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German labor market and fiscal reforms 1999 to 2008: can they be blamed for intra-euro area imbalances?

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Non-technical summary

Research Question

At the beginning of the 2000s, Germany was called Europe's "sick man" because of comparatively low GDP growth, relatively high and persistent unemployment and low price and cost competitiveness. Nowadays, the German economy is frequently called "Europe's growth engine". Price and cost competitiveness has increased significantly since the beginning of the 2000s, building up high current account surpluses and a positive net foreign asset position. By many, structural reforms from 1999 to 2008 in Germany, especially the "Hartz reforms" on the labor market, are considered to be the root of the positive developments in Germany and the thereafter observed imbalances in the Euro Area. We assess the contribution of these reforms to the development of key domestic and foreign macroeconomic variables and especially intra-Euro Area imbalances.

Contribution

We use a modern macroeconomic model to assess the impact of the reforms. To this end, we construct a medium-scale two-country monetary union DSGE model with a detailed frictional labor market structure and a comprehensive fiscal block which is well suited to simulate fiscal and labor market reforms and, therefore, derive quantitative results.

Results

We find that, in terms of German GDP, consumption, investment and (un)employment, the reforms were a clear success albeit the impact on the German trade balance and the current account was only minor. Most importantly, the rest of the Euro Area benefited from positive spillover effects. Our analysis suggests that the reforms cannot be held responsible for the currently observed macroeconomic imbalances within the Euro Area. To explain the persistent German current account surplus one therefore needs to search for and find other arguments. A possible candidate could be higher savings preferences in Germany. The latter could potentially be a result of an ageing society realizing that expected pensions may be lower than previously anticipated or of increased income uncertainty because of massive cuts in the generosity of the unemployment benefit system. However, further research in this direction is certainly needed.

Nichttechnische Zusammenfassung

Fragestellung

Aufgrund vergleichsweise geringer Wachstumsraten, hoher und persistenter Arbeitslosigkeit und niedriger Wettbewerbsfähigkeit wurde Deutschland um die Jahrtausendwende oft "Europas kranker Mann" genannt. Mittlerweile ist es zu "Europas Wachstumsmotor" aufgestiegen. Die preisliche Wettbewerbsfähigkeit hat sich stark verbessert, der Leistungsbilanzsaldo stetig erhöht und das Nettoauslandsvermögen aufgewachsen. Viele machen dafür die Reformpakte von 1999 bis 2008, darunter insbesondere die Hartz-Reformen auf dem Arbeitsmarkt verantwortlich. Wir analysieren, welchen Beitrag die verschiedenen Reformen auf die Entwicklung makrökonomischer Schlüsselgrößen im In- und Ausland hatten. Einen besonderen Fokus legen wir auf die derzeit zu beobachtenden innereuropäischen Ungleichgewichte.

Beitrag

Zur Evaluierung der Reformen nutzen wir ein modernes makroökonomisches Simulationsmodell. Konkret simulieren wir die Reformmaßnahmen in einem dynamisch-stochastischem zwei Regionen umfassenden allgemeinen Gleichgewichtsmodell einer Währungsunion mit einer umfassenden Arbeitsmarktmodellierung und einer komplexen Fiskalstruktur. Das Modell ist geeignet, quantitative Resultate herzuleiten.

Ergebnisse

Was die allgemeine Entwicklung von BIP, Konsum, Investitionen und Arbeitslosigkeit in Deutschland betrifft, können die Reformen als Erfolg angesehen werden. Der Einfluss auf die Handels- und Leistungsbilanz war jedoch gering, was insbesondere auf positive externe Effekte im Rest der Eurozone zurückgeführt werden kann. Unsere Analyse deutet darauf hin, dass die untersuchten Reformen nicht direkt der Hauptgrund für die innereuropäischen Ungleichgewichte sind. Um diese zu erklären, müssen also andere Argumente angeführt werden. Möglicherweise sind dafür die für die Sozialversicherungssysteme ungünstige – und seinerzeit auch breit diskutierte – demographische Entwicklung oder die gestiegene Einkommensunsicherheit verantwortlich, weil beides den Konsum verringert und den Anreiz zum Vorsorgesparen in Deutschland erhöht haben dürfte. Allerdings herrscht darüber in der Literatur noch keine Einigkeit und weitere Forschung in diesem Bereich ist sicher notwendig.

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German Labor Market and Fiscal Reforms 1999 to 2008: Can They be Blamed for Intra-Euro Area Imbalances?*

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Abstract

In this paper, we assess the impact of major German structural reforms from 1999 to 2008 on key macroeconomic variables. By many, these reforms, especially the *Hartz* reforms on the labor market, are considered to be the root of observed imbalances in the Euro Area. Our simulations within a two-country monetary union DSGE model show that, in terms of German GDP, consumption, investment and (un)employment, the reforms were a clear success albeit the impact on the German current account was only minor. Most importantly, the rest of the Euro Area benefited from positive spillover effects. Hence, our analysis suggests that the reforms cannot be held responsible for the currently observed macroeconomic imbalances within the Euro Area. Further simulations highlight the importance of increased savings preferences in Germany to explain the latter.

Keywords: Fiscal Policy, Labor Market Reforms, DSGE Modeling, Macroeconomics

JEL classification: H2, J6, E32, E62.

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1 Introduction

At the beginning of the 2000s, Germany was called Europe's "sick man" because of comparatively low GDP growth, relatively high unemployment and low international competitiveness. Nowadays, the German economy is frequently called Europe's (growth) engine. Price and cost competitiveness has increased significantly since the beginning of the 2000s, building up high current account surpluses and a positive net foreign asset position. Especially the two latter facts have triggered heated debates about Germany's role for intra-Euro Area imbalances (see, among others, Chen et al., 2012, Hobza and Zeugner, 2014, Kollmann et al., 2015, as well as the literature and newspaper articles discussed in the latter paper for an overview). Academic literature cannot yet entirely explain these developments, but far-reaching labor market reforms in the first decade of the new millennium, the so-called *Hartz* reforms, are often considered as a major factor that dampened wage and consumption growth, thereby boosting German price competitiveness and the current account (see Kollmann et al., 2015, or Busl and Seymen, 2013). Some politicians or authors like Kollmann et al. (2015) conclude that similar reforms may be needed in some rest-of-the-Euro Area economies.[1]

The *Hartz* reforms were only part of a full array of structural reforms, starting already in 1999 to address Germany's sluggish economic performance since the end of the reunification boom and to meet future challenges for the social security system. These reforms included not only labor market reforms, but also fiscal reforms which changed inter alia the mix of taxes. To grasp the full impact of specifically these policy measures on the evolution of key macroeconomic variables in Germany and the rest of the Euro Area, this paper offers a comprehensive analysis by means of a structural model.

In detail, we assess the contribution of the major German fiscal and labor market reforms from 1999 to 2008 to the development of key domestic and foreign macroeconomic variables and especially intra-Euro Area imbalances. To this end, we build a two-country monetary union DSGE model with a complex frictional labor market structure and a comprehensive fiscal block which is suited to derive quantitative results. We find that, in terms of German GDP, consumption, investment and (un)employment, the reforms were a clear success. The most important measures for these developments were the *Hartz* reforms, followed by the alleviations in labor taxation and by the decrease in social security contributions combined with increases in consumption taxes. We term the latter reform fiscal devaluation throughout this paper. However, it must be stressed that, by the change in the tax mix, German policy was not primarily aiming at devaluating vis-a-vis the rest of the Euro Area at the time these measures were undertaken.

We find that the reforms were beneficial to the rest of the Euro Area because of positive spillovers in terms of output, consumption and investment. The reforms also activated intra-European trade generating higher German exports as a result of its improved price competitiveness and higher imports resulting from a positive wealth effect for Germany. The overall reform impact on the German current account was only minor, however. Hence, our analysis suggests that the specific reform agenda cannot be held responsible

[1] To see how serious this argument is taken, notice that the current French president Hollande just recently stated in his mid-term speech on September 18, 2014 that France cannot be expected to do reforms within 5 years for which Germany needed 10 years and, according to him, was facing a better (overall) economic environment.

for the observed macroeconomic imbalances within the Euro Area. When we extend the model to discuss potential channels that may have driven the strong increase in the current account surplus, our results point to deeper structural changes. According to our results, a time preference shock in Germany can account for the increase in in the current account surplus. Kollmann et al. (2015) also identify shocks to the rate of time preference to be a main driver of the persistent current account surplus. One potential candidate behind such a time preference shock would be demographic change itself as well as the various policy reactions to it since the end of the 1990ies, reflected in several reforms of the statutory pension system.

The model results further imply that the *Hartz* reforms reduced real wages and may have contributed to the observed wage moderation since the turn of the millennium.[2] Because the increase in employment overcompensated the decline in real wages, aggregate disposable income rose and the reforms did not have a dampening effect on aggregate consumption. This also increased German demand for rest of the Euro Area products. Therefore, the reforms did not cause harmful "beggar-thy-neighbor" effects for Germany's trade partners in the Euro Area, but rather the opposite. This finding is in line with an empirical assessment of the effects of German wage moderation on intra-Euro Area imbalances (see Bettendorf and León-Ledesma, 2015).

Our paper is related to several studies which analyze the effects of the labor market reforms using a structural equilibrium model with search unemployment. Krause and Uhlig (2012) and Launov and Wälde (2013a) focus on *Hartz IV* only, while Krebs and Scheffel (2013) and Busl and Seymen (2013) also consider the effects of *Hartz III*. All papers focus on domestic effects except for Busl and Seymen (2013) who also analyze the spillover effects of structural (labor market) reforms on the Euro Area. Dao (2013a) analyzes international spillovers of *Hartz IV* within a DSGE model, albeit not with search unemployment.

Regarding the effects on domestic macroeconomic variables, in particular unemployment, our results are in the range of the literature, but at the lower bottom. Different results in the literature have their roots in different assumptions about the magnitude of (i) the decrease of unemployment assistance for long-term unemployed and (ii) the increase in matching efficiency. The evidence in these cases, however, is not clear-cut (see Launov and Wälde, 2013b, and Krebs and Scheffel, 2013). In addition, there is no consensus on the pre-reform steady-state unemployment rate which can also be a driver of results (Busl and Seymen, 2013). Similar to Busl and Seymen (2013) and Dao (2013a) we find positive spillover effects on the rest of the Euro Area. This is in line with the empirical and theoretical literature on the international effects of labor market reforms (see, among others, Dao, 2013b, Felbermayr et al., 2012, 2013, Gomes et al., 2011, or Schwarzmüller and Stähler, 2013).

Further, our paper is related to the political debate on fiscal devaluations. The Euro crisis and the need of some member countries to regain price competitiveness renewed the interest in the tools of fiscal devaluation because bilateral exchange rates are fixed

[2]Dustmann et al. (2014) show that even before the *Hartz* reforms, wages declined and international competitiveness of firms rose in Germany. According to them, this evolution was a result of the "localization of industrial relations", i.e. a "decentralization of the wage-setting process from the industry level to the firm level". Arent and Nagl (2013) provide empirical evidence that the Hartz reforms seem to have magnified the trend of declining real wages Germany.

at parity. The proposed tools are value-added (or consumption) tax increases accompanied by a decrease of social security contributions or labor taxes, respectively. There is surprisingly little (formal) literature on this topic given the high interest in political circles. Farhi et al. (2014) provide the only formal analysis of fiscal devaluations in a New Keynesian open economy DSGE model. They find that an intended nominal devaluation can be robustly replicated with a small set of fiscal instruments. As their numerical example for Spain shows, a 10% nominal devaluation would require inter alia an increase of VAT taxes of as much as 7.6 percentage points. Our contribution is to show that, in practice, we should not expect too much from the tool of fiscal devaluation. Similarly, Lipinska and von Thadden (2009) robustly show in a two-country DSGE model that fiscal devaluations generate only small quantitative effects. Engler et al. (2014) show that, if only employers' social security contributions are decreased (instead of employees' and employers' contributions or labor taxes per se), expected effects can be somewhat larger. Considering the example of Germany, which undertook these measures – even though not with the primary purpose to devaluate vis-a-vis the rest of the Euro Area –, we show that effects were indeed relatively modest.

The rest of the paper is organized as follows. Section 2 describes the model and the calibration. In section 3, we present the simulation exercise and a discussion of the results. Section 4 concludes.

2 The model

The model we use for our analysis is an extension of *FiMod* (Stähler and Thomas, 2012), which is a two-country monetary union DSGE model with frictional labor markets and a fiscal block that includes a wide range of taxes and disaggregation of government spending. Households, firms, policymakers and the external sector interact each period by trading final goods, financial assets and production factors. The extension comes in mainly by including short and long-term unemployment along the lines of Moyen and Stähler (2014) and endogenizing labor market participation, while the remaining model features, especially the international structure, is pretty much in line with the base model.[3]

For what follows, we normalize population size of the entire monetary union to unity, of which $\omega \in (0, 1)$ live in Germany, while the remaining $(1 - \omega)$ live in the rest of EMU. Throughout the paper, quantity variables will be expressed in per capita terms, unless otherwise indicated. Both regions are modeled analogously, while we allow structural parameters to differ. Hence, we restrict ourselves to explaining the home country in detail only. If the explicit description of the foreign country is necessary, we use asterisks to denote decisions made by the corresponding foreign agents as well as the structural parameters.

[3]Endogenizing the labor market decision allows us to model in detail the *Hartz IV* reform whose main element was the merger of the unemployment assistance for long-term unemployed and social welfare assistance. Most importantly, while decreasing the level of long-term unemployment assistance with the introduction of *Hartz IV*, the level of social welfare assistance was actually increased. Modelling the participation decision therefore allows us to account for the impact of *Hartz IV* on both, the intensive and the extensive margin of the labor force.

2.1 Households

Following Galí et al. (2007), we assume that each country is populated by a share $(1-\mu)$ of Ricardian households who have access to capital markets and, therefore, substitute consumption intertemporally. These households are called optimizers. The remaining share $\mu \in [0,1)$ is considered to be liquidity-constrained in the sense that they consume all their labor income in each period.[4] We call this latter type "*rule-of-thumb*" household (RoT, henceforth). The welfare function of each type of representative household at time $t=0$ is given by

$$E_0 \left\{ \sum_{t=0}^{\infty} \beta^t \cdot \left(\log\left(c_t^i - h \cdot c_{t-1}^i\right) + \zeta^l \cdot \frac{{l_t^i}^{1-\sigma_l}}{1-\sigma_l} \right) \right\}, \tag{1}$$

where E_t is the expectations operator conditional on time-t information, c_t^i denotes household consumption of final goods, and the superscripts $i = o, r$ denote optimizing and RoT households, respectively. h denotes the degree of habit formation in consumption.

Inside each household, its members may be employed in the public sector (denoted by $n_t^{g,i}$), in the private sector (denoted by $n_t^{p,i}$), be unemployed (denoted by u_t^i), or may not participate in the labor market (denoted by l_t^i for "leisure"). Households obtain utility from leisure (or home production) of those members not participating in the labor market, where σ_l indicates its curvature and $\zeta^l > 0$ is the corresponding scaling parameter relating it to utility stemming from consumption. Given that we assume that unemployment is split into short and long-term unemployment along the lines of Moyen and Stähler (2014), it holds that $1 = n_t^{g,i} + n_t^{p,i} + u_t^i + l_t^i$, with $u_t^i = u_t^{s,i} + u_t^{l,i}$. The superscripts s and l indicate the fraction of household members being short and long-term unemployed, respectively. Differentiating between short and long-term unemployment is primarily done to directly translate the reduction in the eligibility period for unemployment benefits after the *Hartz IV* reform into our model simulations.[5] As becomes clear below, we will assume full consumption insurance within each household, as in Andolfatto (1996) or Merz (1995).

Households in both countries trade consumption and investment goods as well as international nominal bonds. The consumption and investment baskets, c_t^i and I_t^o, respectively, of a household of type i (only type o for investment) in the home country are given by

$$x_t^i = \left(\frac{x_{At}^i}{\omega + \psi} \right)^{\omega+\psi} \left(\frac{x_{Bt}^i}{1-\omega-\psi} \right)^{1-\omega-\psi},$$

with $x_t^i = \{c_t^i, I_t^o\}$, where c_{At}^i, I_{At}^o and c_{Bt}^i, I_{Bt}^o represent consumption/investment demand of goods produced in country Germany (country A) and the rest of EMU (region B), respectively, and ψ is a parameter capturing the degree of home bias in consumption. From now onwards, let $p_{Bt} \equiv P_{Bt}/P_{At}$ denote the *terms of trade*, where P_{At} and P_{Bt} are

[4] This assumption implies that this type of household neither saves, invests nor borrows. Furthermore, we assume that only optimizers own firms. See Andrés et al. (2013) for a model relaxing this strict credit constraint by allowing for patient and impatient households in a search labor market environment.

[5] One could further assume that short and long-term unemployed workers face a different matching efficiency. Krebs and Scheffel (2013) find the job finding rate for long-term unemployed workers to be smaller. We abstract from this complication for simplicity. Still, our results would remain but the reduction in unemployment would be somewhat less pronounced.

the *producer price indexes* (PPI) in countries A and B, respectively. Cost minimization by the household then implies $x^i_{At}/x^i_{Bt} = (\omega+\psi)/(1-\omega-\psi)\cdot p_{Bt}$. Nominal expenditure in consumption and investment goods equal $P_{At}c^i_{At} + P_{Bt}c^i_{Bt} = P_t c^i_t$ and $P_{At}I^o_{At} + P_{Bt}I^o_{Bt} = P_t I^o_t$, respectively, where $P_t = (P_{At})^{\omega+\psi}(P_{Bt})^{1-\omega-\psi}$ is the corresponding *consumer price index* (CPI). Notice that $P_t = P_{At}\cdot p_{Bt}^{1-\omega-\psi}$. Therefore, CPI inflation, $\pi_t \equiv P_t/P_{t-1}$, evolves according to $\pi_t = \pi_{At}(p_{Bt}/p_{Bt-1})^{1-\omega-\psi}$, where $\pi_{At} \equiv P_{At}/P_{At-1}$ is PPI inflation in country A.

Each household's real labor income (gross of taxes) is given by $w^p_t n^{p,i}_t + w^g_t n^{g,i}_t$, where w^p_t is the real wage paid in the private sector (to be derived later), w^g_t is the real wage of the government sector, and $n^{p,i}_t$ and $n^{g,i}_t$ are the number of type-i household members employed in the private and government sector, respectively. The labor income tax rate is denoted by τ^w_t. Household members who are short-term unemployed receive unemployment benefits κ^{Bs}_t, while long-term unemployed members receive κ^{Bl}_t. Those members not participating in the labor market receive a constant per-period payment κ^{SA}, which can be interpreted as social assistance. τ^c_t denotes the consumption tax rate and T^i_t are lump-sum taxes (or, if negative, subsidies).

Optimizing households can further invest in physical capital, domestic government bonds or international assets. Investments in physical capital k^o_t earn a real rental rate r^k_t, while the capital depreciates at rate δ^k. Returns on physical capital net of depreciation allowances are taxed at rate τ^k_t. Nominal government bonds B^o_t pay a gross nominal interest rate R_t. Finally, D^o_t denote holdings of international nominal bonds, which pay the gross nominal interest rate R^{ecb}_t.[6] Π^o_t are nominal per capita profits generated by firms net of vacancy posting costs. We assume that all firms are owned by the optimizing households and that profits are redistributed in a lump-sum manner. Summarizing, and bearing in mind that RoT households consume all their income each period, the budget constraint of the representative household i in real terms is

$$\begin{aligned}(1+\tau^c)c^i_t + I^i_t + \frac{B^i_t + D^i_t}{P_t} \quad + \quad & T^i_t = \frac{\Pi^i_t}{P_t} + \left((1-\tau^k)r^k_t + \tau^k\delta^k\right)k^i_{t-1} \\ & + \frac{R_{t-1}B^i_{t-1}}{P_t} + \frac{R^{ecb}_{t-1}D^i_{t-1}}{P_t} - \frac{\psi_d}{2}\cdot\left(\frac{D^i_t}{P_t} - \frac{\bar{D}^i}{\bar{P}}\right)^2 \\ & + (1-\tau^w)\left(w^p_t n^{p,i}_t + w^g_t n^{g,i}_t\right) + u^{s,i}_t\kappa^{Bs}_t \\ & + u^{l,i}_t\kappa^{Bl}_t + l^i_t\kappa^{SA},\end{aligned} \tag{2}$$

with $I^r_t = B^r_t = D^r_t = k^r_t = \Pi^r_t = 0\,\forall t$. Taking into account that RoT households do not own physical capital, its law of motion is given by

$$k^o_t = (1-\delta^k)k^o_{t-1} + \left[1 - S\left(I^o_t/I^o_{t-1}\right)\right]I^o_t, \tag{3}$$

where $S\left(I^o_t/I^o_{t-1}\right) = \frac{\kappa_I}{2}\left(I^o_t/I^o_{t-1} - 1\right)^2$ represents investment adjustment costs (see Christiano et al., 2005, for discussion). Maximizing (1) subject to equations (2) and (3) yields

[6] In order to ensure stationarity of international bond holdings, we follow Schmitt-Grohé and Uribe (2003) and assume that there exist portfolio adjustment costs of the form $\psi_d/2\left(d_t - \bar{d}\right)^2$, with $\psi_d > 0$ and $d_t \equiv D_t/P_t$. We assume for simplicity that trading in domestic government and in international bonds is not taxed.

standard first-order conditions for optimizing households. These plus the corresponding marginal utility of consumption for RoT households are analogous to those in Stähler and Thomas (2012).

Given the above description, domestic per capita consumption in the home country equals the weighted average of consumption for each household type, i.e. $C_t = (1-\mu)\cdot c_t^o + \mu \cdot c_t^r$. Per capita domestic demand for the home country's and the foreign country's consumption good equals $C_{At} = (1-\mu)\, c_{At}^o + \mu c_{At}^r$ and $C_{Bt} = (1-\mu)\, c_{Bt}^o + \mu c_{Bt}^r$, respectively. For the quantity variables that exclusively concern optimizing households, per capita amounts are given simply by $Z_t = (1-\mu) Z_t^o$, where $Z_t \in \{k_t, B_t, I_t, D_t, I_{At}, I_{Bt}\}$ and $Z_t^o \in \{k_t^o, B_t^o, I_t^o, D_t^o, I_{At}^o, I_{Bt}^o\}$. Employment aggregation will be described in the labor market section below.

2.2 Production

The retail and intermediate goods sectors of the economy are similar to Smets and Wouters (2003, 2007) or Christiano et al. (2005), with the exception that labor services are not hired directly from the households but from a sector of firms that produce homogenous labor services in the manner of Christoffel at al. (2009) or de Walque et al. (2009). In this subsection, we focus on the retail and intermediate goods sectors, postponing the description of the labor market to the next subsection.

2.2.1 Final goods producer

There is a measure-ω continuum of firms in the final goods sector, in which firms purchase a variety of differentiated intermediate goods and bundle these into a final good, which is sold under perfect competition. Assuming that the law of one price holds within the union, the price of the home country's final good is the same in both countries, equal to P_{At}. The problem of the representative retail firm reads

$$\max_{\{\tilde{y}_t(j):j\in[0,\omega]\}} P_{At} Y_t - \int_0^\omega P_{At}(j)\tilde{y}_t(j)dj, \tag{4}$$

where

$$Y_t = \left(\int_0^\omega \left(\frac{1}{\omega}\right)^{1/\epsilon} \tilde{y}_t(j)^{(\epsilon-1)/\epsilon} dj\right)^{\epsilon/(\epsilon-1)}, \quad \epsilon > 1, \tag{5}$$

is the retailer's production function, $\tilde{y}_t(j)$ is the retailer's demand for each differentiated input $j \in [0,\omega]$, and $P_{At}(j)$ is the nominal price of each input. The standard first-order condition for the problem is given by $\tilde{y}_t(j) = (P_{At}(j)/P_{At})^{-\epsilon}\frac{Y_t}{\omega}$. Combining the latter with (4) and the zero profit condition, we obtain that the producer price index in the home country must equal $P_{At} = \left(\int_0^\omega \frac{1}{\omega} P_{At}(j)^{1-\epsilon} dj\right)^{1/(1-\epsilon)}$. Total demand for each intermediate input equals

$$\omega\tilde{y}_t(j) \equiv y_t(j) = \left(\frac{P_{At}(j)}{P_{At}}\right)^{-\epsilon} Y_t. \tag{6}$$

as there are ω retail firms.

2.2.2 Intermediate goods

Each intermediate goods producer $j \in [0, \omega]$ faces the technology

$$y_t(j) = \epsilon^a \cdot \left(k^g_{t-1}\right)^{\eta} \cdot \left[\tilde{k}_t(j)\right]^{\alpha} \cdot \left[lab_t(j)\right]^{(1-\alpha)}, \tag{7}$$

where $\alpha \in [0, 1]$ is the elasticity of output with respect to private capital, $lab_t(j)$ denotes the demand for labor services, $\tilde{k}_t(j)$ is the demand for capital services and ϵ^a is total factor productivity. k^g_{t-1} is the public capital stock available in period t, which is determined by the government and is assumed to be productivity-enhancing; the parameter $\eta \in [0, 1)$ measures how influential public capital is on private production (see Leeper et al., 2010, and Pappa, 2010, for discussion). Intermediate goods firms acquire labor and capital services in perfectly competitive factor markets at real (CPI-deflated) prices x_t and r^k_t, respectively. Cost minimization subject to (7) implies the factor demand conditions for capital and labor $r^k_t = mc_t \cdot \alpha \cdot y_t(j)/\tilde{k}_t(j)$ and $x_t = mc_t \cdot (1-\alpha) \cdot y_t(j)/lab_t(j)$, where mc_t is the real (CPI-deflated) marginal cost common to all intermediate good producers. The ratios $y_t(j)/\tilde{k}_t(j)$ and $y_t(j)/lab_t(j)$ are equalized across firms because of constant returns to scale in private capital and labor and perfectly competitive input prices.

As is standard in the literature, intermediate goods firms set nominal prices à la Calvo (1983). This implies that a randomly chosen fraction $\theta_P \in [0, 1)$ of firms cannot re-optimize their price in each period. A firm that has the chance to re-optimize its price in period t chooses the nominal price $P_{At}(j)$ that maximizes

$$E_t \sum_{z=0}^{\infty} (\beta\theta_P)^z \frac{\lambda^o_{t+z}}{\lambda^o_t} \left[\frac{P_{At}(j)}{P_{t+z}} - mc_{t+z}\right] y_{t+z}(j), \tag{8}$$

subject to $y_{t+z}(j) = \left(P_{At}(j)/P_{At+z}\right)^{-\epsilon} Y_{t+z}$. The first-order condition is standard implying the law of motion of the price level

$$1 = \theta_P \left(\frac{1}{\pi_{At}}\right)^{1-\epsilon} + (1-\theta_P)\tilde{p}_t^{1-\epsilon}, \tag{9}$$

where $\tilde{p}_t \equiv \tilde{P}_{At}/P_{At}$ is the relative (PPI-deflated) optimal price and $\tilde{P}_{At}$ is the optimal price chosen by all period-t price setters.

2.3 The labor market

Following Christoffel et al. (2009) or de Walque et al. (2009), we assume that labor firms hire workers from the household sector in order to produce homogenous labor services, which they sell to intermediate goods producers at the perfectly competitive price x_t. The production function of each labor firm is linear in the number of hours worked by its employee, which is fixed at the level $\bar{h}$. With N^p_t being the fraction of the total labor force employed in the private sector, the total per-capita supply of labor services is given by $Lab_t = N^P_t \cdot \bar{h}$. Equilibrium in the market for labor services requires that $\omega Lab_t = \int_0^{\omega} lab_t(j)dj$.

Using equations (6) and (7) and the fact that the capital-labor ratio is equalized across intermediate goods firms, this yields $Y_t D_t = \epsilon^a \left(k^g_{t-1}\right)^{\eta} k^{\alpha}_{t-1} Lab^{1-\alpha}_t$, where $D_t \equiv$

$\int_0^{\omega} \omega^{-1} \left(P_{At}(j)/P_{At}\right)^{-\epsilon} dj$ is a measure of price dispersion. In what follows, we will specify the matching process, flows in the labor market, private-sector vacancy creation, the corresponding wage determination and labor market participation decisions. Government wages and employment are autonomously chosen by the fiscal authority (see section 2.4).

2.3.1 Matching process and labor market flows

As stated in Section 2.1 already, a household member can be in one of five states: (i) employed in the public sector, (ii) employed in the private sector, (iii) short-term unemployed, (iv) long-term unemployed, or (v) not participating in the labor market. When participating in the labor market, long-term unemployment is the residual state in the sense that a worker whose employment relationship ends and who does not find a job while being short-term unemployed flows into long-term unemployment. All unemployed workers look for job opportunities and only non-participants do not search. We assume that searchers are randomly matched to the private or the public sector.

Denoting total sector-specific per capita employment in period t by $N_t^f = (1-\mu)n_t^{f,o} + \mu n_t^{f,r}$, where $f = p, g$ stands for private and government employment, and the total number of non-participants as $L_t = (1-\mu)l_t^o + \mu l_t^r$, the total economy-wide employment rate is given by $N_t^{tot} = N_t^p + N_t^g$, while the aggregate unemployment rate is given by $U_t = 1 - N_t^{tot} - L_t$. Following Blanchard and Galí (2010), we assume that the hiring round takes place at the beginning of each period, and that new hires start producing immediately. We also assume that workers dismissed at the end of period $t-1$ start searching for a new job at the beginning of period t. Therefore, the pool of searching workers at the beginning of period t is given by

$$\tilde{U}_t = U_{t-1} + s^p N_{t-1}^p + s^g N_{t-1}^g - L_{t-1} = 1 - (1-s^p)N_{t-1}^p - (1-s^g)N_{t-1}^g - L_{t-1},$$

where s^f, with $f = p, g$, represents the constant separation rate in the private (p) and public (g) sector. The matching process is governed by a standard Cobb-Douglas aggregate matching function for each sector $f = p, g$,

$$M_t^f = \kappa_e^f \cdot \left(\tilde{U}_t\right)^{\varphi^f} \cdot \left(v_t^f\right)^{(1-\varphi^f)}, \tag{10}$$

where $\kappa_e^f > 0$ is the sector-specific matching efficiency parameter, $\varphi^f \in (0,1)$ the sector-specific matching elasticity and M_t^f the number of new matches formed in period t resulting from the total number of searchers and the number of sector-specific vacancies v_t^f. The probability for an unemployed worker to find a job in sector f can thus be stated as $p_t^f = M_t^f/\tilde{U}_t$, while the probability of filling a vacancy is given by $q_t^f = M_t^f/v_t^f$. The law of motion for sector and household type-specific employment rates is therefore given by

$$n_t^{f,i} = \left(1 - s^f\right) \cdot n_{t-1}^{f,i} + p_t^f \cdot \left(u_{t-1}^{s,i} + u_{t-1}^{l,i} + s^p n_{t-1}^{p,i} + s^g n_{t-1}^{g,i}\right). \tag{11}$$

Employment in sector f today is given by yesterday's employment that has not been destroyed plus newly created matches in that sector. Notice that, in contrast to the base model of Stähler and Thomas (2012), employment rates for optimizing and RoT households can differ as we have to take into account potentially different labor market

participation rates, l_{t-1}^i, which we will detail in the last subsection of the labor market description. Furthermore, we have to take into account that unemployed workers are now divided into short and long-term unemployment. Following Moyen and Stähler (2014), we assume that, when dismissed, a workers flows into the pool of short-term unemployment. With (a fixed) probability ϑ, workers in this pool become long-term unemployed unless they find a job (which happens at probability p_t^f). ϑ is a fixed policy parameter which may, however, be changed when the government decides to change the entitlement duration for "premium" benefits κ_t^{Bs}. When in the pool of long-term unemployment, a worker only flows out when finding a job at probability p_t^f. This can be summarized by the following two equations:

$$u_t^{s,i} = (1 - \vartheta - p_t^p - p_t^g)\, u_{t-1}^{s,i} + s^p n_{t-1}^{p,i} + s^g n_{t-1}^{g,i} \tag{12}$$

$$u_t^{l,i} = (1 - p_t^p - p_t^g)\, u_{t-1}^{s,i} + \vartheta u_{t-1}^{s,i}, \tag{13}$$

where we have to bear in mind that $u_t^i = u^{s,i} + u_t^{l,i}$ holds. For further reference, we define $\gamma_t^i = u_t^{s,i}/u_t^i$ as the fraction of short-term unemployment (or premium benefit recipients, respectively) to total unemployment. Aggregation across household types is analogous to the employment aggregation.

2.3.2 Asset value of jobs, wage bargaining and job creation

As is standard in the literature, we assume that firms and workers bargain about their share of the overall match surplus to determine wages. Following Boscá et al. (2009, 2010, 2011), we assume that a union, which takes into account (aggregate) utility of optimizing and RoT households, undertakes the bargaining. Furthermore, we assume staggered bargaining of nominal wages similar to Gertler et al. (2008). This implies that, each period, a randomly chosen fraction θ_w of continuing firms cannot renegotiate wages, while a fraction θ_w^n of newly created firms does not bargain over wages and simply pays the average nominal wage of the previous period. Letting $J_t\left(\tilde{W}_t^p\right)$ be the value function of employment for firms that are allowed to bargain over wages and $\Omega_t \equiv (1-\mu)H_t^{o,p}\left(\tilde{W}_t^p\right) + \mu H_t^{r,p}\left(\tilde{W}_t^p\right)$ that of the union, where $H_t^{i,p}\left(\tilde{W}_t^p\right)$ is the corresponding household type-i utility, the Nash problem is given by

$$\max_{\tilde{W}_t^p} \; [\Omega_t]^{\xi} \left[J_t\left(\tilde{W}_t^p\right)\right]^{1-\xi}, \tag{14}$$

where $\xi \in [0,1)$ is the union's bargaining power and $\tilde{W}_t^p$ denotes the nominal wage negotiated in period t. The value function of a firm that renegotiates in that period is given by

$$\begin{aligned} J_t\left(\tilde{W}_t^p\right) = {} & E_t \sum_{z=0}^{\infty} \left\{ [\beta \cdot (1-s^p) \cdot \theta_w]^z \cdot \frac{\lambda_{t+z}^o}{\lambda_t^o} \cdot \left[\bar{h} \cdot x_{t+z} - (1+\tau_{t+z}^{sc}) \cdot \frac{\tilde{W}_t^p}{P_{t+z}} \right] \right\} \\ & + (1-\theta_w) \cdot E_t \sum_{z=1}^{\infty} \left\{ [\beta \cdot (1-s^p)]^z \cdot \theta_w^{z-1} \cdot \frac{\lambda_{t+z}^o}{\lambda_t^o} \cdot J_{t+z}\left(\tilde{W}_{t+z}^p\right) \right\}, \end{aligned} \tag{15}$$

where τ_t^{sc} is the social security contribution rate. The value of the firm is the discounted profit flow in those future states in which it is not allowed to renegotiate plus its continuation value should it have the chance to reoptimize in the next period. For new jobs where firm and worker do not bargain, the nominal wage equals last period's average nominal wage, W_{t-1}^p, and the value of the job equals

$$J_t\left(W_{t-1}^p\right) = J_t\left(\tilde{W}_t^p\right) - E_t \sum_{z=0}^{\infty} \left\{ [\beta \cdot (1-s^p) \cdot \theta_w]^z \cdot \frac{\lambda_{t+z}^o}{\lambda_t^o} \cdot (1+\tau_{t+z}^{sc}) \cdot \frac{W_{t-1}^p - \tilde{W}_t^p}{P_{t+z}} \right\}.$$

The derivation and a more detailed description can be found in Stähler and Thomas (2012). Analogously, we can derive how workers value a match surplus. Since different household types use different stochastic discount factors, we must distinguish between the surplus for an optimizing and a rule-of-thumb household. For a worker belonging to a type-i household, the surplus value of a job in a renegotiating firm is given by

$$\begin{aligned} H_t^{i,p}\left(\tilde{W}_t^p\right) &= E_t \sum_{z=0}^{\infty} \left\{ [\beta \cdot (1-s^p) \cdot \theta_w]^z \cdot \frac{\lambda_{t+z}^i}{\lambda_t^i} \cdot \left[(1-\tau_{t+z}^w) \cdot \frac{\tilde{W}_t^p}{P_{t+z}} - \Xi_{t+z}^{i,p} \right] \right\} \\ &\quad + (1-\theta_w) \cdot E_t \sum_{z=1}^{\infty} \left\{ [\beta \cdot (1-s^p)]^z \cdot \theta_w^{z-1} \cdot \frac{\lambda_{t+z}^i}{\lambda_t^i} \cdot H_{t+z}^{i,p}(\tilde{W}_{t+z}^p) \right\}, \end{aligned} \tag{16}$$

for $i = o, r$, where

$$\begin{aligned} \Xi_t^{i,f} &\equiv \gamma_t^i \kappa_t^{Bs} + (1-\gamma_t^i)\kappa_t^{Bl} + \beta(1-s^f) E_t \frac{\lambda_{t+1}^i}{\lambda_t^i} \left\{ p_{t+1}^g H_{t+1}^{i,g} \right. \\ &\quad \left. + p_{t+1}^p \left[(1-\theta_w^n) H_{t+1}^{i,p}\left(\tilde{W}_{t+1}^p\right) + \theta_w^n H_{t+1}^{i,p}\left(W_t^p\right) \right] \right\} \\ &\quad - \beta(1-s^f) E_t \frac{\lambda_{t+1}^i}{\lambda_t^i} \left\{ \vartheta \cdot \gamma_{t+1} \cdot \mathcal{V}_{t+1}^i \right\}, \end{aligned} \tag{17}$$

represents the outside option of a type-i worker employed in sector $f = p, g$ at time t. The latter is the sum of the household's average unemployment benefits, $\gamma_t^i \kappa_t^{Bs} + (1-\gamma_t^i)\kappa_t^{Bl}$, the expected value of searching for a job in the following period,[7] and the expected utility difference of of being in the short-term unemployment pool and the long-term unemployment pool (see Moyen and Stähler, 2014, for details on the derivation and a more elaborated description). The latter is given by

$$\mathcal{V}_t^i = \kappa_t^{Bs} - \kappa_t^{Bl} + \beta E_t \frac{\lambda_{t+1}^i}{\lambda_t^i} \left\{ \left(1 - p_{t+1}^p - p_{t+1}^g - \vartheta\right) \mathcal{V}_{t+1}^i \right\}. \tag{18}$$

[7] Notice that we have to take into account that, conditional on landing on a private-sector job ($f = p$), the surplus value for the worker is contingent on whether the firm is allowed to bargain (in which case the worker receives $\tilde{W}_{t+1}^p$) or not (in which case she receives today's average wage, W_t^p).

In new jobs where the wage is not optimally bargained, the surplus value enjoyed by type-i workers is given by

$$H_t^{i,p}\left(W_{t-1}^p\right) = H_t^{i,p}\left(\tilde{W}_t^p\right) + E_t \sum_{z=0}^{\infty} \left\{ \left[\beta \cdot (1-s^p) \cdot \theta_w\right]^z \cdot \frac{\lambda_{t+z}^i}{\lambda_t^i} \cdot (1-\tau_{t+z}^w) \cdot \frac{W_{t-1}^p - \tilde{W}_t^p}{P_{t+z}} \right\}.$$

Note that $H_t^{i,g}$ denotes the surplus value of a government job for a type-i worker. As wages there are autonomously set by the fiscal authority, the asset value function simplifies to

$$H_t^{i,g} = (1-\tau_t^w) w_t^g - \Xi_t^{i,g} + \beta(1-s^g) E_t \left\{ \frac{\lambda_{t+1}^i}{\lambda_t^i} \cdot H_{t+1}^{i,g} \right\}, \tag{19}$$

where w_t^g is the real wage paid by the government. Given the asset value functions of firms and workers, equations (15) to (19), we are now in a position to solve the wage bargaining game (14). The resulting sharing rule is given by

$$\Omega_t = \frac{\xi}{1-\xi} \cdot \frac{E_t \sum_{z=0}^{\infty} \left\{ \left((1-\mu) \frac{\lambda_{t+z}^o}{\lambda_t^o} + \mu \frac{\lambda_{t+z}^r}{\lambda_t^r} \right) \left[\beta(1-s^p)\theta_w\right]^z \frac{(1-\tau_{t+z}^w)}{P_{t+z}} \right\}}{E_t \sum_{z=0}^{\infty} \left\{ \frac{\lambda_{t+z}^o}{\lambda_t^o} \left[\beta(1-s^p)\theta_w\right]^z \frac{(1+\tau_{t+z}^{sc})}{P_{t+z}} \right\}} \cdot J_t\left(\tilde{W}_t^p\right). \tag{20}$$

Solving equation (20) for $\tilde{W}_t^p$ by using the corresponding asset value functions gives the optimal wage bargained in period t. The average real wage in the private sector, $w_t^p \equiv W_t^p / P_t$, hence evolves according to

$$w_t^p = \frac{(1-s^p) N_{t-1}^p}{N_t^p} \left[(1-\theta_w) \tilde{w}_t^p + \theta_w \cdot \frac{w_{t-1}^p}{\pi_t} \right] + \frac{M_t^P}{N_t^p} \left[(1-\theta_w^n) \tilde{w}_t^p + \theta_w^n \cdot \frac{w_{t-1}^p}{\pi_t} \right], \tag{21}$$

where $\tilde{w}_t^p \equiv \tilde{W}_t^p / P_t$ is the real optimally bargained wage and $w_{t-1}^p / \pi_t = W_{t-1}^p / P_t$ is the real value of yesterday's average nominal wage at today's prices. We have also taken into account the fact that new and continuing jobs pay the optimally bargained wage with probabilities $1-\theta_w^n$ and $1-\theta_w$, respectively.

It remains to determine how jobs are created. As is standard in the literature, we assume that opening a vacancy has a real (CPI-deflated) flow cost of κ_v^p. Following Pissarides (2009), we further assume that free entry into the vacancy posting market drives the expected value of a vacancy to zero. Under our assumption of instantaneous hiring, real vacancy posting costs, κ_v^p, must equal the time-t vacancy filling probability, q_t^p, times the expected value of a filled job in period t net of training costs. The latter condition can be expressed as

$$\frac{\kappa_v^p}{q_t^p} = (1-\theta_w^n) \cdot J_t\left(\tilde{W}_t^p\right) + \theta_w^n \cdot J_t\left(W_{t-1}^p\right), \tag{22}$$

where we take into account that the wage of the newly-created job may be optimally bargained with probability $1-\theta_w^n$.

2.3.3 Labor market participation

The labor market equilibrium of the previous subsections was derived taken as given labor market participation. It is endogenous in our model, however. In order to decide whether or not (or how much) to participate in the labor market, the household maximizes (1) subject to the budget constraint, equation (2), and the labor market flows, equations (11) to (13), taking into account that $1 = n_t^{g,i} + n_t^{p,i} + u_t^i + l_t^i$, with $u_t^i = u_t^{s,i} + u_t^{l,i}$ and $\gamma_t^i = u_t^{s,i}/u_t^i$, plus the fact that only a fraction of newly created jobs can bargain over wages. This yields

$$\begin{aligned} \zeta^l \cdot {l_t^i}^{-\sigma_l} &= \lambda_t^i \left[\gamma_t^i \kappa_t^{Bs} + (1-\gamma_t^i)\kappa_t^{Bl} - \kappa^{SA} + \beta E_t \frac{\lambda_{t+1}^i}{\lambda_t^i} \left\{ p_{t+1}^g H_{t+1}^{i,g} \right.\right. \\ &\quad \left.\left. + p_{t+1}^p \left[(1-\theta_w^n) H_{t+1}^{i,p} \left(\tilde{W}_{t+1}^p \right) + \theta_w^n H_{t+1}^{i,p} \left(W_t^p \right) \right] \right\} \right], \end{aligned} \tag{23}$$

where use has been made of the fact that $\lambda_t^i \cdot H_{t+1}^{i,p}\left(W_t^p\right)$, $\lambda_t^i \cdot H_{t+1}^{i,p}\left(\tilde{W}_{t+1}^p\right)$ and $\lambda_t^i \cdot H_{t+1}^{i,g}$ are the Lagrangian multipliers for equation (11) conditional on landing in the private or the public sector.[8] The former further has to be differentiated between whether or not wage bargaining is allowed. Equation (23) itself is actually quite intuitive. It equates the marginal utility of leisure with the expected return of participating in the labor market. The latter consists of unemployment benefits and the expectation value of finding employment. The higher it is, the lower is the non-participation rate. Analogously, the higher social assistance payments for non-participants are, the lower is labor market participation.

2.4 Fiscal authorities

Defining the (CPI-deflated) per capita value of end-of-period government debt as $b_t \equiv B_t/P_t$, we can state that it evolves according to a standard debt accumulation equation,

$$b_t = \frac{R_{t-1}}{\pi_t} b_{t-1} + PD_t,$$

where PD_t denotes real (CPI-deflated) per capita primary deficit. The latter is given by per capita fiscal expenditures minus per capita fiscal revenues,

$$\begin{aligned} PD_t &= \left[\frac{G_t}{p_{Bt}^{1-\omega-\psi}} + \left(\gamma_t \kappa_t^{Bs} + (1-\gamma_t)\kappa_t^{Bl} \right) U_t + \kappa^{SA} L_t + \kappa_v^g v_t^g \right] \\ &\quad - \left[(\tau_t^w + \tau_t^{sc}) \left[w_t^p N_t^P + w_t^g N_t^g \right] + \tau_t^c C_t \right. \\ &\quad \left. + \tau_t^k (r_t^k - \delta^k) k_{t-1} + (1-\mu) T_t^o + \mu T_t^r \right], \end{aligned} \tag{24}$$

where G_t denotes per capita government spending in goods and services expressed in PPI terms (hence the correction for the CPI-to-PPI ratio, $P_t/P_{At} = p_{Bt}^{1-\omega-\psi}$). Letting C_t^g and I_t^g denote real per capita public purchases and public investment, respectively, we have the following nominal relationship: $P_{At} G_t = P_{At}\left(C_t^g + I_t^g\right) + (1+\tau_t^{sc}) P_t w_t^g N_t^g$. Dividing

[8] See the appendix in Moyen and Stähler (2014) for more formal details on this issue.

by P_{At} and using $P_t/P_{At} = p_{Bt}^{1-\omega-\psi}$, we obtain

$$G_t = C_t^g + I_t^g + [(1+\tau_t^{sc}) w_t^g N_t^g]\, p_{Bt}^{1-\omega-\psi}. \tag{25}$$

Given public investment, the stock of public physical capital evolves as follows,

$$k_t^g = (1-\delta^g) k_{t-1}^g + I_t^g, \tag{26}$$

where we assume that the public capital stock depreciates at rate δ^g. To guarantee stationarity of public debt, for *at least* one fiscal instrument $X \in \{\tau^w, \tau^{sc}, \tau^b, \tau^c, \tau^k, C^g, I^g, w^g, N^g, T^o, T^r\}$, the government must follow a fiscal rule of the form

$$X_t = \bar{X} + \rho_X \left(X_{t-1} - \bar{X}\right) + (1-\rho_X)\, \phi_X \cdot \left(\frac{b_{t-1}}{Y_{t-1}^{tot}} p_{Bt-1}^{1-\omega-\psi} - \omega^b \right) + \epsilon_t^X, \tag{27}$$

in which the coefficient ϕ_X, i.e. fiscal policy's stance on debt deviations from target, is non-zero (positive for revenue instruments, negative for expenditure instruments). ρ_X is a smoothing parameter.

In addition to Stähler and Thomas (2012), we further allow unemployment benefits to be time-varying, at least before the *Hartz IV* reform. To be precise, we assume that unemployment benefits depend on the previous period's net wage, i.e. $\kappa_t^{Bs} = rrs \cdot (1-\tau_t^w) w_{t-1}^p$ and $\kappa_t^{Bl} = rrl \cdot (1-\tau_t^w) w_{t-1}^p$ in line with German (previous) legislation. After the Hartz IV reform, we assume $\kappa_t^{Bl} = \bar{\kappa}^{Bl}$ to be a fixed amount.

2.5 The foreign country block, international linkages and union-wide monetary policy

This section describes important structural relationships corresponding to the foreign country block not yet captured by the previous model description, points out the international linkages via trade in goods and foreign assets, and describes the union-wide monetary policy rule.

2.5.1 The foreign country

The consumption basket of foreign households is given by

$$c_t^{i*} = \left(\frac{c_{At}^{i*}}{\omega - \psi^*} \right)^{\omega-\psi^*} \left(\frac{c_{Bt}^{i*}}{1-\omega+\psi^*} \right)^{1-\omega+\psi^*},$$

for $i = o, r$, while ψ^* captures the degree of home bias in foreign households' preferences. The foreign country's investment basket is analogously defined. The corresponding consumer price index in the foreign country (which is used as numeraire by households and firms in that country) is given by $P_t^* = P_{At}^{\omega-\psi^*} P_{Bt}^{1-\omega+\psi^*} = P_{Bt}\,(1/p_{Bt})^{\omega-\psi^*}$. Analogously to the home country, we can then calculate the foreign country's consumer price inflation and the corresponding producer price index/inflation.

2.5.2 International linkages

International linkages between the two countries are given by trade in goods and services as well as in international bonds. The home country's net foreign asset position, expressed in terms of PPI, evolves according to

$$d_t = \frac{R^{ecb}_{t-1} \cdot d_{t-1}}{\pi_{At}} + \frac{1-\omega}{\omega}\left(C^*_{At} + I^*_{At}\right) - p_{Bt}\left(C_{Bt} + I_{Bt}\right), \tag{28}$$

where $(1-\omega)\left(C^*_{At} + I^*_{At}\right)/\omega$ are real per capita exports and $p_{Bt}\left(C_{Bt} + I_{Bt}\right)$ are real per capita imports. Zero net supply of international bonds implies $\omega d_t + (1-\omega)\, p^B_t d^*_t = 0$. Terms of trade $p_{Bt} = P_{Bt}/P_{At}$ evolve according to $p_{Bt} = (\pi_{Bt}/\pi_{At})\, p_{Bt-1}$. Finally, the German current account is defined as $ca_t = d_t - d_{t-1}/\pi_{At}$.

2.5.3 Equilibrium in goods markets and GDP

Market clearing implies that private per capita production in the home and foreign country, Y_t and Y^*_t respectively, is used for private and public consumption as well as private and public investment demand,

$$Y_t = C_{At} + I_{At} + C^g_t + I^g_t + \frac{1-\omega}{\omega}\left(C^*_{At} + I^*_{At}\right), \tag{29}$$

$$Y^*_t = C^*_{Bt} + I^*_{Bt} + C^{g*}_t + I^{g*}_t + \frac{\omega}{1-\omega}\left(C_{Bt} + I_{Bt}\right). \tag{30}$$

Consistent with national accounting and in line with Stähler and Thomas (2012), each country's GDP is the sum of private-sector production and government production of goods and services. The latter is measured at input costs, that is, by the gross government wage bill. Hence, home and foreign real (PPI-deflated) per capita GDP are given by $Y^{tot}_t = Y_t + (1+\tau^{sc}_t) w^g_t N^g_t p^{1-\omega-\psi}_{Bt}$ and $Y^{tot,*}_t = Y^*_t + (1+\tau^{sc*}_t) w^{g*}_t N^{g*}_t p^{-(\omega-\psi^*)}_{Bt}$, respectively.

2.5.4 Monetary authority

We assume that the area-wide monetary authority has its nominal interest rate, R^{ecb}_t, respond to deviations of area-wide inflation from its long-run target, $\bar{\pi}$, and to area-wide GDP growth, according to a simple Taylor rule,

$$\frac{R^{ecb}_t}{\bar{R}^{ecb}} = \left(\frac{R^{ecb}_{t-1}}{\bar{R}^{ecb}}\right)^{\rho_R} \left\{ \left[\left(\frac{\pi_t}{\bar{\pi}}\right)^{\omega} \left(\frac{\pi^*_t}{\bar{\pi}^*}\right)^{1-\omega} \right]^{\phi_\pi} \left[\left(\frac{Y_t}{\bar{Y}}\right)^{\omega} \left(\frac{Y^*_t}{\bar{Y}*}\right)^{1-\omega} \right]^{\phi_y} \right\}^{(1-\rho_R)},$$

where ρ_R is a smoothing parameter, ϕ_π and ϕ_y are the monetary policy's stance on inflation and output growth, respectively. This completes the model description. We now turn to the model calibration.

2.6 Calibration

We calibrate our model to quarterly frequency, where the home country (A) represents the Germany and the foreign country (B) is the rest of the European Monetary Union. For the general calibration strategy, we strongly rely on Stähler and Thomas (2012). This means that our strategy consists of (i) matching some targets in the data (mainly fiscal and labor market variables) and (ii) carefully choosing the remaining free parameters values in line with the existing literature. The data we use is based on a large innovative data set for the Euro Area containing a rich set of quarterly fiscal variables, described in more detail in Gadatsch et al. (2015). The primary sources for the various variables are the European System of Accounts (ESA) for the main aggregates and the European Commission for the fiscal variables. Some labor market variables come from OECD data. The size of the home country is set to $\omega = 0.271$, which roughly corresponds to Germany's population share in the EMU. Furthermore, we normalize per-capita GDP and PPI inflation in both countries to one, set the net foreign asset position to zero and assume the terms of trade to be equal to one. Then, we target German import and export shares vis-a-vis the Euro Area, which forces us to derive the home bias endogenously. Long-run targets are summarized in Table 1.

Table 1: Targeted values

Target	Symbol	Value	
		Germany	Rest of EMU
GDP	$\bar{Y}^{tot}$	1	
PPI inflation	$\bar{\pi}_A = \bar{\pi}_B$	1	
Net foreign assets	$\bar{d} = \bar{d}^*$	0	
Terms of trade	$\bar{p}^B$	1	
(Average) Labor income tax rate	$\bar{\tau}^w$	0.3039	0.2765
VAT rate	$\bar{\tau}^c$	0.1831	0.1960
Social security contribution rate	$\bar{\tau}^{sc}$	0.1667	0.3280
Capital tax rate	$\bar{\tau}^k$	0.2143	0.3158
Rate of non-participants	$\bar{L}$	0.1000	0.0600
Unemployment rate	$\bar{U}$	0.0818	0.0946
Fraction of publ. employment	$fracpub = \frac{\bar{N}^g}{1-\bar{U}}$	0.1278	0.1848
Vacancy filling rate (private)†	$\bar{q}^p$	0.70	
Vacancy filling rate (public)†	$\bar{q}^g$	0.80	
Gov. SS spending	$\omega^G = \bar{G}/\bar{Y}^{tot}$	0.2131	0.2256
Gov. SS purchases	$\omega^{Cg} = \bar{C}^g/\bar{Y}^{tot}$	0.1112	0.1006
Gov. SS investment	$\omega^{Ig} = \bar{I}^g/\bar{Y}^{tot}$	0.0165	0.0277
SS debt-to-annual-GDP ratio	$\omega^b = \bar{p}_B^{1-\omega-\psi}\bar{b}/(4\bar{Y}^{tot})$	0.6000	0.6000
Import shares	$(\bar{C}_B + \bar{I}_B))/(\bar{Y}^{tot})$	0.1300	0.0549
Entitlement duration	ϑ	0.0833	0.0833

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Target	Symbol	Value	
		Germany	Rest of EMU
Replacement ratio u^s	$rrs = \frac{\bar{\kappa}^{Bs}}{(1-\bar{\tau}^w)\bar{w}}$	0.60	0.59
Replacement ratio u^l	$rrl = \frac{\bar{\kappa}^{Bl}}{(1-\bar{\tau}^w)\bar{w}}$	0.53	0.46
Social assistance ratio	$rrsa = \frac{\bar{\kappa}^{SA}}{(1-\bar{\tau}^w)\bar{w}}$	0.40	0.35

Source: Target values are calculated as in Gadatsch et al. (2015), where the original data comes from the European System of Accounts (ESA) for the main aggregates and the European Commission for the fiscal variables. Replacement ratios are calculated for average wage earners according to OECD data for 2000 as our initial steady state dates at the beginning of the millennium. Labor market targets marked by an † are from Christoffel et al. (2009), who estimate a matching model on European data.

The parameters choice is summarized in Table 2. In calibrating the model to European data, we strongly rely on Christoffel et al. (2009), who estimate a similar model with a search and matching labor market to European data. Note that the simulation results are highly robust to alternative parameter calibration (a sensitivity analysis will be send upon request). The discount factor is set to $\beta = 0.992$ to match an annual real rate of 3.3%, the labor supply elasticity $\sigma_l = 2$ as well as habits $h = 0.6$ are set close to the mode estimates in Smets and Wouters (2003). The share of Rots is in line with Galí et al. (2007) and Forni et al. (2009). Monetary policy parameters are standard values of a conventional Taylor rule, while the price markup and the Calvo parameters for prices and wages are set in line with estimates from the New Area Wide Model (see Cristoffel et al., 2008, for a discussion). Except for lump-sum taxes, we assume that fiscal policy does not react to deviations in debt from target as described in more detail below. Capital depreciation is set to a standard value of $\delta^k = \delta^g = 0.025$, the capital share in production is set to one third (Cooley and Prescott, 1995) and capital adjustment costs are set to a standard value of 5. The impact of the public capital stock on private sector productivity, η, is set to 0.1 in line with empirical evidence, (see Bom and Lighthart, 2014). According to Schmitt-Grohé and Uribe (2003), it is sufficient to chose a rather small value for the risk premium parameter on international bonds in order to generate a stable equilibrium. So we opt for $\psi_d = \psi_d^* = 0.001$.

Regarding the labor market, the elasticity of the matching function in the private sector, φ^p, is set to 0.6 in line with Christoffel et al. (2009). The value in the public sector, φ^g, is set a bit lower, to 0.4, in line with Afonso and Gomes (2014). Following Christoffel et al. (2009), the bargaining power of workers is set to a standard value of 0.5 (see also Hosios, 2001, for a discussion), while the quarterly separation rate in the private sector is set to 0.04. Again, it is somewhat lower in the public sector. Given these parameters, we endogenously derive the efficiency of the matching function as well as vacancy posting costs as indicated in Table 2 to meet the targeted labor market variables shown in Table 1.

Table 2: Baseline parameter calibration

Parameter	Symbol	Value	
		Germany	Rest of EMU
Relative size of home & foreign country	$\omega; (1-\omega)$	0.271	0.729
Monetary policy			
Interest rate smoothing	ρ_R	0.850	
Stance on inflation	ϕ_π	1.500	
Stance on output gap	ϕ_y	0.125	
Fiscal policy			
Lump-sum tax smoothing	ρ_T	0.010	
Stance on debt (lump-sum tax)	ϕ_T	0.900	
Price stickiness			
Calvo parameter (prices)	θ_P	0.900	
Market power (markup)	ϵ	4.000	
Trade in internat. bonds			
Risk premium parameter	ψ_d	0.001	
Preferences			
Share of RoT consumers	μ	0.4	0.400
Discount rate	β	0.992	
Utility of leisure	σ_l	2.000	
Habits in consumption	h	0.600	
Home bias[e]	ψ	0.564	0.200
Production			
Private-sector capital depreciation	δ^k	0.025	
Public-sector capital depreciation	δ^g	0.025	
Private-sector capital share in prod.	α	0.333	
Public-sector capital influence in prod.	η	0.100	
Invstment adjustment cost parameter	κ_I	5	5
TFP scaling parameter[e]	ϵ^a	0.647	0.588
Labor market			
Matching elasticity (private sector)	φ^p	0.600	
Matching elasticity (public sector)	φ^g	0.400	
Separation rate (public sector)	s^g	0.020	
Separation rate (private sector)	s^p	0.040	
Bargaining power	ξ	0.500	
Calvo parameter (wages of existing jobs)	θ_w	0.830	

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Parameter	Symbol	Value	
		Germany	Rest of EMU
Calvo parameter (wages of newly created jobs)	θ_w^n	0.830	
Private-sector matching efficiency^e	κ_e^p	0.381	0.349
Public-sector sector matching efficiency^e	κ_e^g	0.178	0.199
Vacancy posting costs^e	$\kappa_v^p = \kappa_v^g$	0.319	0.426
Disutility of participation^e	ζ^l	0.003	0.001

Source: Parameter values primarily based on Christoffel et al. (2009) unless indicated differently in the main text. Those marked by an e are derived endogenously to match the steady-state targets of Table 1.

3 Analysis

3.1 Major German labor market and fiscal reforms 1999 to 2008

In the late 1990s and early 2000s, Germany experienced a period of sluggish economic growth and high unemployment. During this time, it was often called "the sick man of Europe" (Dustmann et al, 2014). Beginning in 1999, Germany enacted several fiscal and labor market reforms to counteract this development, among them the *Hartz* reforms which were probably the most prominent reform packages.

Fiscal reforms included several effective tax changes. Beginning in 1999 until 2003, Germany raised indirect taxes (ecological taxes) and, at the same time, decreased social security contributions in order to decrease the price of labor (Deutscher Bundestag, 1998 and Deutscher Bundestag, 1999). These measures can be interpreted as fiscal devaluations. In 2001, Germany decreased corporate taxes and from 2001 to 2005 labor taxes in order to boost price and cost competitiveness, growth and employment (Deutscher Bundestag, 2000). The increase in the value added tax in 2007 was primarily aimed to ensure the stability of public finances (Deutscher Bundestag, 2006). However, since one third of the revenues were used to decrease social security contributions, this measure can also be interpreted as a fiscal devaluation. Finally, in 2008 Germany decreased corporate taxes in order avoid losses in the tax base (Deutscher Bundestag, 2007).

From 2003 to 2005, far reaching labor market reforms were also implemented, the so-called *Hartz* reforms. For our analysis, we focus on *Hartz III* and *Hartz IV* which were put in place in 2004 and 2005, respectively. The goal of *Hartz III* was to increase the matching efficiency on the labor market by restructuring the Federal Employment Agency. The goal of *Hartz IV* was to increase the incentives for unemployed to search for a job. It comprised (i) a decrease in entitlement duration of unemployment benefits for short-term unemployed (*Arbeitslosengeld I*) and (ii) a merger of unemployment assistance for long-term unemployed (*Arbeitslosenhilfe*) into social welfare assistance (*Sozialhilfe*). The merger led to lower unemployment assistance for long-term unemployed but slightly higher social welfare assistance and was called *Arbeitslosengeld II*. For a more detailed

description, see also Deutsche Bundesbank (2006, 2015).

3.2 Model implementation

To implement the fiscal reforms, we have to identify the associated changes in the corresponding tax rates. To this end, we take the official expected changes in the tax base and transform them into changes of the implied tax rate using the implied tax rates published by the European Commission (European Commission, 2014). We feel comfortable with this procedure given that the official expected changes of the tax base do not take into account the endogenous reaction of the tax base to the change in the tax rate. The resulting changes in parameters can be found in Table 3. The are visualized in Figure 1. In order to guarantee stationarity of public debt, we assume that *only* lump-sum taxes levied on optimizers react to debt deviations, ie *only* $\phi_{T^o} = 0.01$, with $\rho_{T^o} = 0.9$, while all other fiscal instruments are kept constant (or the long-run target is changed as summarized in Table 3, respectively). The advantage of this simulation design is that we are able to examine the isolated effects of the reforms because lump-sum taxes levied on optimizers create no further distortions in the model economy. Furthermore, note that, for simulating fiscal devaluations 1999 to 2003 and 2007, social security contributions on the employee's side, $\tau^{sc}_{employee}$, are part of the labor tax rate τ^w_t, while social security contributions on the employer's side, $\tau^{sc}_{employer}$, are captured by τ^{sc}_t in our model.

As regards the labor market reforms, we assume that, following the *Hartz III* reform in 2004, matching efficiency in the public and the private sector, κ^p_e and κ^g_e, respectively, are both permanently increased by 10%. This choice is in line with Krebs and Scheffel (2014). It is a conservative choice given the available empirical evidence provided in their appendix. The *Hartz IV* reform consists of three measures. First, entitlement duration for *Arbeitslosengeld I* is reduced from three to a bit more than one year.[9] This is reflected by a corresponding increase in the probability ϑ of moving from $u^{s,i}_t$ to $u^{l,i}_t$. Second, the replacement rate of long-term unemployed rrl is reduced from 53% to 45% according to OECD data. Furthermore, we have to take into account that, after the *Hartz IV* reform, unemployment assistance for long-term unemployed now is a fixed amount independent of previous wages, such that $\kappa^{Bl}_t = \bar{\kappa}^{Bl} = rrl \cdot (1-\bar{\tau}^w)\bar{w}^p \, \forall t$ holds. Finally, unemployment assistance for long-term unemployed is merged into social welfare assistance such that $\bar{\kappa}^{SA} = \bar{\kappa}^{Bl}$. All measures and their corresponding time paths are summarized in Table 3.

Table 3: Reform instruments and timing

Year	$d\tau^c$	$d\tau^{sc}_{employee}$	$d\tau^{sc}_{employer}$	$d\tau^w$	$d\tau^k$	$d\kappa^e$	$d\vartheta$	$drrl$
1999	+0.51%	-0.42%	-0.42%					
2000	+0.22%	-0.15%	-0.15%					
2001	+0.23%	-0.15%	-0.15%	-1.59%	-1.08%			
2002	+0.22%	-0.15%	-0.15%					

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[9] Entitlement duration for *Arbeitslosengeld I* was generally cut to 12 months. However, elderly workers still face a duration of 18 months. Hence, assuming 15 months can be considered an average.

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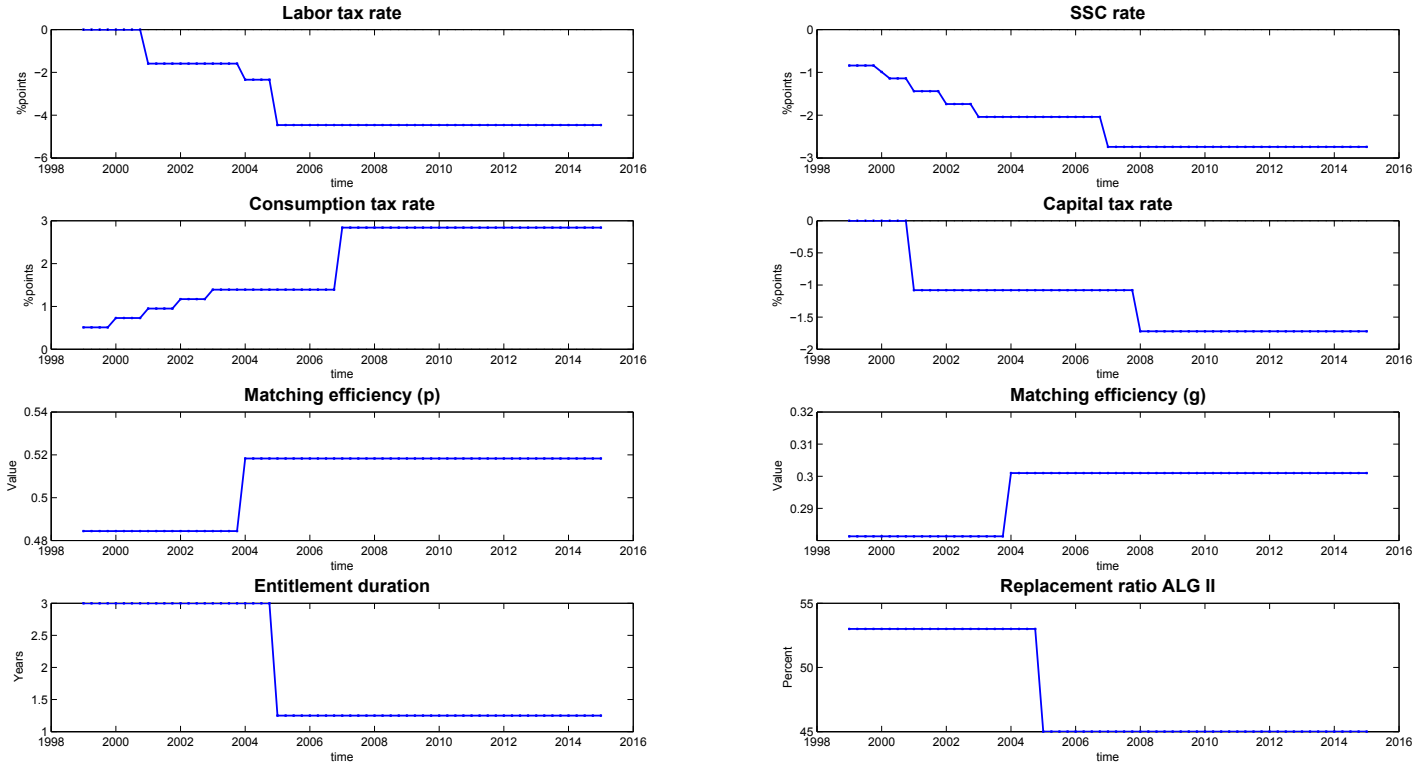
Year	$d\tau^c$	$d\tau^{sc}_{employee}$	$d\tau^{sc}_{employer}$	$d\tau^w$	$d\tau^k$	$d\kappa^e$	$d\vartheta$	$drrl$
2003	+0.22%	-0.15%	-0.15%					
2004				-0.75%		+10.00%		
2005				-2.12%			+11.67pp	-8pp
2006								
2007	+1.45%	-0.35%	-0.35%					
2008					-0.64%			

Notes: For tax rate changes, official expected changes in the tax base are taken from the corresponding draft laws (ie Deutscher Bundestag, 1998, 1999, 2000, 2006 and 2007) and transformed into implied tax rate changes using the taxation trends from European Commission (2014). For the labor income tax rate changes 2001, 2004 and 2005, we take an updated estimation by the German Ministry of Finance (BMF, 2000). The labor tax decrease in 2003 was postponed to 2004 due to the floods in 2002. Social security contributions on the employee's side are captured by changes in τ^w_t in the model, while changes in social security contributions on the employer's side are captured by changes in τ^{sc}_t. The increase in the probability ϑ by about 11 percentage points reflects the fact that average entitlement duration for *Arbeitslosengeld I* is decreased from three years to only one and a half. In addition to reducing the replacement rate rrl, we have to take into account that, in the *Hartz IV* reform, *Arbeitslosengeld II* is now independent of previous wages but a fixed amount depending on the initial steady-state wage. Also notice that social assistance, κ^{SA}, is increased accordingly.

Our simulation starts in 1999 from the initial steady state. For each reform measure, we change the relevant parameters as indicated in Table 3. We assume that single reform measures were not anticipated ex-ante, which implies that anticipation effects only became relevant in case of multi-year reforms. To be precise, the fiscal devaluation in 1999 was not anticipated before 1999. But once the reform package was introduced in 1999, the following increases in consumption taxes and decreases in social contributions until 2003 were fully anticipated. For each reform measure, we then calculate the corresponding transition path to the new steady state. The starting value of the transition path is given by the transition path of the preceding reform measure (the initial steady state for the devaluation reform 1999, respectively). For example, the starting value of the *Hartz IV* reform in 2005 is given by the corresponding value in year 2005 of the transition path of the *Hartz III* reform. The starting value of the *Hartz III* reform of 2004, in turn, is the corresponding value in year 2004 of the transition path of the labor income and capital tax rate reductions of 2001. We proceed analogously for all reform measures. Hence, any reform measure takes into account the steady state and the transition paths of all preceding reform measures. This simulation setup allows us to simulate the entire agenda in the fully non-linear model under perfect foresight.[10] It further allows us to calculate the final steady state implied by the agenda and disentangle the impact of each measure.

[10]Technically, we carry out a deterministic simulation using Dynare's Newton method to solve simultaneously all the equilibrium equations for every period (see Adjemian et al., 2011). The number of simulation periods is set to 500.

Figure 1: Paths of policy variables



Notes: Figure plots simulated paths of policy variables in percentage point deviations from initial steady state except for entitlement duration [which shows years] and the replacement ratio of second-pillar benefits [which is shown in percent of average or (steady-state) wages]. The social security contribution rate pools employee's and employer's contributions. Furthermore, we have to take into account merging of unemployment and social assistance after the *Hartz IV* reform (as described in the main text) in the simulation to follow.

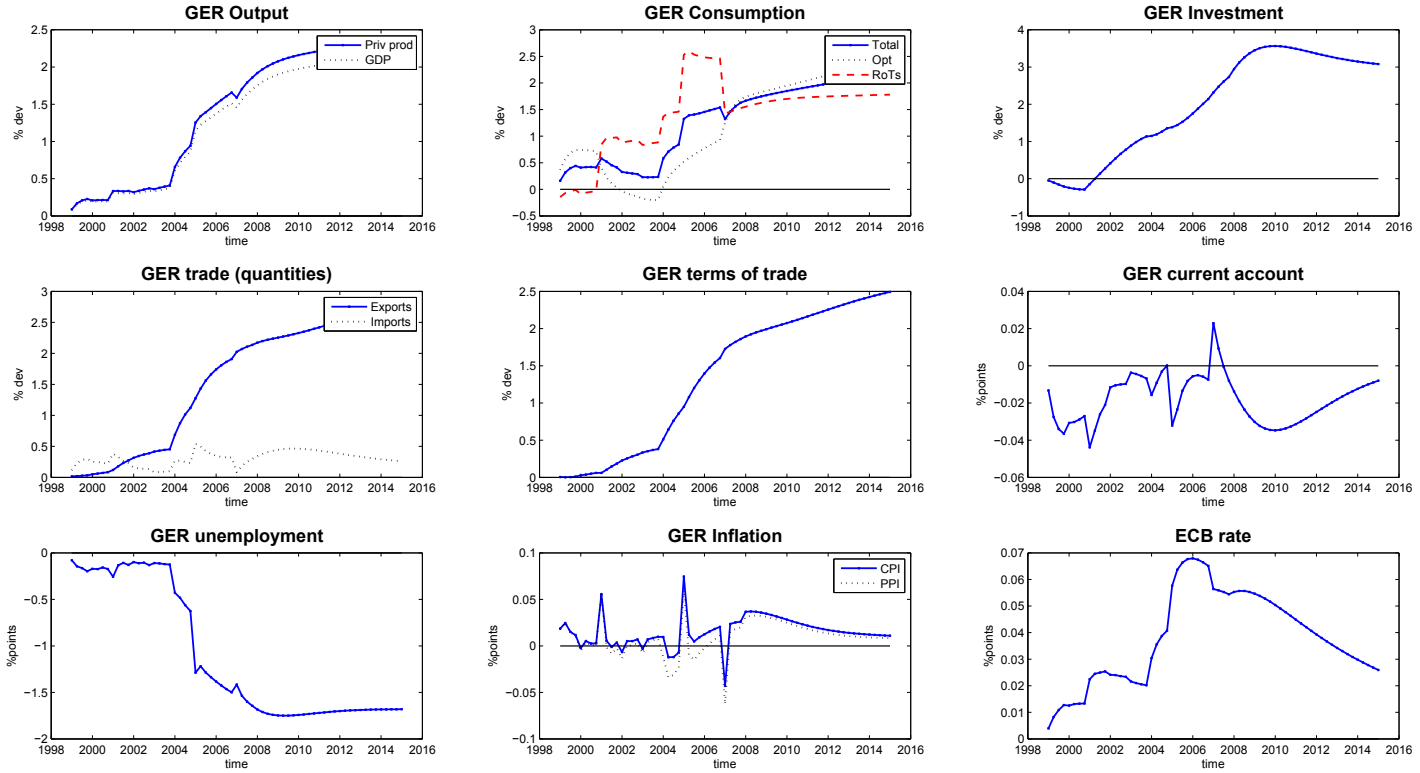
3.3 Results

Figures 2 and 3 show the evolution of selected key macroeconomic variables following the reform agenda for Germany and the rest of the Euro Area, respectively. All deviations are presented in percent to initial steady-state values (percentage point deviations for unemployment, for yearly CPI inflation and interest rates as well as for all ratios), the current account is in percent of (steady state) output.

We observe that the reform agenda had a relatively large impact on German GDP and private production. It slowly but steadily increased German GDP up to roughly 0.52% above its initial steady-state value until 2004. Then, after the *Hartz IV* reforms, we observe a large jump pushing it up to about 2% above its initial steady state in 2015. Total private consumption in Germany also increased by about 2% until 2015. There is a notable difference in RoTs' and optimizers' consumption behavior, however. While RoT households' consumption was hardly affected by the fiscal devaluation in 1999, optimizers' consumption increased. This is due to the fact that RoTs suffer from higher consumption taxes while optimizers are able to bring forward the efficiency gains resulting from the decrease in social security contributions. The decrease in labor taxes in 2001, however, augmented RoT households' disposable income, yielding an increase RoTs' consumption, too. Both *Hartz* reforms generated and increase in optimizers' and RoT households' consumption, primarily driven by the significant decrease in unemployment, which, in 2015, is about 1.8 percentage points below its initial steady-state level. This boost in employment overcompensated the loss in real wages (not shown here; see Figure 4). The latter was a result of the lower fall-back position due to shorter entitlement duration and lower unemployment assistance payments. Private investment is also about 3% higher in 2015 than it was in the initial steady state. The decrease of social security contribution as a result of the fiscal devaluation in 1999 made labor input cheaper. Therefore, firms substituted labor for capital, which lowered the incentive for private capital investment initially. However, increasing GDP and the capital tax reform in 2001 implied a robust rise in private investment thereafter. The *Hartz* reforms, again, increased the attractiveness to employ labor instead of capital, decelerating the increase in investment a bit, while the capital tax reform in 2008 was able to, finally, regain the attractiveness to invest.

Overall, the reforms fostered international competitiveness, the terms of trade and exports. Higher consumption in Germany also fostered demand for rest of the Euro Area products implying more imports and an increase in rest of the Euro Area GDP in 2015 close to about 0.2% compared to its initial steady-state value (see Figure 3). Higher demand for rest of the Euro Area products represented a demand shock implying higher producer prices. The primary impact of German reforms on rest of the Euro Area GDP was in 2004 and 2005 (*Hartz III* and *IV* reforms) and thereafter, which coincides with the jump in private demand in Germany (see Figure 2). Higher output in the rest of the Euro Area was accompanied by a fall in the unemployment rate by roughly 0.15 percentage points in 2015 . Higher employment implied higher income, which fostered private consumption. Higher inflation as well as output in both countries made the common central bank increase interest rates (see Figure 2).

Figure 2: Effects of reform agenda on key macro variables (Germany)



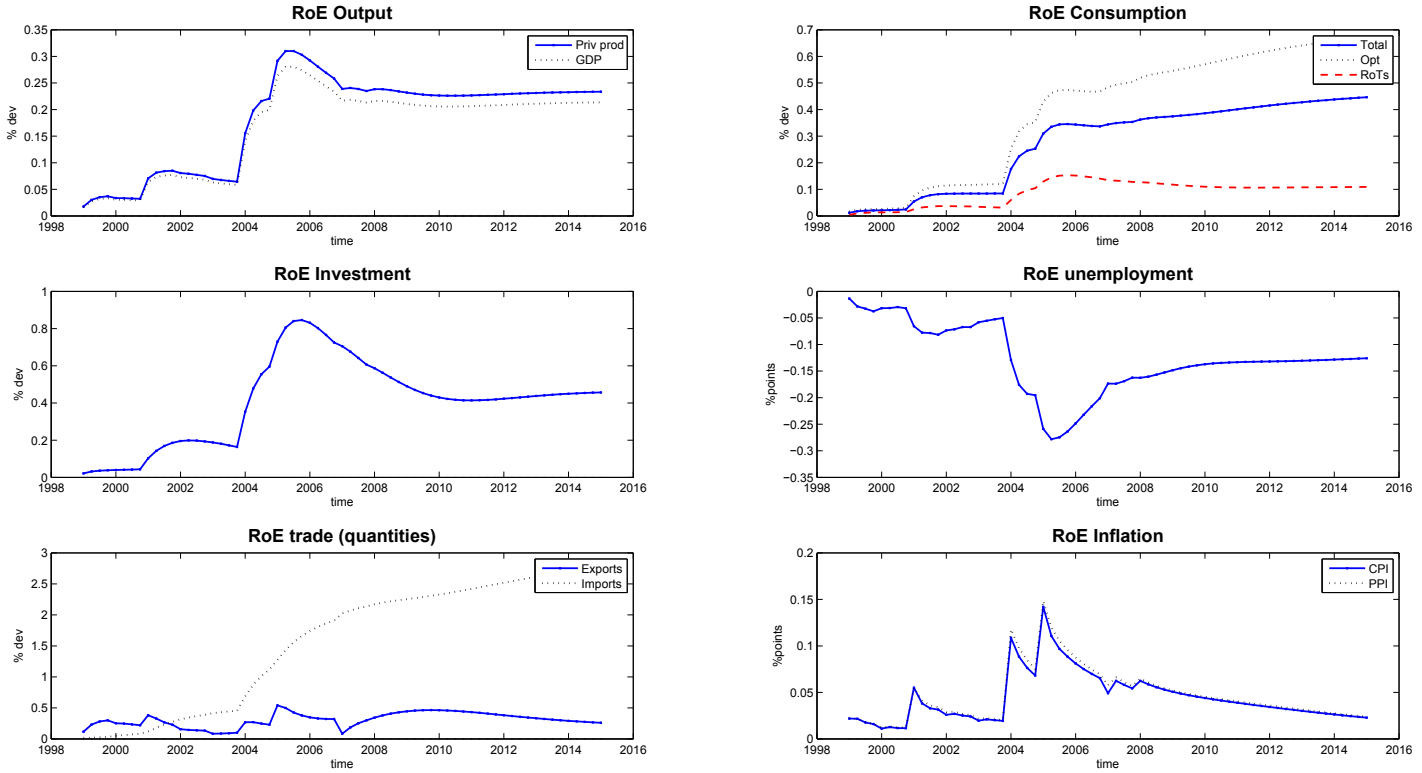
Our description hitherto hints at the conclusion that both, Germany and the rest of the Euro Area benefited from the reforms undertaken in Germany. In relative terms, however, Germany seems to have benefited more than the rest of the Euro Area, which especially holds for GDP developments (2% in Germany versus 0.2% in the rest of EMU) and, to a lesser extent, for consumption (2% versus 0.5%). This is also visible in the increase in the German terms of trade. The impact on the current account, however, was only relatively small as Figure 2 reveals. This can be explained by the fact that the evolution of the current account entails a price and a quantity effect in the trade balance, the former given by the terms of trade and the latter by the trade quantities; see equation (28). Overall, both effects even out. The reform agenda, thus, cannot be held responsible for the persistent increase in the current account in Germany since 2000 although claimed by many to be one of the main drivers. Our analysis therefore suggests that, in order to explain the German current account developments vis-a-vis the rest of the Euro Area, one needs to identify other shocks. We will discuss this further in Section 3.4 below.

Having described the impact of the entire agenda path, it is now interesting to disentangle the impact of different measures. Figure 4 plots the evolution of key macroeconomic variables and the contribution of each single reform.

We observe that fiscal devaluation starting in 1999 persistently improved German GDP by about 0.2% compared to initial steady state. At the same time, it improved rest of the Euro Area GDP. Average real wages were positively affected, mainly because social security contributions were decreased and unemployment fell. The latter increased the workers' fall-back position in the bargaining process, which made them demand higher wages. Reduced social security contributions entailed lower unit labor costs for German firms and lower producer prices. This improved the terms of trade persistently. Higher import demand (see Figure 2) at relatively higher prices, however, had a negative effect on the German current account balances. These effects are in line with the literature (see, among others, Farhi et al., 2014, Lipińska and von Thadden, 2009, or Stähler and Thomas, 2012, for a further discussion). Fiscal devaluation in 2007 yielded much smaller effects because only one third of the created fiscal space was used for reducing social security contributions. The remaining two third were used for debt reductions.

The labor and capital income tax rate reductions in 2001 had qualitatively similar effects on German GDP, imports, exports, its price competitiveness and unit labor costs. Wages now decreased (slightly), however, because the reduction in direct taxes augmented net income of households (who were now willing to accept lower wages). Spillovers to the rest of the Euro Area were also positive, again driven by higher German demand for foreign products. Rest of the Euro Area GDP persistently increased.

Figure 3: Effects of reform agenda on key macro variables (rest of Europe)



Turning to the labor market reforms, we observe that *Hartz III* (combined with a decrease in labor income taxation in the same year) had persistent positive effects on German GDP. The reason is that, because of higher matching efficiency, the labor firms' search costs were decreased. This fostered job creation, unemployment fell and production increased. The increased probability of finding a job put upward pressure on wages. But because overall labor costs and the marginal product of labor, represented by x_t in equation (15), decreased, labor firms lost profits per employed worker, which generated a wage-dampening effect. The latter and the labor income tax reduction in 2004 slightly overcompensated the former effect such that *Hartz III* plus the labor income rate reduction led to a moderate decline in wages. Still, due to an increase in employment, average income increased, which fostered German demand for domestic and foreign products. The latter incentivized firms to increase prices, both in Germany and the rest of the Euro Area. As the price increases were larger in the rest of the Euro Area, German terms of trade increased. However, because of comparatively small trade balance effects, its current account was hardly affected.

The effects of the *Hartz IV* reform (combined with another decrease in labor income taxation) were similar to those of the *Hartz III* reform, qualitatively and quantitatively. The reduction in the entitlement duration increased the fraction of unemployment assistance recipients relative to total unemployment and, therefore, implied a sharp decrease in the aggregate fall-back position of workers. It was further reduced by merging unemployment and social assistance at a lower level than the former unemployment assistance. Naturally, this decreased wages and fostered employment (see also Hagedorn et al., 2015, for a formal discussion on a decrease in unemployment benefits). The fall in the unemployment rate by almost one percentage points due to the *Hartz IV* reform is in line with the literature (see, for example, Krebs and Scheffel, 2013; Krause and Uhlig, 2012, find even higher values using a heterogenous agent model). The higher employment rate clearly overcompensated the fall in per capita wage rate, which becomes evident by inspecting the RoTs' consumption path in Figure 2. Therefore, German demand for home and foreign products significantly increased which made firms in Germany and the rest of the Euro Area increase prices significantly. In contrast to German firms, rest of the Euro Area firms did not face a wage dampening effect resulting in their prices to increase relatively more strongly. Hence, German terms of trade improved significantly. However, given the relatively sharp increase in German imports in combination with the corresponding highly improved terms of trade (which made imported good more valuable expressed in terms of German goods), its current account was merely affected. Note that the *Hartz* reforms generated positive spillover effects. This result is in line with the recent literature on spillover effects of labor market reforms (see, among others, Dao, 2013b, Felbermayr et al., 2012, 2013, Gomes et al., 2011, or Schwarzmüller and Stähler, 2013).

Figure 4: Impact of different reforms on key variables

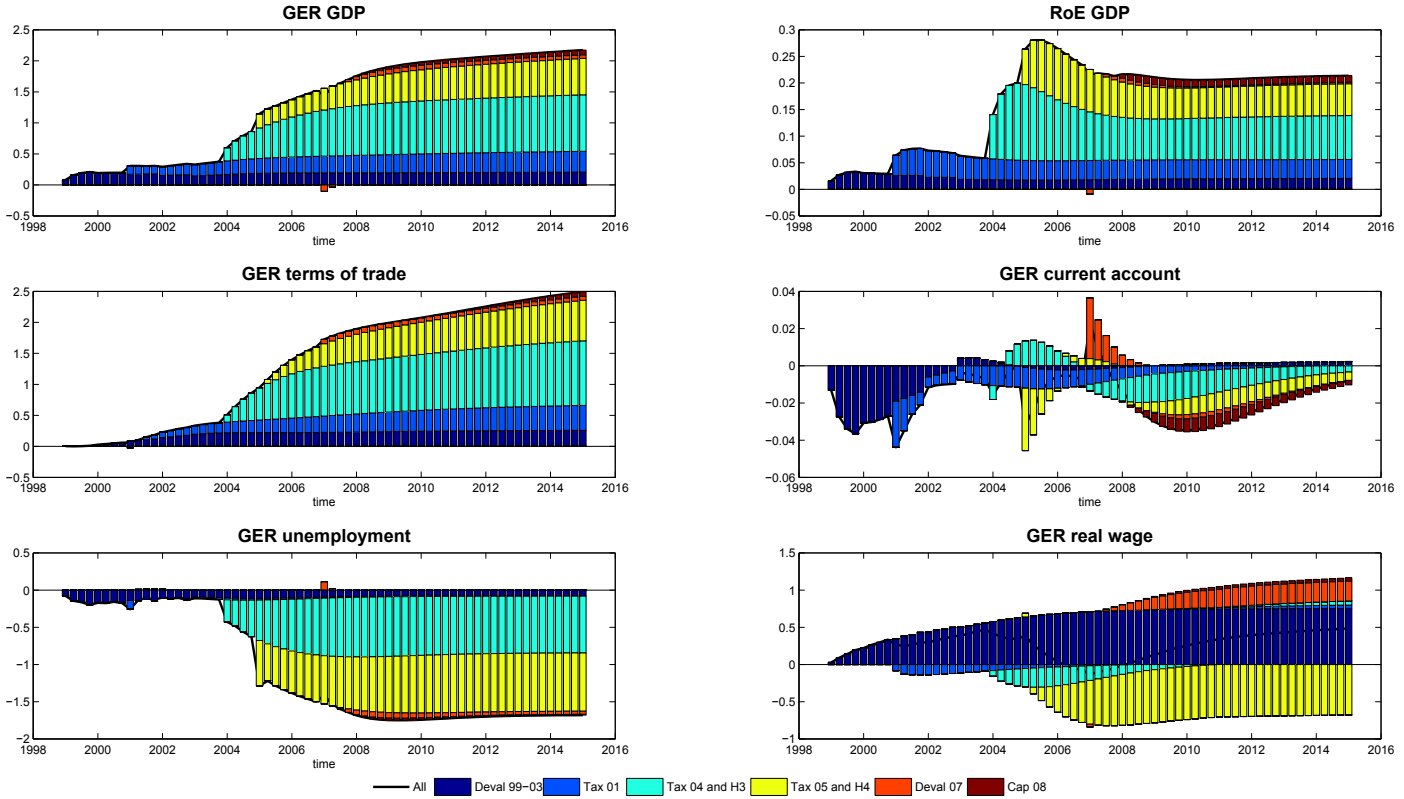


Table 4 summarizes the long run effects of the entire reform agenda described in Table 3 for selected macroeconomic variables relative to the initial steady state values. As we see, the results obtained by inspecting the the transition path until 2015 basically survive in the long run. Hence, in summary, Germany clearly benefited from the reform agenda in terms of German GDP, consumption, investment and (un)employment. But so did the rest of the Euro Area as a result of the positive spillovers described earlier. However, at a much lower level. It seems noteworthy that the reform agenda implied redistribution of relative income from liquidity constraint to optimizing households in both, Germany and the rest of the Euro Area. This can be seen in the larger increase in consumption of optimizing households. German price and cost competitiveness has increased after the reform agenda.

Table 4: Long run effects of the reform agenda

Variable	Percentage(point) deviation from initial steady state
Germany	
GDP	2.40
Aggregate consumption	2.52
Optimizers' consumption	2.95
RoTs' consumption	1.87
Investment	2.79
Unemployment	-1.67
Real wages	0.71
Terms of trade	2.75
Rest of the Euro Area	
GDP	0.23
Aggregate consumption	0.49
Optimizers' consumption	0.74
RoTs' consumption	0.11
Investment	0.44
Unemployment	-0.11
Real wages	0.18

Notes: Table shows long-run effects of the entire agenda path in percentage(point) deviations relative to the initial steady state for selected variables.

3.4 Discussion

The above analysis suggests that the German reform agenda cannot be held responsible for the German current account developments vis-a-vis the rest of Euro Area. However, data shows that the current account was indeed positively affected during the first decade of the new millennium. In order to explain the comparatively persistent German current account surplus one should, therefore, search for arguments in favor of such developments.

One possible candidate for explaining these developments could be demographic change

and corresponding policy reactions to it, reflected in the various reforms of the statutory pension system which may have led to higher household savings (see, e.g., Kollmann et al., 2015). Debates about the sustainability of the German pension system sprouted from about 2001 onwards. Since we do not model a demographic structure and a pension system explicitly, we consider as a shortcut that the combined effect of demographic change and subsequent reforms in the pension system is reflected by an increase in savings.[11] In particular, we assume that, beginning in 2001, households started to evaluate future consumption relatively more. This is implemented by permanent increases in the German discount factor β in 2001, 2003 and 2004. During those years, three pension reforms were implemented. In total, we increase β to 0.9932 (in steps of 0.004 in the corresponding year) and conduct the same analysis as described above (i.e. also including the reform agenda). While it is very hard to pin down the potential increase of β at that time, the suggested increase is still low, given that $\beta = 0.9932$ is compatible with a steady state real interest rate of 2.73%.

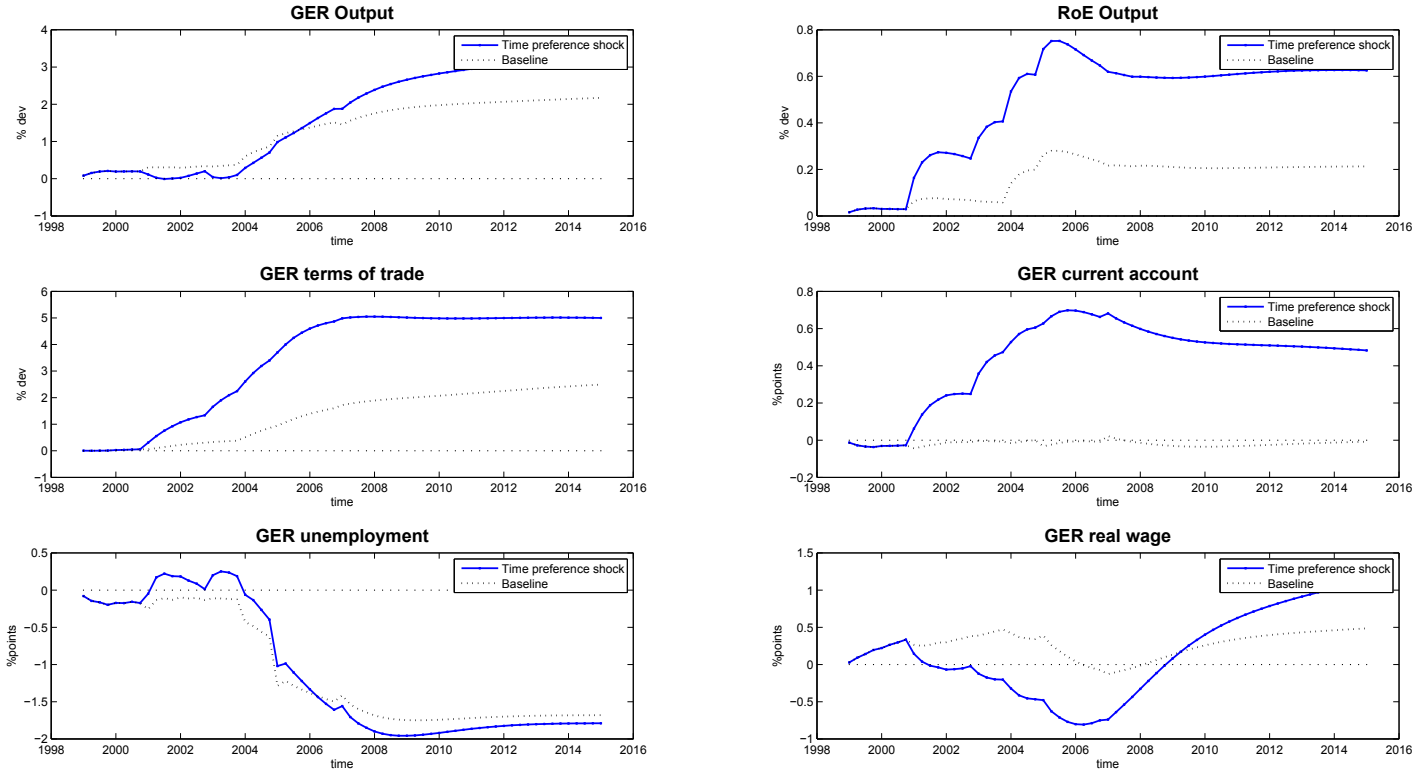
The results are summarized in Figure 5. We observe that including the permanent change in German time-preferences in our model indeed generates a positive and persistent increase in the current account. Relative to the baseline scenario, which only includes the reform agenda, the difference is huge.

The change in time-preferences, starting to take place in 2001, induced optimizing households to decrease consumption and increase investment. Because of higher private investment, capital became relatively more abundant such that German firms – contrary to the baseline scenario – had the incentive to further decrease prices through the marginal costs channel. This significantly augmented the terms of trade improvements. Relatively lower German demand (at least at the beginning of the simulation period) and significantly higher relative prices of rest of the Euro Area goods decreased German imports and boosted exports implying a large positive effect on the German current account. Relative to the policy reforms, comparatively small changes in time preference had a much larger impact on the German current account and trade relations. This gives more confidence for our previous result that the reform measures by themselves were most likely not the main driver.

A side remark is noteworthy concerning the development of wages which started to decline (temporarily) in 2001 (see Figure 5). Because households prefer relatively more future consumption in the presence of a preference shock, they accept lower wages today. Hence, such a shock may be an additional argument for explaining why the wage moderation took place already before the *Hartz* reforms were implemented (see Dustmann et al., 2014).

[11] Note that Kollmann et al. (2015) explain their identified saving shocks with an ageing society realizing that expected pensions may be lower than previously anticipated.

Figure 5: Impact of a permanent time-preference shock



4 Conclusions

In this paper, we built a two-country monetary union DSGE model with a complex frictional labor market structure and a comprehensive fiscal block. The model is well suited to evaluate the impact of German fiscal and labor market reforms on key domestic and foreign macroeconomic variables and to evaluate how much they have contributed to the observed intra-Euro Area imbalances. By many, mostly the *Hartz* reforms on the labor market are considered to be the root of imbalances in the Euro Area. This paper pursues a comprehensive approach and simulates all major fiscal and labor market reforms from 1999 to 2008.

We find that, in terms of German GDP, consumption, investment and (un)employment, the reforms were a clear success albeit the impact on the German current account was only minor. The most important measures for these developments were the *Hartz* reforms, followed by the alleviations in labor taxation and fiscal devaluation. The rest of the Euro Area mainly benefited from these measures in terms of output and consumption. The reforms also activated intra-European trade including higher German exports as a result of its improved price and cost competitiveness and higher imports resulting from a positive wealth effect. The overall impact on the German current account was only minor, however. Hence, our analysis suggests that the reform undertaken cannot be held responsible for the thereafter observed macroeconomic imbalances within the Euro Area.[12]

To explain the persistent German current account surplus one therefore needs to search for other arguments. A possible candidate could be higher savings preferences in Germany. The latter could potentially be a result of an ageing society realizing that expected pensions may be lower than previously anticipated (Kollmann et al, 2015) or of increased income uncertainty because of massive cuts in the generosity of the unemployment benefit system. All that, however, cannot reliably be analyzed in a model which does not explicitly account for the demographic structure of the economy and/or which does not include precautionary savings motives. Overall, the literature is not yet able to give a clear picture explaining these developments and further research in this direction is certainly needed. Our paper contributes to the discussion by showing that not only the *Hartz* reforms, but German fiscal and labor market reforms from 1999 to 2008 in general seemed to have had a less important role than claimed by many.

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[12] Andrés et al. (2014) further show that if trade flows do not respond sufficiently to the reform-induced terms-of-trade depreciation because of relatively low elasticity of substitution between home and foreign goods in preferences, labor market reforms may actually be contractionary in the short run. Under the assumption of Cobb-Douglas preferences in our model (ie substitution elasticity of 1), it is not possible to perform such a robustness exercise. However, the presence of such effects would even strengthen our result.

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