Brain Drain, Fiscal Competition, and Public Education Expenditure*

Hartmut Egger
University of Bayreuth,
CESifo, GEP, and IfW

Josef Falkinger
University of Zurich,
CESifo, and IZA

Volker Grossmann
University of Fribourg,
CESifo, and IZA

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LRH: Hartmut Egger, Josef Falkinger, and Volker Grossmann

Abstract

This paper develops a two-country model to examine the implications of fiscal competition in public education expenditure under international mobility of high-skilled labor. We allow for educational choice, asymmetry of countries with respect to total factor productivity, and tax base effects of migration in source and host country. As the latter may give rise to multiplicity of equilibrium, we carefully take into account alternative belief structures of mobile high-skilled workers. We also look at the consequences of bilateral policy coordination. While in line with other studies on tax competition, bilateral coordination can reduce the under-investment problem in public education spending, it also tends to hinder migration or may even reverse the direction of the migration flow that materializes under non-cooperative policy setting. Due to its potentially adverse effects on migration patterns, bilateral coordination may therefore reduce global welfare and bring the world economy further away from the social planner's solution.

JEL classification: F22; H52

Key words: Educational choice; Fiscal competition; High-skilled migration; Policy coordination; Public education.

*Egger (corresponding author): University of Bayreuth, Universitaetsstr. 30, 95447 Bayreuth, Germany. Phone: +49-921-55-2906, Fax: 55-842905, E-mail: hartmut.egger@uni-bayreuth.de. Falkinger: University of Zurich, Zurichbergstr. 14, 8049 Zurich, Switzerland. Phone: +41-44-634-2290, Fax: 634-4996, E-mail: josef.falkinger@econ.uzh.ch. Grossmann: University of Fribourg, Bd. de Pérolles 90, 1700 Fribourg, Switzerland. Phone: +41-26-300-8266, Fax: 300-9678, E-mail: volker.grossmann@unifr.ch.

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1 Introduction

In the last decades skilled labor has become increasingly mobile and the bulk of skilled immigrants acquired publicly financed education in their home country.[1] This potentially creates severe problems in the source countries of migrants and the consequence may be detrimental fiscal competition, with countries underinvesting in higher education in order to avoid brain drain and to attract high-skilled foreign immigrants (Justman and Thisse, 1997, 2000). This raises the question whether policy coordination could improve social welfare when skilled labor is mobile and how it changes the migration flows.[2]

In this paper, we develop and analyze a two-country model to examine the implications of fiscal competition in public education expenditures under international mobility of high-skilled labor. To capture the idea of higher education (instead of basic, compulsory education), we model education as the outcome of individual choice. With education being publicly financed, our model generates "agglomeration" effects from migration on the tax base in both source and host country; that is, higher emigration reduces the tax base in the source country and increases it in the host country, thereby further reinforcing migration incentives.[3] Due to the existence of agglomeration effects, it may be the case that, for given public spending levels and depending on the belief structure in the economy, migration may or may not occur in equilibrium, thereby potentially creating the problem of multiplicity of equilibria. We carefully address the issue in our analysis in a way which may be useful also in other political games with multiple equilibria.

Motivated by the recent endeavor in Europe to reach a higher degree of coordination in tertiary education (for instance, due to the Bologna process), we study potential gains from coordinated policy setting in the context of public education and international migration. We analyze the behavior of cooperative governments which aim to maximize the aggregate welfare of non-migrants (with transfers across countries to compensate losers), whereas a social planner would also consider the utility of migrants. The justification for this approach is that national governments target the median voter in their country, who is most likely a non-migrant. We show that from the perspective of a utilitarian social planner, bilateral coordination of education policies does not necessarily solve the problem arising from fiscal competition. On the one hand, bilateral coordination tends to increase public education expenditure compared to

the non-cooperative levels. On the other hand, however, bilaterally coordinated policies have consequences for the desired migration pattern. While coordination favors non-migration, the social planner may prefer brain drain in order to extract migration gains. In fact, we demonstrate that an endeavor to stop migration through a bilateral contract may even reduce welfare compared to a non-cooperative equilibrium. Moreover, we show that policy coordination may not always be successful in preventing brain drain, depending on the belief structure and migration costs. In this case, government cooperation may reverse the direction of the migration flow compared to both non-cooperative policy setting and the social optimum.

The remainder of the paper is organized as follows. Section 2 presents the model. Section 3 analyzes the equilibrium for a given public education policy. In Section 4, we examine how governments have to adjust their education expenditure in order to avoid brain drain when labor market integration reduces migration costs for high-skilled workers. Section 5 analyzes non-cooperative policy setting. In Section 6 we explore the consequences of cooperation between governments for public education expenditure and migration patterns; these patterns are compared to both non-cooperative policy setting and the social planner solution. The last section presents our conclusions. Due to space constraints, we do not present formal proofs of lemmata and propositions in this paper but refer the interested reader to the working paper version of our manuscript in Egger, Falkinger, and Grossman (2007).

2 The Model

Consider two open economies indexed H and F ("home" and "foreign") with two types of labor. High-skilled workers (at least a certain share of them) are mobile and look for the best income possibilities in the two economies. In contrast, the labor markets for low-skilled workers are internationally segmented.[4] The two types of labor are used to manufacture a single homogenous (numéraire) good, Y^j, $j = H, F$, according to

$$Y^j = F^j(S^j, L^j) = A^j \left(S^j\right)^{\beta} \left(L^j\right)^{1-\beta}, \tag{1}$$

where $A^j > 0$ and $\beta \in (0,1)$. S^j, L^j are efficiency units of high-skilled and low-skilled labor in $j = H, F$. A^j denotes total factor productivity in country j.

In either country, there is a unit mass of workers, indexed $i \in [0,1]$, who make two decisions: first, whether or not to acquire higher education; and, second, if high-skilled, whether or not to migrate to the other country in order to live and work there. Individuals take the migration decision into account when deciding whether or not to acquire education. That is, individuals are aware of earning opportunities abroad as well as at home. They are endowed with one unit of time. Acquisition of education requires $\bar{e} \in [0,1)$ units of time, so that $1 - \bar{e}$ is the residual working time of an educated individual.

Utility of an individual i living at home is simply given by the level of consumption, $C(i)$. Living abroad implies that utility is given by a discounted value of consumption which reflects the social costs of living in a foreign environment. Formally, the utility of migrant i is given by $C(i)/(1+\theta a(i))$, where $a(i) = 1$ for a mass $q \in (0,1)$ of high-skilled workers and $a(i)$ prohibitively high for the rest of them.[5] Parameter θ reflects the degree of international integration. A decline in θ means a more mobile high-skilled labor force.

An individual without higher education supplies one efficiency unit of low-skilled labor, so that employment L^j is equal to the mass of low-skilled workers in country j. The efficiency units of high-skilled labor supplied by an educated worker depend on the quality of the education system, which is determined by the level of local public education expenditure G^j. An individual born in country j acquires G^j units of high-skilled labor if he/she chooses education. Let $s^j = 1 - L^j$ denote the mass of educated workers and μ^j (μ^k) denote the mass of high-skilled workers educated in j (k) who migrate to country $k \neq j$ ($j \neq k$). Then the total amount of efficiency units of high-skilled labor employed in country $j = H, F$ is given by

$$S^j = (1-\bar{e})\left[(1 - L^j - \mu^j)G^j + \mu^k G^k\right], \; k \neq j. \tag{2}$$

3 Equilibrium Patterns of Brain Drain

Let w_S^j and w_L^j denote country j's wage rate per efficiency unit of high-skilled and low-skilled labor, respectively. Education is financed by a proportional wage income tax, with tax rate

$\tau^j \in [0,1)$ in $j = H, F$. Then, the consumption of a native individual from H is given by

$$C^H = \begin{cases} (1-\bar{e})\left(1-\tau^H\right) w_S^H G^H & \text{if high skilled and working in } H, \\ (1-\bar{e})\left(1-\tau^F\right) w_S^F G^H & \text{if high skilled and working in } F, \\ \left(1-\tau^H\right) w_L^H & \text{if low skilled.} \end{cases} \tag{3}$$

A worker who stays in her/his country of birth must be indifferent as to the choice between acquiring education or remaining low skilled in equilibrium. According to (3), this implies that

$$\phi \equiv \frac{1}{1-\bar{e}} = \omega^H G^H, \tag{4}$$

where $\omega^H \equiv w_S^H / w_L^H$ is the relative wage rate of high-skilled to low-skilled labor in country H in terms of efficiency units.[6] For the migration decision of high-skilled individuals, consumption level $(1-\bar{e})\left(1-\tau^H\right) w_S^H G^H$ when staying at home has to be compared with the discounted consumption level when migrating, $(1-\bar{e})\left(1-\tau^F\right) w_S^F G^H / (1+\theta)$. A high-skilled worker born and educated in H moves to F if and only if

$$1 + \theta < \frac{(1-\tau^F) w_S^F}{(1-\tau^H) w_S^H}. \tag{5}$$

Condition (5) implies that migration can go only in one direction. Thus, either $\mu^H \geq 0$ and $\mu^F = 0$, or $\mu^H = 0$ and $\mu^F \geq 0$ in the following analysis.

Lemma 1 *Let $b \equiv \beta^\beta (1-\beta)^{1-\beta}$. The net wage in country $j = H, F$ is positive if*

$$G^j < \bar{G}^j(\mu^j) \equiv \left(\frac{1-\mu^j}{\phi^\beta} b A^j \right)^{\frac{1}{1-\beta}}. \tag{6}$$

Moreover, for $\mu^H \geq 0, \mu^F = 0$, $\tau^H w_S^H = \phi/(1-\mu^H)$, $\tau^F w_S^F = \phi/[1+\mu^H G^H/G^F]$, and the relative net wage is given by:

$$\frac{(1-\tau^F) w_S^F}{(1-\tau^H) w_S^H} = \frac{b A^F \left(\phi/G^F\right)^{1-\beta} - \phi/\left[1+\mu^H G^H/G^F\right]}{b A^H \left(\phi/G^H\right)^{1-\beta} - \phi/\left[1-\mu^H\right]} \equiv \chi^H\left(\mu^H\right). \tag{7}$$

$\chi^H\left(\mu^H\right)$ is increasing in μ^H and G^H, while decreasing in G^F.

The further analysis assumes that G^j is smaller than the exogenous level $\bar{G}^j(q)$, $j = H, F$. Thus, as q is the maximal emigration rate, condition (6) is satisfied. $\chi^H(\mu^H)$ represents the incentives to migrate from H to F, which – according to (5) – have to be compared with the cost $1 + \theta$. For $\mu^H = 0, \mu^F \geq 0$, an analogous expression $\chi^F\left(\mu^F\right)$ describes the incentives to migrate from F to H.

As migrants take their education level with them to the foreign country, the (relative) wage rate per efficiency unit of skilled labor is decisive for the migration decision. However, the wage per efficiency unit in H, w_S^H, is decreasing in G^H. The reason is that higher education finance raises the supply of skills for a given fraction of individuals which choose higher education. Thus, an increase in G^H makes the home country more prone to brain drain. Furthermore, the government in H must increase its tax revenues in order to finance the additional expenditures associated with an increase in G^H. While in an economy without migration the tax burden per efficiency unit of high-skilled workers, $\tau^H w_S^H$, stays constant when the government increases G^H, the resepective burden rises from ϕ to $\phi/(1-\mu^H)$ if there is brain drain from H to F, that is, if $\mu^H > 0$ and $\mu^F = 0$. The tax payment per efficiency unit of high-skilled labor in F is $\phi/(1 + \mu^H G^H/G^F)$. Inflow μ^H of high-skilled labor from H broadens F's tax base so that the tax burden per individual declines. Thus, the tax channel strengthens the incentives of high-skilled workers to leave H, and it generates agglomeration effects in favor of the receiver country.

Figure 1 shows $\chi^H\left(\mu^H\right)$ and $\chi^F\left(\mu^F\right)$ for given levels of productivity and education expenditure. Without loss of generality, $G^H/G^F \geq \left(A^H/A^F\right)^{1/(1-\beta)}$ is assumed. (Note that the roles of H and F can be exchanged in the following discussion.) $\chi^H\left(\mu^H\right)$ is an increasing function of μ^H, which starts at

$$\chi^H(0) = \frac{bA^F\left(\phi/G^F\right)^{1-\beta} - \phi}{bA^H\left(\phi/G^H\right)^{1-\beta} - \phi} \geq 1, \tag{8}$$

and goes to infinity as μ^H approaches $m^H \equiv 1 - \phi^\beta\left(G^H\right)^{1-\beta}/\left(bA^H\right)$. Function $\chi^F\left(\mu^F\right)$ starts at $\chi^F(0) = 1/\chi^H(0) > 0$ and approaches infinity as μ^F approaches $m^F \equiv 1 - \phi^\beta\left(G^F\right)^{1-\beta}/(bA^F)$. At m^j, $j = H, F$, brain drain would erode j's tax base so that financing G^j would become

unfeasible. Condition $G^j < \bar{G}^j(q)$ implies $\mu^j \leq q < m^j$ and thus restricts the analysis to feasible education levels.

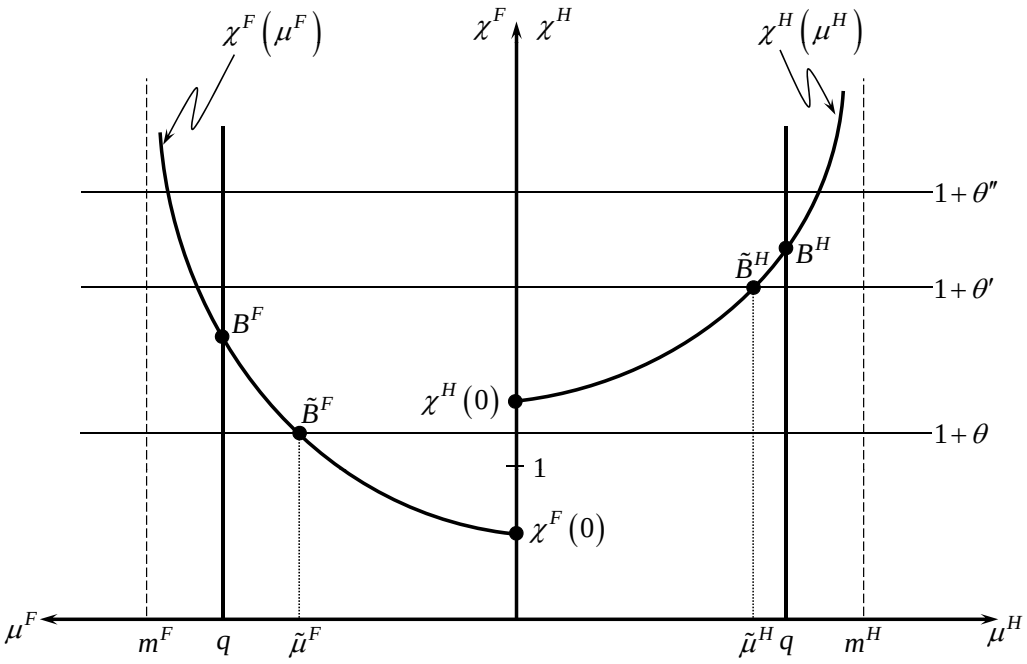

Figure 1: Migration incentives and migration equilibria: $G^H/G^F \geq (A^H/A^F)^{1/(1-\beta)}$

Comparing the returns to migration to the cost of working in a foreign country, we see that the following patterns of brain drain hold in equilibrium. If migration costs are high ($1+\theta''$ in Figure 1), then $\chi^j(\mu^j) \leq \chi^j(q) < 1+\theta''$ for all $\mu^j \leq q$. Thus, according to (5), no educated worker will leave his/her home country and only non-migration can hold in equilibrium in this case. At cost $1+\theta'$, non-migration is still an equilibrium since $\chi^F(0) < \chi^H(0) < 1+\theta'$. However, $\tilde{B}^H$ and B^H are also equilibria. At $\tilde{\mu}^H$, individuals are indifferent as to whether they will work abroad or in their home country. But any deviation to the left eliminates migration ($\chi^H\left(\mu^H\right) < 1+\theta'$ for $\mu^H < \tilde{\mu}^H$), whereas any deviation to the right induces more migration ($\chi^H\left(\mu^H\right) > 1+\theta'$ for $\mu^H > \tilde{\mu}^H$). We call such an equilibrium *unstable*. In contrast, B^H is a stable equilibrium since $\chi^H(q) > 1+\theta'$ and all mobile workers have gone from H to F. If migration costs diminish further, migration from F to H can also be an equilibrium. For instance, at cost $1+\theta$, we have an unstable equilibrium $\tilde{B}^F$ and a stable equilibrium B^F, in addition to equilibrium B^H. Throughout the following analysis, we focus on the stable

equilibria, that is, either $\mu^H = \mu^F = 0$, $\mu^H = q$, or $\mu^F = q$.

In the next section, we examine for given education policies G^H, G^F whether a non-migration equilibrium can be sustained when international labor markets for high-skilled workers become more integrated. We also explain how we deal with policy combinations that give rise to multiple migration equilibria.

4 Opening up the Labor Market for Given Policy

Suppose that up to now, high-skilled workers have worked where they were educated. As in Figure 1, let $\chi^F(0) < \chi^H(0)$. Now suppose migration costs decline from θ'' to θ (such that $\chi^H(0) > 1 + \theta > \chi^F(0)$). In this case, as χ^H is increasing in G^H, domestic education policy is too ambitious relative to total factor productivity and mobile high-skilled workers of country H benefit from leaving their home country and working abroad. The resulting brain drain from H to F has detrimental consequences for immobile workers in H, whose tax burden increases. Therefore, a crucial question facing national policymakers is how education expenditure can be adjusted in order to prevent this brain drain.

If θ approaches zero, an outcome without migration is feasible only if countries H and F choose their policies in such a way that $\chi^H(0) = \chi^F(0) = 1$. In this case, locations H and F are equally attractive for high-skilled workers. According to (7), this requires $G^H/G^F = \left(A^H/A^F\right)^{1/(1-\beta)}$. In Figure 2, line EA with slope $\left(A^H/A^F\right)^{1/(1-\beta)}$ represents the locus of *equal attractiveness*.

An outcome with $\mu^H = 0$ requires $1 + \theta \geq \chi^H(0)$. Using (8), this gives us the following constraint:

$$\frac{G^H}{G^F} \leq \rho_0^H \left(\frac{A^H}{A^F}\right)^{\frac{1}{1-\beta}}, \tag{9}$$

with

$$\rho_0^H \equiv \left[\frac{1+\theta}{1+\theta\phi^\beta \left(G^F\right)^{1-\beta} / \left(bA^F\right)}\right]^{\frac{1}{1-\beta}}.$$

Condition (9) defines the set of policy combinations that are consistent with $\mu^H = 0$. The bound of this set is the incentive constraint for non-migration, represented by I_0^H in Figure 2.

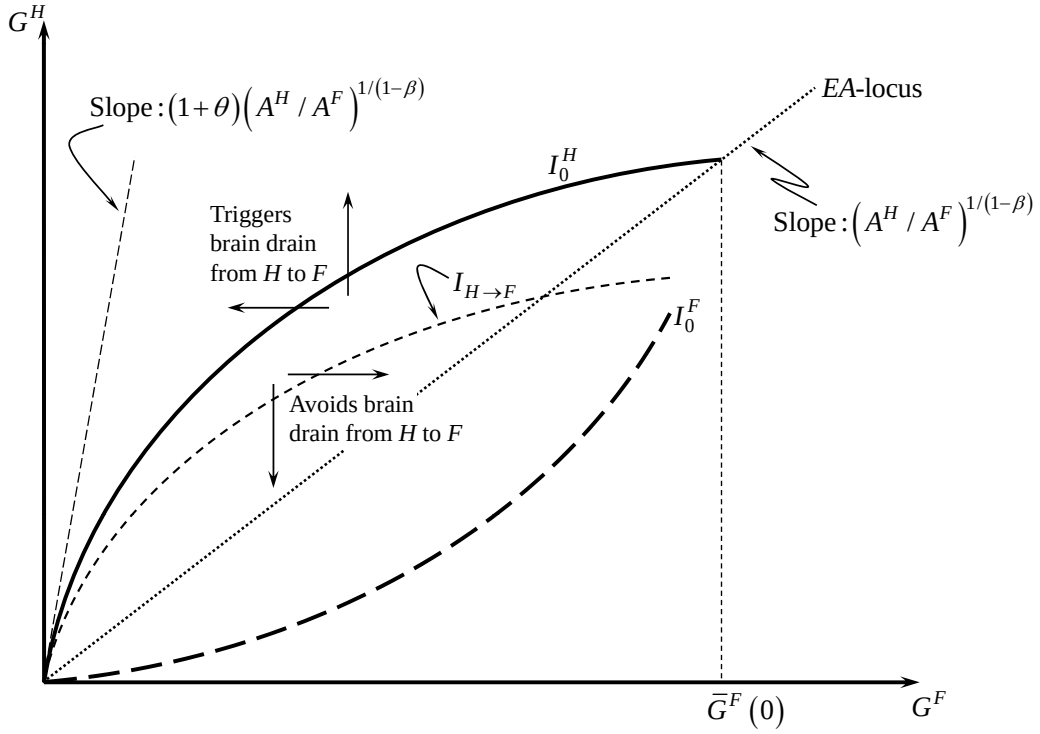

Figure 2: Scope for policy

According to (6), $\left(G^F\right)^{1-\beta} < bA^F/\phi^\beta$. Thus, for $\theta > 0$, $\rho_0^H > 1$ and I_0^H lies above the EA line. Moreover, as G^F increases, ρ_0^H decreases from $(1+\theta)^{1/(1-\beta)}$, for $G^F = 0$, to one, for $G^F = \bar{G}^F(0)$ (use (6)). This explains the concave shape of I_0^H as shown in Figure 2.

Policy combinations on line I_0^H fulfill the condition that $\chi^H(0) = 1 + \theta$ and, therefore, render mobile high-skilled workers indifferent as to whether they should stay at home or work abroad. ρ_0^H describes country H's scope for $\mu^H = 0$ supporting policy. When θ declines, the scope for raising education expenditure above the EA line narrows. To determine which policy combinations are consistent with $\mu^F = 0$, we have added locus I_0^F in Figure 2. The set of policy combinations that are consistent with non-migration is bounded by I_0^H and I_0^F.

But do governments really succeed in preventing brain drain by choosing policy combinations in the lens bounded by I_0^H and I_0^F? We know from Figure 1 that – due to the agglomeration effects of brain drain – the equilibrium migration pattern is not necessarily unique. This implies that certain policy combinations in the lens bounded by the two incentive constraints I_0^H and I_0^F, although consistent with non-migration, may be consistent with brain drain as well, say

from H to F. To determine the policy domain associated with multiple migration patterns, we consider the constraint for policy combinations that prevent brain drain from H to F. This constraint is given by $\chi^H(q) \leq 1+\theta$. In analogy to (9), it can be written in the form

$$\frac{G^H}{G^F} \leq \rho_1^H \left(\frac{A^H}{A^F}\right)^{\frac{1}{1-\beta}}, \tag{10}$$

with

$$\rho_1^H \equiv \left[\frac{1+\theta}{1+\eta\phi^\beta (G^F)^{1-\beta}/(bA^F)}\right]^{\frac{1}{1-\beta}}$$

and $\eta \equiv (1+\theta)/(1-q) - \left(1+qG^H/G^F\right)^{-1}\theta$. For any G^F, $\rho_1^H < \rho_0^H$. The upper bound of policy combinations preventing brain drain from H to F is represented by the curve $I_{H\to F}$ in Figure 2. Since $\rho_1^H < \rho_0^H$, the incentive constraint $I_{H\to F}$ lies below the incentive constraint I_0^H. Only relatively strong expenditure and tax cuts in the source country can outweigh the agglomeration advantages of the receiver country. Like I_0^H, the incentive constraint $I_{H\to F}$ rotates downward when migration costs decline: $\partial\rho_1^H/\partial\theta > 0$ (see Egger, Falkinger, and Grossmann, 2007).

Policy pairs in the region bounded by I_0^H and $I_{H\to F}$ are associated with multiple migration patterns. This multiplicity of migration equilibria constitutes a problem for the characterization of optimal non-cooperative education policies in Section 5. The reason is that national governments base their expenditure decisions on certain expectations concerning the equilibrium migration pattern. However, it is not clear how these expectations are formed if multiple migration patterns are possible. To overcome this problem, we introduce a selection criterion that is based on a publicly known (and identical) *belief* of mobile high-skilled workers about the equilibrium (μ^H, μ^F) pattern.

We distinguish between two types of beliefs. As the baseline scenario, we consider "*stay-home beliefs*". Under stay-home beliefs, mobile high-skilled workers do not migrate whenever an outcome with $\mu^H = \mu^F = 0$ is consistent with rational behavior. In this case, the the scope for policies avoiding brain drain from H to F is given by ρ_0^H, that is, (9) is the relevant constraint. In addition to the baseline case of stay-home beliefs, we also consider the alternative case that migration decisions are based on "*go-abroad beliefs*". Under go-abroad beliefs, mobile high-skilled workers migrate from H to F whenever $\mu^H = q, \mu^F = 0$ is consistent with rational

behavior. In this case, mobile high-skilled workers of country H anticipate the agglomeration effects of migration and the scope for policies avoiding brain drain from H to F shrinks from ρ_0^H to ρ_1^H, that is, (10) instead of (9) becomes the relevant constraint.

5 National Education Policies

In order to shed light on optimal education policies from a national point of view, we first have to specify the national policy goal. Under the reasonable assumption that the median voter does not migrate, the workers who stay are decisive for national governments. Therefore, we look at the impact of G^j on the low-skilled workers and on the high-skilled workers who work in j. By virtue of (3) and (4), the consumption levels of the low-skilled and the non-migrating high-skilled workers are identical and given by net wage $W^j \equiv (1-\tau^j)\, w_L^j$. Thus, we can take W^j as an objective function of the government.

Lemma 2 *The net wage of residents in j is given by*

$$W^j = bA^j \left(\frac{G^j}{\phi}\right)^{\beta} - \frac{G^j}{1-\mu^j+\mu^k G^k/G^j}, \quad j \neq k \in \{H,F\}. \tag{11}$$

For any given $\mu^j, \mu^k \in [0,q]$, objective function W^j has a unique maximum at $\tilde{G}^j\left(\mu^j,\mu^k;G^k\right) > 0$, $j \neq k$. We have (i) $\partial\tilde{G}^j/\partial\mu^j < 0$, (ii) $\partial\tilde{G}^j/\partial\mu^k > 0$, and (iii) $\partial\tilde{G}^j/\partial G^k > 0$ if $\mu^k > 0$, else $\partial\tilde{G}^j/\partial G^k = 0$. Moreover, (iv) $\tilde{G}^j\left(0,0,G^k\right) = \left(\beta bA^j/\phi^\beta\right)^{1/(1-\beta)}$.

For any given migration pattern, Lemma 2 characterizes j's best reply to policy G^k. We use the following notation: G_0^j denotes j's best reply function conditional on non-migration, while $G_{j\to k}^j$ is j's best reply function conditional on brain drain from j to k. However, the best reply functions determined in Lemma 2 are not necessarily consistent with the incentive constraints of mobile high-skilled workers. If an incentive constraint is binding, education expenditure has to be adjusted in order to sustain the assumed migration pattern. Hence, migration incentives limit the scope of national education policy.

Furthermore, a country may have an incentive to undercut education expenditures that are optimal for a certain migration pattern in order to shift brain drain in its own favor. The costs

of deviating from optimal adaptation to a given migration pattern as well as the benefits of changing the pattern of migration can be evaluated by comparing the net wage function W^j for different μ^j, μ^k constellations. Figure 4 illustrates for the three possible equilibria identified in Section 3 the objective function W^H and the best responses of H to a given foreign education policy. Subscripts $H \to F$, 0, $F \to H$ refer to migration from H to F, non-migration, and migration from F to H, respectively.

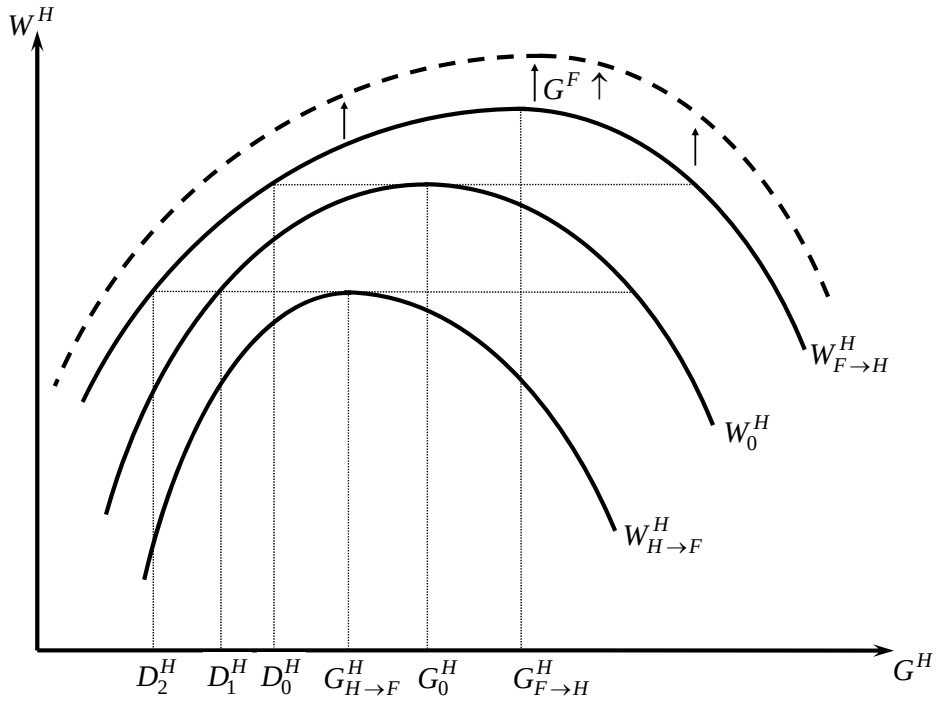

Figure 3: Optimal education policies for different migration patterns and deviation incentives

The ranking $W^H_{H\to F} < W^H_0 < W^H_{F\to H}$ follows from (11), and $G^H_{H\to F} < G^H_0 < G^H_{F\to H}$ follows from Lemma 2. Figure 3 shows that deviation from G^H_0 within range (D^H_0, G^H_0) would be beneficial if such a deviation induced a switch from non-migration to brain drain from F to H. Analogous bounds D^H_1, D^H_2 for attractive deviations exist to the left of $G^H_{H\to F}$. If H succeeds in preventing the outflow of high-skilled labor (or even induces inflow from F) by lowering G^H to below $G_{H\to F}$, this is beneficial as long as G^H remains within the range marked by D^H_1 (D^H_2, respectively). Since, according to (11), an increase in G^F moves the W^H curve for $\mu^H = 0, \mu^F = q$ upward, whereas the W^H curves for $(\mu^H, \mu^F) \in \{(0,0),(q,0)\}$ are unaffected,

D_0^H and D_2^H are decreasing in G^F, while D_1^H is constant.

As outlined in detail in the working paper version of this manuscript, Egger, Falkinger, and Grossmann (2007), the outcome of the policy game (in pure strategies) depends on the belief structure and it is inconsistent with a binding incentive constraint of mobile high-skilled workers. Let us first consider the case of stay-home beliefs. In this case, only a policy pair with $N_0 = (G_0^F, G_0^H)$ – and thus non-migration – is consistent with a best response of both governments.[7] Figure 4 shows the relevant deviation bound D_0^H from conditional equilibrium policy G_0^H. Deviation successfully triggers brain drain from F to H if incentive constraint I_0^F is crossed. Thus, for high migration costs (θ_2), the shaded area DC ("deviation cone") to the right of intersection point T_0 describes the range of deviations from G_0^H that change the pattern of migration in favor of H and increase W^H. There is no policy G^H such that $\left(G_0^F, G^H\right) \in DC$. Thus, for θ_2, H will not deviate from G_0^H and N_0 is an equilibrium under rational policy setting. However, if migration cost θ decreases, incentive constraint I_0^F moves closer to the EA line. If θ is sufficiently low (θ_1), we have an incentive constraint which intersects D_0^H at a point (T_0') to the left of G_0^F. Then the deviation cone DC' contains (G_0^F, G^H), for some G^H and H will deviate from G_0^H. Hence, for sufficiently low migration costs, non-migration cannot be sustained in a Nash equilibrium under rational policy setting.

Under go-abroad beliefs, both $N_0 = (G_0^H, G_0^F)$ as well as $N_1 = (G_1^F, G_1^H)$, with G_1^F, G_1^H being determined by the intersection of best response function $G_{H\to F}^F, G_{H\to F}^H$ in (G_H, G_F)-space, are candidates for a non-cooperative equilibrium of rational governments. For N_0, the deviation incentives are analogous to the situation discussed for stay-home beliefs. If N_1 is realized, then the question is: Will H deviate from conditional best reply $G_{H\to F}^H$ to change the pattern of migration in its favor? If H wants to avoid brain drain from H to F, it must cross incentive constraint $I_{H\to F}$. Figure 5 shows constraints $I_{H\to F}$ as well as deviation bound D_1^H (which is independent of G^F) for two values of migration costs θ_1, θ_1', with $\theta_1' < \theta_1$. While $I_{H\to F}$ rotates downward when θ declines, conditional best replies and deviation bounds do not vary with θ.

If migration costs are sufficiently low (θ_1'), country H has no possibility to reach the relevant deviation cone (DC_1') by deviating from $N_1 = \left(G_1^F, G_1^H\right)$. Given that high-skilled migrants suffer a low burden due to working abroad, the expenditure and tax cuts required to prevent

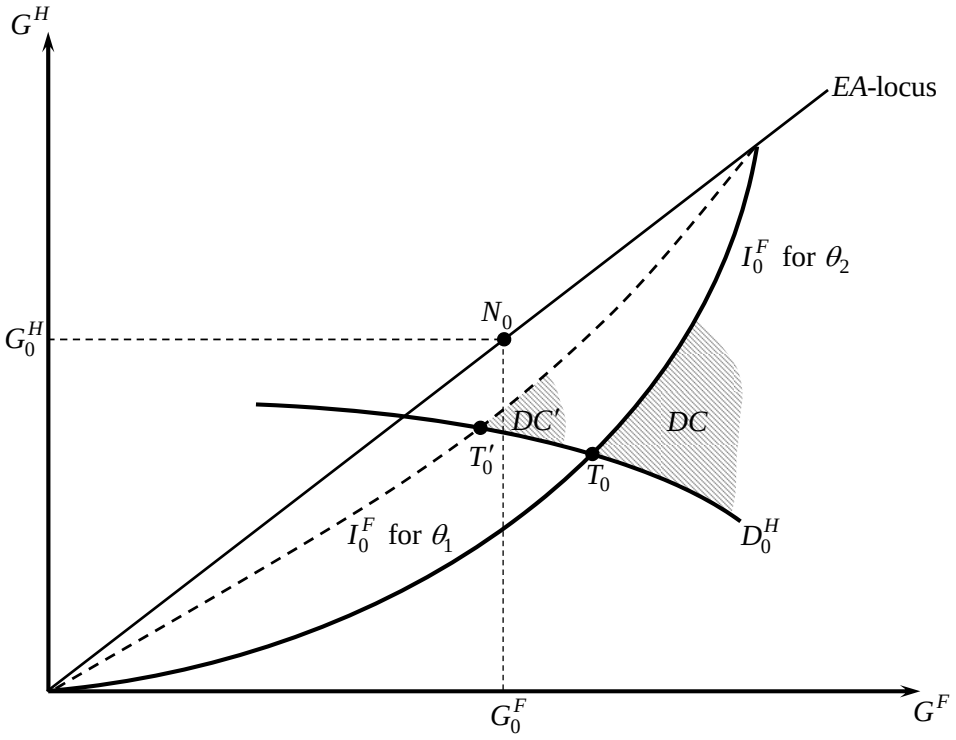

Figure 4: Deviation cones (DC) from conditional non-migration equilibrium ($\theta_1\theta_2$)

migration are too high to be an attractive option for H. In contrast, if the burden of working abroad were more severe (θ_1), then it would be in H's national interest to induce migrants to stay at home by deviating from N_1 to DC_1, that is, by reducing education expenditure.[8]

Summarizing the insights from above, we can formulate the following proposition.

Proposition 1 *A non-cooperative equilibrium (in pure strategies) may not exist. In particular, if θ is sufficiently low, an equilibrium without migration is excluded. Furthermore, an equilibrium with brain drain requires that individual migration decisions are based on go-abroad beliefs and that θ is sufficiently low.*

6 Coordination of National Policies

Facing the results from Section 5, the national governments in H and F can examine whether bilateral coordination of public education expenditure paired with transfer payments between

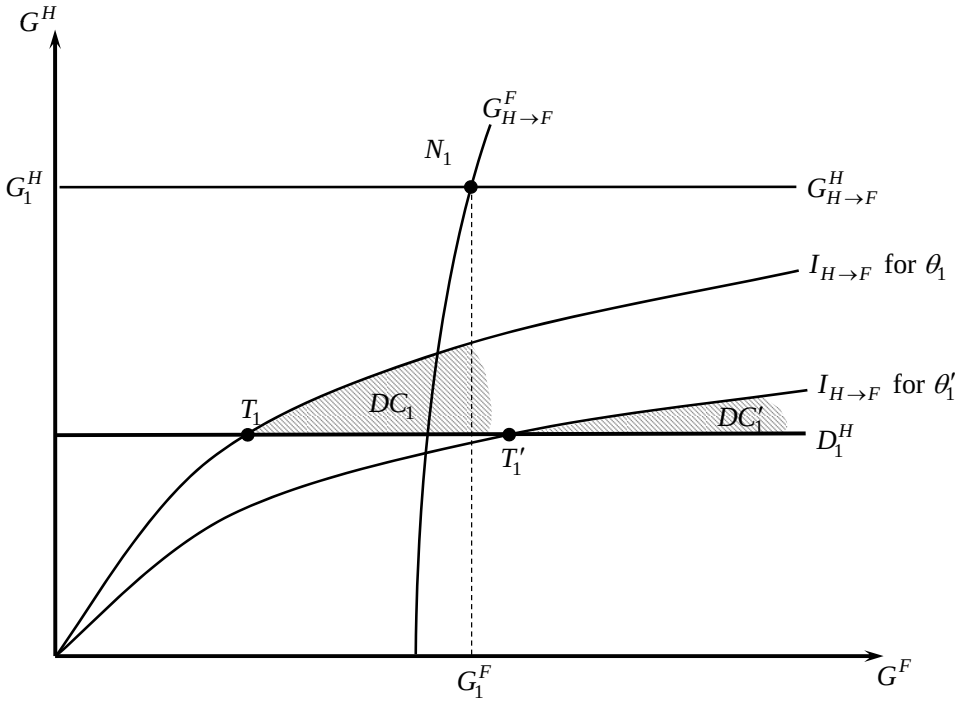

Figure 5: Deviation cones for return migration ($\theta_1' < \theta_1$)

the two countries is beneficial for the median voters represented by immobile workers. Formally, bilateral coordination means that the two countries H and F agree to choose education policies G^H, G^F that maximize the sum of the net income levels of the median voters

$$W^c \equiv W^H + W^F \tag{12}$$

subject to the incentive constraints of mobile workers and subject to the national budget constraints.[9] The main results for coordinated policies are summarized in the following proposition.

Proposition 2 *For any given education policies $G^H, G^F > 0$, W^c is higher at $\mu^j = \mu^k = 0$ than at $\mu^j = q$, $\mu^k = 0$, $j \neq k \in \{H, F\}$. The optimal bilateral contract depends on the beliefs of mobile high-skilled workers. (i) Under stay-home beliefs, the optimal bilateral contract supports non-migration by coordinating on G_0^H, G_0^F. (ii) Under go-abroad beliefs, policies G_0^H, G_0^F are not optimal if migration costs θ are sufficiently low. In this case, governments may want to coordinate on policies that trigger brain drain. (iii) If non-cooperative policy setting of rational*

governments leads to an equilibrium with brain drain, then coordination increases W^c and the direction of brain drain may be reversed.

The proposition shows that national governments that serve the interests of the workers who stay in their country have a preference for non-migration. The reason is that even though the median voter in the host country of migrated labor would gain, this gain is lower than the loss suffered by the median voter in the source country. Therefore, the country threatened by losses from brain drain is willing to pay the other country for not triggering the drain.

If mobile high-skilled workers base their migration decision on stay-home beliefs, coordination definitely supports non-migration. This may or may not require signing a contract. If non-migration is also the outcome of non-cooperative education policies, there is no role for coordination because the best contract would just reproduce the non-cooperative solution. However, according to Proposition 1, reduced migration costs tend to provoke fiscal competition for foreign high-skilled workers. In this case, bilateral coordination has the role of preventing fiscal competition for high-skilled labor and is definitely in the interest of the national median voters.

If migration decisions are based on go-abroad beliefs, coordinating on G_0^H, G_0^F may be less successful in establishing an equilibrium without migration. However, a bilateral contract can stop the possibly ongoing struggle for mobile high-skilled workers under non-cooperative policy setting. Furthermore, if non-cooperative policy setting leads to an equilibrium with brain drain from H to F, bilateral coordination is definitely beneficial for the national median voters. The coordination may imply education policies that reverse the direction of brain drain, leading to a factor flow from F to H. This result may be surprising at first glance because non-migration is the preferred pattern under bilateral coordination. However, non-migration is possibly inconsistent with the optimal bilateral agreements that satisfy the incentive constraints for mobile high-skilled workers.

The bilateral coordination perspective considered here must be clearly distinguished from the social planner solution. National governments care about the utility of median voters but ignore the gains of migrants. In the following, we compare education policies implemented by a utilitarian social planner with the contract resulting from bilateral coordination of education

policies.

One can show that a utilitarian social planner chooses education policies in such a way that

$$SW = W^c + \mu^H W^H \left[\chi^H / (1+\theta) - 1\right] + \mu^F W^F \left[\chi^F / (1+\theta) - 1\right] \tag{13}$$

is maximized, subject to the incentive constraints of mobile high-skilled workers and the budget constraints of governments. For given education policies, SW is not necessarily higher at $\mu^j = \mu^k = 0$ than at $\mu^j > 0$, $\mu^k = 0$, $j \neq k \in \{H, F\}$. The outcome of this comparison depends on the size of migration gains $\mu^j W^j \left[\chi^j / (1+\theta) - 1\right]$, which are part of SW in (13), but are not considered in the W^c-maximizing contract. Hence, the social planner is more likely to opt for a migration equilibrium in order to reap the migration gains of mobile high-skilled labor.

In the working paper version of this manuscript, we undertake two numerical simulation exercises in order to shed further light on how the social planner solution deviates from non-cooperative policies and the bilateral contract. However, in the interest of brevity, we do not present these exercises here. Instead, we summarize the main insights from these exercises as follows and refer the reader, who is interested in further details, to Egger, Falkinger, and Grossmann (2007):

Proposition 3 *Bilateral coordination can help to increase public education expenditure to above suboptimal non-cooperative levels. Moreover, it is useful for overcoming an ongoing battle for mobile high-skilled workers. However, (i) bilateral coordination is biased toward non-migration, and (ii) it may reverse the direction of brain drain compared to both the non-cooperative policy game and the social planner solution; (iii) from a social planner's point of view, non-cooperative education policies can be better than bilateral coordination.*

7 Concluding Remarks

This paper aimed at shedding light on opportunities of and incentives for national governments to provide public finance for higher education and to compete for educated workers. For this purpose we analyzed a simple two-country model in which countries may differ in TFP and where brain drain has agglomeration effects because it affects the tax base in both source and

receiver country. Within this framework, we compared public education expenditure levels, migration patterns, and welfare in non-cooperative political equilibria with the outcomes under bilateral coordination and the social planner solution. As a key result we found that bilateral coordination can reduce the under-investment problem in public education spending but at the same time it tends to hinder migration or may even reverse the direction of the migration flow that materializes under non-cooperative policy setting. Due to its potentially adverse effects on migration patterns, bilateral coordination may therefore reduce global welfare and bring the world economy further away from the social planner's solution.

In the interest of analytical tractability, we had to impose several simplifying assumptions which might limit the practical relevance of our analysis. For instance, we have ignored intertemporal externalities from migration of high-skilled labor – such as changes in productivity. Furthermore, we have not allowed for other forms of policy coordination, like international agreements on taxing graduates.[10] While both of these extensions would be worthwhile to consider in our framework, they are clearly beyond the scope of this paper.

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Notes

[1]In most advanced countries, the bulk of higher education is indeed financed by the public sector. In 2005, the average share of public expenditure for tertiary education within the OECD and the EU19 was 73.1 and 82.5 per cent, respectively (OECD, 2008, Tab. B3.2b).

[2]Policy coordination in higher education has been a major priority in the EU. On the one hand, the recent reforms of national university programs that aim at establishing a uniform European Bachelor/Master system ("Bologna process") are an important step towards stronger coordination in tertiary education policies in Europe. On the other hand, these efforts have been accompanied by a discussion about measures to smooth the risk of brain drain. For instance, the Council of Europe (1995) has recommended that in order to "strengthen higher education and [...] diminish the risk of brain drain, countries are strongly encouraged to [...] develop structured programmes of European and regional, bilateral and multilateral cooperation at government level."

[3]Even though the fiscal externality is highly relevant (see Lucas, 2005, ch. 4), there may of course be other externalities that generate agglomeration effects. For instance, Schiff (2004) argues that the loss of social capital constitutes a key negative externality in the source country of emigration. Borjas (1995) points to positive externalities of immigration due to its positive effect on market size and productivity in the destination country. Carrington, Detragiache, and Vishwanath (1996) argue that emigration exhibits a positive externality as it reduces migration cots for subsequent migrants.

[4]That low-skilled workers are immobile is a standard assumption in the brain drain literature (see Chau and Stark, 1999), even though a few recent studies on the matter allow for simultaneous migration of both high-skilled and low-skilled workers at differing intensities (see Bellettini and Berti Ceroni, 2007).

[5]Restricting the analysis to two types of individuals with respect to migration costs greatly simplifies the analysis. However, the main insights from our analysis would remain the same if more than two types of agents were taken into account. The assumption that not all high-skilled workers can emigrate ($q < 1$) is standard in the migration literature and it guarantees that the mass of educated workers is higher than the mass of high-skilled emigrants so that production does not entirely break down in the source country of emigration.

[6]By assuming (4), we exclude the case of countries with zero higher education from the analytical discussion. For further discussion on this issue, see our working paper Egger, Falkinger, and Grossmann (2007)

[7]Under stay-home beliefs of mobile high-skilled workers there is no brain drain from H to F if both governments choose polices in accordance with their best responses $G^F_{H\to F}$, $G^H_{H\to F}$. Hence, a pure strategy equilibrium with migration is inconsistent with stay-home beliefs.

[8]Apart from avoiding an outflow of high-skilled workers, country H could choose an education policy that leads to reversed brain drain and attracts high-skilled workers educated in F. This case is discussed in the working paper version of this manuscript: Egger, Falkinger, and Grossmann (2007).

[9]We focus on transfer payments that do not affect the migration decision.

[10]See Poutvaara (2004, 2008) for a discussion.