

# Demographic Change and the Labour Share of Income

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## Abstract

Despite similar levels of per capita income, education, and technology the development of labour shares in OECD countries has displayed differing patterns since 1960. This paper examines the role of demography in this regard. Employing an overlapping generations model we simulate how labour shares are affected by increasing expected retirement durations and decreasing labour force growth rates. We simulate these effects in closed economy and small open economy frameworks for countries with fully funded or pay-as-you-go pension systems. The simulations indicate negative labour share effects of both demographic shocks which are particularly large in open economies. We test these results empirically using panel cointegration methods for a panel of 23 OECD countries and find significant long-run effects of all demographic variables on labour shares supporting the results of our simulations.

*JEL classification:* E25, J10, D91, C23

*Keywords:* Labour Share, Demographic Change, Capital Mobility, Panel Cointegration

## 1 Introduction

After rising substantially in the 1960s and early 1970s, labour shares have been steadily declining ever since in most OECD countries. In some countries however, despite similar levels of per capita income, education and technology, labour shares have remained relatively stable (Table 1 and Figure 1 for selected countries). There has been extensive research on factors that might have caused these diverging developments. It is widely argued in literature that the interplay of institutional labour market reforms and high real wage growth on the one hand and a slowdown in productivity growth caused by supply shocks on the other hand, lead to the rise in most European labour shares in the 1960s and 1970s (Bertoli and Farina, 2007). The following recovery of profit shares is by many authors interpreted as a result of the reaction of firms who increased profit shares by reducing labour demand and by shifting to more capital-intensive production techniques (Blanchard, 1997). However, the question remains why in several countries, after returning to their levels of the 1960s in the mid 1980s, labour shares have kept on falling, despite differing outcomes in terms of real wage and labour market dynamics in these countries. Possible explanations brought up in the literature include sectoral composition effects (Serres et al., 2003), privatisation and deregulation (Blanchard and Giavazzi, 2003; Torrini, 2005), union bargaining power (Bentolila and St. Paul, 2003), and globalisation (e.g. Guscina, 2006; Jayadev, 2007).

This paper examines the role of demography as a further potential factor explaining the differing developments of labour shares across OECD countries. As figures 2 and 3 exemplify, the extent to which these countries are affected by demographic change differs substantially. While some countries have seen steady population growth rates others have experienced a substantial slowdown. Moreover, growing life expectancy has led to substantial increases in expected retirement durations if pension ages were not adjusted accordingly. As a result of both factors, old-age dependency ratios are projected to display substantially differing developments until 2050 (Figure 3 for selected countries). Employing a 2-period overlapping generations (OLG) model with CES production function, we simulate how these demographic factors can affect labour shares by altering households' saving and investment behaviour.

To our knowledge, theoretical analysis of labour shares has so far only been conducted for closed economy frameworks and missed the potentially important impact of international capital flows. Though a closed economy model might be somewhat realistic for large countries (e.g. the United States and Japan), an open economy model is certainly more appropriate for small countries (e.g. Luxembourg and Belgium). To provide for both cases, we conduct model simulations for both, closed and small open economy frameworks. We also distinguish between countries with pay-as-you-go (PAYGO) or fully funded pension systems to examine the role of pension systems in this regard. The PAYGO and open economy variants of the OLG model are based on Pemberton (2000). The sole purpose of our simulations is to identify channels through which demography can affect labour shares which are subsequently tested empirically.

We therefore try to keep the OLG model as simple as possible by assuming a 2-period life-cycle and simulating only steady state effects for different combinations of pension systems, openness and elasticities of substitution.

Our simulations indicate that in a closed economy a drop in population growth and higher expected retirement duration can affect labour shares by altering the economy's capital intensity. A shift in a country's capital intensity affects the labour share either positively or negatively depending on whether the production function's elasticity of substitution between capital and labour is greater or lower than one. In a small open economy (SOE) framework with perfect capital mobility, however, the economy takes world interest rates as given and the capital intensity remains thus unaffected. Both, a higher expected retirement duration and a slowdown in labour force growth can nevertheless affect labour shares by creating a gap between domestic savings and domestic investments.<sup>1</sup> Since interest rates are fixed and therefore the domestic capital-intensity is constant as well, excess savings are invested abroad. This improves the country's net foreign asset position and generates higher foreign asset income by which the labour share is reduced independently of the elasticity of substitution between capital and labour.

Based on these insights from the simulation we then test the demographic impact on labour shares empirically using a panel of 23 OECD countries for the period from 1960 to 2007. Employing a panel error correction model to detect long-run relationships we estimate how changes in expected old-age dependency ratios, expected retirement durations and population growth rates have affected labour shares. The estimation results confirm our model simulations. We find significant long-run relationships between all demographic variables and labour shares.

To examine whether demographic factors have different impacts on labour shares depending on pension systems and degree of openness, we then split the panel into subsamples and run separate estimations for countries which operate predominantly a PAYGO pension system vs. countries with predominantly funded pension system and for relatively open vs. relatively closed countries. We find significant negative long run elasticities between the expected retirement duration and the labour share in all subsamples except for relatively open countries. For population growth rates the long-run elasticity is positive, but significant only in the funded pension system subsample. The long-run effect of a higher old-age dependency ratio which combines both other effects is significantly negative in all subsamples.

The remainder of this paper is structured as follows: Section 2 develops the OLG model used to simulate demographic effects on labour shares. Section 3 contains the calibration and results of our simulation for a closed and a SOE framework and for two

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<sup>1</sup> The effect of demographic change on saving and investment behaviour as well as international capital flows has been subject to a number of theoretical and empirical studies (see Domeji and Floden (2006) for an overview). Almost all of these suggest that differences in demographic trends have been an important determinant of international capital flows since WWII.

different pension policies. Section 4 presents the empirical specification and our econometric analysis. Section 5 concludes.

## 2 Demographic change and the labour share in an overlapping generations model

### 2.1 The model for a closed economy

In this section we present a formal definition of the labour share and develop a 2-period OLG model for a closed economy with either PAYGO or funded pension system. In a closed economy, savings are completely invested domestically and changes in saving rates can therefore affect the labour share by altering the capital intensity of production unless the elasticity of substitution between capital and labour is equal to one. We show that the capital intensity depends on the household's expected duration of retirement and the country's labour force growth rate. General equilibrium is constructed via the production sector where, given labour and capital inputs, output and factor prices are determined by a CES production function.

The labour share is defined as the ratio of labour income to total income. It therefore depends on factor prices (wage and profit rates) and endowments of labour and capital, and thus on the capital intensity of production. In a closed economy framework total income equals total production. The labour share, defined in real terms, is therefore

$$ls_t = \frac{w_t L_t}{w_t L_t + r_t K_t} = \frac{w_t L_t}{Y_t}, \quad (1)$$

where  $w$  is the wage rate,  $r$  is the interest rate,  $L$  is the labour force,  $K$  is the domestic capital stock, and  $Y$  is total production.

Given factor inputs of capital and labour, output and factor prices are determined by a representative firm that uses a standard CES production function in units of labour given by

$$y_t = A(\alpha k_t^{-\varepsilon} + (1-\alpha))^{-\frac{1}{\varepsilon}}, \quad \varepsilon = \frac{1-\sigma}{\sigma}, \quad (2)$$

where  $k = K/L$  is the capital intensity,  $A$  represents total factor productivity,  $\sigma$  the elasticity of substitution and  $\alpha$  is a factor share parameter that allows the relative importance of capital and labour in production to vary. For simplicity we assume that  $A$  is constant and not affected by demographic change. Labour inputs grow exogenously at rate  $n-1$  per period:

$$L_t = (n)^t L_0. \quad (3)$$

For simplification we assume 100% capital depreciation per period and static profit maximisation of firms. Both production factors are paid their marginal product:

$$w_t = (1-\alpha)A \left[ \alpha k_t^{-\varepsilon} + 1 - \alpha \right]^{-\left(\frac{1+\varepsilon}{\varepsilon}\right)} \quad (4)$$

$$r_t = \alpha A \left[ \left( \alpha + k_t^\varepsilon (1-\alpha) \right)^{\frac{1}{\varepsilon}} \right]^{1+\varepsilon} - 1. \quad (5)$$

We assume an economy with overlapping generations of households with identical utility functions. Each household lives for a working period during which savings are accumulated, and with probability  $\pi$ ,  $0 < \pi < 1$ , for a second, retired, period, in which the household lives on its accumulated annuities (Pemberton 2000). In a PAYGO system economy, retired households additionally receive public pensions paid by working households. For simplicity, we assume no bequest and households thus save only to provide for old age.

By choosing an optimal consumption path, households maximise their inter-temporal utility. As usual in life-cycle models, the trade-off between consumption in young or old age is determined by the ratio of interest rate and time preference rate, and by the degree of relative risk aversion. Preferences are additive and separable over time. For a representative household who is young at time  $t$  the objective function is

$$U_t = \frac{(c_t^Y)^{1-\theta}}{1-\theta} + \frac{\pi}{1+\rho} \frac{(c_{t+1}^O)^{1-\theta}}{1-\theta}, \quad (6)$$

where  $c_t^Y$  and  $c_t^O$  are the consumption levels of a young and old household at time  $t$ .  $\rho$  denotes the time preference rate and  $\theta$  the coefficient of relative risk aversion. Households can borrow and lend freely at  $r_t$ . Gross return on annuities is  $(1+r)/\pi$  since the average survival rate of each generation is  $\pi$ . Maximisation of lifetime consumption is subject to budget constraints which for an economy with PAYGO pension system are given by

$$c_t^Y = (1-\tau)w_t - s_t \quad (7)$$

$$c_t^O = \frac{1+r_t}{\pi} s_{t-1} + \frac{n}{\pi} \tau w_t, \quad (8)$$

where  $\tau$  is a wage tax rate for working households assumed to be constant. Old households live on the annuities which their generation saved during working age and which are distributed to all pensioners still alive. Assuming that the government runs a balanced PAYGO budget each period, every old household receives additionally a public pension that depends on the currently young generation's wages and the old-age dependency ratio  $\pi/n$ , which equals the ratio of the country's survival rate and the labour force growth parameter  $n$ . The old-age dependency ratio is therefore determined by both demographic factors – the survival probability and labour force growth. In a funded pension system economy  $\tau$  is zero and old households live only on their accumulated annuities.

Since we assume no bequest motives, all savings are spend during retirement. The accumulation equation is therefore

$$k_{t+1} = \frac{s_t}{n}. \quad (9)$$

Higher individual savings increase the capital intensity. A drop in the labour force growth rate will also increase capital intensity as labour supply becomes scarce relative to capital. This in turn will increase wage rates, decrease interest rates and thus lead to lower saving rates. The direct effect of a drop in population growth on the capital intensity will therefore partially be compensated by the interest rate effect. For an economy with PAYGO pension system the young household's saving function derived from inter-temporal utility maximisation is

$$s_t = \frac{\left(\frac{1+r_{t+1}}{1+\rho}\right)^{\frac{1}{\theta}} - \tau \left[\left(\frac{1+r_{t+1}}{1+\rho}\right)^{\frac{1}{\theta}} + \frac{n}{\pi}\right]}{\frac{1+r_{t+1}}{\pi} + \left(\frac{1+r_{t+1}}{1+\rho}\right)^{\frac{1}{\theta}}}. w_t. \quad (10)$$

An increase in  $\pi$  has a positive effect on savings of young households who provide for a higher probability of living through a second retired period. In a funded pension system economy  $\tau$  is zero and therefore savings rates of young households are c.p. higher.

## 2.2 The model for a small open economy

Next, we assume a small open economy and constant world interest rates which the economy takes as exogenous. Capital is perfectly mobile. The domestic capital intensity and wage rate are thus constant as well and no longer functions of the domestic saving rate. A decrease in a country's labour supply leads to lower demand for investment as less capital is needed. In an open economy however domestic saving and investment no longer need to be equal. Additional capital for domestic production can be acquired from abroad and domestic excess capital invested abroad. Assuming that the factor labour is not mobile, the only income from abroad is asset income. All other characteristics of the model remain unchanged. The accumulation equation is now

$$f_{t+1} + k = \frac{s_t}{n}, \quad (11)$$

where  $f$  denotes net foreign assets per domestic worker. Since the capital intensity is constant the complete effect of a decline in the labour force growth rate goes into net foreign assets. Countries experiencing a slowdown of labour force growth relative to the rest of the world should therefore see an improvement of their net foreign asset position.

For the open economy framework we have to alter our definition of the labour share since now total income includes not only domestic income, but also net international

factor payments. Assuming perfect capital mobility, but labour immobility the labour share is now

$$ls_t = \frac{wL_t}{wL_t + r(K_t + F_t)} = \frac{wL_t}{Y_t + rF_t}. \quad (12)$$

From (12) it is obvious that capital returns from abroad reduce the labour share. Demographic change can therefore affect labour shares not only by altering the capital intensity of production (which is constant in a SOE) but also by increasing the share of capital invested abroad. In other words, if labour is immobile and gross national product is increased relative to gross domestic product, the labour share will decline. Changes in labour shares are therefore possible even if firms produce using Cobb-Douglas production functions with  $\sigma = 1$ .

### 3 Model calibration and simulation results

We analyse the steady state effects of a rise in the expected retirement duration, a decrease in the labour force growth rate as well as the combined effects of both demographic factors. A rise in the expected retirement duration is modelled as an increase in the survival parameter  $\pi$ , a decrease in labour force growth rate as a drop in  $n$ . We conduct separate simulations for either closed or small open economies, either PAYGO or funded pension system economies, and economies with elasticity of substitution either lower or greater than one.<sup>2</sup> This gives us a total of 24 variants to be simulated.

The parameter values used in the calibration of our model are set as follows: We interpret each period in the OLG model as lasting for 30 years and assume 100% capital depreciation each period. The coefficient on capital  $\alpha$  is 0.5. We set the survival parameter for the initial steady state  $\pi = 0.7$  and the labour force growth rate to 1% per year implying  $n = 1.35$ . The coefficient of relative risk aversion  $\theta$  equals 0.5. The time preference rate  $\rho = 1.43$  and the wage tax rate for the variants with PAYGO pension system  $\tau = 0.18$  are taken from Pemberton (2000). Elasticities of substitution are either  $\sigma = 0.9$  or  $\sigma = 1.1$ . For each open economy variant we take the interest rate that results from the respective closed economy's initial steady state simulation as exogenous and constant.

Table 2 shows the results of our simulations of demographic shocks for economies with varying combinations of pension systems, openness and elasticities of substitution between capital and labour. The table firstly presents the initial steady state capital intensities and labour shares. Since saving rates and thus capital intensities are c.p. higher in economies with fully funded pension system, the labour share is slightly higher relative to the PAYGO system variant if  $\sigma$  is 0.9 (lower than 1) and slightly

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<sup>2</sup> Since in closed economies labour shares are constant by definition if the elasticity equals one, this case is not simulated.

lower if  $\sigma$  is 1.1 (greater than 1). It further shows capital intensity and labour share adjustments when the survival parameter  $\pi$  is lifted from 0.7 to 0.9 and when labour force growth is reduced to zero ( $n=1$ ). Additionally the combined effects of both demographic shocks are presented.

In the closed economy simulations all demographic shocks increase capital intensities. In line with the standard neo-classical growth model, a drop in labour force growth directly leads to higher capital intensity. A higher survival rate also increases the capital intensity by lifting saving rates of households who provide for a longer expected retirement period. This effect is however muted by the resulting lower interest rates.<sup>3</sup> The effect of higher capital intensity on labour shares is however ambiguous and depends on whether the elasticity of substitution between capital and labour is greater or lower than one. Labour shares drop if  $\sigma = 1.1$ . For  $\sigma = 0.9$ , however, the demographic shocks simulated lead to an increase of labour shares. The closed economy version of our model can therefore help to explain declining labour shares in countries only if elasticities of substitution exceed unity.<sup>4</sup> The pension system appears not to play a particular role in our closed economy simulations as the extent to which labour shares are affected is roughly the same in both systems.

In the simulations for small open economies with perfect capital mobility we take the interest rate resulting from the respective initial closed economy simulation of each variant as exogenous and constant. Unlike closed economies, demographic change no longer entails wage increases in open economies as capital intensities are also constant. Labour share adjustments are now only driven by changes in net foreign asset income. Demographically induced excess savings are invested abroad which improves the country's net foreign asset position and increases households' foreign investment income. As table 2 shows, by increasing the share of households' capital invested abroad, demographic shocks can thus lead to reductions in labour shares even if the production function's elasticity of substitution is lower than one. In case of  $\sigma = 1.1$  reductions in labour shares caused by demographic shocks are also substantially larger in open economies compared to the respective closed economy variants. Furthermore, in open economies the negative effect of a reduction in labour force growth is slightly stronger in variants with PAYGO system. This is caused by households who increase their saving rates to compensate for the expected loss of income from PAYGO-financed public pensions during retirement; the latter being caused by higher old-age dependency ratios. Unlike closed economies, this effect is in open economies no longer mitigated by lower interest rates resulting from higher capital intensities.<sup>5</sup> In open economies with funded pension system, households' saving rates are not affected by shifts in labour

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<sup>3</sup> Demographic effects on interest rates are discussed in the literature evolving around the so-called asset meltdown hypothesis (e.g. Abel, 2001, 2003; Poterba, 2001; Brooks, 2002).

<sup>4</sup> Empirical estimates  $\sigma$  display mixed results. Blanchard (1997) estimates  $\sigma$  to be slightly greater than one in Continental European Countries and slightly lower than one in Anglo-Saxon Countries. Berthold et al. (2002) estimate  $\sigma$  to be substantially greater than one in Germany and France and a Cobb-Douglas-like production structure in the US, whereas Rowthorn (1996) estimates  $\sigma$  to be substantially lower than one in all OECD countries.

<sup>5</sup> Accordingly a possible "asset meltdown" problem is alleviated to the extent that capital is internationally mobile (Börsch-Supan et al., 2006).

force growth rates. The resulting decline in labour shares is therefore slightly smaller. A switch of pension systems could also have an effect on labour shares. This effect is however likely to be rather small. As table 2 shows a complete switch from a PAYGO to a fully funded pension system would alter labour shares by just about one percentage point in all variants.

The simulations suggest that diverging demographic developments could have indeed been a factor contributing to the differing developments of labour shares across regions. Our simulations show that both, increased expected retirement durations and dropping population growth rates can cause labour shares to decline, particularly in economies open to international capital flows.<sup>6</sup> In relatively closed economies the demographic effect is likely to be substantially smaller and could even be positive, although the latter case is very unlikely given the fact that nowadays all industrialised countries have a certain degree of openness to capital flows. Our simulations also suggest that pensions systems should have played only a minor role as labour share effects of demographic shocks have been roughly the same in PAYGO and funded system variants. Switches between pension systems are also unlikely to be a substantial factor, since our simulations suggest only a minor labour share effect even for complete switches from PAYGO to fully funded pension systems.

## 4 Empirical estimation and results

This section examines the empirical links between demography and the labour share. We use population growth rates, expected retirement durations, and expected old-age dependency ratios as demographic variables (see Appendix for data sources and definitions of variables). As shown in chapter 2, the old-age dependency ratio combines both other factors. Data for these variables are available at an annual frequency for most OECD countries from 1960 to 2007. This gives us a data field for 23 countries and 48 years.<sup>7</sup> For this type of data-set time-series-cross-section (TSCS) methods are most efficient in exploring the information of the data's time and cross section dimension (for an overview see Breitung, Pesaran, 2005).

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<sup>6</sup> Another possible channel through which demographic change can influence labour shares is factor biased technological change. If a slowdown in labour force growth leads to an increasing scarcity of labour relative to capital, firms may react by either shifting production abroad or by employing more labour-saving techniques. By adopting technologies that use less labour and more capital at given factor prices, firms decrease the marginal product of labour at a given capital intensity (Blanchard, 1997). In our model an increase of the proportion of relatively capital-intensive methods of production would increase the coefficient on capital  $\alpha$  and decrease the coefficient on labour  $(1-\alpha)$  which also causes the labour share to decline. The resulting effect on the labour share can be shown by plugging (2) into (1). In this case, the labour share equals

$$l_s = \frac{(1-\alpha)L_t^{-\varepsilon}}{\alpha K_t^{-\varepsilon} + (1-\alpha)L_t^{-\varepsilon}}. \text{ It is obvious that } \partial l_s / \partial \alpha < 0. \text{ An increase in } \alpha \text{ reduces the labour share.}$$

<sup>7</sup> We exclude a number of OECD countries from the sample which have been or still are at different levels of development. These are mostly Eastern European countries, such as Czech Republic, Estonia, Hungary, Poland, Slovak Republic, Slovenia, Turkey, and also Israel, Mexico and Russia. Switzerland is also excluded due to lack of available income data.

Additionally to the full sample of countries we build subsamples of countries in line with the simulations of the previous section. All countries are assigned to groups as either PAYGO or funded system countries and as relatively open or relatively closed. Since all countries in our sample operate pension systems that include PAYGO elements we only distinguish between countries with predominantly PAYGO systems and predominantly funded pension systems. Countries are assigned to the PAYGO subsample if the average PAYGO portion of the replacement rate as estimated by Bloom et al. (2007) exceeds 50 % and to the funded subsample if it falls below 50 %. Due to lack of annual data on pension systems we do not control for changes in the PAYGO portion of the replacement rate. Since demography can cause governments to increase the funded portion of the replacement rate this could potentially lead to a bias of the demographic coefficients. However, as our simulations suggest, even a complete switch from a PAYGO to a fully funded pension system is likely to have only a minor effect on labour shares. Moreover the data of Bloom (2007) computed for each country for 3 years between 1961 and 2002 suggest that major shifts in the PAYGO portion of the replacement rates have not taken place in the countries included in our sample. Capturing the impact of openness is also difficult since all countries in the sample have been more or less open to capital flows. We nevertheless try to identify a certain impact of openness by classifying countries as relatively open or closed with regard to interest rate autonomy. For this we refer to country size in terms of population and GDP assuming that relatively large countries have a higher influence on domestic capital returns while small countries should rather be price takers. The G7 countries plus Korea and Spain are thus treated as relatively closed and all others as relatively open.

To get an impression of the properties of the data we perform panel unit root tests for all variables and for all samples. As shown in table 4, unit root tests support the hypothesis of unit roots in labour shares as well as in old-age dependency ratios. The indication of a unit root for the other demographic variables is not confirmed by all tests, but Banerjee and Zanghieri (2003) argue that panel unit root tests may be distorted by cross section cointegration. Since tests for almost all individual series do not reject the hypothesis of a unit root (Table 5) we treat those variables as non-stationary. Unit roots are often removed by taking first difference values, but that would allow us to detect short-run relationships between labour shares and the demographic variables only and ignore possible long-run relationships if the series are cointegrated. As another preparatory step we therefore test for cointegration between the labour shares and the above mentioned demographic variables. The panel cointegration tests of Fisher (Table 6) and Pedroni (table 7) indicate a cointegration relation between the labour shares and the expected retirement duration as well as between labour shares and population growth rates. The tests are devised for the null of no cointegration in panels, including regressions with multiple regressors, time trends and fixed effects. The results for the expected old-age dependency ratio are mixed. The Fisher test indicates no cointegration while the Pedroni tests do. However, the results of the cointegration tests may also be biased if the cross sections are correlated. We therefore estimate an autoregressive distributed lag model which has a simple error correction representation:

$$\Delta l_{i,t} = \alpha + \phi_1 l_{i,t-1} + \phi_2 x_{i,t-1} + \sum_{k=1}^{a-1} \rho_k \Delta l_{i,t-k} + \sum_{q=1}^{b-1} \omega_q \Delta x_{i,t-q} + \varepsilon_{i,t}, \quad (13)$$

where  $l$  is the labour share,  $x$  is the respective demographic variable tested, and  $a$  and  $b$  denote the respective number of significant lags. All variables are log values.

To find the appropriate specification of equation (13) for each group of countries we proceed in the following steps. Firstly, we determine the lag order of the explanatory variables by using the Hannan-Quinn information criterion. Secondly, we use a likelihood ratio test to analyse whether coefficients are homogeneous across cross sections. We start from the most restricted model which is a fully homogenous model (model 1) as in equation (13). This is tested against a model with heterogeneous constants (model 2), a model with heterogeneous short-run coefficients (model 3). If one of the later is superior it is tested against a fully heterogeneous model (model 4). Thirdly, we use the Breusch-Pagan test to detect cross section correlation. In the case of cross section correlation we use the SUR-estimator and otherwise OLS.

The estimation results for the long run coefficients are presented in table 8 for the whole group of countries, in table 9 for the pension system subsamples and in table 10 for the openness subsamples. The resulting long-run elasticities with respect to labour shares (if significant) are presented in table 11. In the sample covering all countries the estimated long-run elasticities are significant for all demographic variables and have the expected signs, which are negative for the expected retirement duration and the expected old-age dependency ratio and positive for the population growth rate. Our empirical estimations thus confirm the results of our simulations and indicate an impact of demographic change on labour shares.

In the subsamples all specifications for expected retirement durations and old-age dependency ratios also show negative long-run elasticities with respect to the labour share. An exception is the case of the open country subsample in which the long-run effect of the expected retirement duration is also negative but not significant. This result is somewhat surprising, since the simulations clearly suggested demographic effects on the labour share to be larger in open economies. However, the elasticity for the expected old-age dependency ratio which combines the effects of expected retirement duration and population growth rates is larger for the open country group compared to the closed country group which is again in accordance with our simulation results. Nevertheless openness appears not to matter as much as could be expected from the simulations. The long-run elasticities for population growth rates are positive, but significant only in the common sample and in the funded pension system subgroup. Pension systems seem to play a certain role as elasticities for the expected retirement duration and the expected old-age dependency ratio are relatively larger in the PAYGO system subgroup. The elasticity of the population growth rate, however, is only significant in the funded system subsample. The fact that the estimated elasticities in the sub groups are not always in line with our simulations should not be overestimated, however. The simulations were made for ideal type economies with regard to openness and pension

system while the variation between countries assigned to different groups is limited since all are OECD countries that are more or less open to capital flows and operate pension systems that include PAYGO elements.

## 5 Conclusions

This paper shows that the diverging patterns of labour share developments in OECD countries also reflect their demographic differences. Demographic change leads to adjustments of households' saving and investment behaviour. This in turn can affect labour shares by either altering domestic capital intensities or the share of income from net foreign assets. Our simulation results indicate that the magnitude of the demographic impact on a country's labour share depends on the country's elasticity of substitution between labour and capital and its openness to international capital flows.

A decline in labour shares in ageing countries - in the public debate often regarded as a distributive problem - can thus also be attributed to provident behaviour of households. Anticipating higher retirement durations or lower PAYGO-financed public pensions due to higher old-age dependency ratios, households increase their saving rates. Higher savings, however, increase domestic capital intensities and thus reduce interest rates. Households adjust to the expected loss of capital returns by investing a growing share of their savings in countries which are less affected by ageing and thus provide higher returns on capital. In return, higher net foreign assets income reduces the country's labour share. If a country's retirement age remains fixed despite continuously growing life expectations, as has been the case in most countries in the past, and if population growth is decreasing or even negative, the country is thus likely to face a declining labour share.

Our empirical findings generally support the simulation results and provide evidence for an impact of demographic change on the labour shares. Interestingly, the important role of openness to international capital flows, as indicated by our simulations, is not confirmed for all demographic variables. This could be due to lack of variation between our openness subgroups consisting of rather similar OECD countries. However, it is also possible that our simulations in fact overestimates the role of openness since a major shortcoming of our model is that it does not take account of international labour mobility. Introducing labour mobility would add an additional mechanism to arbitrage away regional differences in capital intensities, so that the impact of international capital flows would shrink. Another reason could be that some countries have experienced gaps between rates of return on foreign assets and those on foreign liabilities as well as changes in asset valuations e.g. due to currency adjustments (Gourinchas and Rey, 2005). In many countries, developments of net foreign asset positions have thus not been matched by developments of net foreign investment income positions. The U.S. for instance has maintained a generally positive balance of net international investment income even as its net foreign asset position became increasingly negative. Other countries have seen little or even negative foreign

investment income despite large surpluses in net foreign asset positions. Finally, the role of openness for the magnitude of demographic effects might also be a matter in the future rather than the past given that until recently domestic savings and investments have remained surprisingly correlated (Feldstein and Horioka, 1980). As a result most countries' GNPs haven't differed much from their GDPs. But as the Feldstein-Horioka phenomenon appears to be increasingly disappearing (Blanchard and Giavazzi, 2002) the gap between GNPs and GDPs should likely continue to grow as well.

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## Appendix

### Definitions of Variables

The labour share, unlike the wage share, also includes labour income of non-employees (i.e. self-employed or family workers). Since the latter is not provided in national accounts, we follow the widely adopted approach of Gollin (2002) to adjust for labour income of non-employees by assuming that other categories of workers earn the same average wage as employees:

$$ls = \frac{w/L}{GNI/N}.$$

where  $w$  is compensation of employees,  $L$  is the number of employees,  $N$  is total employment and  $GNI$  is Gross National Income at current market prices.

To obtain the expected retirement duration for each cohort  $E(RD)_t$  we use data on life expectancy at age 40 ( $LE_t^{40}$ ) assuming that each year the average worker is 40 years old. For each year and country we take the life expectancy at age 40, add 40 years and subtract the respective standard national retirement age in 2008<sup>8</sup> ( $RA$ ):

$$E(RD)_t = LE_t^{40} + 40 - RA.$$

The expected old-age dependency ratio  $E(ADR)_t$  is computed as the average old-age dependency ratio that a worker at age 40 faces during his expected retirement period. Projected data on old-age dependency ratios are available until 2050:

$$E(ADR)_t = \frac{1}{R} \sum_{r=t+RA-40}^{t+R} ADR_r, \quad R = \lfloor E(RD)_t + 0.5 \rfloor.$$

Since real time data for life expectancy at age 40 and old-age dependency ratios are not available, we assume that earlier projections equal the 2006 data.

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<sup>8</sup> The assumption of constant retirement age at the 2008 level for all countries is certainly critical. In most countries the official retirement age has been virtually constant in the relevant time period beginning in the mid 1980s. A few countries (e.g. New Zealand) however, have altered their official retirement age which might have affected the expected retirement duration. This effect is very hard to quantify, however, as it is difficult to trace back the exact dates when the reforms of the retirement age became publicly aware. If these reforms were enacted well in advance, this might also have affected the behaviour of cohorts to which the new retirement age did not yet apply. We therefore assume the official retirement age of 2008 as applying to all cohorts.

## Groupings:

*Countries classified as relatively open:* Australia, Austria, Belgium, Denmark, Finland, Greece, Iceland, Ireland, Luxembourg, Netherlands, New Zealand, Norway, Portugal, and Sweden.

*Countries classified as relatively closed:* Canada, France, Germany, Italy, Japan, Korea<sup>9</sup>, Spain, UK, and USA.

*Countries assigned to PAYGO system subsample:* Austria, Belgium, Finland, Germany, Greece, Italy, Japan, Netherlands, Portugal, Spain, and Sweden.

*Countries assigned to funded system subsample:* Australia, Canada, Denmark, France, Iceland, Ireland, Korea, Luxembourg, New Zealand, Norway, UK, and USA.

## Data Sources

Compensation of employees, number of employees, GNI at current market prices, total employment: AMECO Database, 2008.

Old-age dependency ratios: OECD Social Indicators, 2006.

Life expectancy: OECD Health Data.

Retirement age: OECD - Pensions at a Glance, 2008.

Total population: OECD Factbook 2008: Economic, Environmental and Social Statistics

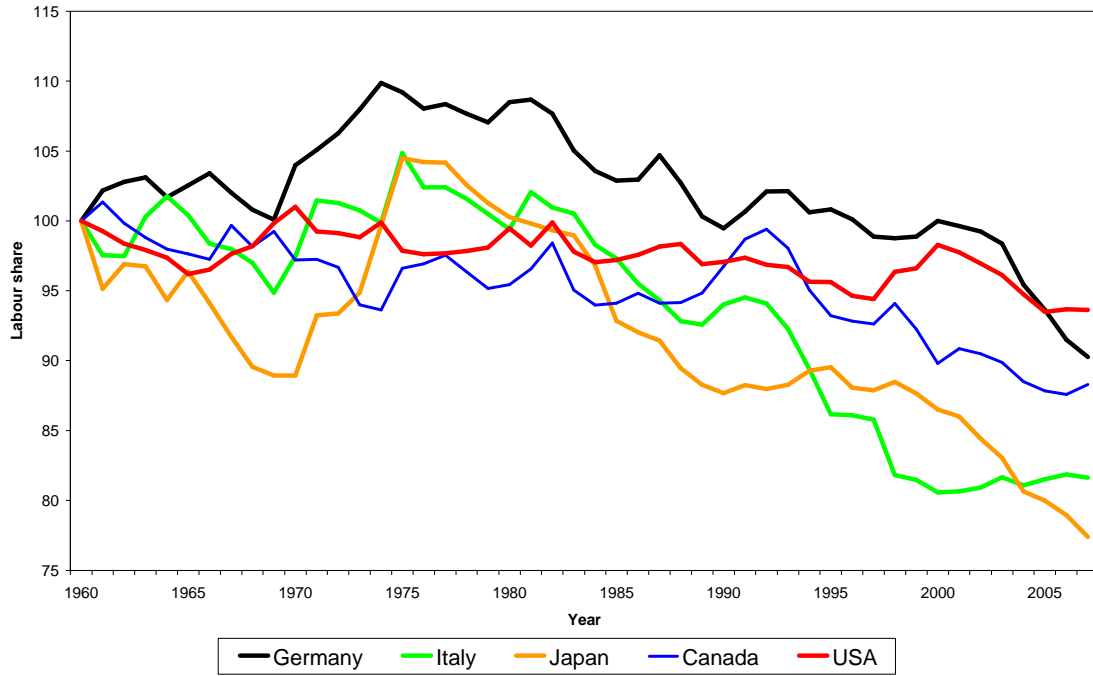
PAYGO portion of replacement rate: Bloom et al. (2007), Gudmundsson (2001) for Iceland.

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<sup>9</sup> Korea became relatively large with regard to GDP only recently. However, since the country was previously relatively autarkic we nevertheless treat it as relatively closed.

**Figure 1**

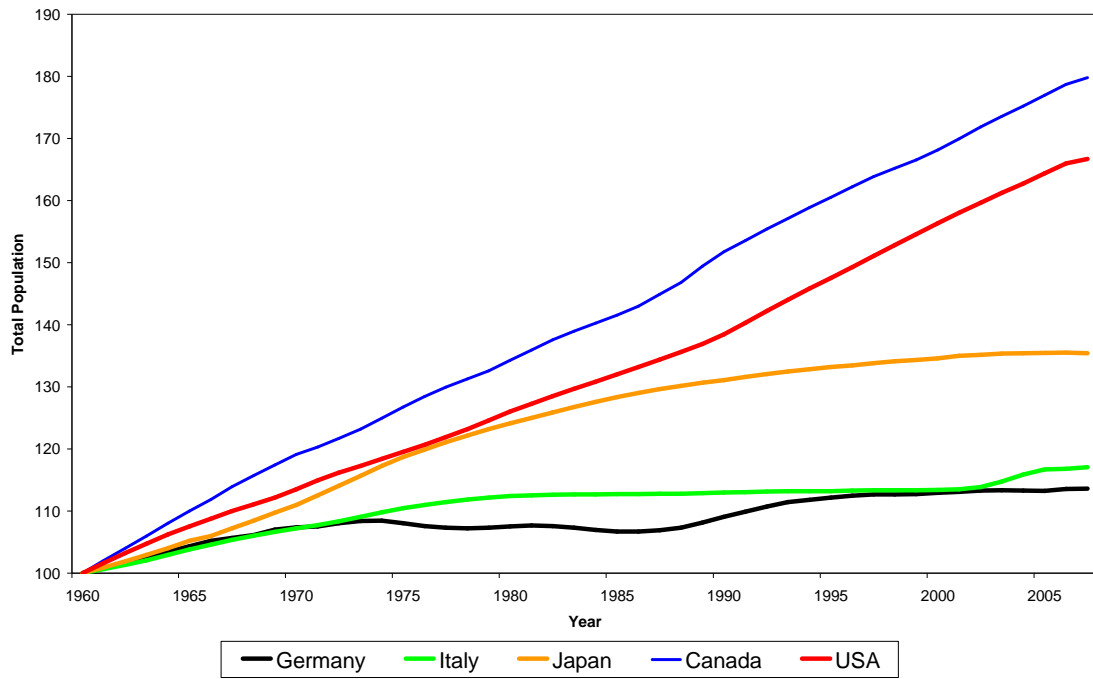
**Labour shares in selected OECD countries (1960 = 100)**



Source: AMECO Database

**Figure 2**

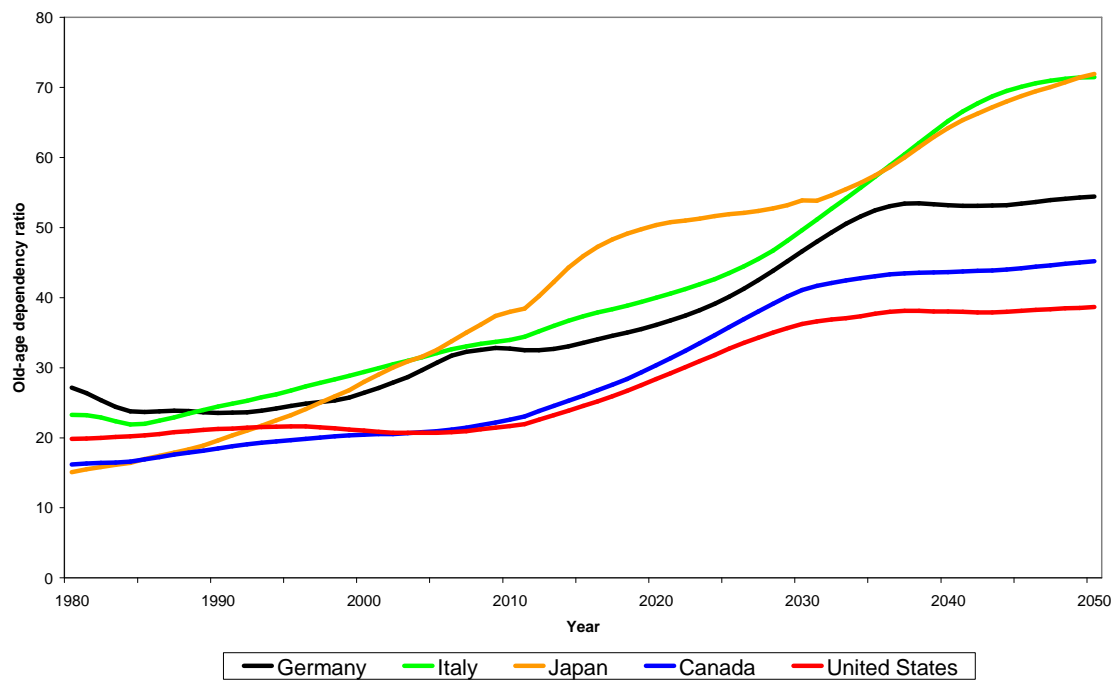
**Population growth in selected OECD countries (1960 = 100)**



Source: OECD Factbook 2008.

**Figure 3**

**Old-age dependency ratios in selected OECD countries**



Source: OECD Social Indicators, 2006

**Table 1**  
**Adjusted Labour Shares in 23 OECD countries**

	1960	1975	1985	2007
Australia	57.5	65.4	61.8	55.1
Austria	70.8	72.9	67.6	57.2
Belgium	55.8	64.1	64.0	59.5
Canada	64.6	62.4	60.8	57.0
Denmark	56.0	62.4	59.6	56.6
Finland	68.4	70.1	65.0	53.1
France	62.2	65.7	63.9	56.3
Germany	59.9	65.4	61.6	54.1
Greece	83.4	56.0	64.4	54.6
Iceland	-	64.0	61.6	-
Ireland	64.1	68.1	68.3	58.7
Italy	66.6	69.9	64.8	54.4
Japan	73.2	76.5	68.0	56.6
Korea	-	79.4	75.7	66.8
Luxemburg	59.2	67.8	55.4	57.1
Netherlands	56.1	69.1	62.5	55.8
Norway	59.3	61.9	52.4	45.7
New Zealand	-	-	54.9 <sup>10</sup>	52.0
Portugal	63.1	85.3	68.6	63.1
Spain	61.6	66.9	61.3	56.3
Sweden	63.8	64.6	63.0	56.5
UK	64.2	71.9	64.7	61.4
USA	64.8	63.4	63.0	60.7

Source: AMECO Database

<sup>10</sup> 1986

**Table 2****Simulation results: Steady state labour shares before and after demographic shocks**

Elasticity of substitution Pension System	$\sigma = 1.1$		$\sigma = 0.9$	
	PAYGO	Funded	PAYGO	Funded
Initial Steady State Capital Intensity ( $\pi = 0.7, n = 1.35$ )	171.3	258.5	64.2	91.6
Initial Steady State Labour Share ( $\pi = 0.7, n = 1.35$ )	37.4	36.5	60.3	61.1
<b>Closed Economy</b>				
Capital Intensity ( $\pi = 0.9$ )	215.4	326.9	76.1	108.5
Capital Intensity ( $n=1$ )	276.5	419.2	84.8	120.9
Capital Intensity ( $\pi = 0.9, n=1$ )	353.7	539.4	100.7	143.7
Labour Share ( $\pi = 0.9$ )	36.9	35.9	60.7	61.5
Labour Share ( $n=1$ )	36.3	35.3	60.9	61.8
Labour Share ( $\pi = 0.9, n=1$ )	35.7	34.8	61.3	62.2
<b>SOE</b>				
Labour Share ( $\pi = 0.9$ )	34.5	33.8	56.5	58.2
Labour Share ( $n=1$ )	31.3	30.8	53.6	55.9
Labour Share ( $\pi = 0.9, n=1$ )	28.6	28.2	49.7	52.6

**Table 3****Descriptive Statistics of the Main Variables (All observations in the sample; 1960-2006)**

	Mean	Standard deviation	Maximum	Minimum	Observations
Labour share	62.6	5.8	88.1	44.1	1048
Expected retirement duration	12.3	2.7	22.1	5.4	915
Expected old-age dependency ratio	32.9	9.3	63.3	11.26	917
Population growth	0.72	0.58	4.5	-0.89	1081

**Table 4**  
**Panel Unit Root Tests**

Country group	Test	Labour share	Expected retirement duration	Exp. old-age dependency ratio	Population growth
All	Levin, Lin, Chu	1.51	-5.04***	-5.18***	-1.60*
	Im, Pesaran, Chin	2.08	-3.95***	1.29	-2.65***
	ADF – Fischer $X^2$	34.31	91.96***	60.31*	66.91**
	PP – Fischer $X^2$	34.26	155.07***	42.54	89.61***
Open	Levin, Lin, Chu	0.21	-3.73***	-4.10***	-0.33
	Im, Pesaran, Chin	0.59	-3.23***	-0.86	-2.41***
	ADF – Fischer $X^2$	29.15	58.33***	35.74	43.77**
	PP – Fischer $X^2$	29.19	126.16***	20.05	70.66***
Closed	Levin, Lin, Chu	2.03	-3.44***	-3.23***	-1.71**
	Im, Pesaran, Chin	2.59	-2.32***	0.97	-1.23
	ADF – Fischer $X^2$	5.16	33.62***	24.57	23.13
	PP – Fischer $X^2$	5.08	28.91***	22.49	18.95
PAYGO	Levin, Lin, Chu	1.62	-3.00***	-2.97***	0.66
	Im, Pesaran, Chin	2.58	-2.30**	1.55	-0.75
	ADF – Fischer $X^2$	13.65	36.62**	25.10	22.73
	PP – Fischer $X^2$	12.90	36.96**	25.36	37.00**
Funded	Levin, Lin, Chu	0.52	-4.04***	-4.36***	-2.50***
	Im, Pesaran, Chin	0.41	-3.25***	0.36	-2.99***
	ADF – Fischer $X^2$	20.66	55.33***	35.21*	44.17***
	PP – Fischer $X^2$	21.37	118.11***	17.18	52.61***

\*, \*\*, \*\*\* Null hypothesis rejected at the 10 %, 5 %, 1 % significance level respectively.

**Table 5**  
**Unit Root Tests for Individual Series**

	Labour Share	Exp. Retirement Duration	Population Growth Rate	Exp. Old-Age Dependency Ratio
Australia	-1.38	-3.03	-2.19	-2.51
Austria	0.49	-4.05***	-2.02	-1.45
Belgium	-2.18	-2	-2.23	-1.82
Canada	-0.31	-1.44	-2.19	0.41
Denmark	-1.3	-0.01	-1.5	-4.75***
Finland	-0.31	-2.29	-1.33	2.05
France	-0.7	-1.83	-2.89**	-1.5
Germany	-0.1	-1.98	-2	-2.6
Greece	-3.15**	-3.16	-2.64*	-0.88
Iceland	-2.6	-10.08***	-3.61***	-1.13
Ireland	-0.69	-1.57	-1.99	-0.58
Italy	-0.06	-2.44	-1.66	-0.44
Japan	0.08	-0.39	-0.13	-0.47
Korea	0.31	-2.21	-1.82	-1.43
Luxemburg	-2.01	-4.18**	-2.37	0.06
Netherlands	-1.12	-2.84	-0.85	-2.04
Norway	0.31	-1.86	-1.54	-3.87**
New Zealand	-2.04	-4.5***	-2.95**	-2.75
Portugal	-1.64	-2.83	-2.07	2.15
Spain	-1.02	-3.78**	-1.86	-1.85
Sweden	-0.52	-1.57	-1.67	-3.01
UK	-1.08	-2.87	-2.42	-0.47
USA	-1.66	-1.85	-1.8	-3.09

**Table 6**  
**Fisher cointegration test**

Sample	Hypothesized No. of CE(s)	Labour Share and Exp. Retirement Duration		Labour Share and Exp. Age Dependency Ratio		Labour Share and Population growth	
		Fisher Stat.*	Prob.	Fisher Stat.*	Prob.	Fisher Stat.*	Prob.
		(from trace test)	(from trace test)	(from trace test)	(from trace test)	(from trace test)	(from trace test)
All	None	96.9	0.00	136.5	0.00	84.9	0.00
	At most 1	57.1	0.13	126.6	0.00	30.8	0.96
Open	None	62.1	0.00	73.1	0.00	54.2	0.00
	At most 1	37.0	0.12	78.1	0.00	20.4	0.84
Closed	None	34.8	0.01	63.4	0.00	30.7	0.03
	At most 1	20.1	0.33	48.5	0.00	10.4	0.92
PAYGO	None	57.1	0.00	82.0	0.00	57.5	0.00
	At most 1	28.0	0.18	70.2	0.00	17.8	0.72
Funded	None	39.7	0.02	54.5	0.00	27.5	0.28
	At most 1	29.1	0.21	56.5	0.00	13.0	0.97

**Table 7**  
**Pedroni cointegration tests**

Sample	Test	Labour share and exp. retirement duration		Labour share and exp. old-age dependency ratio		Labour share and population growth rate	
		Statistic	Prob.	Statistic	Prob.	Statistic	Prob.
All	Panel v-Statistic	1.84	0.07	0.78	0.30	-0.73	0.31
	Panel rho-Statistic	2.63	0.01	2.82	0.01	3.28	0.00
	Panel PP-Statistic	-1.23	0.19	-0.75	0.30	1.38	0.15
	Panel ADF-Statistic	7.40	0.00	8.67	0.00	7.87	0.00
Open	Panel v-Statistic	1.25	0.18	0.28	0.38	-0.66	0.32
	Panel rho-Statistic	1.06	0.23	1.29	0.17	2.38	0.02
	Panel PP-Statistic	-1.09	0.22	-0.73	0.31	0.55	0.34
	Panel ADF-Statistic	4.10	0.00	5.39	0.00	5.55	0.00
Closed	Panel v-Statistic	1.65	0.10	1.32	0.17	-0.21	0.39
	Panel rho-Statistic	1.77	0.08	1.87	0.07	1.87	0.07
	Panel PP-Statistic	-0.42	0.36	-0.08	0.40	2.15	0.04
	Panel ADF-Statistic	5.84	0.00	6.30	0.00	7.90	0.00
PAYGO	Panel v-Statistic	1.46	0.14	1.04	0.23	-0.96	0.25
	Panel rho-Statistic	1.39	0.15	1.54	0.12	1.28	0.18
	Panel PP-Statistic	-0.71	0.31	-0.37	0.37	1.33	0.16
	Panel ADF-Statistic	5.99	0.00	7.13	0.00	8.15	0.00
Funded	Panel v-Statistic	1.12	0.21	-0.08	0.40	0.15	0.39
	Panel rho-Statistic	1.29	0.17	1.45	0.14	1.96	0.06
	Panel PP-Statistic	-1.39	0.15	-1.07	0.22	0.38	0.37
	Panel ADF-Statistic	4.22	0.00	5.11	0.00	3.96	0.00

**Table 8**  
**Estimation results for all countries**

	(1)	(2)	(3)
Labour share (t-1)	-0.29*** (0.04)	-0.08*** (0.01)	-0.36*** (0.07)
Exp. retirement duration (t-1)	-0.08*** (0.03)		
Population growth (t-1)		0.007*** (0.001)	
Exp. old-age dep. ratio (t-1)			-0.06*** (0.02)
ARDL	3,2	3,2	3,2
Model	4	3	4
Estimation	LS	SUR	LS
Observations	811	979	811

\*, \*\*, \*\*\* indicate significance at the 10 %, 5 %, 1 % significance level respectively. Model 1: all coefficients are homogeneous, Model 2: heterogeneous constants and homogeneous short and long run coefficients, Model 3: homogeneous constants and long run coefficients and heterogeneous short run coefficients, Model 4: all coefficients are heterogeneous.

**Table 9**  
**Estimation results for openness subsamples**

	Closed			Open		
	(1)	(2)	(3)	(4)	(5)	(6)
Labour share (t-1)	-0.11*** (0.02)	-0.03** (0.01)	-0.04*** (0.01)	-0.29*** (0.05)	-0.04*** (0.02)	-0.05*** (0.01)
Expected retirement duration (t-1)	-0.03*** (0.01)			-0.07 (0.04)		
Population growth (t-1)		0.002 (0.001)			0.003 (0.002)	
Expected old-age dependency ratio (t-1)			-0.01*** (0.003)			-0.02 *** (0.01)
ARDL	5,4	2,1	5,4	3,2	3,2	3,2
Model	2	1	1	4	3	4
Estimation	LS	SUR	LS	LS	LS	LS
Observations	296	404	296	496	584	496

\*, \*\*, \*\*\* indicate significance at the 10 %, 5 %, 1 % significance level respectively. Model 1: all coefficients are homogeneous, Model 2: heterogeneous constants and homogeneous short and long run coefficients, Model 3: homogeneous constants and long run coefficients and heterogeneous short run coefficients, Model 4: all coefficients are heterogeneous.

**Table 10**  
**Estimation results for pension system subsamples**

	PAYGO			Funded		
	(1)	(2)	(3)	(4)	(5)	(6)
Labour share (t-1)	-0.20*** (0.04)	-0.05*** (0.01)	-0.06*** (0.01)	-0.12*** (0.03)	-0.03** (0.01)	-0.11*** (0.03)
Expected retirement duration (t-1)	-0.10*** (0.03)			-0.03*** (0.01)		
Population growth (t-1)		0.002 (0.002)			0.005** (0.002)	
Expected old-age dependency ratio (t-1)			-0.02*** (0.004)			-0.02*** (0.01)
ARDL	3,2	3,2	3,2	3,3	3,2	3,2
Model	4	3	1	2	1	3
Estimation	SUR	SUR	SUR	LS	LS	LS
Observations	432	495	432	370	484	370

\*, \*\*, \*\*\* indicate significance at the 10 %, 5 %, 1 % significance level respectively. Model 1: all coefficients are homogeneous, Model 2: heterogeneous constants and homogeneous short and long run coefficients, Model 3: homogeneous constants and long run coefficients and heterogeneous short run coefficients, Model 4: all coefficients are heterogeneous.

**Table 11****Long-run elasticities with respect to the labour share**

Sample	Expected retirement duration	Population growth	Expected old-age dependency ratio
All countries	-0.26	0.09	-0.17
Open	n.s.	n.s.	-0.39
Closed	-0.32	n.s.	-0.30
PAYGO	-0.49	n.s.	-0.35
Funded	-0.26	0.16	-0.17