D Activities by Firms

There is a continuum of industries with individual industries indexed by $w \in [0,1]$. In each industry, firms are distinguished by the quality j of the products they produce. Higher values of j denote higher quality and j is restricted to take on integer values. At time $t = 0$, the state-of-the-art quality product in each industry is $j = 0$, that is, some firm in each industry knows how to produce a $j = 0$ quality product and no firm knows how to produce any higher quality product. To learn how to produce higher quality products, firms in each industry engage in R&D races. In general, when the state-of-the-art quality in an industry is j, the next winner of a R&D race becomes the sole producer of a $j+1$ quality product. Since firms are Bertrand price-setters, each R&D race winner is able to price lower quality competitors out of business and takes over the world market in its industry. Thus, over time, product quality improves as innovations push each industry up its quality ladder.

Returns to engaging in R&D are independently distributed across industries and over time. In industry ω at time t, let l_i denote firm i's employment of R&D

labor and let $l \equiv \sum_i l_i$ denote the industry-wide R&D employment. Firm i's instantaneous probability of winning the R&D race and becoming the next quality leader is assumed to equal l_i. Individual R&D firms behave competitively and treat l as given.

Let υ denote the expected discounted rewards for winning R&D races and s denotes the R&D subsidy rate. Then, each firm i chooses its R&D employment to maximize instantaneous profits $ul_i - w(1-s)l_i$. In a steady state equilibrium, firms will determine their R&D levels so that $u = w(1-s)$.

We will now determine the equilibrium rewards for winning R&D races. From equation (4), in any steady state equilibrium, the market interest rate must equal ρ. Not only must we discount profits using ρ, but we must also take into account that every producer is eventually driven out of business by another firm that innovates. This occurs with instantaneous probability l. Thus we obtain as equilibrium R&D conditions:

$$u = \frac{(1\text{-}1/l)E}{r + l} = w(1-s) \tag{6}$$

This equation captures the idea that, in equilibrium, a producer is eventually driven out of business by innovation.

<u>Market for Production Workers</u>

We assume that R&D workers can work in the lab and on the factory floor while production workers only can work on the factory floor, but not in the lab. With $w_p = 1$, each producer employs E/l workers for production. Full employment in the labor market for production workers then implies that

$$L_p = E/l \tag{7}$$

<u>Endogenous Education</u>

A drawback of our analysis above is that we have no theory of how much education workers demand implying that there is no adjustment on behalf of individual workers' human capital formation. Evidently, education for R&D is highly demanding and it seems inappropriate to assume that all individuals in an economy have the choice of becoming a scientist or R&D worker. As in the previous analysis, and in line with many other human capital studies, we therefore continue to assume that a number L_p of workers lacks the capability to acquire higher education while L_r have this capability. The difference is that L_r now faces the decision to determine the number of years in higher education, S. An increase in L_r relative to L_p could represent either an increase in the number of workers capable of acquiring an R&D education, or some university reforms that would imply that less ability is needed for a given university education.

Each worker works a finite length of T years. With S years of schooling, the individual accumulates $h(S)$ of human capital, which is an increasing and concave function. S years of education yield a flow salary of $h(S)w$ where w now is the reward to one unit of human capital. However, with some probability P the worker finds a job abroad that pays a fixed and higher wage $\overline{w}$. Thus, the expected flow salary becomes $h(S)(P\overline{w}+(1-P)w)$.

To determine the optimal number of years of schooling, the individual must consider the benefits and costs of marginal additional schooling, dS. The gains to be made from extra schooling equal the extra return in this state $(P\overline{w}+(1-P)w)\,h'(S)$. Thus, the marginal benefits $\left[(P\overline{w}+(1-P)w)h'(S)\right]dS$ can be reaped during the period $t+S$ to $t+T$ and the present value of these earnings equal $(e^{-rS}-e^{-rT})\left[(P\overline{w}+(1-P)w)\,h'(S)\right]dS\,/\,r$.

During dS the student has no income and had he worked, expected income would have been $(P\overline{w}+(1-P)w)\,h(S)dS$. Moreover, for each year of study, the individual pays a tuition fee of F. Hence, the marginal cost of an extra unit of schooling is the forgone earnings during the period $t+S$ to $t+S+dS$ and the annual fee, or $e^{-rS}\left[(P\overline{w}+(1-P)w)\,h(S)+F\right]dS$. The first-order condition, i.e. marginal benefits equal to marginal cost, yields

$$1-e^{r(S-T)}=\frac{r\left[(P\overline{w}+(1-P)w)h(S)+F\right]}{(P\overline{w}+(1-P)\,w)\,h'(S)} \tag{8}$$

At each instant, we have $(S/T)L_r$ in school and $(1-S/T)L_r$ working in the

R&D departments.

The supply of human capital is the product of the number of educated R&D workers, their work life and each individual's human capital, or $H \equiv L_r(1-\frac{S}{T})h(S)$. As firms do R&D they demand l of human capital per industry. Thus, full employment of human capital in laboratories equals

$$l = L_r(1-\frac{S}{T})h(S) = H \tag{9}$$

<u>Consumer Expenditures</u>

To close the model, we need to determine consumer expenditures. Consumer expenditure E must equal wage income plus interest income on assets owned minus taxes paid to finance the R&D subsidy. The value of all assets, A, equals the stock market value of all firms:

$$A = w(1-s) \tag{10}$$

Then $r A$ is interest income. To determine the tax revenues that need to be raised to finance the R&D subsidies, we note first that l workers do R&D. These workers are paid wl and the government pays the fraction s of this wage bill. Thus, the government must raise swl in taxes to finance the R&D subsidy. The government taxes all wage and interest income. Finally, to determine consumer expenditures on goods we need to deduct the students' tuition fees but these fees pertain to the government that passes them back to the consumers in a lump-sum manner. Hence these fees cancel out from the expenditures expression. The value of purchased goods then becomes:

$$E = L_p + wl + r w(1-s) - swl = L_p + w(1-s)(l + r) \tag{11}$$

<u>Growth and Welfare</u>

We calculate consumer welfare (discounted consumer utility) starting from time $t = 0$. Remember that all consumers are assumed to have identical preferences. Consider first the utility of a consumer with steady state expenditure e. At any point in time, this consumer only buys the highest quality product in each industry, and from (3), this consumer's static demand function is given by $d(j,t,w) = e/p(j,t,w)$. The consumer buys from a producer charging the price λ. Before we substitute this information into (2), we note that, in this equation, $\int_0^1 \log l \, dw = t\text{l} \log l$. l is the instantaneous probability of R&D success. Substituting the above information into (2) yields the consumer's instantaneous utility

$$\log u(t) = t\text{l} \log l \tag{12}$$

Differentiating (12) with respect to time yields growth as (5):

$$g = L_r \,(1 - \frac{S}{T}) h(S) \log l \ = \text{l} \log l \tag{13}$$

To obtain overall consumer welfare we set $e = E$ and substituting (13) into (1) we get welfare as $W = rU = \text{l} \log l \,/\, r + \log(E \,/\, l)$. Merging g with this expression, and utilizing (4) and that $p = l$ we find that welfare is:

$$W = g \,/\, r + \log d \tag{14}$$

Welfare is thus the sum of discounted growth and static demand. Welfare per capita is $W/(L_p + L_r)$ which is relevant when we discuss the welfare effects as workers emigrate.

RESULTS

The system of five equations, (6), (7), (8), (9) and (11), solves for four variables w, l , E and S. Obviously, with five equations and four variables the system is over-determined. However, using (6) through (9) in (11) shows that this last equation also is satisfied. Hence, we can drop equation (11). By eliminating E, we reduce the remaining equation system to three equations. We first solve for w, l , S and can then straightforwardly obtain the effects on expenditures, growth and welfare. The remaining three-equation system yields a determinant:

$$D = \frac{F(P-1)(l-1)\, r L_r L_p \,(h(S) + (S-T)\, h'(S))}{T(P\overline{w} + (1-P)w)^2 (1+r) H'(S)} + \\ + (s-1)\, r \left(\frac{(F + (p\overline{w} + (1-P)w)\, h(S))h''(S)}{(P\overline{w} + (1-P)w) h'(S)^2} - e^{(S-T)r} - 1 \right) \tag{15}$$

A sufficient, though not necessary, condition for this determinant to be positive is that $(h(S)+(S-T)h'(S))$ is negative. This condition can be rewritten as $e > S/(S-T)$ where e is the elasticity of human capital with respect to an increase in schooling years. This elasticity is reasonably positive while the right-hand side of the condition is negative.

Opening up for Emigration

Before 1990, the probability of emigration to high-income countries was virtually zero in the candidate countries. As economic and political freedom increased, and in particular when the countries started to discuss membership in the European Union, the prospects of higher income via emigration increased. Thus, opening up for emigration implies that, with some probability, a worker may obtain a higher wage by emigrating and accepting a work abroad. This option will, by itself, have effects on the economy as it raises the expected gains from higher education, i.e. the expected university premium. The effects of increasing the probability of emigration on optimal schooling years obtain as:

$$\frac{\partial S}{\partial P} = \frac{1}{D} \frac{F(s-1)(w-\overline{w})\,r}{(P\overline{w}+(1-P)w)^2 h'(S)} > 0 \tag{16}$$

i.e. an increase in the probability raises the length of optimal education. We note from (17) that the effect is larger the larger the wage difference to the potential emigration country is. Notable is also that the effect crucially hinges on the tuition fee: if this is zero, the first order condition is unaffected by the probability. (See equation (8).)

Is there any evidence in favor of such an effect as suggested in equation (16)? It is possible to classify the transition countries according to their probabilities of joining the EU. Before 1994, there was not much discussion of EU membership, but after this year the probability of membership, and hence access to the EU labor markets increased in Poland, Hungary, the Baltic countries, the Czech Republic and Slovenia. In the remaining transition countries not much happened that would raise the possibilities of emigration to richer countries.

While no data exists on the evolution of optimal schooling years, we show in the Figure *1a* and *b* how enrollment rates in higher education have changed in transition countries during the 1990:s. We have classified countries according to the possibility of accession to the EU in 1994. Countries to the right, in each panel, have the highest probability of becoming members (Poland, Czech Republic, Hungary, Slovakia, Latvia, Estonia and Lithuania), while countries to the left have low, or zero, probability of becoming a member.

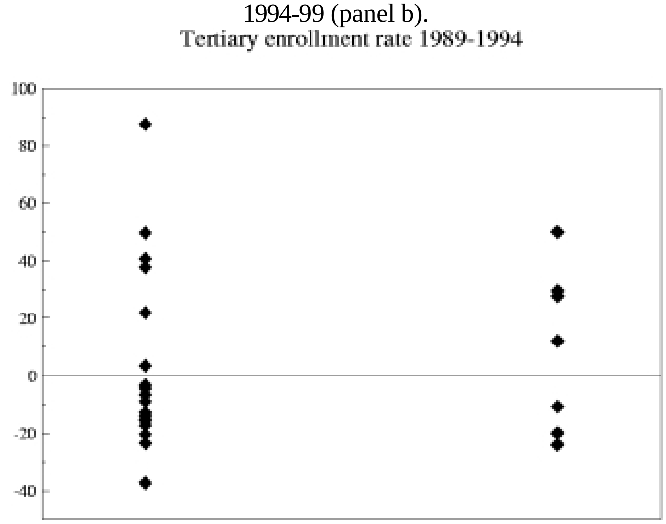
We see that there is not much difference between the two groups in the period 1989-94. In the period after 1994, however, all countries in the high probability group increase the share of tertiary education a great deal and there seems to be a clear tendency that countries in this group have increased considerably more than in the leftward, no-applicants, group. This is certainly no evidence, but it suggests that prospects of EU membership stimulate higher education. It is an issue for future research.

The increase in the probability of emigration to a high wage country reduces the domestic R&D wage:

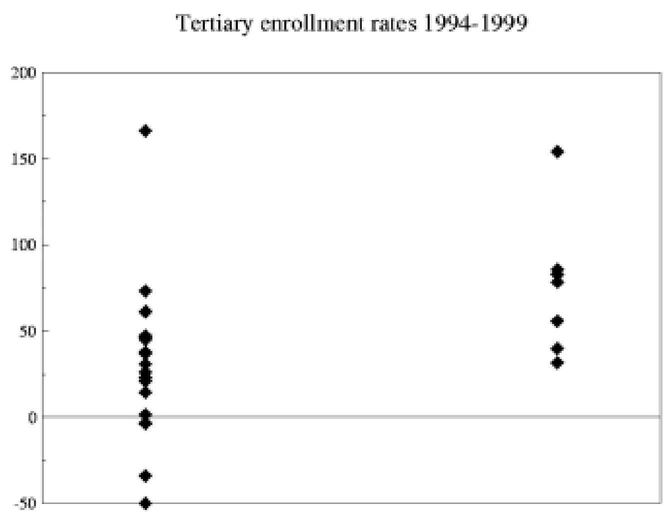
$$\frac{\partial w}{\partial P} = -\frac{(l-1)L_p L_r (h(S) + (S-T)h'(S))}{T(1+r)^2(s-1)} \frac{\partial S}{\partial P} < 0 \qquad (17)$$

The prospects of emigration to a high wage country should lower the wage, which is the reward to one unit of human capital. This fall is consistent with the increase in schooling years that has increased the supply of human capital. The wage effect crucially hinges on the effects on optimal schooling.

Figure 1: Changes in enrollment rates to tertiary education, 1989-94 (panel a) and 1994-99 (panel b).



(a)



(b)

How is growth affected? On the one hand, the higher probability of emigration means that R&D workers now spend more time in school, which reduces the number of R&D workers available in the laboratories. On the other hand, each R&D worker has more specialized education that should raise human capital.

The net effect is unambiguously positive:

$$\frac{\partial l}{\partial P} = -\frac{T}{(h(S)+(S-T)h'(S))}\frac{\partial S}{\partial P} > 0 \tag{18}$$

The quantitative effect hinges crucially on the length of the work life, T. The longer the work life the larger is the positive effect on growth. A basic condition for the positive growth effect is, of course, that the higher probability of emigration has a positive effect on optimal schooling.

Assuming that there is a positive probability of emigrating we can show that the effects of an increase in the R&D wage, $\overline{w}$, in the potential emigration country, are quantitatively identical to those of an increase in the probability of emigration (at any positive *P*).

So far, we have kept factor supplies constant, which, of course, is an unrealistic assumption: For a given probability to be realistic for the *long* run, emigration should occur at the same rate as the probability. Below we focus on the effects of exogenous changes in the supplies of R&D and unskilled labor.

Effects of Factor Supply Changes

Before we analyze the effects of the brain drain, i.e. decreases in the supplies of R&D workers, we shall first discuss the effects of changes in production workers. The comparative static effects of a decrease in production workers on the R&D wage:

$$-\frac{\partial w}{\partial L_p} = \frac{(l-1)r}{D(r+1)}\left\{\frac{(F+(P\overline{w}+(1-P)w)h(S))(h''(S)+rh'(S))}{(P\overline{w}+(1-P)w)h'(S)^2} - e^{(S-T)r} - 1\right\} < 0 \tag{19}$$

In a country from which production workers emigrate the relative wage of the R&D workers goes down. As expected, the increase in relative supplies of R&D workers lowers the relative wage of R&D workers.

We next consider the effects on optimal schooling years:

$$-\frac{\partial S}{\partial L_p} = \frac{1}{D}\left\{\frac{F(1-P)(l-1)r}{(P\overline{w}+(1-P)w)^2 h'(S)(1+r)}\right\} < 0 \qquad (20)$$

In a small emigration country, students will demand less education as production workers leave the country. This is in line with the decrease in the wage of R&D workers, which has lowered the university premium and thus reduced the incentives for schooling. However, we also see that the result hinges on the existence of the tuition fee. (Cf. equation (8)).

Emigration of production workers then implies that domestic R&D workers would find that their salaries are falling and that they will reduce the time spent in school. As domestic educated workers lose, this emigration policy tends to decrease the income differences between the skilled and unskilled workers. The income difference is *wh*-1 and the effects on the wage differences are

$$-\frac{dw}{dL_p}h - \frac{dh}{dS}\frac{dS}{dL_p}w < 0 \qquad (21)$$

i.e. domestic R&D workers lose as compared to production workers.

To explore the effects on the growth rate we differentiate (13) with respect to a decrease in L_p to get

$$-\frac{\partial g}{\partial L_p} = -\frac{\partial l}{\partial L_p}\log l = -\frac{L_r(h(S)+(S-T)h'(S))}{T}\log l\,\frac{\partial S}{\partial L_p} < 0 \qquad (22)$$

In many other growth models a decrease in production workers lowers growth since fewer workers can be put into R&D. Here, the effect runs solely via decreased optimal education that lowers the growth rate.

Before we can evaluate the welfare effects, we need to determine the effects on expenditures. They obtain as:

$$-\frac{\partial E}{\partial L_p} = -1 - \left[\frac{\partial w}{\partial L_p}(l + r) + \frac{\partial l}{\partial L_p}w\right](1-s) < 0 \qquad (23)$$

Expenditures decrease in an emigration country. From (14) we get

$-\frac{\partial W}{\partial L_p} = -\frac{\partial g}{\partial L_p} / r - \frac{\partial \log E}{\partial L_p} < 0$. We are, however, more interested in how welfare per remaining worker, $W/(L_p + L_r)$ is affected. We find that

$$-\frac{\partial (W/(L_p + L_r))}{\partial L_p} = -\frac{1}{(L_p + L_r)}\left[\frac{\partial g}{\partial L_p} / r + \frac{\partial \log E}{\partial L_p} + \frac{W}{(L_p + L_r)}\right] < 0 \quad (24)$$

Welfare among the remaining workers thus falls since both the growth effect and the static consumption (expenditure) effect are negative.

Brain Drain

The central interest of this paper is the effects of an outflow of R&D workers. To explore that we shall do the corresponding comparative static experiments as above but for R&D labor. We find the wage effects of a decrease in R&D workers to be:

$$-\frac{\partial w}{\partial L_r} = \frac{(1-\frac{S}{T})(l-1) r h(S) L_p}{D(r+1)^2} \left\{\frac{(F + (P\overline{w} + (1-P)w) h(S)) h''(S)}{(P\overline{w} + (1-P)w)\, h'(S)^2} - e^{(S-T)r} - 1\right\} > 0 \quad (25)$$

As expected, the relative wage rises as the supply of R&D workers decreases. We expect this increase to be accompanied by an increase in the optimal schooling years. Indeed:

$$-\frac{\partial S}{\partial L_r} = -\frac{1}{D}\frac{F(P-1)(l-1)(1-\frac{S}{T}) r h(S) L_p}{(P\overline{w} + (1-P)w)^2 h'(S)(1+r)^2} > 0 \quad (26)$$

As the number of R&D workers decreases, the students prefer a *larger* number of schooling years. We see that a positive tuition fee, F, is a necessary condition for a change in the number of R&D workers to affect schooling years. The fee causes the wage to affect benefits of schooling more favorably than the costs of schooling.

This increase in years of schooling, in turn, suggests that growth could rise, counteracting the initial negative effect of the outflow of educated people. To obtain the net effect, we differentiate growth with respect to a decrease in L_r :

$$-\frac{\partial g}{\partial L_r} = -\frac{\partial w}{\partial L_r}\frac{(r+1)^2}{l-1}(s-1)\log l < 0 \tag{27}$$

Thus there is an unambiguously negative net effect on growth. While the economy benefits from the increase in schooling years increase, it also loses from the outflow of R&D workers. The net effect is negative.

We turn now to the welfare effects. Since the demand curve is unit elastic, so is the demand curve for R&D workers. From this follows that expenditures are unaffected. From (11) this implies that welfare is solely determined by the growth effect, i.e. welfare decreases.

To sum up the results so far, we thus see that the emigration country *loses* from an outflow of unskilled production workers as well as from an outflow of R&D workers.

Effects of Education Policy

We noted that the effects of labor migration crucially hinge on the existence of the tuition fee. As noted in the introduction, privatization of the education system is a prominent feature of the transition countries and rising private costs of higher education has followed. Remembering that hardly any private institutions existed in the centrally planned economies, *Table 1* shows the drastic increases in the share of private academic institutions that has taken place in transition economies up to the year 2000/2001.

Table 1: Total number and share of private academic institutions
(academic year 2000-2001).

Country	% private	Total number
Albania	0	11
Belarus	26.3	57
Bulgaria	10.3	88
Croatia	34.6	26
Czech Rep.	33.3	42
Estonia	60	35
Hungary	51.6	62
Latvia	39.4	33
Lithuania	9.6	42
Macedonia	33.3	3
Moldova	50	114
Poland	62.9	310

Romania	59.3	140
Russia	37.1	965
Slovak Rep.	10	20
Slovenia	81.9	11
Ukraine	16.4	979

Note: Data in Table 1 are from UNESCO-CEPES (European Centre for Higher Education) www.cepes.ro/information_services/statistics.htm

The existence of the tuition fee in the model allows us to evaluate the effects of education policy. An increase in the tuition fee raises the costs of higher education yielding an expected negative impact on the optimal years of schooling:

$$\frac{\partial S}{\partial F} = \frac{1}{D} \frac{(s-1)\,r}{(P\overline{w} + (1-P)w)\,h'(S)} < 0 \qquad (28)$$

This drop in education years lowers the supply of human capital, which in turn raises the wage, i.e. return to human capital:

$$\frac{\partial w}{\partial F} = -\frac{1}{D} \frac{(l-1)\,r\,L_p L_r (h(S) + (S-T)\,h'(S))}{T(P\overline{w} + (1-P)w)(1+r)^2\,h'(S)} > 0 \qquad (29)$$

As a direct consequence of the drop in years of schooling, the inputs of human capital should fall:

$$\frac{\partial l}{\partial F} = -\frac{L_r (h(S) + (S-T)\,h'(S))}{T} \frac{\partial S}{\partial F} < 0 \qquad (30)$$

As each R&D worker get shorter education, the stock of human capital goes down and with it, the inputs of R&D in firms. This reduces the growth rate since $g = l \log l$. Since expenditures are unaffected (F is returned to the consumers) there is also a negative welfare effect.

CONSEQUENCES FOR TRANSITION ECONOMIES

Soon after the fall of the centrally planned systems in Eastern Europe, the discussion started about the consequences of labor inflows to the EU. This discussion gradually intensified, as it was clear that many transition countries aimed at membership in the European union, which would imply free labor mobility. The early projections claimed that the bulk of emigration would consist of skilled workers, particularly since these workers were considered to be relatively underpaid in the socialist economies.

However, as economies were transformed into market economies relative wages of the skilled workers are likely to have increased. Today, it is not obvious that the skilled workers of the candidate countries have stronger incentives to emigrate than the unskilled.

On the other hand, it is clear that the increased university premium has stimulated higher education, implying that the potential number of skilled emigrants has increased. This development has only partly been counteracted by the increases of the tuition fees of higher education.

In this paper we have specified a model to capture several of these developments. We first showed that the mere possibility of emigration to a high wage country has important effects. If a skilled worker contemplates to emigrate to a high wage country, his expected returns from schooling rises and he selects a longer education, which raises human capital and thus the growth rate. We also presented evidence in line with the notion that the growth of enrollment in higher education is higher in those countries where the prospects of becoming member of the European union are highest.

To the extent that the possibility for emigration is manifested in emigration of skilled workers, this brain drain would raise the wage of the skilled and thus stimulate more schooling among those who stay. While the economy is left with fewer skilled workers, which lowers growth, the workers left behind would be better educated, which raises growth. The net effect on growth is unambiguously negative and welfare is reduced.

This does not mean, however, that labor market integration between the present EU members and the candidate countries necessarily will lead to lowered growth and welfare in the CCs. The mere rise in the possibility to emigrate to high wage countries in the EU will stimulate education and thus growth. Clearly, the CCs would benefit the most if the probability of emigration increased as much as possible and as few as possible of skilled workers emigrate. It should be recognized, though, that a high probability could not be maintained in the long run unless also workers really emigrate.

We also find that an outflow of unskilled workers would lower growth and welfare. In this case, the lowered supply of unskilled workers lowers the relative wage of the skilled and thus reduces the incentives for higher education among skilled workers.

NOTES

1. See OECD (2002).
2. For a discussion of the interaction between political and economic factors as a

determinant of migration, see Lam (2002).

3. Spagat (2002) discusses the growth consequences of human capital and rising inequality in the transition economies.

4. Wong and Yip (1999) also examine an OLG model and find that the brain drain has an adverse effect on static income and reduces growth. In this case, the government must use a more aggressive education policy to compensate for emigration of highly skilled workers. See also Haque and Kim (1995). An earlier study that found possible positive effects of the brain drain is Miyagiwa (1991).

5. The growth rate of utility can be shown to be identical to the growth rate of real *GDP*, see Lundborg and Segerstrom (2002).

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