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Demographic change and the German current account surplus

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Non-technical summary

Research Question

Germany's current account has come under greater scrutiny in recent years, with the high surpluses coming in for criticism from many quarters. This paper shows by how much demographic change contributed to Germany's high surpluses. It then asks to what extent reforms of the German pay-as-you-go pension system can reduce the current account surpluses.

Contribution

This paper uses a two-region model with endogenous savings, labour supply and a bequest motive that is augmented with demographic data projections for OECD countries. It shows that demographic change is a key determinant of the current account. The model is calibrated to match the German economy and its specific pension system. Based on this, the paper analyses counterfactual pension reforms and shows their impact on the German current account.

Results

This paper shows that an ageing population affects the current account balance and, all else equal, causes it to rise. The effect of demographics on the current account balance is small if other countries undergo a similar demographic development and have a similar pension system. In contrast, the specific cohort structure of Germany, with large cohorts born in the middle of the last century, leads to high current account balances up until 2028. The pension system has an impact on the current account balance. A reduction in the pension replacement rate (as assumed for Germany) leads to higher current account surpluses. In contrast, a higher retirement age reduces the capital supply and increases the capital demand and hence reduces the current account.

Nichttechnische Zusammenfassung

Fragestellung

Der hohe positive deutsche Leistungsbilanzsaldo wird von vielen Seiten kritisiert. Dieses Papier zeigt, wie der demografische Wandel, dem Deutschland zurzeit unterliegt, zu diesem hohen Überschuss beiträgt. Es wird zusätzlich untersucht, wie eine Reform des umlagefinanzierten deutschen Rentenversicherungssystems das deutsche Auslandsvermögen und den deutschen Leistungsbilanzüberschuss beeinflusst.

Beitrag

Die Grundlage der Analyse dieses Papiers bildet ein Zwei-Regionen-Modell. In diesem Modell optimieren Haushalte ihre Ersparnisse, ihre Freizeit und ihren Konsum. In das Modell fließen aktuelle Bevölkerungsdaten und -prognosen der OECD ein. Gleichzeitig ist das deutsche Rentenversicherungssystem sehr detailliert abgebildet. Diese Modellwelt ermöglicht, neben der Analyse des demografischen Wandels, auch die Wirkung kontrafaktischer Rentenreformen auf den deutschen Leistungsbilanzsaldo zu analysieren.

Ergebnisse

Eine alternde Gesellschaft lässt den Leistungsbilanzsaldo steigen. Dieser Effekt ist umso kleiner, je ähnlicher die demografische Entwicklung und das Rentensystem in anderen Ländern sind. Hingegen führt die sehr spezifische deutsche Bevölkerungsstruktur mit besonders großen, Mitte des letzten Jahrhunderts geborenen Kohorten bis 2028 zu positiven Leistungsbilanzsalden. Das Rentensystem hat einen spürbaren Einfluss auf den Leistungsbilanzsaldo. Ein sinkendes Rentenniveau in Deutschland erhöht den deutschen Leistungsbilanzsaldo. Ein höheres Renteneintrittsalter wirkt positiv auf die inländische Kapitalnachfrage und wirkt negativ auf das inländische Kapitalangebot. Somit senkt es den Leistungsbilanzsaldo.

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Demographic Change and the German Current Account Surplus*

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Abstract

This paper shows that demographic change plays an important role in the formation of a country's net foreign asset position. An ageing population both lowers the demand and increases the supply of capital in an economy. Fewer workers reduce the required capital stock. As a longer life span leads to a longer retirement phase individuals save more. Simultaneously, necessary adjustments of pay-as-you-go pension systems to an ageing society affect aggregate savings. Taking Germany as an example, this paper applies a two-region model with endogenous savings and labour supply that is augmented with demographic data projections for OECD countries. It shows that demographic change in Germany is an important determinant of the current account. Counterfactual pension reform simulations show that a fixed pension level increases the current account while a fixed pension contribution rate lowers it. An increase in the retirement age results in a strong negative effect on the current account as it reduces the capital supply and increases the capital demand in an economy.

Keywords: Demographic Change, Current Account, Pension System

JEL classification: E27, E62, F21, H55, J11.

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1 Introduction

Germany's current account has come under greater scrutiny in recent years, with the high surpluses coming in for criticism from many quarters, cf. European Commision (2016), International Monetary Fund (2018), Deutsche Bundesbank (2020). However, the causes of current account fluctuations and efficient means to mitigate imbalances are not fully understood.

This paper evaluates whether pension reforms are an appropriate way to reduce current account imbalances. To do so, this paper applies a quantitative overlapping generations (OLG) model to demonstrate the relationship between a country's ageing population and its current account, using Germany as an example. The quantitative model shows that among pension reforms, an increase in the retirement age is most suitable to reduce the high current account surplus.

The current account is in the following defined as the change in a country's net foreign asset position. In turn, net foreign assets are the difference between domestic demand for capital and the domestic supply of capital. Demographic change impacts both sides of the capital market.

The domestic supply of capital equates to the population's aggregate savings. Demographic change affects aggregate savings in two ways. First, it alters the savings behaviour of individual households. Given a longer life expectancy (assuming, for now, an unchanged retirement age), the period over which households draw the comparatively low income from a pension is extended. To smooth the level of consumption over a longer pension-drawing period, households must accumulate more wealth up until they enter retirement. Higher savings of individual households increase the aggregated assets held in an economy. Second, demographic change alters the compositional structure of the population. The bulk of the population shifts from asset-poor young households towards asset-rich old households and eventually to very old households with again lower amounts of assets. Aggregated across all households, this increases the economy's total assets.

Demand for capital falls in an ageing society. Due to a declining working-age population, the number of people in employment goes down. Fewer people in employment require less capital. As a result, a greater supply of capital and a lower domestic demand for capital lead to capital exports and current account imbalances.

The described effect on the current account is not caused by absolute ageing in an economy, however. The deciding factor is the change of a country's age structure relative to the age structure of countries it shares a capital market with. If the foreign demographic structure is constant or if the foreign population is becoming younger, the domestic economy has strong capital exports. If, however, foreign demographic developments are similar to those domestically, the capital exports are small.

Demographic change places a considerable strain on the pension systems, often dominated by pay-as-you-go (PAYG) schemes. The net foreign asset position can be affected positively or negatively depending on how these systems are adapted to the demographic challenges. Quantitative results show that both higher retirement age and a limit on the pension level (with a rising contribution rate) reduce saving incentives and hence capital supply and foreign assets. If the contribution rate is fixed and the pension level thus lowered, however, capital supply and foreign assets increase. A second important channel of how pension reforms affect foreign assets is via capital demand. An increase in the

retirement age leads to an expansion of labour supply and therefore capital demand. To reduce the high current account surplus, a higher retirement age affects both sides of the capital markets and is very effective.

There is a well-established strand of the academic literature that focuses on the pressure induced by demographic change on social security systems that can be quantified with the use of large-scale OLG models (Samuelson (1958), Diamond (1965)) of the Auerbach-Kotlikoff type (Auerbach, Kotlikoff, and Skinner (1983), Auerbach and Kotlikoff (1987)). A far from exhaustive list includes Attanasio, Kitao, and Violante (2007), Krueger and Ludwig (2007), Ludwig and Reiter (2010), Buyse, Heylen, and de Kerckhove (2013), Kitao (2018). Other authors have argued, within structural models, that unsynchronised demographic trends can shape the dynamics of current accounts, e.g., Poterba (2001), Attanasio, Kitao, and Violante (2006), Ferrero (2010), Börsch-Supan, Härtl, and Ludwig (2014), Backus, Cooley, and Henriksen (2014), Eugeni (2015), Carvalho, Ferrero, and Nechio (2016), Cooley and Henriksen (2018), Schön and Stähler (2020), Devriendt and Heylen (2020). This paper combines both strands of the literature and shows how social security reforms affect international capital flows.

This paper is structured as follows. Section 2 describes the quantitative OLG model. Section 3 discusses the calibration of the model. Section 4 explains the theoretical transmission channels and shows the simulation results for two scenarios in which the underlying demographics differ. Section 5 presents counterfactual pension reform simulations and analyses their effects on the German current account.

2 Model

This paper uses an OLG model with explicit age cohorts and comprises two regions. These two regions are "Home" and "Foreign". The model builds on the basic structure of Auerbach and Kotlikoff (1987) and its adoption by Börsch-Supan, Ludwig, and Winter (2006). As the purpose of this paper is the analysis of the German current account, Home will refer to Germany. In this model, Foreign will be an aggregate of the OECD countries excluding Germany.[1] The model contains a single frictionless capital market. This means that a region's capital stock is not determined by its own savings. And that the rate of return on capital is identical in both regions. However, the labour markets in Home and Foreign are completely separate from one another. This means that there is no endogenous labour migration. Both regions produce a homogeneous consumption and investment good, which can be traded without friction. Each region has three sectors: (i.) a household sector with a large number of utility-maximising households, (ii.) a government sector, and (iii.) a corporate sector comprising one representative profit-maximising enterprise.

2.1 Demographics

The demographic process is taken as exogenous and represents the main driving force of the model. Several cohorts that can be of varying size live in parallel in each region i. A

[1] The Foreign region consists of the following 27 countries: Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Republic of Korea, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, UK, USA.

single cohort, k, per se is homogeneous and consists of identical households. Households begin their (economic) lives at the age of 20 (model age $j = 1$) and live to a maximum of 99 years (model age $j = J^T = 80$). At any point in time, t, the various cohorts are at different stages of life: households go through a life cycle in which they first work and then retire. At the end of each period, there is a given probability that households will die earlier than the maximum life span. The older households are, the greater is this probability. Households of later-born cohorts have a higher life expectancy.

The size of the population in region i of age j in period t is given recursively

$$N_{j,t,i} = N_{j-1,t-1,i}\,\pi_{j-1,t-1,i} + Z_{j,t,i}, \tag{1}$$

where $\pi_{j,t,i}$ denotes the age and time and region specific conditional survival rate and $Z_{j,t,i}$ is the net flow of people into region i at a given age in a given period.[2] In combination with the assumed (and also time-varying) number of newborns $N_{1,t,i}$, this creates demographic change, which is the fundamental driver of the model.

2.2 Pension System

Each region i has a PAYG pension system characterized by a contribution rate, $\phi_{t,i}$, and a replacement rate, $\gamma_{t,i}$. The budget of the PAYG pension systems has to be balanced at any time t,

$$\phi_{t,i} w_{t,i} \sum_{j=1}^{J^R_{t,i}-1} \varepsilon_{j,t,i} l_{j,t,i} N_{j,t,i} = \sum_{j=J^R_{t,i}}^{J^T} b_{j,t,i} p_{j,t,i} N_{j,t,i} \tag{2}$$

with

$$b_{j,t,i} = \begin{cases} 0 & \text{if } j < J^R_{t,i} \\ b_{t,i} = \gamma_{t,i}(1-\phi_{t,i}) w_{t,i} \frac{1}{J^R_{t,i}-1} & \text{if } j \geq J^R_{t,i} \end{cases} . \tag{3}$$

On the revenue side, $w_{t,i}$ denotes (gross) wages. Households have age-specific labour productivity denoted by $\varepsilon_{j,t,i}$. Labour supply of households denotes as $l_{j,t,i}$. On the expenditure side of the pension budget equation are pension payments. Pensions are defined by an earnings point system. The paid out pension is calculated by multiplying the number of acquired earnings points, $p_{j,t,i}$, with the pension value, $b_{j,t,i}$. The pension value consists of the replacement rate, $\gamma_{t,i}$, times the wage rate (after pension contributions) at time t divided by $J^R_{t,i} - 1$, the number of years in a standardized working life. $J^R_{t,i}$ is the retirement age in period t in region i. In each period of its working life a fully working household collects one earnings point,

$$p_{j+1,t+1,i} = \begin{cases} p_{j,t,i} + l_{j,t,i} & \text{if } j < J^R_{t,i} \\ p_{j,t,i} & \text{if } j \geq J^R_{t,i} \end{cases} . \tag{4}$$

This earnings point system connects the labour supply during working life with the pension payments received during the retirement phase.

[2] Due to computational reasons, migrants enter the specific region with the exact same amounts of assets and earnings points as households with the same age that already live in the respective region.

Rewriting the pension budget constraint gives

$$\phi_{t,i} w_{t,i} L_{t,i} = \gamma_{t,i}(1 - \phi_{t,i}) w_{t,i} P_{t,i}, \tag{5}$$

where $L_{t,i} = \sum_{j=1}^{J_{t,i}^R - 1} \varepsilon_{j,t,i} l_{j,t,i} N_{j,t,i}$ denotes the number of contributors. The number of contributors equals the aggregate labour supply within each region. The number of pensioners in each region is $P_{t,i} = \sum_{j=J_{t,i}^R}^{J^T} \frac{p_{j,t,i}}{J_{t,i}^R - 1} N_{j,t,i}$.

The law of motion of the replacement rate in Home follows the German pension formula[3]

$$\gamma_{t,H} = \gamma_{t-1,H} \frac{1 - \phi_{t-1,H}}{1 - \phi_{t-2,H}} \left[\left(1 - \frac{Q_{t-1,H}}{Q_{t-2,H}} \right) \times 0.25 + 1 \right] \tag{6}$$

with the old-age dependency ratio defined as

$$Q_{t,i} = \frac{P_{t,i}}{L_{t,i}}. \tag{7}$$

The old-age dependency ratio is the main driving force for the pension replacement rate. If for example fewer households pay contributions or more households claim pensions the replacement rate decreases. A decrease in the replacement rate due to rising expenditures, however, does not fully offset the increase in pension expenditures. Consequently, the contribution rate has to increase to keep the pension budget in balance. The German pension formula splits the economic burden of the demographic change between contributors and pensioners. So it is neither a fixed benefit nor a fixed contribution scheme.

The PAYG system in Foreign is modelled as a fixed benefit scheme.[4] In this case, the pension replacement rate is constant over time with

$$\gamma_{t,F} = \gamma_F. \tag{8}$$

Consequently, an increase in the number of pensioners or fewer contributors to the pension system does not reduce the replacement rate. All additional expenditures and a shrinking contribution base are offset by an increase in the contribution rate. The contributors bear the complete economic burden of demographic change.

The pension contribution rate in each region endogenously adjusts to equalize the pension system budget

$$\phi_{t,i} = \left[1 + \frac{L_{t,i}}{\gamma_{t,i} P_{t,i}} \right]^{-1}. \tag{9}$$

2.3 Firms

Firms produce in each region with a Cobb-Douglas production function employing capital and labour

$$Y_{t,i} = \Omega_{t,i} K_{t,i}^{\alpha} L_{t,i}^{1-\alpha} \tag{10}$$

[3] In the original German pension formula, an additional term exists that accounts for private old-age provisions. A more detailed analysis of the German pension system in the light of demographic change can be found in Schön (2020).

[4] The fixed benefits scheme is the most prevalent pension system in OECD countries, cf. OECD (2019).

where $K_{t,i}$ denotes the aggregate capital stock. The output elasticity of capital is α. The total factor productivity (TFP) levels of each region are denoted by $\Omega_{t,i}$.

The labour productivity of a household, $\varepsilon_{j,t,i}$, is age-dependent. The aggregate labour supply is the sum over all age groups of the fraction of households working times the age specific labour productivity

$$L_{t,i} = \sum_{j=1}^{J_{t,i}^R - 1} \varepsilon_{j,t,i} l_{j,t,i} N_{j,t,i}. \tag{11}$$

A static firm maximizes profits subject to capital accumulation condition

$$K_{t+1,i} = (1 - \delta) K_{t,i} + I_{t,i} \tag{12}$$

where $I_{t,i}$ is gross investment and δ is the depreciation rate.[5]

The first order conditions from profit maximizing define the equilibrium capital intensity ratio within each region

$$r_t + \delta = \alpha \Omega_{t,i} \left(\frac{K_{t,i}}{L_{t,i}} \right)^{\alpha - 1} = \alpha \frac{Y_{t,i}}{K_{t,i}} \tag{13}$$

and gross wages

$$w_{t,i} = (1 - \alpha) \Omega_{t,i} \left(\frac{K_{t,i}}{L_{t,i}} \right)^{\alpha} = (1 - \alpha) \frac{Y_{t,i}}{L_{t,i}}. \tag{14}$$

2.4 Households

By choosing an optimal consumption path and labour supply, each cohort k maximizes at any age j and point in time $t = k + j - 1$ the sum of discounted future utility. The utility function is additive and separable over time. Cohort k's maximization problem at $j = 1$ is given by

$$\max_{\{c_{j,t,i}, l_{j,t,i}\}_{j=1}^{J^T}} \quad \sum_{j=1}^{J^T} \beta_i^{j-1} \left(s_{j,t,i} U \left(c_{j,t,i}, 1 - l_{j,t,i} \right) + (1 - s_{j+1,t+1,i}) B(a_{j+1,t+1,i}) \right) \tag{15}$$

where β_i is the pure time discount factor. In addition to pure time discounting households discount future utility with their unconditional survival probability, $s_{j,t,i} = \prod_{m=1}^{j} \pi_{m-1,t,i}$. Households derive utility from consumption, $c_{j,t,i}$, leisure, $1 - l_{j,t,i}$, and from bequeathing assets to the next generation $B(a_{j+1,t+1})$.

Denoting households assets by $a_{j,t,i}$, maximization of the household's inter-temporal utility is subject to a dynamic budget constraint given by

$$a_{j+1,t+1,i} = \left(1 + \left(1 - \tau_{t,i}^a\right) r_{t+1}\right) \left(a_{j,t,i} + \left(1 - \tau_{t,i}^y\right) y_{j,t,i} - \left(1 + \tau_{t,i}^c\right) c_{j,t,i}\right) \tag{16}$$

where $\tau_{t,i}^a$ is the capital gain tax rate, $\tau_{t,i}^c$ is the consumption tax rate and $\tau_{t,i}^y$ is the labour

[5] Capital adjustment costs are not considered.

and pension income tax rate.[6]

Bequests are distributed equally among the newborn generation,

$$a_{1,t+1,i}\, N_{1,t+1,i} = \sum_{j=1}^{J^T}(1-\pi_{j,t,i})(1+\left(1-\tau^a_{t,i}\right) r_{t+1})a_{j,t,i}N_{j,t,i}. \tag{17}$$

Income consists of asset income and wage income during the working period and pension income during retirement.[7]

$$y_{j,t,i} = (1-\phi_{t,i})w_{t,i}\varepsilon_{j,t,i}l_{j,t,i} + b_{j,t,i}p_{j,t,i}. \tag{18}$$

Maximization is also subject to the constraint that leisure may not exceed 1,

$$0 \leq l_{j,t,i} \leq 1. \tag{19}$$

2.5 Government

The government taxes labour income, pension income, capital income, and consumption in order to finance government consumption, $G_{t,i}$. The government budget reads as

$$G_{t,i} = \tau^y_{t,i}\sum_{j=1}^{J^T} y_{j,t,i}N_{j,t,i} + \tau^c_{t,i}\sum_{j=1}^{J^T} c_{j,t,i}N_{j,t,i} + \tau^a_{t,i}r_{t+1}\sum_{j=1}^{J^T} a_{j,t,i}N_{j,t,i}. \tag{20}$$

2.6 Definition of Equilibrium

A competitive equilibrium of the economy is defined as a sequence of disaggregated variables, $c_{j,t,i}, l_{j,t,i}, a_{j,t,i}$, aggregate variables, $C_{t,i}, A_{t,i}, L_{t,i}, K_{t,i}$, a wage rate $w_{t,i}$, pension policies, $\phi_{t,i}$, $\gamma_{t,i}$, in each region i and a common world interest rate, r_t such that

1. The allocations are feasible, i.e.

$$Y_{t,i} + r_t F_{t,i} = S^n_{t,i} + D_{t,i} + C_{t,i} + G_{t,i} = S^g_{t,i} + C_{t,i} + G_{t,i} \tag{21}$$

   where $F_{t,i}$ is the amount of net foreign assets, $S^n_{t,i}(S^g_{t,i})$ is net (gross) savings and $D_{t,i}$ is depreciation of capital.

2. Factor prices equal their marginal products, i.e., capital rates of return and wages satisfy equation (13) and equation (14).

3. Given prices and initial conditions households maximize life time utility given in equation (15) subject to constraints in equation (16) and equation (19). Firms maximize profits subject to the capital accumulation constraint given in equation (12).

[6]The model assumes that both pension income and labour income are taxed with the same tax rate.

[7]Households face no income risk in the model and have no incentive to accumulate precautionary savings. Besides the old-age provision, the risk of unemployment might be an important driver of asset accumulation. Ruppert and Stähler (2020) analyse the influence of unemployment risk on the current account.

4. Pension policies satisfy equation (5) in every period.

5. Markets clear. Market clearing on national markets requires that

$$C_{t,i} = \sum_{j=1}^{J^T} c_{j,t,i} N_{j,t,i}, \;\; A_{t,i} = \sum_{j=1}^{J^T} a_{j,t} N_{j,t,i}, \;\; L_{t,i} = \sum_{j=1}^{J_{t,i}^{R-1}} \varepsilon_{j,t,i} l_{j,t,i} N_{j,t,i}$$

Market clearing on the international capital market and the assumption of perfect capital mobility across regions requires that the rate of return on financial investment is equalized across all regions,

$$r_t = r_{t,i} \tag{22}$$

and that the sum of all foreign assets, defined as the difference between home assets and the home capital stock, $F_{t,i} = A_{t,i} - K_{t,i}$, across all world regions equals zero, i.e.

$$F_{t,H} + F_{t,F} = 0. \tag{23}$$

International capital flows are defined by the difference between foreign assets in two successive periods,

$$CA_{t,i} = F_{t+1,i} - F_{t,i} = S_{t,i}^g - I_{t,i}. \tag{24}$$

3 Calibration

The calibration aims to match the German economy. Specifically, Germany's (foreign) asset position and its complex pension system are matched to have a good baseline model for policy evaluation.

Calibration of the model requires (i) data for the exogenous demographic processes and (ii) determination of values for several structural model parameters. The first set of structural parameters is taken from the literature. A second set of nine parameters $\{\Omega_H, \Omega_F, \tau^y, \hat{\varepsilon}, \beta_H, \beta_F, \xi_H, \xi_F, \upsilon\}$ is determined by calibration. The calibration procedure is loosely based on Ludwig, Schelkle, and Vogel (2012) and Devriendt and Heylen (2020). It consists of five steps. The calibration is done separately for the two scenarios "Domestic demographic change" and "Global demographic change".[8]

1. Given initial guesses for the parameters of time preference, total factor productivity, bequest motive, income tax and consumption utility weight, an artificial initial steady-state is calibrated. It is assumed that the world economy (Home & Foreign) was in a steady-state in 1960, which is the starting point of the model. The population distribution is assumed stationary at this point. This is achieved by assuming survival rates and fertility rates to be constant at their 1960s value.

2. The demographics (for the respective scenario), the rate of technical progress and data on policy variables (until 2015) are fed into the model as exogenous driving

[8] In Appendix A Tables 1 - 1 provide an overview of the parameters used.

forces and calculate the transition path to the new steady-state (assumed to be reached in 2500).

3. The simulated averages along the transition are calculated and compared with the real moments in the calibration period which is 2015. Overestimation or underestimation ratios are calculated (i.e. simulated moments divided by real moments).

4. The calibration targets of step 1 are rescaled by dividing them by these ratios.

5. Steps 2 to 4 are repeated until the distance between simulated and real moments in 2015 is minimized.

Demographics The model period is one year. For the demographic process, historical data and projections from the OECD are used. These data sets include very detailed information about the age structure of Germany and the rest of the OECD countries at national levels. Additionally, net migration data and projections for Germany and the OECD are used to derive survival rates that are consistent with population age structure. After 2080 the demographic parameters are assumed to be constant.

Technology The output elasticity of capital is set to $\alpha = 1/3$. Furthermore, the model targets the aggregated depreciation to output ratio in Germany, $\frac{\delta K}{Y} = 18\%$, and a capital-output ratio of $\frac{K}{Y} = 2.8$. This implies a yearly rate of depreciation of $\delta = 6.46\%$. The levels of the production in each region in 2015 are targets of the calibration (Home: €3.187 trillion and Foreign: €42.609 trillion). The TFP growth rate is constant and identical in both regions, $\frac{\Omega_{t+1,i}}{\Omega_{t,i}} = \mu_i = \mu$. It is set to the forecast value used by the Bundesbank for GDP projection, $\mu = 0.7\%$.

Labour Productivity The age structure of the employment rate is hump-shaped. In the early years of the household (probably due to ongoing education) it starts low. It reaches a maximum at $j = 30$(=biological age of 50) and then remains. At the statutory retirement age, the employment rate drops sharply. To capture this pattern labour productivity linearly increases over age. Each year the household's productivity increases by ε. It increases for the first 30 years of the household by 20% and remains constant until the retirement age.[9] After the statutory retirement age, labour productivity is zero.

$$\varepsilon_{j+1,t,i} = \begin{cases} \varepsilon_{j,t,i} + \hat{\varepsilon} & \text{if } 1 \leq j \leq 30 \\ \varepsilon_{j,t,i} & \text{if } 30 < j < J^R_{t,i} \\ 0 & \text{if } j \geq J^R_{t,i} \end{cases} \tag{25}$$

with $\varepsilon_{1,t,i}$ such that

$$\frac{1}{J^R_{t,i} - 1} \sum_{j=1}^{J^R_{t,i}-1} \varepsilon_{j,t,i} = 1. \tag{26}$$

[9]This labour productivity profile resembles the findings in Hansen (1993).

Government / Pension System All tax rates are assumed to be the same in both regions. Consumption tax rate is constant over time and set to $\tau^c_{t,i} = \tau^c = 19\%$. The capital gains tax rate is also constant over time and set to $\tau^a_{t,i} = \tau^a = 25\%$. Labour and pension income tax rates are endogenously calibrated. A target in the calibration is the German tax burden of 39.8% of GDP in 2015. The labour and pension tax rate in Foreign is the same as in Home, $\tau^y_{t,i} = \tau^y_t$.

The pension system in Home is closely tied to the German pension system. For the calibration period, the pension replacement rates are taken from the data and set $\gamma_{1,1}$ accordingly. In the forecast period the pension replacement rate follows equation (6). In the benchmark calibration, the pension system in Foreign is a fixed benefit system. The replacement rate for Foreign is difficult to pick as there is not only one pension system and replacement rate in the OECD countries. Therefore the model uses the average net replacement rate, $\gamma_2 = 58.6\%$, described in the recent OECD report, cf. OECD (2019).

Preferences The period-specific utility function is of the standard Cobb Douglas form given by

$$U\left(c_{j,t,i}, 1 - l_{j,t,i}\right) = \xi_i \, ln\left(c_{j,t,i}\right) + \left(1 - \xi_i\right) \, ln\left(1 - l_{j,t,i}\right) \tag{27}$$

where θ is the inverse of the inter-temporal elasticity of substitution and ξ_i is the consumption share parameter, i.e., the weight of consumption relative to leisure in household's utility.

Utility from bequests is

$$B\left(a_{j,t,i}\right) = \upsilon \, ln\left(a_{j,t,i}\right) \tag{28}$$

with $\upsilon \in (0, 1)$ and where $B\left(a_{j,t,i}\right) = 0$ if $\upsilon = 0$. Larger values of υ mean that people leave a larger share of wealth. A further calibration target is the aggregated bequests in Germany which are roughly €315 billion in 2015.[10]

The calibration target for the capital to output ratio in the Home region (Germany) is $\frac{K}{Y} = 2.8$. This capital output ratio together with the capital share and the depreciation rate implies a net return to capital of

$$r_{2015} = \alpha \frac{Y_{2015,H}}{K_{2015,H}} - \delta = 5.4\%. \tag{29}$$

Furthermore the calibration targets the net foreign assets position of Germany in 2015 which is €1.246 trillion .

The total numbers of workers in each region in 2015 are targeted in the calibration. For Home (Germany) this is 40 million workers and for Foreign (OECD) I assume 534 million workers in 2015.[11]

[10] Without the inheritance motive, optimising households would use up their wealth entirely until they reach the maximum age. It should be noted that the inheritance motive is not contingent on the size of the next generation.

[11] These employment estimates are taken from the OECD database.

4 Demographic Change and Current Account

Demographic trends in Germany have been identified as one of the main drivers of Germany's large current account surpluses. In the model introduced here, the current account balance is the change in external assets. In turn, the level of domestic foreign assets is the difference between the domestic supply of assets and the domestic demand for capital.

Capital demand depends on the number of employed persons for whom capital is required. If this number decreases due to demographic trends, the demand for capital also falls. All other things being equal, external assets would have to rise and the current account balance would be positive.

Demographic change in Germany affects the supply of assets primarily via two channels. First, households (on average) adapt their savings behaviour so that total assets ultimately rise. Younger individuals save to prepare themselves for losses of (wage) income in old age. If individuals' life expectancy rises, they must then make provisions to cover a longer period of time (assuming the retirement age remains constant). Moreover, in light of lower birth rates, households are anticipating that a smaller number of young people will have to finance the pensions of an ever greater number of pensioners. Depending on the characteristics of the pension insurance scheme, the pressure on the pension system arising from this could lead to falling pensions (and/or rising contribution rates). The income gap in old age would become wider, and the optimal amount of assets required to smooth consumption would be higher.

Second, demographic change is altering the relative sizes of age groups. In an ageing society such as Germany, the population weight is shifting from young, asset-poor households towards old, asset-rich households. Total wealth rises as a result. This compositional effect is not dependent on the changed savings behaviour described above.

To evaluate the quantitative impact of the ongoing demographic change on the future German current account two scenarios are presented below. In the first scenario, demographic change occurs only domestically (in Germany). The population of Home is based on the OECD population forecast for Germany. In contrast, the demographic structure of the Foreign region (OECD excluding Germany) remains constant on its 2015 level (and not following equation (1)). This highly stylised scenario highlights how domestic populating ageing theoretically affects the current account.

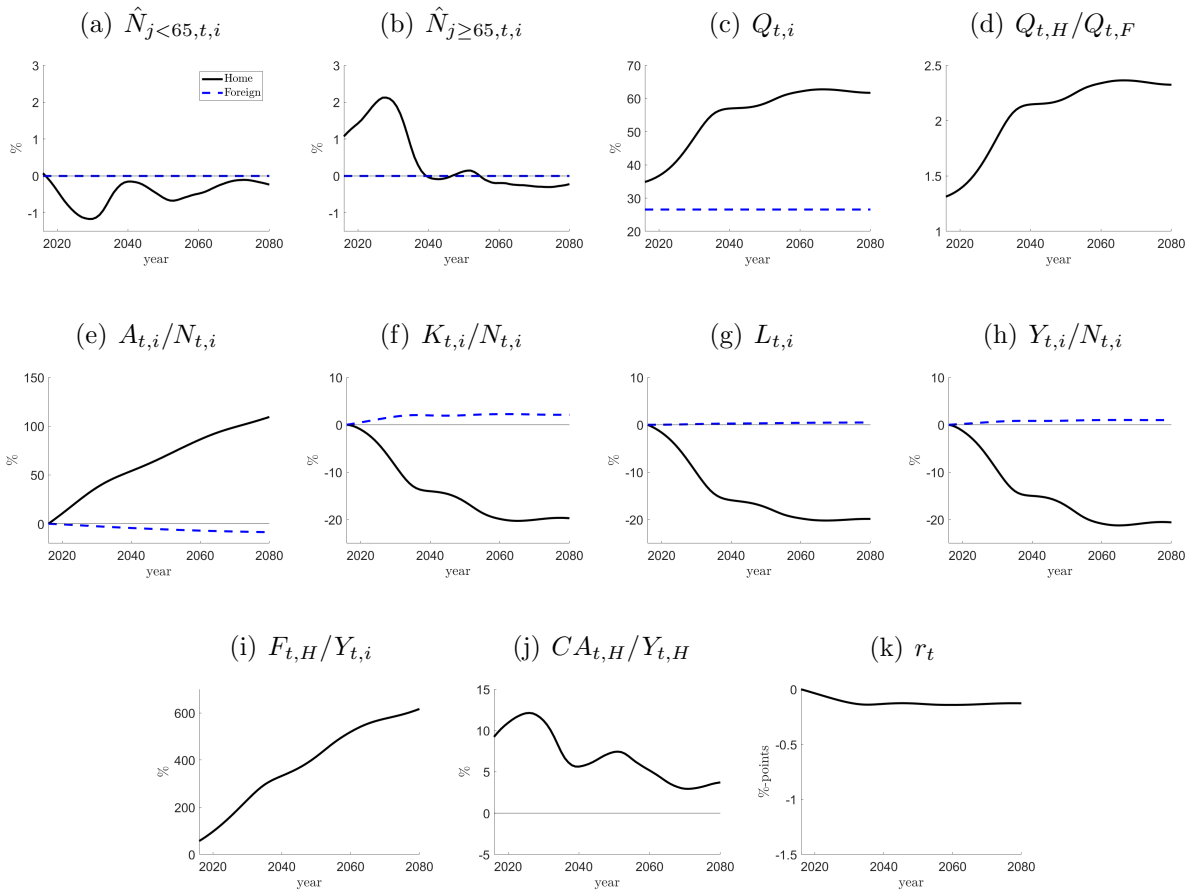
In the second scenario, also the population forecast of the OECD (excluding Germany) is incorporated into the model. The size and the age structure of the OECD as well as the survival rates change over time. This is the more realistic scenario that provides an estimate for the true effect of the demographic change on the current account.

4.1 Domestic Demographic Change

Figure 1 shows the simulation results of the scenario where the demographic change only exists in Germany. In panel (a) of Figure 1, the growth rate of the population that is younger than 65 years in Home (Germany) is constantly negative. It reaches its minimum of -1.2% in 2029. This downturn in the next 10 years is being driven chiefly by the entering of the baby boomer generation into retirement age. This pattern is also reflected by the growth rate of the population older than 65 (panel (b) of Figure 1). Consequently, the ratio of the population older than 65 years to the population younger than 65 years -

the old-age dependency ratio (OADR) - rises. According to the OECD forecast, the OADR in Germany will increase from just under 35% (in 2016) to 63% (in 2066) (panel (c) in Figure 1). This ratio sees significant fluctuations over time caused by disproportionately large generational cohorts. So the baby boomers account for the strong increase between 2020 and 2040. The second surge in the OADR between 2050 and 2060 results from the also relatively large generation of the baby boomers' children.

Figure 1: Domestic demographic change



Notes: Black solid lines show simulation results for Home region. Blue dashed lines show simulation results for Foreign region. Panels (e) - (h) & (k) show relative differences to 2015 level of respective variables.

Demographic change in the Home region has an obvious impact on the domestic macroeconomic variables (panel (e)-(h) of Figure 1). Asset holdings of domestic households rise sharply. As mentioned above, this increase is a result of the longer life expectancies and a changing demographic structure. On the other side of the capital market, the declining number of employed persons in the Home region leads to reduced demand for capital. Less capital and a lower number of employed persons lead to a reduction in aggregate GDP (and GDP per capita).

Although the Foreign region is not subject to demographic change in this specification, the macroeconomic variables change there, too. The reason for this is that the

Home region has excess capital which it relocates abroad. This occurs because the continually high number of employed persons abroad allows for greater return on assets than in Home. The imported capital allows foreign wages to grow, and foreign households slightly increase their endogenous labour supply. In turn, the return on capital decreases (panel (k) in Figure 1). Domestic asset supply affects the yields because the Home region is not atomistically small relative to the Foreign region. Home (Germany) constitutes approximately 8% of the total economy (OECD). However, the falling return on capital reduces the asset-demand of foreign households. In other words, domestic households asset supply crowds out asset holding of foreign households.

As a consequence of lower domestic demand for capital and a rising supply of assets in the Home region, foreign assets of domestic households see strong growth. It is clear to see that there is a strong correlation between net foreign assets (NFA) (panel (i) in Figure 1) and the domestic old-age dependency ratio.[12] In the baseline calibration, the current account (CA) balance would have to reach its peak by around 2025 (panel (j) in Figure 1). However, the balance would also remain positive beyond that time, as the domestic population would continue to age.[13] Here, the response by return on assets has a dampening effect on the current account balance.[14]

4.2 Global Demographic Change

In the next scenario, Foreign (OECD excluding Germany) is now also subject to demographic change in line with the OECD forecast. As in Germany, the growth rate of the population younger than 65 is most of the time negative (panel (a) in Figure 2). The growth rate of the population older than 65 is declining but constantly positive (panel (b) in Figure 2). The old-age dependency ratio rises from 27% in 2016 to 56% in 2080. Admittedly, this means that the OADR in Foreign remains below that of the Home region over the long term. However, it sees similar growth between 2016 and 2080. The level of the relative OADR decreases slightly over time, but with fluctuations (panel (d) in Figure 2). The main reason for the fluctuation is that the baby boomer generation in the OECD is significantly smaller than in Germany.

Similar to the effect of the domestic demographic change on foreign variables, the foreign demographic change affects domestic macroeconomic variables (panel (e) - (h) in Figure 2). In this scenario, the domestic effects are considerably less pronounced compared with the baseline scenario. There is only a small increase in the wealth of

[12] This translates in a strong correlation between the change in the old-age dependency ratio and the current account balance.

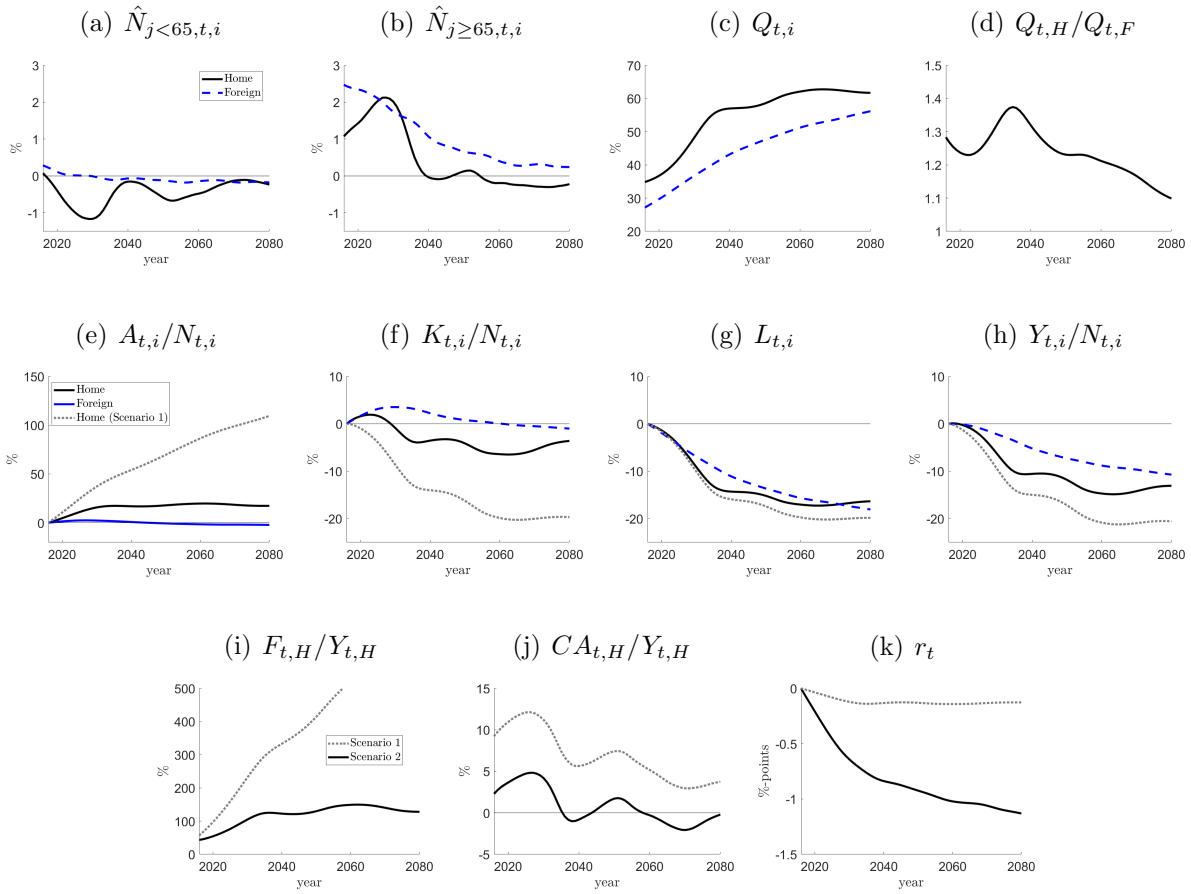
[13] Decomposing the past German current account is not expedient in this specification of the model as it does not account for the German reunification in 1990. However, this event plays a significant role in the development of German external asset. Between 1990 and 2000, German external assets were reimported in their entirety to replenish and/or expand East German capital stock. In terms of the model, German reunification would be a kind of negative capital shock that took the economy off its general path of equilibrium. The high capital surpluses in recent years would therefore be interpreted as a process of returning to the path of equilibrium.

[14] If it is assumed that "other countries" refers not only to the OECD but to the rest of the world, then Germany would be a small, open economy and its savings would have no impact on the global return on assets. In comparison with the described scenario, interest rates do not fall and households increase their saving as a result. The additional wealth would largely flow back out abroad, driving the current account surplus up further.

domestic households. In turn, the domestic capital stock increases in the following years before turn negative in the long run. However, the drop in domestic capital stock is much less pronounced than in the baseline scenario. The number of employed persons, as well as output in the Home region, is higher than in the baseline scenario.

There is no decline in asset holdings of foreign households in this scenario. This is connected to the fact that households' savings behaviour and the demographic structures in other countries are now changing, too. A direct effect of population ageing abroad is that the number of employed persons in other countries now also declines over time. This leads to lower output abroad, both in absolute terms and per capita.

Figure 2: Global demographic change



Notes: Black solid lines show simulation results for Home region in the "Global demographic change" scenario. Blue dashed lines show simulation results for Foreign region in the "Global demographic change" scenario. Grey dotted lines show results of Home region from previous scenario "Domestic demographic change". Panels (e) - (h) & (k) show relative differences to 2015 level of respective variables.

Population ageing in Foreign is likewise of key importance for domestic foreign assets. The smaller build-up of wealth and less pronounced drop in the number of employed persons in Home lead, on average, to a balanced current account (panel (j) in Figure 2). This means that, in this scenario, demographic change cannot explain the present current account surplus that amounts up to 8.9% in 2015, cf. Deutsche Bundesbank (2018).

However, there are large fluctuations in the balance, which are due to the cohort effects mentioned above. As capital demand comes out lower in the aggregate economy (both regions combined), the return on assets also falls much more sharply than in the baseline scenario (panel (k) in Figure 2.

5 Pension System Reforms and Current Account

The previous section gave an understanding of how demographic change impacts the current account and foreign assets. This understanding is important to develop effective policy options to reduce the high German current account surplus which is demanded in various quarters.

The previous simulations showed that one main channel through which the demographic change increases the current account is saving. Savings depends to a large extent on the characteristics of the pension system. A reform of the pension system is therefore a promising tool in shaping the current account. A pension reform might also impact the demand for capital in a given economy. The effects on the current account do not necessarily have to be in the same direction, however. In theory, it is not always clear which effect ultimately prevails. A quantitative economic model can answer this question, however, given the model assumptions.

In the analysis below, I simulate three different reforms of the Home pension system, with current German pension legislation used as the baseline. In the first pension reform, the retirement age gradually increases from 65 in 2015 to 69 in 2055.[15] This increase in retirement age stabilizes the fraction of lifetime households spend in retirement while life expectancy is growing at the 2015 level. The pension level adjusts according to equation (6) and the contribution rate adjusts endogenously to balance the pension budget. The second reform fixes the German pension level at 48% of the average wage and the retirement age at 65. The contribution rate adjusts endogenously to balance the pension budget. The third reform holds the pension insurance contribution rate steady at 18% and the retirement age at 65. In this scenario, the pension level adjusts endogenously to balance the pension budget.

5.1 Increased Retirement Age

A gradual increase in the retirement age from 65 to 69 prolongs the phase in which households are economically active, meaning that the number of persons in work is higher.[16] These additional people in employment require capital. An increase in aggregate demand for capital lowers the current account balance.

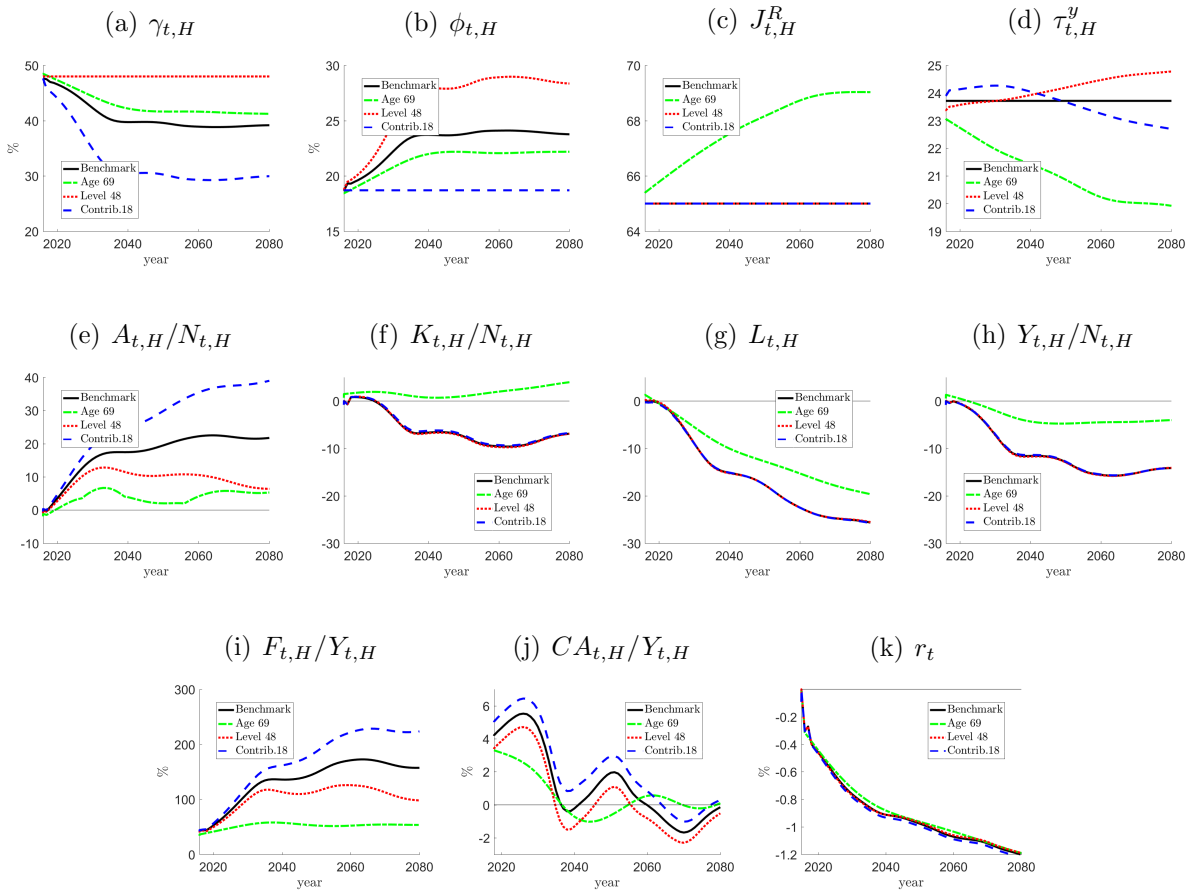
Compared to a constant retirement age, a higher retirement age also reduces optimal retirement provision. For one thing, the time in which households draw a pension, which is only a fraction of the working life wage income, is shorter. For another, more contribution payers and fewer recipients ease the strain on the pension insurance scheme. The pension

[15] The model period lasts one year, which means that the retirement age can only ever go up by one year. In the real world, however, the retirement age is being increased monthly and in increments. To avoid erratic negative fluctuations in the current account balance I smooth the time series using an HP-filter.

[16] Households do not have the option of early retirement. This means that the retirement age has a very strong impact on the number of persons in employment.

level increases relative to the baseline scenario. Both lower the optimal household wealth. Less wealth also means a lower supply of capital, and the domestic current account balance drops, too. A higher labour supply also raises tax revenue. A lower tax rate is sufficient to finance the same government consumption as in the baseline scenario. In turn, this additionally increases the incentive to supply labour and reinforce the effect.

Figure 3: Domestic pension reform



Notes: Black solid lines show simulation baseline results. Green dashed-dotted lines show simulation results for the scenario with increased retirement age. Red dotted lines show simulation results for the scenario with constant pension level. Blue dashed lines show simulation results for the scenario with constant contribution rate. Panels (e)-(h) & (k) show relative differences to 2015 level of respective variables.

In theory, a higher retirement age therefore clearly reduces the current account balance. This result is also reflected in panel (i) of Figure 3. The net foreign assets to GDP ratio is 120%-points lower than in the baseline scenario by 2060.

5.2 Fixed Pension Level

The limit on the pension level currently being called for from many quarters would be funded through higher pension contributions and increased taxes. Higher pension contributions would mean lower net salaries, however, which would lower incentives to supply

labour. A lower labour supply also reduces the demand for capital. The current account balance would therefore have to increase as capital can be invested better abroad.

The stipulated pension level would be higher than in the baseline scenario. Households would therefore have fewer incentives to plan for their retirement in this scenario too, as the loss of income in old age would be lower. All other things being equal, a smaller pension provision would lower the current account balance.

On balance, both the demand for and the supply of capital are declining in Germany. The effects on the current account therefore work in opposite directions, and it is theoretically not possible to derive the net impact. Net foreign assets are lower 45%-points lower by 2060 (panel (i) in Figure 3). Current account balance needs to fall.

5.3 Fixed Pension Contribution

As opposed to limiting the pension level, this reform fixes the contribution rate at the current German level of 18%. Compared with the growth in the contribution rate assumed in the baseline scenario, the contribution would be lower and the net salary higher. The higher net salary raises the incentive to work. More employed persons require more capital and the current account balance drops.

Due to demographic change, stagnant contribution rates result in a lower pension level. If there is a decline in the pay-as-you-go pension, rational households save more. This increase in private saving raises the supply of capital and in turn the current account balance, too.

These effects are also theoretically working in opposite directions in this scenario. The reform results in higher demand for capital and higher supply of capital. The effect of the increasing supply of capital dominates the effect of the increasing demand for capital. The domestic current account balance would be lower. Foreign assets would rise in the long term (blue line in panel (i) in Figure 3). By 2060, they would be 50%-points higher than without a reform.

6 Conclusion

The OLG model simulations show that, when viewed in isolation, the demographic change in Germany leads to a positive and increasing current account balance. Various pension reforms have different effects on the current account. It turns out that a higher retirement age would reduce the current account surplus if, for this reason, households were to work longer. One explanation for this is that the higher supply of labour raises the demand for capital. Secondly, working longer reinforces financial security in old age and the formation of retirement provision is thus significantly reduced.

However, demographic changes in Germany are not sufficient to explain the developments observed in the current account balance. The resulting differences between Germany and abroad are ultimately the key determinants. This concerns, for one thing, demographic trends, but also the design and, under certain circumstances, the pension reforms.

In summary, the following points can be derived from the model simulations: An ageing population affects the current account balance and, ceteris paribus, causes it to rise. The effect of demographics on the current account balance is small if other countries undergo

a similar demographic development and have a similar pension system. In contrast, the specific cohort structure of Germany, with large cohorts born in the middle of the last century, leads to high current account balances up until 2028. The pension system design has an impact on the current account balance. A reduction in pay-as-you-go pension schemes (as assumed for Germany) leads to higher current account balances. A higher retirement age reduces the current account.

A Parameter Values

Table 1: Set parameter

Parameter	Interpretation	Value
α	Capital share	1/3
δ	Depreciation rate	6.46%
μ	Total factor productivity growth	0.7%
τ^c	Consumption tax	19%
τ^a	Capital tax	25%
γ_2	Foreign replacement rate	58.6%
J^R	Statutory retirement age	65

Table 2: Calibration Targets

Targets	Value
GDP Germany 2015 in billion €	3187
GDP (OECD-Germany) 2015 in billion	42.60
Tax burden Germany 2015	39.8%
Employment rate difference over age	20%
Bequests Germany 2015 in billion €	315
Capital Output Ratio in Germany	2.8
Net foreign assets of Germany 2015 in billion €	1246
Total employment Germany 2015 in million	40
Total employment (OECD-Germany) 2015 in million)	534

Table 3: Calibrated parameter

Parameter	Interpretation	Value	
		Domestic	Global
Ω_H	Total factor productivity - Home	1368	1368
Ω_F	Total factor productivity - Foreign	1312	1305
$\hat{\varepsilon}$	Labour productivity profile	7.8%	7.2%
τ^y	Labour and pension income tax	30.6%	29.7%
υ	Bequest motive	5.493	3.839
β_H	Time discount factor - Home	0.975	0.975
β_F	Time discount factor - Foreign	0.973	0.978
ξ_H	Consumption utility weight - Home	0.764	0.774
ξ_F	Consumption utility weight - Foreign	0.754	0.720

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