The German Labour Market Reforms in a European Context: A DSGE Analysis

Claudia Busl and Atılım Seymen

ZEW

Zentrum für Europäische
Wirtschaftsforschung GmbH

Centre for European
Economic Research

Discussion Paper No. 13-097

The German Labour Market Reforms in a European Context: A DSGE Analysis

Claudia Busl and Atılım Seymen

The German Labour Market Reforms in a European Context: A DSGE Analysis[*]

Claudia Busl[a]   Atılım Seymen[b]

November 8, 2013

Abstract

While a widespread consensus exists among macroeconomists that the German labour market reforms in 2003-2005 have successfully contributed to the decline of the unemployment rate, critics claim that the reforms led to wage restraint and consequently consumption dampening accompanied by beggar-thy-neighbour effects, harming Germany's trade partners. We check up on the validity of these arguments by means of a two-country DSGE model featuring intra-industry trade and labour market frictions. Our results suggest that the disproportional growth of GDP (labour productivity) in comparison to consumption (wages) are only partially driven by the reforms. However, we do not find that the reforms contribute to Germany's trade surplus and cause negative spillovers to trading partners in terms of output and employment.

1 Introduction

In the last decade, Germany launched a series of labour market reforms—the so-called Hartz reforms—in order to deal with a protracted unemployment problem. Over the period 2003-2010, following the introduction of the first Hartz reform package, four trends are conspicuous in the German macroeconomic data. First, the unemployment rate declined significantly from 9.3% to 7.1%. Second, the increase in GDP of 8.6% has been much stronger than the increase in consumption of 3.6%. Third, labour productivity rose significantly by 5.5%, accompanied by a merely moderate wage rise of 0.7%. Fourth, the German economy registered large current account surpluses, which have been driven by trade surpluses to a large extent and have persistently been above 5% of GDP since 2005.

While a widespread consensus exists among macroeconomists that the Hartz reforms have successfully contributed to the decline of the unemployment rate, the role of the reforms in driving the other aforementioned developments in the data is anything but clear-cut. Critics of the Hartz reforms read those figures as supportive for the claim that the reforms led to wage restraint and consequently consumption dampening accompanied by beggar-thy-neighbour effects harming Germany's trade partners. But the disproportional growth of GDP (labour productivity) in comparison to consumption (wages) and the German trade surplus may as well have been due to other factors. The aim of this paper is to shed light on this controversy by means of a two-country dynamic stochastic general equilibrium (DSGE) model with search and matching frictions which is calibrated to German and rest of the euro area data. In particular, we want to quantify, if any, the role of the Hartz reforms in the aforementioned developments in the German macroeconomic data. Labour market reforms have been on the policy agenda of many countries following the global financial crisis, and we believe that our paper provides several insights as to their domestic and international impact.

The Hartz reforms had two main components: measures to increase the efficiency of matching the unemployed with vacancies in firms and a significant decline in the unemployment benefit ratio. In our analysis, we address three crucial aspects to evaluate the Hartz reforms. First, we analyse the macroeconomic impact of both components of the reforms in a unifying framework. This aspect has been missing in the existing studies on the Hartz reforms, although it is known that different reform components may interact with each other.[1] Second, we investigate both the short-run and the long-run effects of the reforms, since those may differ substantially. Negative short-run effects may hinder, for example, the willingness for reforms notwithstanding positive long-run effects. Third, we are interested in both do-

---

[1]See Coe and Snower (1997), Daveri and Tabellini (2000), Blanchard and Giavazzi (2003) and Belot and van Ours (2004).

mestic and international effects of the Hartz reforms. The latter have not received the same attention as the domestic effects in the literature, although many commentators accuse the Hartz reforms for being the instrument of a beggar-thy-neighbour policy.

We reckon that a DSGE framework provides a convenient methodological tool to address all three of these aspects within a unifying framework. The DSGE model we work with is borrowed from Fonseca, Patureau, and Sopraseuth (2009) and has several standard features. Most importantly for our analysis, it features several labour market institutions and fiscal policy parameters. In particular, unemployment results from search and matching frictions à la Pissarides (2000) in the labour market. Hence, the model comprises parameters for the efficiency of matching the unemployed with vacant positions in firms and the unemployment benefit ratio, both of which stood at the heart of the Hartz reforms. Furthermore, international spillovers occur through two channels in the model: international goods trade[2] and international financial assets. To be more specific, each country specializes in the production of its own good, whereas consumers in both countries consume a composite good comprising the goods of both countries. This standard intra-industry trade framework maps the trade flows in the euro area in an appropriate way. Finally, there is a riskless nominal interest rate bond that helps to enhance the sharing of resources internationally.

Several studies that we review in the next section point to a steep increase in the matching efficiency following the Hartz reforms, the range of the estimated increase being 10-30%. Additionally, the last package of the Hartz reforms reduced the unemployment benefits by roughly 10 percentage points. When we feed those Hartz phenomena into our model, it is quite successful in replicating general trends in the German aggregate data over the period 2003-2010.[3] In particular, we find that both reform components contributed significantly and to a similar extent to the decline in the German unemployment rate and pushed the economy to a higher growth path. Consequently, our findings suggest that a 3.3 percentage point reduction in the unemployment rate and almost a quarter of the 8.6% increase in the German GDP between 2003 and 2010 is associated with the positive effects of the Hartz reforms.

While the reforms, evaluated separately as well as combined, boost the German economy on many accounts in the model, they do not lead to any negative effects on the trade partner—the rest of the euro area—in the long run. Note that this finding is intrinsic to the model framework we work with. Our model belongs to the class of theoretical models

---

[2]Trade is reckoned to be the most important channel of international transmissions. See, e.g. Baxter and Kouparitsas (2005).

[3]This implies that we compare 8-year changes in the data with steady state changes in our calibrated model. We choose this period, since business cycle effects largely cancel out over such a long horizon. With respect to the model dynamics this should not be problematic, since for most of the variables the adjustment to the new steady state after the introduction of the reforms is completed to a large extent within 2-3 years. Note that our arguments in this paper are not affected by the choice of the period.

which generate, following labour market reforms, small positive spillovers to other countries due to the existence of both intra-industry (Armingtonian) trade and search frictions in the labour market à la Pissarides (2000). These modelling devices seem appropriate to analyse the effects of labour market reforms in the euro area, where the major part of trade is caused by product differentiation and labour markets are far from being frictionless. Dao (2013a) shows in a theoretical framework that is very similar to ours that reforms improving the terms of trade of the foreign country will always lead to higher employment and production there in the long-run, since firms and workers in the foreign country share rents in a way that both benefit from the positive terms-of-trade effect. While Dao (2013a) focuses rather on a reduction of labour taxes for firms, the Hartz reforms also induce positive terms-of-trade effects for the rest of the euro area in our model and thus Dao's finding applies to our model as well. Note that the few existing empirical studies on the issue also point to positive long-run effects of labour market reforms on trade partners. The short-run impact of labour market reforms on the trade partners, in contrast, may not be so obvious a priori and depend on the type of reform.

Our findings do not suggest a high degree of wage moderation in the sense that wages decline relative to labour productivity in the face of the reforms. The combined reforms lead to a decline in the labour productivity of 0.26%, whereas wages decline by 0.39% according to our benchmark calibration.[4] Similarly, only a small amount of the consumption dampening in the data can be traced back to the Hartz reforms: the combined reforms would increase the output (consumption) by 1.94% (1.35%). Finally, in our model the combined Hartz reforms lead to trade deficits in the short-to-middle run, rather than to surpluses as in the German data, according to our findings. This is particularly due to the fact that returns to investment become higher in the German economy following the reforms, inducing foreign households to register trade surpluses and invest in German bonds.

The rest of the paper is organized as follows. The literature on the effects of labour market reforms/institutions and the relation of our paper to that literature is discussed in the next section. Section 3 presents our model. The quantitative results as well as their sensitivity are subject of Section 4. The section starts with the discussion of the model calibration followed by the presentation of the domestic and spillover effects of the Hartz reforms as well as their sensitivity with respect to the calibration of several parameters in separate subsections. Section 4 closes with a discussion of further factors that could—at least partially—have contributed to the trends in the German data. Section 5 concludes.

---

[4]The matching efficiency increase alone would even lead to real wage gains where the real wage would rise by 0.34% vis-à-vis a labour productivity decline of 0.12%. In contrast, the unemployment benefit reform alone would reduce equilibrium wages by 0.86% vis-à-vis a labour productivity decline of merely 0.16%

2 Related Literature

The Hartz reforms have been introduced in four law packages between 2003 and 2005. The last reform package—the so-called Hartz IV— included a decrease of more than 10 percentage points in the unemployment benefit ratio.[5] The measurement of the impact of the first three Hartz law packages on the efficiency of matching the unemployed with vacancies in firms is, however, more challenging and requires the use of econometric techniques.[6] The estimates of Fahr and Sunde (2009), that refer to the impact of the Hartz I/II reforms measured over the period March 2000–December 2003, point to a 5-10% increase in the matching efficiency. The authors measure the impact of the Hartz III reform over the period March 2003–December 2004 to be somewhat weaker. Yet, the joint impact of the first three Hartz law packages on the matching efficiency has been a visible 10-15% within a very short period after their introduction according to the authors' estimates. In a more recent study, Klinger and Rothe (2012) obtain very similar numbers. Hertweck and Sigrist (2013) estimate the range of increase in the efficiency of the matching process in Western Germany of the combined reforms to lie between 12% and 31%, whereby their point estimate, a 23% decrease in the matching efficiency, corresponds to a 20% decrease in the unemployment rate.

In addition to the studies that measure the extent of matching efficiency gains due to Hartz reforms, few papers provide comprehensive analyses of how the reforms affected aggregate macroeconomic variables in general and the unemployment rate in particular: Krause and Uhlig (2012), Krebs and Scheffel (2013), Nie (2010) and Launov and Wälde (forthcoming). These studies all build on models with heterogeneous agents, and their main focus lies on the effects of the Hartz IV reform that changed the German unemployment benefit system substantially. Krause and Uhlig (2012) develop a quantitative labour market model similar to the one in Ljungqvist and Sargent (2007) with skill heterogeneity of workers, search and matching frictions à la Pissarides (2000), and endogenous job acceptance and separation rates. Krebs and Scheffel (2013) combine the incomplete-market model of Krebs (2003) with the model of search unemployment of Ljungqvist and Sargent (1998), while Nie (2010) employs an extension of the same Ljungqvist-Sargent model with a training decision and a

---

[5]The previous German unemployment benefit system consisted of several layers of payments depending on the length of unemployment and/or whether a person received additional vocational training. The estimate of a decline of above 10 percentage points is based on the OECD calculations of the gross replacement ratio. Dao (2013b) also uses a similar figure to ours.

[6]Hartz I-III included a number of efforts to improve the matching efficiency by improving the performance of public employment services and of Active Labour Market Policies (ALMP). In specific, the public employment services were modernized in terms of their organizational structure and were geared to be result and customer-oriented. In addition, incentives for alternative private placement services were introduced to generate market forces and the allocation of measures was subordinated to cost effectiveness. Furthermore, direct integration measures were boosted vis-à-vis training and job creation measures which prevent participants from a fast return into work. See Jacobi and Kluve (2007) for a detailed review of all reform measures.

broader menu of unemployment benefits. The model of Launov and Wälde (forthcoming) is an extension of the standard matching model with time-dependent unemployment benefits, endogenous effort, risk-averse households an exogenous "spell-effect" and Semi-Markov features.

The foregoing papers all find a reduction in the equilibrium unemployment rate following the Hartz IV reform, but differ in their estimates regarding the extent to which the reform reduced the equilibrium unemployment rate in Germany. Krause and Uhlig (2012) find a 35% reduction in the equilibrium unemployment rate of Germany, Krebs and Scheffel (2013) 14% and Launov and Wälde (forthcoming) merely 2.8%.[7] Nie (2010), who explicitly distinguishes between the multiple levels of the former unemployment benefit system, finds that the reduction in unemployment benefits for all workers, regardless of whether they were attending a training programme, lowered the unemployment rate by 11.5% from 11.3% to 10%. Given the large discrepancies between our model framework and the ones in the foregoing studies, we find it useful to compare our findings with theirs. However, our comparisons will mostly be limited to the unemployment rate and output, since the models of the existing studies on the Hartz IV reform do not contain many further aggregate variables such as consumption. Krebs and Scheffel (2013) are an exception in this regard. Moreover, all of the existing studies abstract from international linkages.

A crucial aspect of structural reforms in labour (and product) markets is the potential interaction of different reforms with each other, thus raising or reducing the impact of individual reform components, as implied by the results of several studies such as Coe and Snower (1997), Daveri and Tabellini (2000), Blanchard and Giavazzi (2003) and Belot and van Ours (2004). Yet, the existing studies on the Hartz reforms focus almost exclusively on the impact of the Hartz IV reform, disregarding the impact of the first three reform packages on the matching efficiency. Krause and Uhlig (2012) is the only study that briefly mentions the impact of the matching efficiency increase, but Krause and Uhlig consider only the long-run impact of a matching efficiency increase of 10%, guided by the findings of Fahr and Sunde (2009). Yet, the authors evaluate the impact of such an increase in the matching efficiency in an isolated manner and do not consider the joint impact of both Hartz reform components on the unemployment rate and output. Our study appears to be the first one to address this gap.

Another gap in the existing literature that we try to fill in our study regards the international spillover effects of the Hartz reforms. There is only one study by Dao (2013b), who calibrates a two-country DSGE model with respect to Germany and the rest of the euro area as we do. However, she looks at the impact of the decline in the German unemploy-

---

[7]Note that these calculations are based on different initial, pre-reform steady state unemployment rates. The decline in Krause and Uhlig (2012) is from 10.8% to 8%, in Krebs and Scheffel (2013) from 9% to 7.76%, and Launov and Wälde (forthcoming) from 10.5% to 10.2%.

ment benefit ratio (only in the long run) but does not consider the impact of the increase in the matching efficiency and the way she constructs the labour market differs from ours. While no other study addressed the issue pertaining to the Hartz reforms up to now, several studies deal with the international effects of reforms in labour market institutions. Note that a uniform focus on the international effects of labour market reforms is hardly possible, since there is a lot of variation in the existing studies as to which labour market institutions are the subject of reform. While some studies capture rigidities in labour markets with a mark-up parameter on wages or an index that reflects labour market rigidities as a function of several institutional parameters, others refer directly to clear-cut institutional parameters such as labour taxes or unemployment benefits.

Two studies evaluate the spillover effects of labour market reforms empirically with cross-country panel data, both of which report positive spillover effects of reforms to trading partners. Dao (2013a) investigates the effect of foreign unit labour costs instrumented with statutory social security contribution rates on domestic employment. Felbermayr, Larch, and Lechthaler (2013) include, on the other hand, domestic and foreign tax wedges—defined as the sum of the replacement rate, i.e. unemployment benefit ratio, and wage taxes—as well as several further institutional variables alongside with control variables in their panel regressions which explain the domestic unemployment rate.

The majority of the studies on the international effects of labour market reforms are theoretical. The studies that we review in the following differ substantially across several lines, particularly as to whether they possess New-Keynesian features and are dynamic or static, how they treat labour market rigidities, the number of countries/regions they cover, and whether they contain both traded and non-traded goods. Yet, despite such differences, nearly all theoretical studies that have been published on the subject obtain positive spillover effects of reforms in the long run. A notable exception is the study of Helpman and Itskhoki (2010). Their model builds on a static Melitz-type model with heterogeneous firms enriched with search and matching frictions in the labour market and an additional sector producing homogeneous goods. Thus, their model incorporates intra- as well as inter-industry trade. Spillovers occur mainly through decisions at the extensive margin caused by changes in relative prices, i.e. workers switching between sectors and firms entering (and exiting) foreign and domestic markets. Labour market reforms in the heterogeneous goods sector of one country imply negative welfare effects for its neighbours whereas effects to employment are more differentiated depending on the level of labour market frictions between sectors and countries.

In contrast, Alessandria and Delacroix (2008) find, based on a model with Ricardian trade and without search and matching frictions, that a major part of the welfare gains created through an elimination of firing taxes is exported to trading partners because of

worsened terms of trade. There are no spillovers to employment though. The authors argue that this explains the reluctance for labour market reforms in many countries.

Our model generates, like the majority of the models in the literature, a positive terms-of-trade effect for the (non-reforming) trade partner of the reforming country in the long run. This effect accrues from the relative abundance of the reforming country's good following the labour market reform(s). The terms-of-trade improvement does, however, not necessarily lead to higher output and employment in the trade partner. Dao (2013a) shows that with a competitive labour market and a convenient parameterization of the utility function of the households, negative spillover effects from reforms can occur. In particular, the wealth effect on the labour supply from the terms-of-trade improvement can be larger than the productivity effect on the labour demand in the non-reforming trade partner in such a case. With rigidities in the labour market, in contrast, the employment levels in both countries are lower in equilibrium and there is a rent to be shared between firms and workers in the face of a terms-of-trade improvement in the long run. In other words, positive terms-of-trade effects of output-enhancing labour market reforms in one country lead to positive long-run employment effects for the trade partner if the labour market of the trade partner is subject to rigidities.

As we have already mentioned above, the literature on the spillover effects of labour market reforms is rather diverse as to the reform measures that are evaluated. Bayoumi, Laxton, and Pesenti (2004), Everaert and Schule (2008) and Gomes, Jacquinot, Mohr, and Pisani (2011) approximate the rigidity of labour market institutions by a mark-up parameter that drives a wedge between marginal costs of labour and real wages. While those analyses are illuminating, they do not deal with institutional parameters that policy-makers can address directly and abstract from labour market frictions inducing involuntary unemployment. Other studies refer to specific and observable labour market institutions and comprise the unemployment phenomenon directly. Among those, Dao (2013a), Gomes, Jacquinot, and Pisani (2012) and Coenen, McAdam, and Straub (2008) explore the impact of a reduction in (employers') labour tax rate, while Felbermayr, Larch, and Lechthaler (2012) focus solely on the impact of a change in unemployment benefits. In several further studies such as Dao (2013b), Felbermayr, Larch, and Lechthaler (2013) and Schwarzmüller and Stähler (2011), the effects of more than one reform measure are investigated. These include changes in a combination of a subgroup of measures such as labour taxes, unemployment benefits, search costs, bargaining power of firms and workers and firing costs. Despite the diversity of the models in terms of the measures they evaluate as well as their structure and calibration, the bottom line from the previous paragraph does not change: in the long run, labour market reforms lead to positive spillovers to other countries through the interplay of terms-of-trade effects and labour market rigidities.

To sum up, the spillover effects of labour market reforms are predominantly found to be positive by the existing empirical and theoretical literature. However, the empirical evidence as well as the theoretical analyses on the sign of reform spillovers such as the ones in Dao (2013a) and Felbermayr, Larch, and Lechthaler (2013) refer only to long-run effects. Although few studies such as Dao (2013a), Dao (2013b) and Gomes, Jacquinot, and Pisani (2012) report positive short-run spillover effects of labour tax reductions, negative spillovers in the short run in the case of other reform measures and/or alternative calibrations of the models cannot be ruled out a priori.

3 The Model

In this section, we describe our model framework which is a standard two-country real business cycle model enhanced by matching frictions in the labour market, an international bond market and fiscal policy parameters. It closely follows Fonseca, Patureau, and Sopraseuth (2009). If not stated otherwise, we describe the decision problems of households and firms in the home country, called country 1, in the following. The problem set of the foreign country can be found in Appendix A.

3.1 Households

Each country is inhabited by an infinitely living mass of agents normalized to unity. Agents maximize their lifetime utility at the beginning of each period without knowing whether they will end up unemployed or not. But since they are assumed to be risk averse and to have access to complete income insurance markets, their decisions are independent of their individual labour market outcome. Only the aggregate outcome and, correspondingly, the probability of being employed N_{it} in country i at period t matter. A representative household in country 1 maximizes its expected life-time utility

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[N_{1t} U(C_{1t}^n, h_{1t}) + (1 - N_{1t}) U(C_{1t}^u) \right] \tag{1}$$

where $0 < \beta < 1$ is the discount factor, C_{1t}^n and C_{1t}^u denote consumption in case of employment and unemployment, respectively, and h_{1t} represents the number of hours worked by an employed agent. The number of hours per period is normalized to unity. Thus, time spend on leisure is given by $1 - h_{1t}$. The per-period utility functions of employed and unemployed

individuals are additively separable in consumption and leisure and are given by

$$U(C_{1t}^n, h_{1t}) = log(C_{1t}^n) + \kappa_1^n \frac{(1 - h_{1t})^{1-\xi}}{1 - \xi} \tag{2}$$

$$U(C_{1t}^u) = log(C_{1t}^u) + \kappa_1^u \tag{3}$$

with κ_1^n and κ_1^u being parameters that affect and determine the value of leisure for employed and unemployed agents, respectively, and $\frac{1}{\xi}$ measuring the intertemporal elasticity of substitution of leisure with $\xi > 0$.

Agents receive an income $w_{1t}h_{1t}$ from employment, w_{1t} being the hourly wage rate, subject to an employees' labour tax τ_1^d when they are employed, and fixed unemployment benefits b_1 otherwise. In addition, there are direct transfers from the government to households (or lump-sum taxes on households depending on whether the consumption and labour tax revenues are enough to cover the unemployment benefit payments) amounting to T_{1t} and the profits Π_{1t} accruing from the domestic firms owned by the households. Furthermore, agents can hold bonds denominated in terms of the domestic good available in an international bond market which yield an interest payment i_t for each unit. Households spend their income on consumption including a consumption tax τ_1^c and on new bond holdings B_{1t+1}. If the household changes its bond holdings, it faces a portfolio adjustment cost CA_{1t} which is given by

$$CA_{1t} = \frac{\Phi_b}{2} \left(\frac{B_{1t+1}}{P_{1t}^c} \right)^2 \tag{4}$$

that is scaled by the factor $\Phi_b > 0$. The adjustment cost guarantees the stationarity of the model in the light of its incomplete financial market.[8]

Taking the foregoing elements together, the budget constraint of the representative household expressed in terms of the good produced in country 1 is written as

$$P_{1t}^c (1 + \tau_1^c) C_{1t}^c + B_{1t+1} + P_{1t}^c CA_{1t} = N_{1t}h_{1t}w_{1t} \left(1 - \tau_1^d\right) + (1 - N_{1t}) b_1 + B_{1t}(1 + i_t) + T_{1t} + \Pi_{1t} \tag{5}$$

with P_{1t}^c being the consumer price index at home. As will be seen below, both employed and unemployed agents consume the same amount C_{1t}^c.

The households' optimization decision problem is summarized by the Bellman equation

$$F_{1t}^H = \max_{C_{1t}^n, C_{1t}^u, B_{1t+1}} \left[N_{1t}U(C_{1t}^n, h_{1t}) + (1 - N_{1t})U(C_{1t}^u) + \beta E_t \left(F_{1t+1}^H \right) \right] \tag{6}$$

which is subject to the budget constraint (5) and the law of motion of aggregate employment

---

[8]Schmitt-Grohé and Uribe (2003) discuss this issue in detail.

N_{1t}

$$N_{1t+1} = (1 - s_1) N_{1t} + \phi_{1t}(1 - N_{1t}). \tag{7}$$

In this equation, s_1 is the constant job separation rate for employed workers which is exogenously given[9] and ϕ_{1t} the probability of finding a job when being unemployed. Thus, $\phi_{1t}(1 - N_{1t})$ is the number of successful matches which result in hirings H_{1t}. The number of unemployed agents in country 1 is given by $U_{1t} = 1 - N_{1t}$. Since we normalize the mass of the potential workforce to unity, U_{1t} stands for the unemployment rate at the same time. Note that the hours worked h_{1t} do not directly enter the representative household's optimization problem, since they are determined by negotiations between firms and workers through Nash-bargaining which is handled below.

We define λ_{1t} as the Lagrange multiplier corresponding to the budget constraint (5) and derive the first order conditions of the representative agent's optimization problem (6) as follows. With respect to consumption we obtain

$$\frac{1}{C_{1t}^n} = \frac{1}{C_{1t}^u} = (1 + \tau_1^c) \lambda_{1t} P_{1t}^c. \tag{8}$$

This condition implies that the optimal level of consumption does not depend on the agents' employment status. Therefore, we call the aggregate level of consumption C_{1t}^c in the following. Regarding the bond holdings, the optimality condition is given by

$$1 + \Phi_b \frac{B_{1t+1}}{P_{1t}^c} = \beta E_t \left[\frac{\lambda_{1t+1}}{\lambda_{1t}} (1 + i_{t+1}) \right]. \tag{9}$$

The household's preferences in consumption between foreign and domestic goods are modelled by an Armington aggregator. The consumption level of country 1 is hence given by

$$C_{1t}^c = \left[\kappa^{\frac{1}{\eta}} C_{1t}^{\frac{\eta-1}{\eta}} + (1 - \kappa)^{\frac{1}{\eta}} C_{2t}^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}, \tag{10}$$

where $0 < \kappa < 1$ is the weight of domestic goods in domestic spending and $\eta > 0$ is the elasticity of substitution between foreign and domestic goods. C_{it} denotes the domestic consumption of goods produced in country i. We choose the good produced in country 1 to be our numéraire and fix its price P_{1t} to unity. The terms of trade of the foreign country are accordingly given by $ToT_t = \frac{P_{2t}}{P_{1t}} = P_{2t}$. With these definitions, the minimization of costs for C_{1t}^c results in the demand functions for the goods consumed in country 1 that read

$$C_{1t} = \kappa \left(P_{1t}^c \right)^{\eta} C_{1t}^c \tag{11}$$

---

[9]This assumption is in accordance with empirical evidence: according to Bachmann (2005) job "separations are relatively flat over the business cycle" in Germany.

$$C_{2t} = (1 - \kappa) \left(\frac{P_{1t}^c}{ToT_t} \right)^{\eta} C_{1t}^c. \tag{12}$$

3.2 Firms

In each country a continuum of firms operates in a perfectly competitive market. Firms produce goods with the Cobb-Douglas production technology using domestic labour N_{1t} and capital K_{1t} as input:

$$Y_{1t} = A_1 K_{1t}^{\alpha} \left(N_{1t} h_{1t} \right)^{1-\alpha} \tag{13}$$

where $0 < 1 - \alpha < 1$ is the labour share of income. In addition, the output level depends on the level of the technology A_1, which we keep constant, since it has no relevance for our analysis of the impacts of policy changes.

Each period firms face wage bills amounting to $N_{1t} h_{1t} w_{1t}$ which are subject to taxes, denoted by τ_1^f, contributing to the government budget. Furthermore, they post vacancies in the job market to adjust the size of the workforce for the next period, which is reduced by exogenous job separation. Thereby, they incur a cost $\omega_1 > 0$ for each vacant job posted. The total number of posted vacancies is V_{1t}. With q_{1t} being the probability of finding an appropriate match, the number of successful matches in the labour market leading to hirings H_{1t} can be expressed as $q_{1t} V_{1t}$. Hence, we can rewrite the law of motion of aggregate employment in terms of vacancies as

$$N_{1t+1} = (1 - s_1) N_{1t} + q_{1t} V_{1t}. \tag{14}$$

The accumulation of capital occurs according to the standard law of motion for capital

$$K_{1t+1} = (1 - \delta) K_{1t} + I_{1t}^c, \tag{15}$$

where $0 < \delta < 1$ stands for the capital depreciation rate and investment I_{1t}^c is made up of the same combination of domestic and foreign goods as the consumption basket of households. Firms incur costs when adjusting their capital stock amounting to

$$CI_{1t} = \frac{\Phi_I}{2} \frac{(K_{1t+1} - K_{1t})^2}{K_{1t}}, \tag{16}$$

where $\Phi_I > 0$ is a scaling parameter.

Firms maximize their profits Π_{1t} given by

$$\Pi_{1t} = Y_{1t} - N_{1t} h_{1t} w_{1t} \left(1 + \tau_1^f \right) - \omega_1 P_{1t}^c V_{1t} - P_{1t}^c I_{1t}^c - P_{1t}^c CI_{1t}. \tag{17}$$

Their optimization problem can be summarized as

$$F_{1t}^F = \max_{K_{1t}, N_{1t}} \left[\Pi_{1t} + \beta E_t \left(\frac{\lambda_{1t+1}}{\lambda_{1t}} F_{1t+1}^F \right) \right],$$ (18)

subject to the production technology (13), and the law of motion of capital (15) and aggregate employment (14). Firms' future profit flows are weighted by the ratio of the future to the present Lagrange multiplier $\lambda_{1t+1}/\lambda_{1t}$ of household's budget constraint, since households are the owners of the firms. This weight assesses the relative importance of wealth changes for households.

The optimality conditions with respect to capital and labour can be combined in

$$q_{1t}^T = \beta E_t \left[\frac{P_{1t+1}^c \lambda_{1t+1}}{P_{1t}^c \lambda_{1t}} \left\{ \frac{1}{P_{1t+1}^c} \alpha \frac{Y_{1t+1}}{K_{1t+1}} + q_{1t+1}^T - \delta + \frac{\Phi_I}{2} \left(\frac{I_{1t+1}^c - \delta K_{1t+1}}{K_{1t+1}} \right)^2 \right\} \right]$$ (19)

where we use Tobin's q defined as $q_{1t}^T = 1 + \Phi_I \frac{I_{1t}^c - \delta K_{1t}}{K_{1t}}$ and

$$\frac{\omega_1}{q_{1t}} = \beta E_t \left[\frac{P_{1t+1}^c \lambda_{1t+1}}{P_{1t}^c \lambda_{1t}} \left\{ \frac{1}{P_{1t+1}^c} (1 - \alpha) \frac{Y_{1t+1}}{N_{1t+1}} - \frac{1}{P_{1t+1}^c} h_{1t+1} w_{1t+1} \left(1 + \tau_1^f \right) + (1 - s_1) \frac{\omega_1}{q_{1t+1}} \right\} \right].$$ (20)

3.3 Matching and Bargaining in the Labour Market

The process of matching vacancies and unemployed persons results in hirings according to the following constant returns-to-scale technology proposed by Pissarides (2000):

$$H_{1t} = \chi_1 V_{1t}^\psi (1 - N_{1t})^{1-\psi}$$ (21)

where $\chi_1 > 0$ is a parameter that measures the efficiency of the matching process and $0 < \psi < 1$ denotes the elasticity of the matching function with respect to vacancies.

Each period firms and workers bargain over wages w_{1t} and the number of hours worked h_{1t} within a Nash bargaining framework. The outcome of the negotiation process is obtained by maximizing the weighted marginal value of an additional employed in terms of utility for firms and households:

$$\max_{w_{1t}, h_{1t}} \left(\lambda_{1t} \frac{\partial F_{1t}^F}{\partial N_{1t}} \right)^\epsilon \left(\frac{\partial F_{1t}^H}{\partial N_{1t}} \right)^{1-\epsilon}$$ (22)

where $0 < \epsilon < 1$ measures the bargaining power of the firm. For the household the marginal

value of a match is given by

$$\frac{\partial F_{1t}^H}{\partial N_{1t}} = \kappa_1^u - \kappa_1^n \frac{(1-h_{1t})^{1-\xi}}{1-\xi} + \lambda_{1t}(h_{1t}w_{1t}(1-\tau_1^d) - b_1) + (1-s_1-\phi_{1t})\beta E_t \left[\frac{\partial F_{1t+1}^H}{\partial N_{1t+1}}\right]. \quad (23)$$

For firms the value of an additional worker (in terms of the final good) can be written as

$$\frac{\partial F_{1t}^F}{\partial N_{1t}} = (1-\alpha)\frac{Y_{1t}}{N_{1t}h_{1t}}h_{1t} - (1+\tau_1^f)h_{1t}w_{1t} + (1-s_1)\beta E_t \left[\frac{\lambda_{1t+1}}{\lambda_{1t}}\frac{\partial F_{1t+1}^F}{\partial N_{1t+1}}\right], \quad (24)$$

where we assume that the marginal value of work in production $(1-\alpha)\frac{Y_{1t}}{N_{1t}h_{1t}}$ is taken as fixed in the bargaining process following Andolfatto (1996).

Defining labour market tightness θ_{1t} as $\frac{V_{1t}}{U_{1t}}$, optimal labour contracts according to equation (22) imply

$$w_{1t}h_{1t} = \frac{1-\epsilon}{1+\tau_1^f}\left[\omega_1 P_{1t}^c\theta_{1t} + (1-\alpha)\frac{Y_{1t}}{N_{1t}}\right] + \frac{\epsilon}{1-\tau_1^d}\left[b_1 + \frac{1}{\lambda_{1t}}\left(\kappa_1^u - \kappa_1^n\frac{(1-h_{1t})^{1-\xi}}{1-\xi}\right)\right] \quad (25)$$

$$\frac{\kappa_1^n}{\lambda_{1t}}(1-h_{1t})^{-\xi} = \frac{1-\tau_1^d}{1+\tau_1^f}(1-\alpha)\frac{Y_{1t}}{N_{1t}h_{1t}}. \quad (26)$$

3.4 The Government

The governments in both countries balance their spending on transfers T_{1t} and unemployment benefits b_1 with their income from consumption and labour taxation. In case the amount of the unemployment benefits exceeds the tax revenue, the government imposes a lump-sum tax on the household instead of a transfer payment. For the home country the government budget constraint is hence

$$\tau_1^c P_{1t}^c C_{1t}^c + \left(\tau_1^d + \tau_1^f\right)N_{1t}h_{1t}w_{1t} = T_{1t} + (1-N_{1t})b_1 \quad (27)$$

With unemployment benefits b_1 fixed, transfer payments endogenously adjust to balance the budget.

3.5 Equilibrium

Global equilibrium requires market clearing in financial and goods markets. For the international bond market, the equilibrium is defined as

$$B_{1t+1} + B_{2t+1} = 0. \quad (28)$$

In the markets of home and foreign goods, the equilibrium is given by

$$Y_{1t} = \kappa \left(\frac{1}{P_{1t}^c} \right)^{-\eta} D_{1t}^c + (1 - \kappa) \left(\frac{1}{P_{2t}^c} \right)^{-\eta} D_{2t}^c \tag{29}$$

$$Y_{2t} = \kappa \left(\frac{ToT_t}{P_{2t}^c} \right)^{-\eta} D_{2t}^c + (1 - \kappa) \left(\frac{ToT_t}{P_{1t}^c} \right)^{-\eta} D_{1t}^c, \tag{30}$$

where D_{it}^c denotes the aggregate demand in country $i = 1, 2$ which can be expressed as

$$D_{it}^c = C_{it}^c + I_{it}^c + \omega_i V_{it} + CI_{it} + CA_{it}. \tag{31}$$

Market clearing in the composite good market is obtained if

$$P_{1t}^c D_{1t}^c + P_{2t}^c D_{2t}^c = Y_{1t} + ToT_t Y_{2t} \tag{32}$$

holds.

Note that, due to Walras' law, one of these market clearing conditions is redundant. Finally, putting equations (5), (17), (27) and (31) together one obtains the evolution of the balance of payments in country 1

$$B_{1t+1} - (1 + i_t) B_{1t} = Y_{1t} - P_{1t}^c D_{1t}^c. \tag{33}$$

Note that the trade balance of country 1 reads $TB_{1t} = Y_{1t} - P_{1t}^c D_{1t}^c$ and that of country 2 $TB_{2t} = ToT_t Y_{2t} - P_{2t}^c D_{2t}^c$.

4   The Impact of the German Hartz Reforms

In this section, we start out by describing the calibration of our model to German and euro area data. Then, we present the results from our quantitative analysis. First, we explain the impact of the German labour market reforms on the German economy and compare it to the data. In a second step, we discuss the spillover effects to the "rest of the euro area". In Subsection 4.4, we present the results of a sensitivity analysis to changes in selected parameters and compare our results to the literature. Finally, we propose additional factors that could contribute to the explanation of the gap between wages (consumption) and productivity (output) growth as well as persistent trade surpluses in the German data.

Table 1: Symmetric Calibration

Labour market				Production technology				Preferences				Bond market
ϵ	$\omega V/Y$	ψ	q	α	h	δ	Φ_I	β	κ	η	ξ	Φ_b/NX
0.5	0.015	0.5	0.7	0.34	0.33	0.025	7	0.99	0.7	1	4	0.0038

4.1 Calibration

We calibrate our model to quarterly data and set most of the parameters symmetrically between the two economies. Allowing for heterogeneity only in labour market and fiscal policy parameters, i.e., potential reform parameters, enables us to abstract from differences between the economies that are irrelevant for our analysis. We start by discussing the commonly set parameters, which are summarized in Table 1.

Labour Market We follow the literature on labour market rigidities in Europe (see e.g. Dao (2013b) or Faia, Lechthaler, and Merkl (2013)) in choosing $\epsilon = 0.5$, i.e., by splitting the bargaining power in the Nash-bargaining equally between firms and workers. We set the elasticity of vacancies in the matching function ψ likewise to 0.5 in line with the estimates of Petrongolo and Pissarides (2001), thus preserving the Hosios condition.[10] We set the aggregate vacancy posting costs per GDP $\omega V/Y$ to 1.5% as in Fonseca, Patureau, and Sopraseuth (2009) and show in Subsection 4.4 how sensitive our results are with respect to these costs. The probability of filling a vacancy q is typically set between 0.7 (den Haan, Ramey, and Watson (2000) and Krause and Lubik (2007)) and 0.9 (Andolfatto (1996) and Hairault (2002)). We choose the lower bound of values used in the literature, since a lower probability seems more in line with the European case (see Campolmi and Faia (2011)).

Production Technology The production technology parameters are calibrated to reflect the German/European production environment. While the labour share in production has been roughly constant over the past decades in the US, it was subject to a considerable decline in many European countries including Germany and the gap between the US and Europe has narrowed.[11] In our benchmark calibration, we set the elasticity of substitution for capital α in the production function to 0.34 in accordance with the German data for the past decade. Following the literature, the steady state value of hours worked h is set to 1/3

---

[10]The condition derived by Hosios (1990) implies that the outcome of the bargaining process and thus the level of unemployment in equilibrium is efficient (i.e. welfare maximizing). It is met when the firm's share of surplus is equal to the elasticity of the matching function with respect to vacancies.

[11]According to the *EU KLEMS* database, the labour share of income in Germany declined from 0.72 in the 1970s to around 0.66 in the 2000s. On the other hand, it shrank only by roughly 0.02 points from 0.64 to 0.62 in the US over the same period. See also Hogrefe and Kappler (2012).

and the capital depreciation rate δ to 0.025.[12] The scaling factor of capital adjustment costs is chosen to be $\Phi_I = 7$, which is taken from Patureau (2007) and reflects the volatility of investment (relative to output) in the G7 countries.[13]

Preferences   The discount rate of households is given by $\beta = 0.99$, which corresponds to an annual real interest rate of about 4% according to equation (9) in the steady state.[14] ξ is derived to have the value 4 assuming a (Frisch) labour supply elasticity of $(1-h)/(h\,\xi) = 0.5$ following the recommendation of Chetty, Guren, Manoli, and Weber (2011).[15] The elasticity of internationally traded goods η is set to 1 as in Heathcote and Perri (2013). The parameter defining the home bias of consumed products κ is calibrated by setting the import-to-GDP ratio $(1-\kappa)$ to a value of 0.3 which corresponds to the average import share observed in Germany vis-á-vis the world since the introduction of the euro. Since the home bias in the consumption bundle as well as the elasticity of substitution between domestic and foreign goods might influence spillovers significantly via the trade channel, we carry out a sensitivity analysis with respect to κ and η below.

Finally, the scaling parameter for portfolio adjustment of households Φ_b is derived using empirical estimates of the ratio of the scaling parameter and steady state exports reported to be 0.0038 by Lane and Milesi-Ferretti (2002).

Heterogeneity in Labour Market Institutions and Fiscal Policy   In our basic setup, several parameters and steady state values of variables in country 2 are matched to German data in 2003, whereas country 1 is calibrated to the euro area situation in 2003.[16] We employ data for the EA-12 countries excluding Germany whenever possible in our calculations but

---

[12]Our results in the next sections are hardly sensitive to the choice of the depreciation rate.

[13]We performed a sensitivity analysis setting Φ_I to very low and very high values. Our quantitative results in the next sections are not sensitive to variations in Φ_I. There occurs only a slight change in the initial dynamics of wages and consumption after the introduction of the reforms.

[14]The long term average in annual real interest rates in Germany till 2003 amounted to roughly 3 to 4% (depending on the starting year) which would imply a discount rate between 0.993 and 0.99. Considering only the past decade, on the other hand, would yield a significantly lower interest rate of about 1% and a higher discount rate of 0.998. In the paper, we choose to work with the long term average. Yet, we checked the implication of lower interest rates and higher discount rates as indicated by the recent past. Since the consequent changes in the response to our reforms are minimal, we refrain from reporting further results.

[15]Chetty, Guren, Manoli, and Weber (2011) show that the estimates of the Frisch elasticity of aggregate hours worked differ substantially between micro and macro models, but not the elasticity on the intensive margin. Since our model differentiates between the intensive and extensive margins, we use the value of 0.5 recommended for the Frisch elasticity on the intensive margin. Furthermore, Bargain, Orsini, and Peichl (2011) show that labour supply elasticities do not differ much across countries.

[16]If we use average values over the period 1999-2003 instead of 2003 values, the institutional parameters in our calibration would hardly change. The only sizable difference would be a lower initial unemployment rate which implies smaller effects from the reforms carried out. But since the high unemployment rate was among the triggering factors of the reforms, we prefer to use its immediate pre-reform level.

Table 2: Calibration of Heterogeneity in the Labour Market Institutions and Fiscal Policy

		2003		2010	
		Germany	EA	Germany	EA
$1-N$	Unemployment	9.81	9.02	7.08	10.13
$1/\phi$	Av. duration of unemployment	9.53	16.57	8.68	14.20
ϕ	Job finding probability	31.48	18.11	34.57	21.13
b/wh	Unemployment benefit ratio	31.89	27.70	21.54	27.85
τ_f	Employers' labour tax	17.00	23.75	16.20	23.34
τ_d	Employees' labour tax	17.00	9.44	17.20	8.74
τ_c	Consumption tax	16.00	19.11	19.00	19.14

Notes: All numbers are in percentage points except the average duration of unemployment which is given in months. Unemployment (average duration of unemployment) are EA (EU) averages as published by the OECD including Germany. b/wh, τ_f, τ_d and τ_c are calculated as EA-12 averages excluding Germany using GDP weights at PPP exchange rates of the corresponding year.

Sources: OECD Reference Series, Bundesagentur für Arbeit, OECD Labour Market Statistics, OECD Benefits and Wages: Statistics, OECD Taxing Wages 2003, OECD Taxing Wages 2010, OECD Recent Tax Policy Trends and Reforms in OECD Countries, OECD Consumption Tax Trends 2012.

have sometimes to resort to aggregates including Germany. For simplicity we label the aggregate EA in all tables. Since our reform scenarios are partially based on institutions observed in 2010, we report for both Germany and the euro area the values corresponding to 2010 as well. The corresponding figures are displayed in Table 2.

We use annual harmonised unemployment rates from the *OECD Reference Series* dataset to calibrate the steady state unemployment rate $1 - N$. This definition excludes short term fluctuations in unemployment lasting less than one year. The job finding probability ϕ is set by using the inverse of the average unemployment duration. Data on average duration of unemployment in months stem from the German Federal Employment Agency (*Bundesagentur für Arbeit*) and for the euro area aggregate we use a European average provided by the *OECD Labour Market Statistics*. Consequently, we derive the labour market tightness in the steady state from the relationship $\theta = q/\phi$. We use the data on gross replacement rates (GRR) from the *OECD Benefits and Wages: Statistics* in order to obtain the unemployment benefit ratios of both regions and calibrate b_i by setting the steady state value of $b/(wh)$ equal to the GRR values in 2003.[17] The data on employers' and employees' tax rates on

---

[17]The GRR data consist of unemployment insurance and unemployment assistance benefits and do not take tax and social security contributions on earnings and benefits into account. Furthermore, the GRR

wages (τ^f, τ^d) as well as the consumption tax rate τ^c stem from several OECD publications (see Table 2). The parameters for the matching efficiency χ are calibrated using the steady state relationships of the two countries in 2003. The same applies to the parameters κ^n and κ^u that relate to the impact of leisure on utility.

In the next subsection, we provide a more detailed discussion on the heterogeneity in our calibration of Germany and the euro area. Note that this heterogeneity is also accompanied by differences in the exogenously given job separation rate. The steady state condition derived from equation (7) implies $s = \phi(1 - N)/N$. This yields job separation rates of $s_1 = 0.018$ and $s_2 = 0.034$ in our model calibrated to 2003 values, which are in line with empirical estimates (see Hobijn and Şahin (2009), Gartner, Merkl, and Rothe (2012) or Kohlbrecher, Merkl, and Nordmeier (2013)).

4.2 The Impact of the Reforms in Germany

In contrast to many other countries, the German labour market performed remarkably well during and in the aftermath of the economic crisis of 2008 and 2009. Table 2 summarizes a few telling observations. First, between 2003 and 2010, the unemployment rate increased by 1.1 percentage points in the EA (including Germany), whereas it decreased by 2.7 percentage points in Germany. Second, the job finding probability increased by roughly 3 percentage points in both regions.[18] Third, the unemployment benefit ratio decreased by more than 10 percentage points in Germany, whereas it stayed constant in the rest of the EA-12 during the period 2003-2010. Fourth, the three tax rates that we focus on in this study stayed roughly constant over time in both Germany and the euro area. Note, however, that Germany differs significantly from the average of the remaining EA-12 countries in this respect, particularly in terms of labour taxation. In addition, recall from Section 2 that studies by Fahr and Sunde (2009), Klinger and Rothe (2012) and Hertweck and Sigrist (2013) found a significant increase in the matching efficiency of between 12% and 31% as consequence of the reform package.

The foregoing numbers suggest that a large portion of the strong labour market performance of Germany might be traced back to the increase in the matching efficiency due to the reform laws called Hartz I-III and the decline in the unemployment benefit ratio due to the last reform law, Hartz IV. Therefore, we ask in this subsection to what extent the changes in these two parameters can explain the evolution of several variables in Germany between 2003 and 2010 and whether they generate the undesirable effects put forth by critics

---

data are based on three different household types. They are a weighted average of the payments over the first five years of unemployment with the first year being weighted more heavily.

[18]Note that the average length of unemployment may decrease in times of crisis thus increasing the job finding probability because of a strong increase in the number of short-term unemployed.

Table 3: Percentage Change in Selected Variables between 2003 and 2010

| | Germany | | | | EA | | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
	Data	$\chi_2 \uparrow$	$b_2 \downarrow$	$\chi_2 \uparrow$ & $b_2 \downarrow$	$\chi_2 \uparrow$	$b_2 \downarrow$	$\chi_2 \uparrow$ & $b_2 \downarrow$
Nh	2.91	1.04	1.36	2.20	0.01	0.02	0.03
N	4.95	1.73	1.81	3.28	0.02	0.03	0.05
U	-2.73	-1.56	-1.63	-2.96	-0.02	-0.03	-0.04
ϕ	3.09	6.59	6.98	15.10	0.05	0.06	0.10
h	-1.95	-0.67	-0.44	-1.05	-0.01	-0.01	-0.02
w	0.70	0.34	-0.86	-0.39	0.12	0.16	0.26
Y	8.57	0.92	1.20	1.94	0.14	0.18	0.28
C	3.56	0.99	0.42	1.35	0.37	0.49	0.78
I	7.16	0.68	0.89	1.44	0.37	0.48	0.78
TOT	-1.93	-0.78	-1.01	-1.63			

Data source for the first column: OECD.Stat database.

Notes: The reported change is absolute for U and ϕ, and relative for the remaining variables. Terms of trade are calculated as ratio of CPIs.

of the Hartz reforms. The spillover effects of the reforms on other EA members as well as the effects on Germany's trade balance are deferred to the next section.

Before we present the results from our quantitative experiments, we find it useful to have a look at the first column of Table 3 which summarizes the evolution in selected variables over the period 2003-2010. We observe that total hours worked increased by 2.9% in Germany over this period. This increase resulted from the increase in employment by 5.0% and occurred despite the decline in average hours worked per worker of 1.9%. At the same time, real wages stagnated to a large extent and increased by merely 0.7% over the 8-year period. Furthermore, the increase in GDP between 2003 and 2010 was with 8.6% much higher than the increase in consumption which amounted only to 3.6% and was therefore labeled consumption dampening in the introduction. Finally, the terms of trade of Germany in comparison to its EA neighbours declined by 1.9%, computed as the ratio of consumer price indices between Germany and the EA.[19]

In the following we discuss the effects of an increase in the matching efficiency and a decrease in the unemployment benefit ratio first separately and then jointly to uncover the mechanisms at work and to highlight the consequences of the interactions of the two measures. We pay attention to the long-run effects of the reforms as well as to their short-run

---

[19]Using the ratio of GDP deflators yields a growth rate of -4.86.

effects, since the latter also take centre stage in debates on the implementation of structural reforms. Indeed, structural reforms may incur costs for states as well as for some groups in the society which may hinder their implementation in practice, although their long-run benefits may by far exceed the short-run costs. Another question of interest related to short-run effects is how long it takes for structural reforms to take effect.

Increasing the matching efficiency   In our first exercise, we increase the matching efficiency parameter by 20% in Germany. This value is lower than the point estimate of 23% provided by Hertweck and Sigrist (2013), while it is higher than the estimates of 10-15% reported by Fahr and Sunde (2009) and Klinger and Rothe (2012). Starting out with the parametrization of Germany and the EA as described above for 2003, the adjustment paths of the selected variables of both economies are illustrated in Figure 1. The corresponding equilibrium effects can be found in the second column of Table 3.

The efficiency increase in matching means that for given levels of vacancies and unemployment more people are hired by firms. Hence, after a slight increase on impact firms reduce their steady-state vacancy level by 15.7%. Since the equilibrium output rises by slightly less than 1%, the share of vacancy filling costs of firms in national output declines from 1.5% to 1.3%. At the same time, unemployed agents find a job more easily for a given level of vacancies lowering the equilibrium unemployment rate in Germany to a new level of 8.3%. Consequently, with a non-increasing labour force in our model world, the German employment is predicted to grow by 1.7% in the long run.

With the job finding probability rising by 6.6 percentage points to 38.1% and complete income insurance, the working members of the household slightly decrease their average hours worked by 0.7%, i.e., the income effect dominates, and the hourly wages hence go up by 0.3% in the long run. It is eye-catching that wages exhibit a non-monotonic behaviour after the reform in contrast to other variables. After an initial rise following the reform, they decline due to the drop in vacancies in the first six quarters, but rise again thereafter due to the consumption-hours worked substitution effect.

The combined effect of the changes in employment and hours worked per employee on total hours worked amounts to an increase of 1.0%. Since the increase in wages is accompanied by a decline in hours worked per employee of roughly the same order and the unemployment benefits are fixed, however, the unemployment benefit ratio is hardly affected by the increase in the matching efficiency. Note that even though hourly wages rise by 0.3%, the total wage earnings of an employee (wh) decrease by 0.7% in comparison to the former steady state because of the lower number of hours worked. Nevertheless, the total wage income of the representative household (Nwh) increases by 1.4%, since more members of the household find a job in the new steady state.
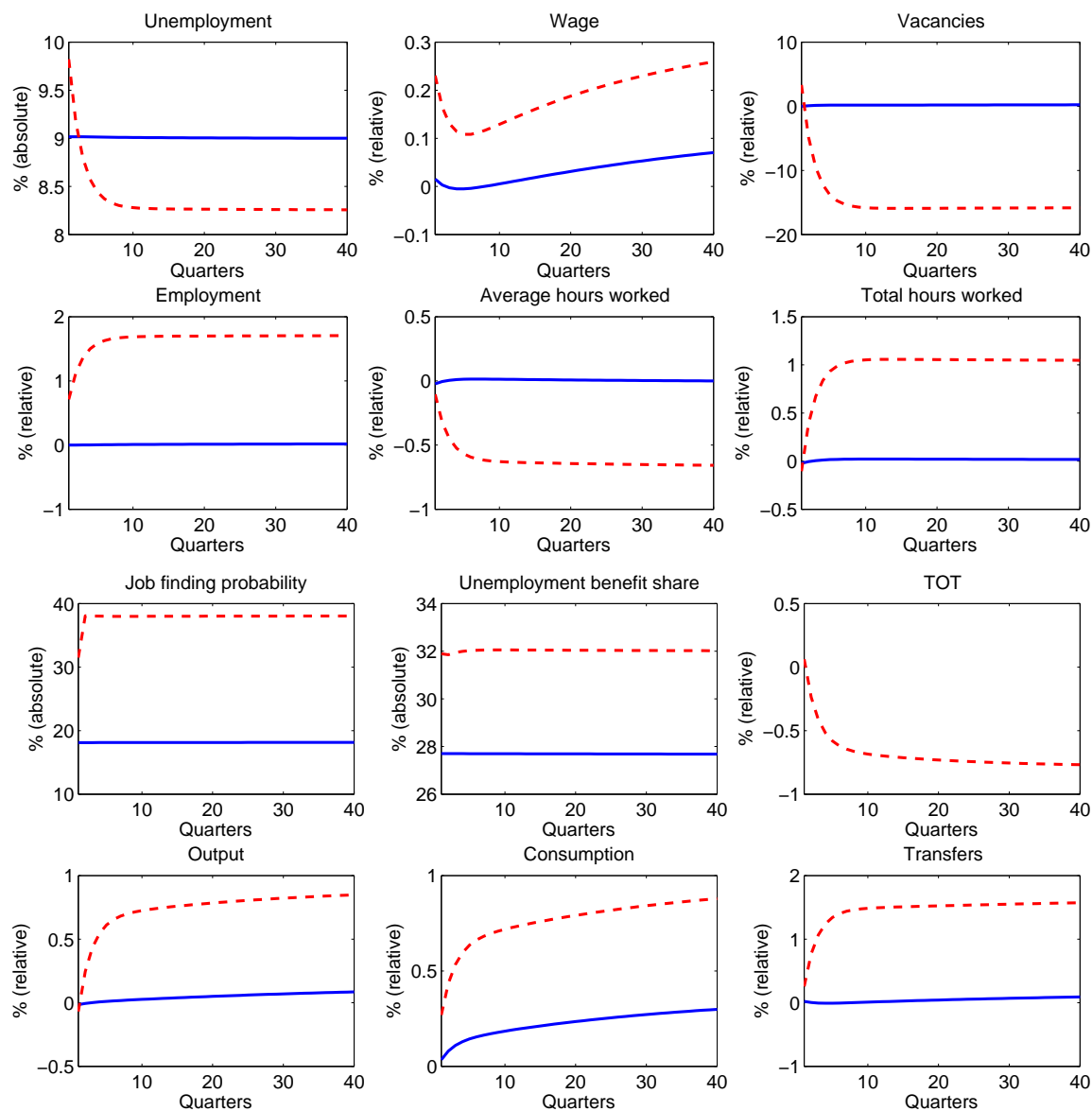
Notes: Red-dashed (blue-solid) line shows the adjustment in Germany (EA) after a 20% increase in the matching efficiency parameter χ of Germany. The initial parametrization follows from the values for Germany and the EA in 2003 given in Table 2.

Figure 1: Increasing the matching efficiency

Finally, output and consumption respectively increase by 0.9% and 1.0% in the long run following the matching efficiency increase. That the consumption increases by slightly more than output in percentage terms reflects the fact that some of the resources that are set free from search activity can be channelled to private consumption. These results imply that the first part of the Hartz reform package tackling the matching efficiency did not cause wage restraint or consumption dampening. In contrast, wages increase even stronger than labour productivity as a result of the matching efficiency increase in our model.

Decreasing the unemployment benefit ratio While the increase in the matching efficiency reduces the frictions in the labour market and thus facilitates higher output and consumption levels, the impact of the second policy reform that we now analyze, the decline in the unemployment benefit ratio by 10.35 percentage points, impacts directly on the labour supply and reduces the outside option of workers in the Nash bargaining and thus ultimately their wages. Note that the unemployment benefit ratio is not a parameter that we control directly. Therefore, what we do in our exercise is to compute a new unemployment benefit level (b) that is obtained by imposing the unemployment benefit ratio of 2010 in Table 2 on total wage per employee (wh) as computed with our initial calibration with 2003 values for Germany.[20] So we decrease the unemployment benefit ratio based on 2003 total wages by 10.35%. Total wages per employee (wh) decline, however, by 1.3% as a result of this reform at the new steady state. Therefore, the effective decline in the unemployment benefit ratio at the new steady state reads 10.1 percentage points.

The unemployment effects of this reform are similar to the effects of the reforms that increased the matching efficiency on many accounts as an inspection of Figure 2 and column (3) of Table 3 shows. The unemployment rate declines to 8.2%, accompanied by a 1.8% increase in employment, in the long run. Thereby, the deterioration in the outside option of workers, which directly impacts on the bargaining outcome through the relationship in equation (25), is the main factor behind the falling wages and corresponding increase in the labour demand. The decline in the unemployment benefit ratio induces more unemployed agents to work at the steady state to compensate for the decline in their income. The subsequent decline in wages generates a negative substitution effect on the hours worked of agents in employment.[21] This leads firms to post 40% more vacancies than at the former

---

[20]One possibility would be to endogenize the unemployment benefit instead of fixing it to a certain value as, e.g.,

$$b_{it} = rr_i w_{it} h_{it},$$

where rr_i stand for the replacement ratio in country i. Such a modification of the model leads, however, to an implausibly high volatility in the unemployment benefit level as it adjusts to changes in current wages (w) and hours worked per employee (h). Fixing the unemployment benefit ratio only at the steady state is, on the other hand, more successful in reflecting the data.

[21]On impact average hours worked rise to compensate the unanticipated reform shock given that employ-
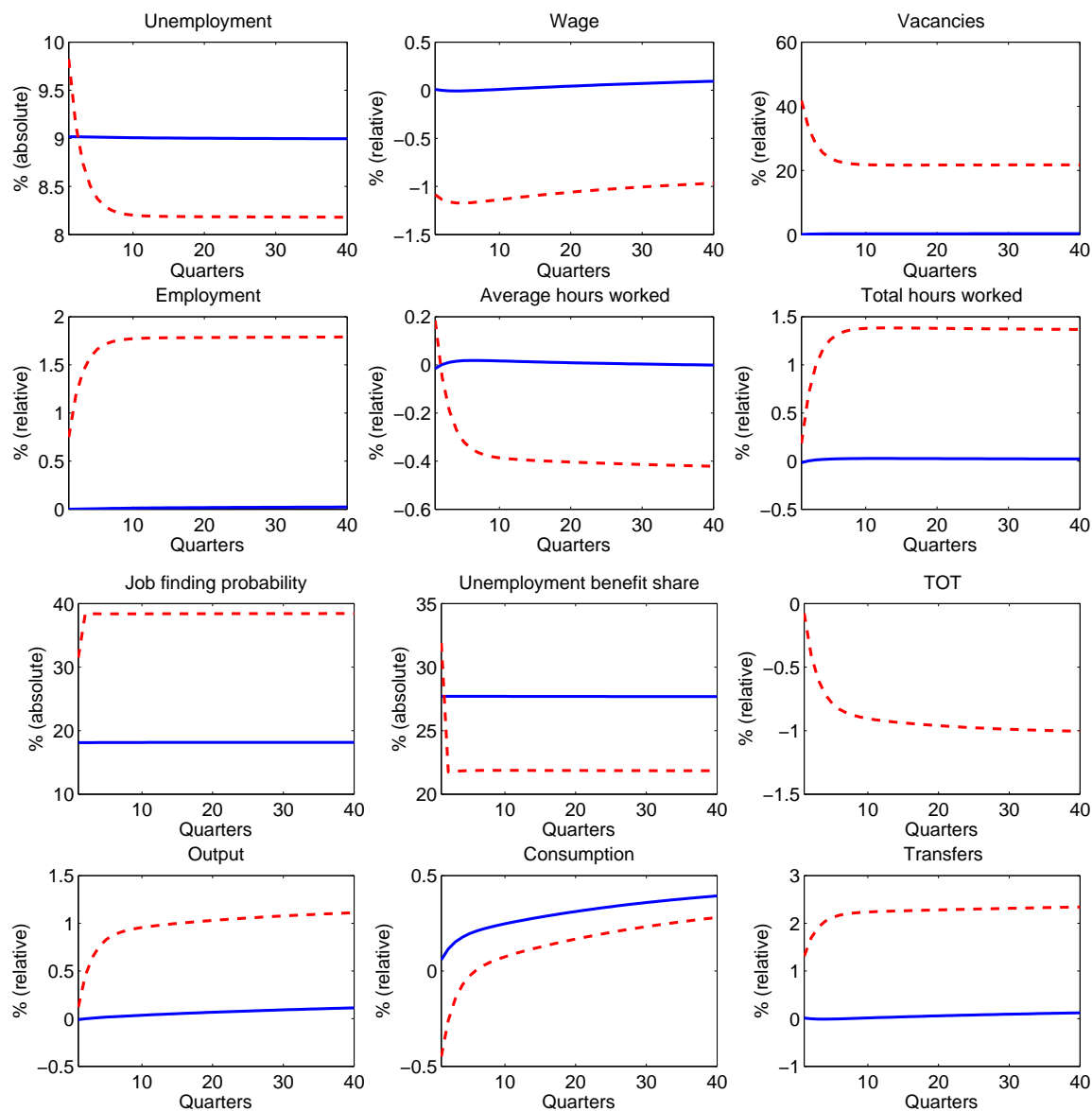
Notes: Red-dashed (blue-solid) line shows the adjustment in Germany (EA) after a 10.35% decline in the unemployment benefit of Germany. The initial parametrization follows from the values for Germany and the EA in 2003 given in Table 2.

Figure 2: Decreasing the unemployment benefits

steady state on impact and 24.4% more in the long run. Consequently, hirings rise by 1.8% and the job finding probability increases to 38.5% at the new steady state.

The total hours worked increases more strongly, by 1.4%, after the decline in unemployment benefits than after the increase in the matching efficiency. As to the total income of the households from wages and unemployment benefits, the increase in equilibrium employment does not compensate for the decline in the hourly wages and unemployment benefit level, the total wage and unemployment benefit before-tax income $(Nwh + (1 - N) b)$ being 1.9% lower at the new steady state than at the former steady state.

Despite the significant positive impact of the decline in the unemployment benefit on employment, output is only weakly affected by the reform in the short run, since the income loss due to the sharp decline in the unemployment benefit and hourly wages depresses the consumption of households strongly. Consumption declines by 0.4% on impact, although it steeply rises in the periods afterwards and eventually approaches its new steady state level which is 0.4% higher than its previous steady state level. The long-run increase in the output level after the decline in the unemployment benefits is with 1.2%, three times as large as the increase in consumption in terms of percentage points. Thus, in contrast to the reform targeting the matching efficiency, a stand-alone reduction of unemployment benefits leads to gaps between the growth of labour productivity and wages as well as output and consumption. The consumption dampening is of a similar size in relative terms as in the data, whereas the wage restraint driven by the reduction in the unemployment benefit ratio is much less pronounced in our model than in reality.

Increasing the matching efficiency and decreasing the unemployment benefit ratio simultaneously   We now introduce the two reforms simultaneously in the model in order to see to what extent they can account for the changes we observe in the data. Before we discuss the quantitative results of this exercise, it is apposite to note that the reforms were not introduced simultaneously in reality. The first three Hartz reforms increasing the matching efficiency were lauched in 2003 and 2004 in pieces, while the last Hartz reform package decreasing the unemployment benefit ratio came in 2005. Moreover, it might be convenient to assume that particularly the measures increasing the matching efficiency manifested themselves gradually over time. Yet, we reckon that these observations should not have a serious impact on the message of this paper, since the findings of Fahr and Sunde (2009), who use data merely until the end of 2004, point to a very quick realization of matching efficiency gains following the reforms. Finally, introducing the matching efficiency gradually to the model would require arbitrary assumptions about the diffusion of the effects of the first reform component, since that phenomenon is not directly observable in the data.

---

ment decisions are predetermined.
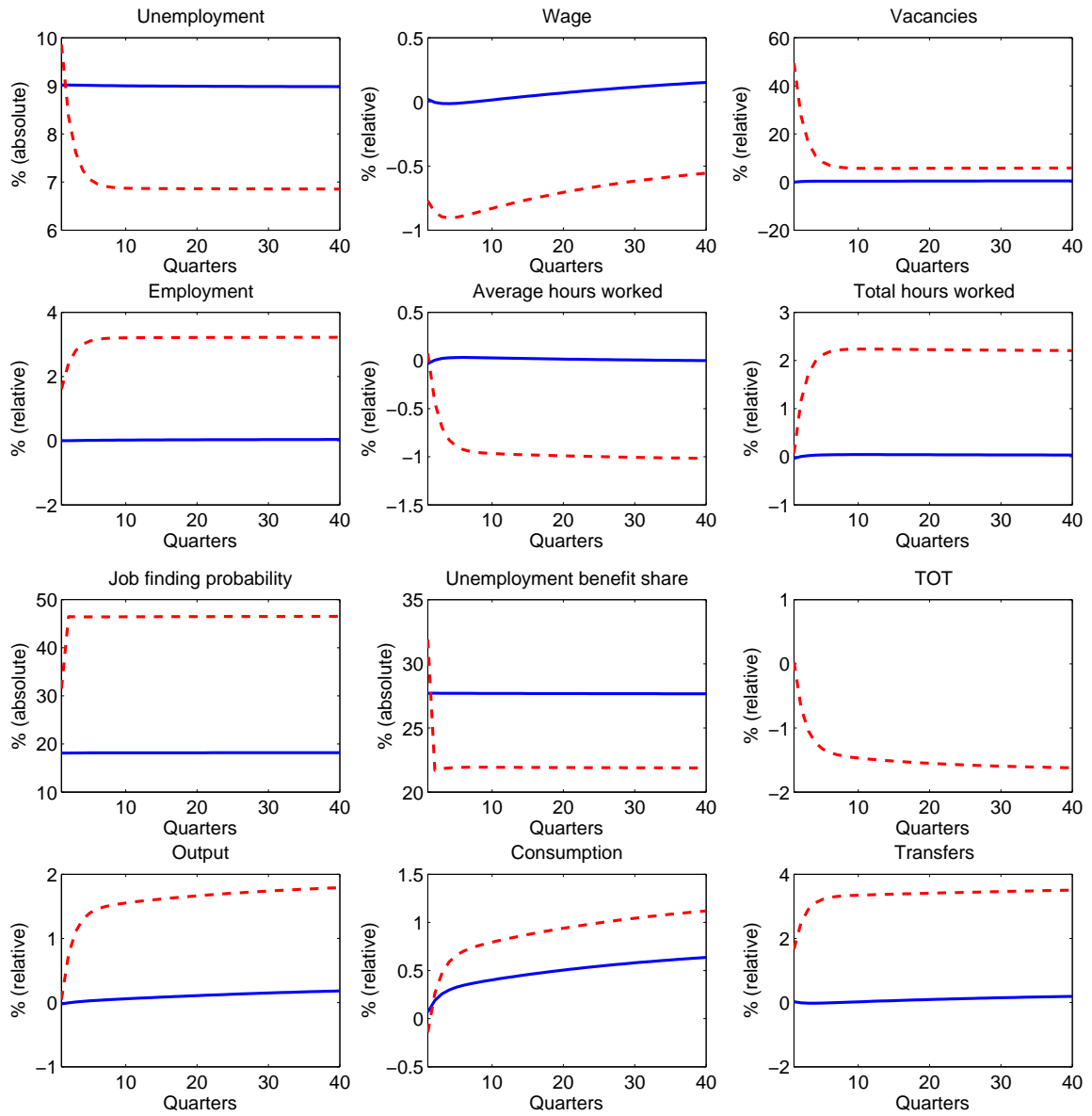
Notes: Red-dashed (blue-solid) line shows the adjustment in Germany (EA) after a 20% increase in the matching efficiency parameter χ and a 10.35% decline in the unemployment benefit of Germany. The initial parametrization follows from the values for Germany and the EA in 2003 given in Table 2.
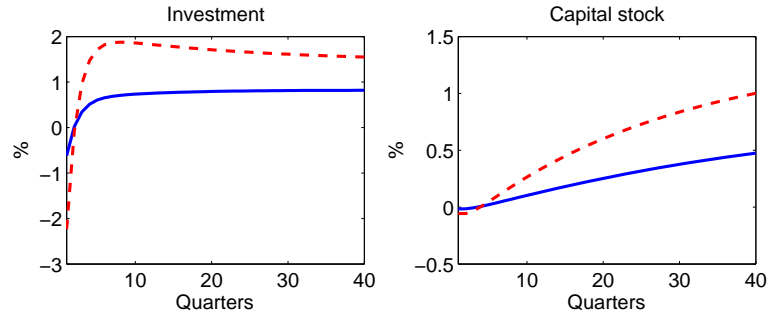
Figure 3: Increasing the matching efficiency and decreasing unemployment benefits simultaneously

Another issue is the timing of the reforms: there were two years between the introduction of Hartz I and Hartz IV. As has already been reported above for the stand-alone reform components, the adjustment to the new equilibrium after reforms takes place within a period of 2-3 years for most of the variables so that our comparison of equilibrium change with the change in the data over an 8-year period would hardly be affected. As to the short run dynamics, if we let the unemployment benefit reduction occur 8 quarters (i.e. 2 years) after the matching efficiency increase, the dynamics would be identical to Figure 1 in the first 8 quarters and then a jump would occur due to the introduction of the matching efficiency reforms which would be qualitatively similar to the dynamics in Figure 2. All in all, the adjustment dynamics would take 5-6 years to converge to the new equilibrium to a large extent for most variables, but the message of our study would hardly be affected by the sequential introduction of the reforms.

The quantitative effects of our exercise are shown in Figure 3 and column (4) of Table 3. When the reforms are introduced simultaneously, their combined effects are not equal to the sum of their individual effects, as a comparison of the sum of the second and third columns of the same table with the numbers in the fourth column suggests. The summed effects of the two separately conducted reforms is larger than the effects of the combined reforms in column (4), which points to the existence of some nonlinearities when the two reforms are introduced simultaneously. For example, whereas the stand-alone increase in the matching efficiency and the reduction in unemployment benefit ratio respectively lead to a 1.56 and a 1.63 percentage point drop in the unemployment rate, making up a total of 3.19 percentage points, the simultaneous introduction of both reform components decreases the unemployment rate by 2.96 percentage points in equilibrium. Recall that the studies on the effects of Hartz reforms reviewed in Section 2, which investigate the impact of the Hartz IV reform only, point to an unemployment rate reduction in the range of 2.8% to 35%. For comparison, our finding of 2.96 percentage points reduction due to the entire Hartz reform package follows from an initial unemployment rate 9.81% and hence suggests a 30% reduction in the unemployment rate.[22]

The dynamic response to the combined reforms, shown in Figure 3 points to the meaningfulness of introducing reforms jointly and the importance of timing. The immediate decline in German consumption by 0.4% after a 10.35% decline in the unemployment benefit may render the implementation of that reform alone rather difficult, although the long-run consumption increase is 0.5% and the consumption level exceeds its before-reform steady-state level already one year after the reform. Nevertheless, if the unemployment benefit reform is introduced simultaneously with the matching efficiency reforms, the immediate impact

---

[22]The introduction of the Hartz IV reform, i.e., unemployment benefit reduction, in our framework alone would lead to a 16.6% reduction in the unemployment rate, which is roughly in the middle of the corresponding values reported in the literature.

Figure 4: Increasing the matching efficiency and decreasing unemployment benefits simultaneously

on consumption is virtually zero and increases gradually following the initial reform period. If we allow for a gap between the introduction of the two reforms, after an initial increase consumption would drop at the point in time where unemployment benefits are reduced and then rise again, but never fall below its initial steady state level. In terms of government budget, on the other hand, both reforms swell the German government coffers as the increase in transfers to households indicate. Thus, such type of reforms could even be desirable at times where government debt levels do not allow other measures that would incur costs for the government budget.

With respect to investment in Germany, we observe that the simultaneous introduction of both reforms reduces domestic investment at impact, although it increases significantly in the long run as illustrated in Figure 4. However, the capital stock in the German economy shows only a negligible decline at impact as a result of the reforms, since the loss from the decline in investment is compensated by the flow of international bonds, i.e. capital from the EA neighbours, as we discuss in the next subsection in more detail.

As to the speed of adjustment to the new equilibrium after reforms, we can differentiate three groups of variables. First, job finding probability and unemployment benefit share adjust immediately after the introduction of reforms, both at home and abroad. Second, labour market variables—unemployment, vacancies, employment, average hours worked and total hours worked—come very close to their new equilibrium values after the reforms within roughly two years. This suggests that labour market reforms of the Hartz type lead to a relatively fast adjustment in terms of (un)employment. This result is in accordance with the findings of Krause and Uhlig (2012). Third, the adjustment of the remaining variables

takes much longer than the ones in the aforementioned two groups. In particular, the very slow adjustment of the trade balance and of net foreign assets (see Figure 6 in the next subsection) is responsible for the slow adjustment of output and consumption. It should be noted, however, that a large part of the adjustment in the latter variables occurs within the horizon of the first two years, in which the labour market almost completes its long-run adjustment to the reforms. The rest of the adjustment in output and consumption has to do with the accumulation and liquidation of international bonds, is quantitatively small and occurs very slowly over the long run.

A striking observation is that the model gets the qualitative changes, i.e., sign changes, in the data correct following the two reforms, as a comparison of columns (1) and (4) in Table 3 suggests. The only exception to this assessment is the change in the wage rate, which increased by 0.7% in the data and decreases by 0.4% in our calculations. This is due to the absence of factors that we did hitherto not take into account as we discuss below. All in all, our quantitative model suggests that these two reforms are able to explain a large portion of what happened in the German data between 2003 and 2010. The estimate of our model of the change in employment (hours worked per employee) is, for example, 3.3% (-1.1%), whereas it happens to be 5.0% (-1.9%) in the data. The total hours worked, which increase by 2.2% due to the two reforms in the model, increased by 2.9% in the data.

As to the output and consumption, the percentage increase in output was 8.6%, more than twice as large as the percentage increase in consumption in the data. According to the model estimates, however, the long-run increase in output is expected to be only 44% larger than the increase in consumption. Furthermore, the model underestimates the increase in output (consumption) by 6.8 (2.2) percentage points. Thus, our benchmark calibration suggests, the Hartz reforms led to a less vigorous growth of consumption in comparison to output, i.e., consumption dampening can partially be attributed to the Hartz reforms. Whereas the percentage increase in output is higher than the consumption increase by a factor of 2.4 in the data, it is higher by a factor of merely 1.4 with our benchmark calibration.

With respect to the gap between the growth in labour productivity and wages, the combined reforms lead only to a very small discrepancy: a 0.3% decrease in productivity faces a 0.4% drop in wages. In the data we observe an increase of productivity of 5.7% against a 0.7% rise in wages. Hence, our exercise suggests that the combined Hartz reforms cannot be a significant factor behind the observed wage restraint in the data. Nevertheless, we observe that the two components of the Hartz reforms have quite different implications in this regard. A stand-alone reform increasing the matching efficiency by 20% would lead to an equilibrium real wage gain of 0.3% vis-à-vis a labour productivity decline of 0.1%. In other words, the matching efficiency component of the reforms has a dampening effect on the wage restraint. A stand-alone unemployment benefit ratio reduction of 10.35 percentage

points, in contrast, would reduce equilibrium wages by 0.9% and labour productivity by 0.2%. Hence, although the latter reform component would contribute somewhat to the wage restraint, its contribution would be just a small portion of what is observed in the data.

The model overestimates the decline in the unemployment rate: it falls to 6.9% after the introduction of the two reforms according to the model, while it declined to 7.1% in 2010 in reality. Note furthermore that there exists an inconsistency between our model and the reality in this context. While we overestimate to decline in the unemployment (rate), we do not overestimate the increase in the employment level with our model.[23] This suggests that demographic factors as well as in- and outflows to and from the potential workforce may also have played a role in shaping the *active* working age population in the period of interest. Moreover, the 2009 global financial and economic crisis may have affected the labour market disproportionately negatively despite the anti-crisis measures of the German government. We abstract from such effects in the paper.

Additionally, to isolate the effects triggered by the labour market reforms, we have abstracted from developments in total factor productivity (TFP) in our analysis, which are taken to be the main driving force of long-run growth in standard models such as King, Plosser, and Rebelo (1988). In these models, growing variables such as output, consumption, investment, wages and labour productivity share the same trend growth rate, while employment (and hence unemployment) are stationary and do not exhibit a time trend. Turning to the *OECD.Stat* database with this insight, we observe that the German multi-factor productivity—i.e., TFP—increased by 4.4% over the period 2003-2010. Adding 4.4 percentage points to the predictions for the corresponding variables in column (4) of Table 3, the gap between the data and our model predictions for output, consumption and investment would diminish to a large extent and the sign of the change in wages would become correct. But we would overshoot the increase in wages by 3.3 and in consumption by 2.2 percentage points, thus even decreasing the relative size of the growth gap between output and consumption as well as labour productivity and wages.

To sum up, our calibrated model is able to mimic what happened in the German data to a large extent when it is driven by the increase in the matching efficiency and the decline in the unemployment benefit ratio together with the TFP growth as observed in the data. Yet, the disproportional increase in output in comparison to consumption and in labor productivity in comparison to real wages in the data can only partly be accounted for by the Hartz reforms according to our findings. We address the remaining discrepancies in Section 4.5 and argue that factors other than labour market reforms are likely to have been responsible for them.

---

[23]Recall that U for both the unemployment level and unemployment rate due to the normalization of the entire workforce in our model.

4.3   International Spillovers

Having discussed the effects of labour market reforms on the German economy, the focus of this section moves to the spillover effects on the outside world, i.e., in our case on the euro area neighbours which may also be reinterpreted as rest of the world since our baseline calibration with $\kappa = 0.7$ reflects Germany's import relationship with the rest of the world. When our two reforms take effect simultaneously, the long-run increase in EA output is 0.28% as shown in column (7) of Table 3.[24] The impact on the EA consumption of 0.78% is stronger than the impact on output. These effects are driven mainly by the terms-of-trade channel and follow partly from the existence of international capital markets as we show in the following.
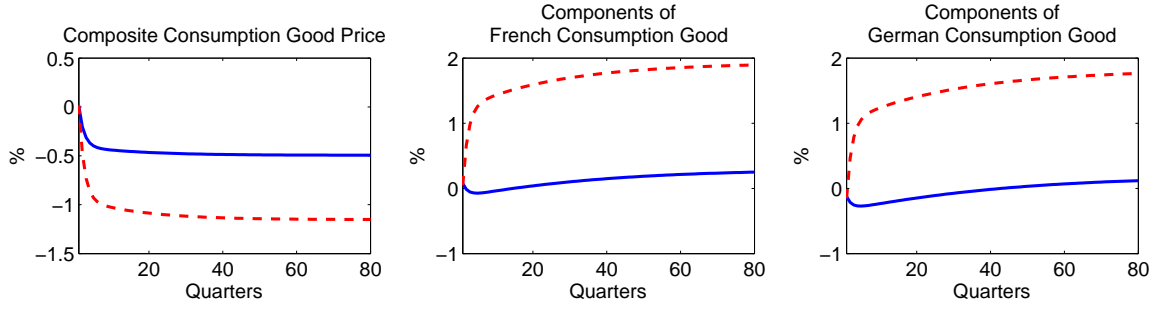
International spillovers are triggered by changes in the terms of trade ToT_t in our framework, similar to Dao (2013a). Following the German reforms, the output in Germany increases, which induces a reduction in the relative price of the German good. The combined long-run effect on the terms of trade of Germany, when the reforms are introduced simultaneously, is a decline of 1.63%. Note that this value is in line with what is reported for the change in the German terms of trade vis-à-vis EA in the data, see the first column of Table 3. The higher valuation of the EA good increases the surplus to be shared between firms and workers through Nash bargaining and has positive employment and output effects on the euro area. It should be noted, however, that the labour market effects of the German reforms on its EA neighbours are rather limited: employment in the EA hardly moves in the short run and increases negligibly by 0.05% in the long run, thus being two orders of magnitude smaller than the effects observed in Germany. Furthermore, in the short-run there are opposing effects which are, however, of very small size: the adjustment in employment, vacancies and output is negative in the first two quarters, whereas the negative effects in wages and transfers reverse after about two years.

The decline in the terms of trade of Germany manifests itself as a decline in the prices P_{1t}^c and P_{2t}^c of the composite consumption goods of both regions as shown in the first graph of Figure 5.[25] Not surprisingly, the households of both regions increase the amount of the German good that goes into their composite consumption good as the second and third graphs of the same figure illustrate. The amount of the EA good in the consumption good of both countries, on the other hand, decreases slightly in the first periods after the joint reforms, whereas it also increases in both regions in the long run.

With the same logic as for consumption, the decline in the German terms of trade renders

---

[24]Just to put the numbers into context, 0.28% of German (rest of EA-12) GDP amounts to 6.99 (18.30) billion EUR in 2010.

[25]Note that $P_{1t}^c = \left[\kappa + (1 - \kappa) ToT_t^{1-\eta} \right]^{\frac{1}{1-\eta}}$ and $P_{2t}^c = \left[\kappa ToT_t^{1-\eta} + (1 - \kappa) \right]^{\frac{1}{1-\eta}}$.

| Composite Consumption Good Price | Components of French Consumption Good | Components of German Consumption Good |

Notes: In the first graph, red-dashed (blue-solid) line shows the price adjustment in Germany (EA) after a 20% increase in the matching efficiency parameter χ and a 10.35% decline in the unemployment benefit of Germany. In the second and third graphs, red-dashed (blue-solid) lines show the percentage change in the German (EA) components of the EA and German composite goods, respectively. The initial parametrization follows from the values for Germany and the EA in 2003 given in Table 2.

Figure 5: Increasing the matching efficiency and decreasing unemployment benefits simultaneously

investments in both German and EA economies cheaper.[26] This leads to an increase in investment and hence accumulation of more capital in both regions after the reforms as has already been illustrated in Figure 4. Note that the increase in the German capital stock also partly occurs thanks to the existence of the international bond market. Whereas none of the countries holds any bonds at the steady state in our two-country world, the favourable macroeconomic conditions that follow from reforms in the German economy motivates EA households to save some of their gain from German reforms and buy German bonds with those savings which in turn are used for increasing German firms' capital stock even further in the middle run. This is reflected in the positive trade balance of the euro area economy in the first 5-6 years after the introduction of the reforms. The EA trade balance turns slightly negative after that period and approaches gradually zero in the very long run. Thereby, the net foreign asset position of the EA as a share of GDP improves gradually, reaching a share of 0.5% about 6 years after the introduction of the reforms as illustrated in Figure 6. These assets are liquidated very slowly after that peak and are mainly used for building capital in the euro area. In the long run, the capital stock in the EA increases by a significant 0.78%, which is more than half of the relative increase in the German capital stock of 1.44%.

In a nutshell, we find positive spillovers of domestic labour market reforms to foreign output, consumption, investment and wages. With Germany being very open ($\kappa = 0.7$), its trade partners benefit from an increase in consumption which is more than half the amount

---

[26]Note that there is no distinction between consumption and investment goods within each country in our model world, i.e. there is only one good the price of which has been given in the previous footnote.
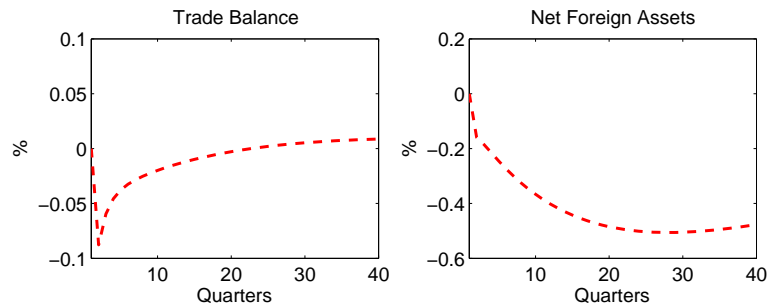
Figure 6: Increasing the matching efficiency and decreasing unemployment benefits simultaneously

of the effect observed in Germany. Spillover effects with respect to unemployment or hours worked are, however, very limited in absolute terms and about two orders of magnitude smaller than the effects in Germany.

4.4 Comparison with the Literature and Sensitivity Analysis

In this subsection, we start with comparing our spillover results with the existing literature. Then, we turn our attention to the impact of a few parameters that might influence the quantitative results significantly if set to different values than we used in our baseline scenario, namely the parameters κ and η subsuming household preferences with respect to the consumption bundle and the share of vacancy posting costs in GDP $\frac{\omega V}{Y}$ determining ω_i. While the size of κ depends on the interpretation of the two-country setup, whether to capture Germany's overall openness to trade or just its openness towards its EA-12 neighbours, η is a parameter which is relatively hard to measure. Both κ and η are expected to affect the size of spillovers through the trade channel. ω directly affects the size of the impact of labour market reforms by influencing the vacancy posting behaviour of firms. In Table 4 we summarize the reform-induced changes in the steady-state values under different scenarios and compare them with our baseline calibration in column (1) where $\kappa = 0.7$ and $\eta = 1$ and $\frac{\omega V}{Y} = 0.015$. The first column of the table states the modification made in comparison to the baseline case.

Comparison with the literature on spillovers   As pointed out in the literature review in Section 2, size and sign of spillovers are influenced by modelling and parametrization choices. Since we model trade as intra-industry trade and allow for labour market frictions, income effects outweigh competitiveness effects in our model and spillovers are positive in the long run by construction. In the following, we discuss further crucial modelling assumptions which may affect the size of spillovers. Then, we turn our attention to the sensitivity of our quantitative results.

With respect to the size of spillovers, Felbermayr, Larch, and Lechthaler (2012) find that a static multi-country trade model with heterogeneous firms and search-and-matching unemployment underestimates the relatively large spillover effects found in the data. While in their empirical analysis spillover effects to employment are one order of magnitude smaller than the effects in the reforming countries, their theoretical model implies effects which are about two orders of magnitude smaller, similar to our model or Dao (2013a). Therefore, the authors introduce completely rigid real wages into their model and observe that spillovers of reforms to the foreign country in terms of unemployment can become almost half as large as in the home country. The increase in spillovers with rigid wages results from the fact that quantities are adjusted much stronger due to a lack of adjustment possibilities through wages. Yet, in our dynamic model, any degree of real wage rigidity with the exception of perfectly rigid wages has no impact on the equilibrium effects of reforms, since wages can be adjusted in the long-run. Assuming perfectly rigid wages for Germany or the EA countries, however, seems exaggerated as the duration of standard collective wage agreements in Germany amounts to 1-2 years.

Dao (2013b) highlights that reform effects can also be transmitted through the interplay of national inflation and a common monetary policy. In her model, she finds that the short-term response to an average tax cut is abated in the reforming country and amplified abroad by the introduction of price rigidities and monetary policy. Thus, nominal rigidities do not alter long-term effects but could dampen incentives to reform because of lower benefits at home directly after the reform and stronger (involuntary) export of benefits to the foreign country.

Furthermore, the relative country size may influence the size of spillovers. Felbermayr, Larch, and Lechthaler (2013) find that the spillover effects of domestic labour market institutions are larger the larger the relative size of the home country. Our model implies that Germany and the rest of the EA-12 are of equal size. Thus, spillovers are supposed to become smaller if country size is taken into account in our setting as Germany constitutes less than 30% of the EA-12. Additionally, as pointed out by Kose and Yi (2006) bilateral trade linkages between two countries, say Germany and France, are much smaller than between Germany and the EA or the world. Therefore, spillover effects of the German reforms

to single countries are supposed to be smaller than to the aggregate. In addition, there could be third-country effects if the German labour market reforms do not affect all trading partners to the same extent. This implies that terms of trade across these countries might change as well and create additional positive or negative effects. To address these effects and the difference between overall openness to trade and bilateral linkages adequately, a three-country framework as in Kose and Yi (2006) is necessary which we leave to future research. Note, nevertheless, that Everaert and Schule (2008) as well as Gomes, Jacquinot, and Pisani (2012), by means of large scale multi-country models, find effects similar to the two-country model literature following labour market reforms, namely small positive spillovers.

Differences in the preferences of the consumption good composition   The choice of the home-bias parameter κ in the country-specific composite consumption goods as well as the elasticity of substitution between foreign and domestic goods η both have a quantitative impact on the responses of domestic and foreign output, consumption, investment and wages to reforms. In contrast, labour market variables as well as the qualitative results described in the foregoing subsections are not altered. These parameters basically determine how the 'cake'—the benefits in terms of economic outcome resulting from the reforms in the home country—is divided up between the foreign and domestic economies. The stronger the home-bias, i.e., the higher κ and the higher the elasticity parameter η the less the foreign country participates in the reform effects. In the first alternative scenario, we set $1 - \kappa = 1 - 0.88$ which corresponds to the average German import share from its EA-12 neighbours in the past decade (in contrast to our baseline scenario where we considered its import share from the rest of the world). For η there is no observable empirical counterpart available and estimates by Hooper, Johnson, and Marquez (2000) of the income and price elasticities of exports and imports in the G7 on data till 1994 lie in a broad range from 0.8 to 2.3. Therefore, we alternatively consider a relatively low value of 0.85 suggested by Corsetti, Dedola, and Leduc (2008) and a higher value of 1.5 which has often been used in international real business cycle models starting with Backus, Kehoe, and Kydland (1994).

If we reduce κ to 0.88, i.e., the share of the domestic good in the foreign consumption bundle is smaller (and larger in the domestic bundle), foreign consumers profit from the price reduction in domestic goods as a result of the reforms less strongly (and domestic consumers accordingly more strongly) than in the baseline scenario (see column (2) of Table 4). This goes along with the fact that the drop in terms of trade ToT_t after the reforms is stronger with higher κ and the adjustment in the trade balance is slower and of a smaller size. In addition, the adjustment through the international bond market occurs more slowly, leading to a weaker (stronger) increase in investment and capital abroad (at home).

Lower values of η imply that consumers in both countries are more prone to adjusting

the composition of their final consumption good in response to exogenous impulses in the economy. Hence, the EA neighbours demand even more of the German and their own good after the joint reforms accompanied by a stronger drop in prices. In consequence, terms of trade deteriorate more strongly with a lower elasticity and adjustments in the trade balance (TB) and the net foreign asset position (NFA) occur more slowly and are smaller compared to the baseline scenario. For $\eta = 0.85$ the TB and NFA of the EA are even negative in the first two and six quarters, respectively. This reflects the fact that a lower elasticity implies stronger adjustment in the composite consumption and investment goods in Germany in the period of the reform, since German firms cannot adjust the labour input immediately and therefore post more vacancies on impact than at the new steady-state level. In the long-run, output and consumption grow weaker at home and rise considerably stronger abroad. The opposite applies to the high elasticity case (see column (4) of Table 4). The adjustments in the labour market at home in terms of employment, hours worked or unemployment after the reforms are hardly effected by changes in the preference parameters. In contrast, abroad a higher home bias of $\kappa = 0.88$ or higher elasticity of substitution $\eta = 1.5$ shrinks the already small spillover effects to unemployment/employment found for the baseline calibration even further. In addition, choosing higher values for these parameters implies a smaller gap between output and consumption growth than in the baseline case at home. The gap between productivity and wage growth is not affected.

Lower vacancy posting costs With our choice of $\frac{\omega V}{Y} = 0.015$ we are close to the upper bound of vacancy posting cost shares used in the literature, which seems justifiable for European economies vis-á-vis the US calibration used in most studies. Nevertheless, the broad range of values used by other authors for the US and the missing empirical evidence for the German and the European case require testing for sensitivity with respect to $\frac{\omega V}{Y}$. Table 4 includes in column (5) the implied changes in the steady state values due to reforms when the ratio of total vacancy posting costs to output is fixed to 1% as in Hairault (2002). If firms are faced with lower costs, they post more vacancies in response to the combined reforms, more hirings occur and the unemployment rate shrinks even stronger to 6.4% in Germany. This leads to higher domestic output, consumption and total hours worked, while wages drop stronger than in the baseline scenario. With a lower vacancy cost share, there is a slightly larger gap between the development of labour productivity and wages as well as output and consumption growth. However, the new parametrization does by no means change our previous conclusions on the contribution of the Hartz reforms to wage moderation and consumption dampening. The amplified effects in the domestic market spill over to the foreign economy through a stronger change in relative prices, i.e., in terms of trade. Thus, we observe stronger increases in foreign output and consumption as well as employment and

Table 4: Sensitivity Scenarios: Percentage in Selected Variables after Reforming χ and b in Germany

		(1)	(2)	(3)	(4)	(5)
Scenario		Baseline	$\kappa = .88$	$\eta = .85$	$\eta = 1.5$	$\frac{\omega V}{Y} = 0.01$
Germany	Nh	2.20	2.21	2.20	2.21	2.55
	N	3.28	3.30	3.28	3.29	3.77
	U	-2.96	-2.98	-2.96	-2.97	-3.40
	ϕ	15.10	15.21	15.06	15.17	18.52
	h	-1.05	-1.05	-1.04	-1.05	-1.18
	w	-0.39	-0.25	-0.44	-0.30	-0.54
	Y	1.94	2.09	1.89	2.04	2.25
	C	1.35	1.76	1.20	1.62	1.50
	I	1.44	1.85	1.30	1.71	1.67
	ToT	-1.63	-1.92	-1.93	-1.07	-1.87
EA	Nh	0.03	0.01	0.04	0.02	0.04
	N	0.05	0.02	0.06	0.03	0.06
	U	-0.04	-0.02	-0.05	-0.03	-0.06
	ϕ	0.10	0.05	0.12	0.06	0.12
	h	-0.02	-0.01	-0.02	-0.01	-0.02
	w	0.26	0.12	0.31	0.17	0.30
	Y	0.28	0.13	0.34	0.19	0.33
	C	0.78	0.37	0.93	0.51	0.91
	I	0.78	0.37	0.93	0.51	0.90
	ToT	-1.63	-1.92	-1.93	-1.07	-1.87

Notes: In the baseline scenario, $\kappa = 0.7$, $\eta = 1$ and $\frac{\omega V}{Y} = 0.015$. Percentage change in U und ϕ is absolute, in all other variables relative.

job finding probability. This suggests that in case the true costs of vacancy posting are lower than in our benchmark scenario, reform effects would be larger for domestic as well as foreign countries. But the relative size of the spillovers becomes only slightly larger than in the baseline case. Even if we decrease $\frac{\omega V}{Y}$ further to 0.5%, the implied change in employment abroad makes up less than 2% of the effect observed in the home country.

4.5 Alternative Explanations

As pointed out in the introduction, dampened consumption relative to output, wage restraint in the form of weaker growth of wages than labour productivity as well as the persistent large current account and trade surpluses recently observed in the German economy are often attributed to the Hartz reforms by critics. When our model is subjected solely to

the Hartz reforms, however, it can only partially account for the consumption dampening and the wage restraint while generating a trade deficit in the short-to-middle run instead of a surplus, as we have seen in the foregoing subsections. In this subsection, we discuss alternative explanations for those phenomena which are not related to the labour market reforms.

We first turn our attention to the bargaining power of workers ϵ which is another criticial parameter in our model, particularly for labour market outcomes. Recent literature suggests that globalization has been one of the drivers of the decline in union membership and thus lower bargaining power of unions (see, e.g., Dreher and Gaston (2007) and Abraham, Konings, and Vanormelingen (2009)). In Europe, this trend has been further strengthened by the eastward expansion of the European Union in 2004, which took place simultaneously with the Hartz reforms. In Germany, for example, trade union density decreased from 25.3% to 18.6% in the period 1999 to 2010 according to OECD data.[27]

In order to explore the potential impact of the decline in the bargaining power of the workers, we first introduce a permanent shock in Germany alone which shifts the bargaining power of the firms ϵ from 0.5 to 0.6. Both short-run and long-run dynamics that accrue from this change are very similar to the dynamics that occur after a stand-alone 10.35 percentage point reduction in unemployment benefits in our model, for which reason we do not report any results from the new experiment in tables or graphs. This should not be surprising, since reductions in both the bargaining power paramater and unemployment benefits weaken workers' ability to impose their terms upon firms in the Nash bargaining process. Hence, the increase in the bargaining power of firms further contributes to the explanation of consumption dampening and wage restraint as does the unemployment benefit reduction, whereas it does not lead to a surplus in the German trade balance at all.

In a second exercise, we impose a contemporaneous and persistent increase of ϵ to 0.6 in both Germany and the rest of the euro area, since globalisation and eastward expansion of the EU affected both of them. Nearly all EU countries registered a decline in trade union density over the period 1999-2010 according to the OECD data. When the bargaining power of firms rises to 0.6 in both Germany and the rest of the euro area, the results for Germany as to most of the variables are very similar to the previous exercise, where we increased ϵ for Germany only. In the upper panel of Figure 7, we report the adjustment of the variables pertaining to the consumption dampening and wage restraint debate, which do not change much in comparison to the previous exercise. Conspicuous differences exist, however, in the adjustment of the terms of trade and the current account, which are reported in the lower panel of Figure 7. The response of the terms of trade is still negative, yet much smaller

---

[27] "Trade union density corresponds to the ratio of wage and salary earners that are trade union members, divided by the total number of wage and salary earners" citing the *OECD Labour Force Statistics* website.

Consumption Dampening | Wage Restraint | Terms of Trade | Trade Balance
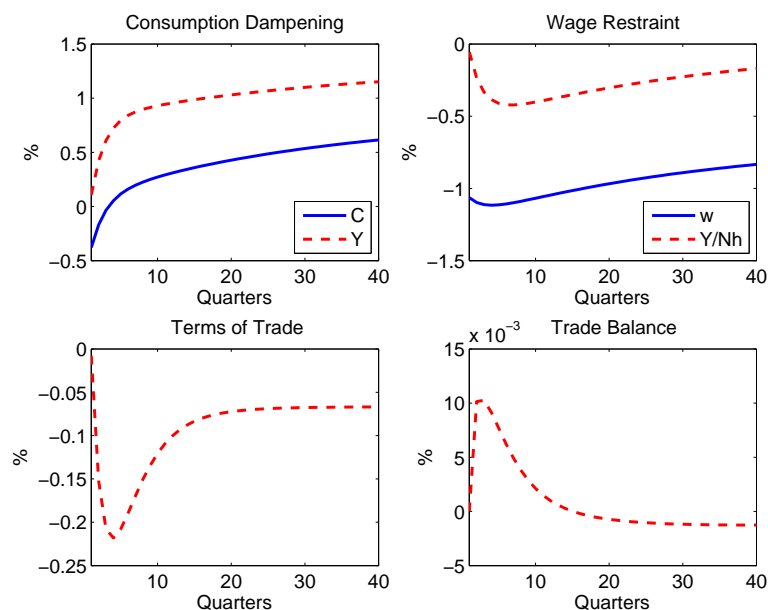
Notes: The graphs show the adjustment in selected variables of Germany after a simultaneous 0.1 percentage point increase in the bargaining power of firms in both Germany and the rest of the euro area. The initial parametrization follows from the values for Germany and the EA in 2003 given in Table 2. The legends in the upper panel: C – consumption; Y – output; w – wages; Y/Nh – labour productivity.

Figure 7: Decreasing the bargaining power of workers

in absolute terms. Moreover, it shows a hump-shaped response in contrast to the foregoing scenario. The German trade account exhibits a small positive surplus of 0.1% of GDP in the first year following the increase in ϵ, which disappears, however, from the second year on. However, the volume and persistency of the surplus hardly matches the data which registers surpluses above 5% of the GDP after 2005.

While our exercise concerning the change in the bargaining power of workers is tentative due to the difficulty of measuring the value of the parameter in the data, we believe that it provides valuable insights for our discussion.[28] On the one hand, we see the potential for the change in that parameter to further explain the consumption dampening and the wage moderation; yet possibly not large enough to close the gap between the model and the data. On the other hand, the decline in the bargaining power of workers can also not explain the large and persistent German trade surpluses.

In the last part of this subsection, we turn our attention to alternative explanations

---

[28]We recognize that the level of decline in the bargaining power as well as the exposure of countries to globalization vary a lot. Moreover, the change occurs not at once but gradually. Yet, these aspects are hard to include in our current framework and are left to future studies.

for the German trade surplus, which could not be traced back to the Hartz reforms or the change in the bargaining power of workers in our model. Therefore, we next review two recent studies which investigated the driving forces of current account and/or trade surpluses (among others). In the first of these, European Commission (2012) economists, who study current account surpluses in the EU by means of an estimated version of the QUEST model of Ratto, Roeger, and Veld (2009), discuss several hypotheses that could potentially explain the German trade surpluses. One hypothesis is that competitiveness gains through wage restraint and labour market reforms have been a major force behind the surpluses.[29] Thereby, the authors implicitly see the wage restraint solely as the product of labour market reforms[30] and emphasize that a decline in the relative unit labour costs has improved the trade competitiveness of Germany relative to the rest of the euro area. However, their results attribute only a moderate role to the wage restraint in the emergence of the surpluses, while the Commission economists find the main drivers of the surpluses to be (i) financial market integration and interest rate convergence in the euro area leading to a narrowing of risk premia and thus net capital outflow from Germany and correspondingly weakening domestic investment, (ii) strong world demand particularly for German capital goods as well as (iii) higher household savings due to population aging accompanied by the introduction of a private pillar in the pension system.

In another related paper, Estrada, Galí, and López-Salido (2013), who study patterns of convergence and divergence in the euro area empirically, investigate the driving forces of the current account among others. They find that relative price levels of tradable goods do not show a strong relation with current account imbalances, whereas the so-called non-price competitiveness factors do. Four non-price competitiveness factors stand out in explaining the current account performance: (i) goods markets efficiency; (ii) the ability of entrepreneurs to adopt existing technologies to enhance the productivity of industries; (iii) the quality of countries' business networks and supporting industries; and (iv) innovation capabilities. Estrada, Galí, and López-Salido (2013) find the role of these factors to be more important than a reduction in wages for reducing and sustaining current account deficits.

To sum up, both European Commission (2012) and Estrada, Galí, and López-Salido (2013) emphasize the importance of a number of non-competitiveness factors as potential driving forces the German current account/trade surpluses. While those factors are out of the scope of our analysis and not included in our model, they are useful potential candidates to explain the gap particularly as to trade surpluses between our model' estimates and the

---

[29]The Commission economists approximate the German labour market reforms by an exogenous labour supply expansion and the reduction in the unemployment benefit ratio.

[30]Note that our results contradict this view, even when we consider a reduction of the unemployment benefit ratio complemented with a decline in the bargaining power of workers. In other words, our analysis suggests the existence of other factors to fully explain the wage restraint.

data. The bottom line of this review for our study is that the driving forces of surpluses are to be searched for in factors other than the Hartz reforms.

5   Conclusion

The still observable repercussions of the 2008-2009 global recession and the slow adjustment in its aftermath, accompanied by monetary and fiscal policies that have already reached their limits as growth stimulator, have put structural reforms on top of the reform agenda of policy makers in many countries. Thereby, labour market reforms feature a high priority, particularly in the European Union where unemployment rates reached high levels in many member economies. In this context, the conspicuous success of the German labour market reforms of 2003-2005—the so-called Hartz reforms—in bringing down unemployment rates seems exemplary. Yet, critics of the Hartz reforms often argue that the reforms had undesirable side effects leading to a strong wage restraint and consequently consumption dampening in Germany accompanied by beggar-thy-neighbour effects harming the country's trade partners.

In the current paper, our goal has been to check up on the validity of this view by investigating the impact of the reform package on macroeconomic outcomes both nationally and in terms of international spillovers. We chose a two-country DSGE model with labour market frictions and intra-industry trade calibrated to data for Germany and the rest of the euro area—the most important trade partner of Germany—as our laboratory to this end.

Our findings show that increasing the matching efficiency and lowering unemployment benefits in our model in line with the observed implications of the Hartz reforms indeed lead to a drop in the unemployment rate of similar size as observed in the data, but neither the wage moderation nor the consumption dampening are as strong as observed in the data. While the matching efficiency increase does not produce such effects at all, reducing the unemployment benefits indeed creates a gap between wages and productivity growth and dampens domestic consumption relative to output to a certain extent. Thus, we conclude, additional factors must have contributed to these developments in the data. As we argue in this paper, globalization-driven changes in the bargaining power of workers represent a prominent factor, which could further explain the wage restraint and the dampened growth of domestic consumption.

In addition, our model does not imply negative spillover effects from the Hartz reforms to trade partners but small positive effects with respect to unemployment and sizeable positive spillovers in terms of consumption and output in the long run. These results are driven by modelling devices which are the most reasonable for an analysis of the European countries—intra-industry-trade and labour market rigidities accompanied by a fairly high unemployment

rate. A further notable observation is that neither the Hartz reforms nor the decline in the bargaining power of workers seem to explain the large current account surpluses of Germany that came into being after 2005. This is indeed in line with the latest findings, as our review of the recent literature suggests, which reports non-price-competitiveness factors rather than labour market reforms as the main driving forces of surpluses.

We find that the adjustment to the new long-run equilibrium takes place rather quickly following the Hartz reforms, the adjustment for labour market variables being almost entirely completed over 2-3 years. Other quantities such as output, consumption and investment register a non-negligible part of their adjustment also over such a short period; however, arriving at the new long-run equilibrium takes much longer for these variables. This is due to consumption smoothing and the effects of international resource-sharing on capital accumulation: both Germany and the rest of the euro area increase their capital stock very slowly and gradually after the reforms. The favourable effects of the reforms on production possibilities leads the rest of the euro area to invest in German bonds in the first 7-8 years after the reforms which are then driven down in order to increase own consumption.

Recall that we compared trends in the German data over the 8-year period 2003-2010 with the change in equilibrium values in our model. Since most business cycle effects typically cancel out each other over such a long period and the adjustment to the new steady state is largely completed for almost all variables of the model within 2-3 years, this should not be problematic for our short-run analysis. A crucial aspect that might affect our long-run comparisons and we did not address in the model is the 2008-2009 global financial and economic crisis. We reckon, for example, that the lack of the global financial crisis in our model could partly explain its overshooting of the drop in the unemployment rate when driven by the Hartz reforms. In this context, it should be emphasized that the German government introduced a number of anti-crisis measures with a positive impact on the labour market outcomes, discussed by e.g. Faia, Lechthaler, and Merkl (2013) and Burda and Hunt (2011) among others. However, those were measures that focused on evening out negative business cycle effects. While long-run effects of the crisis is a contentious topic and is left to future studies, we reckon that the exclusion of the crisis from our model would not lead to any significant changes in our conclusions as to the relation of the Hartz reforms to the 2003-2010 trends in the German macroeconomic data.

To sum up, our study suggests that the German Hartz reforms can only partially explain the wage restraint and consumption dampening observed in the data and do not lead to any beggar-thy-neighbour effects on the trade partners that manifest themselves as a decrease in employment, output or consumption and as large current account surpluses of Germany. Moreover, we find that the effects of the reforms depend on the institutional level of an economy and that there are non-negligible interaction effects between reforms. Therefore,

using the German reforms as best-practice policy may not be advisable as institutions and initial conditions in the labour markets differ across European countries.

Note that, while our model proves to be a useful tool for the analysis of the aggregate effects of the Hartz reforms, it is not informative about distributional issues. The findings of Krebs and Scheffel (2013) suggest, however, that the reform of the unemployment benefits created losses in terms of lifetime consumption for the unemployed, whereas employed persons gained. If these distributional issues are not tackled by the government, the reputation of such reforms in the public might be low, as it has been the case in Germany.

References

Abraham, F., J. Konings, and S. Vanormelingen , 2009, "The Effect of Globalization on Union Bargaining and Price-Cost Margins of Firms," Review of World Economics (Weltwirtschaftliches Archiv), 145(1), 13–36.

Alessandria, G., and A. Delacroix, 2008, "Trade and the (Dis)Incentive to Reform Labor Markets: The Case of Reform in the European Union," Journal of International Economics, 75(1), 151–166.

Andolfatto, D., 1996, "Business Cycles and Labor-Market Search," American Economic Review, 86(1), 112–132.

Bachmann, R., 2005, "Labour Market Dynamics in Germany: Hirings, Separations, and Job-to-Job Transitions over the Business Cycle," SFB 649 discussion paper, No. 2005,045.

Backus, D. K., P. J. Kehoe, and F. E. Kydland, 1994, "Dynamics of the Trade Balance and the Terms of Trade: The J-Curve?," American Economic Review, 84(1), 84–103.

Bargain, O., K. Orsini, and A. Peichl, 2011, "Labor Supply Elasticities in Europe and the US," IZA Discussion Papers, No. 5820.

Baxter, M., and M. A. Kouparitsas, 2005, "Determinants of Business Cycle Comovement: a Robust Analysis," Journal of Monetary Economics, 52(1), 113–157.

Bayoumi, T., D. Laxton, and P. Pesenti, 2004, "Benefits and Spillovers of Greater Competition in Europe: a Macroeconomic Assessment," ECB Working Paper Series 0341, European Central Bank.

Belot, M., and J. C. van Ours, 2004, "Does the Recent Success of Some OECD Countries in Lowering Their Unemployment Rates Lie in the Clever Design of Their Labor Market Reforms?," Oxford Economic Papers, 56(4), 621–642.

Blanchard, O., and F. Giavazzi, 2003, "Macroeconomic Effects Of Regulation And Deregulation in Goods And Labor Markets," The Quarterly Journal of Economics, 118(3), 879–907.

Burda, M. C., and J. Hunt, 2011, "What Explains the German Labor Market Miracle in the Great Recession," Brookings Papers on Economic Activity, 42, 273–335.

Campolmi, A., and E. Faia, 2011, "Labor Market Institutions and Inflation Volatility in the Euro Area," Journal of Economic Dynamics and Control, 35(5), 793–812.

Chetty, R., A. Guren, D. Manoli, and A. Weber, 2011, "Are Micro and Macro Labor Supply Elasticities Consistent? A Review of Evidence on the Intensive and Extensive Margins," American Economic Review, 101(3), 471–75.

Coe, D. T., and D. J. Snower, 1997, "Policy Complementarities: The Case for Fundamental Labor Market Reform," IMF Staff Papers, 44(1), 1–35.

Coenen, G., P. McAdam, and R. Straub, 2008, "Tax Reform and Labour-Market Performance in the Euro Area: A Simulation-Based Analysis Using the New Area-Wide Model," Journal of Economic Dynamics and Control, 32(8), 2543–2583.

Corsetti, G., L. Dedola, and S. Leduc, 2008, "International Risk Sharing and the Transmission of Productivity Shocks," Review of Economic Studies, 75(2), 443–473.

Dao, M. C. , 2013a, "Foreign Labor Costs and Domestic Employment: What Are the Spillovers?," Journal of International Economics, 89(1), 154–171.

———— , 2013b, "International Spillovers of Labour Market Policies," Oxford Economic Papers, 65(2), 417–446.

Daveri, F., and G. Tabellini, 2000, "Unemployment, Growth and Taxation in Industrial Countries," Economic Policy, 15(30), 47–104.

den Haan, W. J., G. Ramey, and J. Watson, 2000, "Job Destruction and Propagation of Shocks," American Economic Review, 90(3), 482–498.

Dreher, A., and N. Gaston, 2007, "Has Globalisation Really had no Effect on Unions?," Kyklos, 60(2), 165–186.

Estrada, A., J. Galí, and D. López-Salido, 2013, "Patterns of Convergence and Divergence in the Euro Area," NBER Working Papers 19561.

European Commission, 2012, "Current Account Surpluses in the EU," The european economy series 9/2012, European Commission Directorate-General for Economic and Financial Affair.

Everaert, L., and W. Schule, 2008, "Why It Pays to Synchronize Structural Reforms in the Euro Area Across Markets and Countries," IMF Staff Papers, 55(2), 356–366.

Fahr, R., and U. Sunde, 2009, "Did the Hartz Reforms Speed-Up the Matching Process? A Macro-Evaluation Using Empirical Matching Functions," German Economic Review, 10(3), 284–316.

Faia, E., W. Lechthaler, and C. Merkl, 2013, "Fiscal Stimulus and Labor Market Policies in Europe," Journal of Economic Dynamics and Control, 37(3), 483–499.

Felbermayr, G. J., M. Larch, and W. Lechthaler, 2012, "The Shimer-Puzzle of International Trade: A Quantitative Analysis," Ifo Working Paper, No. 134.

Felbermayr, G. J., M. Larch, and W. Lechthaler, 2013, "Unemployment in an Interdependent World," American Economic Journal: Economic Policy, 5(1), 262–301.

Fonseca, R., L. Patureau, and T. Sopraseuth, 2009, "Divergence in Labor Market Institutions and International Business Cycles," Annals of Economics and Statistics / Annales d'Économie et de Statistique, 95–96, 279–314.

Gartner, H., C. Merkl, and T. Rothe, 2012, "Sclerosis and Large Volatilities: Two Sides of the Same Coin," Economics Letters, 117(1), 106–109.

Gomes, S., P. Jacquinot, M. Mohr, and M. Pisani, 2011, "Structural Reforms and Macroeconomic Performance in the Euro Area Countries: a Model-Based Assessment," ECB Working Paper Series 1323, European Central Bank.

Gomes, S., P. Jacquinot, and M. Pisani, 2012, "The EAGLE. A Model for Policy Analysis of Macroeconomic Interdependence in the Euro Area," Economic Modelling, 29(5), 1686–1714.

Hairault, J.-O., 2002, "Labor-Market Search and International Business Cycles," Review of Economic Dynamics, 5(3), 535–558.

Heathcote, J., and F. Perri, 2013, "The International Diversification Puzzle Is Not as Bad as You Think," IGIER (Innocenzo Gasparini Institute for Economic Research) Working Papers 472, Bocconi University.

Helpman, E., and O. Itskhoki, 2010, "Labour Market Rigidities, Trade and Unemployment," Review of Economic Studies, 77(3), 1100–1137.

Hertweck, M. S., and O. Sigrist, 2013, "The Aggregate Effects of the Hartz Reforms in Germany," SOEP Papers on Multidisciplinary Panel Data Research 532, DIW Berlin, The German Socio-Economic Panel (SOEP).

Hobijn, B., and A. Şahin, 2009, "Job-Finding and Separation Rates in the OECD," Economics Letters, 104(3), 107–111.

Hogrefe, J., and M. Kappler, 2012, "The Labour Share of Income: Heterogeneous Causes for Parallel Movements?," The Journal of Economic Inequality.

Hooper, P., K. Johnson, and J. Marquez, 2000, "Trade Elasticities for the G-7 Countries," Princeton Studies in International Economics, 87.

Hosios, A., 1990, "On the Efficiency of Matching and Related Models of Search and Unemployment," Review of Economic Studies, 57(2), 360–399.

King, R. G., C. I. Plosser, and S. T. Rebelo, 1988, "Production, Growth and Business Cycles II. New Directions," Journal of Monetary Economics, 21, 309–341.

Klinger, S., and T. Rothe, 2012, "The Impact of Labour Market Reforms and Economic Performance on the Matching of the Short-Term and the Long-Term Unemployed," Scottish Journal of Political Economy, 59(1), 90–114.

Kohlbrecher, B., C. Merkl, and D. Nordmeier, 2013, "The Matching Function: A Selection-Based Interpretation," LASER Discussion Papers - Paper No. 70.

Kose, M. A., and K.-M. Yi, 2006, "Can the Standard International Business Cycle Model Explain the Relation between Trade and Comovement?," Journal of International Economics, 68(2), 267–295.

Krause, M. U., and T. A. Lubik, 2007, "On-the-Job Search and the Cyclical Dynamics of the Labor Market," ECB Working Paper Series 779, European Central Bank.

Krause, M. U., and H. Uhlig, 2012, "Transitions in the German Labor Market: Structure and Crisis," Journal of Monetary Economics, 59(1), 64–79.

Krebs, T., 2003, "Human Capital Risk And Economic Growth," The Quarterly Journal of Economics, 118(2), 709–744.

Krebs, T., and M. Scheffel, 2013, "Macroeconomic Evaluation of Labor Market Reform in Germany," International Monetary Fund, Working Paper No. 13/42.

Lane, P. R., and G. M. Milesi-Ferretti, 2002, "Long-Term Capital Movements," in NBER Macroeconomics Annual 2001, Volume 16, pp. 73–136. National Bureau of Economic Research, Inc.

Launov, A., and K. Wälde, forthcoming, "Estimating Incentive and Welfare Effects of Non-Stationary Unemployment Benefits," International Economic Review.

Ljungqvist, L., and T. J. Sargent, 1998, "The European Unemployment Dilemma," Journal of Political Economy, 106(3), 514–550.

———, 2007, "Understanding European Unemployment with Matching and Search-Island Models," Journal of Monetary Economics, 54(8), 2139–2179.

Nie, J., 2010, "Training or Search? Evidence and an Equilibrium Model," Research Working Paper RWP 10-03, Federal Reserve Bank of Kansas City.

Patureau, L., 2007, "Pricing-to-Market, Limited Participation and Exchange Rate Dynamics," Journal of Economic Dynamics and Control, 31(10), 3281–3320.

Petrongolo, B., and C. A. Pissarides, 2001, "Looking into the Black Box: A Survey of the Matching Function," Journal of Economic Literature, 39(2), 390–431.

Pissarides, C. A., 2000, Equilibrium Unemployment Theory. MIT Press, 2nd edn.

Ratto, M., W. Roeger, and J. i. t. Veld, 2009, "QUEST III: An Estimated Open-Economy DSGE Model of the Euro Area with Fiscal and Monetary Policy," Economic Modelling, 26(1), 222–233.

Schmitt-Grohé, S., and M. Uribe, 2003, "Closing Small Open Economy Models," Journal of International Economics, 61(1), 163–185.

Schwarzmüller, T., and N. Stähler, 2011, "Reforming the Labor Market and Improving Competitiveness: An Analysis for Spain Using FiMod," Discussion Paper Series 2011,28, Deutsche Bundesbank.

A Optimization in the Foreign Country

A.1 Foreign Households

Similar to its domestic counterpart, the representative foreign household maximizes its expected life-time utility

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[N_{2t} U(C_{2t}^n, h_{2t}) + (1 - N_{2t}) U(C_{2t}^u) \right], \tag{34}$$

where the functional form of the per-period utility is the same as for country 1 (see equations (2) and (3)). Foreign households' optimization is subject to the budget constraint (in terms of the good produced in the domestic economy)

$$P_{2t}^c \left(1 + \tau_2^c\right) C_{2t}^c + B_{2t+1} + P_{2t}^c C A_{2t} =$$
$$= ToT_t N_{2t} w_{2t} h_{2t} \left(1 - \tau_2^d\right) + (1 - N_{2t}) ToT_t b_{2t} + B_{2t} \left(1 + i_t\right) + T_{2t} + \Pi_{2t}^F \tag{35}$$

and to the law of motion of employment symmetric to equation (7). In addition foreign bond holders face the same portfolio adjustment costs as domestic bond holders.

The first order conditions for this optimization problem are given by

$$\frac{1}{C_{2t}^c} = \left(1 + \tau_2^c\right) \lambda_{2t} P_{2t}^c \tag{36}$$

$$1 + \Phi_b \frac{B_{2t+1}}{P_{2t}^c} = \beta E_t \left[\frac{\lambda_{2t+1}}{\lambda_{2t}} \left(1 + i_{t+1}\right) \right]. \tag{37}$$

The preferences of foreign households regarding the composition of the final consumption bundle resemble the domestic one and can be written as

$$C_{2t}^c = \left[\kappa^{\frac{1}{\eta}} C_{2t}^* \frac{\eta-1}{\eta} + (1 - \kappa)^{\frac{1}{\eta}} C_{1t}^* \frac{\eta-1}{\eta} \right]^{\frac{\eta}{\eta-1}}. \tag{38}$$

By minimizing the costs for C_{2t}^c the following foreign demand functions are obtained:

$$C_{2t}^* = \kappa \left(\frac{ToT_t}{P_{2t}^c} \right)^{-\eta} C_{2t}^c \tag{39}$$

$$C_{1t}^* = (1 - \kappa) \left(\frac{1}{P_{2t}^c} \right)^{-\eta} C_{2t}^c. \tag{40}$$

A.2 Foreign Firms

Foreign firms face the same production technology, capital adjustment costs and law of motion for capital and employment as domestic firms when maximizing their profits given by

$$\Pi_{2t}^F = ToT_t Y_{2t} - ToT_t w_{2t} h_{2t} N_{2t} \left(1 + \tau_2^f\right) - \omega_2 P_{2t}^c V_{2t} - P_{2t}^c I_{2t}^c - P_{2t}^c CI_{2t} \tag{41}$$

with respect to capital, labour and vacancies. The resulting optimality conditions read as

$$q_{2t}^T = \beta E_t \left[\frac{P_{2t+1}^c \lambda_{2t+1}}{P_{2t}^c \lambda_{2t}} \left\{ \frac{P_{t+1}}{P_{2t+1}^c} \alpha \frac{Y_{2t+1}}{K_{2t+1}} + q_{2t+1}^T - \delta + \frac{\Phi_I}{2} \left(\frac{I_{2t+1} - \delta K_{2t+1}}{K_{2t+1}} \right)^2 \right\} \right] \tag{42}$$

$$\frac{\omega_2}{q_{2t}} = \beta E_t \left[\frac{P_{2t+1}^c \lambda_{2t+1}}{P_{2t}^c \lambda_{2t}} \left\{ \frac{P_{t+1}}{P_{2t+1}^c} \left(1 - \alpha\right) \frac{Y_{2t+1}}{N_{2t+1}} - \frac{P_{t+1}}{P_{2t+1}^c} w_{2t+1} h_{2t+1} \left(1 + \tau_2^f\right) + \left(1 - s_2\right) \frac{\omega_2}{q_{2t+1}} \right\} \right], \tag{43}$$

where q_{2t}^T is Tobin's q and defined symmetrically to country 1.

A.3 Matching and Bargaining in the Foreign Labour Market

The matching and bargaining process follows exactly the same rules as in the domestic labour market (see equations (21) and (22)). The labour contract defining the optimal level of wages and hours worked should satisfy the following first order conditions:

$$\frac{\kappa_2^n}{\lambda_{2t}} \left(1 - h_{2t}\right)^{-\xi} = \frac{1 - \tau_2^d}{1 + \tau_2^f} ToT_t \left(1 - \alpha\right) \frac{Y_{2t}}{N_{2t} h_{2t}} \tag{44}$$

$$w_{2t} h_{2t} = \frac{1 - \epsilon}{1 + \tau_2^f} \left[\omega_2 \frac{P_{2t}^c}{ToT_t} \theta_{2t} + \left(1 - \alpha\right) \frac{Y_{2t}}{N_{2t}} \right] + \frac{\epsilon}{1 - \tau_2^d} \left[b_{2t} + \frac{1}{ToT_t \lambda_{2t}} \left(\kappa_2^u - \kappa_2^n \frac{\left(1 - h_{2t}\right)^{1-\xi}}{1 - \xi} \right) \right]. \tag{45}$$