Incomplete Insurance and Open-Economy Spillovers of Labor Market Reforms[†]

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Abstract

This paper studies how an unemployment-benefit reform in one member state of a monetary union affects savings, net foreign asset positions, and fiscal space across member states when households face incomplete insurance. Lower benefits reduce unemployment and increase fiscal space in the reforming country. Employed workers increase their precautionary savings to compensate for reduced public insurance. A portion of these savings is invested abroad, pushing the non-reforming country into a negative net foreign asset position and lowering its long-run consumption. Despite raising fiscal space and long-run average consumption in the reforming country, the reform may decrease ex-ante welfare because it reduces insurance and depresses consumption during the transition as households self-insure through higher savings. We discipline our proposed model with firm-level evidence on Germany's post-reform tradable-sector expansion following the Hartz IV reform of unemployment benefits. In our simulation, this reform accounts for a substantial share of the observed post-reform open-economy adjustment, whereas the earlier wage moderation cannot explain most of the observed patterns.

JEL classification: E21, E24, F16, F41.
Keywords: Unemployment insurance reform, spillover effects, precautionary savings

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1 Introduction

While the macroeconomic impact of labor market reforms on unemployment, wages, and competitiveness has been extensively studied in the open-economy literature (e.g., Cacciatore, Duval, Fiori, and Ghironi, 2016a,b; Dao, 2013), much less attention has been devoted to the role of households' incomplete insurance and savings behavior for international spillovers in a monetary union.[1] Estimated macroeconomic models for the European Monetary Union (Eurozone) identify an important role of private savings shocks for current account movements across member states (Kollmann, Ratto, Roeger, in 't Veld, and Vogel, 2015). These macroeconomic savings shocks may partly result from changes in precautionary savings behavior induced by major structural reforms.

Germany provides a particularly interesting case because its major reform of the unemployment benefit system in 2005 and 2006 (Hartz IV) simultaneously reduced government-provided insurance for long-term unemployed workers and altered the composition and level of social transfers that are central components of the national budget. This permanent change reshaped both public and private saving behavior in a large member state of the Eurozone, with implications for external debt positions. Around the same period, Germany's aggregate savings rate increased, its unit labor costs declined relative to the rest of the Eurozone, the tradable sector expanded, and net foreign assets rose substantially. Our paper analyzes the connection between this unemployment insurance reform, the reallocation of debt and fiscal capacity within the monetary union, and the resulting international macroeconomic developments.

We develop a two-country model that allows us to quantify the relationship between the German unemployment benefit reform and the observed open-economy facts. In the reforming country, workers face incomplete consumption insurance against unemployment. When unemployment benefits are reduced, employed households optimally accumulate more assets to self-insure against the risk of job loss. These higher precautionary savings increase the net foreign asset position, the current account surplus, and the size of the tradable sector relative to the non-tradable sector in the reforming country. At the same time, the reform lowers unit labor costs relative to the non-reforming economy, improving the reforming country's cost competitiveness. In the non-reforming economy, the common interest rate and household savings initially rise because the supply of physical and public assets cannot adjust immediately. As asset supply expands, the common interest rate falls below its pre-reform level, foreign household saving declines, and consumption remains temporarily elevated. The non-reforming economy runs current-account deficits from the beginning of the transition and gradually accumulates a negative net foreign asset position, which lowers its long-run consumption.

From the perspective of the monetary union, the Hartz IV reform permanently reduces transfer spending in one member state and thereby creates fiscal space. At the same time, the associated increase in private saving raises Germany's net external asset position and shifts

[1] Hochmuth, Moyen, Schröter, and Stähler (2026) analyze the role of precautionary savings for the accumulation of net foreign assets following an unemployment benefit reform. As they use a small open-economy model, they are silent on spillover effects.

the distribution of external claims and debt within the union. In this sense, we study how a permanent change in a large national transfer program, implemented within a common monetary framework, can reshape private saving, cross-border portfolios, external debt, and the fiscal capacity inside a monetary union.

To discipline the quantitative importance of this mechanism, we estimate the increase in Germany's tradable sector in the aftermath of the labor market reform based on German administrative and survey data. Specifically, we document a statistically significant and economically meaningful expansion of the tradable sector relative to the non-tradable sector using the Administrative Wage and Labor Market Flow Panel (AWFP), which covers essentially the universe of German establishments, and the IAB Establishment Panel, which we use to map sectors into tradable and non-tradable categories and to analyze value-added shifts while controlling for intermediate inputs.[2] We use the estimated relative expansion of tradable employment and the corresponding decline in non-tradable employment as two calibration targets. In equilibrium, this sectoral reallocation is the real-side counterpart of exporting precautionary savings, with the current account reflecting the corresponding net acquisition of foreign assets. In this calibrated setting, the German benefit reform can account for a sizeable share of the documented international macroeconomic facts and implies a permanent consumption drop of about 3.3 percent in the rest of the Eurozone. In addition, the reform reduces public unemployment expenditure, so that the home government's fiscal position strengthens markedly.

Our framework embeds incomplete insurance and is designed to analyze the general equilibrium insurance and incentive effects of an unemployment benefit reform in an open-economy setting. Following Challe and Ragot (2016) and Challe, Matheron, Ragot, and Rubio-Ramirez (2017), we assume that all employed workers pool their income, while workers who become unemployed lose access to this insurance arrangement. This generates a first-order (tractable) precautionary savings motive that we embed in a two-country model with an endogenous interest rate. The labor market features search and matching frictions in the spirit of Mortensen and Pissarides (1994) and a rich deterministic unemployment duration structure that allows us to model a reform targeted at long-term unemployed workers and replicating the key features of the Hartz IV labor market reform. Finally, we distinguish between tradable and non-tradable goods. This distinction enables us to connect the macro model tightly to our empirical evidence on the differential response of tradable and non-tradable sectors, and it is crucial for understanding how additional private savings are exported to partner countries in the monetary union. The combination of these ingredients requires tractability with respect to worker heterogeneity. A natural alternative would be a full two-country heterogeneous-agent model. Our approach instead uses a tractable incomplete-insurance structure that allows us to jointly study a two-country monetary union, an endogenous common interest rate, detailed unemployment-duration states, and tradable/non-tradable reallocation within a single framework. The downside of this approach is that we abstract from within-employed wealth heterogeneity and the richer cross-sectional variation in marginal propensities to consume present

[2] The AWFP allows us to control for time-invariant heterogeneity. See Seth and Stüber (2017) and Bachmann, Bayer, Merkl, Seth, Stüber, and Wellschmied (2021) for more information on the dataset.

in a full heterogeneous agent model. Importantly, the core savings-and-external-adjustment mechanism is disciplined by our empirical evidence on the expansion of the tradable sector. Furthermore, our model's quantitative implications for the current account are close to those in the richer small-open-economy heterogeneous-agent benchmark in Hochmuth et al. (2026). Deviations from complete insurance are key to our results. In a complete insurance framework, asset supply is perfectly elastic, and the representative household's Euler equation pins down the steady-state interest rate as the inverse of the discount factor. In contrast, under incomplete insurance there is an upward-sloping asset supply curve, because higher interest rates make saving more attractive for incompletely insured agents. In this environment, a permanent cut in unemployment benefits shifts the domestic asset supply schedule and thereby affects the common interest rate in the monetary union, cross-country capital flows, and external debt positions.[3] This channel is absent in representative-agent models with complete risk sharing and is therefore missing from most quantitative analyses of structural reforms in monetary unions.

Our calibrated quantitative model explains a sizable fraction of the empirical open-economy facts following the Hartz IV reform. Ten years after implementation, the baseline simulation accounts for roughly one-fifth of the observed increase in employed workers' private savings rate and 13 percent of the rise in Germany's net foreign assets relative to GDP. As our two-country model is calibrated to the Eurozone, we compare the quantitative model response to Germany's current account relative to the rest of the Eurozone: Ten years after the reform, the model captures almost half of the current account increase. This magnitude indicates that a meaningful part of the post-reform external adjustment inside the monetary union can be traced back to the German unemployment insurance reform operating through the precautionary savings channel. However, in the baseline, the reform generates ex-ante welfare losses in Germany, with losses concentrated among long-term unemployed workers. The reform reduces insurance precisely in high-marginal-utility unemployment states and induces employed households to reduce consumption during the transition as they build precautionary savings. These insurance and transition costs outweigh the subsequent rise in average consumption, generating ex-ante welfare losses in Germany that are concentrated among long-term unemployed workers. By contrast, households in the rest of the Eurozone experience small ex-ante welfare gains despite lower consumption in the new steady state.

Furthermore, we show that the precautionary savings mechanism is central to our results. Under complete insurance, the external adjustment largely disappears. Conditional on incomplete insurance, the qualitative external effects are robust to alternative wage-bargaining specifications and bargaining power (related to the debate on the wage effects of unemployment benefits, see Jäger, Schoefer, Young, and Zweimüller, 2020), a decline in separations (Hartung, Jung, and Kuhn, 2026), and less generous unemployment insurance in the non-reforming economy.

Finally, we contrast the unemployment insurance reform with another prominent structural development in Germany, namely the wage moderation that began in the 1990s. Several years

[3] The strength of this channel is governed by how sensitive aggregate saving is to the interest rate, which in our incomplete-market setting depends on households' marginal propensities to consume out of wealth.

before the Hartz reforms, wages in the German labor market grew more slowly than aggregate productivity (Dustmann, Fitzenberger, Schönberg, and Spitz-Oener, 2014), which reduced unit labor costs relative to other Eurozone economies. Wage moderation has often been cited as an alternative explanation for Germany's improved competitiveness, current account surplus, and net foreign asset accumulation. In our quantitative model, wage moderation reduces unemployment but does not raise net foreign assets. Instead, it lowers precautionary savings, since unemployment risk falls while unemployment benefits are unchanged. Through the lens of our framework, wage moderation alone cannot account for the combination of higher savings, stronger net exports, and the build-up of external assets that we observe for Germany within the Eurozone.

The rest of the paper is organized as follows. Section 2 relates our contribution to the existing literature on open-economy effects of labor market reform in monetary unions. Section 3 presents empirical macroeconomic facts for Germany and the Eurozone and documents the expansion of the tradable sector relative to the non-tradable sector in Germany after the Hartz reforms. Section 4 introduces the macroeconomic model with search and matching and incomplete insurance. Section 5 explains our calibration strategy and the mapping between model and data. Section 6 presents the quantitative results on domestic and cross-country effects of the reform, quantifies the implications for fiscal space and welfare, examines several robustness exercises, and discusses alternative driving forces. Section 7 concludes.

2 Connection to the Literature

Our research contributes to several strands of the literature. First, we contribute to the effects of labor market reforms in the open economy. Several papers analyze these reforms in models with labor market frictions (see, for example, Cacciatore et al. (2016a), Cacciatore et al. (2016b), Dao (2013), and Poilly and Sahuc (2013)). This body of research finds that labor market reforms yield positive short-run labor market spillover effects. We complement this stream of the literature by incorporating an incomplete household consumption insurance mechanism into a two-country model with search and matching frictions. We demonstrate that less generous unemployment benefits in one country may lead to higher foreign debt in the other country and may thereby depress foreign consumption permanently.

Related to this stream of the literature, Duval, Furceri, and Tovar Jalles (2022) estimate the effects of labor market deregulation on the current account. They find that a loosening of employment protection legislation (EPL) is associated with current account improvements. Duval et al. (2022) argue that these EPL reforms affect precautionary savings, particularly in bad times.

In addition, there are papers that analyze the German Hartz labor market reforms in models without search and matching frictions. Kollmann et al. (2015) and Fadinger, Herkenhoff, and Schymik (2024) find that the Hartz-reforms, coupled with shocks to leisure in a frictionless labor market and shocks to private savings, were important in driving Germany's current account surplus. Fadinger et al. (2024) argue that the reforms improved German competitiveness, caused a boom in the German manufacturing sector, and led to the crowding out of

manufacturing employment in other Eurozone countries. Our model framework with incomplete insurance provides a theoretical foundation for these facts. Due to more precautionary savings in the reforming country, we obtain a short-run boost of the tradable sector in the reforming economy. Furthermore, we analyze the quantitative importance of this channel for spillover effects in the context of the European Monetary Union.

Second, we contribute to the literature on the role of incomplete insurance in open economies[4] (for example, de Ferra, Mitman, and Romei, 2020, de Ferra, Mitman, and Romei, 2021, Auclert, Rognlie, Souchier, and Straub, 2021, Hochmuth et al., 2026, and Guo, Ottonello, and Perez, 2022). de Ferra et al. (2021) document that capital flows from equal to unequal countries due to private savings and higher borrowing of households in unequal countries.[5] Focusing on the Chinese current account surplus, İmrohoroğlu and Zhao (2020) find that incomplete insurance for the elderly led to large household savings and, thereby, to large current account surpluses. In contrast to these papers, we analyze the impact of a structural (labor market) reform on capital flows and long-run spillovers. The tractability of our framework allows us to study the spillover effects on the non-reforming country in a two-country setting with an endogenous interest rate.[6] Our work is related to recent two-country HANK models of monetary unions, such as Bayer, Kriwoluzky, Müller, and Seyrich (2024), who study how monetary and fiscal policy transmit across member states in the presence of household heterogeneity and incomplete markets. In contrast, we focus on a permanent unemployment benefit reform as a decentralized fiscal policy that reshapes net foreign asset positions and long-run consumption across countries inside the union. Our paper complements Hochmuth et al. (2026), who study the domestic effects of a labor-market reform in a small open economy with full consumer heterogeneity. Compared to their paper, we find that domestic aggregate effects and the increase in the net asset position are of similar magnitude. Our tractable two-country open-economy model therefore provides a useful reduced-form representation of a richer heterogeneous-agent environment while allowing us to analyze spillovers.

Third, we contribute to the literature on the spillover effects of unemployment benefit reforms (see Felbermayr, Larch, and Lechthaler, 2013, Felbermayr, Impullitti, and Prat, 2018).[7] Eggertsson, Mehrotra, and Summers (2016b) and Eggertsson, Mehrotra, Singh, and Summers (2016a) show that under secular stagnation and the zero lower bound, unemployment benefit reforms can have beggar-thy-neighbor effects in a monetary union. Fadinger et al. (2024) stress the importance of downward nominal wage rigidities due to the introduction of the Euro for lower manufacturing employment in Eurozone countries in the aftermath of the German Hartz IV reforms. Building on this line of research, we highlight a novel channel that arises with a precautionary-savings motive and in the absence of further frictions (such as the zero lower bound or downward nominal wage rigidities): the rest of the Eurozone experiences

[4] For an early contribution to the interaction of precautionary savings with search and matching in the closed economy, see Krusell, Mukoyama, and Şahin (2010).

[5] Broer (2014) shows that a rise in income risk can depress the net foreign asset position if default leads to exclusion from financial markets.

[6] See Challe and Ragot (2016), Challe et al. (2017), Ravn and Sterk (2021), and Bilbiie (2008) for similar approaches to model consumer heterogeneity in a tractable framework.

[7] In addition, our paper is related to the literature on the effects of labor market institutions in a monetary union. See, for example, Abbritti and Mueller (2013) and Campolmi and Faia (2011).

lower consumption in the long run due to the increase in their debt service. The paper highlights a channel that is absent from the existing quantitative literature on monetary-union labor-market reforms: even without nominal frictions, zero lower bound considerations, or downward wage rigidity, precautionary savings can generate substantial long-run consumption spillover effects.

Finally, we contribute to the literature on the macroeconomic effects of the Hartz IV labor market reform. Studies such as Hartung et al. (2026), Hochmuth, Kohlbrecher, Merkl, and Gartner (2021), Krause and Uhlig (2012), Krebs and Scheffel (2013), and Launov and Wälde (2013) have analyzed the reform effects within structural search and matching models in closed-economy settings. These studies commonly report a decline in unemployment due to the reforms, albeit with differences in the quantitative magnitude. Our research complements these findings by suggesting that lower benefits increase precautionary savings under incomplete insurance, consequently increasing the capital intensity of production. Moreover, we draw attention to the significant open-economy repercussions stemming from these labor market reforms.

3 Institutional Reform and Empirical Facts

3.1 Institutional Reform

The German Hartz IV reform was the fourth part of a sequence of labor market reforms implemented between 2003 and 2006. The Hartz IV reform was introduced in two steps (see Appendix A for further details on the Hartz reforms, in particular, the fourth step). First, in 2005, the replacement rate for long-term unemployment was reduced: The formerly earnings-dependent transfers for long-term unemployed were transformed into fixed transfers with a strict means test. For most groups, this implied a lower replacement rate, although the size of the cut varied with prior earnings and wealth. From 2006 onward, the entitlement duration for receiving short-term unemployment benefits was reduced. On average, there was a substantial cut in the entitlement duration.[8] See Figure 1 for a graphical illustration.

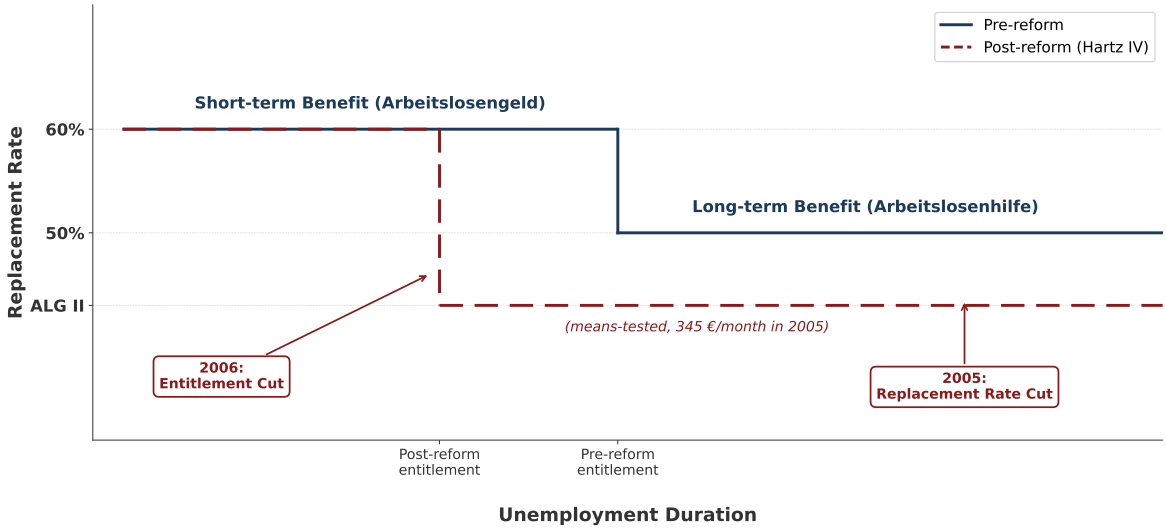
3.2 Macroeconomic Trends

In 2005, Germany's unemployment reached a peak level of roughly 12 percent. In the years after the Hartz IV reform, unemployment declined substantially (see the left panel of Figure 2).

Starting in the early 2000s, Germany's net foreign asset position began to increase, from zero to more than 70 percent of GDP in 2019 (see the middle panel in Figure 2). Correspondingly, Germany started to run a large and persistent current account surplus, which reached a record level of 8.6 percent of GDP in 2015. The current account surplus was driven by a divergence of exports and imports (see the right panel in Figure 2).

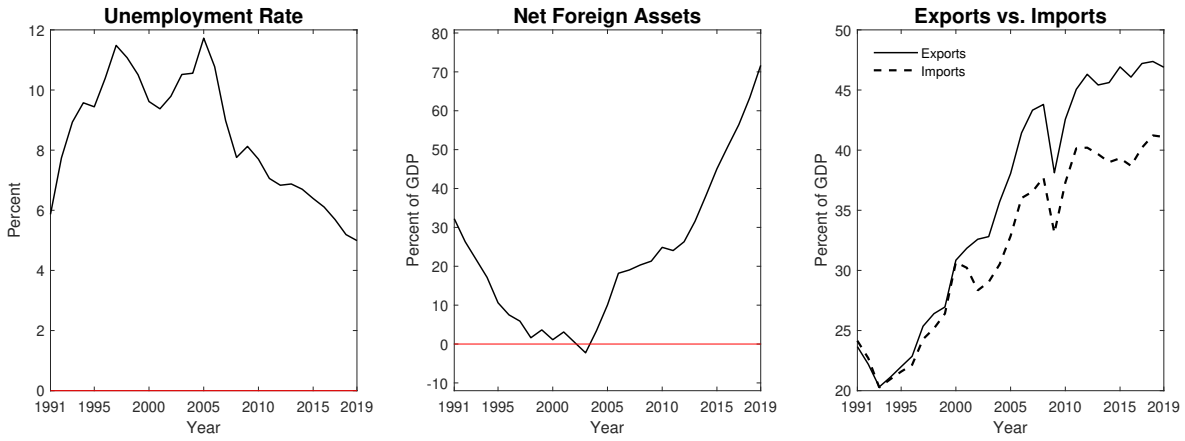
[8] The entitlement cut varied by age group and was strongest for elderly workers. For them, the entitlement duration was reduced from a maximum of 32 months to a maximum of 18 months.

Figure 1: Illustration of unemployment benefit changes due to Hartz IV labor market reform.



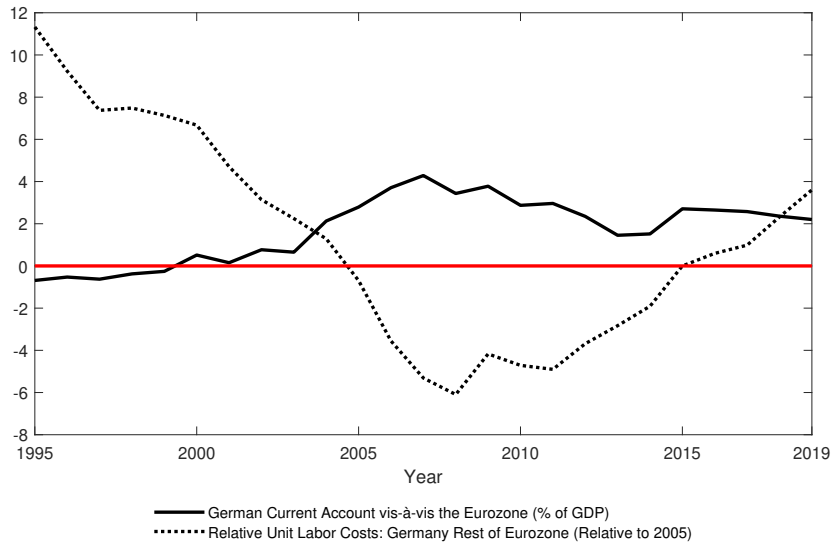
Notes: The horizontal axis shows the duration of unemployment, the vertical axis shows the replacement rate. The unemployment benefit system before 2005 is depicted in blue. The system from 2005 onward (Hartz IV) is depicted in red (dashed). *Arbeitslosengeld I*: short-term unemployment benefit; *Arbeitslosenhilfe*: old long-term unemployment assistance (abolished in 2005); *Arbeitslosengeld II*: means-tested long-term benefit (introduced 2005).

Figure 2: German Unemployment Rate, Net Foreign Assets and Exports vs. Imports.



Sources: Deutsche Bundesbank and Destatis.

Figure 3: Germany's current account surplus relative to the rest of the Eurozone (in percent of GDP) and unit labor costs of Germany relative to the Eurozone (relative to 2005).



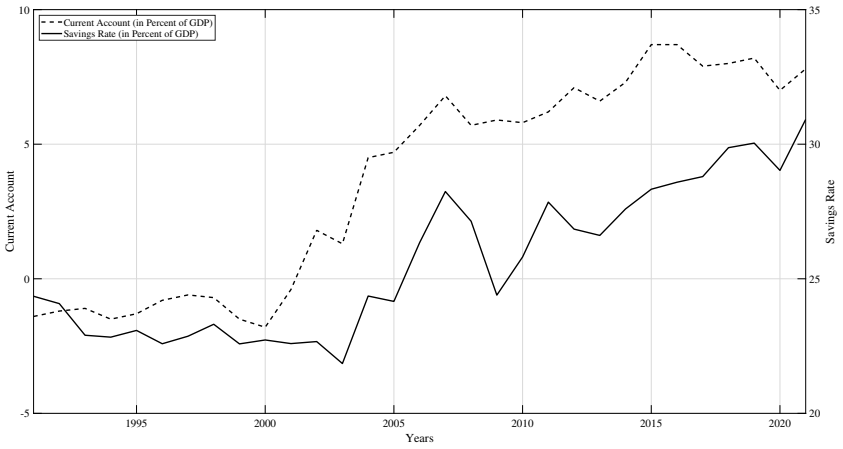
Notes: Germany's current account relative to Eurozone and relative unit labor costs (2005 normalized to 0). Sources: Deutsche Bundesbank and OECD.

Germany's aggregate unit labor costs (defined as labor compensation per worker to production per worker, depicted by the dotted line) relative to the rest of the Eurozone declined from the mid-1990s (see Figure 3). In other words, given the fixed nominal exchange rate within the Eurozone (from 1999 onward), Germany's labor compensation relative to production grew less than in other Eurozone countries. This phenomenon is often called the German "wage moderation" (see, e.g., Dustmann et al., 2014). However, despite these improvements in competitiveness compared to the rest of the Eurozone since the mid-1990s, Germany's current account surplus relative to the rest of the Eurozone only started accelerating from 2004 onward. Symmetrically, Germany started to build up a large positive net investment position relative to other Eurozone countries at the same time (see, for example, Figure 7 in Hünnekes, Konradt, Schularick, Trebesch, and Wingenbach, 2025). Descriptively, the acceleration of the current account and net foreign investment position within the Eurozone corresponds to the point in time when the Hartz labor market reforms were implemented. In Section 6, we provide a model-based explanation for why wage moderation can be expected to have very different open-economy consequences compared to unemployment insurance reforms.

Furthermore, Figure 4 illustrates the strong comovement between Germany's current account surplus and the aggregate savings rate.[9] The aggregate savings rate and the current account show a correlation of 0.89 for Germany. It is also worth emphasizing that our model's relevant metric is the savings rate among employed households. Based on the German Socio-Economic Panel, Hochmuth et al. (2026) show that the private savings rate of employed workers reached its minimum in 2004 and started to increase in the aftermath of the Hartz reforms. They document a roughly 3 percentage point increase in the savings rate for employed households.

[9] Non-financial corporations were also an important driver of the German current account surplus. However, this sector became a major contributor from the financial crisis onward. Savings of non-financial corporations increased from -0.49 percent of GDP in 2008 to 2.84 percent in 2009 (Source: Deutsche Bundesbank).

Figure 4: Germany's current account and savings.



Notes: Germany's current account and savings rate (in percent of GDP). Sources: OECD and IMF.

Furthermore, they show that the groups that were most affected by the unemployment insurance reform in terms of entitlement cut, as defined in Hartung et al. (2026), show the largest increase in the savings rate. This will serve as a reference point for our quantitative simulations.

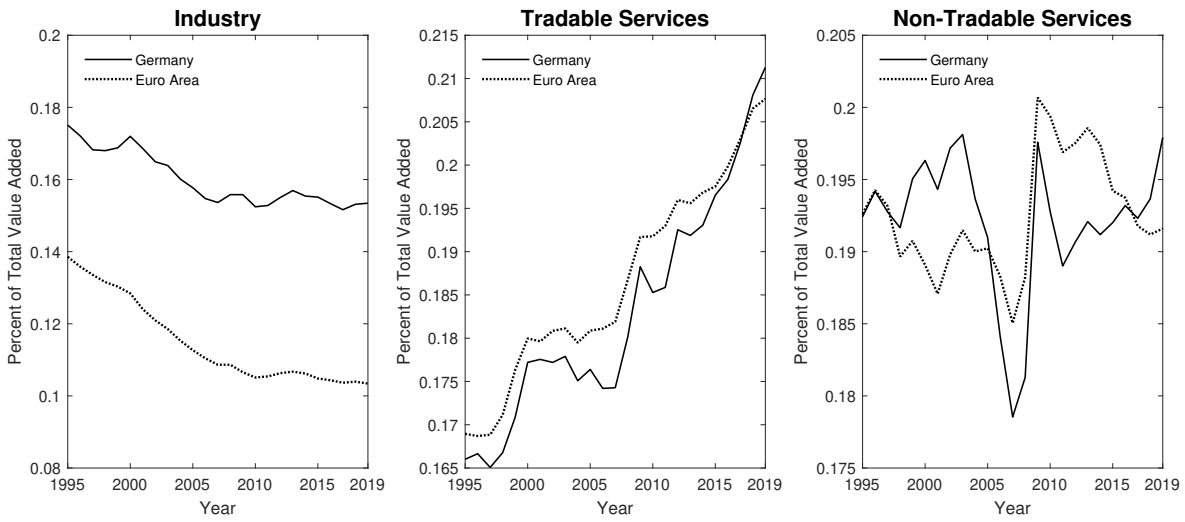
Figure 5 illustrates labor costs in terms of total compensation of employees by sector (industry, tradable services, and non-tradable services) divided by the economy-wide value added. Regarding the industry sector, we observe a similar declining trajectory of the compensation share in Germany and the Eurozone. However, total labor costs relative to aggregate value added in the non-tradable service sector in Germany temporarily dropped by around 2 percentage points at the time of the Hartz IV reform. This fact was first pointed out by Klein and Schiman (2022). In Section 3.3, we will estimate the quantitative shift of the tradable relative to the non-tradable sector in Germany based on rich microeconomic data. Our quantitative model analysis will provide a theoretical explanation for this phenomenon.

In summary, the aftermath of the Hartz reforms is characterized by the following descriptive patterns: (i) an increase in the aggregate savings rate, (ii) a decline in unemployment, (iii) an increase in Germany's net foreign assets and a rise in exports relative to imports, (iv) a real depreciation of Germany relative to the rest of the Eurozone, proxied by relative unit labor costs, and (v) a fall in labor costs in non-tradable relative to tradable services. These patterns serve as reference points for our aggregate model simulations.

3.3 Microeconometric Estimations

We can measure the size of the increase in the tradable sector based on microeconomic data. Compared to aggregate data, this has the advantage that we can control for potential composition effects at the firm level.

To quantify the relative response of the tradable and non-tradable sectors, we use microeconomic evidence from the Administrative Wage and Labor Market Flow Panel (AWFP) and



Notes: Total compensation of employees by sector (% of total value added). Industry excludes construction. Data Source: Eurostat (Gross value added and income by industry).

Figure 5: Germany vs. Eurozone: Labor Costs

the IAB Establishment Panel, covering 1994–2014.[10] In all our specifications, we will use firm-fixed effects to control for unobserved time-invariant heterogeneity.

We use the IAB Establishment Panel to classify sectors into tradable and non-tradable. To this end, we calculate the two-digit sector-specific export shares based on the share of sales abroad relative to total sales in the IAB Establishment Panel. Following Dustmann et al. (2014), we define a two-digit sector to be tradable if the export share exceeds the 25th percentile prior to 2005.[11] The definition of tradability at the sector level has two advantages. First, we believe that it is the economically more relevant definition compared to a definition at the firm level. Although a firm may only be selling a small fraction of its production to foreign countries (say, a supplier that mainly produces for a German producer of cars), it may be located in a sector that produces tradable goods (in our example, production of cars). Second, our tradability definition based on the sector-level can be imputed to the AWFP dataset. This dataset does not contain any information on tradability, but it has two major advantages relative to the IAB Establishment Panel: i) It is an administrative dataset from social security records. ii) It comprises the universe of all German establishments.[12]

We estimate the following fixed-effects model at the establishment level i:

$$\begin{aligned}\log X_{i,t} = \alpha_0 + \alpha_1 t_t + \alpha_2 t_t^2 + \beta_1 \log(\text{GDP}_t^G) + \beta_2 \log(\text{GDP}_t^W) \\ + \gamma_1 \text{HartzIV}_t + \gamma_2 \left(\text{HartzIV}_t \times \text{Tradable}_i\right) + \mu_i + \epsilon_{i,t},\end{aligned}$$

where $X_{i,t}$ is the dependent variable (either full-time employment, wage sum, or value added). The dummy HartzIV_t is a shift dummy that equals one from 2005 onward and zero before.

[10] See Appendices C.1 and C.2 for details on these two datasets.

[11] When we split establishments according to the mean export share, the key message that the tradable sector expanded more after the Hartz reforms remains robust. Results are available on request.

[12] Note that we use establishment and firm interchangeably in our paper. However, the IAB data universe refers to establishments, not firms.

The variable Tradable$_i$ is a time-invariant indicator for whether establishment i belongs to a two-digit sector classified as tradable (i.e., a sector whose export share, defined as sales abroad over total sales, is above the 25th percentile of the pre-2005 sectoral export-share distribution).

Our coefficient of interest is γ_2, which captures the additional change in $\log X_{i,t}$ for tradable relative to non-tradable establishments after the Hartz IV reform. In other words, it measures whether the tradable sector expanded more strongly than the non-tradable sector in the aftermath of the reform.

In all our specifications, we control for a linear and quadratic time trend, and business cycle effects (domestic GDP$_t^G$, and world GDP$_t^W$). In addition, we control for the share of intermediate inputs in a robustness check with the IAB Establishment Panel. It is well known that the intermediate input intensity has changed over time (e.g., due to outsourcing). This control variable allows us to see whether our results are robust to intermediate input changes. We restrict the sample to establishments with at least ten employees on average over the sample period so that the results are not driven by very small establishments.

Table 1: Estimation Results

	AWFP		**IAB Establishment Panel**	
Dep. Variable	log(Emp.)	log(Wage Sum)	log(VA)	log(VA)
Specification	Baseline	Baseline	no Int. Inputs	Int. Inputs
Hartz IV×Tradability	**0.027*** **	**0.047*** **	**0.085***	**0.118*** **
	(0.004)	(0.004)	(0.043)	(0.037)
Hartz IV	-0.006***	-0.039***	-0.066***	-0.034**
	(0.001)	(0.001)	(0.020)	(0.014)
log(GDP Germany)	0.317***	0.534***	0.965***	1.438***
	(0.012)	(0.012)	(0.235)	(0.164)
log(GDP World)	0.088***	0.028***	0.457***	-0.048
	(0.004)	(0.004)	(0.115)	(0.084)
Time Trend	-0.057***	-0.042***	-0.121***	0.003
	(0.001)	(0.001)	(0.020)	(0.016)
Squared Time Trend	0.001***	0.001***	0.002***	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-3.588***	-1.131***	-8.001***	-0.348
	(0.155)	(0.157)	(3.092)	(2.274)
Establishment FE	Yes	Yes	Yes	Yes
Intermediate Inputs	No	No	No	Yes
R^2	0.770	0.806	0.875	0.934
N	7,622,574	7,622,574	68,225	68,225

Notes: Estimations include establishment-level fixed effects. Standard errors are clustered at the establishment level. The first two columns denote results based on the AWFP, and the last two columns show results based on the IAB Establishment Panel. Regressions based on the IAB Establishment Panel include weights.

The estimated coefficient for the interaction term (Hartz IV * Tradability) is positive and statistically significant in all specifications based on the AWFP (see the left side of Table 1). According to our baseline specification, full-time employment increased by 2.7 percent more in the tradable sector than in the non-tradable sector in the aftermath of the Hartz reforms. The wage sum in the tradable sector increased by 4.7 percent more than in the non-tradable sector. These results are consistent with the descriptive evidence in Figure 5, which shows a

relative decline of the non-tradable sector in the aftermath of the Hartz reforms.
The estimations based on the IAB Establishment Panel confirm that the tradable sector expanded more than the non-tradable sector. Two major advantages of the IAB Establishment Panel are that we have information on value added (defined as sales minus intermediate inputs) and that we control for intermediate inputs.
The estimated coefficients for value added are even larger than for employment and the wage sum. Without including intermediate inputs, they are only significant at the 10 percent level. When including intermediate inputs, the interaction term is significant at the 1 percent level. Two factors may explain why the value-added estimates exceed the employment estimates. In addition to an increase in the size of the tradable sector, firms may have realized additional productivity gains. For our quantitative model exercise, we will target the most conservative estimate (namely, 0.027). Thus, our quantitative effects will constitute a lower bound on the reaction of the tradable vs. non-tradable sector and, thereby, the size of the negative consumption spillover effects.
In Appendix B.3, we replace the Hartz IV interaction term with 3-year rolling-windows. Table 8 shows that the effect is strongest in the years immediately after the reform and weakens during the Great Financial Crisis (GFC). Thus, it is unlikely that the upward shift in the tradable sector following the Hartz reforms is driven by savings behavior during the GFC.

4 The Model

We propose a model structure that is rich enough to be calibrated to our microeconomic estimations and to replicate key features of the labor market reform in Germany. At the same time, we require a model that can be solved within a two-country context with endogenous interest rates. This approach allows us to analyze the implications of the largest country implementing a major structural labor market reform within the Eurozone.
First, we assume a two-country Real Business Cycle model to analyze international spillover effects.[13] Second, we assume a labor market with search frictions and immediate rehiring (as in Blanchard and Galí, 2010) where random matching takes place via a Cobb-Douglas constant-returns matching function. We use a rich deterministic structure of different unemployment duration groups (short-term unemployed workers who differ in the length of their unemployment spell and long-term unemployed workers) that allows us to analyze the consequences of the Hartz IV labor market reform, which was targeted toward long-term unemployed.[14] Third, firms produce either tradable or non-tradable goods. All vacancies run through the same aggregate matching function. Sector-specific recruiting is subject to convex vacancy costs (see, for example, Kaas and Kircher (2015) for convex vacancy costs). Relative producer prices of tradables and non-tradables therefore adjust along the transition, and the reallocation of employment between the two sectors becomes an equilibrium outcome that we

[13] We do not model New Keynesian price adjustment costs (e.g., Galí and Monacelli, 2016) because our focus is on the medium- and long-run consequences of permanent labor market reforms; see Section 2 for a discussion.
[14] The labor market structure builds on Hochmuth, Moyen, and Stähler (2019).

can compare to our sector-level evidence.

Finally, following Challe and Ragot (2016) and Challe et al. (2017), we assume that all employed workers are members of a household with consumption pooling. However, once workers become unemployed, they have to leave the family and live on their own but obtain a share of the family's assets. As a result, workers face incomplete insurance against the consumption risk of becoming unemployed, which generates a tractable precautionary savings motive via the employed household head's intertemporal utility maximization.

The incomplete-insurance structure implies that households supply savings in an upward-sloping manner: a higher real interest rate raises the value of self-insurance and induces additional asset accumulation. The equilibrium interest rate is therefore determined endogenously by the intersection of this savings-supply schedule with the demand for savings coming from firms, the government, and international borrowing and lending. By contrast, in a complete-insurance model the interest rate is tied down by the inverse of the discount factor, generating a flat savings-supply curve and eliminating this endogenous adjustment margin. Due to our upward-sloping savings-supply curve, we do not have to assume frictions in the international capital market or portfolio adjustment costs as proposed by Schmitt-Grohe and Uribe (2003) to ensure steady-state determinacy and stationarity. In response to permanent policy changes (such as structural reforms), these frictions have long-run effects on the interest rate and net foreign asset position.[15]

In the presentation of the model in this section, we focus on the home country. The analogous equations also hold for the foreign economy, which is denoted with a subscript F.

4.1 Households

The economy is populated by a continuum of workers of measure one. At any date t, each worker is in one of the labor market states $i \in \{e, eu_1, \ldots, eu_K, uu\}$, where e denotes employment, eu_k short-term unemployment with duration $k \in \{1, \ldots, K\}$, and uu long-term unemployment. Workers are ex ante identical and differ only in their current employment status and asset holdings.

Preferences are CRRA over consumption c_t^i. Expected lifetime utility is

$$U = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(c_t^i),$$

where $\beta \in (0,1)$ is the subjective discount factor and

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

with σ_c denoting relative risk aversion. We denote the marginal utility of consumption by

$$\lambda_t^i = (c_t^i)^{-\sigma_c}, \qquad i \in \{e, eu_1, \ldots, eu_K, uu\}. \tag{4.1}$$

[15] See also Ghironi (2006) for a discussion of this issue in terms of overlapping generation models, which also generate an endogenous savings motive.

Aggregate household consumption C_t consists of tradable consumption, C_t^T, and non-tradable consumption, C_t^N. Bundling is described in Section 4.2.

4.1.1 Employed Workers' Consumption

The family head chooses consumption and next period's asset holdings, a_{t+1}, for all members and redistributes consumption goods and assets equally among employed workers. In contrast, unemployed workers are not part of the family. A worker who loses a job leaves the employed family pool and enters short-term unemployment, indexed by duration $k = 1, \ldots, K$, and becomes long-term unemployed after K periods without a match.

We use the following timing. At the beginning of period t, the economy inherits aggregate capital K_t, government debt b_t, net foreign assets NFA_t, sectoral employment (N_{t-1}^T, N_{t-1}^N), and the unemployment-duration distribution $\{u_{t-1}^{eu,k}\}_{k=1}^K$ and u_{t-1}^{uu}. Current-period matching then determines N_t^T, N_t^N, $N_t = N_t^T + N_t^N$, and the unemployment distribution dated t.

Let $\mathcal{S}_t$ denote the predetermined aggregate state. For the home economy,

$$\mathcal{S}_t = \left(K_t, b_t, NFA_t, N_{t-1}^T, N_{t-1}^N, \{u_{t-1}^{eu,k}\}_{k=1}^K, u_{t-1}^{uu}, \{m_t^{eu,k}\}_{k=1}^K, \mathcal{H}_t, \mathcal{P}_t\right),$$

where $\mathcal{H}_t$ collects the wage, tax, and fiscal histories needed to determine cohort-specific benefits and the fiscal rule. The variable $\mathcal{P}_t$ denotes the announced unemployment-benefit regime. In the two-country equilibrium, $\mathcal{S}_t$ also includes the analogous foreign state variables. We show the relevant state variables in the worker value functions and suppress them elsewhere.

The individual state of an employed worker is the per-employed-worker asset position a_t, while that of a short-term unemployed worker in duration state k is the remaining asset position $m_t^{eu,k}$. A newly unemployed worker enters state eu_1 with assets

$$m_t^{eu,1} = R_t a_t (1 - \tau^F),$$

where $\tau^F \in [0, 1)$ is the fraction of the gross asset payoff retained by the employed family pool when a worker separates and is not re-matched within the period; the complementary fraction $1 - \tau^F$ accompanies the worker into unemployment.[16]

The family head maximizes the utility of a member who is employed. The maximization problem reads

$$V_t^e(a_t, \mathcal{S}_t) = \max_{c_t^e, a_{t+1}} \Bigg\{ u(c_t^e) + \beta E_t \Big[\left(1 - s(1 - \rho_{t+1})\right) V_{t+1}^e(a_{t+1}, \mathcal{S}_{t+1}) + s(1 - \rho_{t+1}) V_{t+1}^{eu_1}(m_{t+1}^{eu,1}, \mathcal{S}_{t+1}) \Big] \Bigg\}. \tag{4.2}$$

Here, s is the exogenous separation rate and ρ_t is the endogenous job-finding rate.

[16] The superscript F refers to the family, as it refers to an internal asset-sharing rule, not a government tax.

Utility is maximized subject to the budget constraint

$$\begin{aligned} c_t^e + a_{t+1} =& (1-\tau_t^w)w_t - \tau_t + \frac{\Pi_t}{N_t} + \left((1-s(1-\tau^F)(1-\rho_t))\frac{N_{t-1}}{N_t}\right) R_t a_t \\ &+ \frac{\rho_t}{N_t}\sum_{k=1}^{K-1} u_{t-1}^{eu_k} m_t^{eu,k+1}, \end{aligned} \tag{4.3}$$

and the debt constraint

$$a_{t+1} \geq 0. \tag{4.4}$$

An employed worker's expenditures for current consumption and next period's assets are financed with labor income net of taxes, $(1-\tau_t^w)w_t$, where τ_t^w is the tax rate on wages and w_t is the wage. The variable τ_t denotes lump-sum taxes or transfers. Aggregate profits Π_t are distributed among employed workers.

The expression on the right upper side in equation (4.3) shows that the full asset payoff remains in the employed family pool if the worker does not separate or is re-matched within the period. If the worker enters unemployment, only the fraction τ^F remains in the family pool.

The final term in equation (4.3) captures residual assets returned by workers who entered unemployment in earlier periods and are re-matched in period t. A worker re-matched from duration state eu_k returns the resources $m_t^{eu,k+1}$ that would otherwise be carried into the next unemployment-duration state.

For the Euler equation below, let $r_t^{eu,k}$ denote the share of the initial household transfer that remains at the beginning of unemployment state eu_k. Thus, $r_t^{eu,1} = 1$ and

$$r_{t+1}^{eu,k+1} = r_t^{eu,k}(1-\theta_t^k).$$

Equivalently,

$$m_t^{eu,k} = r_t^{eu,k} R_{t-k+1} a_{t-k+1}(1-\tau^F).$$

Thus, $\theta_t^k r_t^{eu,k}$ is the share of the original asset transfer consumed in the unemployment state eu_k.

Family members who separate and are not re-matched within the same period receive a fraction $(1-\tau^F)$ of per-capita family assets, while the fraction τ^F remains in the employed family. This internal division of assets reduces the assets available to newly unemployed workers and thereby contributes to the consumption gap between employed and unemployed workers.

The first-order condition for the family's asset choice a_{t+1} can be written as

$$\Omega_t R_{t+1} \leq 1, \tag{4.5}$$

which holds with equality whenever $a_{t+1} > 0$. We make sure that our calibration delivers an interior solution, so equation (4.5) binds throughout. The marginal rate of intertemporal

substitution of a worker is defined as Ω_t (the employed workers' stochastic discount factor). To preview the expression for Ω_t, one additional unit of family wealth can generate marginal utility through three channels. First, it can remain in the employed family pool. Second, it can accompany a worker into unemployment and subsequently return to the pool if the worker is re-employed before exhausting it. Third, it can finance consumption when the worker remains unemployed. The third channel is the source of the precautionary savings motive. Formally,

$$\Omega_t = \beta E_t \Bigg[\underbrace{\left(1 - s(1-\tau^F)(1-\rho_{t+1})\right) \frac{N_t}{N_{t+1}} \frac{\lambda^e_{t+1}}{\lambda^e_t}}_{\text{marginal value of assets retained in the employed family pool}} + \underbrace{\sum_{k=1}^{K-1} \beta^k \frac{\lambda^e_{t+k+1}}{\lambda^e_t} \frac{\rho_{t+k+1}}{N_{t+k+1}} u^{eu_k}_{t+k} r^{eu,k+1}_{t+k+1} (1-\tau^F)}_{\text{marginal value of assets returned upon re-employment}} + \underbrace{s(1-\rho_{t+1}) \frac{\lambda^{eu_1}_{t+1}}{\lambda^e_t} \tilde{r}^{eu,1}_t (1-\tau^F)}_{\text{marginal value of assets consumed during unemployment}} \Bigg]. \tag{4.6}$$

The dates in the second term on the right-hand side of the equation reflect the return timing of the composite asset. The asset chosen in period t pays out in period $t+1$. A worker who separates in period $t+1$ can therefore return residual resources to the family in period $t+2$ at the earliest, and a cohort in duration state eu_k returns its residual resources in period $t+k+1$. The factor N_t/N_{t+1} in the first term converts the payoff on the per-employed-worker asset position into period-$t+1$ resources per employed worker.

For $k = 1, \cdots, K-1$, the unemployment continuation term is defined recursively as

$$\tilde{r}^{eu,k}_t = \theta^k_{t+k} r^{eu,k}_{t+k} + \beta(1-\rho_{t+k+1}) \frac{\lambda^{eu_{k+1}}_{t+k+1}}{\lambda^{eu_k}_{t+k}} \tilde{r}^{eu,k+1}_t,$$

with terminal condition

$$\tilde{r}^{eu,K}_t = \theta^K_{t+K} r^{eu,K}_{t+K}.$$

Because each continuation is normalized by the marginal utility of the preceding unemployment state, the ratios telescope. After substitution, the payoff in state eu_k enters the bracketed term in equation (4.6) with the single ratio $\lambda^{eu_k}_{t+k}/\lambda^e_t$ and discount factor β^{k-1}. Including the outer discount factor in equation (4.6), its total discount factor is therefore β^k.

Absent this precautionary savings channel (i.e., with consumption pooling for all employed and unemployed workers in the economy), equation (4.6) collapses to the standard complete-insurance Euler equation

$$\frac{1}{R_{t+1}} = \beta E_t \frac{\lambda^e_{t+1}}{\lambda^e_t}. \tag{4.7}$$

In our complete-insurance variant, we close the open economy with a standard country-specific bond-demand schedule following Schmitt-Grohe and Uribe (2003), under which the risk-free

interest rate increases with the country's net foreign debt.

4.1.2 Unemployed Workers' Consumption

Short-term unemployed workers differ in their unemployment duration $k \in \{1, \ldots, K\}$. State eu_K is the last short-term unemployment state. A worker who remains unmatched after this state becomes long-term unemployed.

Let $\bar{K}_t \leq K$ denote the duration of short-term benefit entitlement. The benefit paid in asset-holding unemployment state eu_k is

$$\kappa_t^{BS_k} = \begin{cases} rr^s(1-\tau_{t-k}^w)w_{t-k}, & k \leq \bar{K}_t, \\ \kappa_t^{BL}, & k > \bar{K}_t. \end{cases}$$

For Home, long-term benefits are fixed within each policy regime:

$$\kappa_t^{BL} = rr_t^l(1-\bar{\tau}^w)\bar{w}, \tag{4.8}$$

where rr_t^l is constant within each regime. The reform lowers this benefit level by reducing rr_t^l.

Once workers become unemployed, they receive a fraction $1-\tau^F$ of the family asset position. Short-term unemployed consume a share θ_t^k of their wealth. They decide every period how much of their assets they want to consume; thus, θ_t^k is a choice variable.[17] We assume that all assets are exhausted over the K periods of short-term unemployment. Long-term unemployed workers have no asset holdings. This assumption is consistent with means-testing for receiving long-term unemployment benefits.

A member of the short-term unemployment cohort in duration state $k \in \{1, \ldots, K-1\}$ has consumption $c_t^{eu,k}$ and the fraction of remaining asset resources to consume, $\theta_t^k \in [0,1]$.[18] Her individual state is $m_t^{eu,k}$. The maximization problem is

$$V_t^{eu_k}(m_t^{eu,k}, \mathcal{S}_t) = \max_{\{c_t^{eu,k}, \theta_t^k\}} \Big\{ u(c_t^{eu,k}) + \beta E_t \Big[\rho_{t+1} V_{t+1}^e(a_{t+1}, \mathcal{S}_{t+1}) + (1-\rho_{t+1}) V_{t+1}^{eu_{k+1}}(m_{t+1}^{eu,k+1}, \mathcal{S}_{t+1}) \Big] \Big\},$$

subject to the budget constraint for a k-period unemployed worker

$$c_t^{eu,k} + \tau_t = \kappa_t^{BS_k} + \theta_t^k m_t^{eu,k},$$

with remaining asset resources evolving according to

$$m_{t+1}^{eu,k+1} = (1-\theta_t^k) m_t^{eu,k}.$$

[17] Workers of the same unemployment cohort choose a common consumption share and internalize that residual resources flow back to the employed family upon re-employment. Appendix D.1 states the resulting first-order condition.

[18] There is no within-cohort heterogeneity.

In the last short-term unemployment state, the worker consumes all remaining asset resources, so $\theta_t^K = 1$. Her value is given by

$$V_t^{eu_K}(m_t^{eu,K}, \mathcal{S}_t) = u(c_t^{eu,K}) + \beta E_t \left[\rho_{t+1} V_{t+1}^e(a_{t+1}, \mathcal{S}_{t+1}) + (1-\rho_{t+1}) V_{t+1}^{uu}(\mathcal{S}_{t+1})\right],$$

subject to the budget constraint

$$c_t^{eu,K} + \tau_t = \kappa_t^{BS_K} + m_t^{eu,K}.$$

Long-term unemployed workers have no individual asset state and consume their contemporaneous income. Their value is given by

$$V_t^{uu}(\mathcal{S}_t) = u(c_t^{uu}) + \beta E_t \left[\rho_{t+1} V_{t+1}^e(a_{t+1}, \mathcal{S}_{t+1}) + (1-\rho_{t+1}) V_{t+1}^{uu}(\mathcal{S}_{t+1})\right],$$

subject to the budget constraint

$$c_t^{uu} + \tau_t = \kappa_t^{BL}.$$

The solution to the employed and unemployed workers' problems yields state-contingent consumption plans and marginal utilities λ_t^i. In the calibrated equilibrium, $c^e > c^{eu,1}$, so that marginal utility rises when a worker enters unemployment. This consumption gap generates the precautionary savings motive. Following Challe and Ragot (2016), we set the family-retention parameter τ^F such that this inequality holds in the numerical application.

Discussion of the precautionary savings channel. It is useful to summarize how the Hartz IV reform shapes the precautionary savings motive in our model. Long-term unemployed workers hold no assets, consistent with means-testing of long-term benefits. Extra savings while employed, therefore, raise consumption during the K periods of short-term unemployment before means-testing binds, rather than in the long-term state itself. The transition into low-benefit long-term unemployment changes continuation utility but, once all assets have been exhausted, does not directly change the marginal value of assets. The direct precautionary savings effect arises from the entitlement cut. After the reform, workers receive lower benefits already during the final periods in which assets can still be consumed. This raises marginal utility in these periods and the shadow value of assets while employed. Intuitively, saving more does not increase consumption in the long-term state itself (long-term unemployed have no assets by assumption), but it allows workers to consume more during the K periods of short-term unemployment. Thus, the entitlement cut, reinforced by the lower benefit level during these asset-holding periods, triggers an increase in precautionary savings.

4.2 Demand for Different Goods Types

Households consume a bundle of goods and services. This bundle consists of tradables and non-tradables, which are bundled according to a CES aggregator:

$$C_t = \left(\left(\alpha^T\right)^{\frac{1}{\phi^T}} \left(C_t^T\right)^{\frac{\phi^T-1}{\phi^T}} + \left(1-\alpha^T\right)^{\frac{1}{\phi^T}} \left(C_t^N\right)^{\frac{\phi^T-1}{\phi^T}} \right)^{\frac{\phi^T}{\phi^T-1}} \qquad 0 < \alpha^T < 1, \tag{4.9}$$

where α^T represents the share of tradables in the bundle and ϕ^T represents the elasticity of substitution between tradables and non-tradables.
The aggregate consumption price index is

$$P_t = \left(\alpha^T \left(P_t^T\right)^{1-\phi^T} + \left(1-\alpha^T\right) \left(P_t^N\right)^{1-\phi^T} \right)^{\frac{1}{1-\phi^T}}, \tag{4.10}$$

where P_t^N denotes the price of non-tradables and P_t^T is the price of the tradable consumption basket.
The domestic demand for tradables is

$$C_t^T = \alpha^T \left(P_t^T/P_t\right)^{-\phi^T} C_t, \tag{4.11}$$

and for non-tradables

$$C_t^N = \left(1-\alpha^T\right) \left(P_t^N/P_t\right)^{-\phi^T} C_t. \tag{4.12}$$

Thus, the relative demand for tradables vs. non-tradables is a function of the relative prices:

$$\frac{C_t^T}{C_t^N} = \frac{\alpha^T}{1-\alpha^T} \left(P_t^T/P_t^N\right)^{-\phi^T}. \tag{4.13}$$

Tradable consumption consists of home produced tradables, $c_{t,H}$, and foreign produced tradables, $c_{t,F}$, which are aggregated according to a CES function:

$$C_t^T = \left(\left(\gamma^C\right)^{\frac{1}{\eta_C}} \left(c_{t,H}\right)^{\frac{\eta_C-1}{\eta_C}} + \left(1-\gamma^C\right)^{\frac{1}{\eta_C}} \left(c_{t,F}\right)^{\frac{\eta_C-1}{\eta_C}} \right)^{\frac{\eta_C}{\eta_C-1}} \qquad 0 < \gamma^C < 1, \tag{4.14}$$

where γ^C denotes the consumption bias towards goods produced in the home country.
The aggregate price level for tradables is defined as:

$$P_t^T = \left(\gamma^C \left(p_{t,H}^T\right)^{1-\eta_C} + \left(1-\gamma^C\right) \left(p_{t,F}^T\right)^{1-\eta_C} \right)^{\frac{1}{1-\eta_C}}. \tag{4.15}$$

The demand for home and foreign tradables is:

$$c_{t,H} = \gamma^C \left(\frac{p_{t,H}^T}{P_t^T} \right)^{-\eta_C} C_t^T, \quad c_{t,F} = \left(1-\gamma^C\right) \left(\frac{p_{t,F}^T}{P_t^T} \right)^{-\eta_C} C_t^T. \tag{4.16}$$

Thus, relative demand for home and foreign tradables is a function of the real exchange rate:

$$\frac{c_{t,H}}{c_{t,F}} = \frac{\gamma^C}{1-\gamma^C}\,\mathrm{TOT}_t^{\eta_C}, \tag{4.17}$$

with the terms of trade defined as the relative price of foreign and home tradables, $\mathrm{TOT}_t = p^T_{t,F}/p^T_{t,H}$.
We assume that investment goods are tradable (i.e., no non-tradable part as for consumption). Furthermore, tradable consumption goods and investment goods are perfect substitutes. Investment is aggregated in the same way as tradable consumption:

$$I_t = \left(\left(\gamma^C\right)^{\frac{1}{\eta_C}} \left(i_{t,H}\right)^{\frac{\eta_C-1}{\eta_C}} + \left(1-\gamma^C\right)^{\frac{1}{\eta_C}} \left(i_{t,F}\right)^{\frac{\eta_C-1}{\eta_C}} \right)^{\frac{\eta_C}{\eta_C-1}}. \tag{4.18}$$

The relative price of investment in consumption units is $p^I_t = P^T_t/P_t$.
In analogy with tradable consumption, the relative demand for home and foreign investment goods is a function of the real exchange rate:

$$\frac{i_{t,H}}{i_{t,F}} = \frac{\gamma^C}{1-\gamma^C}\,\mathrm{TOT}_t^{\eta_C}. \tag{4.19}$$

For later reference, we define the sectoral producer prices in consumption units as

$$p^T_t = \frac{p^T_{t,H}}{P_t}, \qquad p^N_t = \frac{P^N_t}{P_t}. \tag{4.20}$$

Prices without an H or F subscript denote relative prices in consumption units.

4.3 Production, Sector Choice, and Matching

In the previous section, we discussed the demand for tradables and non-tradables. In this section, we show how supply in the two sectors is determined by vacancy posting and the within-period allocation of capital.
Firms produce either tradable or non-tradable goods, denoted by index $j \in \{T, N\}$, with identical Cobb-Douglas constant-returns technologies in each sector:

$$Y^j_t = e^z (K^j_t)^\alpha (N^j_t)^{1-\alpha}, \qquad j \in \{T, N\}, \tag{4.21}$$

where K^j_t denotes the capital services used in sector j and N^j_t sectoral employment. Capital is rented period by period and can be reallocated freely across sectors, so that

$$K^T_t + K^N_t = K_t, \tag{4.22}$$

where K_t is the aggregate capital stock installed at the beginning of the period. Total employment is $N_t = N^T_t + N^N_t$ and aggregate output is $Y_t = Y^T_t + Y^N_t$.
The sectoral marginal products are $MPL^j_t = e^z(1-\alpha)(K^j_t/N^j_t)^\alpha$ and $MPK^j_t = e^z\alpha(N^j_t/K^j_t)^{1-\alpha}$. Free reallocation of capital services equalizes the value marginal product of

capital across sectors,

$$r_t^k = p_t^T MPK_t^T = p_t^N MPK_t^N,$$

where r_t^k is the common rental rate of capital. In contrast to a one-sector representation, the producer prices p_t^T and p_t^N can differ along the transition. Their ratio is the relative price of tradables that reallocates demand and production between the two sectors.

Aggregate matches are determined by a standard aggregate matching function, with searching workers and aggregate vacancies as inputs. This matching function is assumed to be Cobb-Douglas and constant returns:

$$M_t = \kappa^e S_t^\eta V_t^{1-\eta},$$

where κ^e denotes the matching efficiency, η the matching elasticity, S_t is the total number of searching workers, and V_t is the number of aggregate vacancies ($V_t = V_t^T + V_t^N$). As search is undirected, the probability of a firm to fill a vacancy,

$$q_t = M_t/V_t = \kappa^e \theta_t^{-\eta}, \tag{4.23}$$

is the same in the tradable and non-tradable sector. It is a function of aggregate market tightness, $\theta_t = V_t/S_t$. Sectoral employment evolves according to

$$N_t^j = (1-s)N_{t-1}^j + V_t^j q_t, \qquad j \in \{T, N\}, \tag{4.24}$$

so that the aggregate employment dynamics $N_t = (1-s)N_{t-1} + M_t$ follow by adding up.

Posting vacancies uses resources of the respective sector's own good. Recruiting costs are convex in the sector's vacancy rate $v_t^j = \frac{V_t^j}{N_{t-1}^j}$ (see Kaas and Kircher (2015) for convex vacancy costs), so that expanding recruitment relative to the incumbent workforce becomes increasingly expensive at the margin. Posting V_t^j vacancies in sector j absorbs

$$\mathcal{R}_t^j = \frac{\kappa_j^v \, \bar{v}^j}{1+\chi_j} N_{t-1}^j \left(\frac{v_t^j}{\bar{v}^j}\right)^{1+\chi_j} \tag{4.25}$$

units of sector-j output, where κ_j^v is the sector-specific cost scale, $\chi_j \geq 0$ the recruiting curvature, and $\bar{v}^j = \bar{V}^j/\bar{N}^j$ the pre-reform steady-state vacancy rate.[19]

Multi-worker firms in sector j maximize the present value of profits:

$$\Pi_t^j = \max_{\{K_{t+\ell}^j, N_{t+\ell}^j, V_{t+\ell}^j\}_{\ell=0}^\infty} E_t \sum_{\ell=0}^\infty \Omega_{t,t+\ell} \left[p_{t+\ell}^j \left(Y_{t+\ell}^j - \mathcal{R}_{t+\ell}^j \right) - w_{t+\ell} N_{t+\ell}^j - r_{t+\ell}^k K_{t+\ell}^j \right],$$

[19] The normalization by $\bar{v}^j$ implies that the marginal cost of a vacancy, $\partial \mathcal{R}_t^j / \partial V_t^j = \kappa_j^v (v_t^j/\bar{v}^j)^{\chi_j}$, equals κ_j^v at the pre-reform steady state for any χ_j. The case $\chi_j = 0$ nests linear vacancy costs $\kappa_j^v V_t^j$ as in the one-sector representation.

where $\Omega_{t,t} = 1$ and

$$\Omega_{t,t+\ell} = \prod_{h=0}^{\ell-1} \Omega_{t+h} \qquad \text{for } \ell \geq 1.$$

The maximization is subject to the sectoral employment law of motion and the recruiting cost function (4.25). Wages are determined by economy-wide bargaining as described below, so all firms pay the common wage w_t.

The first-order conditions for vacancies and employment combine to the sectoral job-creation conditions

$$\frac{p_t^j \, \kappa_j^v}{q_t} \left(\frac{v_t^j}{\bar{v}^j} \right)^{\chi_j} = J_t^j, \qquad j \in \{T, N\},$$

$$J_t^j = p_t^j MPL_t^j - w_t + E_t \, \Omega_t \left[(1-s) \, J_{t+1}^j + \frac{\chi_j}{1+\chi_j} \, \kappa_j^v \, \bar{v}^j \, p_{t+1}^j \left(\frac{v_{t+1}^j}{\bar{v}^j} \right)^{1+\chi_j} \right],$$

where J_t^j is the value of a filled job in sector j. The left-hand side is the expected resource cost of creating one additional match in sector j. The last term captures the continuation value of an additional incumbent worker: conditional on next period's employment target, a larger surviving workforce reduces the vacancies required in period $t+1$.

The job-creation conditions determine the allocation of vacancies across sectors. Hiring runs through the same aggregate matching function in both sectors, so differences in expected returns are driven by sector prices and marginal products. If demand shifts toward one sector, its relative price rises, firms in that sector post more vacancies, and employment and production reallocate. With $\chi_j > 0$, marginal recruiting costs rise with the sector's vacancy rate, so the reallocation is spread over time and the relative price does not fully equalize sector returns within the period. This margin is what allows the model to speak to the sectoral employment evidence.

Next, we define the matching market from the worker side. Workers do not direct their search to a sector, i.e., workers search for a job and are randomly matched. Thus, the job-finding rate (ρ_t) is a function of aggregate market tightness:

$$\rho_t = M_t / S_t = \kappa^e \theta_t^{1-\eta}. \tag{4.26}$$

Searching workers are defined as

$$S_t = 1 - (1-s) N_{t-1}. \tag{4.27}$$

Due to our random matching assumption, workers' job-finding probability is the same in all unemployment duration groups and in both sectors.

Unemployment is defined as

$$u_t = 1 - N_t = \sum_{k=1}^{K} u_t^{eu_k} + u_t^{uu}, \tag{4.28}$$

where the number of unemployed workers in the first period ($k = 1$) of their unemployment spell is

$$u_t^{eu,1} = s(1 - \rho_t)N_{t-1}, \tag{4.29}$$

in subsequent periods $k \in (2, K)$ of short-term unemployment the number is given by:

$$u_t^{eu,k} = (1 - \rho_t)u_{t-1}^{eu,k-1}. \tag{4.30}$$

Long-term unemployment evolves according to

$$u_t^{uu} = (1 - \rho_t)[u_{t-1}^{uu} + u_{t-1}^{eu,K}]. \tag{4.31}$$

According to our model structure, searching workers are randomly matched in the tradable or non-tradable sector depending on the number of posted vacancies. Thus, workers only switch sectors when they lose their job and transition to a new job in a different sector. While this assumption appears a bit extreme at first sight, it is in line with empirical evidence by Dauth, Findeisen, and Suedekum (2017).[20]

4.4 Wage Bargaining

We assume that wages are determined by Nash bargaining, where the family head bargains with the firm side over one economy-wide wage. Her bargaining power is ζ. The baseline threat point corresponds to the hypothetical outcome in which bargaining collapses, and workers enter short-term unemployment. The value of entering the first short-term unemployment state is $\mathcal{W}_t^{eu_1}$.

Search is undirected, so newly separated workers face the same ex-ante job-finding probability across sectors. However, continuation values differ across unemployment-duration states because benefits and asset decumulation differ with duration. Under the baseline threat point, the worker-side outside option depends on the continuation value of a newly separated worker and not directly on the unemployment-duration distribution.[21]

The surplus from working is given by $\tilde{\mathcal{W}}_t = \mathcal{W}_t^e - \mathcal{W}_t^{eu_1}$ (see Appendix D.2). Because both sectors pay the same bargained wage, the firm surplus relevant for bargaining is the employment-weighted average of the sectoral job values,

$$J_t = \frac{N_t^T J_t^T + N_t^N J_t^N}{N_t}. \tag{4.32}$$

[20] Dauth et al. (2017) look at transitions between manufacturing and services. They find that direct sector switches among workers are rare. Instead, it is either young entrants that drive sector transitions or returnees out of non-employment.

[21] Appendix E.2 reports a robustness exercise in which the worker-side outside option is a labor-force-weighted average of state-specific fallback values. This specification allows the realized unemployment-duration distribution to enter wage determination directly. It produces a somewhat larger wage decline, but leaves the sectoral reallocation, current-account response, net foreign asset accumulation, and qualitative welfare conclusions largely unchanged. We keep the baseline because its threat point corresponds directly to the breakdown of an incumbent match.

The Nash wage w_t solves

$$w_t = \arg\max_{w_t} [\tilde{\mathcal{W}}_t]^{\zeta} [J_t]^{1-\zeta}.$$

4.5 Investment Fund

We assume that there is an investment fund. It is owned by the family and, thus, discounts the future with the stochastic discount factor Ω_t. The investment fund purchases investment goods and bundles physical capital, government bonds, and international assets into a single asset, which is held by the representative family of employed workers. The positions chosen during period t satisfy the following book-value financing identity:[22]

$$N_t a_{t+1} = b_{t+1} + NFA_{t+1} + K_{t+1}. \tag{4.33}$$

Capital depreciates at rate δ, and converting investment goods into installed capital is subject to adjustment costs:

$$K_{t+1} = (1-\delta)K_t + \left[1 - \frac{\psi_I}{2}\left(\frac{I_t}{I_{t-1}} - 1\right)^2\right] I_t, \tag{4.34}$$

where $\psi_I \geq 0$ governs the strength of the adjustment costs. Let $\mathcal{Q}_t$ denote the shadow value of an additional unit of installed capital, expressed in consumption units. The optimality conditions of the investment fund are:

$$R_{t+1}\mathcal{Q}_t = r^k_{t+1} + (1-\delta)\mathcal{Q}_{t+1}, \tag{4.35}$$

and

$$\begin{aligned} p^I_t = \mathcal{Q}_t \left[1 - \frac{\psi_I}{2}\left(\frac{I_t}{I_{t-1}} - 1\right)^2 - \psi_I \left(\frac{I_t}{I_{t-1}} - 1\right)\frac{I_t}{I_{t-1}}\right] \\ + \frac{\mathcal{Q}_{t+1}}{R_{t+1}}\psi_I \left(\frac{I_{t+1}}{I_t} - 1\right)\left(\frac{I_{t+1}}{I_t}\right)^2, \end{aligned} \tag{4.36}$$

where p^I_t denotes the price of investment goods relative to the consumption basket. Equation (4.35) equates the return on installed capital to the return on financial assets, while equation (4.36) determines investment in the presence of adjustment costs. When $\psi_I = 0$, equation (4.36) implies $p^I_t = \mathcal{Q}_t$. Substituting this result into equation (4.35) yields the standard no-arbitrage condition

$$R_{t+1}p^I_t = r^k_{t+1} + (1-\delta)p^I_{t+1}. \tag{4.37}$$

Because the fund arbitrages between capital, government bonds, and net foreign assets, R_{t+1}

[22] Capital is recorded at book value, so the fund's capital cash flow is $K_{t+1} - R_t K_t$. With $\mathcal{Q}_t$ denoting the marginal value of installed capital, the envelope condition gives

$$\mathcal{Q}_t = 1 + \Omega_t \left[r^k_{t+1} - R_{t+1} + (1-\delta)\mathcal{Q}_{t+1}\right],$$

which, using $\Omega_t R_{t+1} = 1$, implies equation (4.35).

is also the gross return on the composite household asset chosen in period t.

4.6 Government

The government collects a labor-income tax τ_t^w and a lump-sum tax τ_t. It issues government bonds b_{t+1} to finance government purchases G_t, unemployment benefits, and gross payments $R_t b_t$ on outstanding government debt:

$$G_t + \sum_{k=1}^{K} \kappa_t^{BS_k} u_t^{eu_k} + \kappa_t^{BL} u_t^{uu} + R_t b_t = \tau_t^w w_t N_t + \tau_t + b_{t+1}.$$

Government purchases fall on non-tradable goods.[23]
We use the lump-sum tax as the fiscal adjustment instrument. The proportional labor-income tax remains fixed in the baseline. The lump-sum tax follows

$$\tau_t - \bar{\tau} = \rho^{\tau}(\tau_{t-1} - \bar{\tau}) + \chi^b \left(b_t - \omega^b Y_{t-1} \right),$$

where $\bar{\tau}$ denotes steady-state lump-sum tax revenue, ω^b denotes the target debt-to-GDP ratio, ρ^{τ} captures tax smoothing, and χ^b governs the response to deviations of debt from its target. We use this lump-sum closure as a clean benchmark. It isolates the insurance, precautionary savings, and external-adjustment consequences of the unemployment-benefit reform from the separate effects of changing distortionary labor taxes. Put differently, the reform changes households' risk exposure and saving incentives without simultaneously acting as a labor-tax reform. This closure isolates the insurance, saving, and external-adjustment mechanisms from endogenous labor-tax feedback. In Appendix E.7, we replace the lump-sum rule with an analogous labor-tax rule and show that the qualitative welfare ranking and the main spillover mechanism remain unchanged.

4.7 International Linkages

In our model, the two countries, Home and Foreign (denoted with F) are linked by trade in consumption and investment goods as well as international assets. Both countries trade a common one-period asset, so the return R_t is equalized internationally. We define the CPI-based real exchange rate as

$$RER_t = \frac{P_t}{P_{t,F}},$$

so that a decline in RER_t denotes a real depreciation of Home. We separately denote the relative producer price of Home tradables by

$$relp_t^T = \frac{p_{t,H}^T}{p_{t,F}^T} = \frac{1}{TOT_t}.$$

[23] This is consistent with the high service content of government consumption. The implementation also allows for a tradable component of government purchases and for a non-tradable component of investment; both are switched off in the baseline.

The foreign tradable good serves as the numeraire, $p^T_{t,F} = 1$.
Asset market clearing implies that total assets in the home economy, $N_t\, a_{t+1}$, have to equal government debt plus net foreign assets and capital, $b_{t+1} + NFA_{t+1} + K_{t+1}$. Hence, the loanable funds constraint, equation (4.33), must hold. Net foreign asset positions are measured in units of the respective country's consumption basket. As assets for the two countries must be in zero net supply, it must also hold that $rs\, P_t\, NFA_t + (1 - rs)\, P_{t,F}\, NFA_{t,F} = 0$, where rs is the relative size of the home country. A country's net foreign asset position is defined as the last period's assets plus current net exports, NX_t,

$$NFA_{t+1} = R_t NFA_t + NX_t, \tag{4.38}$$

and the current account is given by $CA_t = NFA_{t+1} - NFA_t$. Real per-capita net exports in Home are given by $NX_t = EX_t - IM_t$, with $EX_t = p^T_{t,H}/P_t \cdot (1 - rs)/rs \cdot (c_{t,H,F} + i_{t,H,F})$, and $IM_t = p^T_{t,F}/P_t \cdot (c_{t,F} + i_{t,F})$, where $c_{t,H,F}$ and $i_{t,H,F}$ denote foreign per-capita demand for home tradables.

4.8 Market Clearing

Non-tradable goods must be absorbed domestically. In each country, market clearing in the non-tradable sector requires

$$Y^N_t = C^N_t + \mathcal{R}^N_t + \frac{G_t}{p^N_t}, \tag{4.39}$$

and analogously in the foreign economy. Division by p^N_t converts government expenditure, which is measured in consumption units, into units of the non-tradable good.
Given equation (4.39) and the budget constraints of households, firms, the government, and the net foreign asset accumulation equation (4.38), market clearing for tradable goods holds by Walras' law and is not imposed as an additional equation.[24] Summing across sectors yields the economy-wide resource constraint

$$p^T_t Y^T_t + p^N_t Y^N_t = C_t + p^I_t I_t + G_t + NX_t + \sum_{j=T,N} p^j_t\, \mathcal{R}^j_t + \Delta Z_t, \tag{4.40}$$

where ΔZ_t denotes the change in the asset resources held by unemployment cohorts outside the family (see Appendix D.1). The corresponding constraint holds in the foreign economy.

5 Calibration

This section presents our calibration strategy and describes how we implement the structural labor market reform in our tractable two-country incomplete insurance framework.

[24] Because unemployed workers hold their asset resources temporarily outside the employed family, the aggregation of budget constraints contains the change in these cohort asset accounts. The tradable market condition holds up to this term, which is tied down exactly by the cohort accounting identity stated in Appendix D.1. We verify the identity numerically along the transition.

5.1 Calibration Strategy

Table 2 shows our baseline calibration. The frequency is quarterly, and the calibration of Home (Germany) and Foreign (Rest of Eurozone) is asymmetric. The two regions differ with respect to country size, the steady-state unemployment rate, the job-finding rate, the home bias, and the discount factor. The size of the Home country is 27.1 percent, which corresponds to the German share of GDP in the Eurozone in the year 2005. We set the subjective discount factor of the home country to $\beta = 0.9841$ and the parameter of constant relative risk aversion σ_c to 2. Steady-state productivity is normalized to one in both countries. The foreign discount factor is determined internally such that the home country's pre-reform net foreign asset position is zero (see Table 3 and empirical Figure 2). The reform therefore starts from a balanced external position, and the post-reform paths of the current account and net foreign assets are attributable to the reform itself.

We follow Cacciatore et al. (2016a) and set the elasticity of substitution between home and foreign goods to 6. We set the elasticity of substitution between tradable and non-tradable goods to 0.5 (see Mendoza, 1991). We set the tradable weight in the consumption aggregator to $\alpha^T = 0.79$, using the 2004 output value share of tradable manufacturing and services as a proxy for the initial tradable expenditure weight (Dustmann et al., 2014). Consistent with our definition of tradables, Dustmann et al. (2014) classify sectors as tradables if their export volume is above the 25th percentile of the distribution of export volumes.[25] We set the Home consumption-bias parameter to $\gamma^C = 0.656$, close to the value used by Cacciatore et al. (2016a).[26]

Regarding the labor market, we set the matching elasticity η and workers' bargaining power ζ to 0.5, both standard values. We target steady-state unemployment rates of 8.9 percent for Home and 9.6 percent for Foreign, based on harmonized unemployment rates averaged over 1995–2004 (OECD, Main Economic Indicators). We target a quarterly job-finding rate of 11.6 percent for Home, the average German rate in 2004 prior to the Hartz IV reform (Jung and Kuhn, 2014). We scale the home-to-foreign job-finding rate inversely to the home-to-foreign unemployment rate, which yields a job-finding rate of 10.8 percent.

We use the job-filling rate $q = 0.7$ (Christoffel, Kuester, and Linzert, 2009) to normalize the vacancy scale. Conditional on the unemployment and job-finding targets and this normalization, steady-state flow balance determines the separation rate s, the matching function determines matching efficiency κ^e, and the sectoral job-creation conditions determine the recruiting cost scales κ_T^v and κ_N^v.[27] These parameters are therefore determined internally. In the pre-reform steady state, short-term unemployed workers retain their benefit entitlement for at most $K = 8$ quarters, after which they become long-term unemployed. The reform reduces this entitlement period to four quarters, as described in Section 5.2.

[25] See Table A1 in the Appendix of Dustmann et al. (2014).

[26] Conditional on the zero-NFA calibration, the foreign home bias is determined residually from the steady-state external-balance condition.

[27] With the labor force normalized to one, steady-state flow balance implies $s = \frac{\rho}{1-\rho}\frac{u}{1-u}$. Given q, the matching function implies $\kappa^e = \rho^\eta q^{1-\eta}$, while the sectoral job-creation conditions imply $\kappa_j^v = qS^{f,j}$. Because the recruiting curvature χ_j enters the value of a filled job $S^{f,j}$, the implied recruiting cost scales differ across sectors.

Table 2: Baseline Model Parameters

Parameter Name	Symbol	Value	
		Home	Foreign
Panel A: Externally Set			
Country Size	rs	0.271	0.729
Discount Factor	β	0.9841	See Panel B
Risk Aversion	σ_c	2	2
Steady-State Productivity (Normalization)	e^z	1	1
Home Bias	γ^C	0.656	See Panel B
EOS, Home and Foreign Goods	η^C	6	6
EOS, Tradable and Non-Tradable Goods	ϕ^T	0.500	0.500
Share of Tradables in Consumption	α^T	0.790	0.790
Matching Elasticity	η	0.500	0.500
Workers' Bargaining Power	ζ	0.500	0.500
Recruiting Curvature, Tradable	χ_T	1	1
Investment Adjustment Cost	ψ_I	8.700	8.700
Capital Depreciation	δ	0.030	0.030
Weight on Capital in Production	α	0.330	0.330
Productivity (SS)	e^z	1	1
Number of Short-Term Asset-Holding States	K	8	8
Replacement Rate, Short-Term Unemployed	rr^s	0.600	0.600
Replacement Rate, Long-Term Unemployed	rr^l	0.500	0.500
Persistence of Lump-Sum Tax	ρ^τ	0.800	0.800
Elasticity of Tax Rate to Debt Deviations	χ^b	0.050	0.050
Target Government Debt to Output Ratio	ω^b	0.600	0.600
Share of Assets Retained by Employed Family Pool	τ^F	0.800	0.800
Pre-Reform Steady-State Lump-Sum Tax	$\bar{\tau}$	0	0
Job-Filling Rate (Vacancy-Scale Normalization)	q	0.700	0.700
Panel B: Calibrated Internally			
Discount Factor	β_F	See Panel A	0.9840
Home Bias	γ_F^C	See Panel A	0.871
Recruiting Curvature, Non-Tradable	χ_N	3.500	3.500
Recruiting Cost Scale, Tradable	κ_T^v	4.338	5.019
Recruiting Cost Scale, Non-Tradable	κ_N^v	5.177	5.993
Matching Efficiency	κ^e	0.285	0.275
Separation Rate	s	0.0128	0.0129

Notes: The frequency is quarterly. Panel A lists parameters set outside the model, from data or the literature. Panel B lists parameters implied by steady-state and transition targets, normalizations, and equilibrium conditions. The non-tradable recruiting curvature χ_N is calibrated jointly with the replacement-rate cut to the sectoral employment targets. The foreign discount factor matches the zero pre-reform net foreign asset position of the home country.

Capital depreciates at a rate of 3 percent per quarter, and the weight of capital in production α is 0.33. Capital accumulation is subject to investment adjustment costs. We set $\psi_I = 8.7$, the posterior mean estimated for the euro area by Adolfson, Laséen, Lindé, and Villani (2007). For the policy parameters in the pre-reform steady state, we set the replacement rate for short-term unemployed to 0.6 and the replacement rate for long-term unemployed to 0.5. These values correspond to the legal replacement rates for single earners without children before the Hartz IV reform.

For the fiscal rule, we set the persistence of the lump-sum tax ρ^τ to 0.8. Furthermore, we set the target government debt-to-output ratio to $\omega^b = 0.6$ and the response of the lump-sum tax

to debt deviations to $\chi^b = 0.05$ to ensure stationarity of government debt (see Kirsanova and Wren-Lewis, 2012).[28] When a worker enters unemployment, the employed family pool retains a share $\tau^F = 0.80$ of the worker's asset claim, and newly unemployed workers receive the remaining 20 percent. We set $\tau^F = 0.80$ to the lowest value in our calibration that satisfies the existence condition $c^{eu,1} < c^e$.[29] The pre-reform steady-state lump-sum tax is normalized to zero and adjusts endogenously during the transition.

Table 3: Targets

Target	Symbol	Value	
		Home	Foreign
Relative Reaction of Tradable to Non-Tradable Employment		0.027	–
Non-Tradable Employment Response		-0.0060	–
Unemployment Rate	u	0.089	0.096
Job-Finding Rate	ρ	0.116	0.108
Tradable Producer Price	p_H^T	1	1
CPI	P	1	1
Real Exchange Rate	RER	1	1
Debt-to-GDP Ratio	b/Y	0.600	0.600
Pre-Reform Net Foreign Assets	NFA/Y	0	0

Notes: Steady-state and transition targets of the calibration. The sectoral employment responses are averages over the first 40 quarters and refer to the full reform, that is, both the replacement-rate cut and the entitlement-duration cut. They are matched jointly by the replacement-rate cut and the non-tradable recruiting curvature χ_N. The zero pre-reform net foreign asset position is matched by the foreign discount factor. The job-filling rate $q = 0.7$ is used as a normalization of the vacancy scale and is reported in Table 2.

Table 2 distinguishes between parameters that are set externally (Panel A) from those set internally (Panel B). The latter are determined by steady-state conditions, normalizations, and the transition targets reported in Table 3.

We discipline the reform effects using two moments from our microeconometric estimation: the average difference between the percentage responses of tradable and non-tradable employment over the first 40 quarters after the reform, which we target at 2.7 percentage points, and the corresponding average decline in non-tradable employment of 0.6 percent.[30] The baseline therefore reproduces both the relative sectoral shift and the underlying level responses. Non-tradable employment falls by 0.6 percent, while tradable employment increases by approximately 2.1 percent, consistent with the estimated sectoral responses. This matters for the open-economy results. If the model attributed the full relative response to an expansion of the tradable sector, without any decline in the non-tradable sector, it would overstate the current account improvement and the spillover to the rest of the Eurozone.

The recruiting curvatures govern how strongly sectoral vacancy creation responds to aggregate changes. We set the tradable curvature to $\chi_T = 1$. The Home non-tradable recruiting curvature is jointly calibrated with the replacement-rate cut to the Home sectoral targets and

[28] In the baseline, the proportional labor-income tax is fixed and the lump-sum tax adjusts according to the fiscal rule. Performing an analogous simulation in which the labor tax rate takes care of debt stabilization does not alter our main results qualitatively.

[29] Lower values of τ^F provide more self-insurance and weaken the precautionary-savings motive, making this boundary calibration conservative for our mechanism.

[30] The empirical sample covers 1994–2014, and the post-reform indicator equals one during 2005–2014. For the relative sectoral response, we use the lower bound of 2.7 percentage points.

is then imposed symmetrically in the Foreign economy. This yields $\chi_N = 3.5$.[31]

We use the Foreign tradable producer price as the numeraire, $p^T_{t,F} = 1$ for all t. In the initial steady state, we target $\bar{p}^T_H = 1$ and normalize the CPI in both countries to one. The initial terms of trade and real exchange rate therefore also equal one. Given these targets, the equilibrium interest rate and the asset shares consumed by unemployed workers in states $k \in \{1, \ldots, K\}$ are determined endogenously.

5.2 Reform Implementation

We implement the first reform step by reducing the replacement rate for long-term unemployed workers, rr^l, by 37.9 percent, from 0.50 to 0.31. The size of the cut is calibrated jointly with the non-tradable recruiting curvature so that the full reform simulation, which also includes the entitlement-duration cut described below, matches the 2005–2014 sectoral employment targets (see Figure 1 for an illustration). We further make long-term unemployment benefits time invariant: $\kappa^{BL}_t = \bar{\kappa}^{BL} = rr^{l,new}(1-\bar{\tau}^w)\bar{w}$. The magnitude of the decline in the replacement rate is within the range of plausible estimates.[32] See Section 3 and Appendix A for institutional details.

The second reform step reduces the maximum duration of short-term unemployment benefits by four quarters. Specifically, workers who have been unemployed for five to eight quarters receive long-term rather than short-term benefits after the reform. These workers were eligible for short-term unemployment benefits in the pre-reform economy, so that the maximum duration falls from eight to four quarters. Because the model abstracts from age and employment-history heterogeneity, the four-quarter reduction should be interpreted as a parsimonious representation of the sizable entitlement cuts faced by the groups directly affected by the reform.[33]

We model the full Hartz IV package as a one-time permanent policy change. Both reform steps come into force in the first quarter of the transition, corresponding to the year 2005. The historically staggered introduction of the two steps in 2005 and 2006 is not modeled separately. At the time of the policy change, the economy is in its pre-reform steady state, the change is unanticipated, and there are no further shocks after the policy change.

[31] The higher curvature in the non-tradable sector makes marginal recruiting costs rise more steeply with the vacancy rate and therefore implies that non-tradable vacancy creation reacts less elastically to the reform-induced shift in demand. This helps the model match the estimated decline in non-tradable employment alongside the tradable expansion. Acemoglu and Hawkins (2014) use quadratic vacancy posting costs. Bilal, Engbom, Mongey, and Violante (2022) estimate a curvature parameter of 3.45 for the US economy, very close to our value of $\chi_N = 3.5$.

[32] Note that the discussion on how much the replacement rate due to Hartz IV actually declined has not been resolved. 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) assume a reduction of 67 percent for high-skilled workers and around 24 percent for low-skilled workers. Our replacement rate reduction is inside this range of estimates.

[33] Hartung et al. (2026) show that the cut mainly affected workers aged 45 or older with sufficiently long employment histories and ranged from approximately 6 to 14 months.

5.3 Computation

We solve the reform experiment under perfect foresight using Dynare's stacked perfect-foresight solver. We first compute the pre-reform steady state and use it as the initial condition. We then change the policy parameters associated with the Hartz IV reform, compute the corresponding post-reform steady state, and solve for the deterministic transition path between the two steady states over a finite horizon, imposing the post-reform steady state as the terminal condition. Along the transition, the paths of macroeconomic quantities and prices are jointly determined so that all equilibrium conditions hold period by period.

6 Simulation Results

In this section, we use the calibrated two-country model to quantify the effects of the German Hartz IV unemployment insurance reform on the reforming economy, its non-reforming partner in a common currency area, and the joint external balance. We first describe how the reform changes wages, employment, savings, and unit labor costs at home, and how these changes spill over to the foreign economy and its net foreign asset position. We then examine the long-run implications for output and consumption in both countries, relate the simulated adjustment to the data on German and Eurozone current accounts and savings that can be found in aggregate data (see Section 3), and evaluate the welfare consequences across worker groups. Finally, we contrast these results with a wage-moderation experiment and with several robustness checks.

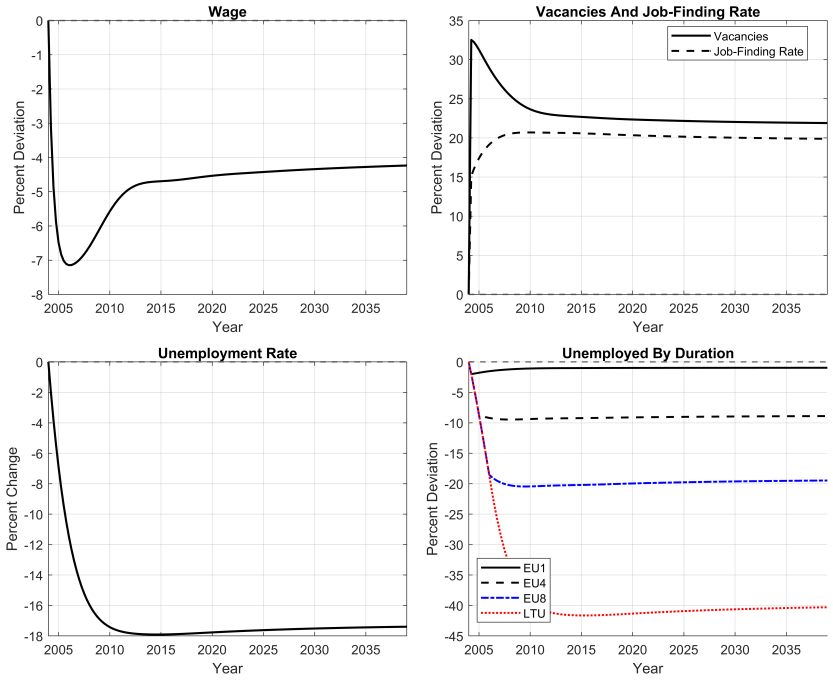
6.1 Effects of Benefit Reform

6.1.1 Effects in the Reforming Economy

The unemployment benefit reform triggers two main effects in the reforming economy. First, as the value of (long-term) unemployment falls, the fallback option in wage bargaining deteriorates, and wages decline immediately. Figure 6 shows that the lower wage stimulates vacancy posting, increases job-finding rates, and reduces unemployment in the reforming economy. Over time, the increase in market tightness and the gradual build-up of the capital stock raise the marginal product of labor. After the first years of the transition, wages partially recover as capital accumulates and the labor market remains tight. They nevertheless remain below their pre-reform level. Burda and Seele (2020) document trends in the German labor market in the aftermath of the Hartz reforms and argue that the Hartz IV reform played a central role. Their documented trends are in line with our model simulations.

Second, the reform reduces public insurance against unemployment. The cut in long-term replacement rates and the shorter duration of the more generous short-term benefits both raise the expected marginal utility of consumption along unemployment paths. This stimulates precautionary savings among employed workers and induces them to accumulate more assets. The household savings rate increases immediately and remains above its pre-reform level

Figure 6: Consequences of the Benefit Reform for the Domestic Labor Market



Notes: Model responses to the labor market reform in our baseline incomplete insurance framework. All adjustment paths are depicted as percent changes from the pre-reform steady state.

throughout the displayed transition (see Figure 7).[34] Domestic consumption falls sharply on impact and remains below its pre-reform level for roughly a decade. It subsequently returns to positive territory, as the increases in employment (lower unemployment risk) and GNP (more output for consumption) dominate the initial precautionary contraction.

The rise in household savings and the wage decline generate a strong and persistent decline in relative unit labor costs, a purely labor-based competitiveness measure (see Figure 7 and Table 5). On impact, lower domestic consumption reduces demand for home-produced goods, while lower wages reduce marginal costs in both the tradable and non-tradable sectors.[35]

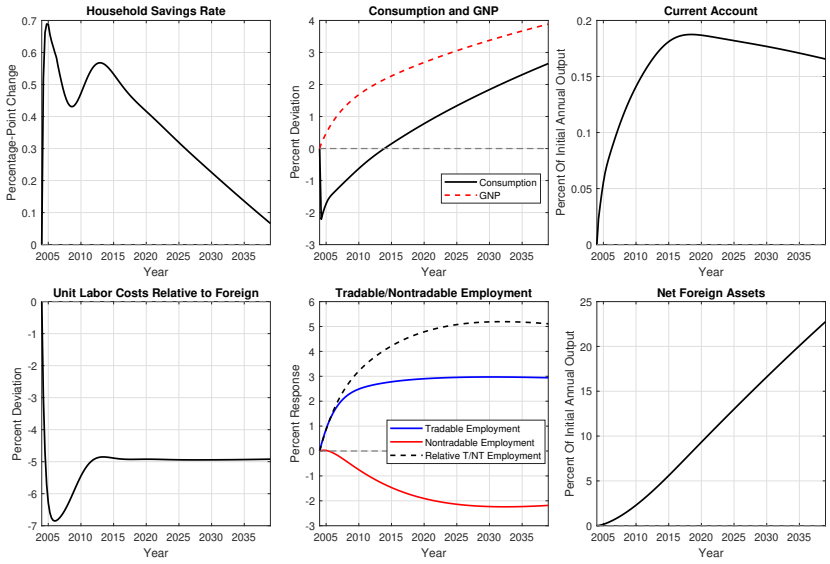
In our quantitative exercise, we target both the relative expansion of tradable/non-tradable employment between 2005 and 2014 and the decline in non-tradable employment as estimated from the AWFP (see Table 1 in Section 3.3). As a result, the model reproduces the empirically observed expansion in tradable employment and decline in non-tradable employment.[36] Since households have access to international assets, the increase in domestic asset holdings that is driven by the strengthened precautionary savings motive translates into a higher net foreign asset position and a persistent current account surplus.

[34] We define the household savings rate as disposable income minus consumption, expressed as a share of disposable income.

[35] In the first period, marginal costs in the reforming economy rise temporarily because vacancy posting spikes.

[36] In the employment regression, the coefficient on the post-2005 Hartz IV dummy is negative, while its interaction with tradability is positive, implying a decline in non-tradable employment and an expansion of tradable employment relative to non-tradable employment. We use this as targets in our model.

Figure 7: Consequences of the Benefit Reform for Savings and Production



Notes: Model responses to the labor market reform in our baseline incomplete-insurance framework. Consumption, GNP, unit labor costs relative to the foreign economy, and sectoral employment are shown as percent deviations from the pre-reform steady state. The household savings rate is shown in percentage-point changes. The current account and net foreign assets are expressed as percent of initial annual output.

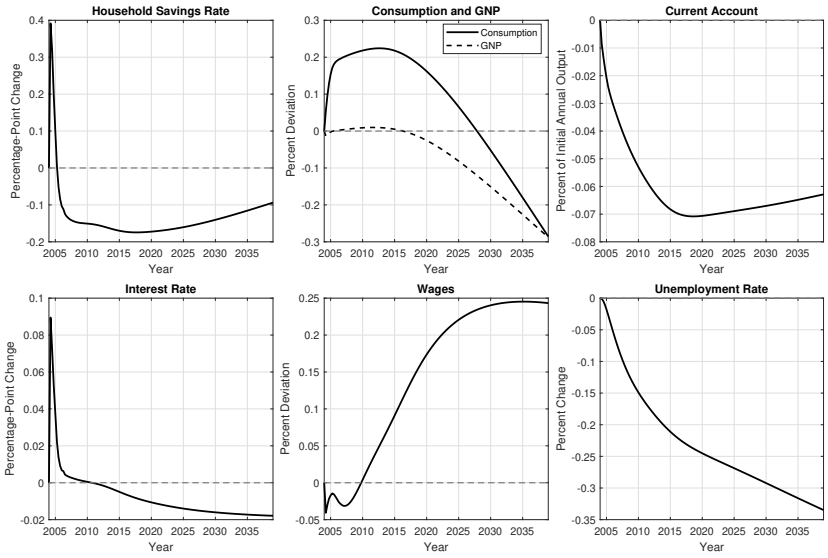
6.1.2 Short-Run Spillover Effects to the Non-Reforming Economy

Figure 8 shows that the international transmission of the reform changes over time. The reform initially increases households' savings rates in the non-reforming economy in reaction to the interest rate increase. The short-lived impact increase of the interest rate is due to general equilibrium forces: the supply of assets cannot adjust immediately—physical capital expands only gradually owing to investment adjustment costs, and government debt is also slow-moving. As the supply of assets expands, however, the interest rate declines and eventually falls below its pre-reform level. Thus, in the medium to long run, the foreign household savings rate consequently drops below its initial level. This behavior is triggered by precautionary savings in the home economy, which reduce the joint equilibrium interest rate in the two-country economy.

Despite the temporary increase in foreign household saving, the foreign economy runs a current account deficit from the beginning of the transition. This is not contradictory: the household savings rate is only one component of national savings, whereas the current account reflects the difference between total national savings and domestic expenditure. In the model, foreign demand exceeds foreign national income, so the country accumulates external liabilities. Foreign consumption initially rises and remains above its pre-reform level for an extended period. However, the persistent current account deficits gradually generate a larger negative net foreign asset position. This reduces long-run consumption.

The reform nevertheless produces a moderate positive labor-market spillover in the non-reforming economy. Foreign unemployment falls throughout the transition. Initially, wages decline slightly, and the value of a filled job rises, increasing firms' incentives to create vacan-

Figure 8: Effects on the Foreign Economy



Notes: Model responses to the labor market reform in our baseline incomplete-insurance framework. Consumption, GNP, wages, and the unemployment rate are shown as percent changes from the pre-reform steady state. The household savings rate and interest rate are shown as percentage-point changes. The current account is expressed as percent of initial annual output.

cies. Foreign vacancy posting and the job-finding probability therefore increase even before the capital stock has adjusted substantially. As the common interest rate subsequently declines, capital accumulation becomes more attractive, and the foreign capital–labor ratio rises gradually. Because capital and labor are complementary in production, capital deepening raises the marginal product of labor and further increases the surplus from a successful match. Vacancy creation and employment consequently expand, while unemployment continues to fall. As workers share the higher match surplus, foreign wages eventually rise above their pre-reform level.

The improvement in foreign labor-market outcomes does not, however, prevent consumption from declining in the long run. Persistent current account deficits turn the foreign economy into a net debtor, and the associated payments on external liabilities reduce the income accruing to foreign residents. This distinction is visible in the declining path of foreign GNP: higher employment and wages support domestic production, but an increasing part of the income generated in the foreign economy accrues to asset holders in the reforming economy. Eventually, the deterioration in net foreign income dominates the positive labor-income effect, and foreign consumption falls below its pre-reform level.

In a currency-union interpretation, the reform therefore generates distinct consumption spillovers. It shifts net asset ownership toward the reforming member. The non-reforming economy, consequently, bears a long-run consumption cost through its increasingly negative net foreign asset position.

6.2 Long-Run Effects

The reform generates significant cross-border consumption spillovers. In the new steady state, aggregate consumption rises by around 11 percent in the reforming economy but falls by more than 3 percent in the foreign economy. The foreign consumption loss occurs despite a modest increase in foreign GDP. As the reforming economy accumulates claims on foreign assets, an increasing share of production in the foreign economy accrues to home asset holders. Foreign GDP and GNP, therefore, diverge, and foreign residents receive less income relative to the output produced within their economy. From a currency-union perspective, the reform improves the external position of the reforming economy at the expense of a persistent debtor position in its partner economy, requiring an ongoing transfer of factor income from the foreign to the home economy.

Our calibration targets the short- to medium-run response of tradable relative to non-tradable employment in the reforming economy using the most conservative estimate from the microeconomic evidence in Section 3.3. The long-run results show that the domestic gains associated with the reform are not confined to the reforming economy's labor market or public finances. They are accompanied by a redistribution of external assets and consumption across member countries. A labor market reform that raises domestic income and asset accumulation can therefore impose persistent consumption losses on its currency-union partners, even when GDP does not decline.

Table 4: Long-run Reform Effects in Home and Foreign Economy (% dev. from steady state)

	Home	Foreign
GDP	2.70	0.24
GNP	8.84	-2.02
Aggr. Consumption	**10.84**	**-3.25**
Unemployment	-17.47	-0.89
C: Tradable	11.42	-3.26
C: Non-tradable	8.70	-3.24
Tradable-to-non-tradable expenditure ratio	-10.78	4.13
CPI	1.88	0.15
TPI	0.82	0.16
Wage	-3.61	-0.09
Interest Rate	-0.02	-0.02
Real Exchange Rate	1.73	-1.70
Capital-Labor Ratio	3.01	0.45
NFA/Output	88.88	-34.70

Notes: Changes compare the saved post-reform steady state with the saved pre-reform steady state. The interest rate and NFA/output are percentage-point changes.

6.3 Model and Data

In Table 5, we contrast the model-implied changes with the corresponding empirical developments in 2014; that is, ten years after the implementation of the labor market reforms. Each entry reports the share of the observed movement accounted for by the model. We contrast the baseline simulation with a complete insurance version of our model.[37]

[37] Appendix E.3 further shows contributions for low- and high-ζ variants of workers' bargaining power.

Table 5 compares the private savings rate reaction of employed workers in the model to the differential change of the private savings rate based on the German Socio-Economic Panel (SOEP), as calculated by Hochmuth et al. (2026). In the data, the private savings rate of employed workers increases by approximately 2.7 percentage points from trough to peak, and our baseline model accounts for more than 20 percent of this increase. On the external side, the baseline simulation explains 13 percent of the observed increase in net foreign assets relative to GDP and more than 9 percent of the overall current account improvement. Consistent with the descriptive evidence that the German surplus rose primarily vis-à-vis Eurozone partners, the model captures almost half of the current account movement relative to the rest of the Eurozone. However, our model overshoots in terms of unit labor costs due to the relatively strong wage reaction.[38]

Table 5: Model Contribution to Empirical Time Series in 2014 (Ten Years After the Reform)

Indicator	Baseline	Complete Insurance
Unemployment	32.9%	12.4%
Private Savings Rate	20.7%	5.5%
Net Foreign Assets/GDP	13.0%	-2.7%
Current Account/GDP	9.2%	0.3%
Current Account vis-a-vis Eurozone/GDP	44.9%	1.2%
Unit Labor Costs Relative to Eurozone	189.2%	48.9%
Private Savings Rate Rest of Eurozone	4.1%	-0.4%

Notes: Each entry reports the share of the observed empirical movement explained by the model-implied average change in calendar year 2014. Complete insurance uses the maintained Schmitt-Grohe and Uribe (2003) closure coefficient $\psi = 0.001$.

In Appendix E.1, we show model responses under complete insurance (with consumption pooling among all households, as in standard models).[39] This case is compared to the patterns in the data in the right column of Table 5. The external patterns observed in the baseline scenario largely disappear when the precautionary savings channel is absent. When all workers are perfectly insured, the reform increases private savings only modestly due to the overall expansionary effects of the reform. However, the strong self-insurance motive is absent and, as a result, the simulated responses of net foreign assets and the current account are negligible and cannot account for the observed surplus. As discussed in Appendix E.1, we cannot hit the tradable-to-nontradable target under complete insurance. Intuitively, under complete insurance, the income risk associated with unemployment is pooled across workers. Thus, households have a substantially weaker incentive to increase savings in response to the reform.[40]

[38] Figure 3 shows that unit labor costs in Germany deteriorated after the Eurozone crisis, while, in particular, Southern European countries improved their competitiveness. It must be kept in mind that the descriptive aggregate numbers contain more than just one shock/policy reform.

[39] In the Appendix, we compare complete and incomplete insurance directly. We use the assumptions of Schmitt-Grohe and Uribe (2003) to guarantee stationarity under complete insurance. For comparability, the Appendix shows the same scenario under incomplete insurance.

[40] In Appendix E.3, we show that the external adjustment is largely unaffected by different bargaining powers.

6.4 Fiscal Space

The unemployment insurance reform sharply reduces public spending on unemployment benefits. Higher employment partly offsets the wage decline, but the wage bill (and hence labor-tax revenue at the fixed tax rate) falls. The reduction in benefit expenditure more than offsets this revenue loss, so that the reform creates additional fiscal space for the reforming government. This pattern is consistent with empirical evidence that household savings rose around the time of the reform and that the government sector became an important driver of aggregate savings shortly thereafter.

To quantify this, we define fiscal space at fixed policy settings. Total unemployment-benefit expenditure is given by

$$B_t^{UI} = \sum_{k=1}^{K} \kappa_t^{BS_k} u_t^{eu_k} + \kappa_t^{BL} u_t^{uu}, \tag{6.1}$$

We distinguish between a *primary* and an *overall* measure of fiscal space. Primary fiscal space measures the reform-induced change in labor-tax revenue net of the change in unemployment-benefit expenditure. Overall fiscal space additionally accounts for changes in interest payments on public debt. Let τ^w denote the time-invariant labor income tax rate, and $\bar{Y}$ output in the pre-reform steady state. Formally,

$$FS_t^{prim} = \frac{1}{\bar{Y}} \left[\tau^w \left(w_t N_t - \bar{w}\bar{N} \right) - \left(B_t^{UI} - \bar{B}^{UI} \right) \right], \tag{6.2}$$

$$FS_t^{ov} = FS_t^{prim} - \frac{1}{\bar{Y}} \left[(R_t - 1) b_t - (\bar{R} - 1)\bar{b} \right]. \tag{6.3}$$

where $\bar{B}^{UI}$ and $\bar{b}$, $\bar{N}$, $\bar{w}$ denote the pre-reform steady-state and parameter values, respectively. Fixed government purchases and fixed lump-sum taxes cancel from these level changes. We exclude the endogenous lump-sum-tax response generated by the fiscal rule because it determines how the fiscal dividend is financed or reused rather than how much fiscal space the reform creates. Both measures are expressed in percentage points of pre-reform GDP.

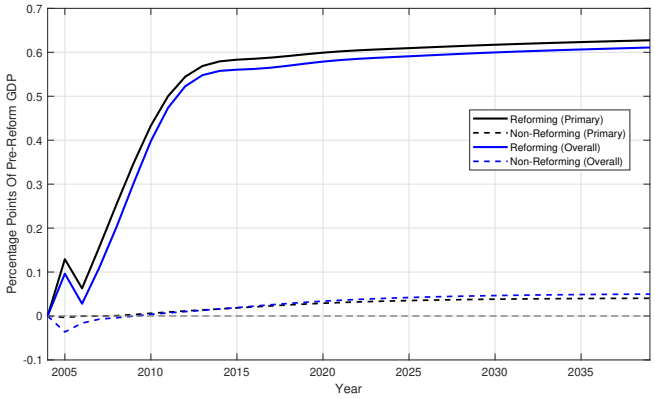
Figure 9 shows government fiscal space in the reforming and non-reforming economies, distinguishing between the primary and overall measures. We report FS_t^{prim} and FS_t^{ov} in percentage points of pre-reform GDP and as annual averages of the quarterly responses. At the fixed labor-tax rate, primary fiscal space is driven by changes in the wage bill and unemployment-benefit expenditure. The overall measure also reflects changes in interest payments on public debt.

In the reforming economy, fiscal space rises sharply during the first year, declines temporarily during the second year, and subsequently rises persistently. Both the primary and overall measures remain positive. Although employment rises, wages decline sufficiently that labor-tax revenues initially fall. The benefit-spending reduction more than offsets this revenue loss. The debt-service channel initially reduces overall fiscal space because the common interest rate rises temporarily. Although the interest rate subsequently falls below its initial level, the reforming economy's larger public-debt stock continues to raise debt service over the horizon

shown.[41] Overall fiscal space, therefore, remains slightly below primary fiscal space, with the gap narrowing over time.

In the non-reforming economy, fiscal space is substantially smaller. Primary fiscal space is approximately unchanged initially, while overall fiscal space becomes temporarily negative because of higher debt-service costs. Both measures subsequently recover and become positive. As Figure 8 shows, foreign consumption and GNP eventually fall below their initial steady-state levels as the non-reforming economy accumulates a negative net foreign asset position vis-à-vis the reforming country. Nevertheless, foreign wages and employment remain slightly above their initial levels over the horizon shown, leaving the labor-tax base marginally higher. Primary fiscal space remains positive but small. However, overall fiscal space eventually exceeds primary fiscal space because the decline in the common interest rate lowers foreign government debt service.

Figure 9: Fiscal Space at Home and Abroad



Notes: Model responses to the labor market reform in the baseline incomplete-insurance framework. The figure reports annual averages in percentage points of pre-reform GDP. Primary fiscal space is the fixed-policy change in labor-tax revenue net of the change in unemployment-benefit expenditure. Overall fiscal space additionally subtracts the change in interest payments on outstanding government debt, $(R_t - 1)b_t$. Fixed government purchases and lump-sum taxes cancel from the level changes, while the endogenous lump-sum-tax change is excluded.

It is instructive to contrast the model results with sectoral savings in Germany. Average private savings rose from 4.1% of GDP in 1991–2004 to 5.4% in 2005–2019. In 2005, private households were the main driver of higher aggregate savings, while in 2006–2007 the government sector took over this role: government net savings increased from around -3 to -4% of GDP in 2001–2005 to -1.7 and $+0.3$% in 2006 and 2007. The Hartz reforms thus expanded fiscal space, but taxes were not reduced immediately. Social security contributions for unemployment insurance, for example, were cut only gradually from 6.5% in 2005/06 to 4.2% in 2007, 3.3% in 2008, and 2.8% in 2009. As a result, households and the government together contributed strongly to the rise in net savings (see Figure 12 in Appendix B.1).

Non-financial firms in Germany only became major net savers during the Global Financial Crisis, with their net savings jumping from -0.5% of GDP in 2008 to 2.8% and 3.2% in 2009 and 2010. Figure 13 in the Appendix shows that the current account vis-à-vis the rest of the

[41] Because the fiscal rule stabilizes debt relative to output, higher output is accompanied by a higher level of public debt.

Eurozone was the main driver of the overall current account surge around 2005, highlighting the importance of spillovers to the Eurozone.

6.5 Welfare Consequences

We now evaluate the welfare implications of the labor market reform. This matters because long-run changes in average consumption and fiscal space may be different from ex-ante welfare in an environment with incomplete insurance and transition dynamics. To assess the welfare consequences of the Hartz IV reform, we compute consumption equivalent variations (CEVs) for each worker group in both countries. For group g in country j, the CEV is the permanent percentage change in consumption in the pre-reform steady state that makes agents indifferent (in terms of expected lifetime utility) between an economy with the reform and one without it.

Table 6 reports the welfare results. In the reforming economy, the Hartz IV reform reduces ex-ante welfare, with an aggregate CEV of -2.07 percent. This is true even though average consumption rises in the new steady state. The reason is that welfare depends on the full transition path and on the distribution of consumption across states with different marginal utilities. The reform reduces insurance precisely in high-marginal-utility states, especially for the long-term unemployed. Furthermore, employed households cut consumption on impact to build precautionary savings. These insurance and transition costs outweigh the later increase in average consumption. Across worker groups, losses are less pronounced for employed workers and early short-term unemployed, but they increase with unemployment duration and are substantial for the long-term unemployed (-10.39 percent) who are directly affected by lower benefit generosity.[42]

In the non-reforming economy, Table 6 shows a small positive aggregate CEV, and all groups experience small welfare gains. From an ex-ante perspective, foreign households benefit from the short-run consumption boom and from the subsequent decline in the common interest rate. Although the non-reforming economy experiences lower consumption in the long run because it accumulates net foreign liabilities, these losses are delayed. In present-value terms, the initial transition gains dominate the later debt-service losses. Hence, the Hartz IV reform is slightly welfare improving abroad. However, it entails non-negligible and uneven welfare losses in the reforming country, especially for the workers most directly exposed to the reduction in unemployment insurance.

A potential concern is that welfare differences of this kind may induce additional adjustment through cross-country migration. However, migration flows were very small over the relevant period, with net migration to Germany averaging less than 0.2 percent of employment between 2005 and 2009 (see Section 6.9 for more details). Thus, abstracting from migration is unlikely to affect our qualitative welfare conclusions. In Appendix E.7, we show that these conclusions remain qualitatively unchanged under an alternative fiscal closure in which adjustment occurs

[42] These welfare losses hinge on treating the reform as a pure reduction in unemployment insurance, holding separation risk fixed. If we instead attribute the post-reform decline in separations documented by Hartung et al. (2026) completely and immediately to the reform, the fall in unemployment risk is itself a large insurance gain, and the aggregate home CEV turns positive (see Appendix E.5).

through distortionary labor taxes rather than lump-sum taxes, although welfare losses in the reforming country become slightly more negative.

Table 6: Consumption Equivalent Variation (CEV) by Group and Country

Group	Reforming Economy (A)	Non-Reforming Economy (B)
Aggregate	-2.07	0.06
Employed	-1.34	0.07
Short-Term Unemployed		
EU1	-4.12	0.05
EU2	-4.83	0.05
EU3	-5.70	0.05
EU4	-6.76	0.05
EU5	-8.12	0.05
EU6	-8.72	0.05
EU7	-9.32	0.05
EU8	-9.88	0.05
Long-Term Unemployed (LTU)	-10.39	0.05

Notes: Entries are percent changes in permanent consumption relative to the pre-reform steady state. The aggregate row uses pre-reform population weights. The transition recursion uses next-period job-finding probabilities and advances unmatched workers from EU1 through EU8 and then to LTU.

6.6 Further Robustness Checks

We conduct the following robustness checks, with additional details provided in the Appendix. First, we show and discuss the adjustment paths under complete consumption insurance in Appendix E.1. These results have already been discussed in Section 6.3 based on Table 5. The main finding is that the long-run consumption spillover effects are absent under complete consumption insurance.

Second, we examine how the entitlement cut interacts with the replacement rate cut (see Figure 1 for an institutional illustration). In our quantitative exercise, the entitlement cut plays a central role. Employed households anticipate that they will no longer be eligible for short-term benefits in quarters five to eight and, therefore, build up additional private savings to bridge this gap. When the replacement rate for the long-term unemployed is reduced on top of this, the increase in private savings is further strengthened (see Appendix E.4 for details).

Third, we show that allowing for a realistic decline in separations following the unemployment insurance reform does not shut down the precautionary savings channel (see Appendix E.5). Hartung et al. (2026) document a substantial decline in separations in the aftermath of the Hartz labor market reforms. In a robustness exercise, we impose the full decline documented in their study while maintaining the same target for the expansion of the tradable sector. Lower separations amplify the domestic labor-market response. They preserve the sign and qualitative pattern of international spillovers but attenuate their long-run magnitudes. Overall, the cross-country effects persist and are not driven by the assumption of constant separation rates.

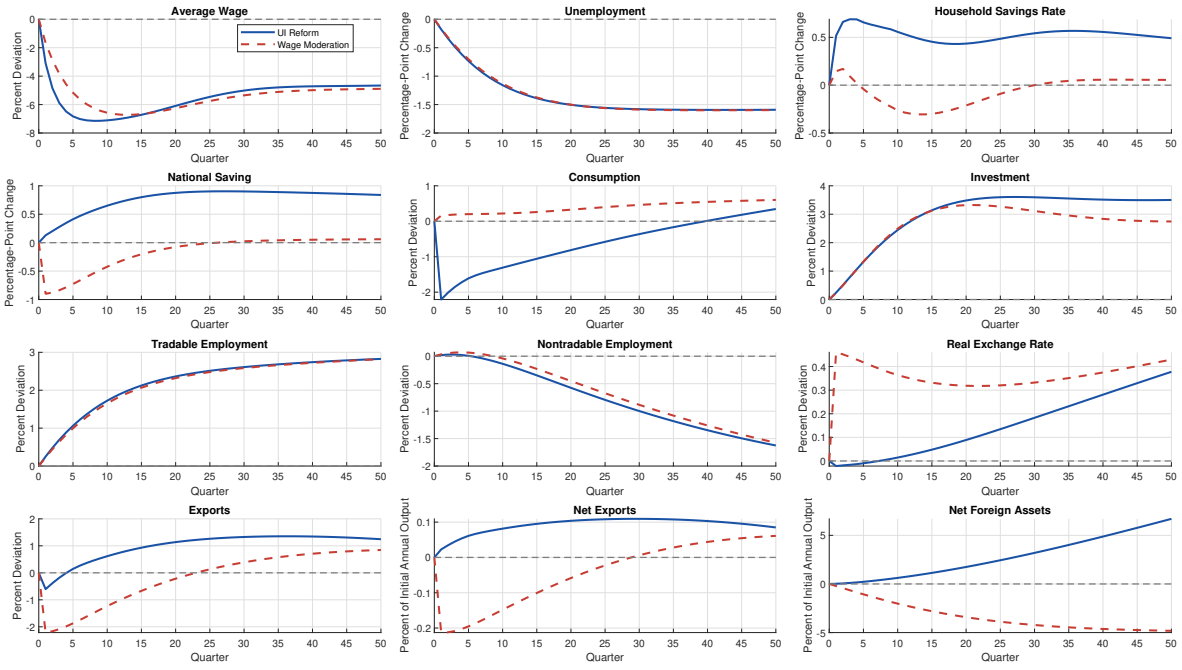
Finally, we assess how much our results depend on the generosity of foreign social insurance. We recalibrate the non-reforming country to feature lower unemployment benefit replacement

rates of 0.45 and 0.40 for short- and long-term unemployment, while keeping the German parameters unchanged (see Appendix E.6). The negative spillovers have the same direction as under symmetric unemployment insurance systems but are attenuated, with consumption and net foreign asset responses roughly one quarter smaller. The foreign economy continues to run current-account deficits, accumulate net foreign liabilities, and experience a persistent decline in consumption. Thus, less generous foreign unemployment insurance dampens, but does not eliminate, the reform-driven reallocation of external debt within the currency union and the associated negative consumption spillovers.

6.7 Effects of the German Wage Moderation

Dustmann et al. (2014) argue that German wage moderation, that is, wage growth below productivity growth, was a key driver of the labor market upswing. We contrast this mechanism with the Hartz IV benefit reform in our baseline calibration. In our framework, wage moderation is modeled as a permanent decline in workers' bargaining power in Nash wage bargaining. The size of the bargaining power shock is chosen so that the implied decline in unemployment matches the one generated by the benefit reform in the reforming economy.[43]

Figure 10: Effects of the Hartz IV Reform vs. the German Wage Moderation



Notes: Model responses to the labor market reform (solid line) and wage moderation (dashed line). Wages, consumption, investment, sectoral employment, the real exchange rate, and exports are shown as percent deviations from the pre-reform steady state. Unemployment and the household and national savings rates are shown as percentage-point changes. Net exports and net foreign assets are expressed as percent of initial annual output.

Figure 10 shows that a decline in workers' bargaining power lowers unemployment. Lower

[43] We reduce Home workers' post-reform bargaining power from 0.50 to 0.285, a decline of approximately 43 percent. The size of the shock is chosen to match the average decline in unemployment generated by the unemployment benefit reform over quarters 1–40.

wages raise firms' expected profits and induce additional vacancy posting, which raises the job-finding rate. This is in line with the idea that wage moderation can improve labor market performance.[44]

Wage moderation also generates a reallocation of employment toward the tradable sector in our model. It nevertheless produces the wrong external adjustment. Because unemployment risk falls while benefit generosity remains unchanged, household and national saving decline, the current account turns into a deficit, and net foreign assets fall. Wage moderation therefore cannot account for the joint post-reform pattern of higher household saving, a stronger current account, and net foreign asset accumulation.

In our framework, this bargaining-power-based wage-moderation channel generates open-economy dynamics opposite to those documented in Section 3 and cannot account for the observed increase in Germany's current account surplus and net foreign asset position.

6.8 Comparison between Austria, Germany, and France

As a further plausibility check of the quantitative model mechanism, we compare aggregate statistics from Germany (solid blue line) to the two neighboring Eurozone countries, Austria and France. The comparisons are descriptive and serve to assess whether the directional predictions of the model are consistent with the data for countries that did not implement a comparable reform.[45] Other than Germany, these two countries did not implement any major unemployment insurance reform around 2005.

Figure 11 shows that Austria and Germany entered the Eurozone with a negative current account balance, with very similar initial dynamics. However, around 2004, Germany and Austria started to decouple in terms of current account dynamics, with Germany's current account accelerating much more. This development is mirrored by a stronger increase in the aggregate savings rate in Germany around the time of the Hartz reforms, which was shortly interrupted by the Great Financial Crisis.

Interestingly, France shows the opposite direction in terms of its current account and savings rate dynamics. While Germany decoupled from Austria and France in terms of the savings rate, the divergence is less pronounced in terms of the investment rate from 2005 onward.[46]

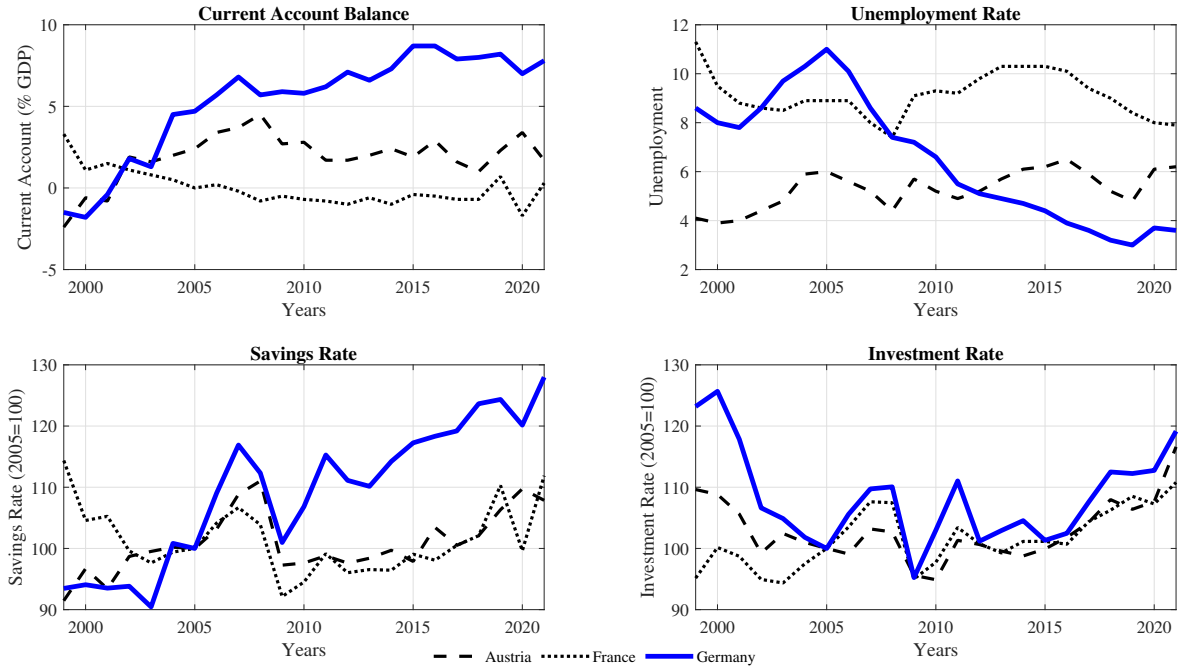
These descriptive patterns are consistent with the mechanism, but they are not a causal test of it. Germany's and Austria's current accounts may also have been driven by other favorable developments. At the same time, Germany clearly decoupled from Austria in terms of the savings rate. Furthermore, only the German labor market saw a sharp decline in unemployment, while France's descriptive statistics resemble the non-reforming economy in our quantitative model, with a declining current account.

[44] The timing of the unemployment decline in our experiment is not intended to match the German data. Unit labor costs in manufacturing started to fall in the 1990s (Dustmann et al., 2014), whereas the aggregate labor market only improved after 2005.

[45] Austria is very similar to Germany in terms of economic structure. In contrast, France shows more differences compared to Germany. It is the second-largest Eurozone economy after Germany. At the same time, aggregate statistics in France may be driven less by country-specific factors than in Spain or Ireland, where the real estate boom-bust cycle played an important role.

[46] The slump in investment at the beginning of the 2000s in Germany is largely driven by transition dynamics in East Germany.

Figure 11: Austria, Germany, and France



Notes: The figure shows the current account in percent of GDP (Source: OECD), the survey-based unemployment rate (Source: OECD), the savings rate indexed to 2005=100 (Source: IMF), and the investment rate indexed to 2005=100 (Source: OECD).

6.9 Discussion and Alternative Driving Forces

In this subsection, we discuss possible alternative driving forces of European current account and net foreign asset movements beyond the German labor market reform. We discuss how these trends affect our quantitative strategy.

First, the China shock is often discussed as an alternative explanation for current account movements. The China shock primarily worked through import competition and export demand to third markets rather than through within-Eurozone capital flows, and therefore does not naturally generate the savings and net foreign asset dynamics that are central to our mechanism.

To address the concern that our results may be confounded by the China shock, we augment our establishment-level regressions with two China-related controls, namely Germany's trade balance with China and German exports to China. As shown in Table 7 in Appendix B.2, the coefficient on the Hartz IV $\times$ tradability interaction term is unchanged in our preferred specifications. This makes it unlikely that our calibration target captures China-related trade dynamics.

Second, the eastern enlargement of the European Union may have strengthened the German position within the Eurozone. Note, however, that we analyze current account movements relative to other Eurozone countries, not those to eastern European countries. Furthermore, Germany maintained transitional restrictions on workers from the 2004 EU accession countries until 2011 (see Caliendo, Opromolla, Parro, and Sforza, 2021). However, as documented in Figure 5, the decline of the non-tradable service sector happened in the immediate aftermath

of the Hartz labor market reforms.

Third, the increasing trend of outsourcing in the production process could play a role in the movement of the tradable relative to the non-tradable sector. We address this by controlling for intermediate inputs in one empirical robustness check (see Table 1). When controlling for intermediate inputs, the estimated coefficient for the expansion of the tradable sector relative to the non-tradable sector is even larger than before. Thus, our calibration strategy is a lower bound in this dimension.

Fourth, our theoretical framework abstracts from cross-country migration. We view this as a reasonable simplification for the Hartz reform episode, because from a legal perspective free mobility within Europe did not translate into quantitatively large migration flows in the years most relevant for our analysis. Net migration to Germany between 2005 and 2009 averaged less than 0.2 percent of employment per year.[47] Non-German net migration only increased substantially between 2010 and 2015. The flows in the immediate aftermath of the Hartz labor market reforms appear too small to overturn the savings, current-account, and net-foreign-asset adjustments that are central to our mechanism. Consistent with this interpretation, Jauer, Liebig, Martin, and Puhani (2019) show in regional panel regressions that migration responses to regional unemployment shocks became only stronger after the Eurozone crisis. They also document that a large fraction of these post-crisis migrants came from non-Eurozone countries. Allowing for migration could modify the quantitative magnitude of the adjustment, but given the small observed flows, it is unlikely to change our qualitative conclusions.

7 Conclusion

This paper shows that an unemployment benefit reform in one member state of a monetary union can reshape cross-border debt positions and fiscal space across the union when households face incomplete consumption insurance. Less generous unemployment insurance triggers more private savings in the reforming country. Households in the reforming country invest a portion of these savings in foreign assets. Consequently, the non-reforming country runs current-account deficits and accumulates a net-foreign debt position after the reform.

We discipline our quantitative exercise by targeting the movement of the tradable to the non-tradable sector in the aftermath of the German Hartz labor market reforms, based on administrative data covering the universe of German establishments. Our estimations show an expansion of the tradable relative to the non-tradable sector. Based on our calibration, we find substantial negative long-run consumption spillovers due to the German Hartz reforms. However, these macroeconomic outcomes should not be interpreted as welfare gains for Germany. Although the reform increases fiscal space and long-run average consumption in the reforming economy, it may lower ex-ante welfare by reducing insurance in unemployment states with high marginal utility and inducing costly precautionary saving during the transition. Thus, it is a challenge for economic policy to design policy measures that decrease unemployment without reducing insurance, consumption, and thereby ex-ante welfare. Con-

[47] During this time period, there was a slight negative net migration of German citizens. However, on average, it accounted only for around 0.1 percent of employment per year. Source: German Federal Statistical Office.

versely, the rest of the Eurozone experiences lower long-run consumption but small positive ex-ante welfare effects. The initial foreign consumption gains and the subsequent decline in the common interest rate outweigh, in present-value terms, the delayed consumption costs associated with higher external indebtedness.

We further contrast the effects of the unemployment-benefit reform with those of wage moderation. Our findings reveal that reduced bargaining power for workers generates external-balance effects opposite to those caused by decreased unemployment benefits. Specifically, wage moderation generates immediate real appreciation and a permanent decline in net foreign assets. Although it reallocates employment to the tradable sector, it produces the wrong household-saving and external-balance responses. In our framework, wage moderation therefore does not account for the joint open-economy developments observed between Germany and the rest of the Eurozone.

Declaration of generative AI and AI-assisted technologies in the writing process During the preparation of this work, the authors used ChatGPT, Claude, AI Assist, and Grammarly for spell checking and minor rephrasing to improve clarity and flow. In addition, the authors used ChatGPT and Claude for checking the code. After using these tools, the authors carefully reviewed and revised the text as needed and take full responsibility for the content of the publication.

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A Institutional Details on German Hartz Reforms

In response to rising unemployment in the early 2000s, the Hartz Commission, chaired by Peter Hartz (see Hochmuth et al. (2021) for more details), developed recommendations for the German labor market. These proposals were implemented gradually between 2003 (Hartz I and Hartz II) and 2005 (Hartz IV). According to Jacobi and Kluve (2006), the Hartz reforms had three main goals: (1) increasing the effectiveness and efficiency of labor market services, (2) activating the unemployed, and (3) boosting labor demand by deregulating labor markets. Under the concept of *"demanding and supporting,"* these four reforms restructured the German labor market:

Hartz I (in action since 2003): This reform facilitated the employment of temporary workers. Additionally, vouchers for on-the-job training were introduced.

Hartz II (in action since 2003): Introduction of new types of marginal employment with low income and subsidies for business start-ups.

Hartz III (in action since 2004): The core element of Hartz III was the restructuring of the Federal Employment Agency.

Hartz IV (in action since 2005): The last step was the most widely discussed reform since it caused a substantial cut in unemployment benefits for several groups. Unemployment benefits proportional to previous earnings were limited to one year, with exceptions for unemployed over 45 years old (*Arbeitslosengeld I*). After one year, unemployed shift to the much lower fixed unemployment benefits *Arbeitslosengeld (ALG) II*[48]. Hence, the unemployment assistance[49] and unconditional social assistance was abolished and replaced by *ALG II* which was independent of previous earnings. Eligibility for ALG II depends on personal wealth and the partner's income. In addition, a sanctioning system was introduced which allowed cuts in the fixed unemployment benefits if the unemployed person breaks an agreement with the Public Employment Agency (e.g., in terms of writing applications, reachability, responsible economic behavior).

B Additional Empirical Evidence

B.1 Germany's Current Account: Sectors and Country Groups

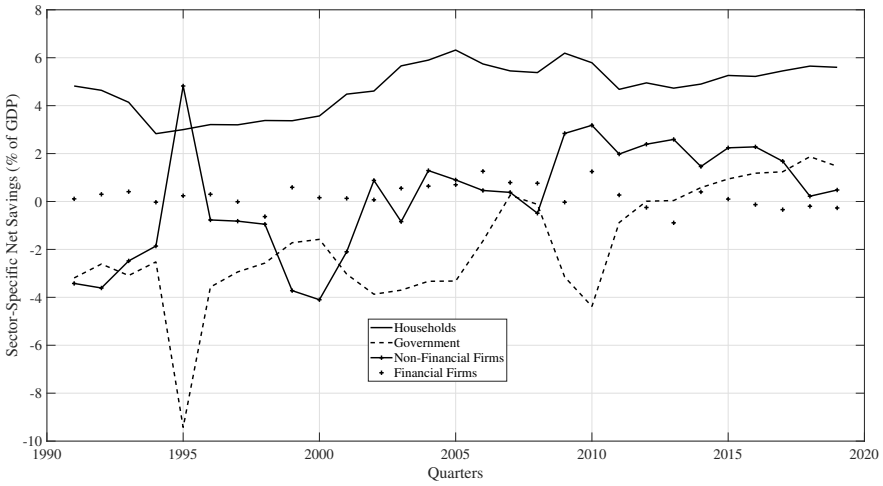
Figure 12 shows the net savings of different sectors in the German economy. Note that the behavior in 1995 was driven by special effects related to the privatization of formerly state-owned companies in East Germany. By definition, the sum of all four sectors adds up to the current account surplus.

Private households became a key contributor to net savings in 2005, i.e., the time when the Hartz reforms were implemented. This is in line with Hochmuth et al., 2026's finding based on the SOEP that employed workers' savings increased from 2005 onward. Note that these two savings concepts differ. Figure 12 shows the aggregate savings of private households (i.e.,

[48] The standard ALG II rate in 2017 is 409 euros.

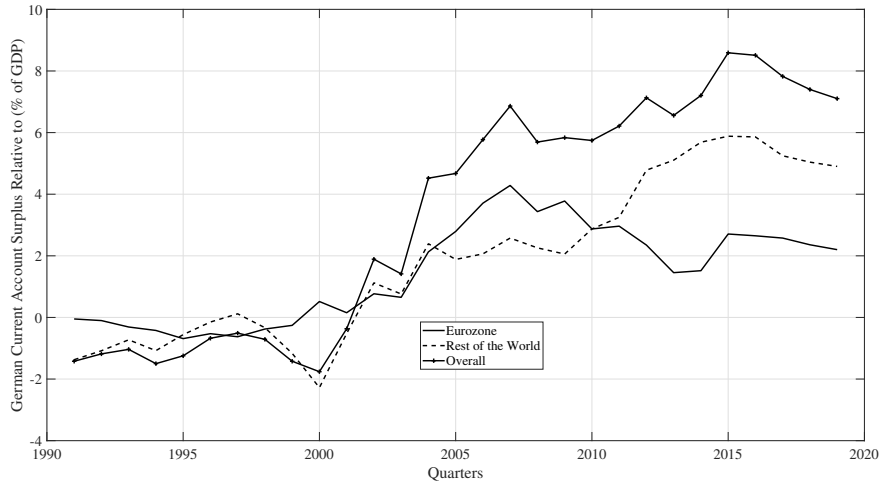
[49] Unemployment assistance (UA) amounted to 53% of previous net earnings (57% with children) and was subject to means tests. Hence, other income and assets reduced the claimable amount of UA.

Figure 12: Net Savings of Different Sectors



Net Savings of Household Sector, Government, Non-Financial and Financial Firms. Source: Deutsche Bundesbank.

Figure 13: Germany's Current Account Relative to Different Country Groups



Germany's current account relative to the Eurozone, relative to the rest of the world and overall. Source: Deutsche Bundesbank.

also (dis)savings from retired workers or unemployed are included). In contrast, Hochmuth et al., 2026's focus is on employed workers' savings, which corresponds to the savings motive in our model.

Figure 13 shows Germany's current account balance (in percent of GDP) relative to the Eurozone (solid line) and to the rest of the world (dashed line). It is visible that the current account surplus relative to the Eurozone was the key driver of the overall acceleration in the current account surplus from around 2005 onward. This development was interrupted by the Great Recession in 2008. In addition, net private household savings (see Figure 12) and the current account surpluses relative to the Eurozone have a correlation of 0.82.

B.2 China as an Alternative Explanation: Micro Evidence

Table 7 revisits our core microeconomic estimates with explicit controls for Germany's trade balance with China or German exports to China. We want to test whether the expansion of the tradable sector after Hartz IV is driven by China-related trade developments rather than by the reform itself.

The table shows that this is not the case. Across our preferred AWFP and IAB specifications, the coefficient on the Hartz IV × tradability interaction term is essentially unchanged. In particular, in the preferred regression specification, the coefficient remains exactly 0.027. This means that our calibration target remains unchanged. The corresponding coefficients in the other specifications are likewise unaffected when we add either Germany's trade balance with China or German exports to China as an additional control. This suggests that the relative post-2005 expansion of the tradable sector in our data is unlikely to be driven by bilateral trade dynamics with China.

Table 7: Hartz IV × Tradability with Additional China Controls

	Baseline	**+ Trade Balance with China**	**+ Exports to China**
AWFP: log(Emp.)	0.027***	0.027***	0.027***
	(0.004)	(0.004)	(0.004)
AWFP: log(Wage Sum)	0.047***	0.047***	0.047***
	(0.004)	(0.004)	(0.004)
IAB-EP: log(VA), no int. inputs	0.085*	0.084*	0.084*
	(0.043)	(0.043)	(0.043)
IAB-EP: log(VA), int. inputs	0.118***	0.117***	0.117***
	(0.037)	(0.037)	(0.037)
Establishment FE	Yes	Yes	Yes
Macro controls	Yes	Yes	Yes
China control	No	Trade balance	Exports

Notes: The table reports the coefficient on the Hartz IV × tradability interaction term from variants of the main micro regressions in Section 3.3. The baseline column corresponds to the preferred specifications from Table 1. The second column additionally controls for Germany's trade balance with China. The third column additionally controls for German exports to China. Each row represents a separate regression. We only show the estimated coefficient for the interaction term. AWFP regressions use the administrative establishment panel, and IAB-EP regressions use the weighted IAB Establishment Panel specifications corresponding to the main text. Standard errors clustered at the establishment level are reported in parentheses.

B.3 Rolling-window Evidence around Hartz IV

Table 8 reports rolling-window regressions that replace the single Hartz IV dummy from Section 3.3 with interactions between tradability and 3-year period indicators, while keeping the establishment-level and macroeconomic controls. Using 2002–2004 as the omitted reference window, the results reveal a stable pattern across data sources. In the AWFP data, tradable establishments show significantly lower employment and wage-sum growth relative to the reference period in all pre-reform windows, but significantly stronger growth in the post-reform windows. These positive effects become somewhat weaker during the Great Financial Crisis (2008–2010). Overall, the rolling-window evidence suggests that the post-2005 improvement among more tradable establishments is not driven by the Great Financial Crisis

period. Rather, it reflects a broader shift around the Hartz IV reform period.

Table 8: Rolling-window Robustness Checks

	AWFP: log(Emp.)	AWFP: log(Wage Sum)	IAB-EP: log(VA), int. inputs
3-year windows, reference period 2002–2004			
1993–1995 × Tradability	-0.030***	-0.051***	-0.233***
	(0.005)	(0.005)	(0.036)
1996–1998 × Tradability	-0.018***	-0.032***	-0.218***
	(0.004)	(0.004)	(0.027)
1999–2001 × Tradability	-0.020***	-0.025***	-0.086***
	(0.003)	(0.003)	(0.016)
2005–2007 × Tradability	0.013***	0.024***	0.112***
	(0.003)	(0.003)	(0.015)
2008–2010 × Tradability	0.006*	0.018***	0.106***
	(0.004)	(0.004)	(0.021)
2011–2013 × Tradability	0.010**	0.022***	0.133***
	(0.005)	(0.005)	(0.024)
R^2	0.772	0.808	0.959
N	7,280,181	7,280,181	76,596

Notes: Each coefficient reports the interaction between establishment tradability and a 3-year time window, with 2002–2004 omitted as the reference period. All regressions retain the baseline macro controls and establishment fixed effects, as in Table 1. The IAB-EP value-added specification additionally controls for intermediate input intensity. Only the coefficients on the tradability × period interactions are reported. The single Hartz IV dummy is excluded, so identification comes from period-specific differences in the tradability effect. Standard errors, reported in parentheses, are clustered at the establishment level. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

C Microeconomic Datasets

C.1 The Administrative Wage and Labor Market Flow Panel

The Administrative Wage and Labor Market Flow Panel (AWFP) aggregates German administrative wage, labor market flow, and stock information to the establishment level for the years 1975–2014 (see Seth and Stüber (2017)). Before aggregating the data to the establishment level, several corrections and imputations were conducted at the micro level.

For consistency, we focus on wages and stocks for "regular workers."Wages are defined as the mean real daily wages of all employed full-time workers in a particular establishment. Daily wages include the base salary, all bonuses and special payments (such as performance bonuses, holiday pay, or Christmas allowance), fringe benefits, and other monetary compensations received throughout the year (or the duration of the employment spell). Therefore, daily wages correspond to a measure of total compensation rather than to a daily base wage. Workers' daily wages above the contribution assessment ceiling are imputed following Card, Heining, and Kline (2015) before aggregating the data to the establishment level.

For our baseline regressions, we restrict the AWFP data as follows. We consider only establishments with, on average, at least ten full-time workers.

C.2 The IAB Establishment Panel

The IAB Establishment Panel is an annual survey of establishments located in Germany. The survey has been conducted since 1993 (Ellguth, Kohaut, and Möller, 2014). The survey

information is collected mostly in face-to-face interviews. The survey aims for a representative sample of about 15,000 to 16,000 establishments each year.
The IAB Establishment Panel contains survey information on the establishments that is not available in the administrative data (such as the AWFP). It covers various topics such as business performance and strategies, investment and innovation activities, vocational/further training, recruitment and layoff behaviour, working time issues, and structural information (e.g., works councils, collective agreements, ownership structure) among others.
The sampling frame of the IAB Establishment Panel comprises all establishments in Germany with at least one employee who is fully liable to social security at June 30th of the previous year. Establishments that have exclusively workers in marginal part-time employment are excluded from the sampling frame. The survey sample is disproportionately stratified in three dimensions: First, the sample is stratified by 16 federal states. Second, the survey sample is stratified by ten establishment size classes as the population is very much skewed towards small establishments. Third, the survey sample stratifies by industries to allow for differentiated analyses in this respect.

D Model Appendix

D.1 Cohort Asset Policies and Accounting

Cohort consumption-share choice. Workers in the same unemployment-duration cohort use a common asset-consumption rule. A marginal increase in the residual resources carried by each member of cohort k into period $t+1$ has two continuation payoffs. If a worker remains unemployed, these resources are valued at $\lambda_{t+1}^{eu_{k+1}}$. If the worker is re-employed, she rejoins the employed family, while the fraction ρ_{t+1} of the cohort that is re-matched returns its residual resources to the family. The latter raises family resources by $\rho_{t+1}u_t^{eu,k}/N_{t+1}$ per employed worker. The common-cohort first-order condition is therefore

$$\lambda_t^{eu_k} = \beta E_t \left[(1-\rho_{t+1})\lambda_{t+1}^{eu_{k+1}} + \rho_{t+1}^2 \frac{u_t^{eu,k}}{N_{t+1}} \lambda_{t+1}^{e} \right], \qquad k = 1, \ldots, K-1, \tag{D.1}$$

with $\theta_t^K = 1$ in the final asset-holding unemployment state.

Cohort asset stock. Let

$$Z_t \equiv \sum_{k=1}^{K-1} u_t^{eu,k} m_{t+1}^{eu,k+1} = \sum_{k=1}^{K-1} u_t^{eu,k}(1-\theta_t^k) m_t^{eu,k} \tag{D.2}$$

denote the end-of-period stock of residual asset resources carried by short-term-unemployment cohorts. Because $\theta_t^K = 1$, workers in the final asset-holding state carry no resources into the

following period. The stock evolves according to

$$Z_t - Z_{t-1} = (1-\tau^F) u_t^{eu,1} R_t a_t - \rho_t \sum_{k=1}^{K-1} u_{t-1}^{eu,k} m_t^{eu,k+1} - \sum_{k=1}^{K} u_t^{eu,k} \theta_t^k m_t^{eu,k}. \tag{D.3}$$

The first term is the asset transfer received by newly unemployed workers. The second term is the residual asset stock returned to the employed family by workers re-matched in period t, and the final term is asset-financed consumption by currently unemployed workers. Accordingly, the term ΔZ_t in the aggregate resource constraint (4.40) is given by $Z_t - Z_{t-1}$. It is zero in any steady state. In the numerical solution, the associated stock-flow identity and the aggregate resource constraint are verified period by period to numerical precision.

D.2 Derivation of the Worker's Marginal Values

To calculate the Nash-bargained wage, we derive the marginal value of an employed worker to the family. As search is undirected, and all firms pay the common wage w_t, sectoral heterogeneity enters wage bargaining only through the firm-side job values J_t^T and J_t^N and their employment-weighted average.

Let $\mathcal{W}_t^e$ denote the marginal contribution of an employed worker to the family value, expressed in utility units. Taking the first-order condition of the family problem with respect to employment yields

$$\begin{aligned} \mathcal{W}_t^e = u(c_t^e) - \lambda_t^e \left[c_t^e + a_t + \tau_t - (1-\tau_t^w) w_t\right] \\ + \beta E_t \Bigg[\lambda_{t+1}^e \left(1 - s(1-\tau^F)(1-\rho_{t+1})\right) R_t a_t \\ + \left(1 - s(1-\rho_{t+1})\right) \mathcal{W}_{t+1}^e + s(1-\rho_{t+1}) \mathcal{W}_{t+1}^{eu_1} \Bigg]. \end{aligned} \tag{D.4}$$

The first line contains the worker's current utility and her net contribution to family resources. An employed worker contributes labor income net of the labor tax, while consuming, saving, and paying the lump-sum tax. The first continuation term captures the asset payoff that remains with the employed family. The entire payoff remains in the family if the worker does not separate or is re-employed within the period. If she enters unemployment, only the fraction τ^F remains in the employed family pool. The remaining terms capture the worker's continuation value. With probability $1 - s(1-\rho_{t+1})$, she remains employed or is re-employed, while with probability $s(1-\rho_{t+1})$, she enters the first short-term unemployment state.

For a worker in short-term unemployment state eu_k, where $k = 1, \ldots, K-1$, the continuation value satisfies

$$\mathcal{W}_t^{eu_k} = u(c_t^{eu_k}) + \beta E_t \left[(1-\rho_{t+1}) \mathcal{W}_{t+1}^{eu_{k+1}} + \rho_{t+1} \mathcal{W}_{t+1}^e\right]. \tag{D.5}$$

In the final short-term unemployment state, an unmatched worker enters long-term unem-

ployment:

$$\mathcal{W}_t^{eu_K} = u(c_t^{eu_K}) + \beta E_t \left[(1-\rho_{t+1})\mathcal{W}_{t+1}^{uu} + \rho_{t+1}\mathcal{W}_{t+1}^{e}\right]. \tag{D.6}$$

The value of long-term unemployment is

$$\mathcal{W}_t^{uu} = u(c_t^{uu}) + \beta E_t \left[(1-\rho_{t+1})\mathcal{W}_{t+1}^{uu} + \rho_{t+1}\mathcal{W}_{t+1}^{e}\right]. \tag{D.7}$$

Under the baseline bargaining specification, the worker surplus is

$$\widetilde{\mathcal{W}}_t = \mathcal{W}_t^{e} - \mathcal{W}_t^{eu_1}. \tag{D.8}$$

The same worker surplus applies to matches in both sectors. The sectoral dimension of the Nash bargain is summarized by the employment-weighted firm surplus,

$$J_t = \frac{N_t^T J_t^T + N_t^N J_t^N}{N_t}.$$

E Further Model Results and Robustness Checks

E.1 Incomplete vs. Complete Insurance and Spillovers

In contrast to a standard search and matching model, our model framework contains a precautionary savings motive (incomplete consumption insurance). To understand the role of incomplete insurance, we compare our model to a model with complete insurance. Under complete insurance, we have a perfectly elastic supply of assets (driven by the standard Euler consumption equation). In the complete insurance case, we assume one representative household. In this case, unemployed workers remain in the family, and consumption is pooled among all households. Thus, there is no precautionary savings motive, and the Euler equation on asset holdings boils down to equation (4.7).

To guarantee stationarity of net foreign assets, we follow Schmitt-Grohe and Uribe (2003) to close open-economy models (SGU, henceforth). We assume that employed households have to pay portfolio adjustment costs on their net foreign assets (when they hold quantities that are different from the initial steady state): $-\frac{\psi}{2}\left(NFA_t - NFA\right)^2$.

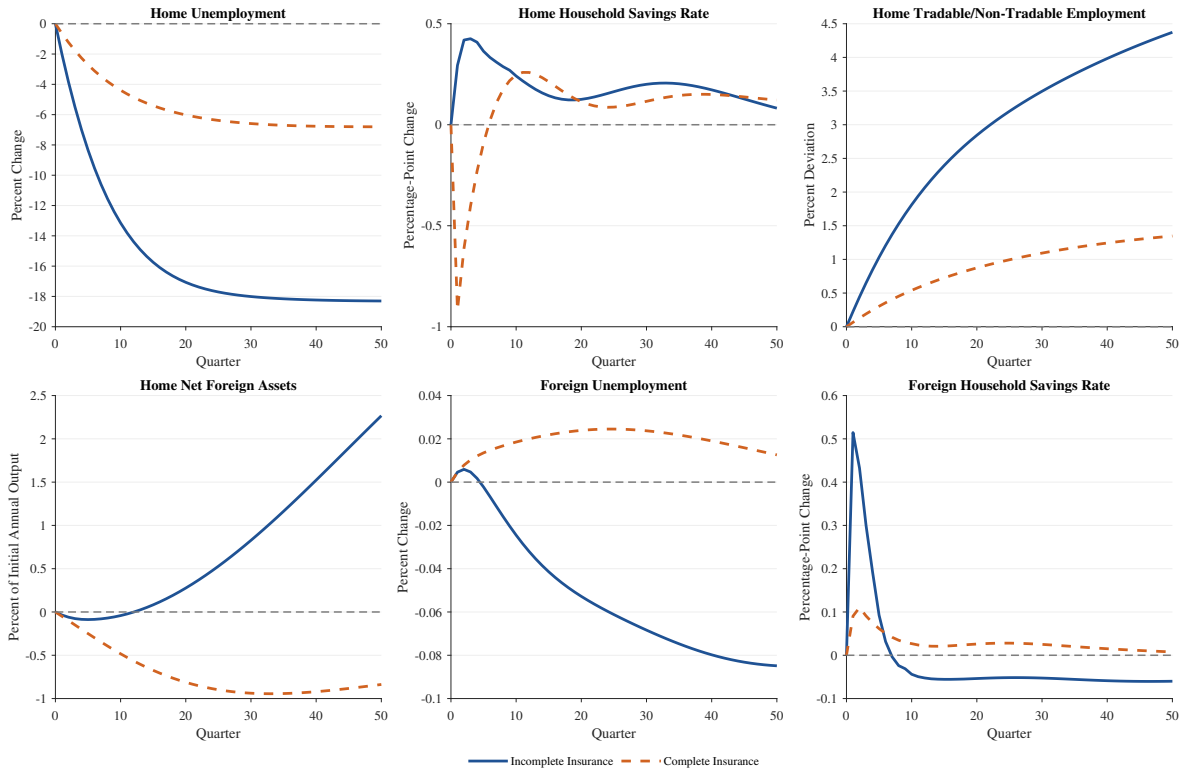
Although we do not require these assumptions in our incomplete insurance framework (see Ghironi, 2006 for a discussion), we impose them for the simulations depicted in Figure 14 for comparability reasons, setting $\psi = 0.001$.[50]

To assess whether recalibrating the reform can bring the complete-insurance economy closer to the same sectoral target, we evaluate the two endpoints of the feasible range for the post-reform long-term replacement rate. With no reduction in the replacement rate, the average increase in tradable relative to non-tradable employment from 2005–2014 is 0.17 percent. When the long-term replacement rate is reduced from 0.5 to zero, the response increases to 1.73 percent. Thus, even the most extensive feasible replacement-rate cut falls around one percentage point short of the empirical target of 2.7 percent. Without precautionary savings,

[50] Note that this makes spillover effects under complete insurance smaller than in our baseline, as Schmitt-Grohe and Uribe (2003) impose a cost of holding net foreign assets.

the reform affects sectoral reallocation only through wages and competitiveness. Because even the most extensive recalibration does not reach the target, we use the same reform implementation as in the incomplete-insurance economy.

Figure 14: Complete vs. Incomplete Insurance



Notes: Model responses to the labor-market reform under incomplete insurance (solid line) and complete insurance (dashed line). Both specifications use the same SGU stationarity parameter of 0.001. Responses are measured relative to the pre-reform steady state; units differ across panels and are reported on the respective axes. H denotes Home, and F denotes Foreign.

As shown in the upper left panel of Figure 14, the benefit reform also generates a labor-market expansion under complete consumption insurance, although the response is substantially weaker. The saving response differs more fundamentally across the two economies. Under complete insurance, the household savings rate initially declines and subsequently rises only modestly above its pre-reform level (upper middle panel). This later increase reflects the reform's expansionary effects on household income rather than precautionary wealth accumulation: because consumption is pooled, households have no need to self-insure against unemployment risk. By contrast, under incomplete insurance, the precautionary savings response is stronger and persistent, leading to a sustained accumulation of net foreign assets (lower left panel). Under complete insurance, net foreign assets instead decline temporarily and eventually return to their initial steady-state level.[51] Consequently, the reform generates only small labor-market and saving spillovers to the non-reforming economy under complete insurance.[52]

[51] Under the SGU closure, the complete-insurance economy's net foreign asset position must return to its initial steady state.

[52] Under incomplete insurance with the SGU closure, net foreign asset accumulation is smaller than in our

E.2 Labor-Force-Weighted Outside-Option Bargaining

The model distinguishes between the values associated with different unemployment-duration states. These values are not identical: benefits, remaining asset resources, and continuation probabilities vary over the unemployment spell. The relevant modeling question is therefore how unemployed workers' state-contingent values enter wage determination.

Under the bargaining specification used in the baseline, the assumption is that the breakdown of bargaining would place an incumbent match in the first short-term unemployment state. The worker surplus is therefore

$$\widetilde{\mathcal{W}}_t^{\mathrm{STU1}} = \mathcal{W}_t^{e} - \mathcal{W}_t^{eu_1}. \tag{E.1}$$

The value $\mathcal{W}_t^{eu_1}$ embeds later unemployment states through continuation values. Thus, changes in long-term benefits and in the values associated with later unemployment states affect the baseline wage bargain indirectly through the expected unemployment path. The realized unemployment-duration shares do not enter the baseline outside option directly.

As a robustness exercise, we replace the incumbent-match outside option by a labor-force-weighted aggregation of state-specific outside options. This specification uses an ex-ante representative-member interpretation. The wage setter evaluates the expected gain from employment for a worker drawn from the attached labor force. For a currently employed worker, the relevant fallback value is the first short-term unemployment state. For a currently unemployed worker, it is the value associated with the worker's current unemployment-duration state. The resulting worker-side surplus is therefore the labor-force-weighted average of the state-specific gains from employment.

Let

$$L_t = N_t + \sum_{k=1}^{K} u_t^{eu,k} + u_t^{uu}$$

denote the attached labor force. The expected fallback value is

$$\mathcal{W}_t^{out,\mathrm{LF}} = \frac{N_t \mathcal{W}_t^{eu_1} + \sum_{k=1}^{K} u_t^{eu,k} \mathcal{W}_t^{eu,k} + u_t^{uu} \mathcal{W}_t^{uu}}{L_t}. \tag{E.2}$$

The worker surplus entering the wage bargain is

$$\begin{aligned} \widetilde{\mathcal{W}}_t^{\mathrm{LF}} = \frac{N_t}{L_t} \left(\mathcal{W}_t^{e} - \mathcal{W}_t^{eu_1}\right) + \sum_{k=1}^{K} \frac{u_t^{eu,k}}{L_t} \left(\mathcal{W}_t^{e} - \mathcal{W}_t^{eu,k}\right) \\ + \frac{u_t^{uu}}{L_t} \left(\mathcal{W}_t^{e} - \mathcal{W}_t^{uu}\right) = \mathcal{W}_t^{e} - \mathcal{W}_t^{out,\mathrm{LF}}. \end{aligned} \tag{E.3}$$

Both the labor-force weights and the state-contingent values are endogenous and are solved jointly with wages and the remaining transition dynamics. Unlike under the baseline specification, the realized unemployment-duration distribution therefore enters wage determination

baseline without this closure because households trade off precautionary wealth accumulation against the portfolio adjustment costs.

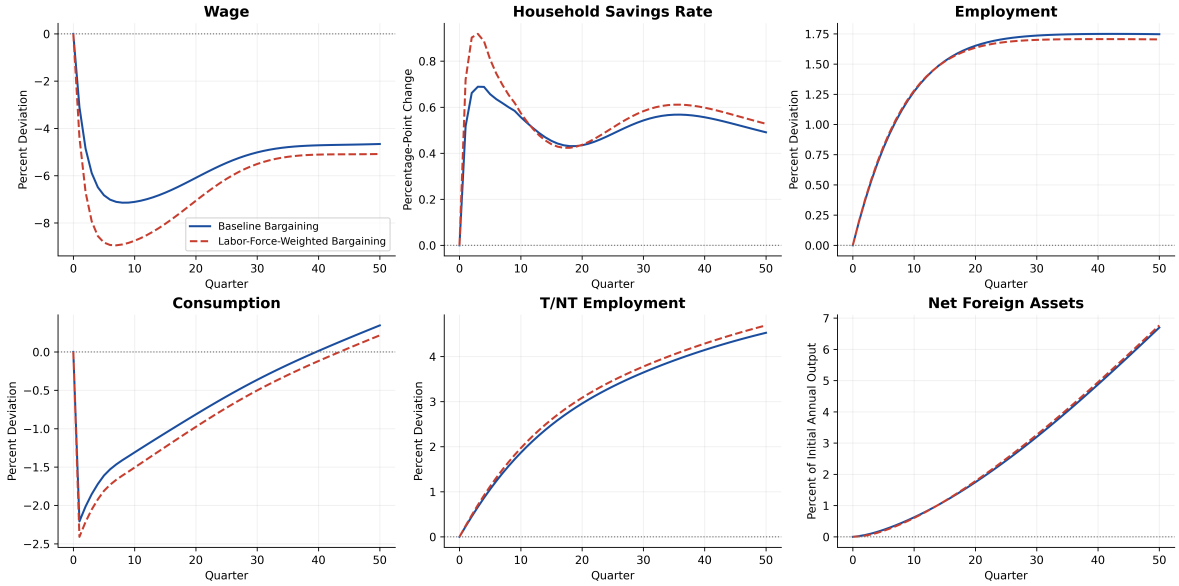
directly. This construction is a reduced-form aggregation of state-specific employment surpluses (not a model of union membership or bargaining over aggregate employment).

To isolate the consequences of the bargaining specification, Figure 15 holds the reform and all structural parameters fixed. The only difference between the two simulations is the definition of the worker-side outside option. Labor-force weighting produces a larger wage decline, while the increase in tradable relative to non-tradable employment is only slightly stronger.

The larger wage adjustment raises the initial private-saving response and reduces consumption a bit further. Employment, investment, the current account, and net foreign assets remain relatively close to their baseline paths. Allowing the endogenous unemployment-duration distribution to enter wage determination directly affects the magnitude of wage adjustment but does not materially alter either sectoral employment reallocation or the external adjustment through the current account and net foreign assets.

The aggregate Home CEV falls from -2.07 percent under baseline bargaining to -2.31 percent under labor-force-weighted bargaining, while the Foreign CEV decreases slightly from 0.064 to 0.059 percent. The Home welfare loss therefore becomes somewhat larger, but the signs and qualitative welfare conclusions remain unchanged.

Figure 15: Domestic Effects Under Labor-Force-Weighted Outside-Option Bargaining



Notes: The figure compares the baseline bargaining specification with the labor-force-weighted outside-option specification. Both simulations use the same reform, bargaining power, recruiting parameters, and remaining structural calibration; only the bargaining fallback value changes.

E.3 Different Bargaining Powers and External Adjustment

Table 9 shows the external adjustment under alternative values of workers' bargaining power. To isolate the effect of this parameter, we change only the bargaining-power parameter, ζ, while holding all other parameters and the implementation of the reform at their baseline values. The external channel remains largely intact. Net foreign asset and current-account

contributions remain very stable across alternative bargaining powers. The private-saving contribution varies more, but remains positive and economically important in all cases. However, relative unit labor costs are more sensitive to changes in benefits when workers' bargaining power is low, since this puts a larger weight on the outside option. This shows that our main quantitative conclusions for the savings and external adjustment channel are robust, whereas competitiveness outcomes are more sensitive to wage-setting assumptions.

Table 9: Bargaining-Power Robustness: Model Contribution to Empirical Time Series in 2014

Indicator	Baseline	$\zeta = 0.4$	$\zeta = 0.6$
Unemployment	32.9%	33.2%	32.8%
Private Savings Rate	20.7%	27.0%	16.7%
Net Foreign Assets/GDP	13.0%	12.1%	13.9%
Current Account/GDP	9.2%	8.9%	9.5%
Current Account vis-a-vis Eurozone/GDP	44.9%	43.7%	46.5%
Unit Labor Costs Relative to Eurozone	189.2%	284.2%	128.0%
Private Savings Rate Rest of Eurozone	4.1%	3.9%	4.3%

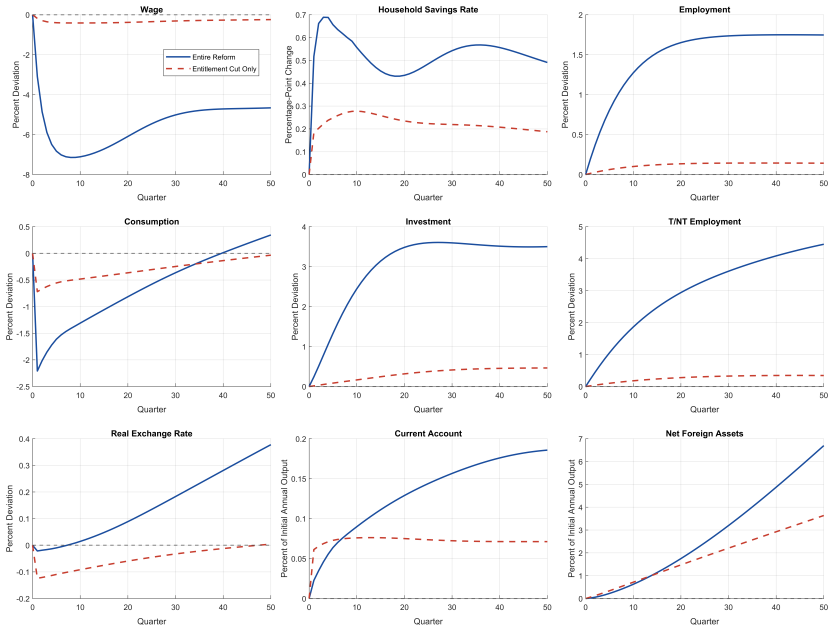
Notes: Each entry reports the share of the observed empirical movement explained by the model-implied average change in calendar year 2014. The robustness columns change worker bargaining power to the displayed value while keeping the reform cut and all other baseline settings fixed.

E.4 Disentangling the Reform Effects

Figure 16 shows the entitlement cut as a separate exercise. In this case, workers receive short-term unemployment benefits for a shorter time period (four instead of eight quarters). They increase their savings to self-insure against the earlier transition to lower long-term benefits. We allow unemployed workers to use their savings during each of the eight unemployment-duration states.

When the replacement rate for long-term unemployed is cut in addition to the entitlement cut, this amplifies the aggregate effects. Considering only the entitlement cut leads to a considerably muted wage and employment response. In addition, the consumption-savings trade-off is muted, and the responses of the current account and net foreign assets are correspondingly smaller.

Figure 16: Entire Reform vs. Entitlement Cut Only



Notes: Model responses to the labor market reform with an incomplete insurance framework for the entire reform (solid line) and only the entitlement cut (dashed line). Wages, employment, consumption, investment, T/NT employment, and the real exchange rate are shown as percent deviations from the pre-reform steady state. The household savings rate is shown as a percentage-point change, while the current account and net foreign assets are expressed as percentages of initial annual output.

E.5 Decline in Separations

In our quantitative model, separations are exogenous. This assumption allows us to isolate how lower unemployment benefits affect precautionary saving and international adjustment through job-finding incentives. However, Hartung et al. (2026) document that the average monthly separation rate was 22 percent lower in 2008–2014 than in 1993–2002. Lower separations may therefore weaken precautionary saving by reducing the probability of entering unemployment, even if unemployment benefits become less generous.

To evaluate whether this additional labor-market adjustment can deactivate the international consumption spillover effects, we assume that separations immediately decreased by 22 percent with the implementation of the Hartz IV reform. Imposing the full decline immediately and attributing it to the unemployment insurance reform constitutes a deliberately front-loaded stress test of our spillover mechanism.

We keep only the targeted 2.7 percentage-point increase in tradable relative to non-tradable employment over the first ten years by recalibrating only the long-term replacement-rate cut. The required cut rises from 37.9 to 40.3 percent.[53]

Figure 17 shows that the immediate decline in the exogenous separation rate substantially strengthens the domestic labor-market response. Home output and employment expand more than in the baseline, while consumption remains above its pre-reform level. Domestic house-

[53] While we are able to match the average difference between the two sectors, we are unable to simultaneously match the sustained decline in non-tradable employment with the strong exogenous decline in separations. The relative-employment target is reached through a stronger expansion of tradable employment, while non-tradable employment eventually rises.

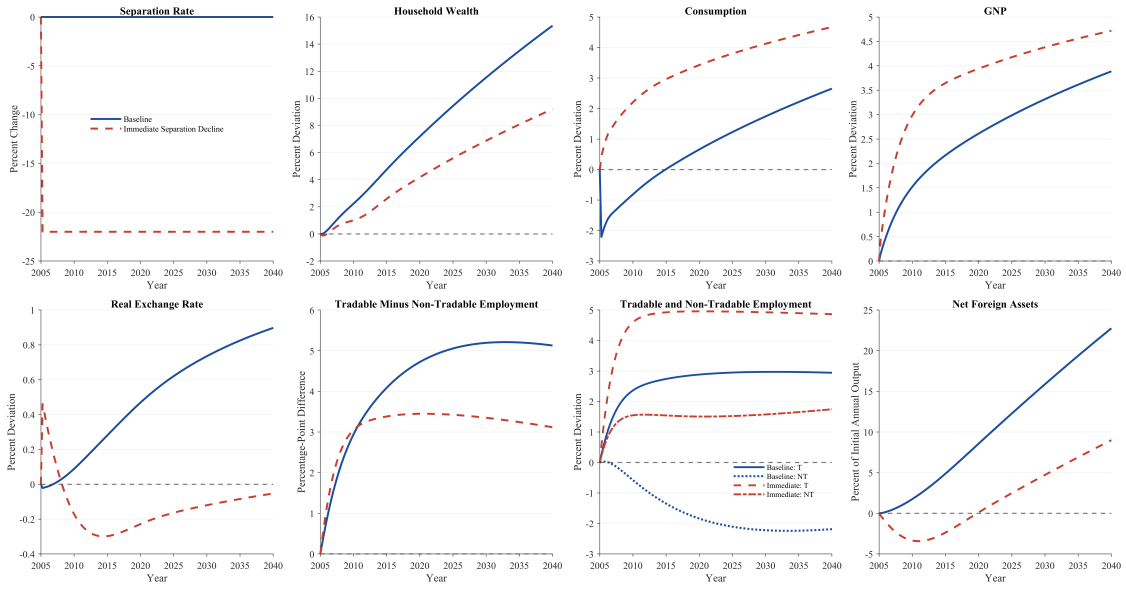
hold wealth rises, and the reforming country continues to accumulate substantial net foreign assets. Net foreign assets initially decline, but subsequently recover and become positive. Their post-reform steady-state increase is, however, smaller than in the baseline.

Table 10 shows that the signs of the international long-run spillovers are preserved, while their magnitudes are attenuated. In the post-reform steady state, the Home net-foreign-asset-to-output ratio rises by about 54 percentage points, compared with 89 percentage points in the baseline. The Foreign net-foreign-asset-to-output ratio declines by about 21 percentage points, compared with 35 percentage points in the baseline, and Foreign consumption falls by about 2 percent rather than by more than 3 percent. Thus, conditional on preserving the targeted tradable-minus-non-tradable employment response, lower separations reduce the magnitude of the external positions and the negative long-run consumption spillover, but do not change their signs.

Foreign aggregate CEV remains slightly positive because it incorporates the initial consumption gains along the transition path. Home aggregate CEV turns positive in this experiment because the immediate separation decline directly lowers the probability of entering unemployment, the key uninsurable risk in the model.

Since the empirical separation rate decline emerged gradually (interrupted by the Great Recession in 2008-09) and may only be partly attributable to the reform, this front-loaded stress test constitutes an extreme robustness test for our model mechanisms. While the separation rate decline changes short-run consumption and ex-ante welfare outcomes in the reforming economy, the savings response continues to generate substantial asset accumulation in the home economy and permanent negative consumption spillovers to the foreign economy. Thus, the signs of the external asset and foreign long-run consumption spillovers are unaffected by this robustness check.

Figure 17: Baseline vs. Separation Rate Decrease



Notes: Model responses to the labor market reform when the Home separation rate immediately declines by 22% (as in Hartung et al., 2026). The long-term replacement-rate cut is retargeted to preserve the 2.7 percentage-point tradable-minus-non-tradable employment response. Units are stated on each axis.

Table 10: Separation-Rate Decline: Domestic Adjustment and International Spillovers

	Baseline Reform	Immediate Separation Decline
Panel A: Post-Reform Steady-State Effects		
Home Output (%)	2.70	4.41
Home Consumption (%)	10.84	10.19
Home Unemployment Rate (%)	-17.47	-41.79
Home NFA/Output (pp)	88.88	54.19
Foreign Output (%)	0.24	0.16
Foreign Consumption (%)	-3.25	-1.95
Foreign Unemployment Rate (%)	-0.89	-0.50
Foreign NFA/Output (pp)	-34.70	-21.26
Panel B: Consumption-Equivalent Variation		
Home Aggregate CEV (%)	-2.07	1.96
Foreign Aggregate CEV (%)	0.06	0.07

Notes: Panel A compares the saved post-reform and pre-reform steady states. Unemployment entries are relative percent changes; NFA/output entries are percentage-point changes. Panel B reports ex-ante consumption-equivalent variation. In the separation experiment, the Home separation rate declines immediately by 22%. The experiment retargets only the long-term replacement-rate cut to the 2.7 percentage-point sectoral-employment target.

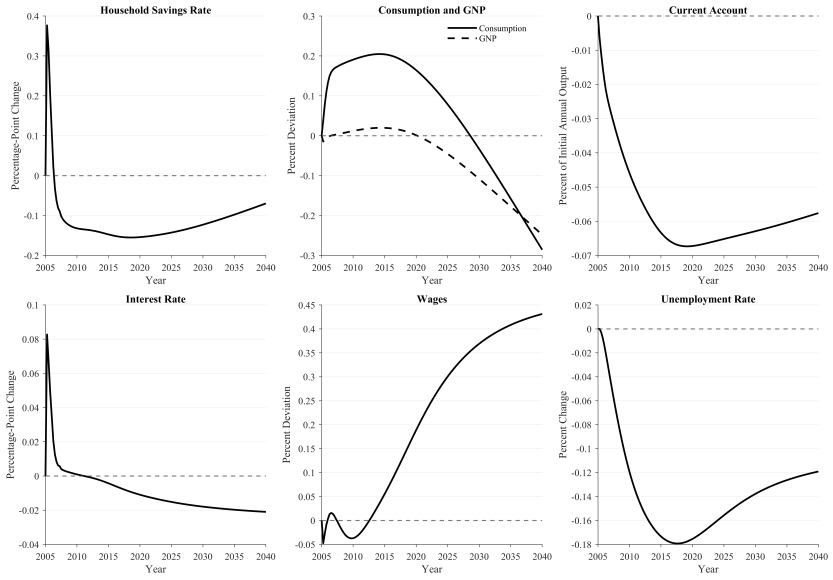
E.6 Asymmetric UI Benefit System

Given that a less generous social insurance system abroad might change savings, investment, and therefore the size of international spillovers (due to different steady-state levels of assets, etc.), we consider an asymmetric calibration with lower foreign replacement rates. This experiment disciplines how much our mechanism relies on Germany's relative generosity and shows that the negative consumption spillovers to the non-reforming country in Figure 18 and Table 11 persist, although they are somewhat attenuated.

Figure 18 displays the transition for the non-reforming country when it is calibrated with a less generous unemployment insurance system. Germany keeps pre-reform short- and long-term replacement rates at 0.60 and 0.50, while the foreign country has replacement rates of 0.45 and 0.40, respectively. The foreign household savings rate rises briefly and then falls below its pre-reform level, while the current account remains in deficit for the non-reforming country. Consumption and GNP initially increase slightly but turn negative over the longer horizon. Foreign wages rise moderately, and the unemployment response remains small, which is similar to our baseline of initially symmetric UI benefits.

Table 11 reports the corresponding long-run effects. Compared with the symmetric unemployment insurance results in Table 4, the consumption and net foreign asset responses have the same signs but are roughly one-quarter smaller. Germany still experiences higher long-run consumption and accumulates substantial net foreign assets, whereas the foreign country becomes a net debtor and experiences lower long-run consumption. Lower foreign replacement rates, therefore, attenuate but do not eliminate the negative long-run consumption spillover effects. In short, our key results remain robust.

Figure 18: Aggregate Effects in the Non-Reforming Country, Asymmetric UI System



Notes: Model responses to the German labor market reform when the foreign country is calibrated with a less generous unemployment insurance system. In the reforming country, short- and long-term replacement rates remain at 0.60 and 0.50, while in the foreign country they are reduced to 0.45 and 0.40.

Table 11: Long-Run Effects for the Asymmetric UI Case

	Home	Foreign
GDP	2.74	0.27
GNP	7.48	-1.46
Aggr. Consumption	8.75	-2.53
Unemployment Rate Change	-17.50	-0.08
C: Tradable	9.31	-2.54
C: Non-Tradable	6.72	-2.48
Tradable-to-non-tradable expenditure ratio	-8.73	3.38
CPI	1.61	0.09
TPI	0.59	0.12
Wage	-3.60	0.46
Interest Rate	-0.03	-0.03
Real Exchange Rate	1.52	-1.50
Capital-Labor Ratio	3.14	0.81
NFA/Output	68.93	-26.86

Notes: Changes compare the saved post-reform steady state with the saved asymmetric pre-reform steady state. The interest rate and NFA/output are percentage-point changes; all other entries are percent deviations.

E.7 Welfare Effects under a Labor-Tax Rule

As a robustness check, Table 12 reports welfare effects when fiscal adjustment operates through the labor tax rather than through a lump-sum tax in both countries. In both cases, we use the same fiscal feedback rule regarding persistence and debt adjustment. However, we use different taxes for the adjustment. In the baseline scenario, we fix labor taxes and let lump-sum taxes respond. In the robustness exercise, we fix lump-sum taxes and let labor taxes

respond instead.

This alternative closure changes how the fiscal burden is distributed across households during the transition. Under the baseline lump-sum closure, fiscal adjustment operates through a largely non-distortionary transfer component that cushions disposable income broadly across employment states. When the adjustment instead occurs through the labor tax, this insurance channel is weakened. Only households with labor income benefit directly from the lower labor tax, whereas unemployed workers benefit only indirectly through their prospects of returning to employment.

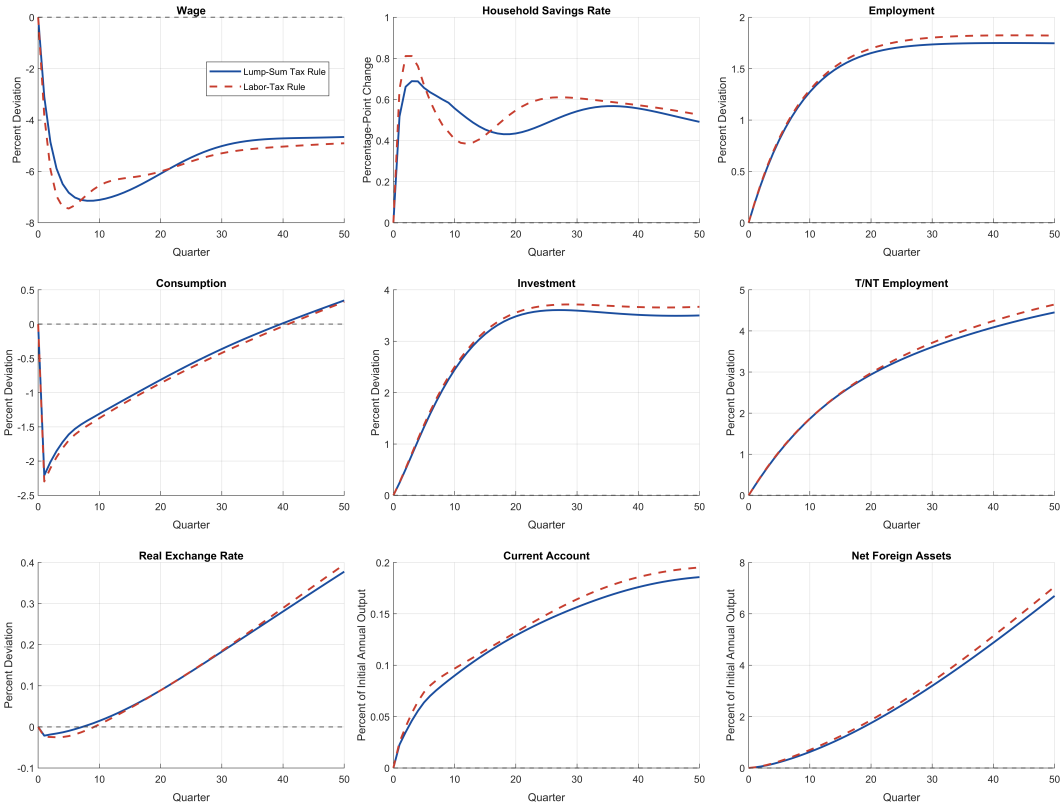
Although employed workers receive a larger direct tax cut, they face somewhat larger welfare losses than in the baseline scenario. Their ex-ante lifetime value also contains the risk of future unemployment and the ensuing lower present value of lifetime resources. As a result, the reform becomes slightly more costly in welfare terms for the reforming economy, with the aggregate consumption-equivalent variation falling from about -2.07 percent to -2.25 percent. The additional welfare losses are concentrated among workers with longer unemployment durations, for whom the absence of the lump-sum cushion is particularly detrimental. Losses rise over the unemployment spell and reach -10.94 percent for the long-term unemployed.

As in the baseline scenario, welfare effects in the non-reforming economy remain very small and slightly positive, at around 0.07 percent. The non-reforming country is affected only indirectly through general-equilibrium spillovers. When changing the fiscal instrument in the reforming economy, most adjustment paths remain very similar under the two fiscal closures (see Figure 19). The labor-tax rule produces a somewhat larger initial wage decline and a different private-saving response, while employment rises slightly more in the reforming economy over the horizon shown.

Table 12: Consumption Equivalent Variation (CEV) by Group and Country: Labor Tax Fiscal Rule

Group	Reforming Economy (A)	Non-Reforming Economy (B)
Aggregate	-2.25	0.07
Employed	-1.48	0.07
Short-Term Unemployed		
EU1	-4.39	0.06
EU2	-5.14	0.06
EU3	-6.04	0.05
EU4	-7.15	0.05
EU5	-8.56	0.05
EU6	-9.21	0.05
EU7	-9.83	0.05
EU8	-10.42	0.05
Long-Term Unemployed (LTU)	-10.94	0.05

Figure 19: Lump-Sum Tax Rule vs. Labor-Tax Rule



Notes: Model responses in the reforming economy following the labor market reform under the baseline lump-sum fiscal closure (solid line) and under the alternative labor-tax fiscal closure (dashed line). Wages, employment, consumption, investment, the tradable-to-non-tradable employment ratio, and the real exchange rate are depicted as percent deviations from the pre-reform steady state. The household savings rate is reported as a percentage-point change, while the current account and the change in net foreign assets are measured as percentages of initial annual output.