DEUTSCHE BUNDESBANK
EUROSYSTEM

Discussion Paper

Deutsche Bundesbank
No 13/2019

Labor market reforms, precautionary savings, and global imbalances

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ISBN 978–3–95729–577–4 (Printversion)
ISBN 978–3–95729–578–1 (Internetversion)

Non-technical summary

Research Question

Among economists and in public policy debates, the issue of global imbalances has returned to the agenda with momentum. While there are many reasons potentially responsible for such imbalances, deregulating the labor market is said to improve international competitiveness, to foster trade and to generate positive effects on current account. Theoretical contributions, however, still disagree on the existence and magnitude of the latter relation.

Contribution

In standard open-economy models with a representative agent entailing perfect consumption insurance, one needs specific assumptions to uniquely determine net foreign assets. But these assumptions do so independent of policy, especially in the long run. Therefore, many theoretical contributions not to find a clear link between labor market deregulation and (permanent) changes in net foreign assets. Against this background, we build a two-region real business cycle model with incomplete consumption insurance and limited cross-sectional heterogeneity that generates permanent savings and interest rate effects in response to policy changes. We then apply the model to quantify the contribution of far-reaching labor market reforms in Germany in the mid-2000s on its current account developments.

Results

We find that deregulating the labor market by lowering the generosity of the unemployment benefits system generates the expected effects: gross wage claims fall, which fosters employment and output growth. But with less generous unemployment benefits, the expected income loss in case of unemployment rises. This augments the incentive to build up precautionary savings. As they are not only invested domestically, but also abroad, the current account increases. In our numerical exercise, we find that German labor market reforms were responsible for about 18% of its current account-to-GDP surpluses since the reform implementation.

Nichttechnische Zusammenfassung

Fragestellung

Die Diskussion über globale Ungleichgewichte hat unter Ökonomen und in öffentlichen Debatten wieder an Gewicht gewonnen. Neben vielen anderen möglichen Faktoren wird die Arbeitsmarktderegulierung als ein wichtiger Faktor für den Aufbau solcher Ungleichgewichte identifiziert. Da eine Arbeitsmarktderegulierung die internationale Wettbewerbsfähigkeit erhöhe, so wird argumentiert, trage sie auch zum Aufbau von positiven Leistungsbilanzpositionen bei. Theoretische Arbeiten sind aber uneins hinsichtlich der Existenz und der Größe dieses Zusammenhangs.

Beitrag

Um die Nettoauslandsvermögensposition in Standardmodellen einer offenen Volkswirtschaft eindeutig zu bestimmen, sind spezielle Annahmen notwendig. Diese bestimmen das Nettoauslandsvermögen jedoch unabhängig von möglichen Politikänderungen. Vor diesem Hintergrund analysieren wir die Frage der Arbeitsmarktderegulierung im Rahmen eines Real Business Cycle-Modells mit unvollständigen Versicherungsmärkten und limitierter Heterogenität im Querschnitt. Dieses Setup führt zu permanenten Änderungen der Sparentscheidung bei strukturellen Politikänderungen. Wir verwenden unser Modell, um die Auswirkungen der deutschen Arbeitsmarktreformen Mitte der 2000er Jahre auf die Leistungsbilanz zu quantifizieren.

Ergebnisse

Eine Reduktion der Arbeitslosenversicherungsleistungen führt innerhalb des reformierenden Landes zu den erwarteten Effekten: Lohnforderungen sinken, was Beschäftigung und Output positiv beeinflusst. Allerdings führt der nun größere erwartete Einkommensverlust im Falle der Arbeitslosigkeit auch dazu, dass Haushalte ihre Sparanstrengungen erhöhen. Diese werden nicht nur im In- sondern auch im Ausland investiert, was die Leistungsbilanz erhöht. Unter Berücksichtigung dieses Wirkungskanals sind die deutschen Arbeitsmarktreformen gemäß unserer Simulationen für ca. 18% des beobachteten Leistungsbilanzanstiegs seit der Implementation der Reformen verantwortlich.

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Labor Market Reforms, Precautionary Savings, and Global Imbalances*

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Abstract

How do labor market reforms affect international competitiveness and net foreign assets? To answer this question, we build a two-region RBC model with labor market frictions, idiosyncratic consumption risk, and limited cross-sectional heterogeneity to establish a direct link between labor market reforms and changes in net foreign assets via a precautionary savings channel. We apply the model to simulate far-reaching labor market reforms in Germany during the mid-2000s. We find that reducing the generosity of unemployment benefits decreases wages, fosters employment and augments competitiveness as well as trade. In addition, we can explain a significant share of the observed increase in German net foreign assets. A standard representative agent framework is not able to generate any notable effects on net foreign assets and the current account.

Keywords: Unemployment benefits reform, current account imbalances, precautionary savings, Hartz reform

JEL classification: E21, E24, F16, F41.

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We thank Mathias Hoffmann, Jochen Mankart, Christian Merkl, Felix Schröter, Vincent Sterk, Lukas Vogel, Werner Roeger, seminar participants at the universities of Linz and Nürnberg, the Banque de France, the Deutsche Bundesbank, the ESCB Working Group on Econometric Modeling and the European Commission for valuable comments. We are grateful for feedback at the following conferences: CEF 2018 (Milan), ICMAIF 2018 (Crete), IIPF 2018 (Tampere), T2M 2018 (Paris), Verein für Socialpolitik 2018 (Freiburg) and NoEG Winter Workshop. We would especially like to thank Zeno Enders, Christian Haefke, Olivier Pierrard, Xavier Ragot and Dimitrios Tsomocos for insightful discussions of our paper. Brigitte Hochmuth acknowledges the hospitality of the Deutsche Bundesbank during the writing of this paper. The paper represents the authors' personal opinions and does not necessarily reflect the views of the Deutsche Bundesbank.

1 Introduction

Among economists and in public (policy) debates, the issue of global imbalances has returned to the agenda with momentum. A prominent example often referred to in these discussions is the high and persistent current account surplus in Germany (see, for example, The Economist, 2017b). Reasons potentially responsible for such imbalances are, among others, financial integration, economic growth in emerging markets, higher foreign demand for German goods, population aging or labor market reforms (see section 2 for details). In this paper, we will focus on the impact of labor market reforms on global imbalances.[1]

Empirically, it can be shown that countries which have recently deregulated their labor markets indeed tend to run current account surpluses; see Bertola and Lo Prete (2015). However, theoretical contributions disagree on the existence and magnitude of such a relation. Most modern open-economy models are capable of linking lower labor costs to higher international competitiveness. However, they do not find a link to the consequential – and notable – improvements in the current account and the net foreign asset positions. This especially holds for the long run (see, among others, Busl and Seymen 2013, Dao, 2013, Cacciatore, Duval, Fiori, and Ghironi, 2016 and Gadatsch, Stähler, and Weigert, 2016, which we discuss in more detail below).

The first and foremost reason for this is that most of the relevant studies use the common representative agent model. In general, this framework entails steady-state indeterminacy and non-stationary dynamics of net foreign assets. An in-depth discussion of this problem and solutions to it can be found in Schmitt-Grohe and Uribe (2003), Hunt and Rebucci (2005), Lubik (2007) and Benigno (2009). At large, these solutions boil down to assuming additional frictions in the international financial markets whenever holdings of net foreign assets exceed some exogenously fixed reference level. That introduces a link between consumption and the net foreign asset position to achieve stationarity. While this pins down the steady-state level of international financial assets uniquely, it does so independent of policy. Therefore, as summarized by Lubik (2007), one can question the usefulness of these assumptions to study international macroeconomic issues when analyzing structural (policy) reforms.

Against this background, we build a two-region RBC model with search frictions and incomplete insurance that generates permanent savings and interest rate effects in response to permanent policy changes. As an exemplary exercise, we use the model to quantify the contribution of the far-reaching German labor market reform in 2005 and 2006 on its current account. The so-called Hartz IV reforms significantly reduced the generosity of the unemployment benefits system.[2] In our model, we can establish a link between these labor market reforms and the evolution of net foreign assets, and we show that the reforms indeed contributed significantly to the German current account surplus.

Our model is in the spirit of Challe, Matheron, Ragot, and Rubio-Ramirez (2017) featuring limited cross-sectional heterogeneity and a first-order precautionary savings mo-

[1] Already in October 2014, Paul Krugman summarized the debate as follows: *"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."*

[2] A detailed description of the Hartz reforms and of the developments of the German current account as well as its net foreign asset position can be found in appendix A.

tive. The two-region framework allows us to analyze trade and asset flows in detail. Incorporating a detailed labor market structure enables us to discuss labor market reforms elaborately. While admittedly still stylized, our modeling choice avoids having to use higher-order solution techniques to obtain an endogenous savings motive (for precautionary reasons) or having to move to a fully-fledged heterogeneous agent model which restricts the number of state variables significantly. As stressed by Ragot (2018), this modeling strategy has several advantages: It generates an elastic asset demand curve on the household side, introduces quasi-heterogeneity and remains analytically tractable. Different from traditional heterogeneous-agent models la Krusell and Smith (1998), agents no longer have to forecast a full, time-varying cross-sectional distribution of wealth in order to make their intertemporal decisions. The wealth distribution is only limited as it is equal for all employed workers and there is no differentiation according to employment histories here. However, we are primarily interested in endogenous changes in labor market risks (resulting from labor market reforms) as well as the effects on global imbalances in a two-region framework (which adds complexity), and less in the precise wealth distribution. We therefore do not consider the simplifications of the chosen framework as a limitation but rather as an advantage for the analysis at hand.[3]

The contribution of our paper is threefold. First, on the theoretical side, we show how to overcome the problem of steady-state indeterminacy and non-stationarity of net foreign assets by including a first-order precautionary savings motive. Our extension pins down savings and net foreign assets as well as the economy-wide (natural) interest rate endogenously, also in the steady state. We no longer require additional assumptions to ensure stationarity and determinacy of net foreign assets in steady state. Second, we use our model to evaluate the effects of a structural labor market reform in Germany on its current account. We show that the existing literature may indeed have underestimated the contribution of these reforms on the global imbalances significantly. While, as mentioned above, the previous literature tends to not find a link between labor market reforms and increasing net foreign asset and current account positions, our model is capable to attribute, on average, about 18% of the observed current account increase to the reforms. Third, we contribute to the ongoing discussion on the spillover effects of labor market policies. We show that, while a reduction in labor costs in one region positively affects international competitiveness, trade, consumption and output in that region (which standard models also find), it is very well possible that it does so at the cost of the other region (which is not a standard outcome), at least in the long-run.

To be more precise, the labor market in our model is characterized by standard search frictions in line with Pissarides (2000). We deviate from the common assumption of perfect consumption insurance as in Andolfatto (1996) and Merz (1995). Following Challe et al. (2017), we assume that workers live in a large family while employed, and all family members make the same consumption/savings decisions. However, once a worker becomes unemployed, she has to leave the family and must subsequently live on her own. She is

[3] Other studies in a similar vein include, among others, Challe and Ragot (2016), McKay and Reis (2016), McKay (2017), McKay, Nakamura, and Steinsson (2017) and Ravn and Sterk (2016, 2017). These analyses all use models of a closed economy, however. An endogenous evolution of net foreign assets and the world interest rate can, for example, be found in models with an OLG structure (see, for example, Gale, 1971, Ferrero, 2010, Di Giorgio and Nistic, 2013, or Di Giorgio and Traficante, 2018, for a discussion). In these models, savings are a result of insuring against longevity, while they are a result of insuring against unemployment in our model.

allowed to take a share of the family assets with her and receives unemployment benefits. During the unemployment spell, the worker decides on the share of assets taken from the family to consume each period endogenously. She is not allowed to borrow. When finding a job again, the (formerly) unemployed worker re-enters the family and brings back the remaining assets. Idiosyncratic unemployment shocks yield an endogenous distribution of workers that can be aggregated at each point in time, thus generating limited cross-sectional heterogeneity.

The incomplete consumption insurance gives rise to a first-order precautionary savings motive: Family members want to insure against income and consumption losses in case of unemployment. The amount of savings is derived endogenously and (also) depends on the unemployment risk. Households can save in physical capital and government bonds domestically. If domestic savings exceed the domestic asset demand, they also invest in international assets. The endogenous world interest rate guarantees that aggregate world asset demand equals supply. Therefore, the net foreign asset position between the two regions is determined endogenously in our model, also in the steady state.

A reduction in the generosity of the unemployment insurance system in one region (Germany in our numerical exercise) yields the standard labor market effects in that region: Because the fall-back utility of workers declines, they accept lower wages. This fosters job creation, employment, and production. International competitiveness eventually increases because of lower unit labor costs.

For savings, however, there are now two opposing effects. On the one hand, higher job creation reduces the risk of a long unemployment spell. This reduces the need for precautionary saving. On the other hand, when becoming unemployed, the income loss increases. This augments the need for precautionary saving. Which of the two effects dominates is not clear from an ex-ante perspective. When simulating the German Hartz IV reforms on the labor market, it is clearly the latter.[4] In order to build up the desired level of savings, aggregate consumption in Germany falls for some time before rising again once asset holdings have increased sufficiently.

The increase in savings in Germany is not absorbed domestically. Hence, Germans transfer savings to the foreign region and the net foreign asset position rises. This increases the German current account. Because the German savings glut increases world asset supply, the world interest rate falls. A lower interest rate makes producing with capital more attractive ceteris paribus. Hence, in relative terms, firms in both regions increase capital input in production. The policy-induced wage reduction in Germany dampens this effect and employment increases, too. This is not the case in the Rest of the Euro Area, and employment there falls eventually. Initially, this can be compensated for by the fact that higher capital input increases the marginal productivity of labor, generating higher wages and an increase in aggregate consumption and output. But these positive effects fade out in the medium to long term. Furthermore, given a higher net foreign asset position in Germany, part of the domestic output of the Rest of the Euro Area needs to

[4] As described in appendix A, the Hartz IV reform had two components. First, the reduction of long-term unemployment benefits. Second, the reduction of the entitlement duration to receive more generous short-term unemployment benefits from a maximum of 32 months to at most 18 months (depending on age). As we will see below, simulating only the former reform step reduces precautionary savings in Germany. In that case, the now lower probability to reach the long-term unemployment state is reduced sufficiently to compensate for the expected income loss. This no longer holds when entitlement duration is reduced, too.

be transferred to Germany in form of interest payments. Taken together, this generates negative consumption spillovers of the Hartz reforms.

Compared to most existing theoretical studies focussing on the effects of labor market reforms on global imbalances (among others, Busl and Seymen, 2013, Dao, 2013, Cacciatore et al., 2016 and Gadatsch et al., 2016), we find a quantitatively important and permanent effect on the German net foreign asset position. Interestingly, our results on the labor market are quantitatively in line with studies that focus on the effect of the Hartz IV reform in a closed-economy framework (see Krebs and Scheffel, 2013 for a comparable decline in unemployment). This makes us confident that our model generates plausible results.

The rest of the paper is structured as follows. The next section briefly reviews the related literature. Section 3 derives a search and matching model with incomplete insurance. We explain the calibration in section 4. Section 5 shows results. Section 7 concludes. An appendix outlines some background on the Hartz reforms and the German current account developments.

2 Connections to Existing Literature

This paper is related to multiple areas of the literature. First, it relates to studies discussing labor market reforms in general, with a special focus on the German Hartz reforms. Second, it relates to the literature that addresses the impact of such reforms on international competitiveness, the current account (CA) and policy spillovers. And third, it is related to the literature of precautionary savings and the linkages to international asset trade.

Kollmann, Ratto, Roeger, in 't Veld, and Vogel (2015) identify mainly four potential explanations of the German current account surplus in an estimated three-country DSGE model. First, they show that financial integration in the sense that interest rates in the Rest of the Euro Area converged to the German rates prior to the introduction of the euro may have contributed to the CA developments. This point is also stressed by Mendoza, Quadrini, and Rios-Rull (2009) who show that, if countries differ in their degree of financial development, financial integration leads to global imbalances. Second, they show that a strong increase in foreign demand caused by high economic growth in emerging markets contributed to higher CA positions (see also Chen, Milesi-Ferretti, and Tressel, 2012). A third explanation is population aging in Germany and the associated reduction in domestic demand due to an increase in savings for retirement (also addressed in Blanchard and Milesi-Ferretti, 2010). Finally, they find that the German labor market liberalization (2002-2005), especially the Hartz reforms, increased the German current account position. Even though the increase in the German current account has multiple reasons, our focus in this paper is on how (and how much) German labor market reforms affected these developments.

In this respect, our paper relates to studies analyzing the effects of the Hartz IV-reform on the current account. But no consensus on the quantitative impact of the Hartz reforms on international imbalances has yet been reached. On the one hand, Kollmann et al. (2015) find that the Hartz reforms were indeed one of the main drivers of the German current account surplus. In their model, they abstract from a frictional labor market and interpret shocks to leisure as changes in the generosity of unemployment

benefits. On the other hand, Busl and Seymen (2013) and Gadatsch et al. (2016) show in models with frictional labor markets that the Hartz reforms, now modeled as an actual decrease in unemployment benefit payments, had basically no effect on Germany's build-up of international assets. Dao (2013) reaches a similar conclusion in an open-economy model with unionized wage bargaining. Going beyond the Hartz reforms, Cacciatore et al. (2016) study the effects of labor market deregulations in general. In a two-country model with endogenous producer entry and search frictions on the labor market, they show that a reduction in unemployment benefits causes an initial short-run increase in the current account which is followed by a strong reversal and a current account deficit. Quantitatively, the effects on the current account that they identify are small, however.

Generally, these theoretical papers find positive spillovers to the rest of the trading partners, at least in the long run. While German international competitiveness indeed increases after the Hartz reforms in these analyses, the reform also augments German income and the demand for foreign goods. The price and quantity effects, in the end, even out in the models such that there are basically no current account effects, but trading partners are positively affected by the demand effect.[5] What the studies discussed so far have in common is that workers are perfectly insured within a family, and there is no precautionary savings motive. We argue that allowing for an endogenous savings motive in steady state (for example, via a precautionary savings channel) is crucial.

There are several other – also empirical – contributions which focus on the general effect of labor market reforms on the current account. For example, Kennedy and Slok (2005) provide empirical reduced-form evidence that a deregulation on the labor market (such as Hartz IV) leads to an immediate fall in prices and wages and, therefore, an increase in the trade balance. In the long run, however, they argue that the capital balance adjusts because the increased profitability of domestic capital leads to an influx of foreign capital. This effect counteracts the increase in net exports and reverses the current account. In OECD country-level panel data, Bertola and Lo Prete (2015) find empirical evidence that labor market deregulations tend to increase a country's current account surplus. In addition, they provide a theoretical model in which the link between a country's current account position and labor market institutions depends on financial market imperfections. Similar to our study, they also stress the precautionary savings channel, however, their focus lies on financial market imperfections and the role of human capital investment. As we quantify the effects of a specific deregulation and stress the role of idiosyncratic consumption risk, we see our work complementary to Bertola and Lo Prete (2015).

Our work is further related to theoretical papers analyzing the interactions between unemployment risk and precautionary savings in a heterogeneous-agent framework (see Challe et al., 2017, Challe and Ragot, 2016, Den Haan, Rendahl, and Riegler, 2017, Heathcote and Perri, 2018, as well as McKay and Reis, 2016, McKay, 2017, McKay et al.,

[5] An exception here is Helpman and Itskhoki (2010). They use a two-sector Melitz (2003) model enhanced with search frictions in the labor market and find that a labor market reform that is beneficial for the reforming country may harm its trading partner as a result of higher international competitiveness. This is because the competitiveness of firms in the home country increases while foreign firms are crowded out in the differentiated sector. In models where traded and non-traded goods are not differentiated, however, this channel is absent. The precautionary savings motive in our model endogenizes world assets and capital interest, also in the steady state, and can thus produce negative spillovers even without product differentiation Melitz (2003).

2017, and Ravn and Sterk, 2016, 2017). These papers abstract from potential effects on a country's net foreign asset position and mainly use a closed-economy framework.

To our knowledge, studies that relate precautionary savings to international developments tend to use higher-order savings motives and, thus, differ to our approach. Hoffmann, Krause, and Tillmann (2014) find cross-sectional empirical evidence for a positive correlation between capital flows and output volatility. In a small open economy RBC model, they explain this stylized fact with a mechanism that links higher expected income volatility with precautionary savings because households want to insure against income shocks. Building on a model of buffer stock saving, Carroll and Jeanne (2009) endogenize the optimal level of domestic and precautionary wealth which serves to insure against idiosyncratic risk and analyze the role of a precautionary savings motive for reducing global imbalances.[6]

Another strand of the literature focuses on the effects of changes in unemployment benefits in a closed economy framework. Prominent studies evaluating the effects of Hartz IV on German unemployment from a macroeconomic perspective are Krebs and Scheffel (2013), Krause and Uhlig (2012), Hochmuth, Kohlbrecher, Merkl, and Gartner (2019) and Launov and Wälde (2013). Krebs and Scheffel (2013), Krause and Uhlig (2012) and Hochmuth et al. (2019) find that decreasing the generosity of the unemployment insurance system reduces wages and unemployment, whereas Launov and Wälde (2013) find only negligible effects. Not specifically related to the German Hartz reforms, Cacciatore and Fiori (2016) also find that a cut in unemployment benefits fosters job creation and output. Focusing on entitlement duration, Hagedorn, Manovskii, and Mitman (2015) find that an abrupt cut in benefit extensions in the US caused a significant increase in employment. In contrast to our study, all those papers abstract from a precautionary savings channel.

We see our paper complementary to those existing papers by providing insight on how much the far-reaching German unemployment benefits reform (Hartz IV) has contributed to the increase in the German current account position via a precautionary savings channel. To our knowledge, we are the first to quantify the effects of a labor market reform in a two-country framework with incomplete insurance.

3 The Model

We build a two-region RBC model with incomplete insurance and search frictions on the labor market in the spirit of Pissarides (2000).[7] In each region, there is a continuum of workers on the unit interval who can either be employed or unemployed. Each worker inelastically works one unit of time. Employed workers live in a large family with a dominant family head. The family head takes over wage bargaining. This modeling strategy

[6] Focusing on the role of aggregate risk, Durdu, Mendoza, and Terrones (2009) assess to which extent the demand for precautionary wealth depends on output volatility, financial globalization as well as the risk of a sudden stop. Fogli and Perri (2006) and Fogli and Perri (2015) relate the role of business cycle volatilities to a country's external balance position. They argue that if residents cannot perfectly insure against country-specific aggregate shocks, the incentive to hold precautionary savings increases which, in turn, affects the net foreign asset position.

[7] We also simulated a three-region version of our model because imbalances not only emerged between Germany and the Rest of the Euro Area but also between Germany and the rest of the world. The results are qualitatively robust to that extension. However, as Germany's relative size decreases, the effects on the world interest rate and spillovers are smaller. Results are available upon request.

serves to eliminate the heterogeneity within the family and ensures equal consumption and savings level for all its members. Thus, there is perfect insurance within the family (in line with Merz, 1995 and Andolfatto, 1996).

Nonetheless, our model features incomplete insurance of idiosyncratic unemployment risk. A worker who becomes unemployed has to leave the family and takes a share of the family's savings with her (a modeling choice building on Challe et al., 2017). All unemployed workers receive government-financed, duration-dependent unemployment benefits κ_t^B, which are more generous for short-term unemployment. When unemployed, workers have to consume their entire savings within $K > 0$ periods. While this assumption may seem restrictive, we see below that, when choosing K to be large enough, unemployed workers have virtually spent all their assets before they reach period K. Furthermore, using survey data evidence on the wealth of the unemployed, we observe that unemployed have very little assets left once their unemployment spell approaches one year; see appendix B for details. How much of their assets they consume each period arises endogenously. If an unemployed worker is hired again, she re-enters the family and brings her remaining assets back to the family. In such an environment, there is a true consumption risk related to employment status. 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 and capital as production inputs. Firms post vacancies and pay vacancy posting costs κ^v to hire unemployed workers. Matches between workers and firms are formed through a standard Cobb-Douglas matching function, and wages are determined by Nash-bargaining. The two regions, Home (Germany) and Foreign (the Rest of the Euro Area), trade imperfectly substitutable goods on competitive markets in a currency union. Labor is immobile across countries. We model both countries analogously. However, the countries will differ in size, the steady-state unemployment rate, replacement rates, and productivity. We denote Home with subscript H and Foreign with F.

Figure 1 summarizes the timing of events within the period. At the first stage, matches are exogenously destroyed, firms post vacancies and new matches are formed. Once matching has taken place, unemployed workers leave the family (taking a fraction of the family wealth with them) and former unemployed members who found a job again re-enter the family. This timing of events allows for immediate re-hiring within the same period and, hence, takes into account that the duration of a large fraction of unemployment spells is below one quarter (see, for example, Gal, 2010). After the labor market transition stage, production takes place. Firms produce and family members receive income in form of net wages, firm profits and interest payments on their assets. Finally, in the consumption/savings stage, the family head allocates the same amount of goods and assets to each member.

3.1 Households: The Family and Unemployed Workers

Within the family, all workers pool their earnings consisting of net wage income, firm profits and interest payments on previous asset purchases. Therefore, there is perfect insurance within employed workers and, as they are symmetric, they choose the same consumption and asset holding level. This is identical to the modeling strategy of Challe et al. (2017) where the family head solves the maximization problem and redistributes

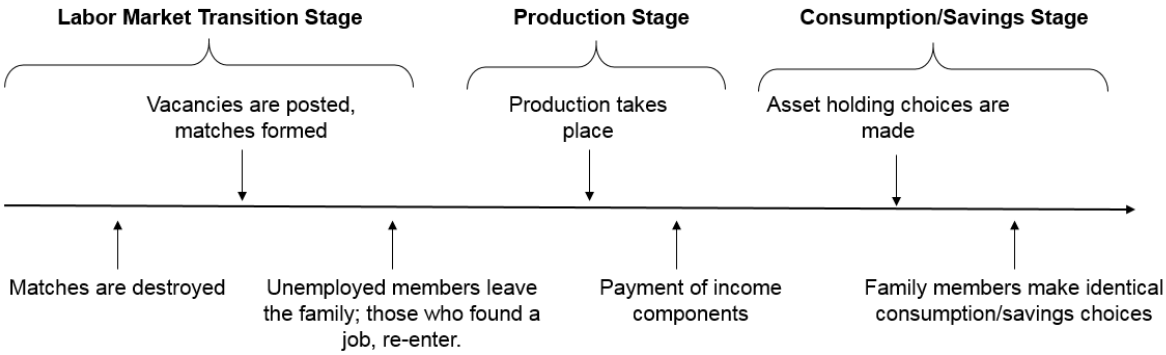

Figure 1: Model time line for family within one period

consumption goods and assets equally among family members. Independent of the employment status $i \in [e, eu_k, uu]$, with e indicating employed, eu_k short-term unemployed for k periods, where $k \in K$, and uu indicating long-term unemployed, workers have CRRA utility with intertemporal risk aversion parameter σ_c

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

An employed worker maximizes

$$V_t^e(S_t) = \max_{\{c_t^e, a_t\}} \left\{ u(c_t^e) + \beta E_t \left[\left(1 - s(1-\rho_{t+1})\right) V_{t+1}^e(S_{t+1}) + s(1-\rho_{t+1}) V_{t+1}^{eu_1}(a_{t+1}, S_{t+1}) \right] \right\} \tag{2}$$

each period t, where c_t^e is real per-capita consumption of a family member and a_t are per-capita assets/bonds that pay gross interest R_t^w. Let $S_t = \{N_{t-1}, k_{t-1}, I_{t-1}, \omega_{t-1}, \tilde{\mu}_t, e_t^z\}$ summarize the aggregate state of the economy, where $N_{t-1}, k_{t-1}, I_{t-1}$ are beginning of period employment, capital and investment, ω_{t-1} denotes last periods wage and $\tilde{\mu}_t\left(\mu_{t-1}^i\right)$ is the beginning of period cross-sectional distribution of workers among labor market states $i \in [e, eu_k, uu]$ and μ_t^i denotes the share of workers in state i, e_t^z denotes aggregate productivity. If the worker is separated, which happens at the exogenously given probability s, and is not re-hired within that period at rate ρ_t, she has to leave the family.[8] Then, she faces utility of being unemployed (for one period), $V_t^{eu_1}$. As we will see below, she subsequentially moves to states $\{V_t^{eu_2}, ..., V_t^{eu_K}, V_t^{uu}\}$ if she is not re-hired during the process. In real terms, each family member is subject to the following per-capita budget constraint

[8] Note that s and ρ_t do not only determine individual probabilities but also the shares of workers being fired and re-hired.

in each period:

$$c_t^e + a_t + \bar{t} = (1-\tau_t^w)\omega_t + \frac{\Pi_t}{N_t} + (1 - s(1-\tau^F)(1-\rho_t))\,\frac{N_{t-1}}{N_t}\,\frac{R_{t-1}^W a_{t-1}}{1+\pi_t} + \frac{\rho_t}{N_t}\sum_{k=1}^{K-1}\left(\mu_{t-1}^{eu_k} r_t^{eu_k}\,\frac{R_{t-k}^W a_{t-k}(1-\tau^F)}{1+\pi_{t-k}}\right). \tag{3}$$

Remember that only employed workers are family members and that the timing of decisions is according to Figure 1. Consumption, c_t^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 $R_{t-1}^W a_{t-1}/(1+\pi_t)$. When workers become unemployed and have to leave the family, they take a share of the family assets with them. However, this is not a fair share, but the family deducts a fraction τ^F of that fair share, which remains in the family. We assume this for two reasons. It helps to mimic the observed differences in wealth levels of employed and short-term unemployed workers. Figure 13 in appendix B shows that the wealth level of employed is considerably higher than the level of wealth short-term unemployed workers have at their disposal. We choose τ^F in order to match this empirical fact. In addition, the family takes into account that workers who lost their job in some previous periods, denoted by $\mu_t^{eu_k}$ and defined in formal detail below, may find a job and return to the family. In that case, they 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 of equation (3), where $r_t^{eu_k}$ defines the remaining share of assets an unemployed worker in state k brings back the family when re-hired (i.e the "rest" of the assets she has left the family with). It holds that $r_t^{eu_1} = (1-\theta_{t-1}^1)$ and $r_t^{eu_k} = r_{t-1}^{eu_{k-1}} - \theta_{t-1}^k$, where θ_t^k is the share of assets consumed in unemployment state k.[9]

Maximizing (2) subject to (3) and the debt constraint $a_t \geq 0$, 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

$$\Omega_t R_t^W \leq 1 \tag{4}$$

with the marginal intertemporal rate substitution of a worker defined as

$$\Omega_t = \beta E_t\left[(1 - s(1-\tau^F)(1-\rho_{t+1}))\frac{\lambda_{t+1}^e}{\lambda_t^e}\left(\frac{1}{(1+\pi_t)} + \sum_{k=1}^{K-1}\beta^{k-1}\frac{\lambda_{t+k}^e}{\lambda_t^e}\,\frac{\rho_{t+k}}{N_{t+k}}\,\frac{\mu_{t+k-1}^{eu_k}\cdot r_{t+k}^{eu_k}(1-\tau^F)}{1+\pi_{t+k}} + s(1-\rho_{t+1})\frac{\lambda_{t+1}^{eu_1}}{\lambda_t^e}\sum_{k=1}^{K}\tilde{r}_{t+k}^{eu_k}(1-\tau^F)\right)\right], \tag{5}$$

[9] 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 $K-1$. Also 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, taking into account that some members become unemployed in the next period and take their assets with them.

where $\tilde{r}_t^{eu_k} = \theta_{t+k}^k/(1+\pi_{t+k}) + \beta\,(1-\rho_{t+k})\,\lambda_{t+k}^{eu_{k+1}}/\lambda_t^e \tilde{r}_{t+1}^{eu_{k+1}}$ as long as $k < K$ and $\tilde{r}_t^{eu_K} = \theta_{t+K}^K/(1+\pi_{t+K})$. Equation (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, boiling down to the standard 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 (5). Furthermore, marginal utility of workers in period k after dismissal, denoted by λ^{eu_k} and derived in formal detail below, enters equation (5) through $\tilde{r}_t^{eu_k}$.

As we aim at analyzing the German Hartz reforms as an exemplary case study, we need to match the basic institutional settings of the German unemployment insurance system. Hence, we distinguish between short and long-term unemployed workers. Short-term unemployed workers in unemployment state k receive a more generous unemployment benefits payment $\kappa_t^{BS_k} = rrs(1-\tau_{t-k}^w)w_{t-k}$, where rrs is the replacement rate related to their net wage income in their last period of being employed. In the pre-reform steady state, unemployed workers move from short to long-term unemployment after K periods. When this happens, they receive an analogous payment κ_t^{BL}, with the difference that the replacement rate is lower, $rrl < rrs$. In period t the maximization problem of a short-term unemployed worker is given by

$$V_t^{eu_k}(a_t, S_t) = \max_{\{c_t^{eu_k}, \theta_t^k\}} \left\{ u(c_t^{eu_k}) + \beta E_t \left[\rho_{t+1} V_{t+1}^e(S_{t+1}) + (1-\rho_{t+1}) V_{t+1}^{eu_{k+1}}((a_{t+1}, S_{t+1}) \right] \right\} \tag{6}$$

subject to the budget constraint

$$c_t^{eu,k} + \bar{t} = \kappa_t^{BS_k} + \theta_t^k R_{t-k}^W \frac{a_{t-k}(1-\tau^F)}{1+\pi_t}. \tag{7}$$

Short-term unemployed workers in k consume a share $\theta_t^k \geq 0$ of their assets in addition to their unemployment benefits each period. θ_t^k is, thus, a choice variable. However, we assume that after K periods, all assets have to be spent.[10] Hence, in the last period of short-term unemployment, the utility function is,

$$V_t^{eu,K}(a_t, S_t) = \max_{\{c_t^{euK}\}} \left\{ u(c_t^{eu,K}) + \beta E_t \left[\rho_{t+1} V_{t+1}^e(S_{t+1}) + (1-\rho_{t+1}) V_{t+1}^{uu}(S_{t+1}) \right] \right\}. \tag{8}$$

Short-term unemployed workers decide each period which share θ_t^k of their assets they consume. The Euler conditions with respect to any θ_t^k are

$$\Omega_t^{eu_k} \leq 1 \tag{9}$$

holding with an equality when $k < K$ and with the marginal rate of intertemporal of an

[10] 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.

unemployed worker in k defined as

$$\Omega_t^{eu_k}\lambda_t^{eu_k} = \beta\rho_{t+1}\lambda_{t+1}^{e}\frac{\rho_{t+1}}{N_{t+1}}\mu_t^{eu_k} + \beta(1-\rho_{t+1})\,\lambda_{t+1}^{eu_{k+1}}, \tag{10}$$

and where the λ's are the corresponding marginal consumption utilities. Since all assets have to be consumed within K periods, it holds that $\sum_{k=1}^{K}\theta_{t-K+k}^{k} = 1$ and, given the choices made previously, θ_t^K is "fixed", implying that the Euler condition of a worker being still unemployed after K periods holds with strict inequality, $\Omega_t^{eu_K} < 1$.

In state K+1 an unemployed worker is considered as a long-term unemployed worker, with the utility,

$$V_t^{uu}(a_t, S_t) = \max_{\{c_t^{uu}\}}\left\{u(c_t^{uu}) + \beta E_t\left[\rho_{t+1}V_{t+1}^{e}(S_{t+1}) + (1-\rho_{t+1})V_{t+1}^{uu}(S_{t+1})\right]\right\}, \tag{11}$$

where

$$c_t^{uu} + \bar{t} = \kappa_t^{BL}, \tag{12}$$

Note that the lower replacement rate of long term unemployed implies $\Omega_t^{uu} < \Omega_t^{eu_K}$.

Given the utilities of the unemployed workers it is straightforward to derive the marginal utilities of consumption by employment status $i \in [e, eu_k, uu]$:

$$\lambda_t^{i} = (c_t^{i})^{-\sigma_c}. \tag{13}$$

The solution of the employed workers' problem are the decision rules for assets, denoted by $g_a(S)$, and consumption, denoted by $g_{c^e}(S)$. Depending on their unemployment spell k, short-term unemployed workers choose decision rules $g_{c^{eu_k}}(a, S)$ for consumption and the share of assets they spend $g_{\theta^{eu_k}}(a, S)$ and long-term unemployed choose $g_{c^{uu}}(a, S)$.

3.2 Production

The representative firm faces the Cobb-Douglas production function $y_t = e_t^z k_{t-1}^{\alpha} N_t^{1-\alpha}$ with input factors capital k_{t-1} and labor N_t. Productivity e_t^z follows an AR(1)-process.

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

$$\Pi_t = \max_{\{k_t, N_t, V_t\}} E_t \sum_{t=0}^{\infty}\Omega_t\left\{\frac{p_t}{P_t}Y_t - \omega_t N_t - \kappa^{v}V_t - r_t^{k}\,k_{t-1} - \frac{\psi^{w}}{2}\left(\frac{\omega_t}{\omega_{t-1}} - 1\right)^2 N_t\right\} \tag{14}$$

subject to the law of motion for employment

$$N_t = (1-s)N_{t-1} + q_t V_t, \tag{15}$$

where ω_t are wages, r_t^k is the capital interest rate and q_t denotes the vacancy-filling probability, all derived below. Real vacancy posting costs are given by κ^v, and changing wages is associated with quadratic Rotemberg adjustment costs governed by ψ^w. Since firms belong to the family, they discount the future with the family's discount factor Ω_t.

The solution to the maximization problem in real terms is given by

$$r_t^k = \alpha \frac{p_t}{P_t} e_t^z \left(\frac{N_t}{k_{t-1}} \right)^{1-\alpha} \tag{16}$$

$$J_t = \frac{p_t}{P_t} e_t^z (1-\alpha) \left(\frac{k_{t-1}}{N_t} \right)^{\alpha} - \omega_t - \frac{\psi^w}{2} \left(\frac{\omega_t}{\omega_{t-1}} - 1 \right)^2 + E_t \left\{ \Omega_t (1-s) J_{t+1} \right\}. \tag{17}$$

p_t corresponds to the producer price index and P_t denotes the consumer price index (both derived later). Equation (16) corresponds to the marginal value of an additional employed worker. The job-creation condition assuming free market entry is given by

$$\frac{\kappa^v}{q_t} = J_t. \tag{18}$$

3.3 Investment funds

Investment funds collect deposits from households, $N_t a_t$, and then allocate them across a number of asset classes: physical capital, k_t, government bonds, b_t, and international assets, NFA_t, subject to the loanable funds constraint

$$N_t a_t = b_t + NFA_t + k_t. \tag{19}$$

As the investment funds are owned by the family, they discount future revenue flows at Ω_t. In order to build up capital, the fund needs to purchase investments goods I_t. Investment in physical capital is subject to the investment adjustment costs as in Christiano, Eichenbaum, and Evans (2005). The law of motion for capital is given by

$$k_t = (1-\delta) k_{t-1} + \left(1 - \frac{\psi^k}{2} \left(\frac{I_t}{I_{t-1}} - 1 \right)^2 \right) I_t \tag{20}$$

which states that today's capital stock equals yesterday's capital stock net of depreciation (at rate δ) plus new investments net of investment adjustment costs, influenced by the parameter ψ^k. This generates the well known no-arbitrage conditions

$$R_t^w = \frac{r_t^k + TQ_{t+1}(1-\delta)}{TQ_t} \tag{21}$$

and

$$1 = TQ_t \left[1 - \frac{\psi^k}{2} \left(\frac{I_t}{I_{t-1}} - 1 \right)^2 - \psi^k \left(\frac{I_{t+1}}{I_t} - 1 \right) \frac{I_t}{I_{t-1}} + \Omega_t \psi^k \left(\frac{I_t}{I_{t-1}} - 1 \right) \left(\frac{I_{t+1}}{I_t} \right)^2 \right], \tag{22}$$

where TQ_t denotes the shadow price of capital, Tobin's Q.

3.4 Matching and Wage Bargaining

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

3.4.1 Matching and Worker Flows

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

$$M_t = \kappa^e U_t^{\eta} V_t^{1-\eta}, \tag{23}$$

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

$$N_t = (1-s)N_{t-1} + M_t. \tag{24}$$

Note that, due to immediate rehiring, the number of searching workers over the period exceeds the total number of unemployed workers at the end of the period. Unemployment is, thus, given by

$$u_t = 1 - N_t = \sum_{k=1}^{K} \mu_t^{eu_k} + \mu_t^{uu}. \tag{25}$$

The number of unemployed workers in their first period of unemployment (who were not immediately rehired) is given by $\mu_t^{eu_1} = s(1-\rho_t)N_{t-1}$. The number of short-term unemployed workers in subsequent states is then determined by the those unemployed workers who did not find a job in the previous period, i.e. $\mu_t^{eu,k} = (1-\rho_t)\mu_t^{eu,k-1}$. The number of long-term unemployed workers is $\mu_t^{uu} = (1-\rho_t)[\mu_{t-1}^{uu} + \mu_{t-1}^{eu,K}]$.

3.4.2 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. This yields

$$\begin{aligned}\mathcal{W}_t^e =& \frac{u(c_{t,j}^e)}{\lambda_t^e} - \left[c_t^e + a_t + \bar{t}_t - (1-\tau_t^w)\omega_t - \beta E_t \left\{ \frac{\lambda_{t+1}^e}{\lambda_t^e}(1 - s(1-\tau^F)(1-\rho_{t+1}))\frac{R_t^W a_t}{1+\pi_{t-1}} \right\}\right] \\ &+ \beta E_t \left\{ \frac{\lambda_{t+1}^e}{\lambda_t^e}(1-s(1-\rho_{t+1}))\mathcal{W}_{t+1}^e + \frac{\lambda_{t+1}^{eu_1}}{\lambda_t^e} s(1-\rho_{t+1})\mathcal{W}_{t+1}^{eu_1} \right\}.\end{aligned} \tag{26}$$

Hence, every 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 her assets to the family. 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 $\mathcal{W}_{t+1}^e$, however, with probability $s\,(1-\rho_{t+1})$, the member has to leave the family because she becomes unemployed. From the perspective of the family, who also cares about the utility of those who may become unemployed next period (because every member could be hit), this is taken into account by $\mathcal{W}_{t+1}^{eu_1}$.

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

$$\mathcal{W}_t^{eu_k} = \frac{u(c_t^{eu_k})}{\lambda_t^{eu_k}} + \beta E_t \left\{ \frac{\lambda_{t+1}^{eu_{k+1}}}{\lambda_t^{eu_k}}(1-\rho_{t+1})\mathcal{W}_{t+1}^{eu_{k+1}} + \frac{\lambda_{t+1}^{e}}{\lambda_t^{eu_k}}\rho_{t+1}\mathcal{W}_{t+1}^{e} \right\}, \tag{27}$$

while in period K it is

$$\mathcal{W}_t^{eu_K} = \frac{u(c_t^{eu_K})}{\lambda_t^{eu_K}} + \beta E_t \left\{ \frac{\lambda_{t+1}^{uu}}{\lambda_t^{eu_K}}(1-\rho_{t+1})\mathcal{W}_{t+1}^{uu} + \frac{\lambda_{t+1}^{e}}{\lambda_t^{eu_K}}\rho_{t+1}\mathcal{W}_{t+1}^{e} \right\}. \tag{28}$$

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

$$\mathcal{W}_t^{uu} = \frac{u(c_t^{uu})}{\lambda_t^{uu}} + \beta E_t \left\{ \frac{\lambda_{t+1}^{uu}}{\lambda_t^{uu}}(1-\rho_{t+1})\mathcal{W}_{t+1}^{uu} + \frac{\lambda_{t+1}^{e}}{\lambda_t^{uu}}\rho_{t+1}\mathcal{W}_{t+1}^{e} \right\}. \tag{29}$$

3.4.3 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 $\tilde{\mathcal{W}}_t = \mathcal{W}_t^e - \mathcal{W}_t^{eu_1}$. The firm's surplus of hiring one additional worker is J_t. Therefore, the wage is derived from solving

$$\omega_t = \max_{\omega_t} [\tilde{\mathcal{W}}_t]^{\zeta} [J_t]^{1-\zeta}, \tag{30}$$

which results in the following wage sharing rule:

$$\left[1 + \psi^w \left(\frac{w_t}{w_{t-1}} - 1\right) \frac{1}{w_{t-1}} + (1-s)\Omega_t \psi^w \left(\frac{w_{t+1}}{w_t} - 1\right) \frac{w_{t+1}}{w_t^2}\right] \tilde{\mathcal{W}}_t = \frac{\zeta}{1-\zeta}(1-\tau_t^w) J_t. \tag{31}$$

3.5 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:

$$G_t + \sum_{k=1}^{K} \kappa_t^{BS_k} \mu_t^{eu_k} + \kappa_t^{BL} \mu_t^{uu} + \frac{R_{t-1}^W b_{t-1}}{1+\pi_t} = \tau_t^w \omega_t N_t + \bar{t} + b_t. \tag{32}$$

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

$$log(\tau_t^w/\bar{\tau^w}) = \rho^{\tau^w} log(\tau_{t-1}^w/\bar{\tau^w}) + \chi^b(b_t/\bar{b}), \tag{33}$$

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).

3.6 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, $ToT_t = p_{t,F}/p_{t,H}$, and the real exchange rate RER_t as the ratio of consumer prices, $RER_t = P_{t,F}/P_{t,H}$.

Asset market clearing implies that total assets in the home economy, $N_t\, a_t$, have to equal government debt plus net foreign assets and capital, $b_t + NFA_t + k_t$. Hence, the loanable funds constraint, equation (19), must hold. As world assets must be in zero net supply, it must also hold that $rs^a\, NFA_{t,H} + (1 - rs^a)\, RER_t NFA_{t,F} = 0$, where rs^a is the relative size of region a. A country's net foreign asset position is defined as last period's assets plus current net exports, NX_t,

$$P_t NFA_t = R_{t-1}^W P_{t-1} NFA_{t-1} + NX_t, \tag{34}$$

and the current account is given by $CA_t = NFA_t - NFA_{t-1}P_{t-1}/P_t$. Real per-capita net exports in a are given by $NX_t = p_{t,H}/P_{t,a} \cdot (1 - rs^a)/rs^a \cdot (c_{H,t,b} + i_{H,t,b}) - p_{t,F}/P_{t,a} \cdot (c_{F,t,a} + i_{F,t,a})$, where region-specific consumption and investment demand, $c_{j,t,j}$ and $i_{j,t,j}$, with $j \in (H, F)$ can be derived as follows. Households are assumed to consume goods produced in home and foreign goods. The corresponding consumption bundle in country $j \in (H, F)$ is given by

$$C_{t,j} = \left(\left(\gamma_j^C\right)^{1-\eta_c} c_{H,t,j}^{\eta_c} + \left(1 - \gamma_j^C\right)^{1-\eta_c} c_{F,t,j}^{\eta_c} \right)^{\frac{1}{\eta_c}} \tag{35}$$

where $c_{H,t,j}$ denotes goods produced in the Home country and consumed in region j. Analogously, $c_{F,t,j}$ denote goods produced in F and consumed in j. γ_j^C denotes the consumption bias towards goods produced in Home, with γ_H^C thus determining the home bias in the home country H. The home bias – to domestic goods in foreign – in F is given by $(1 - \gamma_F^C)$ and $\eta_c \in (-\infty, 1)$ governs the elasticity of substitution between home and foreign goods, which equals $1/(1 - \eta_c)$. As $\eta_c = 0$, the consumption basket is of the Cobb-Douglas form. Demand for home and foreign consumption goods can, therefore, be

expressed as

$$c_{H,t,j} = \gamma_j^C \left(\frac{p_{t,H}}{P_{t,j}} \right)^{-\frac{1}{1-\eta_c}} c_{t,j} \tag{36}$$

and

$$c_{F,t,j} = (1-\gamma_j^C) \left(\frac{p_{t,F}}{P_{t,j}} \right)^{-\frac{1}{1-\eta_c}} c_{t,j}. \tag{37}$$

Assuming an analogous aggregator for physical capital investment, it is straightforward to get net exports. From all this, the consumer price index (CPI) in j will be is given by

$$P_{t,j} = \left[\gamma_j^C p_{t,H}^{-\eta_c/(1-\eta_c)} + (1-\gamma_j^C) p_{j,F}^{-\eta_c/(1-\eta_c)} \right]^{-(1-\eta_c)/\eta_c}.$$

3.7 Market Clearing

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

$$Y_{t,H} = C_{t,H} + G_{t,H} + \kappa^v V_{t,H} + EXP_{t,H} - p_{t,F} IMP_{t,H} + P_{t,H}/p_{t,H} AC_{t,H}, \tag{38}$$
$$Y_{t,F} = C_{t,F} + G_{t,F} + \kappa^v V_{t,F} + EXP_{t,F} - p_{t,H} IMP_{t,F} + P_{t,F}/p_{t,F} AC_{t,F}, \tag{39}$$

where $AC_{t,i} = \frac{\psi^w}{2} \left(\frac{\omega_t}{\omega_{t-1}} - 1 \right)^2 + \frac{\psi^k}{2} \left(\frac{I_t}{I_{t-1}} - 1 \right)^2$ is the sum of wage and capital adjustment costs, both expressed in CPI-deflated real terms.

3.8 Equilibrium and existence conditions

Now we can define the equilibrium. For expositional clarity, we summarize the model definitions for one country.

Definition 1. A recursive equilibrium is a set of value and policy functions, a set of prices, and labor-market flows such that the following statements hold:

1. *Employed workers:* Given R_t^w, ω_t and τ_t^w, the value functions $V^e(S)$ and policy functions $g_a(S)$ and $g_{c^e}(S)$ solve the employed workers' problem.

2. *Short-term unemployed workers:* Given R_t^w and $\kappa_t^{BS_k}$, the value and policy functions $V^{eu_k}(a,S), g_{c^{eu_k}}(a,S)$ and $g_{\theta^{eu_k}}(a,S)$ solve the short-term unemployed workers' problem where $k \in \{1,...,K\}$. Furthermore, for the share of assets consumed in short-term unemployment, it holds that $\sum_{k=1}^K \theta_{t-K+k}^k = 1$.

3. *Long-term unemployed workers:* Given κ_t^{BL}, the value and policy functions $V^{uu}(a,S)$, $g_{c^{uu}}(a,S)$ solve the long-term unemployed workers' problem.

4. *Firm:* Given p_t, R_t^w, ω_t, the demand for capital k_t, labor input N_t and vacancies V_t is optimal (i.e. profit maximizing) from the representative firm's point of view.

5. *Law of motion for capital:* Capital evolves according to (22).

6. *Matching:* ρ_t and q_t are functions of vacancies V_t and unemployment U_t and follow (23). The job-creation condition (18) determines the vacancy-filling rate q_t. Given q_t, employment evolves according to (15).

7. *Wages:* Given $\mathcal{W}^e, \mathcal{W}^{eu_k}, J_t, \omega_t$ satisfies the Nash bargaining solution (30).

8. *Government:* Given $, \omega_t, \kappa_t^{BS_k}$, κ_t^{BL}, τ_t^w and the cross-sectional distribution of workers $\tilde{\mu}$, (32) holds and the labor tax rate follows (33).

9. *Market Clearing and International Linkages:* The market clearing conditions (38) and (39) hold and asset markets clear, hence, (19) is satisfied. In equilibrium, the world-wide value of aggregate imports equals aggregate exports and world assets are in zero net supply.

As described in the model's derivations and summarized above, this equilibrium features a distribution of households that boils down to three main categories. *i*) Workers holding a positive amount of savings to self insure against the risk of becoming unemployed, *ii*) short-term unemployed workers choosing to consume, in addition to their unemployment benefits, a fraction of the savings they have accumulated while being employed (family members), and *iii*) long-term unemployed workers not having any savings left and consuming all their income each period. Formally, the existence of the equilibrium requires that the following restrictions on the corresponding three sets of Euler conditions hold:

$$\begin{cases} i) \;\; \Omega_t^e R_t^W = 1 \\ ii) \;\; \Omega_t^{eu_k} = 1 \; \forall \; k \leq K-1 \text{ and } \Omega_t^{eu_K} < 1 \\ iii) \;\; \Omega_t^{uu} < 1 \end{cases} \tag{40}$$

In the following simulations exercises, we will always numerically check that these existence conditions are satisfied.

4 Calibration

We calibrate the model to quarterly frequency. We build on the calibration strategy of Moyen and Stähler (2014) and Christoffel, Kuester, and Linzert (2009). Table 1 shows the baseline calibration. The calibration of Home (Germany) and Foreign (Rest of Euro Area) is asymmetric. The two regions differ with respect to country size, the steady-state unemployment rate (and, thus, employment risk) and productivity. The size of the Home country, Germany, amounts to 27.1 percent (see Gadatsch et al., 2016). We set the discount factor to $\beta = 0.97$ and the risk aversion parameter to $\sigma_c = 2$. The latter is a standard value from the literature, however, given that it may influence precautionary savings, we perform a robustness analysis of that value in the appendix. The lower value for β is due to the precautionary savings model (see Challe et al., 2017, for a discussion).

Regarding the labor market, we set the elasticity of matches with respect to unemployment to 0.5, which is a standard value. Furthermore, in accordance with IAB

Table 1: Baseline Calibration

	Parameter name	Symbol	Value	
			Home	Foreign
	Country size	Θ	0.27	0.73
	Capital depreciation	δ	0.07	0.07
	Weight on capital in production	α	0.33	0.33
Preferences				
	Discount factor	β	0.97	0.97
	Risk aversion	σ_c	2	2
	Home bias	γ	0.35	0.24
	Elasticity of substitution between home and foreign goods	η^c	0.74	0.74
Bargaining and Production				
	Matching elasticity	η	0.5	0.5
	Workers' bargaining power	ζ	0.5	0.5
	Job-finding rate	ρ	0.116	0.108
	Wage adjustment costs parameter	ψ^W	61.36	61.36
	Productivity (SS)	e^z	1	1
	Investment adjustment costs parameter	ψ^K	5	5
Policy				
	Replacement rate for short-term unemployed	rrs	0.6	0.6
	Replacement rate for long-term unemployed	rrl	0.5	0.5
	Autocorrelation tax rate	ρ^τ	0.99	0.99
	Lump-sum Tax rate (SS)	$\bar{\tau}$	0	0
	Elasticity of tax rate response to debt deviations	χ^b	0.05	0.05
	Share of wealth kept by family head	τ^F	0.71	0.71

Table 2: Targets

Target	Symbol	Value	
		Home	Foreign
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
Import share	im	0.30	n.a.
Unemployment rate	u	0.089	0.096
Job-filling rate	q	0.7	0.7
Firms' Profits	Π	0	0

administrative data, we set the quarterly job-finding rate to 12 percent. This value corresponds to the average job-finding rate in Germany in 2004 (prior to the Hartz IV reform). Furthermore, as we target a slightly higher unemployment rate for the rest of the Euro Area, we correspondingly set a lower job-finding rate for Foreign.[11] Targeting a job-filling rate of 0.7 as in Christoffel et al. (2009) then pins down the matching efficiency, vacancy posting costs and the separation rate. The bargaining power of workers is also set to the standard value of 0.5, but we also perform a robustness analysis here in the appendix. We assume wage adjustment costs to be 61.36 (see Born and Pfeifer, 2019). Investment adjustment costs are set to five in both regions along the lines of Gadatsch, Hauzenberger, and Stähler (2016). In the appendix, we discuss the role of both types of adjustment costs. As expected, the transition is prolonged by the inclusion of adjustment costs, but the qualitative responses are the same, which especially holds for international developments.

For the policy parameters, we set the replacement rate for short-term unemployed to 0.6 and the initial replacement rate for long-term unemployed to 0.5. This corresponds to the legal value for recipients with children (hence, the upper bound). Furthermore, the autocorrelation of the labor tax rate amounts to 0.99. Setting its response to deviations in government debt from target (60% of GDP) to $\chi^b = 0.05$ ensures stationarity in government debt (see Kirsanova and Wren-Lewis, 2012). Performing an analogous simulation in which the lump-sum tax $\bar{t}$ takes care of debt stabilization does not alter our results much. The reason is that all households, also the unemployed workers, will be affected by that tax. The share of wealth kept by the family head is set to $\tau^F = 0.71$ to comply with the existence condition as discussed above.

Table 2 shows the targets in our calibration. In the initial steady state, inflation is assumed to be zero. We normalize $p_{t,H} = 1$ for all t and target $\bar{p}_F = 1$ in the initial steady state. By construction, this implies the real exchange rate as well as the terms of trade to be equal to one in the initial steady state, too. The current account is defined as $CA_t = NFA_t - NFA_{t-1}/(1+\pi_t)$ and is, therefore, zero in steady state. By targeting an import share of 30% in Germany, and given relative prices equal to one, we can derive the import share of the Rest of the Euro Area and the corresponding home bias parameters endogenously (remember that, by the model setup, Germany home bias is given by γ, while it is $(1-\gamma^*)$ in the Rest of the Euro Area). The steady-state targets for the unemployment rates are 8.9 percent in the Home country (Germany) and 9.6 percent in the Rest of the Euro Area. These numbers refer to the harmonized unemployment rates from 1995 to 2004 (quarterly averages, Data source: OECD, Main Economic Indicators, 2017). Given these targets, we then derive the resulting interest rate and asset shares consumed by an unemployed worker in states $k \in K$ endogenously.

As stated above, we vary the parameter of risk aversion and the worker's bargaining power for a robustness check. The corresponding model responses in appendix D illustrate that our results remain qualitatively robust to such variations.

[11] To be more precise, we assume the same inverse ratio u^F/u^H which results in ρ^F=0.108.

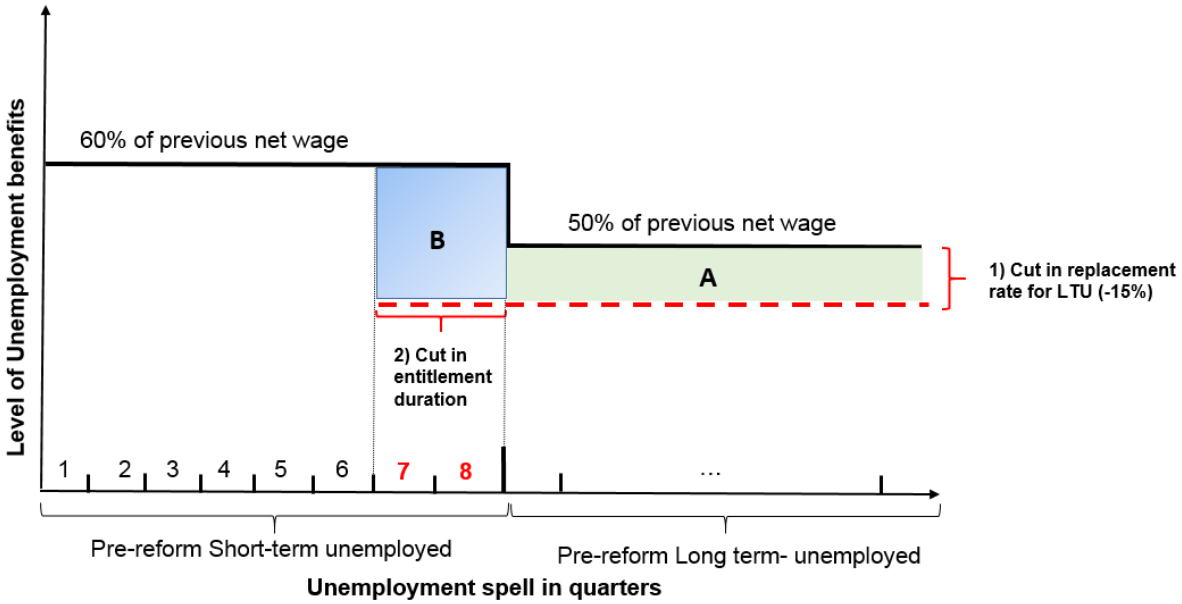

Figure 2: Reform implementation (schematic plot).

5 The Effects of the Hartz IV-Reform

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

5.1 Reform implementation

As discussed in detail in appendix A, the Hartz IV-reform was undertaken in two steps. First, in 2005, the replacement rate for long-term unemployment benefits was reduced, fixed, and hence independent of prior earnings. One year later, from 2006 onward, the entitlement duration for receiving short-term unemployment benefits was reduced. On average, the entitlement duration was roughly cut by half a year, more for elderly workers and less for younger workers.[12] Figure 2 schematically plots how we incorporate these changes in our model.

In our model simulation, we replicate the first reform step (cut in replacement rate for long-term unemployed workers, LTU) by reducing the replacement rate rrl by 15 percent and setting $\kappa_t^{BL} = \bar{\kappa}^{BL} = rrl^{new}(1-\bar{\tau}^w)\bar{w}$.[13] The second reform step (cut in entitlement duration) is implemented by assuming that $\kappa_t^{BS} = \bar{\kappa}^{BL}$ for unemployed workers in states

[12] The entitlement cut actually varied by age group and was strongest for elderly workers. For them, the entitlement duration was reduced from a maximum of 32 months to a maximum of 18 months.

[13] 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 workers by 20 percent. Krause and Uhlig (2012) even assume a reduction of 67 percent for high-skilled workers and around 24 percent for low skilled workers. We hence impose a conservative reduction of the replacement rate in between plausible estimates which is closest to the approach of Hochmuth et al. (2019).

μ^{eu_k} with $k \in [7, 8]$. These workers were eligible for short-term unemployment benefits in the pre-reform scenario, but this duration is now cut by two quarters in the post-reform scenario.[14] For an analogous simulation design, see also Gadatsch et al. (2016).

Furthermore, we assume that, when simulating the full reform starting in 2005, households already anticipated the cut in entitlement duration scheduled for 2006. This implies that, at the time of the reduction in replacement rate for long-term unemployed workers, households know about the upcoming cut in entitlement duration already. We also assume that, at the time of the initial policy change in 2005, the economy is in its initial steady state and that there are no future shocks in the economy after the policy change.

In appendix C.1, we also provide an alternative simulation assuming that the reform was already anticipated at the beginning of 2004, as the Hartz IV-reform was decided upon in December 2003. As we can see, the medium to long-run effects are quantitatively very similar, even though our model does predict some anticipatory effects.

5.2 Results

In the following, we will split our results description into several parts. First, we will focus on the domestic (labor market) effects in Germany and, then, turn to the spillovers to the Rest of the Euro Area. Furthermore, we will differentiate between describing the effects of the full reform agenda and describing the effects of the reduction in long-term benefits. For ease of exposition, we will describe the effects of the full reform package first and, then, turn to the effects of the reduction in the replacement rate only. As we will see, there are some interesting and potentially surprising differences in the transmission.

5.2.1 Effects in Germany

Figures 3 and 4 illustrate the transition after the Hartz IV-reform in Germany. The reduction in the replacement rate for long-term unemployed workers only (labeled "only cut in rr") is depicted with blue shaded areas, the entire reform by the black solid line. Table 3 provides an overview of the long-run effects of both components of the Hartz IV-reform in Germany and in the Rest of the Euro Area. The effects are presented in percent deviations (percentage points if indicated) from the initial steady state at the beginning of 2005 (prior to the reduction in the replacement rate). As we can see in the appendix, where the full transition path is plotted, transition takes quite a while.

As expected, the reduction in the generosity of the unemployment benefit scheme leads to a decrease in wages because the workers' bargaining position worsens resulting from the reduced fall-back utility. Lower wages increase the marginal value of a worker to firms. As a result, they post more vacancies. This augments the job-finding rate and reduces the aggregate unemployment rate. The drop in unemployment differs by duration of unemployment (see lower middle panel of Figure 3). It is highest for long-term unemployed workers. The reason is obvious: Given a higher job finding rate, the probability to actually enter the pool of long-term unemployment declines. On aggregate,

[14] Note that we do not reduce the number of periods K in which unemployed workers have to consume their savings. This implies that, in the post-reform scenario, some workers who receive long-term unemployment benefits may still have assets left.

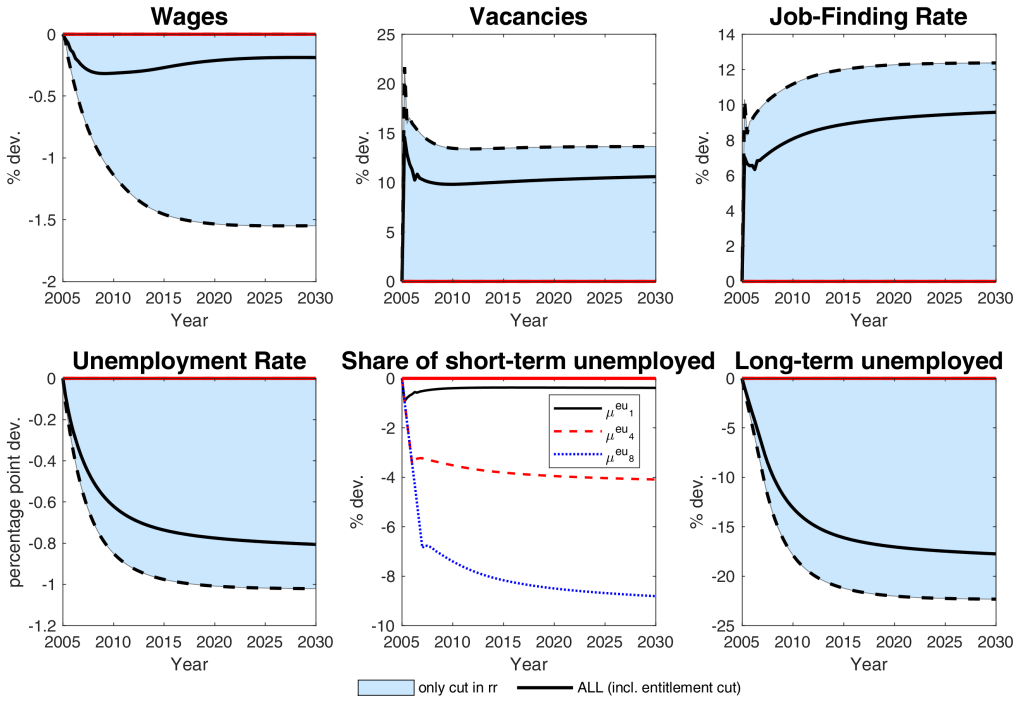

Figure 3: Effects of the Hartz IV-reform package on labor market outcomes.

unemployment falls by around 0.8 percentage points in the medium and by around 1 percentage point (9.4 percent) in the long run (see appendix C.3 and Table 3).

From an ex-ante perspective, it is not clear what this implies for savings. On the one hand, the positive labor market effects reduce the incentive to save for precautionary reasons because the expected duration of staying unemployed (for long) falls. On the other hand, the expected income loss when becoming unemployed is higher, which augments the need for precautionary savings.

Turning to the aggregate effects illustrated in Figure 4, we can see that the latter effect dominates for the full reform agenda (it does not for the pure reduction in long-term benefits, which we describe at the end of this subsection in more detail). As a result, Germans increase savings. Because the necessary assets are not fully provided domestically (being restricted by domestic government bonds and domestic capital), agents also buy international bonds. Thus, the current account increases. A reduced wage income and the higher savings effort makes households consume less for a while. This also reduces imports from the Rest of the Euro Area, which fosters higher net exports. In the medium to the long run, however, domestic consumption recovers (once sufficient savings have been built up) and consumption in the Rest of the Euro Area declines (see Figure 7 and the description below). This leads to a fall in net exports eventually.

The German savings glut increases world asset supply. Hence, the world interest rate falls and, in contrast to a conventional representative agent model, only reaches a level below its initial steady state in the new long-run equilibrium (see Table 3). A lower interest rate makes capital investment more attractive. As a result, capital and the capital-to-labor ratio (which we call capital intensity henceforth) increases in both

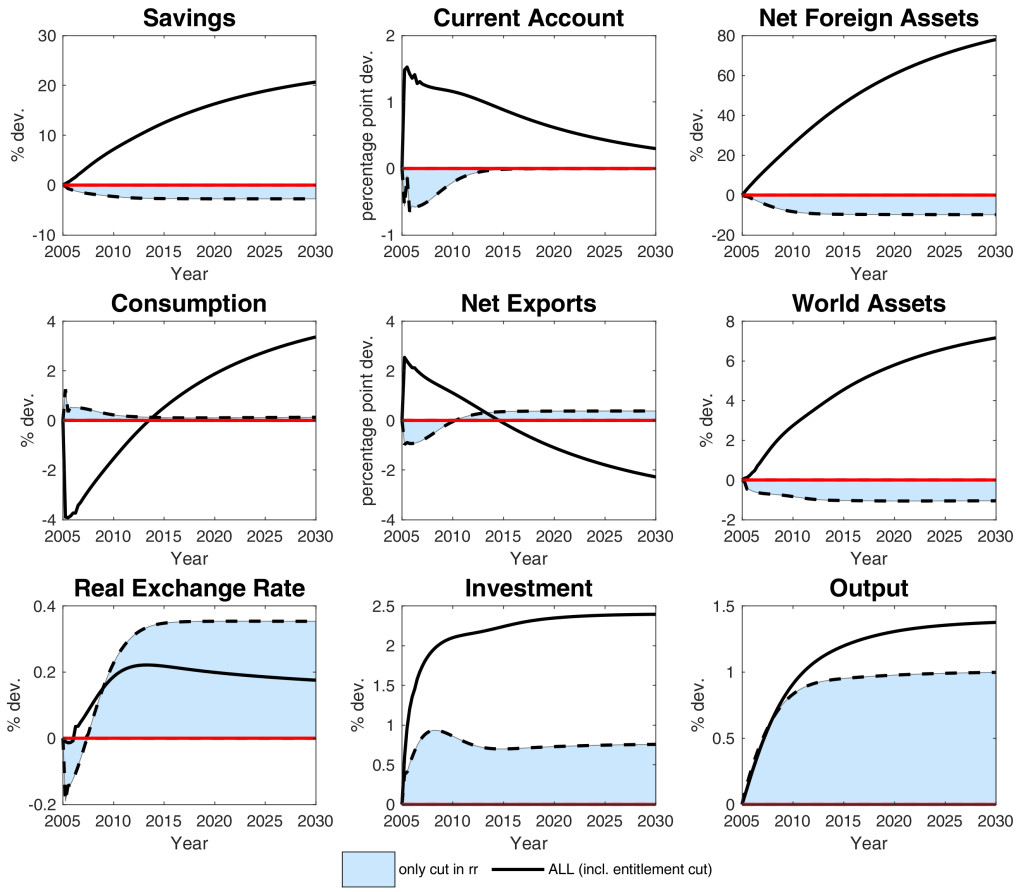

Figure 4: Aggregate effects of the Hartz IV-reform package.

regions, see Figure 5.[15] Higher capital in production augments the marginal product of labor and dampens the wage reduction in Germany. In the Rest of the Euro Area, it fosters the wage increase (see Figure 7). Lower wages in Germany and higher wages in the Rest of the Euro Area improve German international competitiveness and the real exchange rate rises. Overall, the rise in investment in combination with the increase in employment leads to a boost in aggregate output.

If we compare the labor market effects of the entire reform package to those when only reducing the replacement rate for long-term unemployed workers (Figure 3 and Table 3), we note that the effects when only cutting the replacement rate are larger than those for the full reform package. Even though this does not translate to the other macroeconomic aggregates (see Figure 4), it may seem surprising that the full reform package, which actually decreases the generosity of the unemployment insurance system significantly more, generates smaller labor market effects. It can be explained by the precautionary savings motive in our model.

[15] Remember that, in the end, the world interest rate determines the capital-to-labor ratio in both regions, see equations (16) and (21). The differences in the capital stock in Figure 5 can, thus, be explained by differences in employment levels.

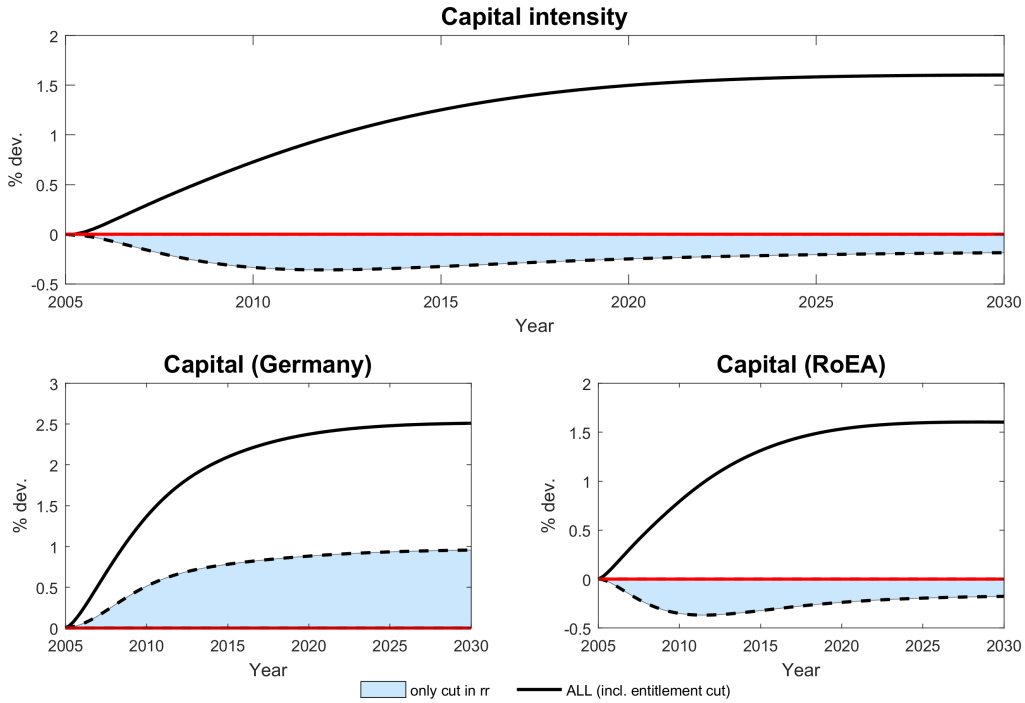

Figure 5: Effects of the Hartz IV-reform package on capital.

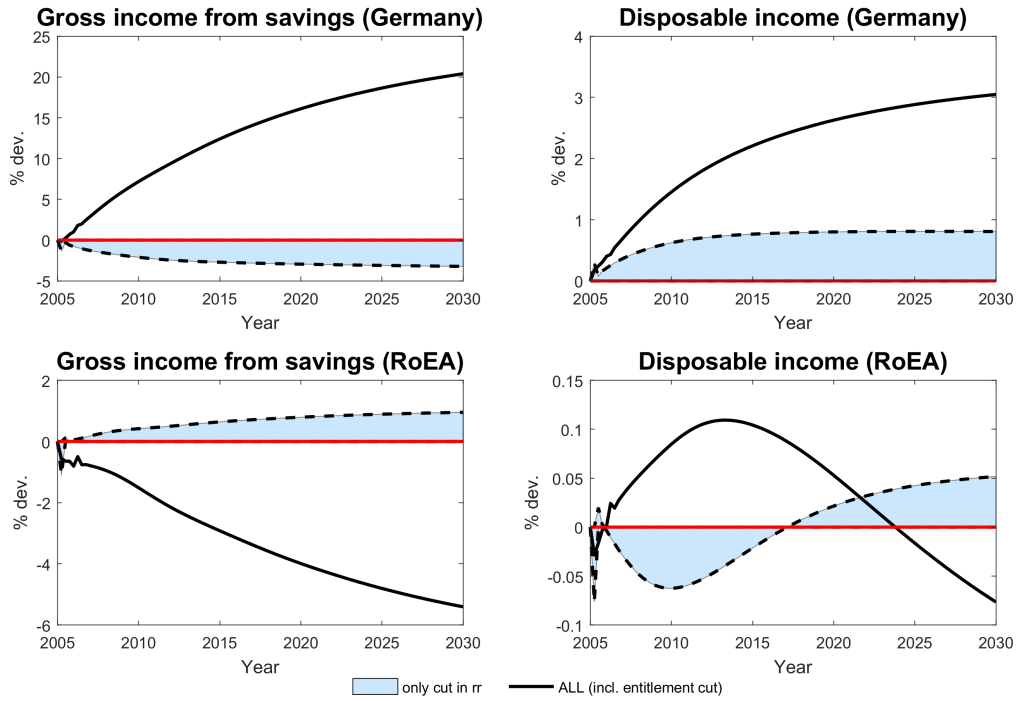

Figure 6: Effects of the Hartz IV-reform package on savings and disposable income.

When inspecting Figure 4, we see that the cut in long-term unemployment benefits implies that Germans actually reduce savings. The reason is that the increase in the job-finding rate reduces the likelihood of falling into long-term unemployment. In contrast to the full reform package, income from interest payments on savings in Germany now falls (see Figure 6). This is also true for holdings of net foreign assets and the current account (Figure 4). Furthermore, lower savings in Germany do not lead to a fall in the world interest rate but rather to the opposite: it increases slightly. This augments the costs of using capital in production. The incentive for firms to hire relatively more workers instead of producing with capital rises and capital intensity falls (see Figure 5). A smaller increase in capital in production reduces the marginal productivity of labor, in relative terms, and wages fall more quickly, compensating for the wage-increasing effect of higher re-employment chances (see Figure 3). The increase in disposable domestic income, defined as output plus interest payments from international asset holdings, is significantly smaller than after the full reform (Figure 6). In addition to the stronger fall in wages, this is a result of the fact that saving, and, in particular, net foreign assets actually fall (Figure 4). Consumption still increases slightly on impact (because there is no need to build up more precautionary savings) before moving back to a level mildly above the pre-reform steady state (see Figure 4 and Table 1).

5.2.2 Spillover-effects to the Rest of the Euro Area

In public discussions on the Hartz reforms, Germany has been repeatedly criticized because these reforms are claimed to have fostered an increase in German international competitiveness that constitutes a beggar-thy-neighbor effect. As discussed above, this is generally not confirmed by the literature. Existing studies (for example Gadatsch et al., 2016, Busl and Seymen, 2013 and, Vogel, 2012) find that lower wages generate lower producer prices and increase German international competitiveness. This makes it more difficult for foreign firms to sell their products. However, in the long-run, this competitiveness effect is outweighed by positive demand effects in Germany. Therefore, existing literature tends to find positive demand spillovers to the Rest of the Euro Area.

Our model simulations provide a more elaborate answer to that question. We also find positive demand spillovers when focussing on output (see Figure 7). However, households in the Rest of the Euro Area actually lose disposable income in the long run after the full reform (see Figure 6). This is a result of three factors. First, households in the Rest of the Euro Area reduce savings. As a result, income from interest payments on savings falls. Second, even though wages increase, also due to the fact that capital intensity has increased (see Figure 5 and the above discussion), the reduction in the relative price between capital and labor generates unemployment. Production tilts more towards producing with capital. This reduces labor income. And, third, part of the increase in domestic output of the Rest of the Euro Area has to be transferred to Germany in form of interest payments on their net foreign assets. All this reduces consumption in the Rest of the Euro Area, as can be seen in see Figure 7.[16] Interestingly, when implementing the cut in the replacement rate only, the negative spillovers to the Rest of the Euro Area persist.

[16] To compensate for the consumption loss, the family head reduces savings (which increases consumption for about the first almost 5 years after the reform). While this is mitigated by higher unemployment risk eventually, it is not strong enough to offset the savings reduction.

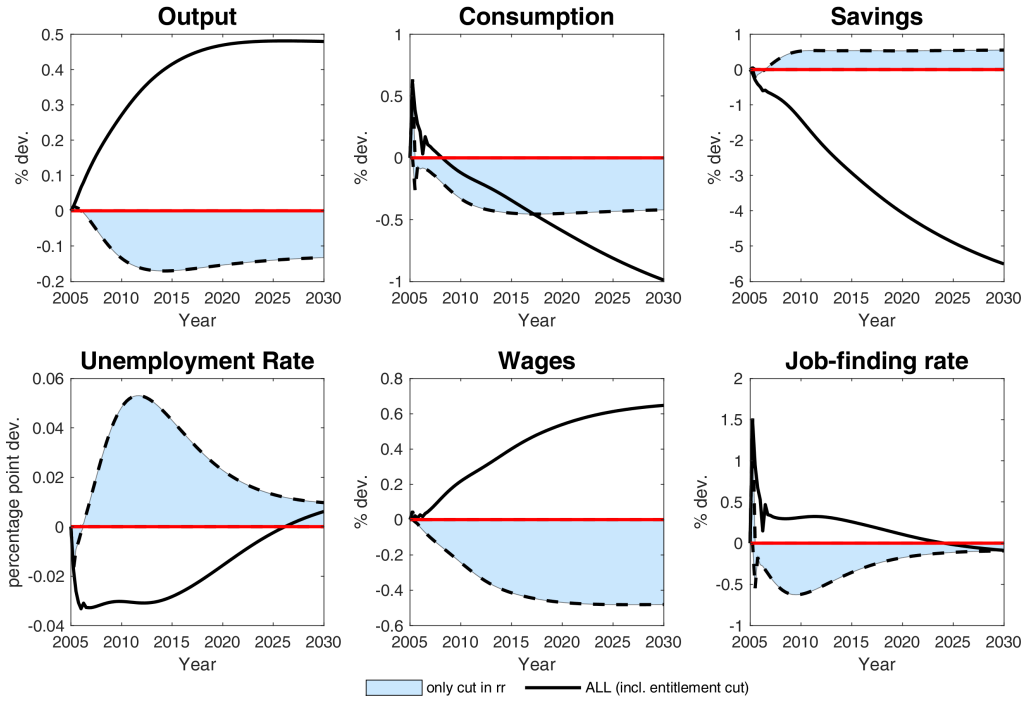

Figure 7: Effects of the Hartz IV-reform package on the Rest of the Euro Area.

The reason lies in the higher interest rate caused by the decrease in German savings. A higher world interest rate and the "disproportionate" wage reductions in Germany reduce aggregate output in the Rest of the Euro Area due to relatively high German international competitiveness (see Figures 4 and 7).

Overall, our model predicts that aggregate consumption in the Rest of the Euro Area is negatively affected by the Hartz IV-reform in both reform scenarios. As discussed above, this stands in contrast to the predictions of small, positive consumption spillovers in a standard representative agent model.

5.3 Contribution of Hartz IV to Germany's Current Account Surplus

Figure 8 depicts the share of Germany's current account relative to GDP that can be explained by the labor market reform. It shows the quarterly current account effects generated by our model simulations as the share of the actual quarterly current account developments in the data for the years 2005 to 2016 (the data is retrieved from Eurostat; we seasonally adjusted the quarterly data using X12-Arima). Over the entire time span since the reform, the German Hartz IV-reform has contributed by around 10 to 35 percent of the current account developments.[17] The German current account relative to GDP was 4.8 percent in the first quarter of 2005 and climbed to around 8 percent by the end of 2016.

[17] Note that the inclusion of adjustment costs does not drive our results, which is especially true for the current account. In appendix C, we compare the model responses with and without adjustment costs.

Germany	Variable	% deviations from initial steady state All	Cut in rrl
Aggregates	Output	1.41	1.00
	Consumption	4.69	0.13
	Savings	24.65	-2.77
Labor market	Wages	-0.22	-1.55
	Vacancies	10.94	13.64
	Job-finding Rate	9.93	12.38
	Unemployment Rate	-9.40	-11.48
	Share of unemployed in period 1	-0.40	-0.52
	Share of unemployed in period 2	-4.24	-5.29
	Share of unemployed in period 3	-9.14	-11.30
	Share of long-term unemployed	-18.42	-22.35
Consumption	C. of employed	4.33	-0.23
	C. of unemployed in period 1	8.04	0.78
	C. of unemployed in period 2	5.94	-1.67
	C. of unemployed in period 3	3.19	-4.83
	C. of long-term unemployed	-15.00	-15.00
Rest of the Euro Area	Output	0.47	-0.13
	Consumption	-1.42	-0.41
	Savings	-6.93	0.57
	Unemployment Rate	0.15	0.10
	Wages	0.68	-0.47

Table 3: Long-run effects of Hartz IV: Total and only cut in replacement rate for long-term unemployed (rrl).

On average, 0.58 percentage points (or roughly 18%) of this increase by 3.2 percentage points can be attributed to the Hartz IV-reform according to our model simulations. The Hartz IV-reform may still explain a (decreasing) share of around 10 percent each quarter today, as shown by the 2016 value of Figure 8.

6 Comparison to the Representative Agent Framework

In the previous sections, we showed that including a precautionary savings motive into an otherwise standard two-region RBC model causes the net foreign asset position to increase permanently if unemployment benefits are reduced. But how important is this precautionary savings motive? To answer this question, we also simulate a representative agent version of our model, skipping the assumption that unemployed workers have to leave the family. In this setting, workers are again perfectly insured against the idiosyncratic risk of becoming unemployment because they all consume the same, independent of their employment status (as in Andolfatto, 1996 and Merz, 1995). Again, simulations are done in a non-linear fashion under perfect foresight.

However, as discussed in the introduction, we need to impose an exogenous level of net foreign assets to solve for the steady-state indeterminacy. Following the literature, we assume that it is zero in the initial steady state (see, for example, Gadatsch et al., 2016). To ensure stationarity of net foreign assets, we follow the proposition of Schmitt-Grohe

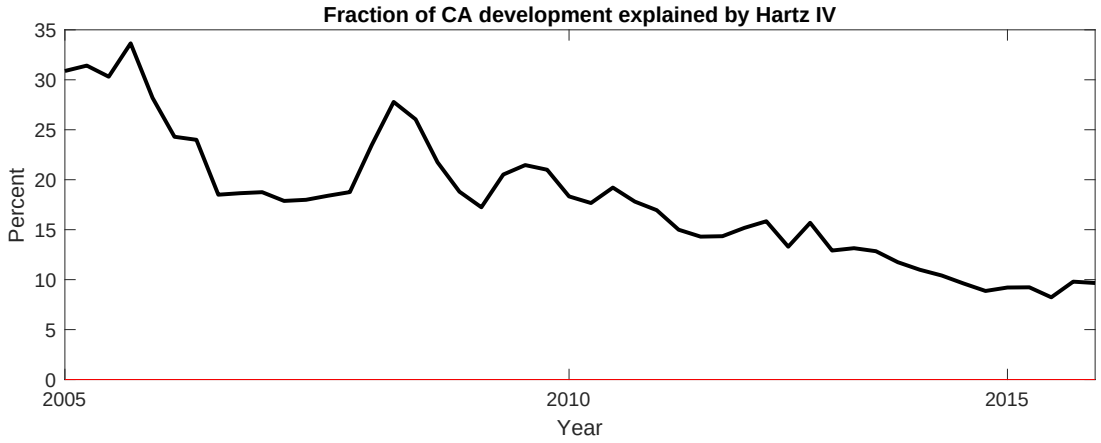

Figure 8: Contribution of Hartz IV to CA surplus

and Uribe (2003) and assume a risk premium on international bonds that increases with the country's net foreign asset position. More precisely, the interest rate paid or received by investors is now given by $R_t^w e^{-\psi(NFA_t - \bar{NFA})}$, where ϕ is set to 0.01 (see also Gadatsch et al., 2016).[18]

The differences between these modeling assumptions become clear in Figure 9. By construction, the incentive to hold precautionary savings is zero in the representative agent framework. Savings even decrease slightly in response to the reform. That is because the labor market reform generates expansionary effects due to the rise in employment caused by lower wages. The decline in savings leads to a small and short-lived fall in the current account balance and the net foreign asset position. 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. The representative agent framework also predicts (very small but) positive consumption spillovers to the rest of the Euro Area. This results from higher income in Germany in the long run and the resulting demand spillovers. In our precautionary savings model, these spillovers are negative as discussed previously.

7 Concluding Remarks

In this paper, we have build a two-region RBC model with labor market frictions and incomplete insurance to study the effects of labor market reforms on global imbalances. We have shown that, by the introduction of a first-order precautionary savings motive and limited cross-sectional heterogeneity, we can circumvent the problem of steady-state

[18] Given that, in the representative agent-version of our model, there is no individual consumption risk due to unemployment as in Andolfatto (1996) and Merz (1995), the Euler condition boils down to the conventional one: $\lambda_t = \beta\lambda_{t+1} \cdot R_t^w e^{-\psi(NFA_t - \bar{NFA})}$. As discussed by Schmitt-Grohe and Uribe (2003) and in the introduction, we have to assume frictions in international capital markets, which we introduce by assuming a risk premium on international bond holdings. Furthermore, also note that the marginal value of employment now boils down to the conventional one. All equations related to the limited cross-sectional heterogeneity drop out in the representative agent-version of the model, while the rest remains unchanged.

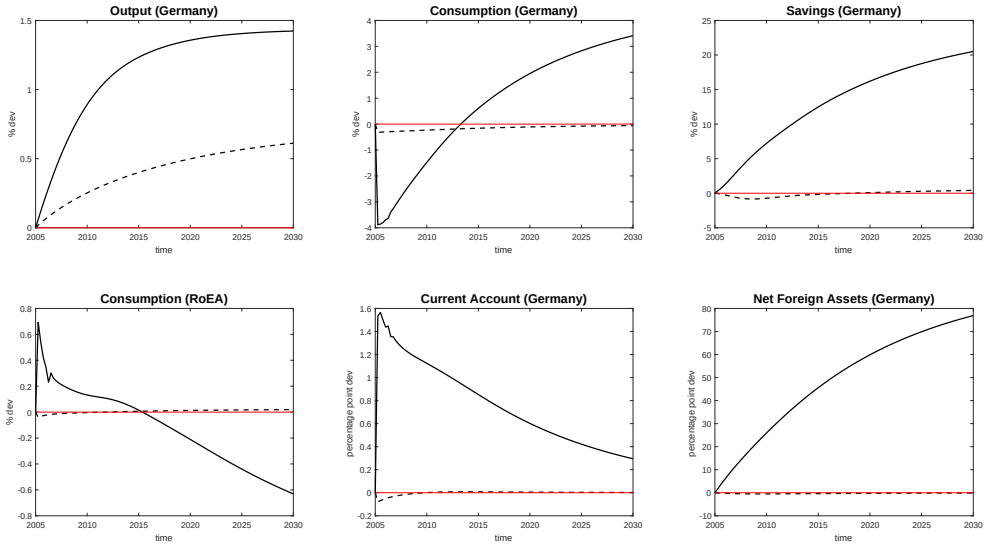

Figure 9: Comparison to the representative agent framework

indeterminacy and non-stationarity of net foreign assets present in traditional macro models. In our model, changes to the conventional RBC setup are not large and the model is still tractable.

Applying our model to simulate the far-reaching unemployment benefits reform in Germany (Hartz IV), we find that the reduction in the generosity of the unemployment insurance scheme indeed increases precautionary savings significantly. Because not all of these additional savings can be invested domestically, the net foreign asset position and the current account increase, much more than what a representative agent model would generate. Because of these international capital flows and capital adjustments in production, our model simulations also identify a small negative spillover of the Hartz IV-reform to the Rest of the Euro Area, at least in terms of private consumption spending. The standard representative agent model would predict a positive spillover due to demand effects. Because of the long transition from the pre-reform steady state to the final one, we also find positive demand spillovers in our model over the short to medium turn. These fade out over time, however.

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A Background

This section briefly outlines the background of 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.

A.1 The German Current Account and Net Foreign Asset Position

The current account is 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 10 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). Even though Germany had current account surpluses prior to the German Reunification of around 4 percent of GDP (see Figure 11), in the time between 1991 and 2000, 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 comment in The Guardian, 2017, and The Economist, 2017b).[19]

A.2 The Hartz Reforms

Germany's bad economic performance around the 2000s motivated a comprehensive reform package. The centerpiece of the reform agenda was a set of extensive labor market reforms, commonly known as the "Hartz reforms" (for a detailed description of the Hartz reforms, see Jacobi and Kluve, 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 reorganization 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,

[19] 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.

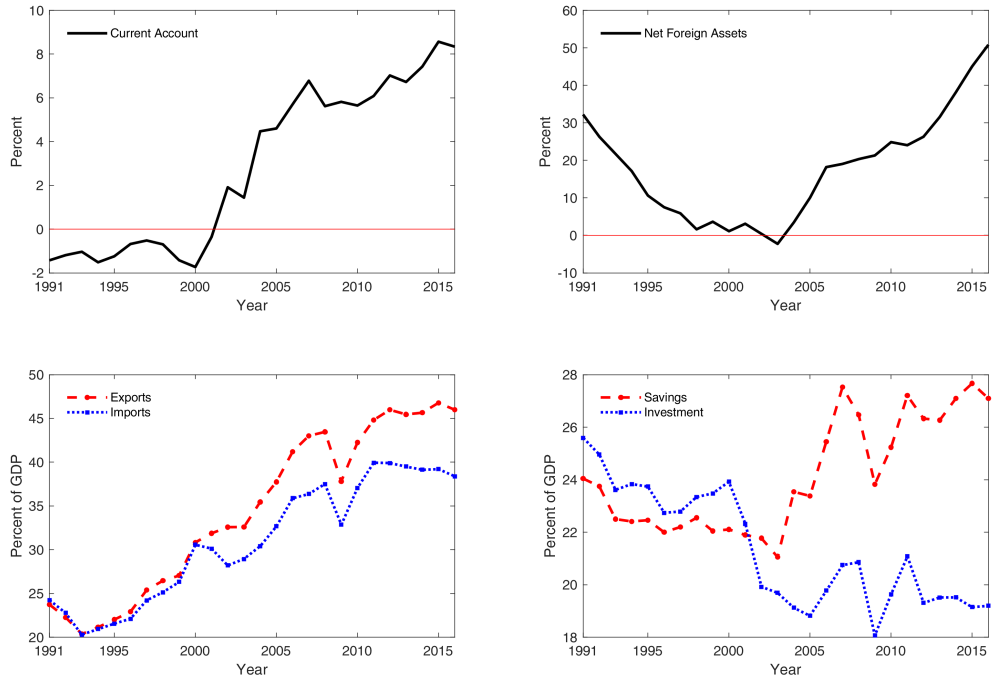

Figure 10: The German Current Account, Savings and Investment, Exports and Imports

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

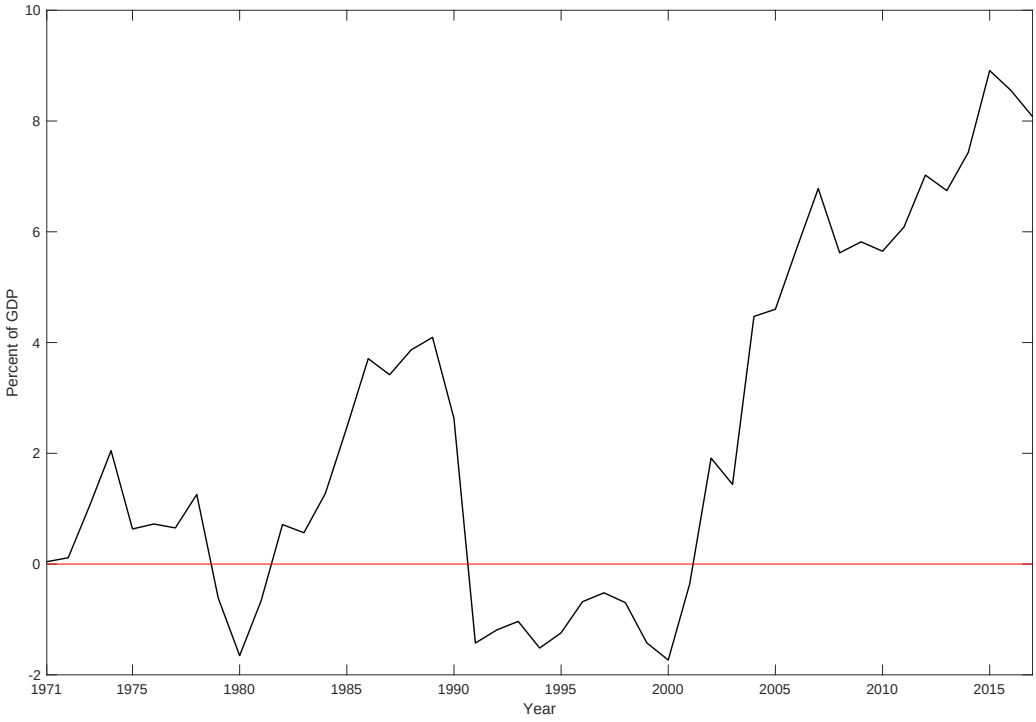

Figure 11: The German Current Account, 1971-2016

Note: Data Sources: The World Bank, World development indicators.

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 maximum entitlement duration of short-term unemployment benefit receipt was reduced. The severity of the entitlement cut differed by age. Prior to the reform, the maximum duration was 12 months for workers younger than 45 years and ranged up to 32 months for workers who were older than 56 years. In 2006, when the reform came into action the maximum duration entitlement of unemployment benefit receipt was 12 months for workers below the age of 55 and 18 months for older workers (see Riphahn and Schrader, ming for details). In 2008, the maximum duration for older workers was softened again to a maximum entitlement duration of 24 months. For many, these reforms were an important driver of the increase in German competitiveness and its current account surplus.

B Micro-evidence on Wealth by Employment Status

We use data of the IAB Panel Study Labour Market and Social Security (PASS)[20] to answer the following questions: How much wealth do recently unemployed people have at the beginning of their unemployment spell? How does the level of wealth evolve during unemployment? For this purpose, we use the survey question on the amount of savings of a household.[21] Savings refer to wealth in the form of savings accounts, shares or life insurance, while housing is explicitly excluded. The descriptive statistics of household wealth by the employment status of the interviewed person (usually the main earner) are illustrated in Figure 12. A median employed household owns between 1.000 and 9.999 euros of wealth, while a household with a short-term unemployed household head owns less than 1.000 euros. A median household with a long-term unemployed household head (receiving the less generous unemployment benefits, ALG II) have on average no wealth at all. Hence, households with an unemployed main earner have significantly less wealth compared to an average employed household. A closer look at the distribution of wealth by the duration of short-term unemployment (see Figure 13) reveals further insights: First, at the beginning of an unemployment spell, the wealth level is higher and decreases (almost) continuously over the short-term unemployment spell. Note that these descriptives are restricted to workers below the age of 50 who are eligible for at most twelve months of short-term unemployment benefits (older workers may receive ALG I for up to 24 months). However, there is a discontinuity (from the 6th to the 10th month) which is due to a composition effect of workers: In order to be eligible for the entire 12 months of ALG I, one must have had a job subject to social security contributions for at least 24 continuous months, otherwise the eligibility is reduced. Therefore, a fraction of workers can fall into the pool of long-term unemployed after six months already. Figure 13 shows that a worker at the beginning of the unemployment spell has more wealth than a worker after receiving 12 months of short-term unemployment benefits. Note that this picture is purely descriptive and we do not control for worker characteristics, therefore part of the picture is driven by composition effects: richer workers (who are most likely better educated) find a job quicker and return to the pool of employed workers. In addition, the IAB PASS survey contains a question of whether the household has lived off its savings during the main earner's unemployment spell (prior to receiving long-term unemployment benefits). This question was answered affirmatively by 10.21 percent of ALG II recipients.

[20] The IAB PASS survey was first carried out in 2007 and consists currently of ten waves. Each wave consists of approximately 10,000 households. Its focus lies on the circumstances and characteristics of recipients of Unemployment Benefit II (ALG II). For a detailed description of the IAB PASS survey, see Trappmann, Beste, Bethmann, and Müller (2013). Data access was provided via a Scientific Use File (project no.: 101900) supplied by the Research Data Centre (FDZ) of the German Federal Employment Agency (BA) at the Institute for Employment Research (IAB).

[21] The answers can be one of the following categories: no wealth, less than 1.000 euros, 1.000-2.499 euros, 2.500- 4.999 euros, 5.000-9.999 euros, 10.000-19.999 euros, 20.000-49.999 euros, and more than 50.000 euros.

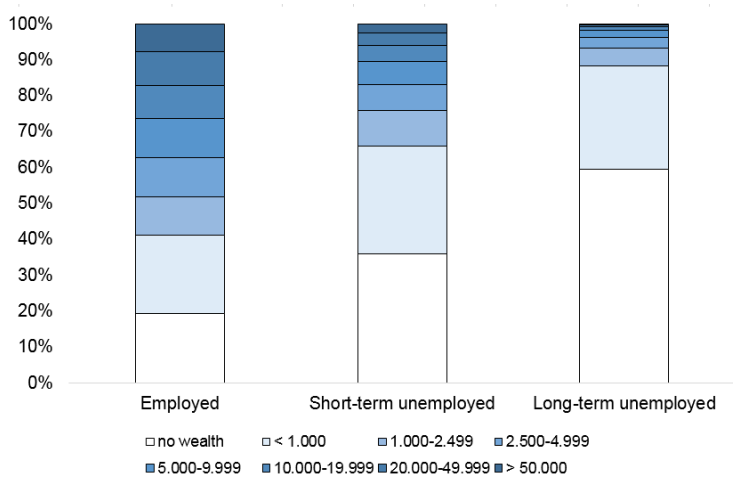

Figure 12: Wealth by Employment Status

Source: IAB PASS survey, own illustration.

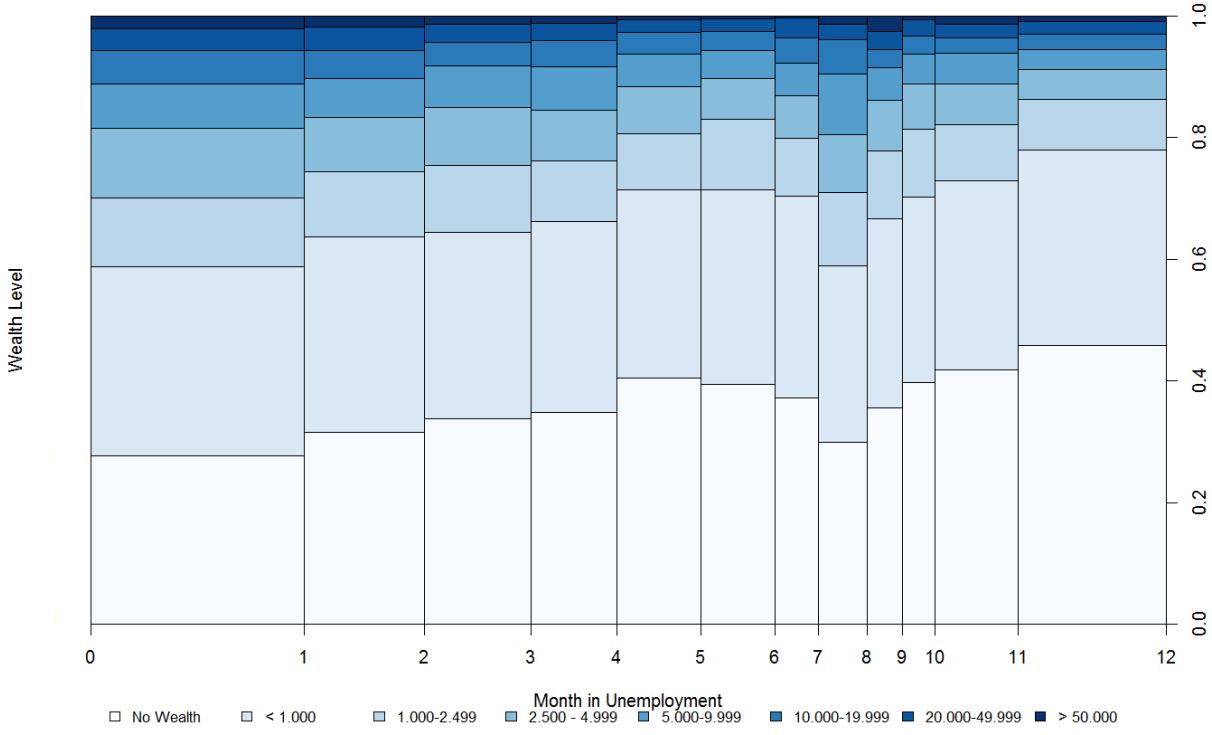

Figure 13: Wealth by Duration of Unemployment

Source: IAB PASS survey, own illustration
Note: Bar width shows the number of unemployed in the corresponding month of unemployment.

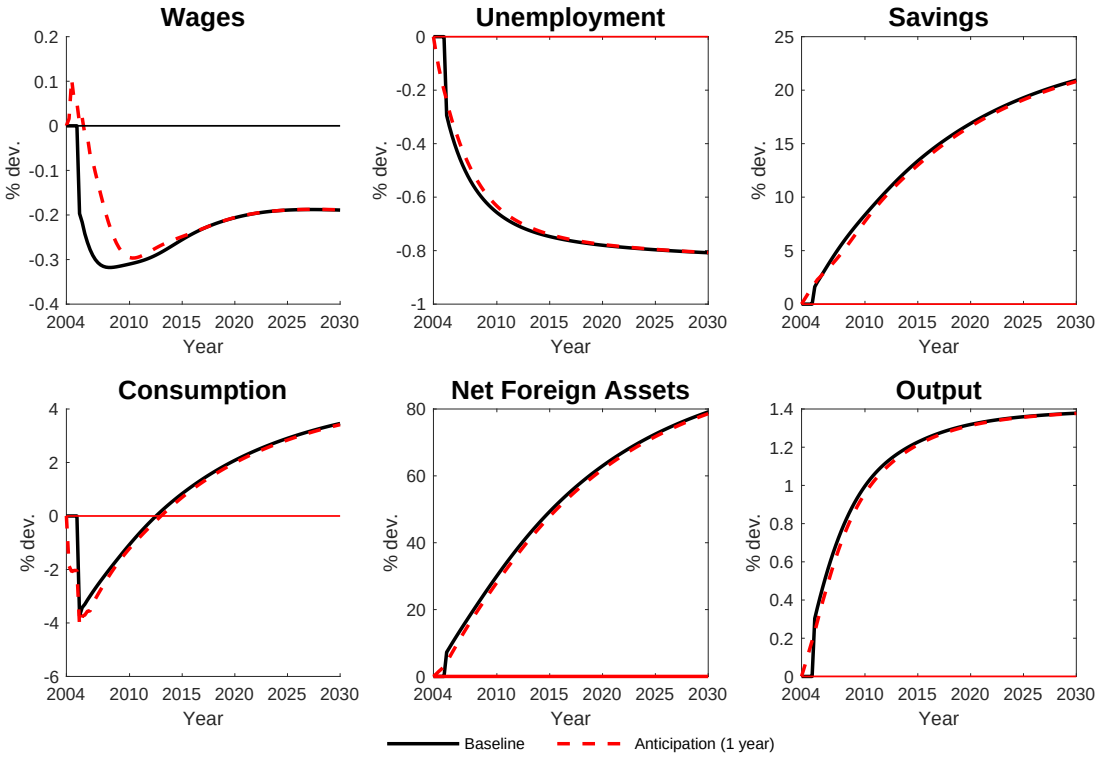

Figure 14: Allowing for anticipatory effects of both reform step one year in advance.

C Further results

In this section, we discuss the role of anticipation effects, the role of wage and investment adjustment costs and show the transition path for the long run.

C.1 Anticipatory Effects

As we can see in Figure 14, assuming that the Hartz IV-reform was already anticipated one year prior to its implementation indeed generates some frontloading of the effects. For example, unemployment already starts to fall in 2004, and so does consumption. Output, investment and net foreign assets start to increase. However, the differences are minor and there are no significant qualitative changes.

C.2 The Role of Adjustment Costs

Figure 15 compares the model's responses without adjustment costs in wages and capital (dashed line) to our baseline model (solid line). Unsurprisingly, the inclusion of adjustment costs leads to a dampened effect on wages and hence unemployment in the short and medium run. In the medium to long run, however, the drop in unemployment in Germany is of similar size (actually, in the very long run, i.e. the steady state, they are the same). With respect to savings and the building up of the current account, the model responses hardly differ. Therefore, our results on the contribution of the German labor market reform on the current account are quantitatively robust.

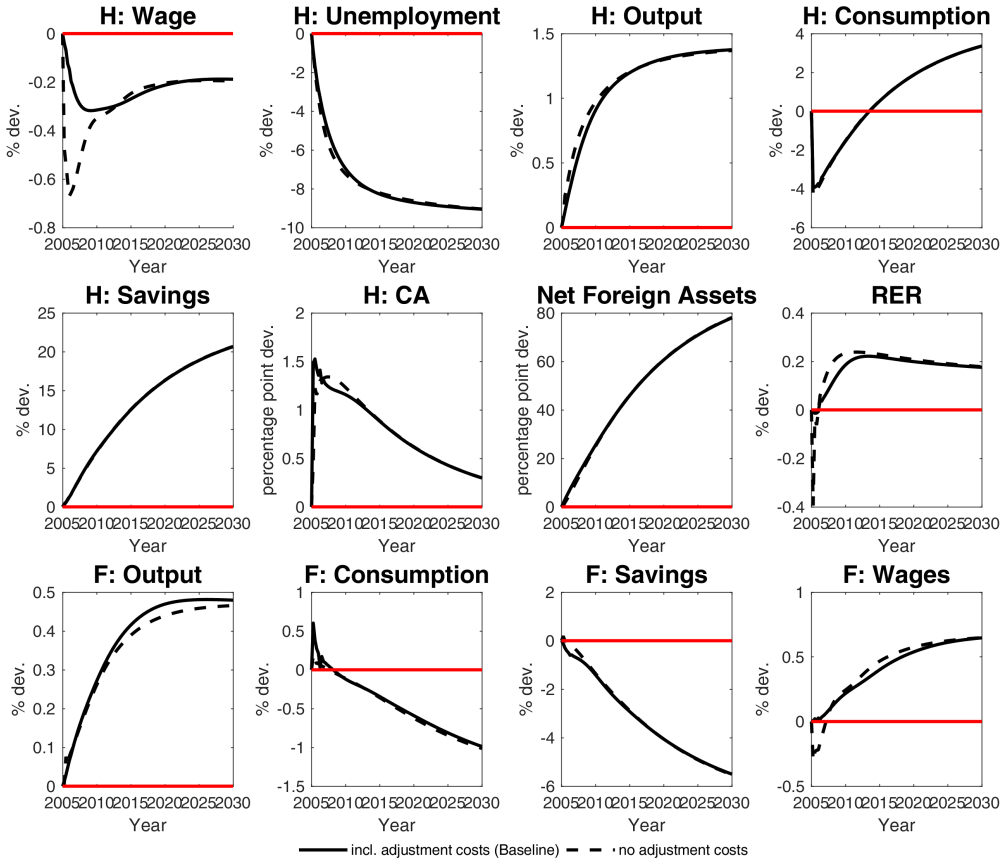

Figure 15: The effect of adjustment costs

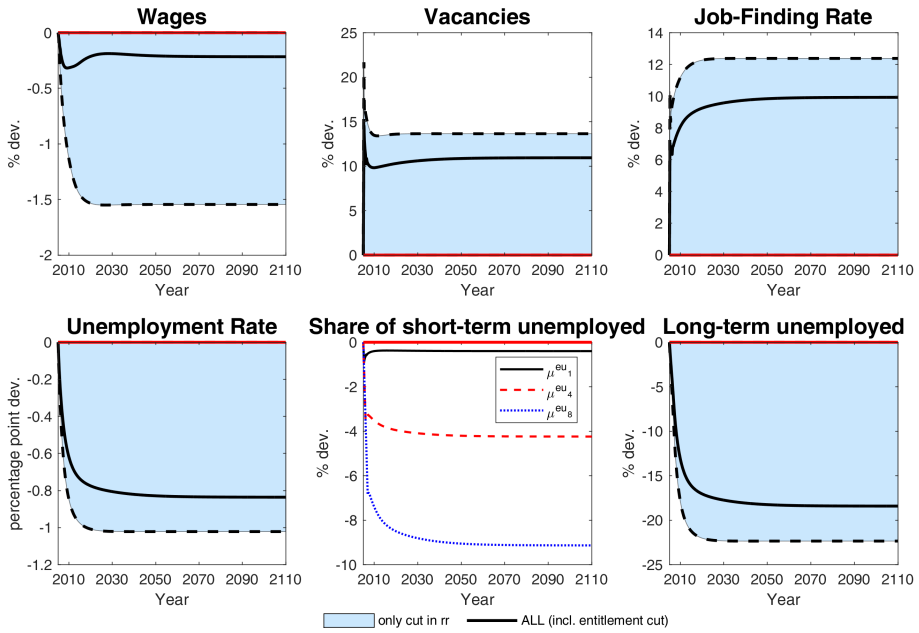

Figure 16: Long-run effects of the Hartz IV-reform package on labor market outcomes.

C.3 Long-run Effects

Here, we plot the analogous figures for the transitional dynamics already shown in the main text. However, as they only range until 2030 in the main text, we show them until 2110 here. As claimed in the main text, the transition indeed takes quite a while.

D Sensitivity Analysis

To check for the robustness of our results, we vary two potentially crucial model parameters, the parameter of relative risk aversion (σ_c) and worker's bargaining power (χ). Figure 19 illustrates the model response to setting σ_c to 1.7 and 2.3 (relative to a value of 2 in our baseline calibration). Interestingly, for a lower value of risk aversion, the increase in savings and net foreign assets is slightly stronger relative to our baseline version. Because workers value future income streams less when decreasing the parameter σ_c, they care more about today's wages in relative terms. This dampens the wage reduction, the job-finding rate and, as a result, the reduction in unemployment or, put differently, the increase in the job finding rate. As the increase in the job finding rate mutes the increase in savings, as discussed in the main text, the incentive to increase savings is now slightly stronger. The opposite reasoning applies for an increase in the parameter of risk aversion.

If we increase the workers' bargaining power (to $\chi = 0.6$, for example), this also dampens the wage reduction (see also Figure 19). The reason is that wages now depend less on the workers' fall-back utility. Because, in the post-reform scenario, the replacement rate rrl for long-term unemployment benefits is reduced by 15%, the new level of κ^{BL} is fixed relative the steady-state wage of the pre-reform scenario and entitlement duration for short-term benefit recipients is reduced by two quarters (before unemployed workers

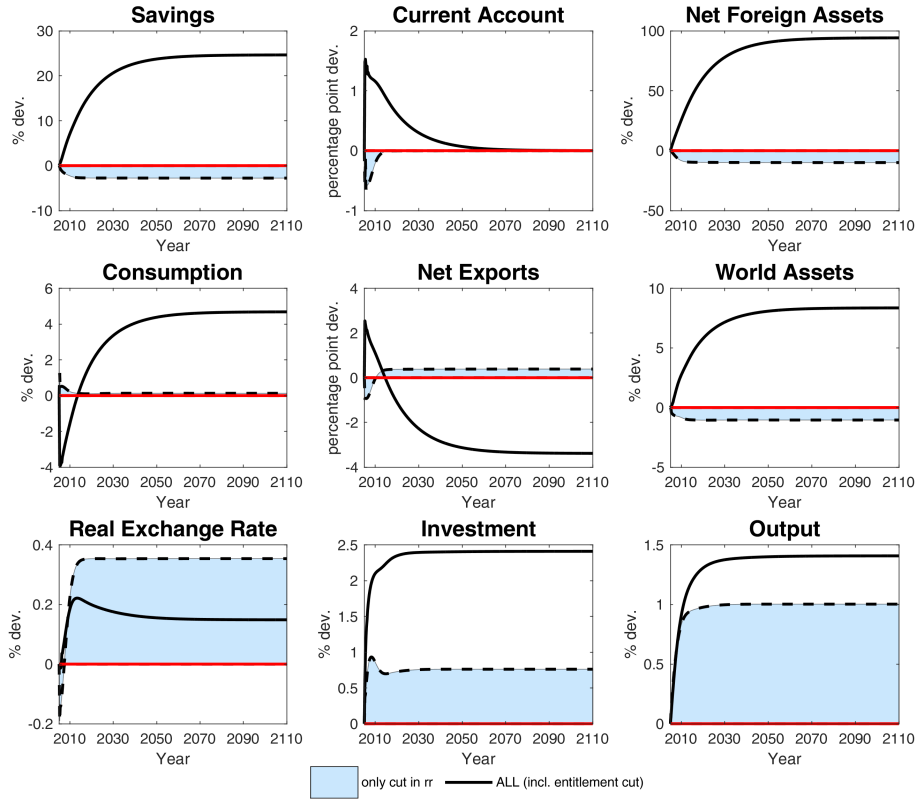

Figure 17: Long-run aggregate effects of the Hartz IV-reform package.

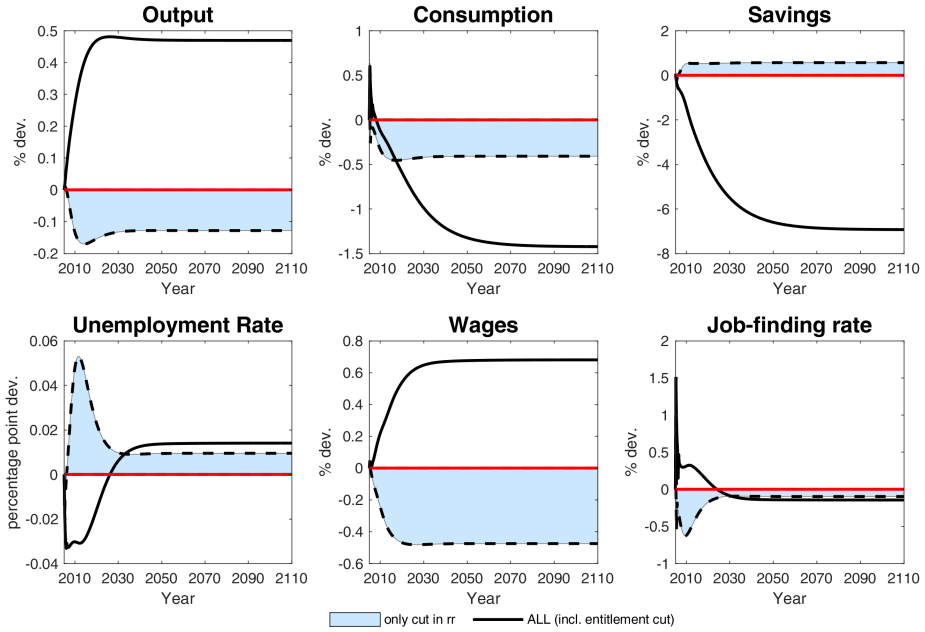

Figure 18: Long-run effects of the Hartz IV-reform package on the Rest of the Euro Area.

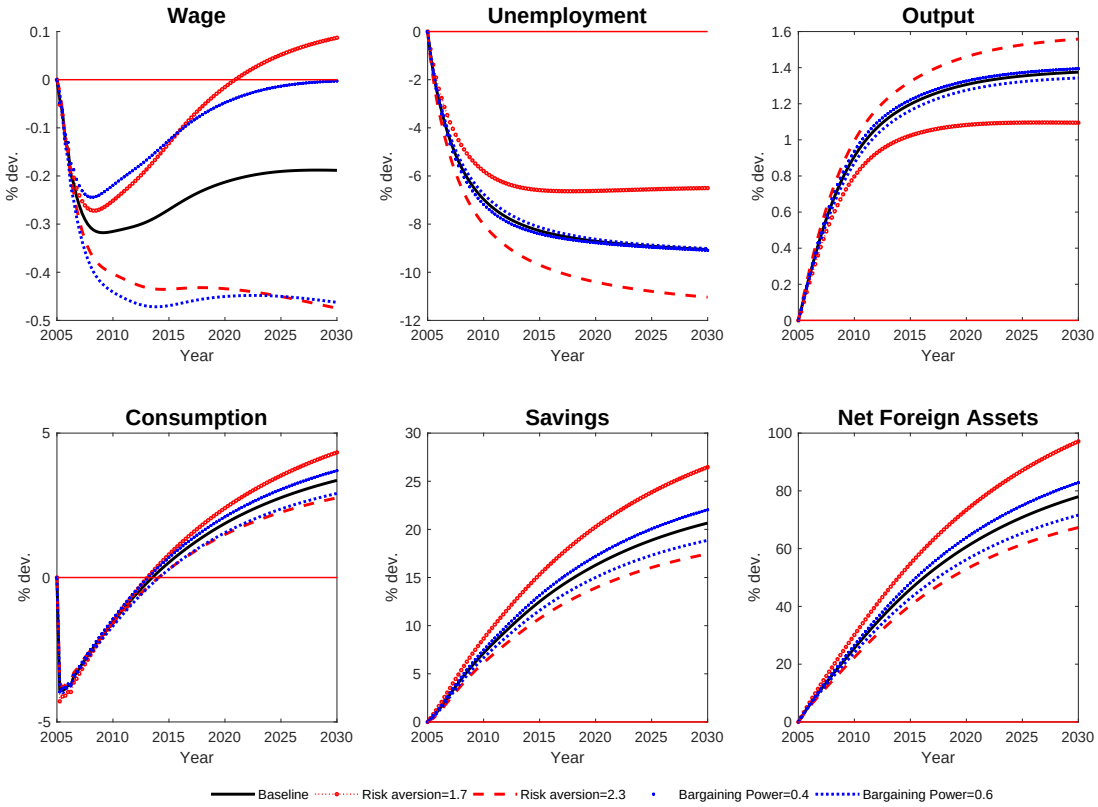

Figure 19: Sensitivity Analysis w.r.t risk aversion and worker's bargaining power

receive the fixed benefit), the relative income loss is now higher than it is in our baseline calibration. This increases the incentive to save more, which decreases the real interest rate more. That reduces the capital costs in production. As this leads to an increase in capital input, also augmenting labor productivity, this fosters production and output which, at the same time, further contributes to a lower wage reduction. The opposite is true when decreasing the workers' bargaining power.