THE INTERPLAY BETWEEN TRADE UNIONS AND THE SOCIAL SECURITY SYSTEM IN AN AGING ECONOMY

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Abstract

The paper investigates the impacts of demographic change on the financial sustainability of a pay-as-you-go social security system in an economy with unemployment caused by trade unions. Using a simple two-period overlapping generations approach, it can be shown that the trade union behavior with respect to wage setting may have favorable effects on per capita contributions, if labor demand is sufficiently inelastic with respect to the wage rate. In contrast, if firm's labor demand reacts more sensitive to changes in the wage rate, the behavior of the trade union may amplify the imposed burden of demographic change on the social security system.

JEL-Codes: E24, H55, J11, J51

Keywords: demographic change, PAYG public pensions, trade unions, unemployment, tax burden, output elasticity of capital, wage elasticity of labor demand

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1 Introduction

Demographic change, defined as increasing longevity and low fertility, is a phenomenon which is highly relevant for industialized countries as well as for transition countries. While the replacement fertility rate of 2.1 is nowadays again reached by some countries like France, the United Kingdom or Ireland, other countries like Germany or Italy still expect a shrinking working age population in the future. In contrast, longevity steadily increases worldwide, although in different paces. A major concern with respect to these developments is about the effect of demographic change on the fincancial stability of pension systems and the effects on economic key indicators such as economic growth, productivity and savings.

If demographic change goes hand in hand with an increased amount of savings per capita, and therefore higher capital supply, it may cushion its own adverse impacts on the sustainability of defined benefits pension systems. On one side this may work via an increased wage level, if benefits grow less strong than wages. On the other side, according to Schmähl (1990), the close interdependencies between the labor market and the social security system may have favorable effects on the financing burden. As already suggested by de la Croix et al. (2013), labor market imperfections matter when eveluating pension systems and reforms under demographic pressure. If demographic changes causes an expansion of capital supply, it may induce labor demand such that realatively more contributors to the social security system will be available and the rise in the per capita financing burden may be lowered.

The savings rate, expressed as percentage share of gross savings on the gross domestic product, were empirically found to be positive affected by increased longevity. Kinugasa and Mason (2007) find that the increased duration of life could lead to higher saving rates, but will not lead to a decline. Cavallo et al. (2016) conclude from their empirical study that demographic factors had a significant positive impact on saving rates only in Asia, but no effect in other regions. Bloom et al. (2003) find empirical support for a positive effect of longevity on national savings rates. Bloom et al. (2007) confirm these results for economies with defined contributions pension schemes. For pension systems with defined benefits, as e.g. PAYGO, and high replacement rates the effect appears to be much smaller. Though a positive effect of demographic factors on savings can be identified, descriptive statistics show that the savings rate itself rather stayed constant or declined during the last 30 years (figure 1 shows the savings rates for some European contries). In contrast, gross savings as well as savings per capita steadily increased as shown in figure 2.

Similiar to Dedry et al. (2016), this paper links the effects of demographic change with a social security system in a two-period OLG model. Furthermore, as e.g. in Corneo, Marquardt, et al. (2000), Ono (2007) or Wang (2016), a link between the social security system and the wage setting of monopoly trade union is implemented. These three elements allow for the analysis of the direct and indirect effects of demographic change on employment,

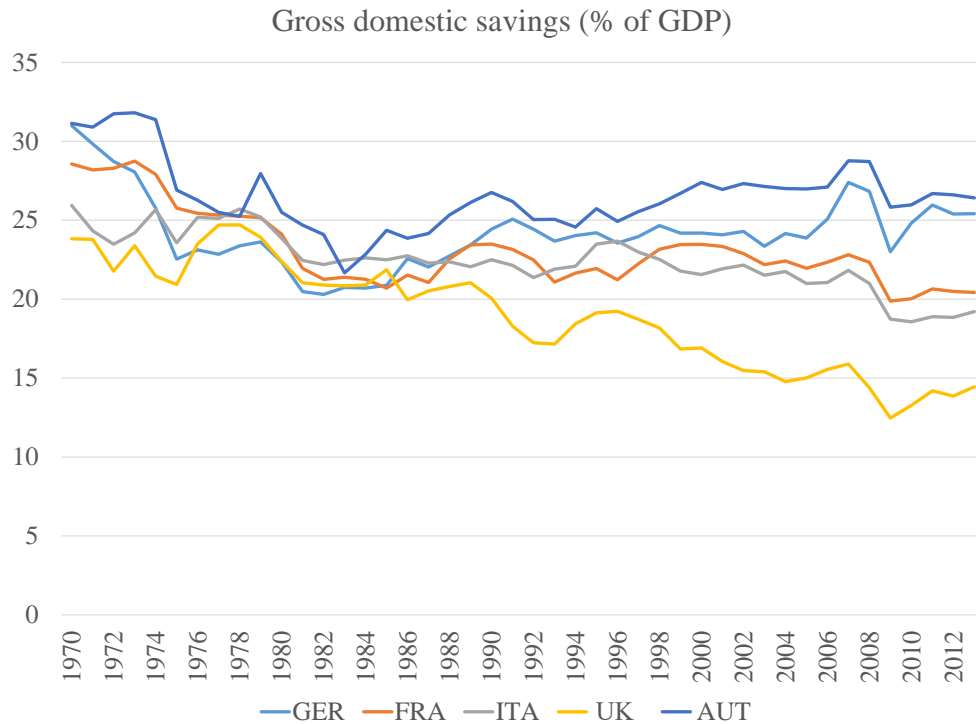Gross domestic savings (% of GDP)

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Figure 1: Savings rate. Sources: World Bank (2017), OECD (2017).

savings and the per capita burden of the social security system. To focus on the role of the trade union in this setting, a single closed economy is considered. It will be shown that the wage setting behavior of the trade union strongly matters for the sustainability of the social security system and per capita financing burden. It may have favorable effects on the social security system if the labor demand is inelastic and adverse effects if it is rather elastic.

An aspect that cannot be captured in closed economy models is that of international capital movements. Börsch-Supan et al. (2006) stress especially this point and argue that the crucial distinction between open and closed economies in the context of population aging is the different development of the economies' interest rates. The results derived in the paper in hand will also hold true for for a big open economy, but not for small ones where relative prices cannot adjust and induce labor demand. Nevertheless the same effects may occur by capital inflow from other countries as demographic change is a worldwide phenomenon, although highly differentiated between countries.

The paper is organized as follows. Chapter 2 develops the model. Chapters 3 and 4 presents the calibration and the simulation results. Conclusions are drawn in chapter 5.
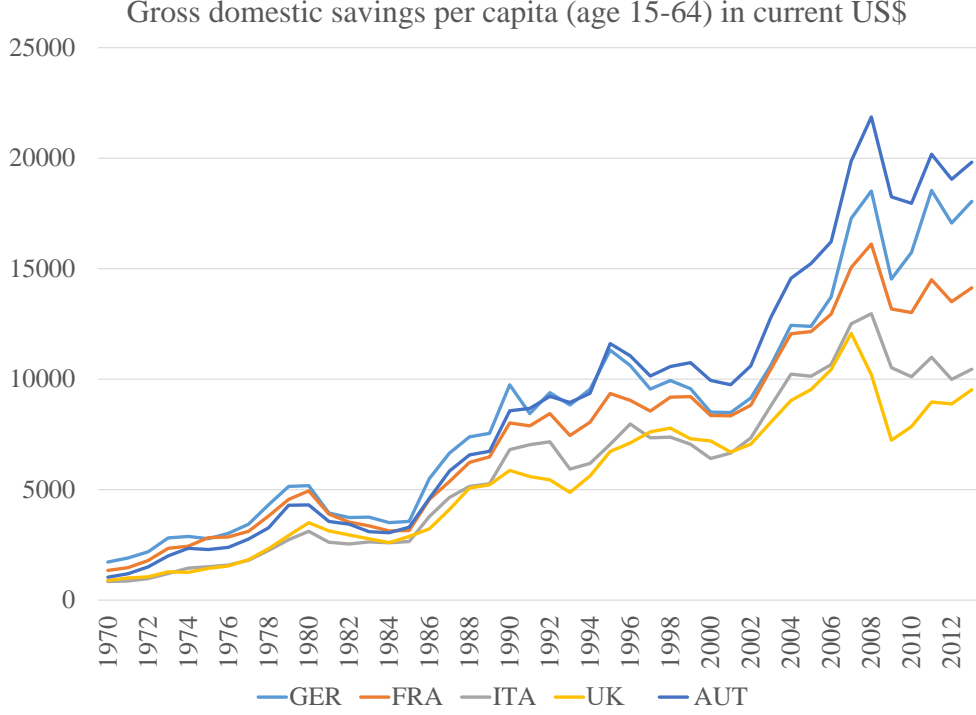
Figure 2: Gross domestic savings. Sources: World Bank (2017), OECD (2017) (gross domestic savings), OECD (2017) (working age population), own caluclations (gross domestic savings per capita).

2 The model

The basic structure of the model refers to the standard OLG framework developed by Samuelson (1958) and Diamond (1965). It is extended by an imperfect labor market, represented by a monopoly trade union. Time is discrete and the economy is closed. A representative household exists for each living generation as well as a representative firm for the companies. Households have perfect foresight, do not leave bequests and supply labor inelastically. Life-time uncertainty is offset by a perfect insurance market. The social security system is characterized by a unitary social benefit which is financed by the employed and transferred to the unemployed and the retirees.

2.1 Demographics

The population of the economy consists of two generations: the young and the old. All individuals survive the first period, but only a fraction of the second period. The mass of young individuals in the population is denoted by $Z_{y,t}$ and the mass of old individuals by $Z_{o,t}$. Total population Z_t is then equal to

$$Z_t = Z_{y,t} + Z_{o,t} \tag{1}$$

$$= Z_{y,t-1}(1+x_t) + Z_{y,t-1}\pi_t \tag{2}$$

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with $x_t \geq -1$ reflecting the young population's growth rate from period $t-1$ to period t. Aging is implemented by introducing uncertainty about the length of life time via a deterministic survival probability $0 \leq \pi_t \leq 1$.

The young individuals can be further distinguished by their labor market status. The group of the young therefore divides into the employed N_t and the unemployed U_t

$$Z_{y,t} = N_t + U_t \tag{3}$$

$$= (n_t + u_t)Z_{y,t} \tag{4}$$

with n_t as employment rate and u_t as unemployment rate.

2.2   Representative household

All young individuals in the economy belong to a representative household. Each young individual inelastically supplies one unit of labor. If employed, individuals earn the gross wage w_t the share τ_t of which is taxed away. If unemployed, individuals receive a social benefit b_t. The disposable income is used to finance consumption $c_{y,t}$ and to build up savings s_t. If individuals reach the retirement age, they stop working and use their savings s_t and the social benefit b_t to finance consumption $c_{o,t+1}$ in the second period of their life-time. For simplicity social benefits are assumed to be the same for the unemployed and the retirees. The flow budget constraints of the both periods are then given by

$$c_{y,t} + s_t = w_t(1 - \tau_t)n_t + b_t u_t \tag{5}$$

$$c_{o,t+1} = \frac{1 + r_{t+1}}{\pi_{t+1}} s_t + b_{t+1} \tag{6}$$

Following Diamond (1965), $1 + r_{t+1}$ describes the return on income invested in firms' securities, with r_{t+1} representing the rental rate per unit of capital. It is assumed that firms offer only simple loans with a maturity of one period after issuing.

Life-time uncertainty is offset by insurance companies which offer securities promising fixed payments in the retirement period. Following the interpretation of the survival probability π_t as reflecting the average individual length of the second life-time period, the payments could be visualized as annuities that are paid at regular fractions of the respective time period. For the formal implementation of such an insurance it is assumed that the insurance companies are risk neutral and operate on competitive private annuity markets (Yakita, 2001, see also; Cipriani, 2014). The yield of the security then amounts to $\frac{1+r_{t+1}}{\pi_{t+1}}$.

The representative household optimizes life-time utility over both periods by choosing the optimal level of consumption when being young, $c_{y,t}$ and when being old, $c_{o,t+1}$. The time preference is implicitly captured by the longevity paramter π_{t+1}. Assuming that utility, $U(\cdot)$ is additive, separable and logarithmic, the representative household of generation t

maximizes the per young capita objective function

$$u_{y,t}(c_{y,t}, c_{o,t+1}) = \ln(c_{y,t}) + \pi_{t+1} \ln(c_{o,t+1}) \tag{7}$$

with respect to the inter-temporal budget constraint

$$c_{y,t} + c_{o,t+1} \frac{\pi_{t+1}}{1 + r_{t+1}} = w_t(1 - \tau_t)n_t + (1 - n_t)b_t + b_{t+1} \frac{\pi_{t+1}}{1 + r_{t+1}} \tag{8}$$

Optimizing lifetime utility by the standard Lagrange method results in the Euler equation

$$\frac{c_{o,t+1}}{c_{y,t}} = 1 + r_{t+1} \tag{9}$$

Optimal savings s_t in period t then result to be

$$s_t = \frac{\pi_{t+1}}{1 + \pi_{t+1}} \left[w_t(1 - \tau_t)n_t + (1 - n_t)b_t - \frac{b_{t+1}}{1 + r_{t+1}} \right] \tag{10}$$

and are obtained by combining equation (9) and the flow budget constraints.

2.3 Social security system

All expenditures for social security are financed via a pay-as-you-go system, implying intergenerational transfers. The respectively young generation finances the benefits $b_t = w_t^m$, with w_t as gross wage rate and $0 < m < 1$ as proportionality parameter. The social security system's budget balances via the income tax rate τ_t such that

$$\tau_t w_t N_t = b_t(U_t + Z_{o,t}) \tag{11}$$

$$\tau_t = \frac{1}{n_t w_t^{1-m}} \left(\frac{\pi_t}{1 + x_t} + (1 - n_t) \right) \tag{12}$$

Equation (12) implies the following relationships. First, an increase in the employment rate ceteris paribus lowers the required tax rate to balance the budget. The same holds true for the wage rate. Second, a demographic shock, expressed by higher longevity and lower fertility, increases the pressure on the tax rate, ceteris paribus. The model aims at investigating the behavior of the tax rate when all variables may change mutually at the same time due to a demographic shock. Therefore, the social security system is completely endogenous with respect to the social benefit and the tax rate.

2.4 Representative firm

The firms in the economy use a Cobb-Douglas technology for production with the two input factors capital, K_t and labor, N_t. All workers are equally efficient and do not differ in their

productivity. In per young capita variables, the production function can be written as

$$f(k_t, n_t) = Ak_t^{\alpha} n_t^{1-\alpha} \tag{13}$$

with $A > 0$ denoting the total-factor-productivity and $0 \leq \alpha \leq 1$ denoting the elasticity of output with respect to capital. The firms issue securities to obtain the required capital for production. For one unit of capital investment, firms pay an interest of r_t. Capital depreciates at the rate δ. The marginal cost for one worker amounts to w_t.

To maximize profits in period t, the representative firm decides about the optimal amount of capital k_t and the optimal number of workers n_t for a given wage rate. The firm's per young capita objective function is

$$x_t^F = f(k_t, n_t) - (r_t + \delta)k_t - w_t n_t \tag{14}$$

Following standard Lagrange optimization, the first order conditions with respect to k_t and n_t are

$$f_{k_t} = r_t + \delta \tag{15}$$

$$fn_t = w_t \tag{16}$$

where f_{k_t} and f_{n_t} are respectively the marginal product of capital and labor. Labor demand then is given by

$$n_t = \left(\frac{A(1-\alpha)}{w_t} \right)^{\frac{1}{\alpha}} k_t \tag{17}$$

2.5   Trade union

Equilibrium unemployment is introduced by a simple monopoly trade union (see e.g. Oswald (1982) or Booth (1995)). It is assumed that old individuals are excluded from membership such that only the young individuals are represented in the unons objective function. Furthermore, the union takes the unemployment benefit as given. Maximizing the expected utility of the young individuals over the wage rate defines the optimization program of the union as follows

$$\max_{w_t} V = n_t(w_t) \ln(w_t(1-\tau)) + (1 - n_t(w_t)) \ln(b_t) \tag{18}$$

As the union is aware of the firm's optimal labor demand, the resulting wage rate will be

$$w_t = \frac{b_t}{1 - \tau} e^{\alpha} \tag{19}$$

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2.6 Capital market equilibrium

An equilibrium on the capital market requires that the supply of capital coincides with the demand for capital. Thus, the capital market equilibrium balances

$$s_t Z_{y,t} = K_{t+1} \tag{20}$$

$$s_t = \frac{K_{t+1}}{Z_{y,t+1}}(1+x_{t+1}) \tag{21}$$

$$\frac{s_t}{(1+x_{t+1})} = k_{t+1} \tag{22}$$

with k_{t+1} describing the capital used by the firm in period $t+1$ from savings s_t in period t.

3 Calibration

The simulation aims at obtaining a general impression of the working of the model and its endogenous reactions to an exogenous shock in demographic variables. Two cases are considered: (i) high utilization of capital and (ii) high utilization of labor in the production process. Households are assumed to have perfect foresight.

The output elasticity of capital takes a value of $\alpha = 1/2$ in case (i) and $2/3$ in case (ii). Capital depreciates completely after one period such that $\delta = 1$. Total factor productivity is fixed at $A = 21$, ensuring that ceteris paribus the endogeneous employment rate takes values $0 < n < 1$ in both cases. The social benefit proportionality parameter takes an arbitrary value of $m = 0.7$, which corresponds to an inital replacement rate about 35%.

Demographic variables are at values of $\pi = 0.3$ and $x = -0.3$ before the demographic shock hits the economy. This implies the unrealistic assumption that total population does not change over time, but gets ever older. Demographic change then is represented by a once and for all shock in period $t = 0$, which pushes the demographic variables to the values $\pi_{t=0} = 0.35$ and $x_{t=0} = -0.35$.

4 Simulation results

The model economy is in a steady state prior to the demographic shock, which occurs in period $t = 0$. In period $t = 9$ the economy accomplishes its adjustment reaction. Tables (1) and (2) summarize the transition path for some endogenous variables. Figures (3) and (4) display the adjustment of the employment rate graphically for the both different cases of a high and a low output elasticity of capital.

For case (i) as well as for case (ii), the new steady state is characterized by higher per capita financing burden of social security, increased savings per young capita, higher wages and lower rental rates for capital. The gross savings rate (savings + depreciated capital as

percentage share of GDP) increased only slightly, which seems to be in line with empirical evidence. But, most importantly, both cases differ with respect to the labor market conditions. Case (i) is characterized by a higher employment rate and case (ii) by a lower employment rate compared to the initial steady state.

In period $t = 0$ a peak in employment and a sharp increase in capital intensity and wages can be observed. This coincidence is not by chance and can be explained by the mechanisms working on the imperfect labor market.

Table 1: Simulation results for $\alpha = 1/2$

Period	n	τ	s	k	z	w	r
-3	0.73	0.36	2.69	3.84	0.19	24.01	3.59
-2	0.73	0.36	2.69	3.84	0.19	24.01	3.59
-1	0.73	0.36	2.96	3.84	0.19	24.01	3.59
0	0.77	0.38	3.14	4.56	0.20	25.52	3.32
1	0.76	0.38	3.20	4.83	0.20	26.46	3.17
2	0.76	0.39	3.23	4.93	0.20	26.80	3.11
3	0.76	0.39	3.24	4.97	0.20	26.92	3.09
4	0.75	0.39	3.24	4.98	0.20	26.97	3.09
5	0.75	0.39	3.24	4.98	0.20	26.98	3.09
6	0.75	0.39	3.24	4.98	0.20	26.99	3.09
7	0.75	0.39	3.24	4.99	0.20	26.99	3.09
8	0.75	0.39	3.24	4.99	0.20	26.99	3.08

Table 2: Simulation results for $\alpha = 2/3$

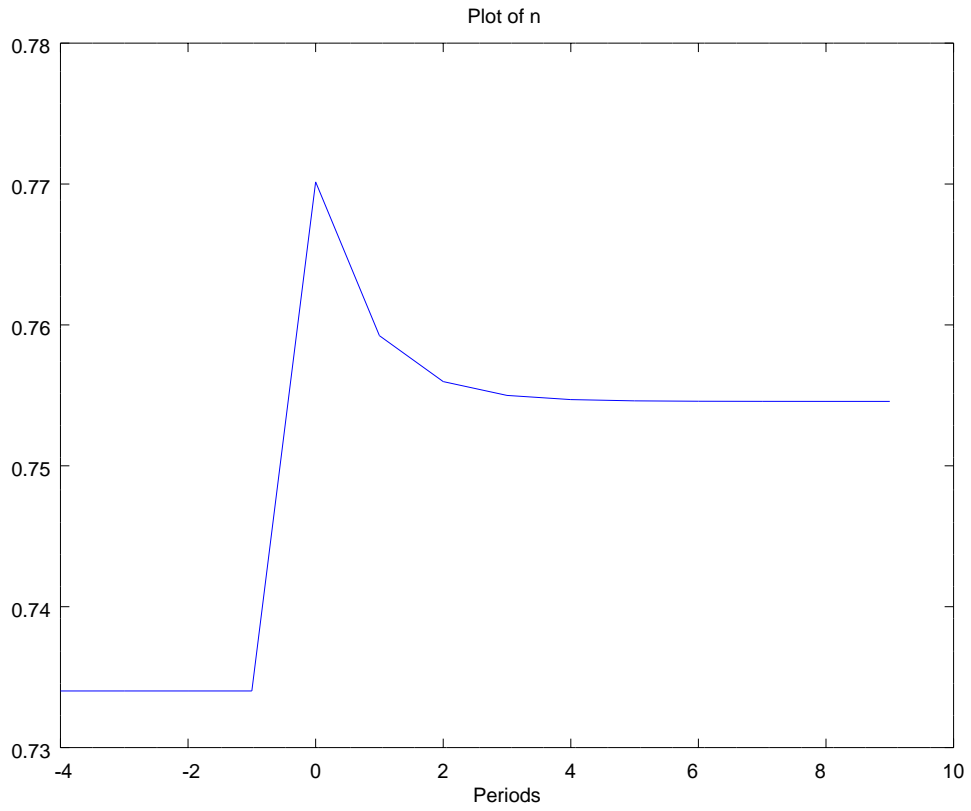| Period	n	τ	s	k	z	w	r
-3	0.91	0.22	3.44	4.91	0.14	21.47	6.99
-2	0.91	0.22	3.44	4.91	0.14	21.47	6.99
-1	0.91	0.22	3.83	4.91	0.15	21.47	6.99
0	0.94	0.25	4.16	5.89	0.15	23.83	6.59
1	0.90	0.27	4.32	6.40	0.15	25.84	6.29
2	0.89	0.27	4.40	6.65	0.15	26.82	6.15
3	0.88	0.28	4.44	6.77	0.16	27.28	6.09
4	0.88	0.28	4.45	6.83	0.16	27.50	6.06
5	0.88	0.28	4.46	6.85	0.16	27.61	6.05
6	0.87	0.28	4.47	6.87	0.16	27.65	6.04
7	0.87	0.28	4.47	6.87	0.16	27.68	6.04
8	0.87	0.28	4.47	6.87	0.16	27.69	6.04

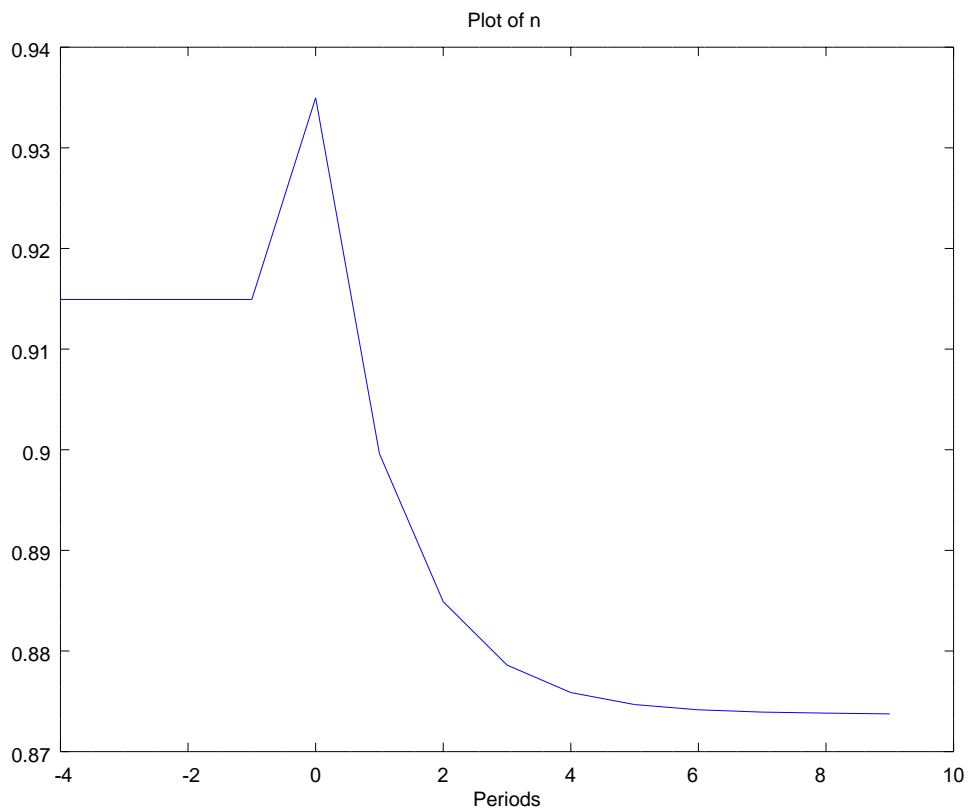Figure 3: Reaction of employment rate for $\alpha = \frac{1}{2}$.

Figure 4: Reaction of employment rate for $\alpha = \frac{2}{3}$.

Due to perfect foresight, households increase savings in period $t = -1$ such that capital supply increases in period $t = 0$. Higher capital supply shifts the labor demand curve of the firm outwards, while the demographic change leads to an increase of the tax rate for given employment and wages. Thus the firm has two incentives to increase employment: achieve a new optimal labor-capital ratio and alleviate the rise in wage rates which occured due to the direct effect of demographic change on the tax rate.

In case (i) as well as in case (ii), period $t = 0$ is characterized by an employment rate that lies above the initial steady state value. As also the total wage bill increases, housheolds have an incentive to further increase savings. This savings effect induces new labor demand in period $t = 1$ as the marginal product of labor again increases for every level of employment. It is important to note that there is no continued change in the values of the demographic variables. The tax rate may therefore only adjust, if either wages or employment take new values. In this situation it is favorable for the firm to demand less labor and accept higher wages at the same time, although the labor demand curve shifted to the right. This reaction enables the firm to employ an optimal capital-labor ratio, which could not be reached, if employment would be expanded.

Analytically, this can be seen by combining equations (12), (17) and (19). These equations have to be fulfilled simultaneously in equilibrium and implicitly determine the employment rate. Rewriting the three equations yields

$$\left(\frac{k_t}{n_t}\right)^\alpha A(1-\alpha) = \left(e^\alpha + \frac{1-n_t}{n_t} + \frac{\pi}{n_t(1+x_t)}\right)^{\frac{1}{1-m}} \tag{23}$$

where on the left hand side is written the marginal product of labor and on the right hand side the equilibrium wage rate in dependence of the employment rate. As the firm has a right to manage, it chooses a level of employment which balances both sides of the equation. While an increase in capital k_t shifts the marginal product of labor curve, an adjustment in n_t represents a movement on the curve. In period $t = 0$, additionally to an increase in k_t, the value of the term $\frac{\pi}{n_t(1+x_t)}$ increases. Though employing more workers decreases the value of the marginal product on the left hand side, it alleviates the burden from the tax driven wage increase. Employment expands until the benefit from lower wages outweighs the losses in the value of the marginal product.

In period $t = 1$, the term including the demographic variables in equation (23) stays constant on the new level. This is in contrast to the capital supply, which still grows due to increased savings from households. In period $t = 1$ it is now more favorable for the firm to lower employment. The adjustment will take place until the burden from growing wages outweighs the gains from higher marginal products. The generality of this mechanism holds whenever the wage rate set by the monopoly union reacts more sensitive to changes in employment than the marginal product of the last worker employed.

Principally, the reasoning holds equally true for case (i) and for case (ii). The only

difference lies in the severeness of the firms reaction to the ongoing adjustment of savings in period $t = 1$ and afterwards. With a stronger emphasis on the importance of capital in the production process when α takes a relatively high value, the firm is able to substitute workers more easily, whenever the conditions for employing labor worsen. In this case (i), the labor demand curve is flatter such that higher wages are more easily compensated by lowering employment than in case (ii), where the slope of the labor demand curve is steeper for any given level of employment.

For the financial sustainability of the social security system case (i) exhibits favorable effects and case (ii) exhibits adverse effects. Though in both cases the per capita burden increases and wages rise, emplyoment develops differently. Comparing the steady states respectively in periods ($t = -2$) and ($t = 8$) shows that the economy with a relatively low utilization of capital experiences a positive labor market effect while the economy with a high utilization incurs a negative labor market effect. In case (i) relatively more people contribute to the financing of the social security system which implies an implicit alleviation for each contributor compared to a setting without a potential employment labor market effect. Case (ii) instead embeds an implicit aggravation with respect to the financing burden as in the new steady state relatively less individuals contribute to the social security system.

The aforementioned results would not occur under the consideration of a perfect labor market. An inelastic supply of labor fixes the employment rate at a level of $n = 1$ such that only emerging wage differentials may cushion the financing burden. Additionally, if there was an earmarked replacement rate of the social benefit, the tax rate (12) would be affected only by demographic variables. A cushioning labor market effect could not occur, which is a standard result in the related literature.

Introducing Nash-bargaining or bargaining power into the right-to-manage model does not change the qualitative results presented above. Only the wage-labor allocations on the labor demand curve would reallocate less strongly over the transition path. This implies that the threshold value of α with respect to the final qualitative direction (positive or negative) of the employment level adjustment may increase for the given set of parameter values.

5 Conclusion

The findings of the paper are briefly summarized. If demographic change increases the capital supply in the economy due to an increased amount of savings per capita, the net effect of the induced labor demand adjustment on the employment rate may be positive or negative. The qualtitative result depends on the labor demand elasticity of the wage rate or respectively the output elasticity of capital. If it takes a relatively high value, the effect of demographic change on the financial sustainability may intensify not only directly over demographic variables but also indirectly over the firm's incentives to lower the level of workers employed. If the output elasticity of capital instead takes a relatively low value, the

negative effect of demographic change is cushioned, though the same direct effects on the social security system apply. The rationale behind these results is the balancing of the firm's gains and losses from increased/ decreased marginal product of labor and the acceptance of higher/ lower wages via employment effects on the height of the tax rate.

The results found in this paper imply that economies with a relatively high dependence of production on capital utilization and collective bargining on the labor market, may be adversely affected by demographic change with respect to the financial sustainability of the social security system. Though demographic change may potentially lead to higher savings per capita and may initally induce labor demand, the long run may be characterized by a direct negative effect on the employment rate and thus an indirect negative effect on the financing burden.

Future research and extensions of this model will focus on the derivation of more general results, e.g. the formulation of general production and utility functions as well as the analytical identification of the threshold value of the output elasticity of capital, α. Further extensions may include a consideration of a third working period or allowance of working in the retirement period, which should lead to a crowding out of savings such that positive or negative labor demand inductions will be weakended. Futhermore, a consideration of efficient bargaining seems to be promising for giving further insights about the role of the output elasiticity of capital. Finally, a comparison of different types of labor market imperfections within the same or similar demographic setting will allow for a deeper understanding of the interplay between labor markets, social security systems and demographic change.

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