Global Imbalances, Precautionary Savings and Labor Market Reforms: The German Hartz Experience[†]

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Preliminary and incomplete – comments are more than welcome!

Abstract

We propose a novel framework to analyze the contribution of the German labor market reforms on its current account surplus. We show that precautionary savings increase substantially after a major reduction in the unemployment benefit scheme (Hartz IV). In our two-country model with incomplete insurance, we find that about 40 percent of Germany's increase in net foreign assets and its current account surplus may be attributed to the Hartz IV reform. The cut in entitlement duration had a strong impact, while the effects of the reduction in the replacement rate for long-term unemployment on savings were milder. A representative agent framework is not able to reproduce any notable current account effects after the reform.

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1 Introduction

"As they [the Germans] see it, their economy was in the doldrums at the end of the 1990s; they then cut labor costs, gaining a huge competitive advantage, and began running gigantic trade surpluses." (Paul Krugman, October, 2014)

In current discussions on the topic, for many, Krugman's quote pictures quite well what happened to Germany's trade balance and its net foreign asset position.[1] Far-reaching labor market reforms, called the Hartz reforms, which primarily entailed a significant reduction in the generosity of the unemployment benefit system, and which we will describe in more detail below, are often held responsible for the decline in labor costs. While modern dynamic macroeconomic models are indeed capable to link the generosity of the unemployment insurance system with lower wages and higher international competitiveness, they tend to fail at linking the consequential – and notable – improvements in the current account and the net foreign assets positions (e.g. Dao, 2013, Busl and Seymen, 2013, Baas and Belke, 2014 and Gadatsch et al., 2016b).

The first and foremost reason for this is that most of the relevant studies use the common representative agent framework. However, the standard DSGE model, in general, entails steady-state indeterminacy and nonstationary dynamics of net foreign assets. While Schmitt-Grohe and Uribe (2003), Erceg et al. (2005), Hunt and Rebucci (2005), Benigno (2009) and others discuss a number of alternative mechanisms to circumvent this problem, all these alternatives boil down to assuming additional frictions in the international financial markets introducing a link between consumption and the net foreign asset position to achieve stationarity. More precisely, it is usually assumed that, whenever holdings of net foreign assets exceed some exogenously fixed reference level, risk premia, intermediation costs or some disutility will emerge. While this pins down the steady-state level of international financial assets uniquely, it does so independent of policy. Therefore, the usefulness of these assumptions to study international macroeconomic issues, especially when analyzing structural (policy) reforms, has been questioned (see Lubik, 2007 for an in-depth discussion of the issue). The literature on international macroeconomics, which we will discuss more in detail in the literature section below, has thus introduce precautionary savings motives to the baseline workhorse model, which avoids having to exogenously impose a net foreign asset position and endogenizes the savings decision. However, to our knowledge, none of the existing analyses has yet linked precautionary savings to structural labor market reforms.

In this paper, we introduce a simple and tractable precautionary savings motive into an otherwise standard two-region RBC model with search frictions on the labor market. It enables us to explain about 40% of the increase in Germany's net foreign asset position and another 40% of the cumulated current account developments after the introduction of the Hartz reforms.[2] Relative

[1] Indeed, the current account imbalances have repeatedly been criticized in the European Commission's Macroeconomic Imbalance Procedure (MIP) and by the International Monetary Fund (IMF); see among others Chen et al. (2012), Hobza and Zeugner (2014) and Kollmann et al. (2015).

[2] The difference between the net foreign asset position and the cumulated current account arises due to real exchange rate effects in our model.

to a standard RBC model, which explains virtually nothing of the current account developments and effectively nothing of the structural changes in net foreign assets by construction, this is a large difference.

More precisely, we depart from the representative agent model by introducing quasi-heterogeneity and, thereby, endogenize the demand for assets and also the long-run interest rate in the economy. In doing so, we expand a model with limited cross-sectional heterogeneity in the spirit of Challe and Ragot (2016) to a two-region economy. This class of models is characterized by an endogenous distribution of household types which can be aggregated in every point in time. As stressed by Ragot (2017), this simplified version of heterogeneity has several advantages: Besides the benefit that it remains analytically tractable, it allows to analyze optimal policies and make normative statements. In the model, households who become unemployed face a consumption risk and want to insure against it. They can do so in form of saving in interest-bearing assets. Whenever domestic asset demand is not supplied domestically, households move to international financial markets.

A reduction in the generosity of the unemployment benefit system (like in the Hartz reforms) now directly increases the households' consumption risk and the demand for precautionary savings. As the necessary assets are not fully provided domestically, households purchase them internationally and, thus, the net foreign asset position increases. In our model, calibrated to Germany and the rest of the Euro area, the Hartz reforms imply an increase of the German net foreign asset-to-GDP ratio of 25% (versus 51% observed in the data), and up to 50% of the increase in actual the cumulated German current account-to-GDP ratio are explained by the Hartz reforms. This tells us two things. First, it is very likely that the Hartz reforms have contributed more to the developments of the German current account and its international asset position than what standard RBC/DSGE models made us believe. Second, Hartz was still not the only culprit, however. Other factors, such as ageing and pension reforms, for example, probably had their share, too. In order to understand these developments better, further research is certainly warranted. Interestingly, a cut in the replacement rate of long-term unemployment benefits leads to a slight decrease in the net foreign assets position, whereas a cut in the entitlement period of short-term unemployment benefits to one third has large effects.[3] Furthermore, we find that the unemployment rate fell by more than 1 percentage point due to the Hartz reform. This is well in line with findings by Krebs and Scheffel (2013) and shows that our model generates plausible results. In a representative agent version of our model, the German net foreign asset position remains unchanged. This illustrates the importance of allowing for a savings motive.

The contribution of our paper is threefold. First, we show that existing literature underestimates the contribution of the Hartz reforms on the German current account by introducing a model that explicitly allows for a precautionary savings motive through incomplete insurance

[3] Given the pre-Hartz legislation in Germany, the reason for this is that the cut in the replacement rate for long-term unemployment benefits only affects households *directly* who are unemployed for more than three years. Because of a falling reservation wage and the resulting increase in the likelihood to find a job, the unemployment-related consumption risks decreases. This latter effect dominates the former in terms of the precautionary savings motive. Cutting entitlement duration, however, affects the (short-term) consumption risk much more such that the increased job-finding probability can no longer compensate for the reduced unemployment benefits and, thus, the incentive to save increases.

against the risk of becoming unemployed. Second, we contribute to the literature that shows that the standard way to close open-economy DSGE models (as in Schmitt-Grohe and Uribe, 2003) is not appropriate to study the effects on the current account and net foreign assets resulting from permanent structural changes and/or reforms (such as the Hartz reform taken here as an example). Third, we contribute to the discussion on spillover effects of labor market policies and show that the reduction in the generosity of unemployment benefits had a positive impact on the rest of the Euro Area.[4]

The rest of the paper proceeds as follows. The next section briefly reviews the related literature, while Section 3 outlines the background on the Hartz reforms and the German current account developments. Section 4 derives a search and matching model with incomplete insurance. We explain the calibration in section 5. Section 6 shows results. We compare our model to the representative agent framework in Section 6.4. Section 7 concludes.

2 Related literature [*to be extended/reshuffled...*]

Our paper is related to several strands of the literature. First, it relates to papers discussing labor market reforms as such, with a special focus on the German Hartz reforms. Second, it relates to a subset of this literature discussing the impact of these reforms on the current account. And third, it is related to the literature of precautionary savings and the linkages to international asset trade. In what follows, we will discuss this literature in more detail.

Prominent studies focusing on the effects of Hartz IV on German unemployment from a macroeconomic perspective are Krebs and Scheffel (2013), Krause and Uhlig (2012) and Launov and Wälde (2013). We will use our framework to contribute to the ongoing discussion on the aggregate employment effects of the reform.

One of the earliest contributions with a focus on the interaction of savings and the current account is Ghosh and Ostry (1997). They extend the intertemporal approach to the current account (see Obstfeld and Rogoff, 1995) and allow for effects of aggregate income shocks on the current account via an external savings channel. Furthermore, there exist several important contributions regarding the effects of precautionary savings on the US current account deficit. Caballero et al. (2008) argue that the reason for the current account imbalance lies in different growth rates of developed economies. Fogli and Perri (2006) argue that the decreased business cycle volatility after the Great Moderation caused the US current account deficit. Mendoza et al. (2009) make the point that different financial market developments across countries constitute a reason for global imbalances and Carroll and Jeanne (2009) endogenize the optimal level of domestic and precautionary wealth which serves to insure against idiosyncratic risk.

Focusing on the effect of labor market reforms on the current account, Kennedy and Slok (2006) argue that a deregulation on the labor market (such as Hartz IV) leads to an immediate fall in prices and wages. This increases the trade balance. In the long run, a rise in the relative

[4] As a side effect, the introduction of a precautionary savings motive may provide some guidance on a microfoundation of stochastic discount factor shocks because if affects discounting. The Euler equation on asset holdings now directly depends on the consumption risk which results in a "stochastic discount factor" that varies endogenously in our model.

profitability of domestic capital attracts foreign capital and reduces capital exports. This effect counteracts the increase in net exports and reverses the current account. Hence, they employ two out of three possible angles of the current account, namely the trade balance and the capital balance.

Bertola and Lo Prete (2015) make use of the third angle, the savings-investment balance. They argue that if labor market institutions are aimed at reducing the income risk in case of becoming unemployed and, thus, prevent fluctuations in consumption, then, labor market deregulations increase the uninsurable risk of becoming unemployed. This increase in risk leads to higher precautionary savings and a positive effect on current accounts. However, the increase in production efficiency (due to the decrease in distortionary institutions) and in turn higher consumption today, may counteract the aforementioned increase in the current account. Bertola and Lo Prete (2015) show that the magnitude of this offsetting effect crucially depends on the degree of financial market imperfections. Kennedy and Slok (2006) as well as Bertola and Lo Prete (2015) empirically find a (weak) positive relationship between labor market deregulations and current accounts. Nonetheless, neither quantifies the effect of a specific deregulation.

Kollmann et al. (2015), Gadatsch et al. (2016b) and Baas and Belke (2014) try to quantify the effect of Hartz IV on the current account in a state-of-the art macro model. However, no consensus on the quantitative impact of the Hartz reforms on international imbalances has yet been reached. On the one hand, in an estimated three-region DSGE model, Kollmann et al. (2015) find that negative wage markup shocks, which they attribute to the Hartz reforms, were indeed one of the main drivers of the German current account surplus. On the other hand, Gadatsch et al. (2016b) show in a model with frictional labor markets that the Hartz reforms had basically no effect on Germany's built-up of international assets.[5] Baas and Belke (2014) draw a similar conclusion using a two-country/two-sector DSGE model with search frictions and endogenous job separations. They argue that there is no danger of a *beggar-thy-neighbor-policy* due to the reform. However, all these studies have in common that they use the standard representative agent framework. Given that the flip-side of the current account is the saving-investment balance, in all these models, there is no savings motive.

Furthermore, the discussion on the spillover effects of labor market policies is still ongoing. In a trade model with heterogeneous firms and search and matching friction, Felbermayr et al. (2015) find positive but quantitatively small effects of a reduction of labor market frictions. On the contrary, Helpman and Itskhoki (2010) find negative spillover effects using a two-sector model in the spirit of Melitz (2003) enriched with search-and matching frictions. However, none of these studies has focused on the effects of a precautionary savings motive. Therefore, we will also contribute to this strang of literature. [More on the literature...]

[5] While, in their model, German international competitiveness indeed increases after the Hartz reforms, this also augments German income and demand for foreign goods. The price and quantity effects, in the end, even out in the model such that there are basically no current account effects.

3 Background

This section briefly outlines the background on Germany's current account and its net foreign asset position. We also summarize the main points of the cluster of labor market reforms which were implemented in Germany between 2003 and 2005, the so-called Hartz-reforms.

3.1 The German Current Account and Net Foreign Asset Position

The current account is a defined as a country's increase in domestic net claims on foreign incomes or outputs (see Obstfeld and Rogoff, 1995). Hence, the current account balance is given by the difference between national savings and domestic investment. If savings exceed investment, residents hold claims on foreign goods or assets.

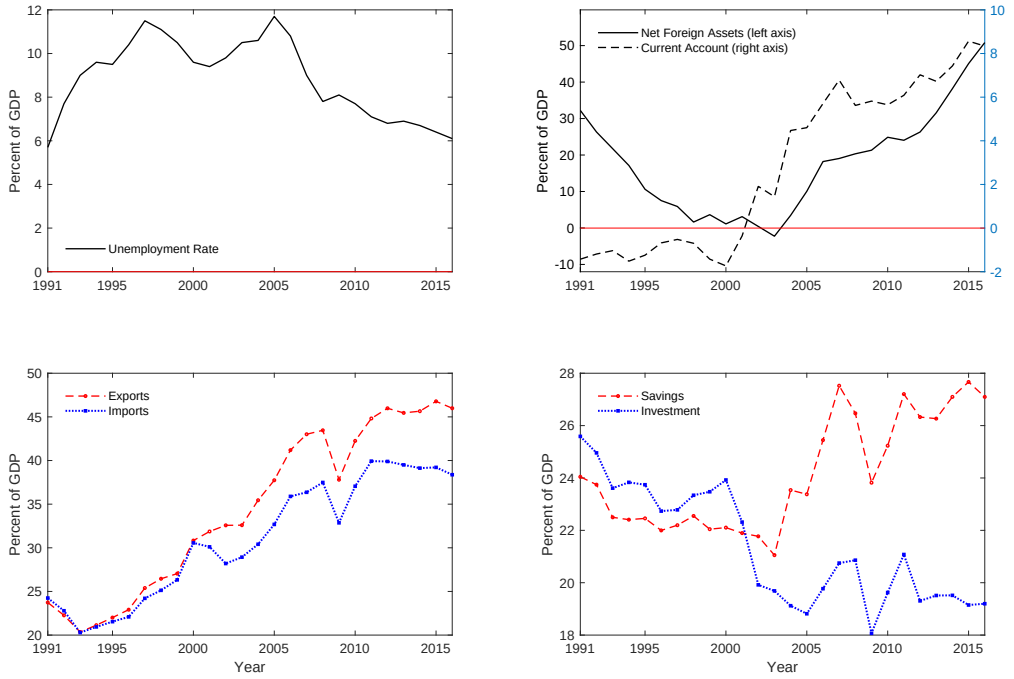
Figure 1 shows the German unemployment rate, the evolution of the German current account (CA) balance, the net foreign asset position (NFA), exports (EX) and imports (IM) as well as the savings (S)-investment (I) balance (in percent of GDP) from 1991 onwards. Between 1991 and the early 2000s, a decade that was characterized by high unemployment rates and low GDP growth, Germany has repeatedly been called 'the sick man of Europe' (see for example The Economist, 2017a). During that time, there were no imbalances worth mentioning. However, starting in 2001, the German economy experienced a complete reversal: International competitiveness rose and exports started to persistently exceed imports. In addition, savings and investment diverged dramatically. By the (simplified) identity of the current account, $CA = EX - IM = S - I$, this implies large current account surpluses and an increasing net foreign asset position. In fact, Germany's NFA position reached a level of 51 percent of GDP in 2016 and, therefore, makes the country a big net lender. These imbalances have been subject to worldwide criticism (see, for example, Eichengreen's commment in The Guardian, 2017, and The Economist, 2017b).[6]

The natural question to ask is, what caused the dramatic increase in the German current account? In a comprehensive analysis based on an estimated DSGE model, Kollmann et al. (2015) name financial integration (the interest rate convergence of the rest of the Euro Area to the German), strong economic growth in emerging markets, the German labor market reforms (i.e. Hartz reforms) and low domestic demand caused by an ageing population and a pension reform as potential causes. In this paper, we focus on the most prominent German labor market reform in the German post-war era (Hartz IV) and quantify its contribution to the existing global imbalance of Germany vis-à-vis the Euro Area.

3.2 The Hartz Reforms

Germany's bad economic performance around the 2000s motivated a comprehensive reform package. The centrepiece of the reform agenda was a set of extensive labour market reforms, commonly known as the "Hartz reforms" (named after Peter Hartz, the chairman of the independent committee which drew up the package of reforms; for a detailed description of the Hartz

[6] Interestingly, the reversal of the German unemployment rate started several years after. Beginning in 2005, unemployment halved from around 12 percent to 6 percent in 2016, and it is currently still falling.



Note: Exports and Imports refer to both goods and services. Savings refer to gross savings and are defines as disposable income minus consumption and net transfers.Data Sources: German National Statistical Office (2017) and Bundesbank (2017).

Figure 1: The German Current Account, Savings and Investment, Exports and Imports

reforms, see Jacobi and Kuve, 2006). Their objectives were to improve job matching efficiency and incentives to take up employment (Hartz I), promote the transition to self-employment and introduce more flexible arrangements for minor employment relationships (Hartz II), further support the matching process between firms and workers through a reorganisation of the Federal Labour Agency (Hartz III).

In 2005, the farest-reaching and most discussed Hartz IV reform was implemented with the aim to reduce workers' reservation wages and increase labor supply. Prior to Hartz IV, short-term unemployed workers were entitled to unemployment benefits of 60 percent of their previous net wage (*"Arbeitslosengeld"*). Short-term unemployment benefits expired after three years on average. Unemployed workers were then considered long-term unemployed and received a less generous unemployment benefit (*"Arbeitslosenhilfe"*) amounting to 53 percent of their previously earned net wage. For unemployed workers with children, the replacement rates were 67 and 57 percent, respectively. Persons who were not eligible for unemployment benefits received means-tested social assistance (*"Sozialhilfe"*; in 2004, the standard rate for a single household was around 300 euros, not including one-time benefits).

The Hartz IV reform had two components: First, social assistance and long-term unemployment benefits were merged into the purely means-tested *"Arbeitslosengeld II" (ALG II)*. Hence, from 2005 onwards, long-term unemployment benefits were independent of previous earnings. Second, the entitlement duration of short-term unemployment benefits was reduced from around three years to approximately twelve months. The entitlement duration depends on the age of the unemployed worker. The maximum duration of one year refers to workers younger

than 45 years. Older unemployed were entitled to 18 months of ALG II. In 2008, the maximum duration for older workers was softened again to a maximum entitlement duration of 24 months. The policy change became effective 2006. For many, these reforms were an important driver of the increase in the German competitiveness and its current account surplus.

4 The Model

We use a two-country model (representing the European Monetary Union) with heterogeneous agents and search frictions on the labor market in the spirit of Pissarides (2000). In each country, there is a continuum of workers on the unit interval who can either be employed or unemployed. Our model features incomplete insurance of idiosyncratic unemployment risk. While employed workers live in a large family and consume and save the same ("perfect insurance"), a worker who becomes unemployed has to leave the family and takes a fair share of the family's savings with him (a modelling choice building on Challe and Ragot, 2016). All unemployed workers receive government-financed unemployment benefits κ_t^B. They are different for short and long-term unemployed. Unemployed workers have to consume their entire savings within $K > 0$ periods. How much of their assets they consume each period arises endogenously.[7] If an unemployed worker is hired again, he re-enters the family. By this modelling choice, there is now a true risk of becoming unemployed that gives rise to precautionary savings without altering much in the standard RBC model.

As is common in the RBC literature, there is a representative firm owned by the family. It uses labor as its sole production input. Firms post vacancies and pay vacancy posting costs κ^v to hire unemployed workers. Matches between searching workers and firms are formed with a standard Cobb-Douglas matching function and wages are determined by Nash-bargaining. The two countries, Home (Germany) and Foreign (the Rest of the Euro Area), trade imperfect substitutable goods on competitive markets in a currency union. Labor is immobile across countries. We model both countries analogously. However, the countries differ by size (with the German population share amounting to 27.1%). We denote Home with subscript H and Foreign with F.

4.1 Households: The family and unemployed workers

As stressed above, all employed workers live in one family. Within the family, all workers pool their earnings consisting of net wage income, firm profits and interest payments on previous asset purchases. Family members make the same consumption and asset holding decision. Independent of the employment status $i \in [e, e\,u_k, u\,u]$, where $k \in K$, employed (e), short-term unemployed for k periods($e\,u_k$) and long-term unemployed ($u\,u$) workers have CRRA utility with intertemporal risk aversion parameter σ_c

$$u(c_t^i) = \frac{(c_t^i)^{(1-\sigma_c)} - 1}{(1-\sigma_c)}. \tag{4.1}$$

[7] While this assumption may seem restrictive, we see below that, when choosing K to be large enough, unemployed workers have virtually spend all their assets before they reach period K. Furthermore, using survey data evidence, we observe that unemployed have virtually no assets left if their unemployment spell approaches one year.

An employed worker maximizes

$$V_t^e(c_t^e, a_t) = \max_{\{c_t^e, a_t\}} u(c_t^e) + \beta E_t[(1-s(1-\rho_{t+1}))V_{t+1}^e(c_{t+1}^e, a_{t+1}) + s(1-\rho_{t+1})V_{t+1}^{eu_1}(c_t^{eu_1})] \quad (4.2)$$

each period t, where c_t^e is real per-capita consumption of a family member and a_t are par-capita assets/bonds that pay gross interest R_t^w. If the worker is separated, which happens at the exogenous given probability s, and is not immediately re-hired, which happens at the job-finding rate ρ_t, he has to leave the family and faces utility of being unemployed in the first period of unemployment, $V_t^{eu_1}$. As we will see below, he subsequentially moves to states $V_t^{eu_2}, ..., V_t^{eu_K}, V_t^{uu}$ if he is not re-hired during the process.

In real terms, the family member is subject to the following budget constraint:

$$c_t^e + a_t + \bar{t} = (1-\tau_t^w)\omega_t + \frac{\Pi_t}{N_t} + R_{t-1}^W \frac{a_{t-1}}{1+\pi_t} + \frac{\rho_t}{N_t} \sum_{k=1}^{K-1} (\mu_{t-1}^{eu_k} r_t^{eu_k} \frac{R_{t-k}^W a_{t-k}}{1+\pi_{t-k}}). \quad (4.3)$$

Consumption, c^e, and asset purchases, a_t, as well as a lump-sum tax, $\bar{t}$, have to be financed by the wage income, ω_t, which is subject to a labor income tax at rate τ_t^w, firm profits, Π_t, divided by the number of family members, N_t, and interest payments on assets $R_{t-1}^W a_{t-1}/(1+\pi_t)$. In addition, each family member takes into account that unemployed workers who find a job in the next period and return to the family bring the share of assets they have not yet consumed back to the family (of which the individual family member then receives a share $1/N_t$). This corresponds to the last term on the right-hand side, where $r_t^{eu_k}$ defines the remaining share of assets a worker being unemployed in state k brings back the family when re-hired the next period. It holds that $r_t^{eu_1} = (1-\delta_{t-1}^1)$ and $r_t^{eu_k} = r_t^{eu_{k-1}} - \delta_{t-1}^k$. Remember that unemployed workers in period K do not have any assets left at the time they would return to the family. Hence, the sum only goes to $K-1$. Further note that the maximization problem of the family head is the maximization of an employed worker multiplied by the number of family members N_t. In addition, the family head takes into account that some members become unemployed in the next period and take their assets with them.

Taking first order conditions of 4.2 subject to 4.3 with respect to consumption c_t^e and assets a_t results in the family member's marginal utility of consumption and optimal asset holdings choice given by

$$\lambda_t^e = (c_t^e)^{-\sigma_c} \quad (4.4)$$

and

$$\Omega_t = \frac{1}{R_t^W} = \beta E_t \Bigg[(1-s(1-\rho_{t+1})) \frac{\lambda_{t+1}^e}{\lambda_t^e} \Bigg(\frac{1}{(1+\pi_t)} + \sum_{k=1}^{K-1} \beta^{k-1} \frac{\lambda_{t+k}^e}{\lambda_t^e} \frac{\rho_{t+k}}{N_{t+k}} \frac{\mu_{t+k-1}^{eu_k} \cdot r_{t+k}^{eu_k}}{1+\pi_{t+k}} + s(1-\rho_{t+1}) \frac{\lambda_{t+1}^{eu_1}}{\lambda_t^e} \sum_{k=1}^{K} \tilde{r}_{t+k}^{eu_k} \Bigg) \Bigg], \quad (4.5)$$

where $\tilde{r}_t^{eu_k} = \delta_{t+k}^k/(1+\pi_{t+k}) + \beta \lambda_{t+k}^{eu_{k+1}}/\lambda_t^e \tilde{r}_{t+1}^{eu_{k+1}}$ as long as $k < K$ and $\tilde{r}_t^{eu_K} = \delta_{t+K}^K/(1+\pi_{t+K})$.

Equation 4.5 is the Euler equation in our setting. In the standard representative agent framework, all but the first term on the right-hand side would be zero, yielding the well-known Euler equation. When taking the precautionary savings motive into account, Ω_t is now the stochastic discount factor from period t to the next, and λ_t^e equals the marginal utility of consumption of an employed worker. The family members take into account that workers who are unemployed today may find a job in the next period and bring assets back to the family. This results in the second term on the right-hand side of equation 4.5. Furthermore, an employed worker also considers that all short-term unemployed workers who live off their savings in period k after dismissal derive some marginal utility λ^{eu_k}, resulting in the last term of equation 4.5.

In order to match basic German institutional settings of the unemployment insurance system, we distinguish between short and long-term unemployed workers. Short-term unemployed workers receive the more generous unemployment benefits κ_t^{BS} which is a share rrs of their previously received net wage income. In the pre-Hartz reform steady state, unemployed move form short to long-term unemployment after K periods. When this happens, they only receive κ_t^{BL}, which is a share $rrl < rrs$ of the previously earned net wage. In period t the maximization problem of a short-term unemployed worker in state $k \in (1,..,K-1)$ is given by

$$V_t^{eu_k}(c_t^{eu,k}) = \max_{\{c_t^{eu_k}, \delta_t^k\}} u(c_t^{eu_k}) + \beta E_t[\rho_{t+1} V_{t+1}^e(c_{t+1}^e, a_{t+1}) + (1-\rho_{t+1}) V_{t+1}^{eu_{k+1}}(c_t^{eu_{k+1}})] \tag{4.6}$$

while, in the K^{th} state, the maximization problem reads,

$$V_t^{eu,K}(c_t^{eu,K}) = \max_{\{c_t^{eu_K}, \delta_t^K\}} u(c_t^{eu,K}) + \beta E_t[\rho_{t+1} V_{t+1}^e(c_{t+1}^e, a_{t+1}) + (1-\rho_{t+1}) V_{t+1}^{uu}(c_t^{uu})] \tag{4.7}$$

All short-term unemployed workers face the budget constraint

$$c_t^{eu,k} + \bar{t} = \kappa_t^{BS_k} + \delta_t^k R_{t-1}^W \frac{a_{t-k}}{1+\pi_t} \tag{4.8}$$

where the unemployment benefits $\kappa_t^{BS_k}$ are defined as $(1-\tau_t^w)\, w_{t-k}\, rrs$. The maximization problem for a long-term unemployed workers is given by

$$V_t^{uu}(c_t^{uu}) = \max_{\{c_t^{uu_k}\}} u(c_t^{uu}) + \beta E_t[\rho_{t+1} V_{t+1}^e(c_{t+1}^e, a_{t+1}) + (1-\rho_{t+1}) V_{t+1}^{uu}(c_t^{uu})] \tag{4.9}$$

subject to

$$c_t^{uu} + \bar{t} = \kappa_t^{BL} \tag{4.10}$$

where in the baseline scenario κ_t^{BL} is time-varying and defined as $(1-\tau_t^w)\, w_{t-K-1}\, rrl$, with rrl denoting the less generous replacement rate for the long-term unemployed.[8]

Short-term unemployed workers consume a share δ_t^k of their assets each period. However,

[8] We implement the first component of Hartz IV by making κ^{BL} time-invariant as long-term unemployment benefits were purely means-tested and independent of the previous wage from 2005 onwards.

after K periods, all assets are spent. Therefore, long-term unemployed workers only have (less generous) unemployment benefits left to use for consumption. Maximization of 4.6, 4.7 and 4.9 subject to 4.8 and 4.10 respectively, results in the corresponding marginal utilities of consumption for unemployed workers $i \in [e, eu_k, uu]$

$$\lambda_t^i = (c_t^i)^{-\sigma_c} \tag{4.11}$$

Furthermore, short-term unemployed workers decide each period which share δ_t^k of their assets they consume.[9] Since all assets have to be consumed within K periods, it holds that $\sum_{k=1}^{K} \delta_{t-K+k}^k = 1$. The first-order conditions with respect to any δ_t^k is given by:

$$\beta \rho_{t+1} \lambda_{t+1}^e \frac{\rho_{t+1}}{N_{t+1}} \mu_t^{eu_k} + \beta(1-\rho_{t+1}) \lambda_{t+1}^{eu_{k+1}} = \lambda_t^{eu_k}. \tag{4.12}$$

4.2 Production

The representative firm faces the production function $y_t = e^{prod_t} N_t$ with labor N_t as the sole input factor and productivity e^{prod_t} follows an AR(1)-process.

The firm maximizes profits Π_t by choosing the level of employment N_t and the number of vacancies V_t. Therefore, the maximization problem reads

$$\Pi_t = \max_{\{N_t, V_t\}} E_t \sum_{t=0}^{\infty} \Omega_t \{ Y_t - \omega_t N_t - \kappa^v V_t \} \tag{4.13}$$

subject to the law of motion for employment

$$N_t = (1-s) N_{t-1} + q_t V_{t-1}. \tag{4.14}$$

q_t denotes the vacancy-filling probability, derived in the next subsection, and real vacancy posting costs are given by κ^v. Since firms belong to the family, they discount the future with the family's discount factor Ω_t.

Taking first-order conditions of 4.13 subject to 4.14 with respect to N_t and V_t, results in the firm's optimality conditions (in real terms):

$$J_t = \frac{p_t}{P_t} e^{prod_t} - \omega_t + E_t \{ \Omega_t (1-s) J_{t+1} \}, \tag{4.15}$$

where p_t corresponds to the producer price index and P_t denotes the consumer price index (to be derived later). Equation 4.15 corresponds to the marginal value of an additionally employed worker. The job-creation condition is

$$\frac{\kappa^v}{q_t} = J_t. \tag{4.16}$$

[9] This corresponds to the basic cake-eating problem of Gale (1967) where, in our context, the cake is the value of assets with which a recently unemployed worker leaves the family.

4.3 Matching and Wage Bargaining

The following section describes the modelling of the labor market block in our model. We follow Blanchard and Galí (2010) and allow for immediate rehiring.

4.3.1 Matching and Worker Flows

Matches between workers and firms are established via a constant-return Cobb-Douglas matching function,

$$M_t = \kappa^e U_t^{\eta} V_t^{1-\eta} \tag{4.17}$$

where the total number of searching workers (who enter the matching function) is given by $U_t = 1-(1-s)N_{t-1}$. Furthermore, we define market tightness θ_t as the ratio of vacancies over searchers $\theta_t = V_t/U_t$. The firm's vacancy filling rate is given by the ratio of matches over vacancies, $q_t = M_t/V_t$, and, from the worker's perspective, the probability of finding a job is defined as $\rho_t = M_t/U_t$. The resulting law of motion for employment is given by

$$N_t = (1-s)N_{t-1} + M_t \tag{4.18}$$

Note that, due to immediate rehiring, the number of searching worker exceeds the total number of unemployed workers in one period. Unemployment is, thus, given by

$$u_t = 1 - N_t = \sum_{k=1}^{K} \mu^{e\,u_k} + \mu^{u\,u} \tag{4.19}$$

The number of unemployed workers in their first period of unemployment (who were not immediately rehired) is given by $\mu_t^{e\,u_1} = s(1-\rho_t)N_{t-1}$, and the number of short-term unemployed workers in subsequent periods is the determined by last period's unemployed who did not find a in period t, ie $\mu_t^{e\,u,k} = (1-\rho_t)\mu_t^{e\,u,k-1}$. The number of long-term unemployed workers consists of last period's short-term unemployed in their K's period of unemployment plus the pool of long-term unemployed who were not matched in the current period, $\mu_t^{u\,u} = (1-\rho_t)[\mu_{t-1}^{u\,u} + \mu_{t-1}^{e\,u,K}]$.

4.3.2 Workers Marginal Value

In order to calculate the Nash-bargained wage, we need to derive the worker's marginal value of employment. It depends on whether she is part of the family or unemployed. The marginal value of an employed worker can be derived by taking the first-order condition of the family's value function subject to the family's budget constraint with respect to the level of employment N_t (see Appendix B.7 for a detailed derivation). This yields

$$\begin{aligned} \mathscr{W}_t^e = & \frac{u(c_{t,j}^e)}{\lambda_t^e} - [c_t^e + a_t + \bar{t}_t - (1-\tau_t^w)\omega_t] - \beta E_t[\frac{\lambda_{t+1}^e}{\lambda_t^e}(1-s(1-\rho_{t+1})\frac{R_t^W a_t}{1+\pi_{t-1}}] \\ & + \beta E_t[\frac{\lambda_{t+1}^e}{\lambda_t^e}(1-s(1-\rho_{t+1}))\mathscr{W}_{t+1}^e + \frac{\lambda_{t+1}^{e\,u_1}}{\lambda_t^e} s(1-\rho_{t+1})\mathscr{W}_{t+1}^{e\,u_1}] \end{aligned} \tag{4.20}$$

Hence, every additional employed worker adds utility $\frac{u(c_t^e)}{\lambda_t^e}$ to the family. In addition, every family member contributes labor income and returns to their share of assets to the family (taking into account that some members become unemployed and leave with their savings). Furthermore, every employed worker consumes, saves and pays taxes. If the family member is still employed in the next period, the gain for the family is $\mathscr{W}_{t+1}^e$, however, with probability $s(1-\rho_{t+1})$, the member has to leave the family because she becomes unemployed. In this case, there is an expected utility gain for the family of $\mathscr{W}_{t+1}^{eu_1}$.

The marginal values of a short-term unemployed up to $k \in (1,...,K-1)$ is given by

$$\mathscr{W}t^{eu_k} = \frac{u(c_t^{eu_k})}{\lambda_t^{eu_k}} + \beta E_t\{\frac{\lambda_{t+1}^{eu_{k+1}}}{\lambda_t^{eu_k}}(1-\rho_{t+1})\mathscr{W}_{t+1}^{eu_{k+1}} + \frac{\lambda_{t+1}^{e}}{\lambda_t^{eu_k}}\rho_{t+1}\mathscr{W}_{t+1}^{e}\} \tag{4.21}$$

A short-term unemployed worker in period K generates the following marginal utlitiy of working:

$$\mathscr{W}t^{eu_K} = \frac{u(c_t^{eu_K})}{\lambda_t^{eu_K}} + \beta E_t\{\frac{\lambda_{t+1}^{uu}}{\lambda_t^{eu_K}}(1-\rho_{t+1})\mathscr{W}_{t+1}^{uu} + \frac{\lambda_{t+1}^{e}}{\lambda_t^{eu_K}}\rho_{t+1}\mathscr{W}_{t+1}^{e}\} \tag{4.22}$$

For the long-term unemployed worker, the utility value is given by

$$\mathscr{W}_t^{uu} = \frac{u(c_t^{uu})}{\lambda_t^{uu}} + \beta E_t\{\frac{\lambda_{t+1}^{uu}}{\lambda_t^{uu}}(1-\rho_{t+1})\mathscr{W}_{t+1}^{uu} + \frac{\lambda_{t+1}^{e}}{\lambda_t^{uu}}\rho_{t+1}\mathscr{W}_{t+1}^{e}.\} \tag{4.23}$$

4.3.3 Wage Bargaining

Using the marginal utilities of working for different household types derived in the previous subsection, we can solve for the Nash-bargained wage. We assume that firms and the family head bargain for new as well as existing matches. The family head's bargaining power is ζ and the surplus of having one additional employed member is given by $\mathscr{\tilde{W}}_t = \mathscr{W}_t^e - \mathscr{W}_t^{eu_1}$. The firm's surplus of hiring one additional worker is J_t. Therefore, the wage solves

$$\omega_t = \max_{\omega_t}[\mathscr{\tilde{W}}_t]^{\zeta}[J_t]^{1-\zeta} \tag{4.24}$$

which results in the following wage sharing rule:

$$\mathscr{\tilde{W}}_t = \frac{\zeta}{1-\zeta}(1-\tau_t^w)J_t. \tag{4.25}$$

4.4 Fiscal authority

The fiscal authority finances government spending G_t and unemployment benefits for short and long-term unemployed workers ($\sum_{k=1}^{K}\kappa_t^{BS_k}\mu_t^{eu_k} + \kappa_t^{BL}\mu_t^{uu}$) as well as interest payments on outstanding government debt ($\frac{R_{t-1}^W b_{t-1}}{1+\pi_t}$) by a lump-sum tax $\bar{t}$, a labor-income tax τ_t^w and by issuing new government bonds b_t.

$$G_t + \sum_{k=1}^{K}\kappa_t^{BS_k}\mu_t^{eu_k} + \kappa_t^{BL}\mu_t^{uu} + \frac{R_{t-1}^W b_{t-1}}{1+\pi_t} = \tau_t^w\omega_t N_t + \bar{t} + b_t \tag{4.26}$$

Asset market clearing implies that total assets in the home economy, $N_t\, a_t$, have to equal government debt plus net foreign assets, $b_t + NFA_t$. Hence, for government debt, it holds that

$$b_t = N_t a_t - NFA_t. \tag{4.27}$$

As we are interested in the steady-state comparison and the corresponding transition path after a policy change in the analysis below, we assume that government spending is exogenously given by $\bar{G}$. However, for a stochastic analysis, it would be straightforward to extend this to an AR(1)-process. The labor tax rule is given by

$$log(\tau_t^w/\bar{\tau^w}) = \rho^{\tau^w} log(\tau_{t-1}^w/\bar{\tau^w}) + \chi^b(b_t/\bar{b}), \tag{4.28}$$

where ρ^{τ^w} is a smoothing parameter and χ^b determines the elasticity of the labor income tax rate to deviations from the steady-state level of government debt. This ensures stationarity of government debt (see Schmitt-Grohe and Uribe, 2007).

4.5 International Linkages

In our model, the two countries are linked by trade in consumption goods and international assets. We define the terms of trade ToT_t as the ratio of producer prices $ToT_t = p_{t,H}/p_{t,F}$ and the real exchange rate RER_t is defined as the ratio of consumer prices $RER_t = P_{t,F}/P_{t,H}$

The intra-temporal allocation across goods is given by

$$cint_{t,H} = \gamma_H^C \left(\frac{p_{t,H}}{P_{t,H}}\right)^{-\eta_c} c_{t,H} \tag{4.29}$$

for Home goods and analogously for imported goods from Foreign:

$$cext_{t,H} = (1-\gamma_H^C)\left(\frac{p_{t,F}}{P_{t,H}}\right)^{-\eta_c} c_{t,H} \tag{4.30}$$

where $cint_{t,j}$ denotes goods produced and consumed in the Home country and $cext_{t,j}$ denote imports from the rest of the Euro Area. A rise in γ_c in the home country increases relative demand for home goods and a rise in the relative price ration $p_{t,H}/p_{t,F}$ lowers demand for local goods with a constant price elasticity $-\eta_c$.

Aggregate consumption of goods in country $j \in (H,F)$ consists of goods from home ($cint_{t,j}$) and foreign ($cext_{t,j}$)

$$C_{t,j} = (\gamma_j^C)^{1/\eta_c} cint_{t,j}^{(\eta_c-1)/\eta_c} + (1-\gamma_j^C)^{1/\eta_c} cext_{t,j}^{(\eta_c-1)/\eta_c})^{\eta_c/(\eta_c-1)} \tag{4.31}$$

$$\tag{4.32}$$

The Consumer Price index for Home is given by

$$P_{t,H} = [\gamma_H^C p_H^{1-\eta_c} + (1-\gamma_H^C) p_F^{1-\eta_c}]^{1/(1-\eta_c)}$$

and analogously for Foreign.

Therefore, the country's net foreign asset position is defined as last period's assets plus current net exports.

$$P_t NFA_t = R^W_{t-1} P_{t-1} NFA_{t-1} + NX_t \tag{4.33}$$

The current account is defined as $CA_t = NFA_t - NFA_{t-1}/(1+\pi_t)$. Furthermore, it must hold that Home's net foreign asset position equals Foreign's net foreign asst position $NFA_{t,H} + RER_{t,H} NFA_{t,F} = 0$.

4.6 Market Clearing

Equilibrium in the goods market implies that the economy-wide resource constraint must hold in Home (H) and in Foreign (F):

$$Y_{t,H} = C_{t,H} + G_{t,H} + \kappa^v V_{t,H} + EXP_{t,H} - p_{t,F} IMP_{t,H} \tag{4.34}$$

$$Y_{t,F} = C_{t,F} + G_{t,F} + \kappa^v V_{t,F} + EXP_{t,F} - p_{t,H} IMP_{t,F} \tag{4.35}$$

5 Calibration

We calibrate the model to quarterly frequency. We build on the calibration of Moyen and Stähler (2014) and Christoffel et al. (2009). Table 1 shows the baseline calibration. The calibration of Home (Germany) and Foreign (Rest of Euro Area) is symmetric except for country size. The size of the Home country, Germany, amounts to 27.1 percent. The Rest of the Euro Area (Foreign) is therefore almost four times bigger than Germany (see Gadatsch et al. (2016b)). We set the discount factor to 0.992 and the risk aversion parameter to 1.5 as in Christoffel et al. (2009). Regarding the labor market, we set the elasticity of matches with respect to unemployment to 0.6 (see also Christoffel et al., 2009). Workers and firms have equal bargaining power, hence, $\zeta = 0.5$ which is the conventional value in the literature. Furthermore, we set the separation rate to 4 percent and normalize productivity for Germany to one in steady state. The target of the job-filling rate of 0.7 as in Christoffel et al. (2009), see Table 2, pins down the matching efficiency, vacancy posting costs and the job-finding rate.

Regarding the policy parameters, we set the replacement rate for short-term unemployed to 0.67 and the initial replacement rate for long-term unemployed to 0.57. This corresponds to the legal value for recipients with children (hence, the upper bound). Furthermore, the autocorrelation of the tax rate and government spending amounts to 0.8. In our baseline scenario, we set the lump-sum tax rate to zero and the labor tax rate is 0.24 in steady state (see Gadatsch et al., 2016a). In addition, we allow the tax rate to respond the deviations in government debt to ensure stationarity in government spending. The parameter χ^b determines the elasticity of this response and is set to 0.05 (see Kirsanova and Wren-Lewis, 2012).

Table 2 shows the targets in our calibration. We set GDP equal to the steady state employment level $\bar{N} = (1-\bar{u})$. In steady state, inflation is zero and prices are set to one. By construction, also

the real exchange rate and the terms of trade are zero in steady state. The current account is defined as $CA_t = NFA_t - NFA_{t-1}/(1+\pi_t)$ and therefore zero in steady state. In addition, we target steady state unemployment rates in both countries of 8.8 percent. The unemployment rates refer to the average harmonized unemployment rates between 2000 and 2004, which are remarkably close in both regions and amount to 8.9 percent in Germany and 8.7 % in the Rest of the Euro Area. For calibration, we choose the mean between these two regions, hence 8.8 percent.[10]

	Parameter name	Symbol	Value	
			Home	Foreign
	Country size	Θ	0.27	0.73
Preferences				
	Discount factor	β	0.992	0.992
	Risk aversion	σ_c	1.5	1.5
	Home bias	γ	0.6	0.6
Bargaining and Production				
	Matching elasticity	η	0.6	0.6
	Workers' bargaining power	ζ	0.5	0.5
	Separation rate	s	0.04	0.04
	Productivity (SS)	e^{prod}	1	-
Policy				
	Replacement rate for short-term unemployed	rrs	0.67	0.67
	Replacement rate for long-term unemployed	rrl	0.57	0.57
	Autocorrelation government spending	ρ^G	0.8	0.8
	Autocorrelation tax rate	ρ^τ	0.8	0.8
	Lump-sum Tax rate (SS)	$\bar{\tau}$	0	0
	Labor Tax rate (SS)	τ^w	0.24	0.24
	Elasticity of tax rate response to debt deviations	χ^b	0.05	0.05

Table 1: Baseline Calibration

Target	Symbol	Value	
		Home	Foreign
GDP	Y	0.9120	0.9120
PPI inflation	π	0	0
PPI	p	1	1
CPI	P	1	1
Real exchange rate	RER	1	1
Terms of Trade	ToT	1	1
Current Account	CA	0	0
unemployment rate	u	0.088	0.088
Job-filling rate	q	0.7	0.7
Firms' Profits	Π	0	0

Table 2: Targets

[10] Data source: OECD, Main Economic Indicators, 2017

6 The effects of the Hartz IV reform

In this section we describe how we implement the entire German labor market reform, Hartz IV, in our model environment and present the results.

6.1 Reform implementation

In our model, we simulate both components of the Hartz IV reform. In a first step, we reduce the replacement rate for long-term unemployed by 20 percent.[11] From 2005 onwards, ALG II was purely means tested and independent of prior earnings. For this reason, we set $\kappa_t^{BL} = \kappa^{BL}$ to a fixed value in the simulation below (while, in the initial steady state, $\kappa_t^{BL} = (1-\tau^w_{t-K-1})w_{t-K-1}\text{rrl}$, it is assumed to be given by $\kappa^{BL} = (1-\bar{\tau}^w)\bar{w}\text{rrl}\times 0.8$ after 2005, where $\bar{w}$ is the initial steady-state wage). In a second step, we reduce the maximum entitlement duration of short-term unemployment benefits from a maximum of three years to approximately 12 months. We implement this reform component by setting the replacement rate for workers who are in their second and third year of unemployment (i.e. for μ^{eu_2} and μ^{eu_3}) to the long-term unemployment benefits κ^{BL}. For simplicity, we assume that, at the time of the policy change, the economy is in its initial steady state, that the changes are unanticipated and that there are no future shocks in the economy after the change in tax policy. This allows us to isolate the effects of changes in property taxation from other shocks.

6.2 Results

In what follows, we will describe the results of the model analysis just described. We will first describe the effects resulting in Germany and, then, turn to spillovers to the rest of the Euro Area. We differentiate between a reduction of the replacement rate alone and the results of the entire Hartz IV package.

6.2.1 Effects in Germany

Figures 3 and 2 illustrate the transition after the two Hartz IV reform components in Germany (everything expressed in percent or percentage point deviation from the initial steady state). The first reform step (the reduction in the replacement rate for long-term unemployed workers only) is depicted with blue shaded areas and the entire reform effects are represented by the black solid line.

As expected, the reduction in the generosity of the unemployment benefit scheme leads to a decrease in wages because the workers' bargaining position worsens. This effect is stronger when both, replacement rates for long-term unemployed workers and the entitlement duration

[11] This corresponds to the reduction of the average net replacement rate of two earnings levels, 67% and 100% of an average adult full-time worker, respectively (Source: CESifo Dice, 2013 based on OECD Benefits and Wages statistics, 2013). Note that the discussion on how much the replacement rate due to Hartz IV actually declined is still ongoing. Launov and Wälde (2013) use a decline of 7 percent, whereas Krebs and Scheffel (2013) implement a reduction of the replacement rate for long-term unemployed by 20 percent and Krause and Uhlig (2012) assume a reduction of 67 percent for high-skilled and around 24 percent for low skilled. We are closest to the value used by Krebs and Scheffel (2013).

to receive "premium benefits" are cut (see Figure 2). Lower wages increases the marginal value of a worker to the firm, which, therefore, posts more vacancies and the job-finding rate increases. This lowers the aggregate unemployment rate. The drop in unemployment differs by duration of unemployment and is highest for long-term unemployed workers. The reason is obvious: Given a higher job finding rate, the probability to move into the pool of long-term unemployment declined.

A falling unemployment rate fosters production and, at least in the medium-term, consumption because aggregate labor income increases. However, in Figure 3, we observe that there are notable difference between only considering the cut in the replacement rate for long-term unemployed workers and the whole Hartz IV reform, especially with regard to the savings decision. When only considering the effect of a reduction in the replacement rate for long-term unemployed workers, we have already noted that it becomes less likely to enter this long-term unemployment's pool from the perspective of an employed family member and average expected income increases. Hence, there are two opposing effects at work. On the one hand, benefits when becoming long-term unemployed fall, decreasing the reservation wage. On the other hand, the likelihood for this to happen also decreases. As the latter effect dominates the former, households immediately increase consumption and reduce savings slightly because of a reduction in the income risk resulting from unemployment. As Figure 8 in the Appendix reveals, this holds for households that are still far away from becoming long-term unemployed. However, the closer a short-term unemployed worker gets to the threshold of receiving less generous unemployment benefits, and especially for the long-term unemployed workers as such, the opposite holds. Nonetheless, as their share is small, the consumption and savings behavior of the other groups dominates the aggregate. As the demand for precautionary savings falls after this reform step, the interest rate increases slightly on impact because asset supply remains virtually constant. As the positive effects materialize, especially for consumption and its resulting marginal utilities, savings again start to normalize and the interest rate moves back to its original level.[12] This also implies that the effects on the net foreign asset position of this reform step are only minor (see Table 3, which summarizes the long-run results).

When also taking into account the reduction in the entitlement duration, which came into action in 2006, the beneficial effects on the labor market are no longer strong enough to overcompensate for the consumption risk when becoming unemployed. The reason is that, now, the increase in the job finding rate is not sufficiently high to compensate short-term unemployed households for the fact that the consumption risk now approaches much quicker. This can also be confirmed by Figure 8 and Table 3, where we see that, even in the medium-term, all but the employed and the very short-term unemployed households now decrease consumption after the Hartz IV reforms, even though aggregate wage income increased. The reason is that they now want to prepare for the potential income loss in case of an unemployment spell. Hence, they significantly increase precautionary savings. This increase in savings cannot be supplied domestically such that the demand for net foreign assets increases, as does the demand for world savings. Given the rise in net foreign assets, the current account must increase as well. As Figures

[12] Remember that the interest rate is the inverse of the discount factor. As labor market conditions improve on the aggregate, the discount factor is reduced on impact and, then, moves back to more or less its initial value.

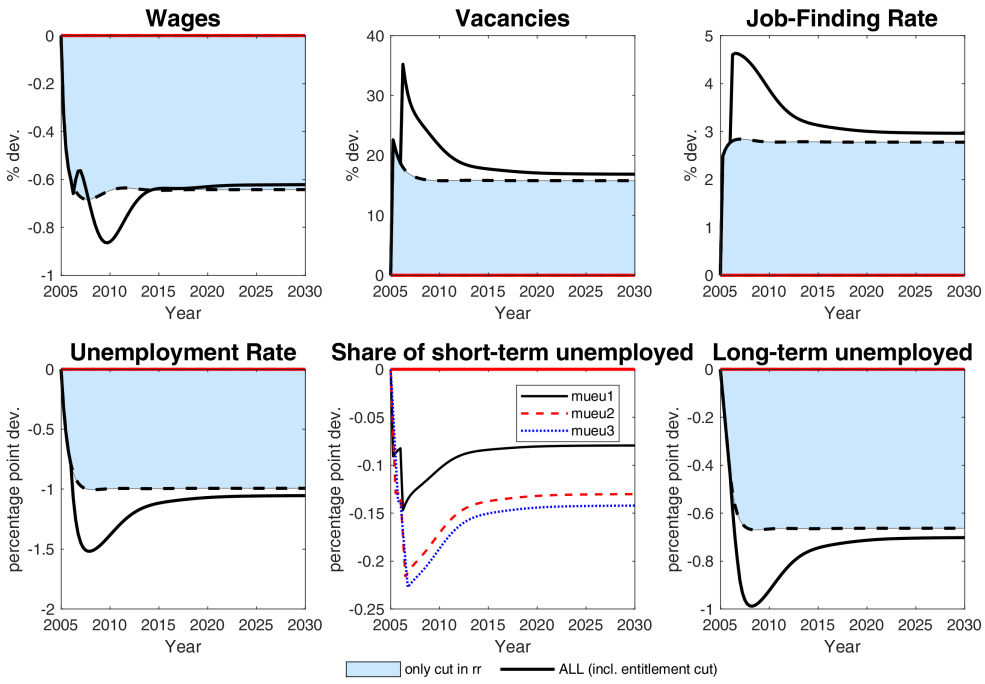


Figure 2: Effects of the Hartz IV reform package on labor market outcomes.

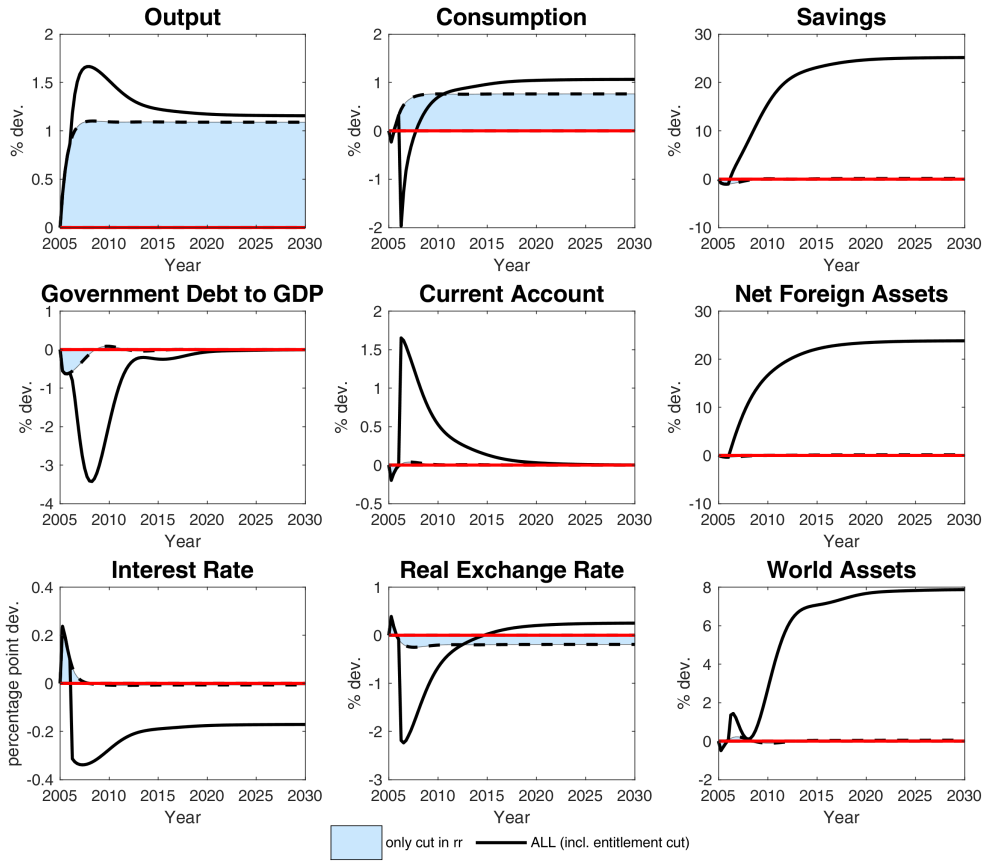


Figure 3: Aggregate effects of the Hartz IV reform package.

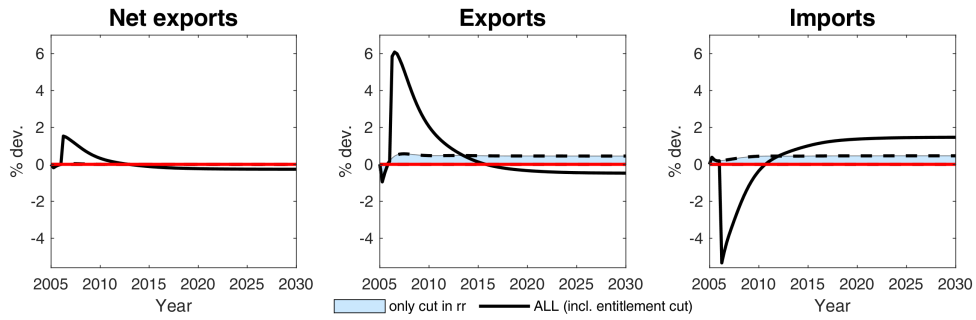


Figure 4: Aggregate effects of the Hartz IV reform package.

3 and 4 reveal, this is indeed the case. Because of the relatively strong export demand, driven by a sharply increasing consumption in the rest of the Euro Area (see Figure 5 as well as the description in the next subsection), Germany's real exchange rate initially worsens before the positive wage-dampening effects start to materialize.

In total, we find a decline in German unemployment due to the reform of more than 1 percentage point. Our results are remarkably well in line with the results found in Krebs and Scheffel (2013). They evaluate the reform effects in a closed-economy, fully heterogeneous agent model with incomplete insurance and human capital. This confirms that our model generates plausible results. Overall consumption in Germany increases after the Hartz reforms. However, Table 3 shows that consumption responses to both reforms were very heterogeneous by worker type (see also Figure 8 in the Appendix). Although on aggregate, consumption increased by more than one percent due to Hartz IV, there were clearly winners and losers. The rise in consumption is entirely attributed to employed workers. Unemployed workers substantially reduced their consumption. The decline in consumption was sharpest for long-term unemployed and amounts to 16 percent in total. This confirms recent findings by Giannelli et al. (2016) who argue that the Hartz reforms contributed to the rising inequality in the German labor market.

6.2.2 Spillover-effects to the Rest of the Euro Area

Regarding the spillovers to the rest of the Euro Area, we see in Figure 5 that they are, in general, positive. Households in the rest of the Euro Area know that they will benefit from higher demand in Germany eventually as Germany also increase import demand. This will, in turn, increase employment, wages and re-employment chances and, thus, decreases their unemployment-related consumption risk. Hence, they decrease precautionary savings and their net foreign asset position falls. Because they can now take up debt vis-à-vis Germany, they increase consumption in the medium-term. This holds true as long as the interest payment on their outstanding debt vis-à-vis Germany starts to be large enough such that they have to cut on consumption again (see Table 3). The dampening effect of the interest payments on outstanding debt on consumption also explains the decrease in wages, even though the job finding rate remains higher and unemployment lower in the new steady state.

Table 3 provides an overview of the long-run effects of both components of the Hartz IV reform on Germany as well as on the rest of the Euro Area. Note that the effects denote percent

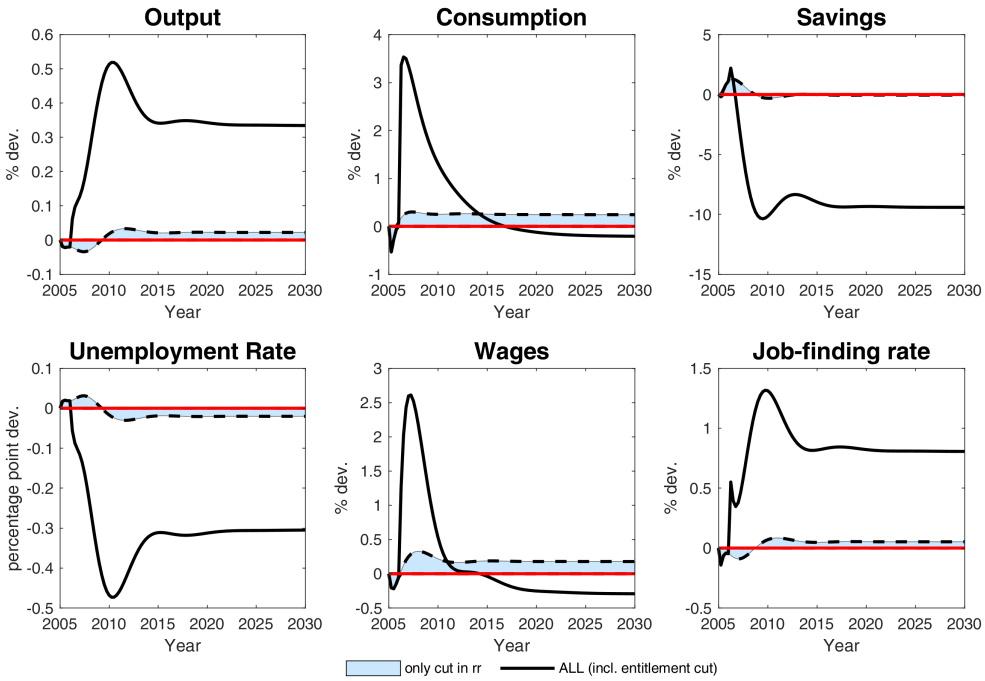


Figure 5: Effects of the Hartz IV reform package on the rest of the EMU.

deviations (percentage points if indicated) from the initial steady state at the beginning of 2005 (prior to the reduction in the replacement rate).

6.3 Contribution of Hartz IV to Germany's current account surplus

Figure 6 depicts the share of Germany's current account that can be explained by the labor market reform. The upper panel shows the cumulated development of the German current account (solid line) for the years 2005 to 2016 in comparison to the cumulated current account effects generated by our model in response to the Hartz IV reform. In 2005, the German current account surplus was 4.6 percent of GDP and reached a level of 78 percent by 2016. In our model, the initial effect is negative due to the decrease in savings after the cut in the replacement rate. Starting in 2006, the cumulated effect of the entitlement cut reaches up to 23 percent by 2016. The lower panel of Figure 6 illustrates the fraction of the current account surplus that can be explained by our model. In 2007, around 60 percent of the cumulated current account surplus can be explained by the reform. On average, the explanatory value amounts to 40 percent.

6.4 Comparison to the representative agent framework

Next, we turn to a representative agent version of our model. In the representative agent setting, workers who fall into unemployment are not expelled and continue living as part of the family. Hence, there is complete insurance for all agents (see Appendix C for a formal description of the representative agent model version). In order to ensure stationarity of net foreign assets, we introduce portfolio adjustment costs as proposed in Schmitt-Grohe and Uribe (2003). They take

Germany	Variable	Percent deviations from initial SS: All	Cut in rrl	Entitlement cut
Aggregates	Output	1.13	1.06	0.07
	Consumption	1.28	0.91	0.37
	Savings	22.90	1.14	21.76
	NFA in percent of GDP	25.25	1.26	23.99
Labor market	Wages	-0.55	-0.49	-0.06
	Vacancies	17.27	16.08	1.19
	Job-finding Rate	1.13	1.06	0.07
	Unemployment Rate (pp)	-1.04	-0.97	-0.06
	Share of unemployed in period 1 (pp)	-0.09	-0.08	-0.01
	Share of unemployed in period 2 (pp)	-0.14	-0.13	-0.01
	Share of unemployed in period 3 (pp)	-0.15	-0.14	-0.01
	Share of long-term unemployed (pp)	-0.65	-0.61	-0.04
Consumption	C. of employed	1.22	0.76	0.46
	C. of unemployed in period 1	1.47	2.74	-1.27
	C. of unemployed in period 2	-1.66	-0.21	-1.45
	C. of unemployed in period 3	-4.73	-3.11	-1.62
	C. of long-term unemployed	-20.00	-20.00	0.00
Rest of the Euro Area	Output	0.34	0.00	0.34
	Consumption	-0.31	0.21	-0.52
	Savings	-8.56	0.38	-8.94
	Unemployment Rate (pp)	-0.31	0.01	-0.33
	Wages	-0.41	0.09	-0.50

Table 3: Long-run effects of Hartz IV: Total and by reform step

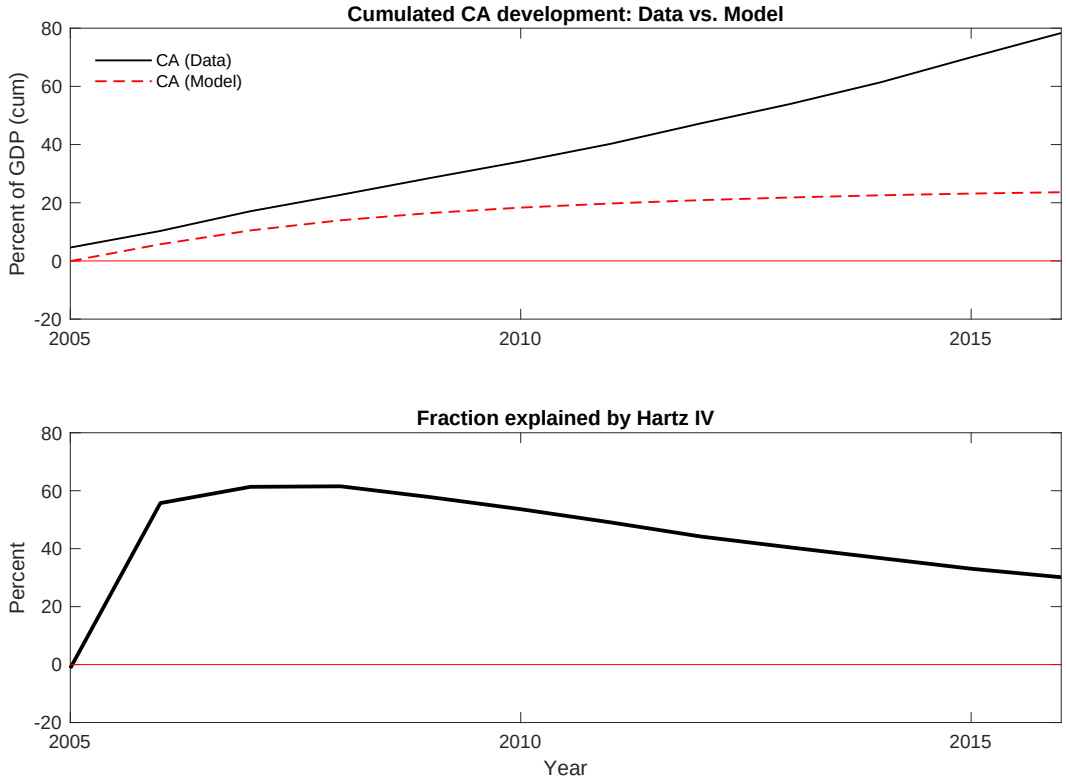


Figure 6: Contribution of Hartz IV to CA surplus

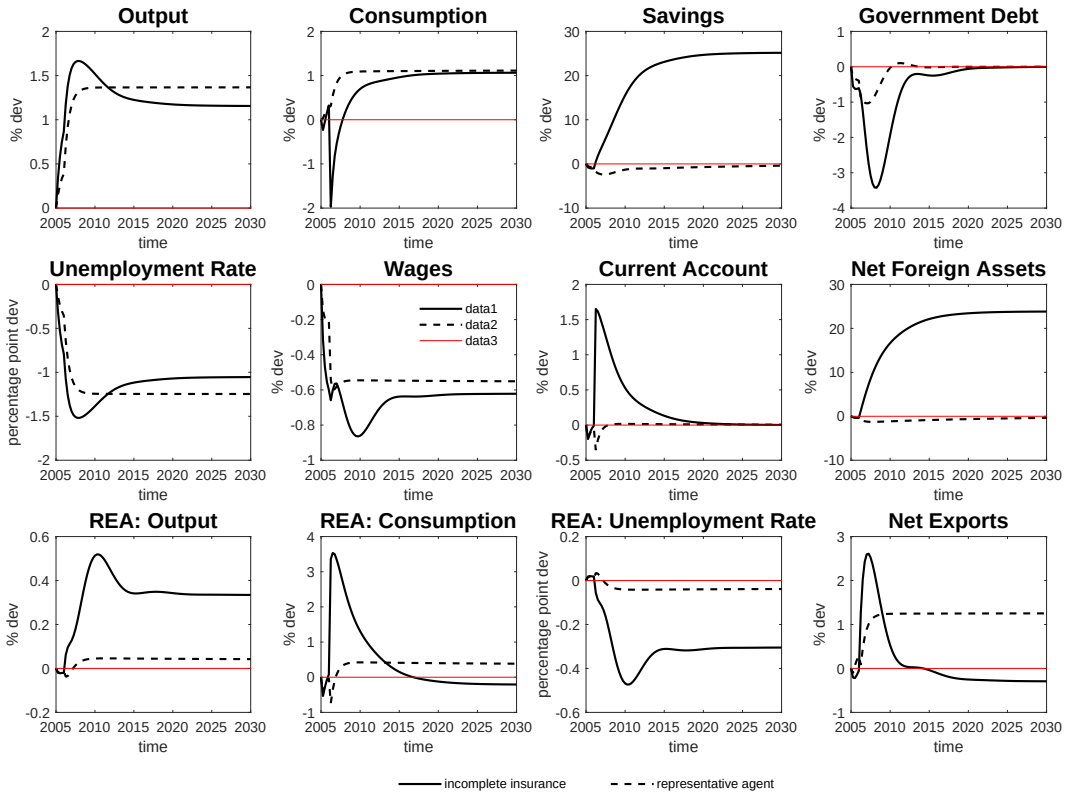


Figure 7: Comparison to the representative agent framework

the form $\frac{\phi}{2}(NFA_t - N\bar{F}A)^2$, where we set ϕ to 0.001. The remaining parameters are derived as described in the main text. Figure 7 highlights the importance of allowing for a precautionary savings motive. The solid line shows the impulse responses in our baseline model and the dashed lines illustrate a representative agent version of our model.

Unsurprisingly, in the representative agent framework, agents do not react to the decrease in the generosity of unemployment benefits by increasing savings. On the contrary, they decrease savings and, instead, prefer to consume more. The increase in consumption also raises output and leads to a decline in the unemployment rate. Furthermore, the rise in consumption (or the decline in savings) leads to a fall in the current account balance and the net foreign asset position. However, the stable consumption path after the Hartz IV reform also leads to higher net-exports in the medium and long run. In addition, due to the missing precautionary savings motive and subsequent small effect on the current account, spillover effects to the rest of the Euro Area are negligible small.

This confirms our prediction that as long as households are perfectly insured against the risk of becoming unemployed, a drop in the replacement rate and a cut in the entitlement duration has hardly any effect on the current account.

7 Concluding Remarks

This paper analyzes the effects of the most important labor market reform in the German post-war era, Hartz IV, on its contribution to global imbalances. In a model with a frictional labor market and incomplete insurance, we find that the lower fall-back option in case of unemployment, significantly increases worker's precautionary savings. First, we show that besides a substantial decline in unemployment of more than 1 percentage point, the Hartz IV reform contributed substantially to Germany's current account surplus. Since 2005, on average 40 percent of the German current account surplus can be attributed to the Hartz IV reform. Second, we illustrate that in a representative agent version of our model, there is no incentive to save. Therefore, this class of model is unsuitable to study effects on the current account which is by definition the flip-side of the savings-investment balance.

Interestingly, the two components of the reform (a reduction in the replacement rate for long-term unemployed) and a cut in the entitlement duration of short-term unemployment benefits) had very different macroeconomic effects. On the one hand reduction in the replacement rate mainly contributed to the increase in GDP and consumption as well as on the decline in wages and unemployment. On the other hand, the effect on the current account stems primarily from the entitlement cut.

We interpret these findings the following way: A reduction in the replacement rate generates a dominating wealth effect due to the decrease in unemployment. This decreases the incentive to hold precautionary savings. However, after the cut in short-term benefit entitlement, incomplete insurance kicks in and makes the treat to live on long-term unemployment benefits immanent. This causes agents to save.

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A Additional Figures

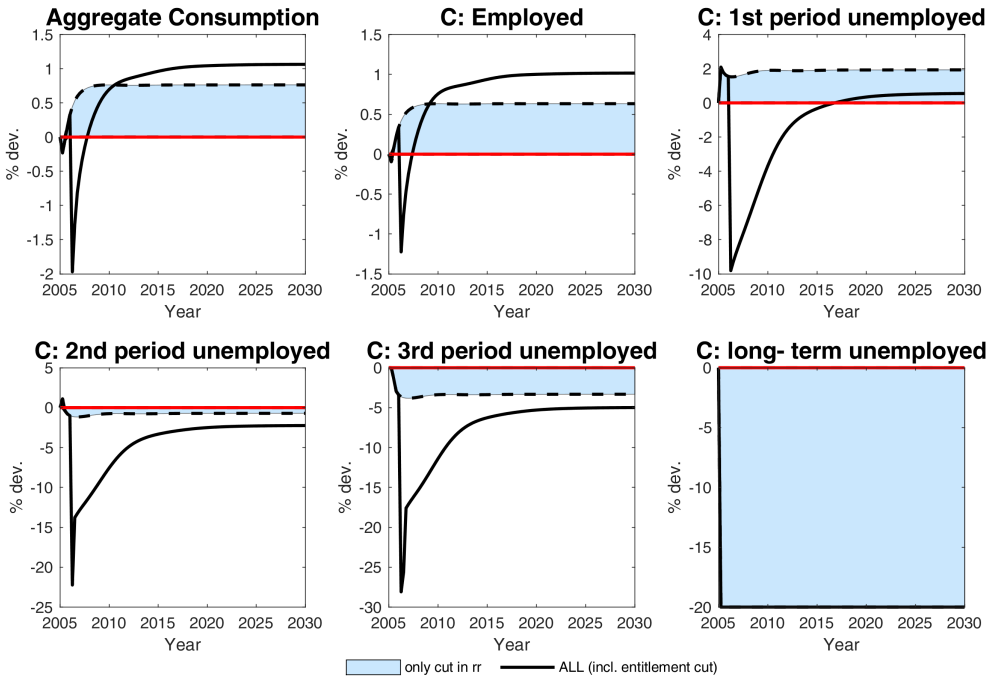

Figure 8: Effects of the Hartz IV reform package on disaggregated consumption levels.

B Model Derivations

B.1 Lagrangian for an employed worker:

$$\begin{aligned}\mathscr{L}^e = u(c_t^e) + \beta E_t[(1-s(1-\rho_{t+1})V_{t+1}^e + s(1-\rho_{t+1})V_{t+1}^{eu} - \lambda_t^e(c_t^e + a_t + \bar{t} \\ -(1-\tau_t)\omega_t - \pi_t - \frac{R_{t-1}^W a_{t-1}}{1+\pi_t} - \frac{\rho_t}{N_t}(\mu_{eu_1,t-1}(1-\delta_{t-1}^1)\frac{R_{t-1}^W a_{t-1}}{1+\pi_t} \\ +\mu_{eu_2,t-1}(1-\delta_{t-2}^1-\delta_{t-1}^2)\frac{R_{t-2}^W a_{t-2}}{1+\pi_{t-1}})]\end{aligned} \tag{B.1}$$

This results in the FOCs:

$$\frac{\partial \mathscr{L}^e}{\partial c_t^e} : \lambda_t^e = (c_t^e)^{-\sigma_c} \tag{B.2}$$

which corresponds to the marginal utlitiy of an employed worker.

$$\frac{\partial \mathscr{L}^e}{\partial a_t} : \lambda_t^e = \beta E_t[(1-s(1-\rho_{t+1}))\frac{\partial V_{t+1}^e(c_{t+1}^e, a_{t+1})}{\partial a_t} + s(1-\rho_{t+1})\frac{\partial V_{t+1}^{eu}(c_{t+1}^{eu}, a_{t+1})}{\partial a_t}] \tag{B.3}$$

$$\frac{\partial V_{t+1}^e}{\partial a_t} = \lambda_{t+1}^e(\frac{R_t^W}{1+\pi_{t+1}} + \frac{\rho_{t+1}}{N_{t+1}}(\mu_{eu_1,t}(1-\delta_t^1)\frac{R_t^W}{1+\pi_{t+1}}) \tag{B.4}$$
$$+ \lambda_{t+2}^e\frac{\rho_{t+2}}{N_{t+2}}(\mu_{eu_2,t}(1-\delta_t^1-\delta_{t+1}^2)\frac{R_t^W}{1+\pi_{t+2}})$$

$$\frac{\partial V_{t+1}^{eu1}}{\partial a_t} = \lambda_{t+1}^{eu1}\frac{R_t^W\delta_t^1}{1+\pi_{t+1}} + \beta(1-\rho_{t+2})\frac{\partial V_{t+2}^{eu2}}{\partial a_t} \tag{B.5}$$

$$\frac{\partial V_{t+2}^{eu2}}{\partial a_t} = \lambda_{t+2}^{eu2}\frac{R_t^W\delta_t^2}{1+\pi_{t+2}} + \beta(1-\rho_{t+3})\frac{\partial V_{t+3}^{eu3}}{\partial a_t} \tag{B.6}$$

$$\frac{\partial V_{t+3}^{eu3}}{\partial a_t} = \lambda_{t+3}^{eu3}\frac{R_t^W\delta_t^3}{1+\pi_{t+3}} \tag{B.7}$$

Using the Envelope theorem and plugging in gives:

$$\begin{aligned}\lambda_t^e =& \beta E_t[(1-s(1-\rho_{t+1}))\lambda_{t+1}^e(\frac{R_t^W}{1+\pi_t} + \frac{\rho_{t+1}}{N_{t+1}}\mu_t^{eu_1}(1-\delta_t^1)\frac{R_t^W}{1+\pi_{t+1}}) \\ &+ \lambda_{t+2}^e(\frac{\rho_{t+2}}{N_{t+2}}\mu_t^{eu_2}(1-\delta_t^1-\delta_{t+1}^2)\frac{R_t^W}{1+\pi_{t+2}}) + s(1-\rho_{t+1})\lambda_{t+1}^{eu1}(\frac{R_t^W\delta_t^1}{1+\pi_{t+1}} \\ &+ \beta(1-\rho_{t+2})\lambda_{t+2}^{eu2}(\frac{R_t^W\delta_t^2}{1+\pi_{t+2}} + \beta(1-\rho_{t+3})\lambda_{t+3}^{eu3}\frac{R_t^W\delta_t^3}{1+\pi_{t+3}}))))]\end{aligned} \tag{B.8}$$

Rearranging results in the Euler equation for optimal asset holdings:

$$\begin{aligned}DRet =& \frac{1}{R_t^W} = \beta E_t[(1-s(1-\rho_{t+1}))\frac{\lambda_{t+1}^e}{\lambda_t^e}(\frac{1}{1+\pi_t} + \rho_{t+1}\frac{1}{N_{t+1}}(\frac{\mu_t^{eu_1}(1-\delta_t^1)}{1+\pi_{t+1}})) \\ &+ \frac{\lambda_{t+2}^e}{\lambda_t^e}(\frac{\rho_{t+2}}{N_{t+2}}\mu_t^{eu_2}(1-\delta_t^1-\delta_{t+1}^2)\frac{1}{1+\pi_{t+2}}) + s(1-\rho_{t+1})\frac{\lambda_{t+1}^{eu1}}{\lambda_t^e}(\frac{\delta_t^1}{1+\pi_{t+1}} \\ &+ \beta(1-\rho_{t+2})\lambda_{t+2}^{eu2}(\frac{\delta_t^2}{1+\pi_{t+2}} + \beta(1-\rho_{t+3})\lambda_{t+3}^{eu3}\frac{\delta_t^3}{1+\pi_{t+3}})))]\end{aligned} \tag{B.9}$$

B.2 Lagrangian for a short-term unemployed worker who is 1 period unemployed:

$$\mathscr{L}^{eu,1} = u(c_t^{eu,1}) + \beta E_t[\rho_{t+1}V_{t+1}^e + (1-\rho_{t+1})V_{t+1}^{eu,2}] - \lambda_t^{eu,1}(c_t^{eu,1} + t - \kappa_t^{BS,1} - \delta_t^1\frac{R_{t-1}^W a_{t-1}}{1+\pi_t}) \tag{B.10}$$

This results in the marginal utility of consumption for a short-term unemployed worker:

$$\frac{\partial \mathscr{L}^{eu,1}}{\partial c_t^{eu,1}} : \lambda_t^{eu,1} = (c_t^{eu,1})^{-\sigma_c} \tag{B.11}$$

The optimal share of assets to consume in the first period of unemployement is determined by:

$$\frac{\partial \mathscr{L}^{eu,1}}{\partial \delta_t^1}: \beta \rho_{t+1} \frac{\partial V^e}{\partial \delta_t^1} + \beta(1-\rho_{t+1}) \frac{\partial V^{eu,2}}{\partial \delta_t^1} = \lambda_t^{eu,1} \tag{B.12}$$

$$\frac{\partial V_{t+1}^e}{\partial \delta_t^1} = \lambda_{t+1}^e \frac{\rho_{t+1}}{N_{t+1}} \mu_t^{eu,1} \tag{B.13}$$

$$\frac{\partial V_{t+1}^{eu,2}}{\partial \delta_t^1} = \beta \rho_{t+2} \lambda_{t+2}^e \frac{\mu_t^{eu,2} \rho_{t+2}}{N_{t+2}} + \beta(1-\rho_{t+2}) \lambda_{t+2}^{eu,3} \tag{B.14}$$

$$\Rightarrow \beta \rho_{t+1} \lambda_{t+1}^e \frac{\rho_{t+1}}{N_{t+1}} \mu_t^{eu,1} + \beta(1-\rho_{t+1})(\beta \rho_{t+2} \lambda_{t+2}^e \frac{\mu_t^{eu,2} \rho_{t+2}}{N_{t+2}} + \beta(1-\rho_{t+2}) \lambda_{t+2}^{eu,3}) = \lambda_t^{eu,1} \tag{B.15}$$

B.3 Lagrangian for a short-term unemployed worker who is 2 periods unemployed:

$$\mathscr{L}^{eu,2} = u(c_t^{eu,2}) + \beta E_t[\rho_t V_{t+1}^e + (1-\rho_t) V_{t+1}^{eu,3}] - \lambda_t^{eu,2}(c_t^{eu,2} + t - \kappa^{BS,2} - \delta_t^2 \frac{R_{t-2}^W a_{t-2}}{1+\pi_{t-1}}) \tag{B.16}$$

This results in the marginal utility of consumption for a short-term unemployed worker:

$$\frac{\partial \mathscr{L}^{eu,2}}{\partial c_t^{eu,2}}: \lambda_t^{eu,2} = (c_t^{eu,2})^{-\sigma_c} \tag{B.17}$$

The optimal share of assets to consume in the second period of unemployement is given by:

$$\frac{\partial \mathscr{L}^{eu,2}}{\partial \delta_t^2}: \beta \rho_{t+1} \frac{\partial V^e}{\partial \delta_t^2} + \beta(1-\rho_{t+1}) \frac{\partial V^{eu,3}}{\partial \delta_t^2} = \lambda_t^{eu,2} \tag{B.18}$$

$$\frac{\partial V_{t+1}^e}{\partial \delta_t^2} = \lambda_{t+1}^e \frac{\rho_{t+1}}{N_{t+1}} \mu_t^{eu,2} \tag{B.19}$$

$$\frac{\partial V_{t+1}^{eu,3}}{\partial \delta_t^2} = \lambda_{t+1}^{eu,3} \tag{B.20}$$

$$\Rightarrow \beta \rho_{t+1} \lambda_{t+1}^e \frac{\rho_{t+1}}{N_{t+1}} \mu_t^{eu,2} + \beta(1-\rho_{t+1}) \lambda_{t+1}^{eu,3} = \lambda_t^{eu,2} \tag{B.21}$$

B.4 Lagrangian for a short-term unemployed worker who is 3 periods unemployed:

$$\mathscr{L}^{eu,3} = u(c_t^{eu,3}) + \beta E_t[\rho_t V_{t+1}^e + (1-\rho_t) V_{t+1}^{uu}] - \lambda_t^{eu,3}(c_t^{eu,3} + t - \kappa_t^{BS,3} - \delta_t^3 \frac{R_{t-3}^W a_{t-3}}{1+\pi_{t-2}}) \tag{B.22}$$

This results in the marginal utility of consumption for a short-term unemployed worker:

$$\frac{\partial \mathscr{L}^{eu,3}}{\partial c_t^{eu,3}}: \lambda_t^{eu,3} = (c_t^{eu,3})^{-\sigma_c} \tag{B.23}$$

B.5 Lagrangian for a long-term unemployed worker:

$$\mathscr{L}^{uu} = u(c^{uu}) + \beta E_t[\rho_{t+1} V^e_{t+1} + (1-\rho_{t+1}) V^{uu}_{t+1} - \lambda^{uu}_t (c^{uu}_t + t - \kappa^{BL}]$$

This results in the marginal utility of consumption for a long-term unemployed worker:

$$\frac{\partial \mathscr{L}^{uu}}{\partial c^{uu}_t} : \lambda^{uu}_t = (c^{uu}_t)^{-\sigma_c} \tag{B.24}$$

B.6 Firm Side

$$\mathscr{L}^{Prod} = Y_t - \omega_t N_t - \kappa^v V_t + \beta E_t[\Omega_t V^{Prod}_{t+1}(N_{t+1}, V_{t+1})] - J_t(N_t - (1-s)N_{t-1} - q_t V_t)$$

where J_t is the lagrange multiplier and denotes the marginal value of a worker to the firm. Plugging in Y_t gives

$$\mathscr{L}^{Prod} = exp(prod)N_t - \omega_t N_t - \kappa^v V_t + \beta E_t[\Omega_t V^{Prod}_{t+1}(N_t, V_{t+1})] - J_t(N_t - (1-s)N_{t-1} - q_t V_t)$$

Taking FOCs:

$$\frac{\partial \mathscr{L}^{Prod}}{\partial N_t} : J_t = exp(prod) - w_t + \beta E_t \Omega_t J_{t+1}(1-s)$$
$$\frac{\partial \mathscr{L}^{Prod}}{\partial V_t} : -\kappa^v + J_t q_t = 0 \rightarrow J_t = \frac{\kappa^v}{q_t}$$

B.7 Workers Marginal Utility

Lagrangian for Employed Workers (Family Head) reads as following:

$$\begin{aligned}\mathscr{L}^{Family} = & N_t u(c^e_t) + \beta E_t[(1-s(1-\rho_{t+1}))N_t V^e_{t+1}(a_{t+1}, c^e_{t+1}) + s(1-\rho_{t+1})N_t V^{eu1}_{t+1}(c^{eu1}_{t+1})] \\ & - \lambda^e_t (N_t c^e_t + N_t a_t + N_t \bar{t} - N_t(1-\tau_t)\omega_t - \Pi_t - (1-s(1-p_t)N_t)\frac{R^W_{t-1} a_{t-1}}{1+\pi_t} - \\ & \rho_t \frac{N_t}{N_t}(\mu_{eu_1,t-1}(1-\delta^1)R^W_{t-1}\frac{a_{t-1}}{1+\pi_t} + \mu_{eu_2,t-1}(1-\delta^1_{t-2}-\delta^2_{t-1})R^W_{t-2}\frac{a_{t-2}}{1+\pi_t}]\end{aligned}$$

Defining $\mathscr{W}^e_t = \omega_t/\lambda^e_t$, $\mathscr{W}^{eu1}_t = \omega^{eu1}_t/\lambda^{eu1}_t$ and $\mathscr{W}^{uu}_t = \omega^{uu}_t/\lambda^{uu}_t$ and rearranging, gives the marginal value of an employed worker (=family member):

$$\begin{aligned}\mathscr{W}^e_t = & \frac{u(c^e_t)}{\lambda^e_t} - [c^e_t + a_t + \bar{t}_t - (1-\tau_t)\omega_t] - \beta E_t[\frac{\lambda^e_{t+1}}{\lambda^e_t}(1-s(1-\rho_{t+1})\frac{R^W_t a_t}{1+\pi_{t-1}}] \\ & + \beta E_t[\frac{\lambda^e_{t+1}}{\lambda^e_t}(1-s(1-\rho_{t+1}))\mathscr{W}^e_{t+1} + \frac{\lambda^{eu1}_{t+1}}{\lambda^e_t}s(1-\rho_{t+1})\mathscr{W}^{eu1}_{t+1}]\end{aligned}$$

C Derivation for representative worker version

C.1 Representative Family Head

$$V_t^E = u(c_t^E)$$

subject to

$$c_t^R + a_t + \bar{t} = (1-\tau_t)\omega_t N_t + (1-N_t-\mu_t^{uu})\kappa_t^{BS} + \mu_t^{uu}\kappa_t^{BL} + \Pi_t + R_{t-1}^W \frac{a_{t-1}}{1+\pi_t}$$

C.2 Lagrangian and FOCs

$$\begin{aligned}\mathscr{L}^R = u(c_t^e) + \beta E_t[V_{t+1}^R - \lambda_t^R(c_t^e + a_t + \bar{t} - (1-\tau_t)\omega_t N_t - (1-N_t-\mu_t^{uu})\kappa_t^{BS} - \mu_t^{uu}\kappa_t^{BL} \\ - \pi_t - \frac{R_{t-1}^W a_{t-1}}{1+\pi_t})]\end{aligned} \tag{C.1}$$

This results in the FOCs:

$$\frac{\partial \mathscr{L}^R}{\partial c_t^e} : \lambda_t^R = (c_t^e)^{-\sigma_c} \tag{C.2}$$

which corresponds to the marginal utlitiy of an employed worker.

$$\frac{\partial \mathscr{L}^R}{\partial a_t} : \lambda_t^R = \beta \lambda_{t+1}^R \frac{R_t^W}{1+\pi_{t+1}}$$

Using the Envelope theorem and plugging in gives:

$$\lambda_t^R = \beta \lambda_{t+1}^R \frac{R_t^W}{1+\pi_t} \tag{C.3}$$

Rearranging results in the Euler equation for optimal asset holdings:

$$DRet = \frac{1}{R_t^W} = \beta E_t[\frac{\lambda_{t+1}^R}{\lambda_t^R}\frac{1}{1+\pi_t}]$$

C.3 Employment Dynamics

Evolution of employment level

$$N_t = (1-s)N_{t-1} + M_t$$

Number of employed workers

$$\mu_t^e = N_t$$

Number of recent short-term unemployed workers= were fired and did not immediateley get a new job in period 1

$$\mu_t^{eu,1} = s(1-\rho_t)N_{t-1}$$

Number of short-term unemployed workers in further periods k

$$\mu_t^{eu,k} = (1-\rho_t)\mu_t^{eu,k-1}$$

Number of long-term unemployed workers

$$\mu_t^{uu} = (1-\rho_t)[\mu_{t-1}^{uu} + \mu_{t-1}^{eu,K}]$$

C.4 Workers Marginal Utility

The family head maximizes:

$$\mathcal{W}_t^e = (1-\tau_t)\omega_t + \beta E_t[\frac{\lambda_{t+1}^e}{\lambda_t^e}(1-s(1-\rho_{t+1}))\mathcal{W}_{t+1}^e + \frac{\lambda_{t+1}^{eu1}}{\lambda_t^e}s(1-\rho_{t+1})\mathcal{W}_{t+1}^{eu1}]$$

Short-term unemployed up to K-1:

$$\mathcal{W}t^{eu,k} = \frac{\kappa_t^{BS}}{\lambda_t^{eu}} + \beta E_t\{\frac{\lambda_{t+1}^{eu,k+1}}{\lambda_t^{eu}}(1-\rho_{t+1})\mathcal{W}_{t+1}^{eu,k+1} + \frac{\lambda_{t+1}^e}{\lambda_t^{eu,k}}\rho_{t+1}\mathcal{W}_{t+1}^e\} \tag{C.4}$$

Short-term unemployed in K (last period of short-term UB):

$$\mathcal{W}t^{eu,K} = \frac{\kappa_t^{BS}}{\lambda_t^{eu,K}} + \beta E_t\{\frac{\lambda_{t+1}^{uu}}{\lambda_t^e}(1-\rho_{t+1})\mathcal{W}_{t+1}^{uu} + \frac{\lambda_{t+1}^e}{\lambda_t^{eu,K}}\rho_{t+1}\mathcal{W}_{t+1}^e\} \tag{C.5}$$

Long-term unemployed:

$$\mathcal{W}_t^{uu} = \frac{\kappa_t^{BL}}{\lambda_t^{uu}} + \beta E_t\{\frac{\lambda_{t+1}^{uu}}{\lambda_t^{uu}}(1-\rho_{t+1})\mathcal{W}_{t+1}^{uu} + \frac{\lambda_{t+1}^e}{\lambda_t^{uu}}\rho_{t+1}\mathcal{W}_{t+1}^e\} \tag{C.6}$$