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DISCUSSION PAPER

Subsidizing Education in the Economic Periphery: Another Pitfall of Regional Policies?

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Subsidizing Education in the Economic Periphery: Another Pitfall of Regional Policies?

ABSTRACT

One of the most prominent instruments of regional policy is to foster education and human capital formation in economically lagging regions. However, regional policy of this type can actually hurt instead of help the poor areas. The reason is that individual geographical mobility increases with the personal skill level. Through education subsidies, particularly if targeted on relatively high skilled workers, individuals can cross some threshold level of qualification beyond which emigration accrues. Regional policies then result in a human capital flight harmful to individuals remaining in the economic periphery. This fatal result does not hold for such policies that foster basic education and focus on the relatively low skilled.

Keywords: Regional Policy, Education Subsidies, Human Capital, Labour Mobility, European Union

JEL-classification: H 3, F 4, R 1

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1) Introduction

Many federal governments conduct regional policies, i.e. they try to reduce spatial inequalities of real incomes and living standards within an integrated economic area. One of the most notable cases is the European Union, where roughly one third of the yearly EU-budget is spent to achieve regional economic and social cohesion. The fear is that without corrective policy interventions regional divides might be strengthened that endanger the coherence of the economic and political union. Economic theory is underpinning this anxiety through such approaches like endogenous growth theory or ´new economic geography´, which are telling that the free market mechanisms alone might not render regional convergence like neoclassical theories mean to imply. Quite contrarily, through cumulative and circular causation mechanisms stemming from agglomeration advantages and increasing returns to scale, inequalities and "core-periphery-divides" in these models can become more pronounced over time.

One of the most prominent political strategies to help poor regions is to foster education and human capital formation of the local workforce. The European Commission e.g. devotes roughly 30 per cent of all resources spent for the so called ´objective 1´-regions to promote training and education activities. The hope is that with better developed skills, the lagging areas will sooner or later catch up with the rest of the community.

In the recent discussion, economists have highlighted at least two problematic aspects of regional policies. Firstly, it is unclear whether there is a convincing economic case at all for a more equitable spatial resource allocation in presence of a technology exhibiting localised increasing returns to scale. And secondly, even if cohesion policy is defended on different, equity or political grounds, it is still questionable if the particular instruments used to countervail agglomeration are indeed well suited to reach this goal.

This second issue has been discussed in some detail for the case of infrastructure investments (Martin, 2000; Martin/Rogers, 1995). Through secondary market adjustments, the actual effects of this policy can completely deviate from the intended ones, as infrastructure improvements might facilitate further central agglomeration instead of limiting it. In this paper, we try to look at the other typical instrument of regional policies, subsidies to education, from a comparable perspective. Our central point is to show that education oriented regional policies also might actually hurt instead of help the economic periphery.

The underlying logic hinges on the interrelation of individual skill level and geographical mobility. It is well established that geographical mobility increases with the individual skill level (see Gianetti, 2001; Hunt, 2000; Mauro/Spilimbergo, 1999). One simple theoretical rationale for this stylised fact that will also play a crucial role in our model is that agglomeration wage premia are generally higher for skilled than for unskilled labour (Moeller, 2002), whereas approximately identical mobility costs accrue to all types of workers.[1] Now consider the role of regional policies designed to promote the skills of individuals in the poorer region. Through enhancing the individual skill levels some recipients might cross a threshold level of qualification beyond which emigration out of the peripheral regions pays off. This migration choice, or in general the location decision of single agents, affects other individuals through (pecuniary) externalities. This is why workers left behind in the peripheral region suffer from the brain drain that has been induced by regional policies.

Only if the recipient group for subsidies is chosen such that training does not increase emigration, regional policies in fact deliver a closing income difference between centre and periphery. The implication of this result is that regional policies should focus on basic training and education for low skilled workers, because they have a lower propensity to migrate after the education period.

The framework we use to illustrate our point is an OLG-model with heterogeneous agents who endogenously decide on education. The technology is characterised by monopolistic competition and localized increasing returns, in order to analyse regional policy in an environment in which spatial agglomeration plays a role. But before we come to our model in section 3, we first briefly summarize the working of European regional policy and the academic debate on various aspects of it in section 2, where we also discuss how our model relates to the existing literature.

[1] This assumption requires come comment. One could argue that the mobility costs of skilled people with high personal incomes are higher, maybe due to a preference for more sophisticated housing. On the other hand, mobility costs can be the interpreted in a wider sense as capturing all sorts of "psychic costs" that arise when changing locations: costs to adapt to new cultural environment, costs of establishing new social networks, costs of gathering information about local market conditions etc. These costs are supposedly lower for high skilled labour, and therefore the assumption of skill invariant relocation costs seems reasonable on balance.

2) Regional policies and its spatial effects: An overview

The EU-Commission has a very particular strategy to achieve spatial equity, summarized in the Second Cohesion Report (EU Commission, 2001:117)

> "*The Treaty [of the European Community], by making explicit the aim of reducing disparities in economic development, implicitly requires that EU policies, and cohesion measures in particular, should influence factor endowment and resource allocation and, in turn, promote economic growth. More specifically, cohesion policies are aimed at increasing investment to achieve higher growth and are not specifically concerned either with expanding consumption directly or with redistribution of income*."

Thus, Brussels does not satisfy itself by redistributing potential gains from economic integration through fiscal transfers. It rather explicitly tries to influence the spatial resource allocation in order to reduce agglomeration. The funds available to pursue this goal are substantial. In the time period 2002-2006, an amount of 213 billion € is available for cohesion policy, from which 64% are used for interventions under ´objective 1´. Since EU-funding is only available as an additional source of financing for specific projects, the true amount of resources transferred to the periphery is actually understated by the above number. Eligible areas for ´objective 1´-funding are NUTS II-regions with a GDP per capita below 75% of the community's average. This comprises exclusively the remote areas at the outside boarders of EU-15: nearly all of Greece, Spain and Portugal as well as Southern Italy, East Germany, the Burgenland (AT). as well as parts of the UK and Ireland.[2] In total, remarkable 22% of the total EU-population are covered under ´objective 1´-funding.[3]

Structural interventions in these regions have three broad priorities. About 35% of structural funds under ´objective 1´ are spent on the improvement of infrastructure with a special focus on interregional transportation networks. Direct subsidies to firms located in the periphery are of decreasing importance, but also still amount to 35%. The

[2] Northern Finland and Northern Sweden are also covered under objective 1 despite of having a per capita income well above 75% of the EU average. This exception is being made, because they are considered "extremely remote areas".

[3] This illustrates how pronounced regional differences are within the EU. If an identical policy would be conducted in the US, the eligible regions would only make up for 2% of the American population (Puga, 2001).

remaining share is spent to promote education, with a special emphasis on promoting skills compatible with the "information society" and with new technologies (Guersent, 2001). The short- and medium-run goals of regional policies can roughly be described as trying to enhance the regional productivity level and thereby foster investment and growth in the recipient areas. In view of mobile factors of production, the Commission is trying to guide factors to settle, or respectively to remain in the periphery.

As many authors have pointed out, such a policy is illogical given the theoretical models that motivate regional policies in the first place. If the EU-Commission thinks that the new divergence theories with increasing returns, localised spillovers etc. are an appropriate description of reality, it is unclear why it should try to offset or hinder agglomeration. If increasing returns are at work, spatial concentration is efficient since production costs are saved on aggregate (Boldrin/Canova, 2001; Martin, 1999; Fujita/Thisse, 1996). Moreover, agglomeration and growth tend to be mutually reinforcing processes, so that an asymmetric distribution of economic activity also tends to increase growth (Martin/Ottaviano, 2001; Quah, 1997), and to lower aggregate unemployment (Suedekum, 2002a). An efficiency oriented policy would therefore allow for agglomeration or even subsidize it, and subsequently redistribute the gains through income transfers (Suedekum, 2002b). EU regional policies on the other hand end up in a trade-off between efficiency and regional equity (Martin, 1999), as the interventions that retain production in the periphery invoke efficiency losses at the pan-European level. The conventional result is thus that one can not make a convincing economic case for regional policies.[4] Seemingly it are really equity or political considerations on which the very existence of regional policies is grounded.

However, there exist additional problematic aspects from a positive point of view. As Martin (1999) has shown, some policies intended to achieve less agglomeration and more territorial equity can, through secondary market adjustments, effectively result in their exact opposite. Improvements of interregional transportation facilities e.g. result in lower transaction and travelling costs. This is thought to benefit the periphery in terms of a better accessibility, a more vital participation in central markets etc. Alas, it can

[4] One should note that recently Ottaviano/Thisse (2002) have presented a model where markets produce over-agglomeration, and consequently a government should lower the equilibrium degree of spatial inequity from a normative point of view. However, at the moment this result should be seen as a distinct theoretical possibility originating in assumptions on properties of the utility function at use.

also turn out that the reduction of spatial transaction costs actually fuels further relocation of production factors away from the periphery and into the already highly developed centres. But if infrastructure subsidies facilitate agglomeration, they must be viewed as a failure judged on the basis of their original intents. Empirical finding that support this view have been provided by Faini (1983) and Combes/Lafourcade (2001).

As will be shown in this paper, actual and intended results of education oriented regional policies can also substantially deviate. The essential reason is that political interventions might cause secondary effects, here in form of labour emigration, that policymakers in reality might not be fully aware of.

Our paper is also somehow related to the literature in public finance and fiscal federalism. Razin/Sadka (2001) or Wildasin (2000) e.g. show that labour is responsive to jurisdictional policy differences like the tax system or the welfare regime, and that migration in turn puts these public policies under strain. Specific reference to the impact of migration on the public provision of education has been made by Chau/Stark (1999) or Webb (1985). These perspectives, however, differ from ours as these authors are concerned with the question how the policy of single governments is constrained by labour mobility, or with the welfare implications of jurisdictional fiscal competition for mobile factors. Closest to our analysis is the model of Haque/Kim (1995), who show that emigration of high skilled labour is harmful to developing countries, and that national governments might therefore have little interest in providing higher education in order to reduce the human capital flight.

In this paper, however, we do not analyse policies mandated by subordinated regional or national governments, but are rather interested in the spatial implications of discretionary interregional transfers mandated by a federal authority like the European Commission. We do not intend to answer *why* these transfers exist.[5] Instead, we satisfy ourselves with deriving the spatial implications of exogenously imposed education subsidies for individuals in the economic periphery. We consider an integrated economic area consisting of two regions. Since regional policy almost by definition is only pursued if there are real economic disparities between spatial units, one region must be

[5] More specifically, we do not address the issue why regional policy is implemented against the background of the voting and decision making procedures in the European Union, nor do we model the federal government as maximizing total welfare for the integrated economic area as a whole. Furthermore, we abstract from any other policy measure that subordinate governments might pursue and focus exclusively on the discretionary interregional transfers.

initially poorer than the other. This ´objective 1´-region receives structural funding in form of education subsidies by a federal government authority (the EU commission) that collects taxes in the rich core region for the financing. At first we will only model the poor peripheral region explicitly in section 3, and take the economic variables of the core as exogenously given. After having described the equilibrium in this partial model in section 4, we derive the implications of education oriented regional policy in section 5. Afterwards we generalize our model in section 6 by endogenising the economic variables of the core region. Section 7 provides a conclusion of our main results with respect to the pervasiveness of education oriented regional policy, and addresses potential policy conclusions.

3) The Model

Let the peripheral region in our model be labelled as r = 1, whereas the core region is named r = 2. Region 1 is populated by two generations of heterogeneous agents. For simplicity we abstract both from output and population growth, and assume that in each period a new generation L_1 is born. Young and old individuals in both regions are endowed with one unit of non-leisure time. The young can invest in human capital by devoting time to education. Investments pay off in the old age period by expanding the available effective time budget that is then solely used for working. Learning productivity differs across the individuals of each generation L_1 depending on personal skill characteristics denoted by η^i. There are no financial markets and hence no savings in the model, so that the education choice is the only means for consumption smoothing. Individuals born in region 1 are tied to their location of birth during young age. They can not move to the core at the beginning of their lifetime. However, it is possible to emigrate after the first period and to spend the second lifetime period in the core region 2. Interregional labour migration imposes mobility costs that are equal for all individuals regardless of their personal ability level.

3.1. Consumers

The OLG-framework used to describe the consumer behaviour is modelled in a similar way as in Haque/Kim (1995). An individual i derives utility from consumption c. To keep the analysis tractable, we work with a logarithmic utility function with a time dis-

count rate β. The regional superscript $s = \{1, 2\}$ denotes the residence region of the individual at old age. Lifetime utility $U^{i,rs}$ is given by

$$U^{i,1s} = \log c_{t,t}^{i,1s} + \beta \log c_{t,t+1}^{i,1s} \quad , \tag{1}$$

where $c_{t,t+1}^{i,1s}$ denotes consumption of some individual i born at time t in region 1 and residing in region $s = \{1, 2\}$ at time t+1. $\ell_t^{i,1s}$ is the time fraction devoted to education during young age. There are no direct costs of education, but only opportunity costs for foregone earnings.

Since region 1 is considered eligible for structural funding from the federal government, the individuals receive an education subsidy. For simplicity we only consider linear subsidies δ proportional to the schooling time that is financed through taxes in the rich region 2. With these assumptions, the budget constraints can be written as

$$c_{t,t}^{i,1s} = w_{1,t}(1 - \ell^{i,1s}) + \delta \ell^{i,1s} \tag{2}$$

$$c_{t,t+1}^{i,1s} = w_{s,t+1}(1 + \eta^i \ell^{i,1s}) - m_{1s} \tag{3}$$

The variables $w_{1,t}$ and $w_{s,t+1}$ denote the after-tax wages per effective labour unit devoted to work in the respective region and time period. Since income is taxed only in the core region, we have to distinguish net and gross unit wages in region 2. We denote the gross unit wage in region s by $W_{s,t+1}$, and the (proportional) income tax rate by φ_s. We simply find that $w_{s,t+1} = (1 - \varphi_s) W_{s,t+1}$, where φ_1=0. Mobility costs m_{1s} arise only for individuals who choose to leave region 1 after the first period of life.

$$m_{1s} = \begin{cases} 0 & if \ s = 1 \\ m > 0 & if \ s = 2 \end{cases} \tag{4}$$

The individual simultaneously decides on the amount of education and the old age residence region at the beginning of period t. Utility maximization with respect to $\ell^{i,1s}$ yields the following first-order-condition

$$\frac{c_{t,t+1}^{i,1s}}{c_{t,t}^{i,1s}} = \beta\eta^{i}\,\frac{w_{s,t+1}}{w_{1,t}-\delta} \quad . \tag{5}$$

Together with the budget constraints (2) and (3), the optimal education choice can be computed as

$$\ell^{i,1s} = \frac{\beta}{1+\beta}\Phi_1 \;-\; \frac{1-(m_{1s}/w_{s,t+1})}{\eta^{i}(1+\beta)} \quad , \tag{6}$$

where $\Phi_1 = \dfrac{w_{1,t}}{w_{1,t}-\delta} \geq 1$ is a measure of how intensively education is subsidized for individuals from region 1.

Proposition 1. *$\ell^{i,1s}$ increases with η^{i}, m and δ, it decreases with $w_{s,t+1}$, and it is greater if s =2 than if s = 1.*

An evaluation of (6) shows that more able people spend more time on education than individuals with a low learning efficiency η^{i}. Education subsidies δ induce individuals to devote more time to schooling. Interestingly, individuals who plan to emigrate after period t (m_{rs}=m) ceteris paribus demand more education than do people who are going to remain in the same region in t+1 (m_{rs}=0). The anticipation of future emigration already induces stronger educational attainment today, which is an argument close to Stark/Helmenstein/Prskawetz (1997). The effects of m and $w_{s,t+1}$ on the optimal learning choice of emigrants are due to intertemporal substitution and the smoothing of the lifetime earnings profile.

By substituting (6) into the budget constraints we can compute the optimal consumption path for given residence choices. An individual who remains in region 1 during t+1 will reveal the following consumption profile

$$c_{t,t}^{i,11} = w_{1,t}\left(\frac{1+\eta^{i}-\delta/w_{1,t}}{\eta^{i}(1+\beta)}\right)$$

$$c_{t,t+1}^{i,11} = \beta w_{1,t+1}\left(\frac{1+\eta^i - \delta / w_{1,t}}{(1+\beta)(1-\delta / w_{1,t})}\right)$$

If she spends her second lifetime period in region s=2, the consumption path is

$$c_{t,t}^{i,12} = w_{1,t}\left(\frac{1+\eta^i - \delta / w_{1,t} - m\, J^{i,12}}{\eta^i (1+\beta)}\right)$$

and

$$c_{t,t+1}^{i,12} = \beta w_{2,t+1}\left(\frac{1+\eta^i - \delta / w_{1,t} - m\, J^{i,12}}{(1+\beta)(1-\delta / w_{1,t})}\right),$$

where $J^{i,12} = \left(1 - \frac{\delta}{w_{1,t}}\right)\left(\frac{1}{w_{2,t+1}}\right)$.

Obviously not only education activity, but also consumption in both periods differs depending on the old age residence choice that is anticipated in the first period of the lifetime. By inserting these consumption levels in the utility function (1), we can compute individual i's utility levels for the case that she remains in her original location ($U^{i,11}$), and for the case of emigration ($U^{i,12}$).

$$U^{i,11} = \log\left(\left[1+\eta^i - \delta / w_{1,t}\right]^{1+\beta} w_{1,t+1}{}^{\beta}\, \mathrm{K}^{i,12}\right) \tag{7}$$

$$U^{i,12} = \log\left(\left[1+\eta^i - \delta / w_{1,t} - m\, J^{i,12}\right]^{1+\beta} w_{2,t+1}{}^{\beta}\, \mathrm{K}^{i,12}\right)$$

where $\mathrm{K}^{i,12} = w_{1,t}\left(\frac{1}{\eta^i (1+\beta)}\right)\left(\frac{\beta}{(1+\beta)(1-\delta / w_{1,t})}\right)^{\beta}$.

An individual i will reside in that region during old age that offers the higher utility level for given net unit wage rates $w_{1,t+1}$ and $w_{2,t+1}$. By equating $U^{i,11}$ and $U^{i,12}$ we find after some manipulation the level of personal ability η^i at which an individual is indifferent between migrating and remaining in region r=1 *for given wages*

$$\tilde{\eta}^i = \frac{1}{\Phi_1}\left(\frac{m / w_{2,t+1}}{1-\omega} - 1\right) \tag{8}$$

where $\omega_1 = \left(w_{1,t+1} / w_{2,t+1}\right)^{\frac{\beta}{1+\beta}}$ is a measure of region 1's relative net unit wage. It can be shown that individuals with personal skills below $\tilde{\eta}^i$ derive higher utility from remaining in the original location of birth ($U^{i,11} > U^{i,12}$), whereas individuals with skills larger than $\tilde{\eta}^i$ are better of spending their second lifetime period in region 2. Thus, (8) can be understood as the theoretical value of the *cut-off ability level* beyond which migrating to region 2 is more attractive than staying in region 1 for given net unit wages.

What fraction of each generation L_1 has learning abilities larger than $\tilde{\eta}^i$ is a matter of the distribution of learning skills. Suppose that η^i is uniformly distributed across the L_1 individuals in the range [1;d], i.e. the least talented individual (indexed i=0) can not expand her effective labour units through education, whereas the average learning efficiency is 1+d/2. With this distribution, the fraction μ of each generation L_1 that is going to remain in region 1 is given by

$$\mu = \frac{1}{d}\left(\tilde{\eta}^i - 1\right) \tag{9}$$

From (9) it can be seen that emigration is attractive to a smaller fraction of the population (i.e. μ is larger), the higher is the regional unit wage $w_{1,t+1}$ relative to region 2, the higher are mobility costs m and the lower is the education subsidy δ.

3.2. Production

We now turn to the production side of this economy, which is characterised by localized agglomeration economies in spirit of the seminal paper by Ethier (1982). There is a single final consumption good Y_r which is produced in both regions $r = \{1, 2\}$ without direct use of labour by assembling a large number of symmetrical intermediate inputs X_r. We assume that there is perfect competition in the Y-sector and that the final good can be traded freely across space. This implies that there is price equalization on the market for Y across regions. Without loss of generality we can use the price p^Y as the nu-

meraire and normalize it to one. This construction has been proposed in the trade model of Matusz (1996) and offers a great deal of analytical simplification.

Unlike the final good Y_r, intermediate inputs are assumed to be non-tradable. For the production of Y_r in region r=1, only local intermediates X_1 can be used. The production function is given by a symmetrical CES function

$$Y_1 = \left(N_1 (X_1)^{\theta}\right)^{1/\theta} \qquad \text{with } 0 < \theta < 1 \text{ [6]} \qquad (10)$$

N_1 indicates the number of intermediates available in region 1. Due to symmetry, one can write down the following minimum cost function for producing one unit of Y_1.

$$G_1 = \left(N_1 (p_1)^{\frac{\theta}{\theta-1}} \right)^{\frac{\theta-1}{\theta}} \qquad (11)$$

p_1 is the price for one of the symmetrical intermediates. The function G_1 is decreasing in N_1. As put by Matusz (1996), this is "intended to capture Adam Smith's notion that output is increasing in the division of labour", because an increase in N_1 represents the deeper partition of a specific production task into more narrowly defined sub steps.

The production of the single intermediate inputs is done by small, monopolistically competitive firms that use labour only. The requirement of labour units necessary to produce the quantity X_r of an intermediate good is given by

$$\varsigma_1 = a + bX_1 \qquad \textit{with } a>0,\ b>0 \qquad (12)$$

Note that the labour requirement ς_1 is for effective labour units, not for people working. Due to the fixed input requirement a, and the unlimited number of potential varieties in the X-sector, every single intermediate will be produced by only one firm and thus N_1 also indicates the number of active firms in region 1. Following Dixit/Stiglitz (1977) we

[6] The parameter θ is a measure of the differentiability of single intermediate inputs. If θ is close to one, they are nearly perfect substitutes. Rearranging yields σ = 1/(1-θ), the elasticity of substitution between single varieties.

say that each firm is small relative to the market. We can then abstract from strategic interactions and apply the Chamberlinian "large group" assumption according to which profit maximizing prices are a constant mark-up over marginal costs, $p_{1,t} = \frac{b}{\theta} w_{1,t}$.

The firm's profits are driven down to zero by the entry of potential competitors, i.e. $\pi_1 = p_{1,t} X - w_{1,t} (a + bX_1) = 0$. Without loss of generality we choose units such that $b=\theta$. It follows that profit maximizing prices $p_{1,t}$ are equal to the unit wage rate $w_{r,t}$. And by using (12), we can rewrite the zero profit condition in the X-sector as

$$X_1 = \varsigma_1 = \frac{\alpha}{1-\theta} \tag{13}$$

All X-firms in either region are operating at the same scale of output, which in our case is identical to the demand for effective labour units per firm. Note however, that firm sizes can very well differ with respect to the number of employed persons, as a firm does not care if it employs one worker with ς embodied labour units or ς workers with one labour unit each. The maximum number of intermediates that can be produced in region r is restricted by labour supply. Let $S_{1,t}$ denote labour supply at time t. The number of firms and varieties is then simply

$$N_{1,t} = \frac{S_{1,t}}{X} = \frac{(1-\theta)}{\alpha} S_{1,t}. \tag{14}$$

It is now straightforward to compute the equilibrium remuneration per labour unit $w_{1,t}$. Since the price for the final consumption good is given with $p^Y=1$, unit costs G_1 must also adjust to one in order to ensure zero profits in the Y-sector. By (11), this implies that

$$w_{1,t} = W_{1.t} = \left(N_{1,t}\right)^{\frac{1-\theta}{\theta}} = \left(\frac{1-\theta}{a} S_{1,t}\right)^{\frac{1-\theta}{\theta}} \tag{15}$$

As can be seen, the equilibrium (unit) wage $w_{1,t}$ is an increasing function of effective regional labour supply $S_{1,t}$. The intuition for this result is simple: with more labour supply in region 1, more intermediate inputs can be produced and the technology for pro-

ducing Y_1 becomes more sophisticated. Unit costs G_1 decline, while the sales price p^Y remains unchanged. Temporary profits arise in the Y-sector in region 1 that induce producers to enter the market. Prices for intermediates X_1 are competed up, and by the zero profit condition for the X-sector these must completely be absorbed by higher unit remunerations. Note that (15) must not be confused with the personal income of an individual i, which is given by the unit wage multiplied with the effective labour units offered in either period. Thereby, talented workers of course have higher income levels than unskilled workers. Note further that in (15) we have established a purely regional pecuniary externality. The regional unit wage only depends on the effective labour supply in region 1, not on the scale of the other region.

3.3 Labour supply

The crucial variable in this model is the regional labour supply $S_{1,t}$, which not only depends on the population size in region 1, but also on the education and migration choices of the individuals. Labour supply at time t consists of the number of labour units that the two generations offer. For the young generation with size L_1 this is the amount of time that they do not devote to education. The old generation only has the size μL_1, since the $(1-\mu)L_1$ most talented workers spend their old age in region 2. Recall that members of the young generation reveal different educational behaviour depending on their old age residence choice. Labour supply in region 1 can then be written as

$$S_{1,t} = \int_{i=0}^{\mu L_1} (1-\ell_t^{i*,1}) + \int_{i=\mu L_1}^{L_1} (1-\ell_t^{i*,2}) + \int_{i=0}^{\mu L_1} (1+\eta^i \ell_{t-1}^{i*,1})$$

or

$$S_{1,t} = (1+\mu)L_1 + \int_{i=0}^{\mu L_1} \ell^{i*,1}(\eta^i - 1) - \int_{i=\mu L_1}^{L_1} \ell^{i*,2} \qquad (16)$$

The first term in (16) represents the pure population size that is constant in steady state when μ is at its equilibrium level. The second term are the net returns to education of those who remain in region 1 during both periods. The third term indicates the costs for region 1 that arise because later emigrants do not use their entire time budget for working. From (16) it can be seen that labour supply $S_{1,t}$ increases with μ for several reasons. Firstly, because the pure population mass is larger the fewer people emigrate to region

2. Secondly, because more people realize the returns to education in region 1. And thirdly, because fewer opportunity costs arise in region 1 for educating people whose private and social returns will be realized elsewhere.

It also becomes clear that the linkage that runs from labour supply to equilibrium remunerations in (15) can represent both a pure scale effect and a human capital externality: $S_{1,t}$ and thereby $w_{1,t}$ can be high either because many people are around ("agglomeration wage premium"), or because they embody a high number of labour units. A final important thing to note is that skilled workers gain more in absolute terms from these regional linkages, since they embody a higher number of labour units to which (15) applies.

3.4. Government

To close the model, we finally have to describe government's behaviour. The government in our model is a federal authority with only one objective: It collects income taxes in region 2 to subsidize education in region 1, i.e. it pursues education oriented regional policies. The budget constraint can be written as

$$\varphi_2 \, S_{2,t} \, W_{2,t} = \delta \left(\int_{i=0}^{L_1} \ell_t^{i,1s} \right) \tag{17}$$

4) Equilibrium

In this section we derive the spatial equilibrium allocation of workers (μ*). For the time being we will treat the wage in the other region as an exogenous parameter $\overline{w}_{2,t+1}$, which by assumption is sufficiently higher than $W_{1,t}$ and does not change with μ.[7]

The equations (8) and (15) together establish a cumulative causation mechanism in this model. In section 3.1. we have derived the fraction (1-μ) of each generation L_1 that

[7] The net wage in region 2 must be higher than the gross wage in region 1 even if μ=1. If region 2 has the same technology as region 1, this higher wage $w_{2,t}$ must be due to an sufficiently higher effective labour supply $S_{2,t}$ that would even endogenously increase as workers immigrate from the small region 1. We come back to this issue in section 6. The assumption of higher central wages $w_{2,t}$ in any case rules out the possibility of migration from region 2 to region 1.

leaves home after the first period of lifetime. This fraction is larger, the lower is the wage rate in region 1 relative to region 2. On the other hand, in section 3.2. it has been shown that the equilibrium unit wage in region 1 decreases the lower is labour supply. Put differently, people leave if wages are low, and wages are low if people leave. This circular logic in particular applies to individuals with strong learning capabilities η^i. Their emigration has a stronger bearing on region 1, firstly because they have demanded a high amount of education during young age. At time t+1, when the investment pays off both privately and socially, the high skilled workers leave the small region, which consequently foregoes the positive linkages that originate in their human capital.

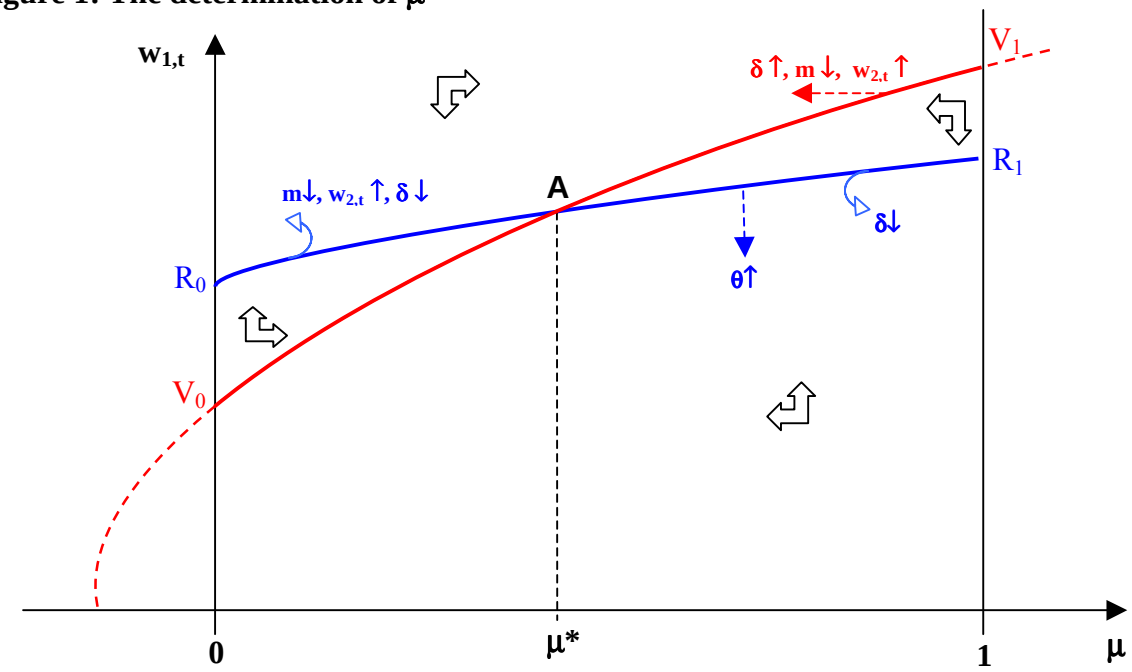
In figure 1 this cumulative logic is represented by two equilibrium relations between μ and the wage rate $w_{1,t}$ for given parameter values $\overline{w}_{2,t+1}$, m, δ and θ. This graphical approach offers the essential insights of this section and is thus chosen for expositional purposes.[8] The locus V_0V_1 is derived from (9), the optimal residence choice based on consumers' utility maximization. It shows the fraction μ as a function of $w_{1,t}$ and for given parameter values. The positive slope represents the result derived from (9) that μ is increasing in ω. The locus R_0R_1 represents the technological relation (15) and depicts equilibrium unit wage $w_{1,t}$ as a function of labour supply $S_{1,t}$, which is endogenously increasing in μ.

Within the feasible range $\mu \in \{0;1\}$ the adjustment mechanisms in this system work as following: for points above (below) the R_0R_1 schedule, the wage $w_{1,t}$ is too high (low) for any given value of μ. Using the zero profit condition described in section 3.2. the wage must realign such that it is consistent with the equilibrium locus R_0R_1. This determines the phase arrows in the vertical direction. Similarly, for points to the right (left) of V_0V_1, μ is too high (low) for any given wage $w_{1,t}$. Individuals can still increase lifetime utility through changing locations, and migration will occur until μ is consistent with V_0V_1.

[8] An exact analytical expression of μ^* can be obtained by plugging (15) and (16) into (9). This yields the following expression that only depends on exogenous parameters, and that in principle can be solved for μ^*:

$$\mu = \frac{1}{d\Phi_1}\left((m/\overline{w}_{2,t+1}) \Big/ \left[1 - \left[\frac{1-\theta}{a} S_{1,t}(\mu) \right]^{\frac{1-\theta}{\theta}} / \overline{w}_{2,t+1} \right] - 1 \right) - \frac{1}{d}$$

Figure 1: The determination of μ*



As long as V_0V_1 is steeper than R_0R_1, which will be the only case we consider throughout, there is a unique and stable equilibrium at point A with a spatial equilibrium configuration μ*.[9] This μ* is consistent both with efficient production and with optimal residence choice. The system in figure 1 can now be used to analyse the impact of various parameter changes on μ*, out of which a change in δ is of particular interest and will be analysed in the next section. But before it is also instructive to look at the comparative statics of changes in m, $w_{2,t}$ and θ.

Changes in θ are most easy to analyse, since only the R_0R_1 locus is affected. The parameter θ reflects the differentiability of the single intermediate inputs in region 1 and can be understood as an inverse measure of the degree of increasing returns in this region. The higher is θ, the lower is the equilibrium wage $w_{1,t}$ for any given value of μ. The curve R_0R_1 shifts down as θ increases, which implies that μ* is a decreasing function of θ. There is thus more population drain from region 1 the less important are the localized increasing returns.

A change in the (exogenous) wage $\overline{w}_{2,t}$ affects both curves in figure 1. The impact on V_0V_1 is obvious: if the attainable wage in region 2 increases, the incentive to leave

home after the first period is larger for given values of $w_{1,t}$ and m. The curve V_0V_1 is shifted to the left. The curve R_0R_1 is also affected, because education demand and thereby labour supply change. This can be seen best by considering the following: the point R_1 shows the equilibrium wage $w_{1,t}$ if nobody of the young generation L_1 will emigrate after the first lifetime period (μ=1). This wage can be computed as $w_{1,t} = \left(\frac{1}{X} \left[2L_1 + \int_{i=0}^{L_1} \ell^{i*,1}(\eta^i - 1) \right] \right)^{(1-\theta)/\theta}$, which is independent of $\overline{w}_{2,t}$.

Yet, at all other points along the R_0R_1 schedule, any given fraction of later emigrants $(1-\mu)L_1$ will spend less time on education as $\overline{w}_{2,t}$ increases. This consequently increases labour supply of later emigrants during their young age in region 1 and thus has positive impacts on wages $w_{1,t}$ for any given value of μ. Graphically, an increase in $\overline{w}_{2,t}$ implies a clockwise rotation of R_0R_1 around the point R_1. The net effect of an increase in $\overline{w}_{2,t}$ on μ* is thus theoretically ambiguous.

A similar point applies to changes in the parameter m, the level of mobility costs. V_0V_1 shifts to the left as migration barriers are removed, because emigration is more attractive for given values of $w_{1,t}$ and $\overline{w}_{2,t}$. But again, as shown in proposition 1, a decrease in m implies a reduction in the education demand of later emigrants, thereby an increase in labour supply and thus a clockwise rotation of R_0R_1 around R_1. Supposedly (given our numerical simulations) the "direct" effect on V_0V_1 will dominate over the effect on R_0R_1 that originates in the individuals' intertemporal substitution, but theoretically the other possibility can not be excluded.

[9] in the other case with R_0R_1 steeper than V_0V_1 the system is characterised by dynamic instability of μ*, and will in general be driven towards a corner solution.

5) The effect of education oriented regional policies

How does an increase in δ affect the two equilibrium loci in figure 1? The immediate effect of higher education subsidies is an increase in education from *all* L_1 individuals regardless where they are going to spend the time period t+1.[10] This has drawbacks both on labour supply as well as on the equilibrium residence choice.

The effect of more education on labour supply is ambiguous and depends on the range of μ. If μ is high, i.e. if a large fraction of the L_1 young individuals remain in region 1 when the human capital investment pays off, the consolidated impact on effective labour supply is positive. The time used for education by the young is overcompensated by the returns to it during old age.[11] This latter effect weakens as μ gets lower. If the returns to education are largely realized elsewhere, an increase in education demand of the young generation results in lower overall labour supply $S_{1,t}$. Graphically the R_0R_1 locus in figure 1 is stretched in a counter-clockwise direction, as the point R_1 on the axis shifts upwards, whereas R_0 is shifted down.

The second effect of an increase in δ is a shift of the curve V_0V_1 to the left. At any level of $w_{1,t}$, a larger fraction (1-μ) of the generation L_1 crosses the threshold level of qualification beyond which emigrating to region 2 yields a higher lifetime utility. The intuition here is the following: any individual has stronger incentives to devote time to schooling upon receiving more education subsidies. Simultaneously, however, the individual who will embody a higher number of effective labour units during old age now also has a stronger incentive to move to the region that offers the higher unit labour remuneration, i.e. region 2.

The net effect of an increase in δ can be seen graphically in figure 2. Prior to the regional policy intervention the equilibrium has been at point A, with a spatial configuration μ*. Afterwards the new equilibrium is at A´ with a lower value μ*´ and also a lower equilibrium unit remuneration $w_{1,t}$. This implies that the education oriented regional policy effectively has led to more emigration, and to a lower equilibrium wage for each labour unit that is supplied by individuals in region 1. In figure 2, which is of

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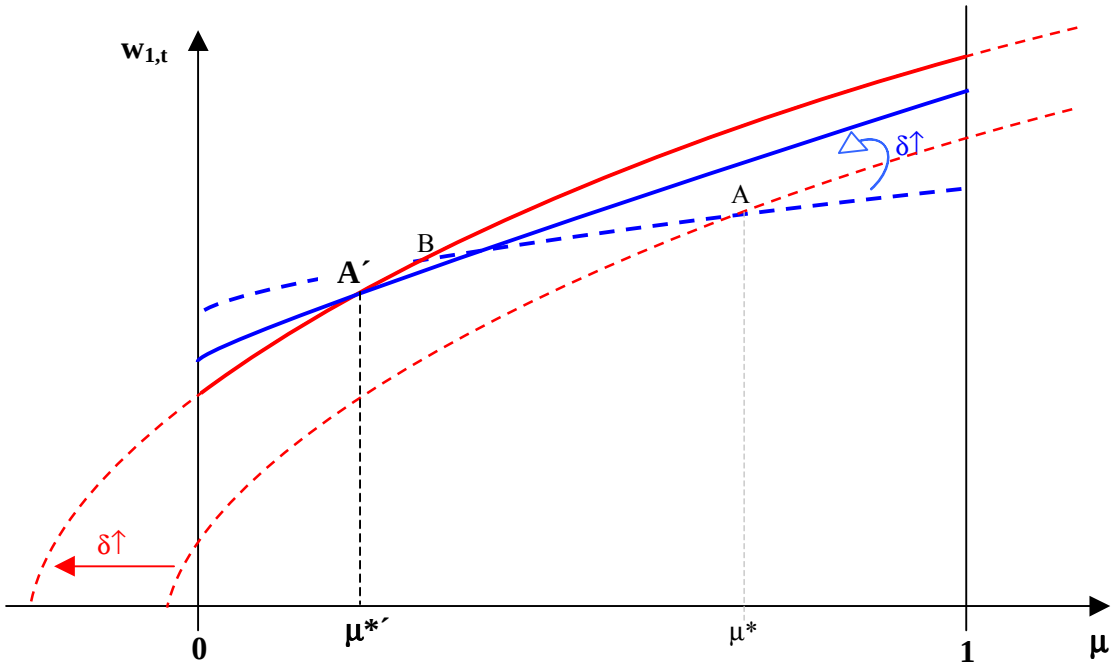
[10] From evaluating (6) it can be seen that $\frac{\partial \ell^{i,1}}{\partial \delta} = \frac{\partial \ell^{i,2}}{\partial \delta}$, i.e. the effect of an increase in subsidies on the optimal learning time does itself not depend on the residence choice for the second time period.

[11] This can be seen in (16): with μ large enough, the second term is greater than the third.

course just a graphical example for one particular parameter constellation, this final result is compounded of two complementary forces pushing in the same direction. Taking the shift of V_0V_1 alone, i.e. only considering the labour mobility effect of the regional policy, the new equilibrium would be at point B. Yet, the "bad news" for region 1 are still amplified by the rotation of the R_0R_1 curve, which is stemming from the alternation of optimal education and labour supply decisions. Put differently, region 1 suffers from the regional policy not only because more people will take the opportunity of better education to leave once it is possible. Additionally, the prospective emigrants also reduce labour supply and devote more time to schooling in order to "prepare" better for their old age in region 2. This higher education demand of later emigrants is solely a burden for region 1, since it does not receive any of the returns associated with it.

Figure 2: An increase in δ



For regional policy there is an interesting implication to be drawn: apparently the individuals who remain in the recipient region suffer especially if μ is quite low to begin with. Recall that the reaction of labour supply $S_{1,t}$ on a change in δ depends on the range of μ. If μ is close to one, the policy shock δ↑ induces an overall increase in labour supply. This is then counteracting the other effect, the shift of V_0V_1, and not complementing it as in the example above. Hence, the actual effects of regional policy seem to be

particularly problematic for the poorest, most lagging regions (like e.g. Greece or Southern Portugal) with a low initial value of μ, and not so much for the advanced candidates within the group of ´objective 1´-regions.

In case the shift of the V_0V_1-locus is small, which is the case when individuals are particularly reserved towards migration, the overall effect of an increase in δ is determined by the reaction of the R_0R_1-curve. If in the relevant area the curve rotation is upwards, then the intended objectives of the regional policy intervention might actually be achieved: less population and brain drain and an increase in the regional wage level. This is one illustration of a general point, namely that actual and intended effects of public policies deviate less if the degree of factor mobility is low. The important insights of this section are finally summarized in the following proposition 2

Proposition 2. *An increase in δ leads to lower values of μ^* and $w_{1,t}$ if labour is sufficiently mobile. The reaction is stronger, the lower is the initial value of μ.*

5.1. Policy alternatives

Intuitively, regional policies aiming to improve the living standards of region 1 by means of education subsidies should pay attention to the induced migration incentives in order to perform better judged on the basis of their own intents. This could be achieved if the subsidy would not be levied upon all individuals alike, but if instead the recipients could be chosen such that improving their education does not alter their optimal residence choice.

Suppose we allow the proportional education subsidy to differ between individuals (δ_i). From (8) it follows that all individuals from the young generation L_1 are going to leave region 1 whose ability level is greater than $\hat{\eta}^i = \left(\frac{m / w_{2,t+1}}{1-\omega} - 1 \right)$, even when they receive no education subsidies ($\Phi_1^i = 1$).

If the federal authority's objective is to *maximize* the income level *in region 1*, it obviously has no interest in subsidizing those individuals who will emigrate anyway.[12] For

[12] If feasible, the Commission could even consider to levy a ´negative education subsidy´ on the most talented individuals, i.e. to charge tuition fees. Such proposals have occurred in the literature, e.g. in form of Bhagwati's "brain drain tax" (see Bhagwati, 1976), but will not be discussed further in this paper.

all individuals with abilities η^i below $\hat{\eta}^i$, the subsidy rate δ_i should be chosen such that emigration is just prevented. Manipulating (8), we can show that this is the case if

$$\delta_i = w_{1,t}\left(1-\eta^i \Big/ \left(\frac{m / w_{2,t+1}}{1-\omega}-1\right)\right). \tag{18}$$

From (18) it follows that the least talented individuals should receive the highest subsidy and that subsidization should fade out with increasing personal ability levels. Of course it depends on whether enough funds can be raised in region 2 to finance exactly this policy rule. But the important implication of (18) is that it gives the upper bound of education subsidies to individual i in order to prevent brain drain.

6) Endogenising the core region

The unfortunate consequences of regional policy are even more pronounced when we generalize our approach and explicitly model the wage formation in the core region 2. Consumer behaviour and goods production in region 2 is structurally identical to region 1 as described in section 3. This specifically means that the final output Y_2 is manufactured under the use of N_2 symmetrical local intermediates X_2, and that each single firm in the X-sector operates at a unique output scale, given by (13), also in region 2. The number of firms N_2 as well as the equilibrium producer wage for each effective labour unit $W_{2,t}$ are then functions of *regional* labour supply alone, [13] i.e.

$$W_{2.t} = \left(\frac{1-\theta}{a}\ S_{2,t}\right)^{\frac{1-\theta}{\theta}} \qquad\qquad W_{1.t} = w_{1,t} = \left(\frac{1-\theta}{a}\ S_{2,t}\right)^{\frac{1-\theta}{\theta}} \tag{19}$$

We have claimed that an analysis of regional policy only makes sense if one region is richer than the other. Equation (19) makes clear that a regional disparity in our model has to be due to a sufficiently larger labour supply in region 2. In the vein of our OLG-

[13] The same were true if we allow for trade in intermediate inputs, but impose (´iceberg´)-transportation costs for the shipping of intermediates. In this case, the larger region wastes fewer resources for transportation, the zero profit conditions for the sectors X and Y are only consistent with a higher equilibrium wage rate in the larger region. For a discussion of this type of technology with tradable intermediates see Suedekum (2002a).

model, it is natural to think that the higher labour supply in region 2 is due to a larger size of each new born generation L_2. This larger size translates via the inherently regional pecuniary externality into higher unit wages in region 2. But recall that income in region 2 is taxed in order to finance the education subsidies in region 1. The size of the generation L_2 must therefore be sufficiently larger than L_1 in order to ensure that after-tax unit wages in region 2 are still larger than gross unit wages in region 1.[14]

If this is warranted, the possibility of migration from region 2 to region 1 is ruled out. We can then easily apply the consumer problem described in section 3.1. also to individuals from region 2 and compute the optimal education choice $\ell^{i*,22}$ as

$$\ell^{i,22} = \frac{\beta}{1+\beta} - \frac{1}{\eta^i(1+\beta)} \quad .$$

The overall labour supply in region 2, $S_{2,t}$, is given by

$$S_{2,t} = 2L_2 + \int_{i=0}^{L_2} \ell^{i*.22}(\eta^i - 1) + (1-\mu)L_1 + \int_{i=\mu L_1}^{L_1} \eta^i \ell^{i*,12} \,, \tag{20}$$

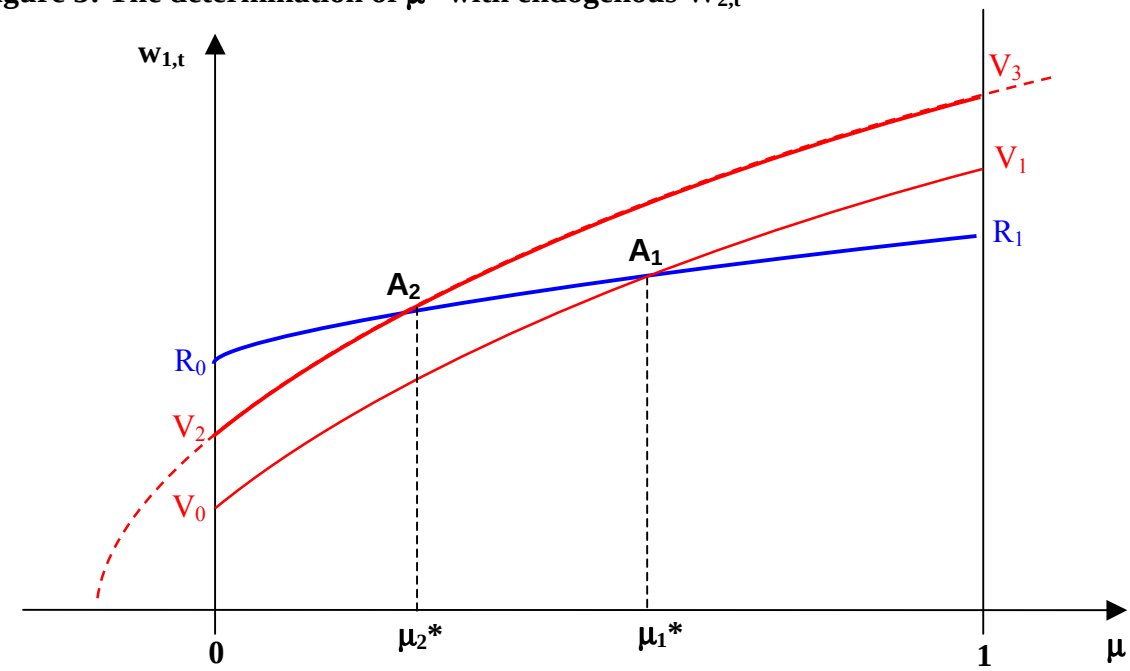
which is an increasing function of the immigrant population $(1-\mu)L_1$. Hence, the only substantial difference of this generalized model approach compared to the equilibrium determination in section 4 is that $W_{2,t+1}$ will no longer be independent of μ, as labour supply and thus unit wages in region 2 increase endogenously with emigration from region 1.

This has drawbacks on the optimal location decision of individuals from region 1 as described by (9). Since $W_{2,t}$ is larger the lower is μ, the actual cut-off ability level beyond which emigration starts off is actually lower than implied by section 4, where the endogenous impact on the $W_{2,t}$ has been neglected. This effect can again be graphically illustrated in figure 3. The technological relation R_0R_1 is unaffected by the endogenous dependence of $W_{2,t}$ on μ and remains unchanged compared to figure 1.

[14] One can show that this condition holds if the relative overall labour supply $S_{2,t}/S_{1,t}$ is larger than $(1-\varphi_2)^{\theta/\theta-1}$, even if there is no emigration from region 1 (i.e. if μ=1).

The "true" graphical relation that describes utility equalization across the two regions is, however, not given by the V_0V_1-curve from section 4. It is rather given by some curve V_2V_3 that runs strictly to the left of the V_0V_1-schedule. For any given value of $w_{1,t}$, the corresponding value of μ consistent with interregional utility equalization is strictly lower if individuals take the endogenous effects of migration on the wage in region 2 into account. The "true" equilibrium point is thus given by A_2 rather than by A_1, and the fraction μ of the generation L_1 that remains in region 1 during t+1 is only μ_2* rather than μ_1*.

Figure 3: The determination of μ* with endogenous $W_{2,t}$



The cumulative causation spiral described above is thus accentuated if we endogenise the wage formation of the core region. Any emigration out of region 1 puts the relative wage ω under strain from two sides. And thus, the true amount of equilibrium brain drain has been understated by section 4. But other than that, the central insights with respect to parameter changes, most notably with respect to changes in the education subsidy rate δ, remain qualitatively unchanged.[15]

[15] It is also possible to show that with the technology assumed in this paper, a core-periphery-structure can develop endogenously when starting from a situation where both regions are ex-ante completely identical. The increasing returns constitute a motive for spatial agglomeration (a "centripetal" force), that is only opposed by the presence of mobility costs. This centrifugal force is more pervasive for individuals with low individual ability levels, for whom agglomeration rents play a lesser role. A social planner who

7) Conclusion and discussion of the policy implications

Basically two important conclusion follow from our analysis with respect to the pervasiveness of education oriented regional policies. Firstly, we have shown that this type of regional policy might be ineffective or even counterproductive based on the self-defined political goal to reach more territorial equity, because it might only lead to more emigration of human capital out of the already poor recipient areas. And secondly, we have argued that policymakers might be able to avoid this brain drain if they focus education subsidies on the relatively low skilled workers in the ´objective 1´-areas.

With respect to our first conclusion we feel that we have complemented a view that is well established at various other points in the literature. The intentions and the actual effects of any policy can deviate, in particular if there is factor mobility in the economy. This general point also applies to cohesion policies, as it has been shown by Martin (1998, 1999) for the case of infrastructure subsidization. Our analysis verifies this point also for the case of education oriented regional policies. It seems reasonable to say that policymakers in reality are not always fully aware of these hidden pitfalls. One contribution of the paper is thus to demonstrate that short sighted political interventions motivated by well-meant intentions are insufficient to guarantee the desired outcome.

It seems also safe to say that regional policy has performed rather weakly in the recent decades, as regional convergence was very slow if not absent despite the enormous sums that have been spent on cohesion policy (see Boldrin/Canova, 2002). The results of this paper might help to explain why things have gone the wrong direction.

Furthermore, our central argument that the provision of more education and skills might lead to more exit behaviour seems plausible also against the background of other economic contexts. For example, any firm will face a similar trade-off if it provides its workers with training and non-specific human capital. If workers become more skilled, they also become more attractive to other firms or even to direct competitors of their current employer.[16] Any firm therefore has to consider that more training of its incumbent workforce can also lead to a higher probability of quits (e.g. Booth/Zoega, 1999)

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has to take into account the skill-invariant mobility costs would therefore relocate some interior population fraction from region 1 to region 2. He would draw the subpopulation of migrants from the top of the skill distribution in region 1. After the core-periphery structure prevails, the analysis on the positive effects of education subsidies from sections 4 and 5 applies.

[16] In perfect markets, a firm would not pay for general human capital, but only for the provision of firm-specific skills. In reality, however, it is hardly possible to distinguish general and specific human capital.

and ultimately to a loss of qualified human resources. Our analysis on the basis of regions rather than of firms seems to be quite closely related. Considerations in a similar vein are even known from development economics. Bhagwati (1976) has pointed out that a brain drain can cause considerable welfare losses to developing countries, and Haque/Kim (1995) have used this reasoning to show that governments of developing countries might therefore have little interest to provide higher education.

This leads us to the discussion of our second main policy conclusion, namely that regional policy should focus on relatively low skilled workers. This is a very stark result that gives rise even to quite cynical interpretations ("do not support clever students"). Most economists working on regional development would probably give exactly the opposite advice, namely that local authorities should take maintenance of a qualified stock of human resources and try to introduce "innovation clusters" to their area. However, these policy prescriptions do not need to stand opposite to our results.

Our analysis by its construction also acknowledges the crucial importance of human capital for regional development. It only shows that a naive way of supporting education can be quite misleading. The intention was simply to reveal *one particular mechanism* that is relevant when *one particular method* of regional education policies is pursued. Recall that the human resource policy in our analysis was simply introduced as a transfer to individuals proportional to their time spend in education. If one is preoccupied with this particular type of policy, the consequence that a regional catching-up is only rendered if transfers are paid to the relatively immobile factors seems quite plausible.

However, there might be other policies that focus on the support of high skilled individuals and that reveal a better performance. For example, suppose that instead of direct subsidies to individuals, the federal authority would rather sponsor the foundation of universities or innovation centres in peripheral regions. Supposedly continuous positive externalities would spill out from such institutions, benefiting mainly those individuals who are actually located in the peripheral region. The government might pay wage subsidies to skilled workers who are willing to locate in the economic periphery, or it might issue education loans that are only turned into pure subsidies if the individual realizes the private and social returns to education in the targeted recipient area. In other words, almost surely there are other forms of education oriented regional policies that work

better than the instrument described in our model. But the understanding about the specific impact of different policies on the spatial structure of an economy is still at an infant stage. Therefore it seems worthwhile to point out that certain types of education policies will probably not work so well.

A final point to note is that our analysis was preoccupied with the political goal of achieving territorial equity. As it has been pointed out in section 2, this goal might actually lack a convincing economic justification, since localised agglomeration advantages can not be exploited when the spatial resource allocation is dispersed. Given that the political goal is fuzzy, we have not derived any welfare implications on the overall pervasiveness of education subsidies for the integrated area as a whole. It is quite possible that the brain drain out of the periphery is actually welfare improving, because the positive feedback effects in the core region are larger than the negative feedback effects in the periphery. If this were so, the agglomeration rents could e.g. be redistributed and the periphery could be compensated for the centripetal economic tendencies through income transfers, and still the economy as a whole would be better off.[17]

But the focus of this paper was different. It was simply to point out that it might be more difficult to sponsor regional convergence and the catching up of poor regions than previously thought. There is an inherent hazard that the recipients of education subsidises do not remain in the areas that were intended to be sponsored. This hazard is particularly great if skills are supported that are also badly needed in the economic centres. Arguably, this is the case at the moment for European regional policies that put strong emphasis on the development of rather sophisticated IT- and telecommunication skills (Guersent, 2001). If it is regional convergence that shall be supported, policymakers should at least - in view of the main implications of this theoretical analysis - critically reconsider if the priorities of European regional policies are then set correctly.

[17] For a more extensive elaboration of this argument see Ross (2002) or Suedekum (2002b).

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