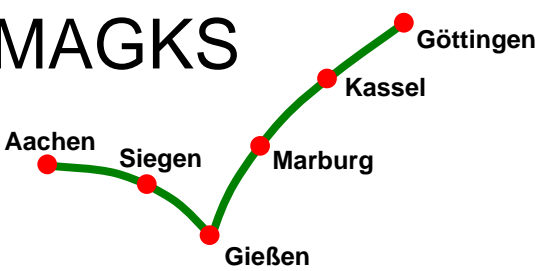


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# Aging and Immigration Policy in a Representative Democracy

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May 7, 2010

## Abstract

This paper analyzes how population aging affects immigration policy in rich industrialized countries. It sets up a two-period model of a representative democracy with two overlapping generations. The government's preferred immigration rate increases with the share of retirees in the population. The paper differentiates between an economy without a pension system and one with pay-as-you-go pensions. As immigrants have more children than natives, the chosen immigration rate is contingent on the design of the pension system. If pension contributions and benefits are set freely by the government, equilibrium immigration is lower than it is in the absence of a pension system. On the contrary, it is higher if the pension level is fixed ex ante to a relatively generous level, since native workers then benefit from sharing the burden of pension contributions with the immigrants.

*JEL classification:* J1, D78, F22

*Keywords:* Demographic Change, Political Economy, Immigration Policy

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# 1 Introduction

Virtually all industrialized countries are facing a decline in birth rates and an increase in life expectancy resulting in substantial population aging. Against this background, the question arises how rich countries adjust their immigration policies in the wake of demographic change. For instance, the United Nations' report on replacement migration (UNDP 2001) investigates how much immigration would be necessary to offset population aging in various low-fertility countries. Apparently, the supply of potential migrants is not a limiting factor for international labor flows, see e.g. Facchini and Mayda (2008) who make restrictive immigration policies responsible for low observed international labor flows.

This paper sets up a political economy model of a representative democracy to answer the question whether the demand for immigrants is higher in countries with an older population. It accounts for the fact that immigrants in industrialized countries tend to have more children than natives, altering the political balance in subsequent periods. Furthermore, the paper distinguishes between different possible pension system characteristics. While the benchmark model abstracts from public pensions, the model extensions in section 4 contrast a pension system with fixed benefits to one with fully flexible benefits and contributions.

Point of departure is a two-period economy with two overlapping generations, young workers and old retirees. In each period the respective government sets the immigration level to maximize political support from its voters, i.e. from both currently living generations. The electorate is heterogeneous since workers and retirees have conflicting preferences concerning the number of immigrants. Due to its effects on factor accumulation, immigration policy in the first period not only influences the welfare of current generations but it also has consequences for welfare in the second period. Immigration policy is, therefore, a sequential game between the governments of the subsequent periods. The equilibrium of this game is derived to analyze how the population growth rate influences the level of immigration. The bottom line of the analysis is that in a representative democracy an increase in the share of old individuals in the electorate enhances immigration. This result holds regardless of whether old individuals have a pension income financed by young individuals' contributions or only an income from private savings.

In the present model, preferences concerning immigration are driven both by the impact of immigration on factor prices and on the pay-as-you-go (PAYG) pension system, and by non-economic factors subsumed in a "disutility" parameter. The income effects induced by immigration in the host country have been analyzed under a variety of assumptions, see e.g. Razin

and Sadka (2000, 2004), Epstein and Hillman (2003), and Kemnitz (2003). In theory, immigration alters factor prices by increasing labor supply (wages decline while returns to capital increase). If the labor market is not fully flexible, unemployment may increase instead, as in Kemnitz (2003). These effects are dampened if capital is mobile internationally, or if production structures adjust as predicted by the Rybczynski theorem, see e.g. Hillman and Weiss (1999). Despite capital mobility and trade migration seems to have an impact on incomes: Whereas Card (1990) finds that the Mariel boatlift of 1980, a worker inflow of 7% of the Miami labor force, had virtually no effect on wages and unemployment rates there, there is evidence for negative wage effects at the national level, see e.g. Borjas (2003). Furthermore, Angrist and Kugler (2003), using European panel data from 1983 to 1999, find that in Europe, immigration displaced natives, and that unemployment effects were more negative in countries with less flexible labor markets. Meanwhile, non-economic factors clearly shape attitudes towards immigration, see for instance O'Rourke and Sinnott (2006) and Mayda (2006).

This model builds on several related papers with endogenous immigration policy. Benhabib (1996) examines immigration policy in a median voter model with heterogeneous wealth endowments, whereas Mazza and van Winden (1996) analyze the determination of redistribution and immigration policies in a representative democracy with workers and capital owners. In both models, individuals are in favor of admitting immigrants if these are different from themselves. In the dynamic models by Dolmas and Huffman (2004) and Ortega (2005) preferences are mitigated or even reversed as immigrants get to vote on redistribution policy in the future. Natives may then favor the admission of immigrants who are similar to themselves. This effect is counteracted in the present model by the high number of immigrants' offspring, who will oppose high pension benefits in the future.

Scholten and Thum (1996) and Haupt and Peters (1998) analyze immigration policy in the presence of (exogenous) PAYG pensions in median voter models with three generations. Immigration policy is determined by the old workers' preferences in their settings. More closely related to this analysis is a relatively recent paper by Sand and Razin (2007). They analyze equilibrium immigration and pension policy making in a dynamic set-up with two overlapping generations. In their median-voter framework, population aging may lead to a switch from the young voters' preferred policies to an implementation of the old voters' preferred policies, namely maximum immigration and a tax rate which maximizes social security revenue. Following Hillman and Weiss (1999), the present approach chooses a political support function, which includes all groups of voters, to model a representative democracy, rather than a median voter model. In contrast to Sand and

Razin (2007), the predicted consequences of aging are less drastic. Instead, the relationship between population growth and the equilibrium immigration level is continuous.<sup>1</sup>

The economic model is set up in section 2 and immigration policy is analyzed in section 3. Section 4 adds a social security system to the model. Section 5 concludes.

## 2 The Economic Model

The economic framework is a two-period version of an overlapping-generations model with workers and retirees. A two-period model is sufficient to show the key effects of immigration on both generations' utility levels while it is relatively straightforward to solve: Individuals know that the world ends after two periods and there is a closed-form solution for the equilibrium in the second period, which can be used to derive the equilibrium in the first period.

In each period  $t = 1, 2$  competitive firms produce a single aggregate good with a Cobb-Douglas technology:

$$Y_t = K_t^\alpha L_t^{1-\alpha} .$$

Young individuals supply one unit of labor. The workforce  $L_t$  is composed of natives and immigrants such that  $L_t = N_t(1 + \gamma_t)$ , where  $\gamma_t$  is the ratio of immigrants per native worker (as in Sand and Razin 2007). The capital stock  $K_t$  is given by the old individuals' savings. For simplicity capital is assumed to depreciate completely after one period. The capital stock per worker (native or immigrant) is defined as  $k_t \equiv K_t/L_t$  and the capital stock per native worker as  $\tilde{k}_t \equiv K_t/N_t$ , therefore  $k_t = \tilde{k}_t/(1 + \gamma_t)$ . International trade or capital mobility which might result in world factor price equalization are ignored. For a given capital stock per native worker, immigration thus lowers the capital intensity in production and thereby wages, whereas capital returns increase. Equilibrium factor prices are then given by

$$w_t = (1 - \alpha)\tilde{k}_t^\alpha(1 + \gamma_t)^{-\alpha} \quad \text{and} \quad 1 + r_t = \alpha\tilde{k}_t^{\alpha-1}(1 + \gamma_t)^{1-\alpha} . \quad (1)$$

In each period, young individuals receive a wage income  $w_t$ . The young generation born in the first period allocates the wage income to consumption and savings. The young generation born in the second period only lives for that period and therefore consumes its entire wage income. Old individuals are retired and consume all of their wealth  $s_{t-1}(1 + r_t)$ . In the benchmark

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<sup>1</sup>Note that in an overlapping-generations model with many generations, aging would not lead to drastic changes in the median voter's preferred policy either.

setting there is no social security system. Utility is logarithmic in consumption:

$$\begin{aligned} U_1^y &= \ln c_1^y + \beta \ln c_2^o - d\gamma_1 - \beta d\gamma_2, & U_2^y &= \ln c_2^y - d\gamma_2, & \text{and} \\ U_t^o &= \ln c_t^o - d\gamma_t, & t &= 1, 2. \end{aligned}$$

The term  $d\gamma_t$  denotes a disutility related to immigration or to the integration of immigrants, which is not accounted for in incomes and does not affect individuals' consumption decision. For instance, an increased heterogeneity of social norms and customs may reduce utility as in Hillman (2002) and Krieger (2005). Additionally, the parameter  $d$  may capture a reduction in the utility derived from public goods which results from heterogeneous preferences (see Alesina and La Ferrara 2005). The young in period 1 also anticipate the disutility  $d\gamma_2$  related to immigration in period 2. Optimal savings and consumption of the first-period young are

$$s_1 = \frac{\beta}{1+\beta} w_1, \quad c_1^y = \frac{1}{1+\beta} w_1, \quad \text{and} \quad c_2^o = \frac{\beta}{1+\beta} w_1 (1+r_2). \quad (2)$$

Immigration is permanent and the children of immigrants are considered as natives, such that  $N_2 = (1+n)N_1 + (1+m)\gamma_1 N_1$ , where  $n$  is the native rate of population growth and  $m$  the immigrant rate of population growth. Defining the difference between the population growth rates of immigrants and natives as  $\delta = m - n$ , the number of workers in period 2 is  $N_2 = [(1+n)(1+\gamma_1) + \delta\gamma_1]N_1$ . In line with empirical evidence on immigration to industrialized countries, only the case  $\delta \geq 0$  is considered. Immigrants are fully integrated into the economy after one period and are allowed to vote in their old age.

The capital market is in equilibrium if  $K_2 = s_1 L_1$ . The capital endowment of each native worker in the second period is given by

$$\tilde{k}_2 = \frac{\beta(1-\alpha)\tilde{k}_1^\alpha(1+\gamma_1)^{1-\alpha}}{(1+\beta)[(1+n)(1+\gamma_1) + \delta\gamma_1]}, \quad (3)$$

since  $\tilde{k}_2 = s_1(1+\gamma_1)N_1/N_2$ . According to (3), immigration lowers capital accumulation per native worker:

$$\frac{d\tilde{k}_2}{d\gamma_1} = -\frac{\tilde{k}_2}{1+\gamma_1} \left[ \frac{\delta}{(1+n)(1+\gamma_1) + \delta\gamma_1} + \alpha \right] < 0. \quad (4)$$

The reason for this result is that both wage income and thereby individual savings, and the ratio of savers to next period's native workers decline with immigration.

### 3 Immigration Policy in the Benchmark Model

The political economy equilibrium is derived under the assumption of a representative democracy in which the government accounts for the welfare of both contemporaneously living generations when setting immigration policy. More precisely, in each period  $t = 1, 2$  the government sets  $\gamma_t$  to maximize the following objective function:

$$W_t = \omega_t^o V_t^o + \omega_t^y V_t^y ,$$

where  $V_t^o$  and  $V_t^y$  denote the indirect utility of a representative old and young individual, respectively, while  $\omega_t^o$  and  $\omega_t^y$  denote their political weights. This objective function is more suitable for replicating policy outcomes in a representative democracy than the median voter's utility, as Hillman and Weiss (1999) argue. It can be motivated by a probabilistic voting framework as in Lindbeck and Weibull (1987) and Coughlin et al. (1990). It is assumed that both generations are equally responsive to policy changes, such that the government weights each generation's utility with its share in the electorate:<sup>2</sup>

$$\omega_t^o = \frac{1 + \gamma_{t-1}}{(2 + n)(1 + \gamma_{t-1}) + \delta\gamma_{t-1}} \quad \text{and} \quad \omega_t^y = 1 - \omega_t^o .$$

The sequence of events is as follows: at the beginning of each period, the respective government decides on immigration policy. Production takes place after immigration, and finally young individuals decide how to allocate their wage income to consumption and savings. It is straightforward to solve the model by backward induction. Therefore, equilibrium immigration policy in the second period is discussed first. The second-period immigration rate is then used to derive the first-period equilibrium. While a closed-form solution for  $\gamma_2$  exists, this is not the case for  $\gamma_1$ . However, it is possible to identify the different channels through which first-period immigration affects the young and old generations and to solve numerically for the equilibrium.

#### Immigration Policy in the Second Period

In the second period, the young prefer not to admit any immigrants because of the induced decline in the wage and because of the disutility related to immigration,  $d\gamma_2$ . The old would like to admit immigrants up to the point where the marginal increase in the capital return is equal to the marginal

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<sup>2</sup>Relaxing this assumption would allow for the influence of interest groups as in Facchini and Mayda (2008).

non-income disutility  $d$ . Marginal utilities are

$$\frac{dV_2^o}{d\gamma_2} = \frac{1-\alpha}{1+\gamma_2} - d \quad \text{and} \quad \frac{dV_2^y}{d\gamma_2} = -\frac{\alpha}{1+\gamma_2} - d \quad (5)$$

for the old and young respectively. From the government's first-order condition

$$\omega_2^o \frac{1-\alpha}{1+\gamma_2} - \omega_2^y \frac{\alpha}{1-\gamma_2} - d = 0 ,$$

follows the policy rule

$$1 + \gamma_2 = \frac{\omega_2^o - \alpha}{d} . \quad (6)$$

Equilibrium immigration is contingent on past immigration but not on the state variable  $\tilde{k}_2$ . The policy rule in (6) has a number of properties which are worth discussing because they also apply to the first period: A positive number of immigrants is admitted ( $\gamma_2 > 0$ ) as long as  $d < \omega_2^o - \alpha$ , i.e., the non-income disutility of integrating immigrants has to be sufficiently small. Since only the old generation favors admitting a positive number of immigrants, the second-period immigration rate rises with the old's population share (and declines with their share in aggregate income). The population share is contingent on the native population growth rate, on the previous period's immigration rate and on the difference in population growth rates between natives and immigrants.

A high native population growth rate  $n$  implies that the political weight of the old generation is low. Population aging – a decline in the population growth rate  $n$  – therefore leads to a rise in immigration (for a given first-period immigration rate):

$$\frac{\partial \gamma_2}{\partial n} = -\frac{(\omega_2^o)^2}{d} < 0 .$$

The immigration rate in the first period alters the age composition of the electorate in the second period as long as immigrants have more children than natives: The second-period population share of the old generation declines as more immigrants are admitted in the first period. Consequently,  $\gamma_2$  declines in  $\gamma_1$ :

$$\frac{d\gamma_2}{d\gamma_1} = -\frac{1}{d} \cdot \frac{\delta(\omega_2^o)^2}{(1+\gamma_1)^2} \leq 0 \quad \text{iff} \quad \delta \geq 0 . \quad (7)$$

The second-period immigration rate is also a declining function of  $\delta$  (for given  $\gamma_1 > 0$ ) since a higher number of children among the immigrants from the previous period increases the share of young individuals:

$$\frac{\partial \gamma_2}{\partial \delta} = -\frac{\gamma_1}{1+\gamma_1} \frac{(\omega_2^o)^2}{d} \leq 0 \quad \text{iff} \quad \gamma_1 \geq 0 .$$



In summary, the government's preferred immigration rate in the second period clearly increases as the young generation's share in the electorate declines. However, the immigration rates in both periods are substitutes. A high first-period immigration rate thus counteracts the effect of population aging on the second-period immigration rate. The effects of first-period immigration on both generations and the first-period government's preferred immigration rate will be discussed now.

## Immigration Policy in the First Period

The first-period government accounts for the impact of its immigration policy decision on factor accumulation and on the immigration rate set by the second-period government. In the first period, the old generation's marginal utility from immigration is the same as in the second period,  $dV_1^o/d\gamma_1 = (1 - \alpha)/(1 + \gamma_1) - d$ . However, the young generation's marginal utility is contingent on factor accumulation and future policy:

$$\frac{dV_1^y}{d\gamma_1} = \frac{1}{c_1^y} \frac{1}{1 + \beta} \frac{dw_1}{d\gamma_1} + \beta \frac{1}{c_2^o} \frac{\beta}{1 + \beta} \left[ \frac{dw_1}{d\gamma_1} (1 + r_2) + w_1 \frac{dr_2}{d\gamma_1} \right] - d - \beta d \frac{d\gamma_2}{d\gamma_1}. \quad (8)$$

While the declining wage lowers consumption in young and old age, immigration also has some second-order effects on the future capital return (via its impact on capital accumulation and on the future age composition of the electorate). Furthermore, since the immigration rates in both periods are substitutes, admitting more immigrants in the first period lowers the disutility related to immigration in the second period, which can be seen from the last term in (8). The impact of immigration on the wage rate is

$$\frac{dw_1}{d\gamma_1} = -\frac{\alpha}{1 + \gamma_1} w_1, \quad (9)$$

while the impact on the future capital return is given by

$$\frac{dr_2}{d\gamma_1} = -\frac{1 - \alpha}{\tilde{k}_2} (1 + r_2) \frac{d\tilde{k}_2}{d\gamma_1} + \frac{1 - \alpha}{1 + \gamma_2} (1 + r_2) \frac{d\gamma_2}{d\gamma_1}, \quad (10)$$

with  $d\gamma_2/d\gamma_1 < 0$  given by (7) and  $d\tilde{k}_2/d\gamma_1 < 0$  given by (4).

The government's first-order condition in the first period can be written

as

$$\begin{aligned}
& \omega_1^o \cdot \frac{1 - \alpha}{1 + \gamma_1} - \omega_1^y \cdot \frac{\alpha(1 + \beta)}{1 + \gamma_1} \\
& + \omega_1^y \beta \cdot \frac{1 - \alpha}{1 + \gamma_1} \left[ \frac{\delta}{(1 + n)(1 + \gamma_1) + \delta\gamma_1} + \alpha - \frac{\delta(\omega_2^o)^2}{(1 + \gamma_1)(\omega_2^o - \alpha)} \right] \\
& - d + \omega_1^y \beta \frac{\delta(\omega_2^o)^2}{(1 + \gamma_1)^2} = 0 ,
\end{aligned} \tag{11}$$

where the population shares reduce to  $\omega_1^o = 1/(2+n)$  and  $\omega_1^y = (1+n)/(2+n)$ , since there is no past immigration. This equation is highly non-linear in the immigration rate  $\gamma_1$  and therefore cannot be expressed analytically in closed form. Note, however, that  $\gamma_1$  does not depend on the state variable  $\tilde{k}_1$  either, but only on the model parameters. The impact of the parameters determining the demographic structure of the population is of primary interest, i.e. the impact of the native population growth rate  $n$  and of the difference between the immigrant and the native population growth rate  $\delta$ .

While in the second period a lower population growth rate  $n$  enhances immigration by increasing the old generation's share in the electorate, it has some additional (contrasting) effects on the equilibrium immigration rate in the first period. First, as argued in section 2, immigration reduces the future ratio of capital to native workers, implying a higher future capital return, because of lower wages and because of a lower number of savers relative to the number of next-period natives. Both of these effects are enhanced by a low population growth rate, weakening the opposition of the young generation to immigration. Second, the dampening effect of first-period immigration on second-period immigration is larger the lower is the native population's growth rate. This has two opposing effects on preferences over the level of first-period immigration. A lower  $\gamma_2$  due to a higher  $\gamma_1$  directly increases the young generation's lifetime utility, also weakening the young's opposition to immigration as  $n$  declines. However, the second-period capital return is reduced, enhancing opposition to immigration. In summary, a lower population growth rate induces several expanding effects on immigration policy, but also a contracting effect, since the increase in the future return on savings is dampened.

Contrary to the second period, the difference in population growth rates between immigrants and natives  $\delta$  does not influence the political weights of the two generations in the first period, since there is no past immigration.<sup>3</sup> However,  $\delta$  alters the impact of the first-period immigration rate on the second-period immigration rate  $\gamma_2$  and on second-period capital per native

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<sup>3</sup>This simplification would not apply in a setting with a longer time-horizon.

$\tilde{k}_2$ . It can be shown that  $\delta$  has contrasting effects on both derivatives. On the one hand, first-period immigration has a stronger negative impact on second-period immigration the larger the reduction in the old generation's future political weight  $\omega_2^o$ . As mentioned above, this weight declines as immigrants have more children than natives. On the other hand, there is also a level effect: the impact of  $\gamma_1$  on  $\gamma_2$  is weaker the smaller  $\omega_2^o$ . Similarly,  $\gamma_1$  has a stronger negative impact on  $\tilde{k}_2$  the larger  $\delta$ . This is because the ratio of savers to next-period natives declines with the difference in population growth rates between immigrants and natives. However, there is also a level effect: the impact of  $\gamma_1$  on  $\tilde{k}_2$  is weaker the smaller is  $\tilde{k}_2$ , which is the case for a large difference in population growth rates. Intuitively, the government admits many immigrants if there is a strong negative impact of immigration on capital immigration, since this implies higher capital returns in the second period.

If immigrants have the same number of children as natives, immigration policy does not have any impact on the future age composition of the electorate and the nonlinear terms vanish. For this special case ( $\delta = 0$ ), immigration policy is determined by the time-invariant rule

$$1 + \gamma_1 = \frac{(1 - \alpha) - (1 + n)\alpha(1 + \alpha\beta)}{(2 + n)d}.$$

The derivative of the immigration rate with respect to the population growth rate can then analytically be shown to be negative. For  $\delta > 0$ , however, numerical simulations are necessary to find a solution for  $\gamma_1$  and to investigate the impact of  $n$  and  $\delta$ .

Before discussing the simulation results the choice of parameter values is now motivated. This investigation largely follows Börsch-Supan et al. (2003) in defining the different parameter values. Population parameters are taken from the United Nations' Population Division Database (UNPD 2006). The production share of capital  $\alpha$  is set to 0.35. According to Börsch-Supan et al. (2003) a common assumption for the annual discount rate of households is 0.01. If it is assumed that each of the two life periods lasts for 30 years,<sup>4</sup> this corresponds to a discount factor  $\beta$  of about 0.75. The benchmark native population growth rate is  $n = -0.2$ , which is computed from the 2000-2005 average number of children per woman for the world's more developed regions. The difference between the immigrant and native population growth rates  $\delta$  is set to 0.5, the difference between the less developed regions (excluding the least developed regions) and the more developed regions. The non-economic disutility parameter related to the integration of immigrants,

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<sup>4</sup>An increase in life expectancy is not modeled.

$d$ , is set to 0.1. This is, of course, somewhat arbitrary; however, this parameter has a direct and unambiguous impact on equilibrium immigration. Therefore, the effect of picking a different value for  $d$  is quite clear.

Figure 1 illustrates the simulation results. Population aging visibly increases the government's preferred immigration rate  $\gamma_1$ . Bear in mind that this attenuates the positive effect of population aging on second-period immigration since the immigration rates in both periods are substitutes. The aggregate effect of the population growth rate on the second-period immigration rate is given by

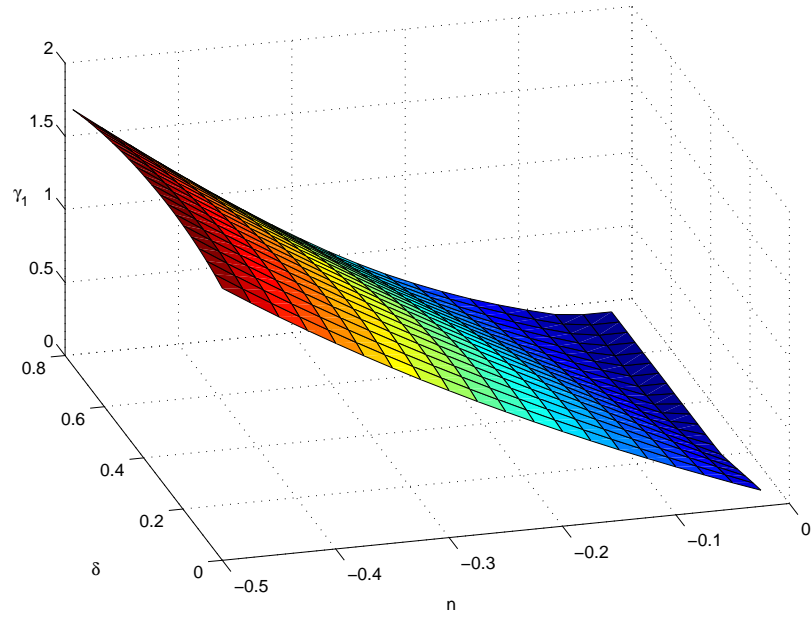
$$\frac{d\gamma_2}{dn} = \frac{\partial\gamma_2}{\partial n} + \frac{d\gamma_2}{d\gamma_1} \cdot \frac{\partial\gamma_1}{\partial n}.$$

With  $\partial\gamma_1/\partial n < 0$ , the positive effect of population aging on the second-period immigration rate is at least attenuated by a higher first-period immigration rate. The simulations reveal that the aggregate effect of aging on the immigration rate in the second period is positive for low population growth rates but negative for population growth rates close to zero. Meanwhile, the overall effect of the difference between the native and the immigrant population growth rate is ambiguous. Figure 1(b) shows more clearly that  $\delta$  has a non-monotonic effect on  $\gamma_1$ . Similar to an increase in the native population growth rate, an increase in the difference between population growth rates lowers immigration, given that this difference is already high. However, the opposite is true for a low difference  $\delta$ . The conclusions which can be drawn from the simulations are outlined in proposition 1.

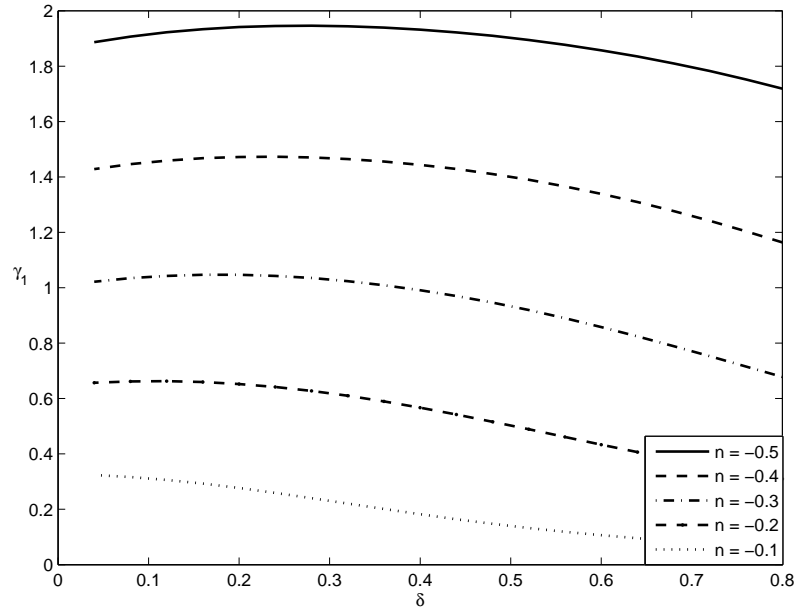
**Proposition 1** *In a representative democracy without a social security system,*

- (i) *a lower native population growth rate has a direct positive effect on the equilibrium immigration rate. However, the immigration rates in the two periods are substitutes.*
- (ii) *the difference between the native and the immigrant population growth rate has a non-monotonic effect on the equilibrium immigration rate. The immigration rate increases for low differences in population growth rates but decreases for high differences.*

Summarizing, immigration influences voters' welfare in two ways, by altering factor prices and by causing a non-income disutility. Population aging leads to a higher level of immigration in the first period since immigration increases the return on the old generation's accumulated capital. If immigrants have more children than natives, first-period immigration raises the share of young voters in the second period. Consequently, the immigration rates in



(a) Impact of  $n$  and  $\delta$



(b) Impact of  $\delta$  for given  $n$

Figure 1: Impact of  $n$  and  $\delta$  on First-Period Immigration

both periods are substitutes. The following section turns to the question of whether the existence of a social security system changes these results.

## 4 Social Security

Since aging implies a higher old-age dependency ratio, immigration is often seen as a (partial) solution to financing problems of social security, in particular of PAYG pension systems. Therefore, a pension system is introduced into the model to investigate the relationship between immigration and social security. Net wages are  $w_t(1 - \tau_t)$ , where  $\tau_t$  is the contribution rate to the pension system. A balanced budget is assumed such that

$$\tau_t = \frac{b_t}{w_t(1 + l_t)} ,$$

with  $b_t$  as the level of individual pension benefits.

Optimal savings and consumption of the first-period young are then given by

$$\begin{aligned} s_1 &= \frac{\beta}{1 + \beta} w_1(1 - \tau_1) - \frac{1}{1 + \beta} \frac{b_2}{1 + r_2} , \\ c_1^y &= \frac{1}{1 + \beta} w_1(1 - \tau_1) + \frac{1}{1 + \beta} \frac{b_2}{1 + r_2} , \quad \text{and} \\ c_2^o &= \frac{\beta}{1 + \beta} w_1(1 - \tau_1)(1 + r_2) + \frac{\beta}{1 + \beta} b_2 . \end{aligned} \tag{12}$$

Note that the impact of immigration on capital accumulation, determined by  $\tilde{k}_2 = s_1(1 + \gamma_1)N_1/N_2$ , is ambiguous. Although the ratio of workers to next period's native workers  $(1 + \gamma_1)N_1/N_2$  declines with immigration, the net wage may not. Furthermore, per capita savings increase with a declining discounted value of future pension benefits.

Equilibrium immigration policy with PAYG pensions is analyzed in two different settings. In the first setting, pensioners receive a flat benefit  $b_t = b$ , whereas in the second setting, the government can freely set the social security contribution rate  $\tau_t$  in each period.<sup>5</sup> Even though the government cannot freely set pension contributions in the first setting, these are endogenously determined by its choice of the immigration rate.

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<sup>5</sup>The same results would hold if the government was assumed to set  $b_t$  instead of  $\tau_t$ .

## Flat Benefit

In the case of a flat benefit, the government sets immigration policy  $\gamma_t$  to maximize (3), taking into account that individuals allocate consumption according to (12). Individuals' marginal utility in the second period is not the same as in a model without a social security system, see (5). Instead, it is given by

$$\frac{dV_2^o}{d\gamma_2} = \frac{1-\alpha}{1+\gamma_2} \cdot \frac{s_1(1+r_2)}{c_2^o} - d \quad \text{and} \quad \frac{dV_2^y}{d\gamma_2} = -\frac{1}{1+\gamma_2} \cdot \frac{w_2(\alpha-\tau_2)}{c_2^y} - d, \quad (13)$$

for the old and young generation respectively, where

$$c_2^o = s_1(1+r_2) + b \quad \text{and} \quad c_2^y = w_2(1-\tau_2).$$

In this setting, immigration has no effect on the old generation's social security benefits. The old's utility gain due to increasing capital returns is smaller the smaller the share of private savings in the old's total consumption – the larger social security benefits. Although the young experience a utility loss due to declining wages, they benefit from a declining social security contribution rate. For  $\tau_2 > \alpha$ , the young's marginal economic utility from raising immigration is actually positive. Even if  $\tau_2 \leq \alpha$ , the old's and young's preferences in the presence of PAYG pensions are closer together than in the benchmark model.

From the first-order condition

$$\omega_2^o \frac{1-\alpha}{1+\gamma_2} \frac{s_1(1+r_2)}{c_2^o} - \omega_2^y \frac{1}{1+\gamma_2} \frac{w_2(\alpha-\tau_2)}{c_2^y} - d = 0,$$

the government's preferred immigration rate can be computed numerically. Again, population aging increases the share of individuals who clearly favor immigration. Additionally, aging now boosts the positive effect of immigration on the young's utility because a lower native population growth rate implies higher pension contributions. Note that the equilibrium immigration rate is now contingent on the old's and young's consumptions levels, and therefore on the state variable  $\tilde{k}_2$ . The results for the second period are not discussed separately, but the first-order condition of the second-period government is used for the simulations of the full model with social security.

In the first period, immigration affects the old in the same way as in the second period:  $dV_1^o/d\gamma_1 = (1-\alpha)/(1+\gamma_1) \cdot s_0(1+r_1)/c_1^o - d$ . The old's benefit from increasing capital returns is smaller the smaller the share of private savings in their consumption. Meanwhile the young's welfare is also

affected by the impact of first-period on second-period immigration and by the change in future capital returns:

$$\begin{aligned} \frac{dV_1^y}{d\gamma_1} &= \frac{1}{c_1^y} \frac{1}{1+\beta} \left[ \frac{dw_1(1-\tau_1)}{d\gamma_1} - \frac{b}{(1+r_2)^2} \frac{dr_2}{d\gamma_1} \right] \\ &+ \frac{\beta}{c_2^o} \frac{\beta}{1+\beta} \left[ \frac{dw_1(1-\tau_1)}{d\gamma_1} (1+r_2) + w_1(1-\tau_1) \frac{dr_2}{d\gamma_1} \right] \\ &- d - \beta d \frac{d\gamma_2}{d\gamma_1}, \end{aligned} \quad (14)$$

where  $c_1^y$  and  $c_2^o$  are given by (12).

The impact of immigration on the young's net wage,

$$\frac{dw_1(1-\tau_1)}{d\gamma_1} = -\frac{w_1(\alpha-\tau_1)}{1+\gamma_1},$$

may be positive or negative, as in the second period. Furthermore, immigration in the first period affects second-period capital returns via capital accumulation and via the second-period immigration rate, as in (10).

Raising immigration raises the future share of young voters, which suggests a negative derivative  $d\gamma_2/d\gamma_1$ , confirmed by the simulations. The impact of immigration on capital accumulation is contingent on  $r_2$  and therefore also on the derivative  $d\gamma_2/d\gamma_1$ :

$$\frac{d\tilde{k}_2}{d\gamma_1} = \frac{-\frac{\delta}{(1+\gamma_1)^2} \tilde{k}_2 - \frac{\beta}{1+\beta} \frac{w_1(\alpha-\tau_1)}{1+\gamma_1} + \frac{1}{1+\beta} \frac{1-\alpha}{1+\gamma_2} \frac{b}{1+r_2} \frac{d\gamma_2}{d\gamma_1}}{\frac{\omega_2^y}{\omega_2^o} + \frac{1}{1+\beta} \frac{1-\alpha}{\tilde{k}_2} \frac{b}{1+r_2}}. \quad (15)$$

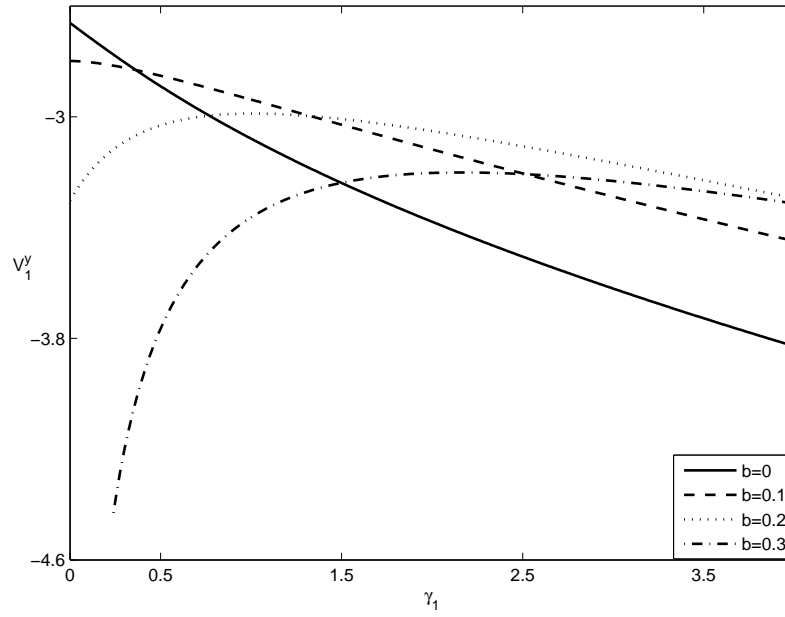
Although the net wage may increase with immigration, the decreasing ratio of savers to second-period natives and the increasing value of discounted second-period benefits cause a dampening effect of  $\gamma_1$  on  $\tilde{k}_2$ , also confirmed by the simulations.

Figure 2 illustrates that, in the first period as well, both generations' conflict of interest concerning immigration is less pronounced than in the absence of a pension system. Given a native population growth rate of  $n = -0.2$  and a difference between the immigrant and the native population growth rate of  $\delta = 0.5$ , figures 2(a) and 2(b) show both generations' utility levels as functions of first-period immigration, for different degrees of generosity of the pension system.<sup>6</sup> One can see from the figures that the old's utility gain

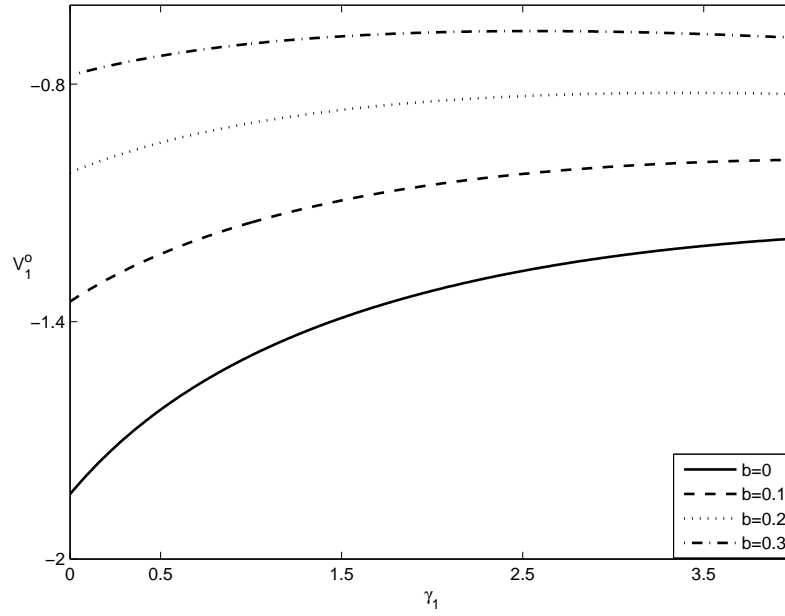
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<sup>6</sup>Only benefit levels below the level of the wage income (in the absence of immigration),  $w_1|_{\gamma_1=0} = 0.37$  are considered. The capital stock per native worker and immigration in the second period are computed endogenously.





(a) Impact of  $\gamma_1$  on  $V_1^y$



(b) Impact of  $\gamma_1$  on  $V_1^o$

Figure 2: Impact of Immigration on Welfare

from increasing capital returns is smaller the larger pension benefits, while the young's utility loss from a decreasing gross wage is mitigated or even reversed by decreasing pension contributions. For sizable levels of social security benefits, the young thus also prefer positive levels of immigration over no immigration.

To derive the level of immigration in the first period, the following Lagrangian is set up:

$$\mathcal{L} = \omega_1^o V_1^o + \omega_1^y V_1^y + \lambda \frac{dW_2}{d\gamma_2} + \mu \left( \tilde{k}_2 - \frac{\omega_2^o}{\omega_2^y} s_1 \right) .$$

The government in the first period thus maximizes aggregate welfare in the first period subject to the first-order condition in the second period and subject to the capital accumulation condition. To find the equilibrium of the 2-period model, one has to solve the system

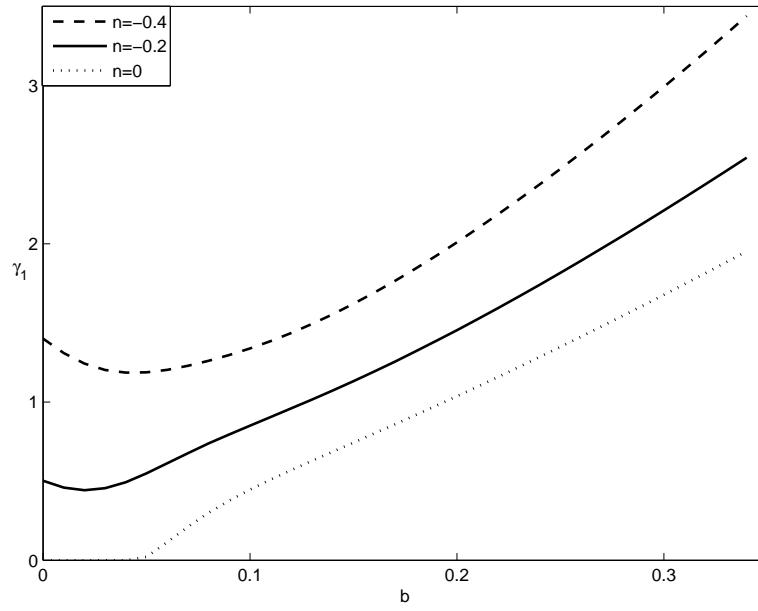
$$\frac{d\mathcal{L}}{d\gamma_1} = 0, \quad \frac{d\mathcal{L}}{d\tilde{k}_2} = 0, \quad \frac{d\mathcal{L}}{d\gamma_2} = 0, \quad \tilde{k}_2 - \frac{\omega_2^o}{\omega_2^y} s_1 = 0 \quad \text{and} \quad \frac{dW_2}{d\gamma_2} = 0 .$$

It is relatively straightforward to compute these derivatives numerically.

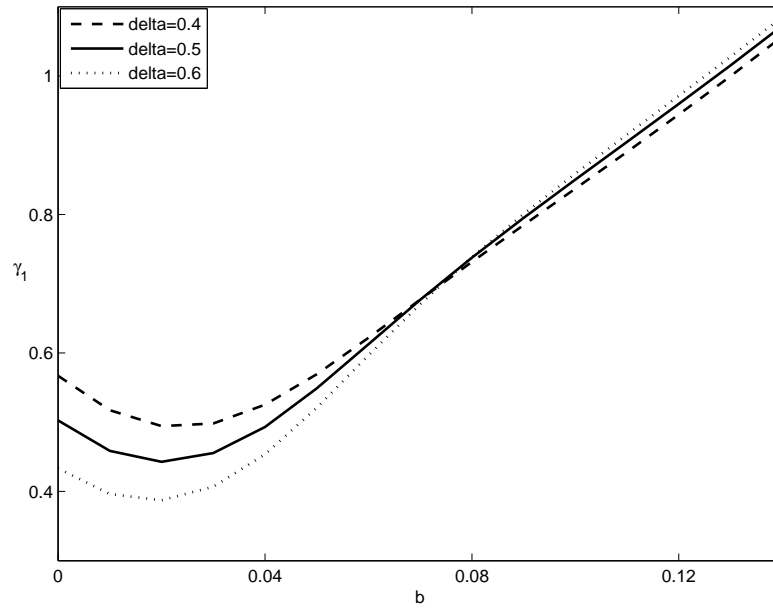
Figure 3 shows the simulated equilibrium values for first-period immigration  $\gamma_1$  as a function of the level of individual pension benefits  $b$ . The solid line in figures 3(a) and 3(b) is based on the benchmark parameter values  $n = -0.2$  and  $\delta = 0.5$ . The figures illustrate that an initially positive preferred immigration rate is reduced by the introduction of pensions. This is due to the old generation's decreased utility gain, as private savings account for a smaller share of their income. While immigration still entails a non-income disutility, its effectivity as a device for income redistribution is reduced. However, the government's preferred immigration rate increases as pensions increase further, because the young generation benefits from sharing the burden of pension contributions with the immigrants. While figure 3(a) shows the relationship between  $b$  and  $\gamma_1$  for various levels of the native population growth rate, figure 3(b) shows a smaller detail of this relationship for various levels of the difference in population growth rates. As in the case without a social security system, population aging clearly enhances immigration, while the impact of differences in the number of children is ambiguous.

The conclusion is:

**Proposition 2** *Given a PAYG pension system with exogenous benefits  $b$*   
*(i) the level of pension benefits has a non-monotonic effect on equilibrium immigration. The government's preferred immigration rate decreases for small*



(a) Different levels of  $n$



(b) Different levels of  $\delta$

Figure 3: Impact of Social Security on First-Period Immigration

levels of  $b$ , but increases above the immigration rate in the absence of PAYG pensions for high levels of  $b$ .

(ii) a lower native population growth rate has a positive effect on the equilibrium immigration rate.

(iii) the difference between the native and the immigrant population growth rate has an ambiguous effect on the immigration rate.

Notice that in this setting the old's pension benefits are not contingent on the level of the young's wages. This is different if the government can freely set both the current immigration rate  $\gamma_t$  and the current social security contribution rate  $\tau_t$ . That setting is discussed next.

## Fully Flexible Contributions and Benefits

The government now maximizes its objective function (3) with respect to  $\gamma_t$  and to  $\tau_t$ . Even though substantial pension reforms in the last decade have met with a lot of opposition, it seems plausible to assume that industrialized countries' governments are able to change the parameters of the social security system over time. In many industrialized countries, the level of pension benefits is at least partly tied to wages. Actual PAYG pension systems should therefore be located between the two extreme settings discussed here.

Second period consumption levels are  $c_2^o = s_1(1+r_2)+b_2$  and  $c_2^y = w_2(1-\tau_2)$ , where  $b_2 = \tau_2 w_2(1+l_2)$  and  $\tau_2$  is set by the government. Immigration negatively affects the young generation since the gross wage declines. It has several effects on the old generation's welfare: on the one hand immigration raises the capital return and also the number of contributors to social security. On the other hand, the declining gross wage reduces social security benefits, ceteris paribus. The net effect of higher immigration on the old generation's welfare is positive. Marginal utilities reduce to (5):

$$\frac{dV_2^o}{d\gamma_2} = \frac{1-\alpha}{1+\gamma_2} - d \quad \text{and} \quad \frac{dV_2^y}{d\gamma_2} = -\frac{\alpha}{1+\gamma_2} - d ,$$

just as in the case without social security. Although the income change from immigration is proportional to consumption and thus higher for the old and lower for the young with a social security system in place, the marginal utility of income is accordingly lower for the old and higher for the young. The additional effects of immigration induced by the existence of a social security system exactly cancel out and consequently, the chosen level of immigration in the second period is given by (6).

Regarding social security contributions, the old and young generations' preferences are unambiguous. While the old favor high benefits, the young

would prefer not to pay any social security contributions. From the government's first-order condition follows the equilibrium social security contribution rate<sup>7</sup>

$$\tau_2 = \frac{\omega_2^o - \alpha}{1 - \alpha} . \quad (16)$$

Equilibrium social security contributions increase in the population share of the old generation. Although the social security contribution rate in the second period is independent from second-period immigration, it is contingent on first-period immigration since first-period immigration reduces the share of old voters in the second period.

In the first period, the old generation's marginal utility corresponds to the one in the second period and thus does not differ from the case without a pension system. However, the young generation's marginal utility does not reduce to equation (8). Instead, it is given by

$$\begin{aligned} \frac{dV_1^y}{d\gamma_1} &= \frac{1}{c_1^y} \frac{1}{1 + \beta} \left[ \frac{dw_1}{d\gamma_1} (1 - \tau_1) + \frac{d(b_2/(1 + r_2))}{d\gamma_1} \right] \\ &+ \beta \frac{1}{c_2^o} \frac{\beta}{1 + \beta} \left[ \frac{dw_1}{d\gamma_1} (1 - \tau_1) (1 + r_2) + w_1 (1 - \tau_1) \frac{dr_2}{d\gamma_1} + \frac{db_2}{d\gamma_1} \right] \\ &- d - \beta d \frac{d\gamma_2}{d\gamma_1} . \end{aligned} \quad (17)$$

with  $dw_1/d\gamma_1$  and  $dr_2/d\gamma_1$  still given by equations (9) and (10), where  $d\gamma_2/d\gamma_1 < 0$ , still given by (7). The key difference is that immigration in the first period now has an impact on future social security policy, with

$$\frac{d\tau_2}{d\gamma_1} = - \frac{1}{1 - \alpha} \frac{\delta (\omega_2^o)^2}{(1 + \gamma_1)^2} < 0 .$$

Lower future pension contributions *ceteris paribus* imply lower benefits and a negative effect on the young generation's utility. This suggests that the government's chosen immigration rate will be lower than in the absence of a pension system. Furthermore, lower future benefits enhance capital accumulation since individuals have to provide for their old age consumption.

The impact of immigration on capital accumulation is now determined by

$$\begin{aligned} \frac{d\tilde{k}_2}{d\gamma_1} &= - \frac{\delta}{(1 + \gamma_1)^2} \frac{\omega_2^o}{\omega_2^y} \tilde{k}_2 \\ &- \frac{\omega_2^o}{\omega_2^y} \left[ \frac{\alpha}{1 + \gamma_1} \frac{\beta}{1 + \beta} w_1 (1 - \tau_1) + \frac{1}{1 + \beta} \frac{d(b_2/(1 + r_2))}{d\gamma_1} \right] . \end{aligned} \quad (18)$$

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<sup>7</sup>See Lorz (1999) and more recently Gonzales-Eiras and Niepelt (2007) who derive similar results in models without immigration.

Discounted future benefits  $b_2/(1+r_2)$  can be written in terms of  $\tau_2$  and  $w_1$ :

$$\frac{b_2}{1+r_2} = \frac{\frac{1-\alpha}{\alpha} \frac{\beta}{1+\beta} \tau_2}{1 + \frac{1-\alpha}{\alpha} \frac{1}{1+\beta} \tau_2} \cdot w_1 (1 - \tau_1) .$$

Since immigration reduces both  $w_1$  and  $\tau_2$  it has a negative impact on discounted future benefits:

$$\frac{d(b_2/(1+r_2))}{d\gamma_1} = -\frac{b_2}{1+r_2} \left[ \frac{\alpha}{1+\gamma_1} + \frac{\delta(\omega_2^o)^2}{(1+\gamma_1)^2} \cdot \frac{1}{(\omega_2^o - \alpha) \left(1 + \frac{\omega_2^o - \alpha}{\alpha} \frac{1}{1+\beta}\right)} \right] < 0 , \quad (19)$$

and therefore a positive (partial) effect on capital accumulation. The simulations show that the aggregate effect on capital accumulation is still negative.

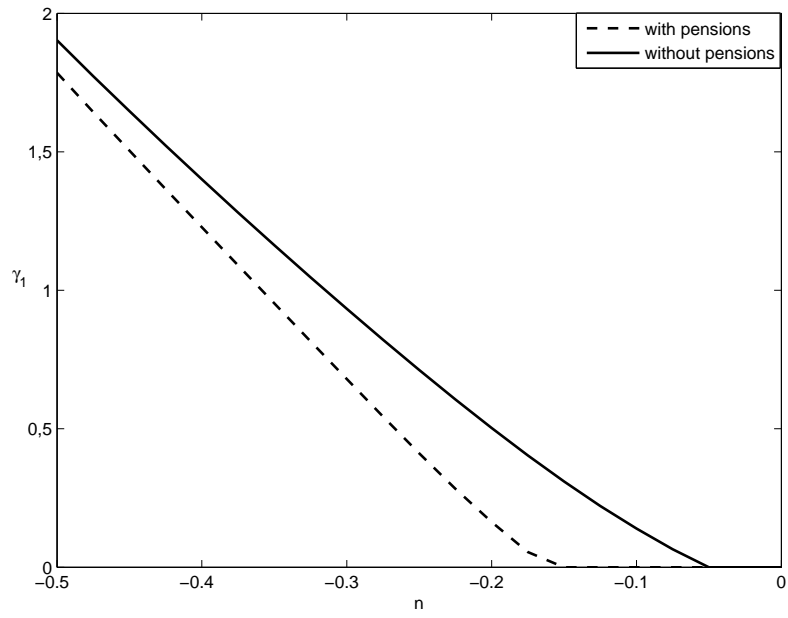
Meanwhile, the effect on undiscounted benefits is ambiguous: even though the contribution rate and the number of future immigrant contributors decline, the future ratio of native contributors to pension recipients increases. Furthermore, the impact of immigration on the future wage rate is ambiguous. The derivative can be written as

$$\frac{db_2}{d\gamma_1} = b_2 \frac{\omega_2^o}{\omega_2^y} \frac{\delta}{(1+\gamma_1)^2} + b_2 \left( \frac{\alpha}{\tilde{k}_2} \cdot \frac{d\tilde{k}_2}{d\gamma_1} - \frac{2-\alpha}{1+\gamma_2} \cdot \frac{1}{d} \frac{\delta(\omega_2^o)^2}{(1+\gamma_1)^2} \right) , \quad (20)$$

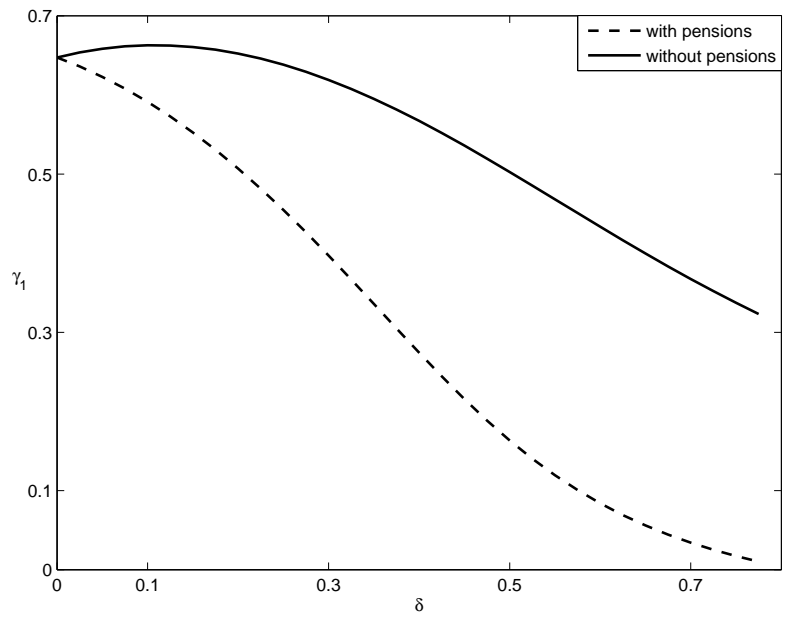
with  $d\tilde{k}_2/d\gamma_1$  defined by equations (18) and (19). The first term in (20) is the effect on the future ratio of native contributors to pension recipients, while the last term is the effect on the future share of old voters, which determines both  $\gamma_2$  and  $\tau_2$ .

The simulations of the model confirm that the equilibrium immigration rate in the presence of fully flexible pension contributions and benefits is lower than in the absence of a pension system, see figure 4. Figure 4(a) shows the relationship between the first-period immigration rate and the native population growth rate in the presence and in the absence of social security, given  $\delta = 0.5$ . Figure 4(b) shows the relationship between the first-period immigration rate and the difference in population growth rates given  $n = -0.2$ .

Since the old generation unambiguously benefits from immigration, population aging still boosts immigration, as figure 4(a) shows. The difference between the native and the immigrant population growth rate still has a non-monotonic effect, see figure 4(b). Note that if immigrants have the same number of children as natives ( $\delta = 0$ ), the existence of a PAYG pension system does not affect immigration. This result is due to the fact that first-



(a) Impact of  $n$



(b) Impact of  $\delta$

Figure 4: First-Period Immigration With and Without a Pension System

period immigration then does not have any impact on the second-period pension contribution rate  $\tau_2$ . The findings of the model with a pension system with fully flexible parameters are summarized in the following proposition.

**Proposition 3** *Given a PAYG pension system with fully flexible benefits and contributions*

- (i) the equilibrium immigration rate is lower than in the absence of a pension system.*
- (ii) a lower native population growth rate has a positive effect on the equilibrium immigration rate.*
- (iii) the difference between the native and the immigrant population growth rate has a non-monotonic effect on the equilibrium immigration rate.*

Recall that in the presence of exogenous old-age pensions financed by the young generation the equilibrium immigration rate may well be higher than in the absence of a pension system. However, the immigration rate is lower if the government can freely decide on both the volume of immigration and the generosity of the pension system. If the pension benefit is exogenous, young individuals benefit from sharing the burden of pension contributions with immigrants. This effect is absent when the burden of pension contributions is endogenous. However, then, immigration generates a negative externality for the young generation as long as immigrants have more children than natives: the larger future cohort of young individuals will induce lower pension contributions and *ceteris paribus* lower benefits.

## 5 Conclusion

This paper has analyzed the effects of population aging on immigration policy in a two-period economy with two overlapping generations. A representative democracy was modeled by assuming that in each period the respective government limits immigration to the level that maximizes aggregate welfare of its voters. Immigration preferences are driven by economic as well as non-economic motives: immigration alters factor prices and additionally causes a disutility not related to individual incomes. Population aging implies that the old generation receives a higher political weight in the government's objective function. Aging has an expansionary effect on the chosen immigration level, due to the fact that immigration increases the return on the old generation's savings. However, since immigrants have more children than natives, a high immigration rate in the first period is tantamount to a large share of young voters, and therefore low immigration, in the second period.



In the presence of a PAYG pension system, immigration additionally affects the level of pension contributions and/or benefits. Population aging still unambiguously enhances immigration but the predictions concerning the effect of pensions on immigration policy are contingent on how the pension system is modeled. The paper contrasts a system with fixed benefits to one with fully flexible contributions and benefits. With exogenous pension benefits, the young and old generations' preferences are closer together than in the absence of a pension system: whereas the old's utility gain from immigration decreases with a decreasing share of private savings in their consumption, the young's net wage may even increase with immigration since individual pension contributions decline. For high benefit levels, equilibrium immigration is higher than in the absence of a pension system, while the reverse is true for low benefit levels. Contrary to this, the chosen immigration rate is lower than in the absence of pensions when the government can freely set contributions: the government anticipates that immigration will reduce its young voters' future pensions benefits. As immigrants have more children than natives, the future old's population share declines with immigration.

In the benchmark model presented in this paper, positive levels of immigration are driven solely by old individuals' preferences for high capital returns. If pension benefits are fixed, native young workers also benefit from sharing the burden of pension contributions with immigrant workers. Further insights can be expected from introducing different skill levels into the model. Skilled native workers may support the immigration of low skilled workers and vice versa. Furthermore, as the The World Bank (2009) outlines, the agglomeration of skilled labor may entail benefits because of increasing returns to scale and external effects such as welfare spillovers as in Facchini and Mayda (2008).

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