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International Migration in the Presence of Public Goods

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ABSTRACT. – This paper presents a broad analysis of how non-migrants are affected by immigration in the presence of public goods. Welfare-effects of migration are first considered in a comparative-static framework which is then supplemented by an analysis of costs and benefits in a more-period-context. This enables a consideration of immigration-induced expansions of the public capital stock on the one hand and its effects on public enlargement and replacement investments on the other.

La migration internationale en présence des biens publics

RÉSUMÉ. – Cet exposé analyse comment les résidents sont affectés par l'immigration en présence des biens publics. D'abord, les effets de la migration sont considérés dans un cadre comparatif-statique qui est, par la suite, complété par une analyse à l'aide d'un modèle comportant plusieures périodes. Ceci permet d'examiner les expansions des capitaux publics dus à l'immigration et ses effets sur les investissements d'élargissement et de remplacement.

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1 Introduction

In the last few years, there have been huge migration flows to the western part of Europe. Especially in Germany, which has taken in large numbers of foreign people, tensions are running high. Apart from the fear of increasing unemployment, concern is rising with respect to the usage of publicly provided goods by immigrants. As several authors suggest (e.g. GIESECK *et al.* [1992], KOLL [1993], or BORJAS [1994] and SIMON [1989] for the U.S.), the migrants' usage of the nation's public capital stock can lead to increased congestion. As a result, public enlargement investments might become necessary which in the future additionally induce increased public expenditure on replacement investments. On the other hand, migrants participate in the tax burden and therefore also help financing running costs for an already existing public capital stock. In the emigration country, tax revenue, crowding and public good supply possibly decrease. Whether an immigration actually improves or worsens the non-immigrants' position under the conditions described is therefore not obvious and necessitates a clear analysis of congestion costs and the actual change in public enlargement– and replacement investments on the one hand and the change in tax revenue on the other hand. For a discussion of the consequences of an international migration for the immigration *and* the emigration country the following analysis considers a two-country-trade model with public goods.

The analysis of the precise question of how non-migrants are affected by an international migratory movement in the presence of public goods has largely gone without a suitable theoretical ground. Problems connected with this question have partly been dealt with in the literature on the Brain Drain (e.g. BHAGWATI [1976], which however does not model the public sector explicitly. The latter will receive central attention here. In the local public finance literature, on the other hand, problems concerning the interaction between interregional migration and publicly provided goods have been dealt with extensively (e.g. TIEBOUT [1956]; for a survey see RUBINFELD [1987] and WILDASIN [1987]). However, as this literature mostly concentrates on efficiency aspects of public provision in the presence of free labour mobility, the production structure is often modelled quite simply, not seldom assuming the existence of only one private good. Some authors have extended this framework in order to incorporate trade in goods with exogenous terms-of-trade (e.g. BERGLAS [1976], WILSON [1990]). These publications seem to be promising steps towards a stronger integration of aspects of international trade and public finance. In the trade literature migration is also an important subject. There, distributional aspects and influences on a country's terms-of-trade are considered (e.g. DIXIT and NORMAN [1980], WOODLAND [1982], LEINER and MECKL [1995]). Finally, the influence of public goods on trade is a developing subject of research. An important feature of public goods that is often assumed–their non-tradeability–has its place in trade theory already.

The present paper integrates aspects of both areas of research by analysing the effects of international migration in the presence of public goods in a trade-theoretic framework. As the underlying model is quite complex, the comparative-static effects derived in the presence of endogenous goods' and factor prices are often ambiguous. It would therefore be helpful to analyse the theoretic framework in a computable general equilibrium context. The present discussion of various effects is to be seen as a first step towards such an analysis.

The paper proceeds as follows: Section 2 presents a two-country-trade model with public goods. Section 3 first considers the comparative-static welfare effects of an international migration. Afterwards, the periods in which an immigration induces public enlargement– and replacement investments are thoroughly discussed in a more-period context. Section 4 shortly derives devices for possible immigration policies. Section 5 concludes. Details of the comparative-statics are given in an appendix.

2 The Model

We consider a two-country model with $\overline{r}$ goods, $\overline{s}$ factors and a public good g in each country. Because of Walras' law we choose one private good as a numéraire good and set its price equal to one such that $\mathbf{p}$ denotes the price vector of the non-numéraire private goods. In the following subsections, the behaviour of consumers, private producers and the government is described.

2.1. Consumer Behaviour

The demand side of the model can be formulated with the help of the expenditure function $e(\mathbf{p}, g, l, u)$ that defines the minimum expenditure for a private consumption vector $\mathbf{c}$, which is necessary in order to reach a predetermined utility level u, given the price vector for private goods $\mathbf{p}$, the supply of the publicly provided good g and a total population l consuming the public good. The public good in each country is assumed to be a national public good which does not create international spillovers. The relationship between the supplied capacity of g and the total number of users l specifies a level of (quality-adjusted) collective good consumption $\tilde{g}$ [1]. It is assumed that

$$(1) \qquad \tilde{g} = f(g, l); \quad \frac{\partial f}{\partial g} > 0; \quad \frac{\partial f}{\partial l} \leq 0.$$

That is, the actual level of (quality-adjusted) public good consumption increases as the supply of g increases. In the case of pure public goods,

1. As an example, g could be interpreted as a highway, whereas $\tilde{g}$ gives the resulting level of consumption additionally dependent on the number of drivers using g. See HILLMAN [1978] and ARAD and HILLMAN [1979].

a change in the number of users has no influence on the level of (quality-adjusted) consumption. Crowding, however, is modelled by assuming $\tilde{g}$ to be decreasing in l. For some public goods like positive human capital or cultural externalities it could also be possible that $\partial f / \partial l > 0$. The expenditure function can now be defined as:

$$(2) \qquad \tilde{e}(\mathbf{p}, g, l, u) := \min_{\mathbf{c}} \left\{ \mathbf{p}^T \mathbf{c} : \ \ h(\mathbf{c}, \tilde{g}) \geq u, f(g, l) = \tilde{g}, c \geq 0 \right\}$$

where h denotes a quasi-concave utility function. The expenditure function is concave in $\mathbf{p}$ and additionally assumed to be convex in g and l. In the case of positive externalities created by migration the expenditure function could be concave in l but in the following we will abstract from this case as we exclusively look at crowding [2]. The partial derivative of the expenditure function with respect to g, $D_g \tilde{e}(\cdot) < 0$, is equal to the (negative) demand shadow price of the publicly provided good, i.e. the value of private expenditure that the consumer is willing to give up for an additional unit of the publicly provided good, which at constant l leads to a utility increasing rise in $\tilde{g}$. Moreover, the partial derivative with respect to l, $D_l \tilde{e}(\cdot) > 0$, can be interpreted as crowding costs incurred by consumers. These costs are defined as the compensating value of minimum expenditure necessary to reach a constant predetermined utility level as the total population consuming the publicly provided good increases. Crowding costs are zero if the public good is of the pure type; otherwise they are positive.

In the following we assume identical homothetic preferences in both countries. The expenditure function can then be written as

$$\tilde{e}(\mathbf{p}, g, l, u) = e(\mathbf{p}, g, l) \cdot u$$

2.2. Firm behaviour

The supply side is described by the social product function $y(\mathbf{p}, g, \mathbf{v})$, which describes the maximum value of *private* production produced with a constant returns to scale technology at a given price vector $\mathbf{p}$, a given supply of g and a given supply of factors of production $\mathbf{v}$:

$$(3) \qquad y(\mathbf{p}, g, \mathbf{v}) := \max_{\mathbf{v}^j, \mathbf{v}^g} \left\{ \sum_{j=1}^{\bar{r}} p_j \cdot f_j(\mathbf{v}^j) : f_g(\mathbf{v}^g) \geq \delta \cdot g; \right.$$
$$\left. \mathbf{v}^g + \sum_{j=1}^{\bar{s}} \mathbf{v}^j \leq \mathbf{v}; \sum_{j=1}^{\bar{s}} \mathbf{v}^j = \mathbf{v}^p; \mathbf{v}^g, \mathbf{v}^j, \mathbf{v}^p \geq 0 \right\}$$

2. For the properties of the expenditure function with pure public goods see SCHWEINBERGER [1994:4]. Congestion in a duality framework is modelled in WILSON [1990].

Here, $\mathbf{v}^p(\mathbf{v}^g)$ denotes the vector of factors of production in the private (public) sector. δ is the constant rate of depreciation in the public sector. The social product function is convex in $\mathbf{p}$ and concave in g. Its partial derivative with respect to the public good, $D_g y(\cdot) < 0$, defines the (negative) supply shadow price of the public good, i.e. the value of private production that has to be given up in order to produce an additional unit of the publicly provided good [3].

The social product function is concave in $\mathbf{v}$ and its partial derivative with respect to factor endowments determines the vector of factor prices $\bar{\mathbf{w}}$:

$$\bar{\mathbf{w}}(\mathbf{p}, g, \mathbf{v}) = D_{\mathbf{v}} y(\mathbf{p}, g, \mathbf{v}) \tag{4}$$

The determination of factor prices in the presence of an exogenously supplied and internationally non-tradeable public good has to be analysed in more detail. If the country under consideration produces at least as many private goods as factors of production exist, that is $\overline{r} \geq \overline{s}$, and if we additionally assume that a detraction of factors from the private industries towards the public sector does not lead to specialisation, then $D_{\mathbf{v}}\bar{w} = D_g\bar{w} = 0$, such that a change in the endowment of factors in the private industries has no influence on factor prices. If, on the other hand, the country is specialized in production, factor prices can change and $D_g\bar{w}$ depends on the factor intensity of g. All private goods and the public good differ in their factor intensities of production. This is an assumption that matters quite a lot in trade theory but not in the local public finance literature where the private good is often used as the single input in the production of the publicly provided good.

As will be described in more detail below, a country's labour force is equal to the number of residents l. In the following, we consider a migration-induced change in labour supply and keep all the other factors of production included in $\mathbf{v}$ constant such that the revenue function can be written as $y(\mathbf{p}, g, l)$.

2.3. Government Behaviour

The government sector supplies the public good, whose quantity consumers and producers take as given. The decision on the amount of public good to be supplied to residents can be based on several aims. For example, the government could wish to bring about a constant and exogenously given level of public good consumption $\tilde{g}$. Instead, the government's public good supply could be led by an optimization calculus. This can aim at maximizing the residents' welfare or instead world welfare as a whole. An international migratory movement could now counteract these aims such that public good supply would need to be adjusted. The resident population is therefore concerned about the usage of publicly provided goods by immigrants, or to put it more precisely, concerned whether immigrants

3. See SCHWEINBERGER [1994:6].

really "pay their way" for publicly provided goods. Hence, it is necessary to ascribe the costs actually incurred by residents through the usage of public goods by immigrants. For these purposes, production costs of g and the methods of how these are financed have to be specified. In the following, we assume that

- the existing public capital *stock* has already been completely financed by the resident population
- only replacement investments, which are modelled as a *flow*, have to be financed with the help of currently raised taxes.

The explicit modelling of replacement investments takes account of the fact that these are important public expenditures. Following SEITZ [1995] new urban infrastructure in Germany creates annual costs for replacement investments which amount to 6-7% of the initial investment expenditure. Therefore, these costs should not be neglected.

Production costs are minimized, as expressed by the linear homogeneous cost function of g:

$$b_g(\mathbf{w}) := \min_{a_{ig}} \left\{ \sum_{i=1}^{\bar{s}} a_{ig} \cdot w_i : f_g(\mathbf{a}^g) \geq 1 \right\} \tag{5}$$

with a_{ig} as input coefficient of factor i in the production of g. As the infrastructure is assumed to depreciate with a constant rate δ aggregate public investment i^g consists of enlargement investments $g_{\tau+1} - g_\tau$ and replacement investments $\delta \cdot g_\tau$:

$$i^g = g_{\tau+1} - g_\tau + \delta \cdot g_\tau \tag{6}$$

where τ denotes periods. In the following, we will consider *steady states* in which the government undertakes replacement investments in order to sustain a constant infrastructure capital stock. In the absence of enlargement investments aggregate public investments amount to replacement investments only:

$$i^g = \delta \cdot g_\tau$$

From this follow aggregate costs as

$$c(\mathbf{w}, g) = b_g(\mathbf{w}) \cdot \delta \cdot g \tag{7}$$

As the existing infrastructure is already completely financed, only replacement investments have to be financed with the help of taxes. For this purpose the government levies a proportional income tax. The income tax is one of the most important sources of tax revenue countries raise for financing the provision of public services. With the total income for the domestic and the foreign country (foreign variables with capital letters) respectively being defined as:

$$y^*(\mathbf{p}, g, l) \equiv y(\mathbf{p}, g, l) + b_g(\mathbf{w}) \cdot \delta \cdot g \tag{8}$$

$$Y^*(\mathbf{p}, G, L) \equiv Y(\mathbf{p}, G, L) + B_G(\mathbf{W}) \cdot \Delta \cdot G, \tag{9}$$

the governmental budget constraints stating that tax revenue has to equal public provision costs can be written as

$$t \cdot y^{*}(\mathbf{p}, g, l) = b_g(\mathbf{w}) \cdot \delta \cdot g \tag{10}$$

$$T \cdot Y^{*}(\mathbf{p}, G, L) = B_G(\mathbf{W}) \cdot \Delta \cdot G. \tag{11}$$

Income tax rates for the domestic and foreign country can then easily be derived as:

$$t = \frac{b_g(\mathbf{w}) \cdot \delta \cdot g}{y(\mathbf{p}, g, l) + b_g(\mathbf{w}) \cdot \delta \cdot g} \tag{12}$$

$$T = \frac{B_G(\mathbf{W}) \cdot \Delta \cdot G}{Y(\mathbf{p}, G, L) + B_G(\mathbf{W}) \cdot \Delta \cdot G}. \tag{13}$$

Hence, the government adjusts tax rates such that the budget is always balanced. Note that a situation with free trade is assumed, such that $\mathbf{p} = \mathbf{P}$. Furthermore, labour is in inelastic supply such that the consumption-leisure decision is not distorted by the income tax system.

2.4. Initial Equilibrium

In the following, we assume that the total population $l(L)$ in the two countries considered consists of two income classes, with $n(N)$ being the high and $m(M)$ being the low income group, i.e. $l(L) = m + n(M + N)$. One can imagine that the first group (called capitalists) possesses one unit of labour and additionally all the other factors of production, whereas the other group (called labourers) only possesses labour. The budget restrictions of the different income classes can then be written as:

$$m \cdot e(\mathbf{p}, g, l) \cdot u_m = m \cdot (1 - t) \cdot w(\mathbf{p}, g, l) \tag{14}$$

$$n \cdot e(\mathbf{p}, g, l) \cdot u_n = y(\mathbf{p}, g, l) - m \cdot (1 - t) \cdot w(\mathbf{p}, g, l) \tag{15}$$

$$M \cdot e(\mathbf{p}, G, L) \cdot U_M = M \cdot (1 - T) \cdot W(\mathbf{p}, G, L) \tag{16}$$

$$N \cdot e(\mathbf{p}, G, L) \cdot U_N = Y(\mathbf{p}, G, L) - M \cdot (1 - T) \cdot W(\mathbf{p}, g, L) \tag{17}$$

where $w(W)$ denotes the domestic (foreign) wage rate. Equal expenditure functions in both countries arise from identical preferences. From (14) and (15) or (16) and (17), respectively, follow the national budget restrictions:

$$(m \cdot u_m + n \cdot u_n) \cdot e(\mathbf{p}, g, l) = y(\mathbf{p}, g, l) \tag{18}$$

$$(M \cdot U_M + N \cdot U_N) \cdot e(\mathbf{p}, G, L) = Y(\mathbf{p}, G, L). \tag{19}$$

In the following, we analyse the effects of an international migration of low income group members, i.e. unskilled workers, and assume the high-income group to be internationally immobile. At present, this is a very typical form of international migration to be observed.

Furthermore, we need the condition for the clearing of the world private goods' markets:

$$\mathbf{x}(\mathbf{p}, g, l) + \mathbf{X}(\mathbf{p}, G, L) = 0 \tag{20}$$

with

$$\mathbf{x}(\mathbf{p}, g, l) = D_{\mathbf{p}} y(\mathbf{p}, g, l) - \frac{D_{\mathbf{p}} e(\mathbf{p}, g, l)}{e(\mathbf{p}, g, l)} \cdot y(\mathbf{p}, g, l)$$

denoting the vector of excess supply and $D_{\mathbf{p}} e/e$ standing for the marginal propensity to consume private goods. Here, it is recognized that $(m \cdot u_m + n \cdot u_n) = y/e$ as we see from (18).

With the help of (18), (19) and (20) the condition for an optimal public good supply can now be analytically formulated. By totally differentiating (18) and (19) and setting the changes in utility following a change in public good supply equal to zero we receive:

$$(m \cdot u_m + n \cdot u_n) \cdot D_g e(\mathbf{p}, g, l) - D_g y(\mathbf{p}, g, l) = \mathbf{x} \frac{d\mathbf{p}}{dg} \tag{21}$$

$$(M \cdot U_M + N \cdot U_N) \cdot D_G e(\mathbf{p}, G, L) - D_G Y(\mathbf{p}, G, L) = -\mathbf{x} \frac{d\mathbf{p}}{dG} \tag{22}$$

At constant goods' prices, equations (21) and (22) give the Samuelson conditions, stating that the sum of the demand shadow prices for the public good have to equal its supply shadow price. For large open economies a deviation of public provision from allocative efficiency implied by the Samuelson condition can be rational. This is the case if a country wants to strategically influence its terms-of-trade. In the following, by assuming that public good supply is based on an optimization calculus instead of being exogenously provided, we consider the case in which governments abstract from this strategic behaviour. Consequently, governments choose the amount of national public provision such that the Samuelson condition holds in both countries:

$$(m \cdot u_m + n \cdot u_n) \cdot D_g e(\mathbf{p}, g, l) = D_g y(\mathbf{p}, g, l) \tag{23}$$

$$(M \cdot U_M + N \cdot U_N) \cdot D_G e(\mathbf{p}, G, L) = D_G Y(\mathbf{p}, G, L). \tag{24}$$

Then, world welfare with respect to public good provision is maximized.

Summarizing, the model can be expressed through equations (12), (13), (14)-(17), (20), (23) and (24). This determines $t, T, u_m, u_n, U_M, U_N, \mathbf{p}, g$ and G. In the following, distributional aspects between income groups within one country are not considered, i.e. only aggregate national utilitarian welfare, defined as $m \cdot u_m + n \cdot u_n$ and $M \cdot U_M + N \cdot U_N$, respectively, matters [4, 5].

2.5. Migration Equilibrium

A free international migration of workers in the presence of public goods does not necessarily imply an equalization of the domestic and foreign wage rate. At given *identical* levels of collective good consumption in both countries, i.e. $\tilde{g} = \tilde{G}$ at $e(\mathbf{p}, g, l) = e(\mathbf{p}, G, L)$, following (14) and (16) workers' utility levels are equalized as their net incomes adjust internationally: $(1-t) \cdot w(\mathbf{p}, g, l) = (1-T) \cdot W(\mathbf{p}, G, L)$. This implies that a wage differential, which compensates differing tax prices for the public good, $t \cdot w$ and $T \cdot W$ respectively, persists in the migration equilibrium:

$$(25) \qquad w(\mathbf{p}, g, l) - W(\mathbf{p}, G, L) = t \cdot w(\mathbf{p}, g, l) - T \cdot W(\mathbf{p}, G, L).$$

Given identical levels of collective good consumption, in the country with the higher (lower) wage rate in an equilibrium, workers have to pay higher (lower) tax prices for the public good (FLATTERS, HENDERSON and MIESZKOWSKI [1974]). In a situation where the domestic level of collective good consumption is larger (smaller) than in the foreign country, workers' income after taxes has to be lower (higher) in the domestic country and is therefore not equalized internationally. In a migration equilibrium a wage differential probably exists, implying that world output is *not* maximized.

3 Effects of Migration

The following analysis begins with a consideration of the model's comparative-static effects. Here, the general welfare effects of an international migration and the detailed conditions under which immigration necessitates an adjustment in the public capital stock are considered. As this framework is not suitable for a simultaneous consideration of the change in enlargement– *and* replacement investments the theoretic analysis is then supplemented by a consideration of a more-period context in which a clear

4. The choice of this simple social welfare function makes sense if it is assumed that each individual has exactly one vote in a hypothetical political process.
5. For a detailed discussion of distributional aspects of international migration in a trade-theoretic context see LEINER and MECKL [1995].

identification of additional investments and migration-induced changes in tax revenue becomes possible.

3.1. Comparative-Static Effects of Migration

The comparative-static analysis proceeds from the initial equilibrium described in section 2. It is therefore clear that it only considers the residents' welfare in both countries and consequently excludes the migrants. This is because it is the group of non-immigrants that actually decides on the design of a suitable migration policy. By total differentiation of (18) and (19) we get with $dm = -dM = dl = -dL$:

$$\psi = \mathbf{x} \cdot \frac{d\mathbf{p}}{dl} + [D_g y - (m \cdot u_m + n \cdot u_n) \cdot D_g e] \cdot \frac{dg}{dl} - (m \cdot u_m + n \cdot u_n) \cdot D_l e + t \cdot w \tag{26}$$

$$\Psi = -\mathbf{x} \cdot \frac{d\mathbf{p}}{dl} + [D_G Y - (M \cdot U_M + N \cdot U_N) \cdot D_G e] \cdot \frac{dG}{dl} + (M \cdot U_M + N \cdot U_N) \cdot D_L e - T \cdot W \tag{27}$$

where $\psi = (m \cdot du_m/dl + n \cdot du_n/dl) \cdot e(\mathbf{p}, g, l)$ describes the domestic, non-immigrants', and $\Psi = (M \cdot dU_M/dl + N \cdot dU_N/dl) \cdot e(\mathbf{p}, G, L)$ the foreign, non-emigrants', aggregate welfare change following an international migratory movement of workers. As (26) and (27) show, an international migration affects the domestic as well as the foreign level of national welfare through a change in the terms-of-trade $(d\mathbf{p})$, a change in public good supply (dg), a congestion cost effect and a change in tax revenue. As the government decides on changes in public good supply and simultaneously adjusts tax rates such that the budget is balanced, tax rate changes are not explicit. That is, the interactions between additional tax revenue, additional public good provision and possible tax rate changes are not visible.

The terms-of-trade effect is irrelevant for aggregate world welfare, defined as $\psi + \Psi$. This is because the terms-of-trade effect can be seen as a mechanism of internationally redistributing income between countries via changes in prices for private products that one country imports and the other exports (see LEINER and MECKL [1995]). Therefore, terms-of-trade effects influence the choice of migration policies at the national level, at which these policies usually are being implemented. A further important policy relevant effect is the congestion cost effect. Congestion costs will be zero in the presence of pure public goods. If, on the other hand, the public goods are assumed to be of the non-pure type, congestion costs will be positive (negative) in the country of immigration (emigration) as the level of crowding changes following the migratory movement. As migrants participate in the financing of public replacement investments tax revenue increases in the destination country and decreases in the country of emigration. We can now discuss the conditions under which the non-migrant population in each country wins or loses following an international migratory movement of workers.

It is obvious that migrants automatically gain a share of the public good supply by entering the destination country just because of the public good's property that nobody can be excluded from consumption. But does this hurt the resident population? CLARKE and NG [1993] point out: ... *to the extent that current publicly available benefits (e.g. roads, libraries) are funded out of past community savings rather than current taxes, public expenditures themselves represent a redistribution from existing to new residents.* From this some authors like WEBER and STRAUBHAAR [1994] derive the necessity of a compensation for the resident population in form of entrance fees. Nevertheless, the analysis of our model contradicts these speculations quite clearly. As we intend a consideration of a public capital stock already in existence which has already be completely financed by the resident population, let us first abstract from a potential change in public good supply such that dg/dl in (26) equals zero. Equation (26) then shows that the mere existence of additional users has no welfare deteriorating effect on residents unless congestion occurs and the terms-of-trade change; instead tax revenue increases. This is because the costs for public provision are sunk. From this follows

PROPOSITION 1: The fact that migrants automatically gain a share of the public capital stock by entering the immigration country does not affect residents if the good under consideration is of the pure type. Instead, in a small open economy with pure public goods and constant factor prices non-immigrants (non-emigrants) unambiguously win (lose), because for a given public capital stock tax rates can be decreased (increased) following the simple cost sharing argument.

Let us now analyse in detail the conditions under which a migration-induced adjustment of public good supply becomes necessary and how this affects national welfare. We have seen that in the most simple case the government wishes to supply a constant level of quality adjusted public good consumption $\tilde{g}$ to its residents. From $e(\mathbf{p}, g, l) = e(\mathbf{p}, \tilde{g})$ we get:

$$D_g e \cdot dg + D_l e \cdot dl = D_{\tilde{g}} e \cdot d\tilde{g} = 0.$$

It follows that:

$$\frac{dg}{dl} = -\frac{D_l e}{D_g e} > 0 \tag{28}$$

With pure public goods no congestion occurs such that no adjustment needs to be undertaken. Only in the presence of impure public goods does immigration automatically lead the government to enlarge public provision.

If the government is instead led by an optimization calculus aiming at maximizing world welfare, i.e. without strategically influencing the terms-of-trade, total differentiation of (23) shows how a migration-induced adjustment of public good supply then proceeds:

$$\begin{aligned} \frac{dg}{dl} =& \frac{1}{a} \cdot [D_{g\mathbf{p}} y - (m \cdot u_m + n \cdot u_n) \cdot D_{g\mathbf{p}} e] \cdot \frac{d\mathbf{p}}{dl} \\ &+ \frac{1}{a} \cdot [D_{gl} y - (m \cdot u_m + n \cdot u_n) \cdot D_{gl} e - u_m \cdot D_g e] \end{aligned} \tag{29}$$

with

$$a = (m \cdot u_m + n \cdot u_n) \cdot D_{gg}e - D_{gg}y > 0$$

The first line in (29) describes how a change in private goods' prices affects the demand and supply shadow prices of the public good. With $D_{g\mathbf{p}}y < 0$ a positive (negative) change in the terms-of-trade leads to a decreased (increased) production in the public good and simultaneously implies an increased (decreased) demand for the public good as $D_{g\mathbf{p}}e < 0$. The first effect in the second line describes how a migration-induced change in public provision costs affects the necessary adjustment of the public capital stock g. An increase (decrease) in public provision costs implies $D_{gl}y < 0 (> 0)$ as more (less) private production has to be given up for an additional unit of the public good. Consequently, immigration will lead to a shrinkage (enlargement) of the public capital stock, i.e. $dg/dl < 0 (> 0)$. A rise in congestion implies that residents wish to give up less private production for an additional unit of g such that $D_{gl}e > 0$ leading to a decreased demand for the public good. In the presence of pure public goods this effect equals zero. The last term in the second line gives the migrant's demand shadow price for the public good which automatically leads to an increase in its demand.

PROPOSITION 2: Whereas the aim of a constant $\tilde{g}$ exclusively implies immigration-induced public enlargement investments in the presence of impure public goods, a welfare maximizing adjustment of g could also lead to an enlargement or shrinkage in the presence of pure public goods.

We can now analyse how the degree of optimality in public good provision in the initial equilibrium, combined with a migration-induced change, affects residents' welfare. Thus, we first analyse the effect $[D_g y - (m \cdot u_m + n \cdot u_n) \cdot D_g e] \cdot dg/dl$ in (26) for the destination country. If the public good is optimally supplied in the initial equilibrium such that $D_g y - (m \cdot u_m + n \cdot u_n) \cdot D_g e = 0$, an optimal adjustment in its provision leaves the resident population unaffected; additional costs are just internalized through their demand shadow prices. But, if on the other hand an under– or an oversupply exists in the initial equilibrium, meaning that the Samuelson condition does not hold, a welfare maximizing adjustment in public provision is impossible. Nevertheless, public good supply could be enlarged following an immigration, for example with the aim of maintaining the initial equilibrium's quality adjusted level of public provision. Such an adjustment is then undertaken without recognition of an existing non-optimal supply. An overprovision of public good supply in the initial equilibrium, i.e. $D_g y - (m \cdot u_m + n \cdot u_n) \cdot D_g e < 0$, then implies that an immigration-induced marginal increase in public good supply decreases the non-immigrants' welfare as their marginal willingness to pay for the additional unit is smaller than marginal costs. But if g is initially undersupplied, i.e. $D_g y - (m \cdot u_m + n \cdot u_n) \cdot D_g e \cdot dg/dl > 0$, a marginal enlargement of public provision leads to a clear welfare-improvement for the resident population as their willingness to pay for an additional unit is larger than marginal production costs such that they actually wish for an enlargement in public good supply.

PROPOSITION 3: If the public good is optimally supplied in the initial equilibrium, an immigration–induced enlargement leaves the resident population unaffected. If, instead, the public good is initially undersupplied (oversupplied) public enlargement investments improve (worsen) the residents' welfare.

3.2. **Effects of Migration in a More-Period-Context**

It is impossible to infer the complete change in the non-migrants' welfare from equations (26) and (27). The comparative-static framework only yields the migration-induced change in public enlargement investments whereas the simultaneously occuring change in replacement investments does not become obvious. In order to give a complete picture of the aggregate change in public investments we now lay out a three-period-model which allows for a clear identification of additional investments and the change in tax revenue. Considerations will be simplified by assuming a small open economy. We consider (i) the period before immigration $(\tau - 1)$, (ii) the period in which immigration takes place (τ), and (iii) the period after immigration $(\tau + 1)$.

(i) In $\tau - 1$ the resident population has already completely financed the existing public capital stock. Only replacement investments have to be undertaken. This period's public investment volume is therefore equal to

$$i^g_{\tau-1} = \delta \cdot g_{\tau-1}. \tag{30}$$

With the help of (12) this period's income tax rate can thus be derived as

$$t_{\tau-1} = \frac{b_g(\mathbf{w}) \cdot \delta \cdot g_{\tau-1}}{y^*} \tag{31}$$

(ii) In period τ immigration takes place, which necessitates an enlargement of the public capital stock. With replacement investments remaining constant the public investment volume amounts to

$$i^g_\tau = g_{\tau+1} - g_\tau + \delta \cdot g_\tau. \tag{32}$$

The associated income tax rate in this period amounts to

$$t_\tau = \frac{b_g(\mathbf{w}) \cdot [(g_{\tau+1} - g_\tau) + \delta \cdot g_{\tau-1}]}{y^* + w \cdot \Delta l} \tag{33}$$

The effect $w \cdot \Delta l$ shows that immigrants share in the costs of the immigration country's public tasks and therefore help financing the provision of the public capital stock.

Obviously, immigration-induced costs in this period equal public expenditures for enlargement of the capital stock:

$$c(\mathbf{w}, g_\tau) = b_g(\mathbf{w}) \cdot (i^g_\tau - i^g_{\tau-1}) = b_g(\mathbf{w}) \cdot (g_{\tau+1} - g_\tau). \tag{34}$$

The migrants' impact on the income tax rate compared to the previous period is given by

$$t_\tau - t_{\tau-1} = \frac{b_g(\mathbf{w}) \cdot (g_{\tau+1} - g_\tau) - w \cdot \Delta l \cdot t_\tau}{y^*} \tag{35}$$

Thus, the immigrants' impact on the tax rate is ambiguous: The additional tax income can be larger as well as smaller as additional aggregate public investment costs. Accordingly, the tax rate may have to be reduced or raised.

(iii) In the period following the immigration movement the migration-induced enlargement of the public capital stock leads to an increase in replacement investments:

$$i^g_{t+1} = \delta \cdot g_{t+1} > \delta \cdot g_t \tag{36}$$

This period's tax rate then equals

$$t_{\tau+1} = \frac{b_g(\mathbf{w}) \cdot \delta \cdot g_{\tau+1}}{y^* + w \cdot \Delta l} \tag{37}$$

Migration-induced costs in period $\tau + 1$ amount to

$$c(\mathbf{w}, g_{\tau+1}) = b_g(\mathbf{w}) \cdot (i^g_{\tau+1} - i^g_\tau) = b_g(\mathbf{w}) \cdot \delta \cdot (g_{\tau+1} - g_\tau). \tag{38}$$

Compared to the previous period, the tax rate can ambiguously be reduced

$$t_{\tau+1} - t_\tau = b_g(\mathbf{w}) \cdot [(\delta - 1) \cdot (g_{\tau+1} - g_\tau) - \delta \cdot g_\tau] < 0$$

but compared to the period before immigration the actual occured tax rate change is unclear

$$t_{\tau+1} - t_{\tau-1} = \frac{b_g(\mathbf{w}) \cdot \delta \cdot (g_{\tau+1} - g_\tau) - w \cdot \Delta l \cdot t_{\tau+1}}{y^*} \tag{39}$$

as, again, additional tax income raised from immigrants could be larger as well as smaller as migration-induced public expenditures.

PROPOSITION 4: Immigration-induced costs include the costs for the enlargement of the public capital stock and the increase in replacement costs for all future periods. Benefits result from the migrants' participation in financing the enlargement and all future replacement investments.

To determine the net impact of immigration we have to compute the present value of the net benefits ψ^*. This is done with the help of the time preference rate θ that gives the interest rate that the resident population would accept in order to delay its consumption to the future:

$$\psi^* = \left(1 + \frac{\delta}{\theta}\right) \cdot b_g(\mathbf{w}) \cdot (g_{t+1} - g_t) - \left(t_\tau + \frac{t_{\tau+1}}{\theta}\right) \cdot w \cdot \Delta l \tag{40}$$

As (40) shows, the net effect of immigration on public expenditures is actually ambiguous. The likelihood that immigration is connected with net costs for the resident population increases with the necessary public enlargement investment from which increased public replacement investments follow. Additionally, the net impact of an immigration becomes worse the smaller the migrants' factor incomes are. The resident population unambiguously gains if (i) the additional tax income in the immigration period τ outweighs public expenditures for the enlargement investment and (ii) if the migrants' participation in all future replacement investments is larger than the increase in replacement investments.

Consequently, the immigrants' contributions to all future public tasks is an aspect that must not be neglected. It is often overlooked, however, for example when only short-run immigration costs in form of public enlargement investments are considered. According to (40), residents discount future migration-induced changes in public expenditures with the help of the time preference rate θ. Obviously

> PROPOSITION 5: If immigration is connected with net costs in future periods these are valued worse the smaller the time preference rate θ is, that is, the stronger the preference for future consumption. But if on the other hand immigration implies future gains, a strong (weak) preference for future consumption would result in an increased (decreased) benefit from immigration.

Now that we have discussed the welfare effects of an international migration in the presence of public goods, the next chapter is concerned with the derivation of migration policy devices.

4 Implications for Migration Policy

Let us now shortly consider the model's migration policy implications. The government could be assumed to pursue differing policy objectives. For instance, the immigration country's government can follow a migration policy designed to completely compensate the resident population for possibly incurred welfare losses. Alternatively, the government can use immigration as an instrument to increase and consequently maximize the residents' welfare.

4.1. **Compensating Migration Policy**

A compensating migration policy is supposed to aim at a compensation for welfare losses accruing to non-immigrants through an exogenous marginal inflow of foreign workers such that the residents' initial utility level prevails. As was demonstrated in the comparative-static framework, the resident population is not hurt by the usage of a given and already completely financed stock of pure public goods by immigrants. This is because these costs are sunk costs and marginal costs of an additional user are zero. If we now first abstract from endogenous goods' prices, a need for governmental action does not exist as no welfare deterioration occurs. From this follows that entrance fees as a pure compensation for immigrants' now participating at the stock of public capital is critical if the residents' welfare is not worsened. If, on the other hand, public replacement investments are considered and if the public capital stock does not need to be adjusted, only the difference between potential congestion costs and the tax price would have to be levied as an entrance fee.

More interesting is the case where the government has to undertake public enlargement investments following immigration. A discussion of the comparative-static welfare effects of a marginal immigration has shown that in the case of an optimal public good supply no welfare losses occur. An entrance fee as a compensation for welfare losses would in this context only be justified if a migration-induced adjustment in public good supply is combined with overprovision as this implies that additional production costs of g are larger than the residents' willingness to pay. The maximum possible entrance fee needed for compensation would have to be levied if the aggregate welfare loss to residents is balanced with the help of additional investments in public provision such that the initial utility level and the combined level of $\tilde{g}$ are reestablished. If, on the other hand, non-immigrants wish to substitute private for public consumption in order to attain their initial utility level, dg/dl will be smaller than in the previous case. Consequently, entrance fees will have to be lower. This is because, by revealed preferences, a situation in which consumers wish to substitute private for public consumption must be relatively welfare improving; otherwise they would not have done it. A positive (negative) terms-of-trade effect would lead to a lower (higher) entrance fee in the presence of public goods.

In contrast to the procedure in the comparative-static framework the analysis of net costs and benefits of immigration in a more-period context assumed exogenous migration-induced enlargements of the public capital stock. As the discussion shows, the design of an entrance fee would have to take all present and future costs and tax contributions into account such that its implementation is justified only if immigration is associated with a discounted net income loss.

4.2. **Welfare Maximizing Migration Policy**

A welfare maximizing migration policy now implies the use of immigration as a measure to reach the country's optimal population size. For an optimal rate of immigration in this framework, the Samuelson condition (23) and the condition for an optimal membership size have to be fulfilled. The latter is reached by setting ψ in (26) equal to zero:

$$t \cdot w = -\mathbf{x} \cdot \frac{d\mathbf{p}}{dl} + (m \cdot u_m + n \cdot u_n) \cdot D_l e \tag{41}$$

Consequently, for a small open economy with pure public goods, the optimal rate of immigration is reached when the wage rate is driven down to zero such that no additional tax revenue is raised through immigration.

This would imply that the public capital stock is completely financed by taxing the immobile factors. For impure public goods the optimal rate of immigration is attained when additional tax income equals marginal congestion costs. If a positive (negative) terms-of-trade effect additionally benefits (hurts) the non-immigrants, the optimal population size would be larger (smaller) than with $d\mathbf{p} = 0$.

For a small open economy, (41) shows that it is always better to attract high income immigrants as incurred congestion costs are independent of the type of immigrants but additional tax income raised is then higher.

A more detailed discussion of the welfare effects of international migration in the presence of public goods would have to exactly compare the length of time over which the public good is financed with the capacity's length of life. An interesting aspect discussed in SIMON [1989] is that a clear gain can arise for natives if public good supply is bond financed and the length of life of a project is shorter than the periods left to finance it. In the very extreme case, immigrants would pay for a public capital stock that is not in existence anymore. From this follows an interesting policy implication: If a country's government decides to allow immigration at a later point of time, it would always be rational to finance the public good with the help of bonds. This is because migrants then participate in these costs.

5 Conclusion

In this paper the relationship between international migration and public goods was analysed in a two-country trade model. At first, comparative-static welfare effects were derived. It was assumed that the existing public capital stock is already completely financed by the resident population and that public replacement investments for sustaining this stock are financed with the help of current taxes. As this comparative-static framework is unable to simultaneously consider immigration-induced public enlargement *and* replacement investments additionally a more-period-framework was introduced in which an adaquate discussion of migration-induced changes in public investments became possible. We were able to contradict the wideheld opinion that a migration-induced adjustment of public good supply always hurts the resident population, if the enlargement is exclusively due to immigration. With the help of the comparative-static analysis it was demonstrated that if an underprovision of the public good exists prior to immigration, a migration-induced enlargement in its supply increases the non-immigrants' welfare as their marginal willingness to pay for the additional supply is larger than additional marginal costs. The more-period-context then presented a more thorough identification of immigration costs in form of additional enlargement and replacement investments which have to be weighed against the increased tax revenue. It became clear that the effect of immigration on the residents' welfare is ambiguous as the additional tax income can outweigh migration-induced public investment expenditures such that the effect of immigration could actually be positive. Furthermore, it became obvious that the future contributions of immigrants to all public tasks must not be neglected. As migrants participate in the financing of all future replacement investments they importantly help establishing a constant national public good supply. The analysis demonstrated that these future contributions have to be discounted with the help of the resident population's time preference rate. As a result, the net-benefit of immigration on residents improves if future gains can be reaped and the time preference rate is low such that a strong preference for future consumption exists. In the same context, future welfare losses would be valued worse. Thus, the more-period framework not only enables an identification of short-run costs in form of enlargement investments but also makes a valuation of the immigrants' future impacts possible. Finally, the paper shortly analysed immigration policy aspects by distinguishing between migration policies which aim at compensating residents for incurred welfare losses only or at maximizing the residents' welfare.

The comparative-static analysis had to center on the discussion of various partial comparative static effects of international migration, as the underlying model with endogenous goods' and factor prices is quite complex. It would therefore be helpful to analyse the theoretic framework in a computable general equilibrium context, as interactions would then become clearer.

The present analysis underlined the importance of immigrants as tax payers sharing in public provision costs. The question, whether immigrants subsidize the resident population, that is, whether they pay more in taxes than they use public goods or whether they are themselves subsidized, remains an empirical one. If congestion effects and necessary additional public investments are small such that the cost sharing argument dominates other effects, immigration probably is welfare improving. For the future, it has to be recognized that the industrial destination countries experience declining birth rates. In the absence of immigration a diminishing population would imply a lower level of public good supply or alternatively constant public good provision at increased cost per capita. Immigration can then be used as a measure to sustain the level of public good provision. This becomes increasingly important if public goods additionally are used as productivity enhancing inputs into private production. Consequently, the argument that immigrants play an important role in financing the social security system seems to similarly apply to financing public good provision and therefore needs further consideration.

Clearly, the aspect of public goods in designing migration policies is only one among others, as for example the problem of unemployment in the destination countries. Nevertheless, its discussion in a trade-theoretic framework contributes to understanding fundamental consequences of migration in an international context.

APPENDIX

The complete totally differentiated system can be written in matrix form and determines $(m \cdot u_m + n \cdot u_n), (M \cdot U_M + N \cdot U_N), t, T, g, G$ and $\mathbf{p}$:

$$\mathbf{AB} = \mathbf{C}$$

$$\mathbf{A} = \begin{pmatrix} e(\mathbf{p}, g, l) & 0 & 0 & 0 & k & 0 & -\mathbf{x} \\ 0 & e(\mathbf{p}, G, L) & 0 & 0 & 0 & K & \mathbf{x} \\ 0 & 0 & y^* & 0 & h & 0 & f \\ 0 & 0 & 0 & Y^* & 0 & H & F \\ 0 & 0 & 0 & 0 & a & 0 & b \\ 0 & 0 & 0 & 0 & 0 & A & B \\ 0 & 0 & 0 & 0 & D_g\mathbf{x} & D_G\mathbf{X} & D_\mathbf{p}\mathbf{x} + D_\mathbf{p}\mathbf{X} \end{pmatrix}$$

$$\mathbf{B} = \begin{pmatrix} m \cdot du_m + n \cdot du_n \\ M \cdot dU_M + N \cdot dU_N \\ dt \\ dT \\ dg \\ dG \\ d\mathbf{p} \end{pmatrix}$$

$$\mathbf{C} = \begin{pmatrix} -(m \cdot u_m + n \cdot u_n) \cdot D_l e + t \cdot w \\ (M \cdot U_M + N \cdot U_N) \cdot D_L e - T \cdot W \\ -t \cdot w + (1-t) \cdot D_l b_g(\mathbf{w}) \cdot \delta \cdot g \\ T \cdot W - (1-T) \cdot D_L b_G(\mathbf{W}) \cdot \Delta \cdot G \\ -(m \cdot u_m + n \cdot u_n) \cdot D_{gl} e - u_m \cdot D_g e + D_{gl} y \\ (M \cdot U_M + N \cdot U_N) \cdot D_{GL} e + U_M \cdot D_G e - D_{GL} Y \\ D_L \mathbf{X} - D_l \mathbf{x} \end{pmatrix} \cdot dl$$

with

$$k = (m \cdot u_m + n \cdot u_n) \cdot D_g e - D_g y$$

$$K = (M \cdot U_M + N \cdot U_N) \cdot D_G e - D_G Y$$

$$a = (m \cdot u_m + n \cdot u_n) \cdot D_{gg} e - D_{gg} y$$

$$A = (M \cdot U_M + N \cdot U_N) \cdot D_{GG} e - D_{GG} Y$$

$$b = (m \cdot u_m + n \cdot u_n) \cdot D_{g\mathbf{p}} e - D_{g\mathbf{p}} y$$

$$B = (M \cdot U_M + N \cdot U_N) \cdot D_{G\mathbf{p}} e - D_{G\mathbf{p}} Y$$

$$h = t \cdot D_g y - (1-t) \cdot [D_g b_g(\mathbf{w}) \cdot \delta \cdot g + b_g(\mathbf{w}) \cdot \delta]$$

$$H = T \cdot D_G Y - (1-T) \cdot [D_G b_G(\mathbf{W}) \cdot \Delta \cdot G + b_G(\mathbf{W}) \cdot \Delta]$$

$$f = t \cdot D_\mathbf{p} y - (1-t) \cdot D_\mathbf{p} b_g(\mathbf{w}) \cdot \delta \cdot g$$

$$F = T \cdot D_\mathbf{p} Y - (1-T) \cdot D_\mathbf{p} b_G(\mathbf{W}) \cdot \Delta \cdot G$$

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