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Angaben zur Veröffentlichung / Publication details:

Fries, Claudia. 2015. "Transmission Channels and Spillover Effects in a Globalised World." Augsburg: Universität Augsburg.

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Transmission Channels and Spillover Effects in a Globalised World

Dissertation

zur Erlangung des Grades
Doktor der Wirtschaftswissenschaften (Dr. rer. pol.)
der Wirtschaftswissenschaftlichen Fakultät
der Universität Augsburg

vorgelegt von
Dipl.-Volkswirtin Claudia Fries, geb. Busl

Augsburg, Juni 2014

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Datum der mündlichen Prüfung: 3. Dezember 2014

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1

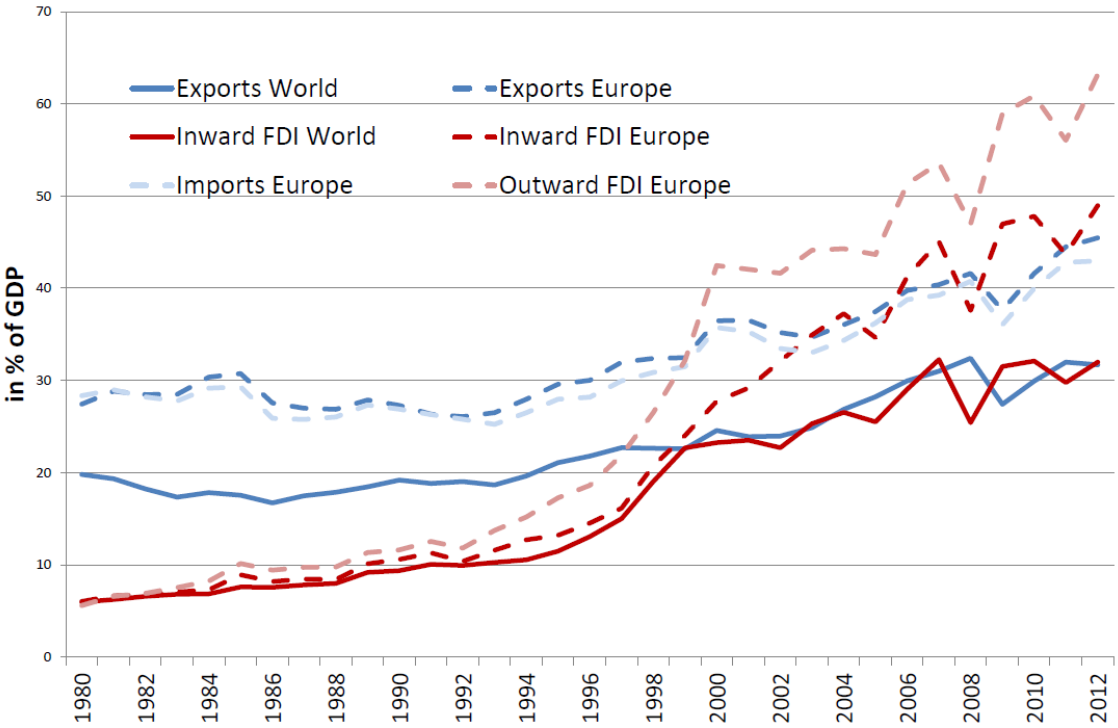
Introduction

In the past decades, the world economy has been characterised by an increasing degree of globalisation. Since the mid-nineties the two main indicators of globalisation, international trade and cross-border capital holdings, have been on the rise. Worldwide exports as well as foreign direct investment (FDI) inward positions have reached unprecedented levels amounting to about 30% of gross domestic product (GDP) in the last decade (see Figure 1.1). This process was driven by several factors: on the one hand, there have been significant advances in information and communication technologies and in transportation systems. On the other hand, trade in goods and services as well as capital movements have been subject to a set of liberalisation policies. Taken together, these developments have enhanced international competition between firms.

In Europe, the politically induced integration process further added to the international globalisation trend. By the creation of its single market, the European Union actively promoted higher trade and investment flows between its member states but also with the rest of the world. Imports and exports and similarly FDI inward stocks of European countries reached more than 40% of GDP in recent years and FDI outward positions even touched the 70%.[1]

The consequence of this globalisation process is a system of strongly interlinked economies which therefore influence each other through various channels positively as well as negatively. A striking example of possible consequences of such dependencies is the US subprime crisis having started in 2007. Due to global banking, financial institutions all around the world engaging in this market were in trouble. In addition, the following recession in the US dampened exports in a considerable number

[1] European Commission (2012) provides a detailed picture of the trade and financial integration in the EU.



Source: UNCTAD foreign direct investment stocks and goods and services trade flows.

Fig. 1.1. Development of Trade and FDI in Europe and the World

of countries. And finally the loss of confidence in credit and financial markets led to a tightening of credit supply not only in the US. In Europe, many countries fell into a deep recession and the crises in the banking system were followed by sovereign debt crises in several countries. On the positive side, strong cross-country linkages may be beneficial for technological progress, economic growth, price and consumption levels and ultimately for economic welfare. Furthermore, this may involve that countries are affected by economic shocks in a similar way. This their capability of sharing a common monetary policy as in the European Monetary Union (EMU).

The previously cited facts and arguments give an impression of how influential these cross-country linkages and their transmission effects on the respective economies can be. It demonstrates the need for a sound understanding of the interconnectedness of economies and the possible transmission channels. Only a profound knowledge of the spillover channels enables a correct evaluation of the effects of economic shocks. It provides a fundament for the analysis and discussion of policy alternatives and of related questions such as the relevance of coordinated policies as

well. It is essential to take into account the linkages between economies when e.g. the impact of reforms in product and labour markets are analysed (as in Chapter 3 and 4). Finally, the knowledge about the impact of globalisation is needed to assess where the drawbacks of the globalisation process are. Policy makers need to be aware of who the "losers" of the development are which should be assisted or compensated in order to ensure welfare gains and social justice at the same time.

Based on these needs, a vast body of literature emerged in the last decades. The following overview confines itself to a few strands of this literature which inspired the three studies presented in this thesis.

The Impact of Globalisation on the Comovement of Business Cycles

The first strand deals with the question of how globalisation influences the similarity of business cycles across countries. In addition to measuring the degree of synchronisation, studies in this field attempt to assess the drivers of comovement in cyclical fluctuations. The importance and policy relevance of this subject stems on the one hand from the interest to understand the worldwide business cycle dependencies. If there are strong transmission mechanisms of business cycles present, policy interventions of one country influence the economic outcome of other countries to a greater extent. And the larger such spillovers are, the more they deliver a rationale for the coordination of policies across countries. On the other hand, the optimum currency areas (OCA) theory started by Mundell (1961) assigns great relevance to the similarity of business cycles in participating countries. The rationale behind this optimality criterion is that a joint monetary policy can only be beneficial for all members if they are at the same stage of the cycle because of the one-size-fits-all interest rate. As such it is also a premise for the well-functioning of the EMU. Thus, from a policy perspective it is of particular interest to individuate structural policies that—by fostering synchronisation—improve the efficiency of the common monetary policy.

In consequence, the evolution of the comovement properties of the main macroeconomic aggregates over time and their underlying driving factors became a prominent topic. The assessment of the development in synchronisation in the data varies greatly with the underlying time period, country coverage and methods of studies and includes evidence for falling correlations as well as for increased convergence. On world wide data from 1985 to 2008, Kose et al. (2012) conclude that business cycle fluctuations diverged between industrial and emerging market economies, whereas

within these two groups of countries there has been substantial convergence. For the euro area, Weyerstrass et al. (2011) and Lee (2013), among others, document a high and increasing degree of synchronicity before the introduction of the euro in 1999 but no further rise afterwards. Furthermore, dynamic factor models such as Kose et al. (2008, 2012) and Karadimitropoulou and León-Ledesma (2013), which decompose the cyclical fluctuations of the main macroeconomic aggregates into global, country-specific and idiosyncratic factors, reveal that factors common to all countries have been on the rise during the globalisation period (considering industrial or G7 countries only).[2] Note, however, that these studies do not distinguish between truly global shocks and country- or industry-specific shocks that are transmitted to all countries.

There are a number of empirical studies taking a different route by examining which cross-country linkages determine the synchronisation of business cycles between countries, to which the first study of this thesis in Chapter 2 contributes. The starting point of this empirical literature is—similar to the studies discussed before—to assess the effect of increased trade and financial linkages on the comovement as theory does not give clear predictions. International trade flows create demand- and supply-side linkages between countries, and financial integration enhances risk sharing between countries, which both should lead to more correlated economic outcomes across countries. In this case, however, both channels may also have an impact on the industry structure by stimulating specialisation. If sector-specific shocks play an important role, as Karadimitropoulou and León-Ledesma (2013) argue, this development should rather decrease the cyclical comovement. The impact on the sector structure is a consequence of increased competition amongst countries with strong trade and financial linkages as well as technology transfer. The competition promotes not only the most productive firms which can offer the lowest prices (see Melitz, 2003) but also enhances high quality and innovation. Finally, the complicated interplay of national institutions in the labour and product market as well as fiscal or monetary policy stances might also interfere with the impact of globalisation on comovement properties of the main macroeconomic aggregates.

The results of most empirical studies indicate a significant positive impact of international trade on output correlations (see Frankel and Rose, 1998 or Baxter

[2] Karadimitropoulou and León-Ledesma (2013) support this result when they define the global factor as the sum of sector-specific factors which are common among all countries and their world factor which is the same for all industries.

and Kouparitsas, 2005). Recent evidence, however, by Kappler (2011), Böwer and Guillemineau (2006), Jansen and Stokman (2011) and Keil and Sachs (2012) points to a dependence of the result on the chosen method (cross-country or cross-regional regressions) and the underlying time period (until the mid-nineties). For financial linkages the picture is even more heterogeneous. While Kose et al. (2003) or Imbs (2004) find a positive significant impact on business cycle synchronisation, Kalemli-Ozcan et al. (2013) detect the influence to be significant but negative. Again, results seem to depend on the identification method and time frame, but also strongly on the measure of financial integration. As discussed in more detail in Section 2.1, the set of measures considered includes de facto and de jure measures as well as price- and volume-based measures for various assets.

The Impact of FDI on the Comovement of Business Cycles

The analysis in Chapter 2, which is based on Busl and Kappler (2013), concentrates on the influence of foreign direct investment, which has a special position among financial linkages. The multinational firms accruing from these cross-border investments provide a broad spectrum of transmission channels including intra-firm trade and internal capital markets that exceed the simple initial financial flow (a more detailed description of the potential channels follows in Section 2.1).

In this study, we identify the main sources of business cycle synchronisation across a set of highly economically integrated countries. We extend the previous literature on the determinants of business cycle synchronisation in two dimensions. First, we put special attention on the influence of intensified FDI relations when we identify the impact of the main determinants of business cycle synchronisation, namely trade and financial integration and differences in the sectoral structure. FDI stocks have increased strongly in the past decades, much stronger than trade linkages, and by now a few large multinational firms represent a large share of economic output and employment in many countries (Kleinert et al., 2012). Hence, they provide a basis for strong international linkages through their cross-border activities such as intra-firm trade, firm-wide investment plans or wage setting. In particular for the EMU, foreign direct investments are essential elements for completing the internal market and thus promoting economic integration and overall competitiveness of the region. While economic rationale and research suggest that promoting FDI through investment policies is a valid instrument to remove barriers in order to complete the internal market (Ilzkovitz et al., 2007), theory and available empirical evidence are less clear

about the effects of deeper cross-border capital links within a region on business cycle synchronisation, as mentioned above. Thus, there could be a potential conflict between European policies that aim at fostering FDI linkages and the efficient policy-making by the European Central Bank (ECB) if member states' cycles tend to move apart because of desynchronising forces of the FDI channel. Studying the question whether two countries that are strongly linked through capital stocks show a higher comovement of output cycles than two countries that are less connected through capital cross-links will clarify such concerns.

Our second contribution to the literature is a more technical one, as we argue below. It is a necessary step forward in the empirics of business cycle synchronisation to use panel instead of cross-section data to identify contemporaneous bilateral relations among the determinants. Previous research mainly focused on data averaged over time and employed cross-section regressions on country (pair) means of the explanatory variables. In such regressions, business cycle synchronisation between two countries is usually measured by the Pearson correlation coefficient of GDP cycles over the entire sample period. Some studies impose a panel structure by computing correlation coefficients and averages over few non-overlapping sub-periods of equal size (e.g. Schiavo, 2008; Hsu et al., 2011). These approaches lead to an identification problem if the data are characterised by trends over time since averages become time dependent and the building of arbitrary sub-periods will randomly influence regression results. As will be shown in Chapter 2, in particular trade and FDI intensity measures display strong time trends. A more systematic way of exploiting the between and within variation of the data is to directly run panel regressions and, moreover, take country-pair and period fixed effects into account. Country-pair fixed effects consider unobserved heterogeneity between two countries that arises, for instance, due to geographical or cultural proximity while period-specific effects capture common time shocks in the similarity measures. The latter are relevant for distinguishing the transmission of shocks through trade and FDI linkages from common shocks as a source of output cycle synchronisation (e.g. Kappler, 2011). Thus, panel estimations are much more capable of reconciling theory with empiricism than pure cross-sectional or pseudo panel estimation approaches.

Our results in Chapter 2 show that the contemporaneous effect of trade integration on business cycle synchronisation is in fact not as robust as the cross-section effects reported by previous studies. Therefore, the correlation between trade relations and synchronisation may be largely driven by common underlying factors.

This finding is in accordance with the literature discussed above, highlighting the importance of global shocks. Furthermore, regarding FDI linkages, we find in most cases a positive significant coefficient, but for inner European FDI relations we do no find a significant impact. Finally, increasing heterogeneity in the sector composition between countries is found to have a negative impact on their cyclical synchronisation.

Our findings with respect to FDI imply that policies fostering bilateral FDI integration do not harm synchronisation between countries. On the contrary, they may even increase comovement. The importance of developing policies that enhance synchronisation is particularly evident in the light of the past years, when the heterogeneity in economic development between the countries in the eurozone increased, forcing the ECB to use country-targeted policy measures in addition to the common interest rate. Since these measures are highly disputed by experts and come at a risk, the ECB plans to abandon the non-standard measures once its member countries exhibit a stable and more similar economic development.

The International Effect of Labour Market Reforms

To stimulate growth and stabilise the economy especially in underperforming countries, structural reforms have been put on top of the agenda of policy makers. Thereby, labour market reforms feature a high priority, since unemployment rates have reached high levels in many member economies. As noted before, when such policy interventions are designed and evaluated, the strong economic linkages between countries need to be taken into account. Hence, a multi-country framework becomes indispensable. Such a framework allows not only to answer the question how the international environment influences the impact of a reform on the country in which it is undertaken. It also embeds the possibility to analyse the spillover effects of the reform to foreign countries.

The main transmission channel in most models, after a reform which improves somehow the competitiveness of a country, operates through changes in the relative prices of traded goods. A change in the terms of trade may cause shifts in the traded quantities as shown in the basic two-country real business cycle model by Backus et al. (1994). The effect stemming from the relative price channel may be altered if the structure of the economy is modelled in more detail. If heterogeneity of firms is taken into account, these effects are accompanied by adjustments through firm entry and exit decisions (see e.g. Melitz, 2003). The bargaining of wages between

workers and employers, as discussed in the following, may dampen implied wage changes in favour of employment adjustments in the foreign country. Furthermore, if countries are subject to a common monetary policy, Dao (2013b) shows that in the short run, spillovers increase and domestic effects are dampened whereas, in the long run, effects are not altered. And last but not least, shifts in the relation to third parties may create additional effects as Chapter 4 highlights. A second channel arises if one allows for trade of financial assets in the model. While the trade channel has a direct impact on demand, integrated financial markets influence the economy indirectly by allowing for short-term current account imbalances and thus a more flexible reallocation of resources between countries. Furthermore, channels related to non-price competitiveness are of great importance for transmission effects as well, as European Commission (2012) or Estrada et al. (2013) show. They name goods market efficiency, technological readiness, business sophistication and innovation capabilities amongst others. Unfortunately, these factors and the related mechanisms are difficult to integrate in a standard international macroeconomic model.

The literature dealing with the international effects of reforms in labour market institutions, to which the studies in Chapter 3 and 4 contribute, is relatively recent. Nevertheless, there is already 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.

The studies reviewed 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 on employment in the long run. A notable exception is the study of Helpman and Itskhoki (2010). Their model is based 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 employment effects 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.

The majority of the models in the literature generates 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 for the trade partner. Dao (2013a) shows that with a competitive labour market and a convenient parametrisation of the utility function of the households, negative spillover effects from reforms can occur. In particular, the wealth effect on labour supply from the terms-of-trade improvement can be larger than the productivity effect on labour demand in the non-reforming trade partner in such a case. With rigidities in the labour market, on the contrary, 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 mentioned above, the literature on spillover effects of labour market reforms is rather diverse as to the reform measures that are evaluated. Bayoumi et al. (2004), Everaert and Schule (2008) and Gomes et al. (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 et al. (2012) and Coenen et al. (2008) explore the impact of a reduction in the (employers') labour tax rate, while Felbermayr et al. (2012) focus on the impact of a change in unemployment benefits. In further studies such as Dao (2013b), Felbermayr et al. (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.

So far, only 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 et al. (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 further institutional variables alongside with control variables in their panel regressions which explain the domestic unemployment rate.

Chapters 3 and 4 contribute to the model-based literature on the international effects of labour market reforms. Both studies build on a dynamic stochastic general equilibrium (DSGE) model which is borrowed from Fonseca et al. (2009) and has several standard features. Most importantly for the analyses, it features 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. Furthermore, international spillovers occur through two channels in the model: international goods trade and international financial assets. To be more specific, each country specialises in the production of its own good, whereas households consume a composite good, which comprises the intermediate goods of all countries. This standard intra-industry trade framework maps the trade flows in the European environment in an appropriate way. Finally, there is a riskless nominal interest rate bond that helps to enhance the sharing of resources internationally.

The Macroeconomic Effects of the German Labour Market Reforms

In Chapter 3, which is based on Busl and Seymen (2013), the effect of the German labour market reforms of the past decade—the so-called Hartz reforms—on the macroeconomic outcomes of Germany and its European neighbours is analysed. We do not only assess the spillover effects of these reforms but also look at the macroeconomic implications for the German economy as critics of the Hartz reforms claimed that the reforms led to wage restraint and consequently to consumption dampening accompanied by beggar-thy-neighbour effects harming Germany's trade partners. But the disproportional growth of GDP in comparison to consumption, labour productivity in comparison to wages and the German trade surplus may as well have been due to other factors. The aim of the study is to shed light on this controversy by means of a two-country DSGE model with search and matching frictions which is calibrated to data from Germany and the rest of the euro area. In particular, we want to quantify the role of the Hartz reforms, if any, in the aforementioned developments in the German macroeconomic data. Furthermore, labour market reforms have been on the policy agenda of many countries following the global financial crisis, hence our analysis 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, three crucial aspects to evaluate the Hartz reforms are addressed. 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.[3] 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 domestic 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.

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

Several studies that we review in Chapter 3 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 our model with those Hartz phenomena, it is quite successful in replicating general trends in the German aggregate data over the period 2003-2010.[4] 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 which generate, following the 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).[5] 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. Remember 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

[4] 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 study are not affected by the choice of the period.

[5] This has been shown by Dao (2013a), as mentioned before, in theoretical framework that is very similar to ours. 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.

decline by 0.39% according to our benchmark calibration.[6] 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 small trade deficits in the short to medium run, rather than to surpluses as in the German data. 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. Accordingly, additional factors must have contributed to these developments in the data. As we argue in this study, globalisation-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.

A question not tackled in Chapter 3 is whether single European countries have been affected in a similar way to the European average. The reforms may have hit Germany's neighbours to a different extent as they differ in their trade relationship to Germany and in their institutions. In consequence, relative competitiveness between Germany's neighbours may have shifted, inducing negative indirect effects to employment in some countries. In case these indirect effects have been very large, thus overturning positive direct effects, single countries may even have experienced negative spillovers. The study in Chapter 4, which is based on Busl (2014), elaborates on the question how important indirect spillover effects can become in quantitative terms and how they affect the overall spillover.

Third-Country Effects of Labour Market Reforms

Theoretical literature on spillover effects of labour market institutions on foreign (un-)employment builds on two-country model economies. Thus, it focuses on the direct impact a country has on its neighbour(s) by carrying out reforms. However, a reform in one country may also trigger indirect effects which occur through shifts between the affected foreign countries and, hence, cannot be analysed in a two-country model. The scope and contribution of this study is the analysis of the indirect effect in the simplest possible framework with three countries.

[6] 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%

To be more specific, if a labour market reform in the domestic country decreases the terms of trade with each of its trading partners to a different extent (e.g. because of differing trade relations), then the terms of trade between the trading partners themselves change as well. Therefore, a specific partner experiences an appreciation in its terms of trade with the reforming country, evoking (positive) effects on its economy. Contemporaneously, its terms of trade with the other countries may also appreciate or depreciate depending on the characteristics of the countries involved. Thus, the overall effect of a reform in the domestic country incurred by a neighbouring country consists of the sum of the direct effect generated by changes in the relation with the domestic country and the indirect effect caused by shifts in the relation to other countries. If the country of interest experiences a stronger appreciation than other countries in its terms of trade with the domestic country, it also appreciates with respect to the other countries. In consequence, the aggregated spillover effect exceeds the direct effect. This aspect provides a potential explanation for the puzzle raised by Felbermayr et al. (2012). They claim that recent empirical evidence by Felbermayr et al. (2013) points to much higher spillovers relative to the effects in the reforming country than their model simulations.[7] However, if the relative prices of the other countries react stronger, the country of interest needs to depreciate with respect to these countries, creating an opposing effect. It cannot be ruled out a priori, that the indirect effect dominates the direct effect, in certain cases leading to negative overall spillover.

In Chapter 4, the relevant impact factors for the direction and strength of the indirect as well as the direct effect and the resulting overall effect are described. In contrast to previous studies, I do not focus on the characteristics of the reforming country but on the characteristics of its trading partners and in particular on differences between these countries which provoke indirect effects. Of course, this study is not the first to include indirect effects by modelling more than two countries. There are several studies based on medium to large scale multi-country models (see e.g. Everaert and Schule, 2008, Gomes et al., 2012), which analyse the (spillover) effects of labour or product market reforms for a specific country setup. The scope of these studies is, however, to evaluate the outcome of specific reform scenarios.

[7] Other model based studies find spillover effects of a similar size as in the Felbermayr et al. (2012) model, see Busl and Seymen (2013).

Thus, they do not provide a detailed analysis of the composition and possible values of the spillover effects.[8]

This analysis is based on a slightly modified version of the model in Chapter 3. Most importantly, a third country with identical production and labour market institutions is added to the framework. This three-country setup offers the possibility to model the bilateral and overall trade intensities appropriately at the same time (defining the third country as rest of the world), which is not possible in a two-country model, but important for a quantitative evaluation because of their influence on the size of the spillover effect. Furthermore, countries are allowed to differ with respect to their size.

The main part of the analysis deals with the long-run, i.e. equilibrium, effects of a reform. Therefore, under the assumption that the current account needs to be balanced in equilibrium, only the trade channel matters for the transmission in this part. In contrast, when the dynamic response to a reform in the last part of Chapter 4 is investigated, the financial channel is important to allow for short-term current account deficits or surpluses. Given that the only transmission mechanism in the long run is a change in terms of trade, the qualitative results of the study apply to all kinds of reforms which affect the terms of trade. In Chapter 4, I consider a reduction in the unemployment benefit ratio, which is inspired by a German example of the recent past, the so-called Hartz IV reform, and the related hot debate on the spillover and side effects of such reforms as discussed in Chapter 3.

As the derivation of analytical results with respect to the sign and size of the direct and indirect effects is only feasible to a limited extent, I analyse the relevance of several country characteristics by simulating the reform for varying values of the corresponding parameters on an empirically meaningful scale. The baseline calibration is thereby orientated towards the European context and the German reform scenario. I find that of particular relevance for the size of the overall employment spillover and its components are the relative openness and bilateral import preferences of countries in conjunction with their size. The initial unemployment rate, the unemployment benefit ratio, the capital share, the elasticity of matching and the employee's labour tax rate matter as well for the magnitude of the overall spillover. But the size of the indirect effect turns out to be relative small vis-à-vis the direct effect in all simulations. In consequence, a negative indirect effect, which is e.g. obtained

[8] Felbermayr et al. (2012) also work with a three-country model, but they only consider symmetric neighbour countries. In consequence, a reform does not cause shifts between these countries.

for relatively small and open countries, does not dominate the positive direct effect. This implies that the aggregated spillover is always positive, which is in accordance with the two empirical studies by Felbermayr et al. (2013) and Dao (2013a). The relative size of the overall spillover effect measured as the ratio between the change of employment in the country of interest and the reforming country ranges between 0 and 11% for calibrations in an empirically realistic range. The upper range, which is measured for a very specific calibration with extreme values, is therefore well above the average of 9% estimated by Felbermayr et al. (2013). But for an average European country, the spillover turns out to be well below at 1 to 2%.

To summarise the introduction, this thesis contributes to the literature on the effects of globalisation in three different aspects. The study presented in Chapter 2 inquires the role of FDI in the synchronisation of business cycles. Chapter 3 provides an analysis of national and international macroeconomic effects triggered by the German labour market reforms. The indirect spillover effects of labour market reforms through a third country are subject of Chapter 4. A overall conclusion and outlook are given in Chapter 5.

2

Does Foreign Direct Investment Synchronise Business Cycles? Results from a Panel Approach[1]

In this chapter, we study the determinants of the comovement of business cycles. This research aim has a tradition in the literature that studies the conditions of optimum currency areas in terms of business cycle synchronisation. This is highly policy relevant since a considerable degree of business cycle synchronisation between member countries of currency unions is an important prerequisite for a successful operation of monetary policy because of the one-size-fits-all interest rate. Empirical evidence on the channels through which cyclical comovement is induced will add to the knowledge necessary to develop structural policies that improve the efficiency of the single monetary policy.

The following analysis pays special attention to the synchronising effects of foreign direct investment (FDI). Promoting FDI plays a role for the economic integration strategy of the EU as well as for the growth enhancing policies of many other countries. In the next section, we discuss the channels through which FDI may impact on the comovement of business cycles. Furthermore, we provide a short overview on the theoretical motivation and the empirical results for the main determinants of business cycle synchronisation based on the pertinent literature.

Our empirical strategy deviates from the standard cross-sectional identification approach pursued by most studies in that it builds on panel data. So far, genuine panel data is used by few studies only (see Kappler, 2011, Kalemli-Ozcan et al., 2013) which focus on one specific determinant of synchronisation. The advantages of a panel over a cross-sectional approach are discussed in Section 2.2, where we introduce our empirical strategy. Section 2.3 contains explanations about the measurement concepts and data for the variables of our model. Estimation results and sensitivity

[1] This chapter is based on joint work with Dr. Marcus Kappler. It is a revised version of WWWforEurope Working Paper no 23 (see Busl and Kappler, 2013).

tests are presented in Section 2.4, followed by some concluding remarks in the final section of this chapter.

2.1 Literature

Despite the considerable degree of cross-boarder activities arising from foreign direct investment, so far theoretical analyses on the effects of financial integration on business cycles focused almost exclusively on the case of portfolio investment and bank integration. The studies by Russ (2007) and Cavallari (2007, 2008, 2010) are an exception. These authors integrate heterogeneous firms in a monetary two-country business cycle model, which choose whether to enter a domestic or foreign market and whether to serve foreign markets through trade or through a foreign affiliate according to their productivity. Households participate in firms activity by holding shares of all types of home based firms. Thus, the activities of multinational firms foster the comovement of output across countries by increasing the degree of (dividend) income interdependence.

As regards financial integration in a broader sense, Heathcote and Perri (2002) show that in standard two-country, two-good international real business cycle (IRBC) models the cross-country correlation between output is higher in the case of financial autarky than with the existence of an internationally integrated bond market or complete asset market. In open financial markets, firms can reallocate their resources more efficiently, i.e., to the country with higher productivity, if hit by a shock. Thus, increased financial integration lowers the synchronisation of output. But if investors are subject to binding collateral constraints, Devereux and Yetman (2010) and Devereux and Sutherland (2011) find that comovement differs with respect to the type of financial integration. While integration in bond markets continues to result in lower output correlation in their model, integration in equity markets, where constraints are in place, leads to a transmission of technology shocks across countries through the balance sheet of constrained (international) investors causing output fluctuations to co-move. A similar mechanisms is emphasised by IRBC models incorporating multinational banks, which were developed in the aftermath of the financial crisis of 2007 and 2008 (see Olivero, 2010; Enders et al., 2011; Ueda, 2012). In these studies, financial integration is modeled by financial intermediaries (banks) operating at a global level. In consequence, a negative country-specific shock to the capital of a bank spreads to another country because of binding capital

constraints faced by the international bank, which results in comovement of international output fluctuations. In contrast, country-specific technology shocks do not lead to synchronised business cycles just like in a conventional IRBC model such as Backus et al. (1992).

The empirical literature suggests several additional transmission channels of business cycle shocks through multinational firms which are not incorporated into business cycle theory so far. First, FDI gives rise to increasingly international supply chains enhancing the spillover of idiosyncratic shocks from one country to another.[2] Furthermore, Stevens and Lipsey (1992) and Desai and Foley (2006) provide evidence that rates of return and investment of affiliates within a multinational firm are highly correlated, pointing to cross-border investment plans. Budd et al. (2005) and Jansen and Stokman (2006) both come to the same conclusion, though the first study is based on a firm-level panel and the second on macro data: Multinationals share their profits between their affiliates providing a further transmission channel. Balance sheet effects (similar to what Devereux and Yetman, 2010 and Devereux and Sutherland, 2011 propose) may be another transmission channel since the balance sheet of a multinational may be more susceptible to changes in the financial conditions in one of its host countries due to its international exposure (see Desai et al., 2008). But multinational firms may also benefit from their internal capital markets (see Desai et al., 2004) and therefore perform better than local firms under strong financial constraints as Hovakimian (2011) and Alfaro and Chen (2012) point out. Finally, when engaging in business abroad, multinational firms trigger knowledge and technology transfers which in turn may narrow the gap between GDP growth rates.

To summarise, from a theoretical point of view the direction of the influence of FDI on synchronisation is not clear. Most of the possible channels, however, point to a positive relation between FDI integration and cyclical comovement. But as Morgan et al. (2004) point out, the sign of the relation may strongly depend on the type of shock. If the financial sector of a foreign country is hit by a negative shock, a parent company may support its affiliate with financial liquidity. If in contrast there is an adverse shock to productivity, the parent may withdraw its support and shift resources to more profitable locations.

[2] IRBC models in the spirit of Burstein et al. (2008) capture vertical integration by explicitly including trade in intermediate goods. They find this to be an important channel for synchronisation.

Most empirical studies on the determinants of business cycle synchronisation report a positive impact of financial integration on output comovement irrespective of the measure in use. De-jure measures like composite indices based on the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER)[3] are employed as well as de-facto volume-based or price-based measures like bilateral asset holdings and capital flows or return spreads of equity or bond holdings (see e.g. Kose et al., 2003,Imbs, 2004,Imbs, 2006,Schiavo, 2008,Keil and Sachs, 2012). In contrast to these studies, Kalemli-Ozcan et al. (2013) use bilateral international bank assets and liabilities and adopt panel methods including country pair and time fixed effects to quarterly data. They detect a strong negative effect of their measure of financial integration on business cycle synchronisation and ascribe this opposing result to an omitted variable bias in cross-section analyses, which could not account for global shocks and unobservable country pair specific heterogeneity. Davis (2014) argues that the integration on differing financial markets may lead to different effects on synchronisation depending on whether transmission occurs through the wealth (divergence) or through the balance sheet channel (convergence). According to his estimation results, integration in credit markets occurs mainly through the balance sheet channel yielding a positive effect on comovement. Equity market integration, in contrast, has a negative effect which points to wealth effects as the main transmission channel.

Only few empirical studies investigate the influence of bilateral FDI linkages on comovement of business cycles. Considering the strong growth and large scale of foreign direct investment positions, but also the various potential transmission channels arising from multinational firms discussed above, this economic linkage is more than just a financial link and a relevant factor to be included. Empirical findings by Otto et al. (2001), Hsu et al. (2011), Jansen and Stokman (2011) and Keil and Sachs (2012) conclude that the positive effects of increased FDI linkages dominate. The latter two note that there is a shift in importance from trade to FDI in the mid-nineties. Dées and Zorell (2012) in contrast do not find a significant direct impact of FDI which may be due to their unusual unscaled FDI measure.

In addition to FDI linkages, we include as major endogenous factors explaining business cycle synchronisation trade integration and differences in countries' sector structure. Trade linkages are the most reviewed and robust determinant of business

[3] See for instance the Chinn-Ito index (Chinn and Ito, 2008) or the restriction indices by Schindler (2009).

cycle synchronisation in the literature.[4] The positive direct effect of stronger trade relations found in the data is in line with theoretical considerations according to which trade directly links foreign and domestic demand and supply. Thus, trade seems to be an obvious channel for transmission of demand and supply shocks. However, IRBC models have notorious difficulties to match the empirical findings quantitatively (see Kose and Yi, 2006). Comparing estimations over subperiods, Böwer and Guillemineau (2006), Jansen and Stokman (2011) and Keil and Sachs (2012) find that the relevance of trade linkages for bilateral synchronisation has decreased since the mid-nineties. New evidence on the dynamic relationship between synchronisation and trade intensity by Kappler (2011) casts doubt on the importance of trade in the transmission of cyclical shocks. His results support the common-shock view as they point to common or global factors being the main drivers of synchronisation which trigger changes in trade flows contemporaneously. In this study we focus on the contemporaneous effect of time-varying trade intensity while accounting for common shocks through year specific effects.

Similarities in the sectoral structure of two countries may also be of importance for the bilateral comovement of their business cycles. Countries with a similar industry structure are supposed to exhibit higher comovement other things being equal since they will respond in similar ways to global and sector-specific shocks. An idiosyncratic shock to a sector in a country will more likely spread to another country if the countries are engaged in related businesses. However, extant empirical evidence on the importance of sectoral similarity is mixed. Differences in the sectoral structure are either found to decrease synchronisation of business cycles significantly (for instance Imbs, 2004, 2006 or Inklaar et al., 2008) or to have no significant impact at all (see Baxter and Kouparitsas, 2005).

2.2 Empirical Approach

Our estimations to identify the determinants of comovement in cyclical fluctuations are based on the following equation:

$$\rho_{ijt} = \alpha_1 FDI_{ijt} + \alpha_2 T_{ijt} + \alpha_3 SD_{ijt} + \alpha_4 I_{1,ijt} + \mu_{ij} + \lambda_t + \varepsilon_{ijt}, \tag{2.1}$$

[4] See Frankel and Rose (1998), Imbs (2004), Baxter and Kouparitsas (2005) to cite the most influential.

where ρ_{ijt} is our measure of business cycle synchronisation between country i and country j at time t. FDI_{ijt} denotes the bilateral FDI intensity, T_{ijt} is a measure for trade integration, and SD_{ijt} represents the differences in the sectoral structure within country pairs. These variables are treated as endogenous variables in the following. In $I_{1,ijt}$ we include additional time and country-pair varying exogenous covariates. The disturbances follow a two-way error component model, where μ_{ij} denotes country-pair specific effects, λ_t common year specific effects and ε_{ijt} the remainder stochastic disturbance. A detailed description of all variables and their measurement concepts as well as of their potential impact is given in the next section.

Note that our three endogenous variables may not only directly impact on business cycle synchronisation as described in the previous section, but may also interact with each other and therefore have an indirect impact on synchronisation. To be specific, inter-industry trade integration is supposed to rise as a result of increasing differences in the sector structure to exploit endowment differences or comparative advantages. Intra-industry trade, in contrast, may be fostered by more similar industries. Increased trade integration in turn results in deeper specialisation according to classical trade theory based on comparative advantages and economies of scale. This argument is valid for inter-industry trade. But as pointed out by Frankel and Rose (1998) and Imbs (2004) among others, trade between industrialised countries and especially between European countries is predominantly of the intra-industry type. As such it could be a source for knowledge spillovers similar to FDI and therefore augment similarity. In addition, trade is supposed to have a positive impact on FDI since both are driven by common factors such as the productivity level of firms (see Helpman et al., 2004). Inversely, effects could point in both directions: on the one hand, horizontal FDI may substitute trade where trade costs are prohibitively high or firms want to be closer to the customer, on the other hand vertical FDI (i.e., off-shoring parts of the production) or export-platform FDI may stimulate trade in intermediate as well as in final goods.[5] Finally, higher similarity may stimulate new FDI in order to benefit from technological knowhow abroad, to be closer to the costumer or to reduce transport costs. The impact of FDI linkages on the industry composition is, however, ambiguous. Due to FDI induced technology transfer, countries might become more similar with respect to their industry composition, whereas the slicing of the supply chain and the possibility to diversify risks gives rise to a higher degree of specialisation.

[5] For a analysis of the two-way linkages between FDI and trade see Aizenman and Noy (2006).

To take these indirect effects into account, Imbs (2004) proposed the estimation of a system of equations. In addition to the equation explaining the bilateral comovement of business cycles, such a system contains one equation for each endogenous variable. Thus, equation (2.1) could be amended by the following equations

$$FDI_{ijt} = \beta_1 T_{ijt} + \beta_2 SD_{ijt} + \beta_3 I_{2,ijt} + u_{2,ijt} \tag{2.2}$$

$$T_{ijt} = \gamma_1 FDI_{ijt} + \gamma_2 SD_{ijt} + \gamma_3 I_{3,ijt} + u_{3,ijt} \tag{2.3}$$

$$SD_{ijt} = \delta_1 FDI_{ijt} + \delta_2 T_{ijt} + \delta_3 I_{4,ijt} + u_{4,ijt}, \tag{2.4}$$

where each endogenous determinant depends on the other endogenous variables and on exogenous factors $I_{m,ijt}$ with $m = 2, 3, 4$ being the index of the additional equation. By analogy with equation (2.1) the disturbances $u_{m,ijt}$ are modelled as a two-way error components structure:

$$u_{m,ijt} = \mu_{m,ij} + \lambda_{m,t} + \varepsilon_{m,ijt}. \tag{2.5}$$

Note, however, that we do not estimate the whole system. We focus on identifying the direct effects of the determinants of comovement in business cycles, i.e. we estimate only equation (2.1) by means of a two-stage least squares approach. Nevertheless, we take the whole system into account when instrumenting, since the instruments stem from the exogenous variables $I_{m,ijt}$ with $m = 2, 3, 4$ included in equations (2.2) to (2.4). Even if we do not estimate equations (2.2) to (2.4) "... much can be gained in specifying a system of simultaneous equations as it permits identification of the coefficients of endogenous regressors using as instruments exogenous regressors excluded from the equation of interest.", as Cameron and Trivedi (2005, p.762) state.

We acknowledge that an estimation of equations (2.2) to (2.4) would nevertheless be useful to disentangle the indirect effects of the determinants resulting from their interdependence. We would for example know whether trade linkages indirectly foster synchronisation by enhancing FDI or decrease the differences in the sector composition. In an attempt to identify these relations, we came across the same problem for all three equations: Our available instrument sets (see Subsection 2.3.2) were rejected by Hansen's J test in almost all cases. One of the possible reasons may be the close relation of trade and FDI, which are determined by very similar factors. This makes it difficult to find an instrument which is correlated with one and exogenous to the other of the two variables. If the exogeneity con-

dition for the instruments is not met, inconsistently estimated coefficients are the consequence. Therefore, we refrain from estimating non properly identified indirect effects and from an estimation of the whole system with a three-stage least squares (3SLS) estimator.[6] Previous studies reporting estimates for the indirect relations either worked with exactly identified systems where overidentifying tests can not be applied assuming the exogeneity or without reporting tests of their instrumentation (see Imbs, 2004, Imbs, 2006, Schiavo, 2008, Inklaar et al., 2008, Hsu et al., 2011, Dées and Zorell, 2012, Keil and Sachs, 2012).

In our analysis, we first conduct estimations based on in a collapsed cross-section sample with observations pooled over time in keeping with many previous studies. A pure cross-section or between identification strategy employing means of time-varying variables, however, is subject to several objections. Identification over the variation in long-term average behaviour between country pairs is based on the assumption of a stable relation between the variables over time. Several studies like Frankel and Rose (1998), Inklaar et al. (2008) or Keil and Sachs (2012) deal indirectly with the concern of missing stability by splitting their samples into subperiods (which serves in Inklaar et al. (2008) also to generate more observations). If results for subperiods are considered separately, they point to a change in the importance of trade and FDI over time, corroborating this concern. As we show below, measures of trade and FDI integration contain strong trends in their behaviour over time. Thus, an interpretation of their means over the long term is highly questionable. Applying panel estimation methods allows to capture the within variation in the data. In addition, cross-section estimates may suffer from omitted variable bias, since some variables of interest are not observable and a sound theoretical foundation of the estimated equation is not at hand. Using panel data enables us to mitigate this problem by taking unobservable country-pair specific effects into account which capture time invariant explanatory factors. Furthermore, we introduce year specific effects to control for common shocks to both countries. This is an important aspect in the light of the strong global shocks of the last years and cannot be tackled in a cross-section approach. Cross-section data does not allow to disentangle whether higher comovement is caused by transmission, e.g. through trade, or by common shocks. Hence, the impact of a strong global shock may in the cross-section view be

[6] A 3SLS estimator, which takes contemporaneous correlations across equations into account and is thus more efficient, would suffer from a bias due to inconsistent estimation of single equations in the system.

interpreted as stronger economic integration, i.e., increased transmission, because the variables of interest contemporaneously move in the same direction.

For these reasons, in the main part of our analysis, we estimate the equation explaining synchronisation with an appropriate panel instrumental variable approach. We employ the error component two-stage least squares (EC2SLS) estimator proposed by Baltagi (1981) and expounded in Baltagi (2008), which is a random effect 2SLS estimator based on a weighted average of fixed effects and between 2SLS estimators. It differs from a conventional random effects or generalised 2SLS estimator in taking into account not only endogeneity stemming from correlations between country-pair fixed effects and explanatory variables but also endogeneity between the explanatory variables as described by equations (2.2) to (2.4).[7]

2.3 Measurement Concepts and Data

2.3.1 Business Cycle Synchronisation and its Endogenous Determinants

We measure bilateral synchronisation of business cycles ρ_{ijt} as the negative absolute difference between two countries' real GDP growth rates following Giannone and Reichlin (2008), Kappler (2011) and Kalemli-Ozcan et al. (2013):[8]

$$\rho_{ijt} = -\left|\Delta Y_{it} - \Delta Y_{jt}\right|. \tag{2.6}$$

This approach has an interpretation similar to the Pearson correlation coefficient—higher levels of ρ_{ijt} indicate a higher degree of bilateral synchronisation between country i and j in year t. But it has several advantages over this traditional time-invariant correlation measure of business cycle synchronisation. First, it reveals the variation in synchronisation over time. Thereby the stationary nature of synchronisation becomes evident.[9] Second, ρ_{ijt} is independent of the underlying sample period for each t, which is not the case for the mean-based correlation coefficient as used in most studies, even if it is estimated over subperiods or a rolling window. In addition, our growth rate based measure is not subject to measurement errors and to critiques

[7] The EC2SLS estimator employs more instruments than the G2SLS estimator by exploiting the restrictions in the error-component structure of the variance-covariance matrix and is thus more efficient (see Baltagi, 1981).

[8] Detailed information on data sources are listed in Appendix A.1.

[9] This applies not only to the synchronisation measure used in our study but also to other time-variant synchronisation measures proposed in literature, namely by Yetman (2011), Mink et al. (2007), Morgan et al. (2004) and Alesina et al. (2003).

on filtering methods which applies to estimated measures of business cycles, e.g. by the HP filter, and their correlations.

When measuring bilateral FDI and trade integration, we want to capture the economic importance of these linkages for both countries. Therefore, we apply the following measurement concept

$$T_{ijt} = \frac{EX_{ijt} + IM_{ijt}}{GDP_{it} + GDP_{jt}} \tag{2.7}$$

$$FDI_{ijt} = \frac{Out_{ijt} + In_{ijt}}{GDP_{it} + GDP_{jt}}, \tag{2.8}$$

where bilateral export and import flows and FDI inward and outward stocks, respectively,[10] are scaled by the sum over the GDP of both countries.[11] So as long as a shock affects trade or FDI and output proportionally, we observe no change in our intensity measure. We do not account for FDI flows, since they are of minor relevance with respect to their size (relative to GDP). Furthermore, being mainly the adjustment of existing FDI relations, they are just one of the channels through which existing multinationals affect business cycle comovement. As described in detail in Section 2.1, the existence of FDI stocks/multinational firms opens up several transmission mechanisms from international supply chains to technology transfer (including intra-firm investment and finance which constitute FDI flows). The stronger the linkages between countries in terms of FDI stocks, the stronger these channels may work.
To capture differences in the sectoral structure between countries we resort to value added shares s_{zit} for the sectors $z = (1, ..., Z)$ of the *OECD STAN* database covering all economic activities (including services) according to the International Standard Industrial Classification (ISIC) rev. 3 to compute

$$SD_{ijt} = \sum_{z=1}^{Z} |s_{zit} - s_{zjt}| . \tag{2.9}$$

[10] With respect to data on bilateral trade flows and FDI stocks, we follow the approach proposed by Feenstra et al. (2005): since in practice $EX_{ijt} = IM_{jit}$ and $Out_{ijt} = In_{jit}$ does not hold, we use the data from the importing/inward FDI country if available which is assumed to be more reliable.

[11] In some studies total trade flows/FDI positions of both countries are used as scaling factor. The resulting measures have a different interpretation from ours: they capture the importance of a particular bilateral trade/FDI relation relative to overall trade/FDI of these countries. Thus, these measures assign the same importance to large trade flows between very open countries and small trade flows between relatively closed countries with small overall trade. We think that it is the economic value of linkages which matters for synchronisation and not their share in countries' overall linkage portfolio.

This measure is equal to zero if countries have an identical sector structure and reaches its maximum of two for completely disjunct sectors.[12] We expect a negative coefficient in our estimation since larger differences in the sector structure between two countries should decrease their degree of synchronisation as they make the transmission of idiosyncratic shocks less likely.

2.3.2 Exogenous Variables and Instruments

Equation (2.1) as well as equations (2.2) to (2.4) include a set of exogenous explanatory variables denoted by $I_{m,ijt}$. While variables in $I_{1,ijt}$ are simply exogenous explanatory variables for our equation of interest, all variables included in $I_{2,ijt}$ to $I_{4,ijt}$ but not in $I_{1,ijt}$ serve as instruments for the identification of the coefficients of endogenous regressors in the synchronisation equation. In the following we describe the set of variables in all $I_{m,ijt}$.

In the synchronisation equation (2.1) we include in $I_{1,ijt}$ bilateral measures comparing monetary and fiscal policy within country pairs. The discrepancy in monetary policy between countries is captured by absolute differences between short term interest rates. This measure is the higher, the higher the discrepancy between monetary policies, whereas for country pairs which are both in the euro area it becomes zero[13]. Coordinated monetary policy may increase synchronisation by enhancing similar reactions to a common shock or being itself the source of a common shock. In a currency union, the stability of the exchange rate may provide an additional indirect positive effect by stimulating trade integration. But in case of idiosyncratic shocks, countries under a common monetary policy may lack the possibility of adjustment to keep cycles moving together. Empirical studies find only weak evidence for similarity in monetary policy as an enhancing factor (see Baxter and Kouparitsas, 2005). Divergence in fiscal policy is measured as bilateral differences in the government budget balance in percentage of GDP following Darvas et al. (2007). From a theoretical point of view, the effect of fiscal policies on synchronisation is ambiguous depending on the type of economic shock and on the type of fiscal policy. On the one hand, discretionary or rule-based fiscal spending may be used to dampen the effects

[12] Note that we calculated SD_{ijt} only for country pairs and years where the database covered at least 50% of the economy wide value added.

[13] Differences in the short term interest rates may be seen as the lower bound of overall differences in monetary policy. The extraordinary country specific measures used by the ECB in the last years show that there may be additional differences even within a currency union, at least during times of crisis. In consequence, the coefficient of monetary policy has to be interpreted as the upper bound.

of country-specific or asymmetric shocks implying a positive impact of fiscal divergence on cyclical comovement. On the other hand, fiscal policy may also be employed in a pro-cyclical way or even be the source of a country-specific shock and therefore loosen comovement. Empirical studies of Darvas et al. (2007) or Inklaar et al. (2008) suggest that a higher discrepancy between fiscal deficits has at best a negative effect on the comovement of business cycles or none as Clark and Van Wincoop (2001) find. Although previous literature (see Inklaar et al., 2008) based on cross-section identification shows that there are no major differences in the results between an exogenous and an endogenous treatment of these policy variables, the assumption of no contemporaneous reaction of policy to cyclical fluctuations does not necessarily hold in a panel model. We therefore consider an alternative specification where we include both policy variables with a lag of one year instead of the contemporaneous variables. For the lagged variables the assumption of exogeneity is justifiable from a theoretical point of view. Furthermore, it is known that business cycles usually react with a lag to changes in fiscal and monetary policy. Qualitatively, there is virtually no difference in the results between including the contemporaneous and the lagged values of the policy variables. At the same time, a noteworthy change in the size of coefficients is observed for FDI integration which results to be about 25% higher in some specifications when lagged policy measures are used.

As instruments for the endogenous regressors (and as covariates for the remaining equations) previous papers employ mainly time-invariant country pair specific variables like the well-established gravity variables for trade or the indicators on the degree of de jure financial openness by La Porta et al. (1998) for financial integration. In our panel estimation approach all time-invariant explanatory factors are absorbed by country pair fixed effects. Therefore, by our research design only time-variant variables are considered as instruments.

Theoretically, an optimal candidate for $I_{2,ijt}$ as an instrument and exogenous explanatory variable for FDI integration would be a de jure measure of openness to FDI. As a change in GDP growth is unlikely to cause a contemporaneous regulatory change, it can be assumed that a bilateral version of a de jure measure of FDI but also trade openness is uncorrelated to the synchronicity measure. The OECD provides an index on FDI Regulatory Restrictiveness, but unfortunately only for a few years.[14] But even more comprehensive data on the legal situation like the indices by Schindler (2009) on direct investment restrictions or the more general Chinn-Ito

[14] The index is provided for the years 1997, 2003, 2006 and on an annual basis since 2010.

index (Chinn and Ito, 2008) measuring the degree of capital account openness are problematic for panel data analyses since their within variation is low for most countries and thus their explanatory power is limited. If we include one of these variables—transformed into a bilateral measure by taking sums or differences—in $I_{2,ijt}$ our regressions return an insignificant effect in the first stage no matter in which estimation specification, while the coefficients of the second stage do not change. Therefore, we do not include any de jure measure of capital or FDI openness in $I_{2,ijt}$. Instead we use indicators for de facto capital controls to explain the degree of bilateral FDI linkages. A better general access to capital in each single country may be an important criterion for direct investment decisions and therefore be favourable to FDI integration. The same holds true for trade integration. Since the following measures are not based on truly bilateral data but are computed by taking differences or sums of indicators for overall capital openness of each of the two countries, it seems reasonable to assume their endogeneity with respect to bilateral FDI integration. We include the bilateral sum of the gross private capital flow ratio to GDP as a volume-based measure of capital openness. As an alternative, we use a price-based measure, namely the return spread between share price indices which are constructed to represent share price movements in national stock markets. According to theory, in perfectly integrated capital markets the law of one price should hold, implying equal returns on comparable assets (Keil and Sachs, 2012). Smaller return spreads indicating a higher degree of financial market integration are therefore expected to foster FDI integration. Additionally, we include lagged FDI integration as suggested by Schiavo (2008) and a measure of overall economic development of a country pair given by the bilateral sum of GDP per capita.

In explaining trade integration with panel data we can build on an established literature. We follow Egger (2000) in including the following index measuring the similarity in the economic size of countries in $I_{3,ijt}$:

$$GDPsimilar_{ijt} = 1 - \left(\frac{GDP_{it}}{GDP_{it} + GDP_{jt}}\right)^2 - \left(\frac{GDP_{jt}}{GDP_{it} + GDP_{jt}}\right)^2. \qquad (2.10)$$

This index is the larger, the more similar two countries are in terms of GDP. Very similar countries are supposed to have a high degree of intra-industry trade and therefore also of general trade linkages. Furthermore, $I_{3,ijt}$ contains the same measure of overall economic development like $I_{2,ijt}$. Additionally, we include an index on the

degree of bilateral (de jure) economic integration which is taken from the *Database on Economic Integration Agreements* by Baier and Bergstrand (2007), but which is only available until 2005.

Differences in the sector structure are explained by overall economic development (like trade and FDI linkages) and by differences in economic development/wealth between countries measured by the absolute difference in GDP per capita. These two measures both draw on the idea that economies manifest certain patterns regarding the industrial composition in different states of development (Imbs and Wacziarg, 2003). This argument may be less appropriate the more similar countries are with respect to their sectoral structure and stage of development.

For most of the described instruments it is not possible to completely exclude a correlation with our measure of bilateral cyclical comovement between countries by theory. Therefore, we test the validity of instruments by means of Hansen's J test, i.e., testing the validity of overidentifying restrictions. In contrast to the Sargan test, this test is consistent in the presence of heteroscedasticity. Note that for panel random effect estimators Hansen's J test can even be applied if there is only one instrument for each endogenous determinant. When applying the EC2SLS estimator, the exogenous regressors (in our case the indicators for monetary and fiscal policy as well as all year dummies) are subject to a GLS transformation before the estimation. In the IV estimation (on the transformed data) the transformed regressors are all treated as endogenous while for each of them their demeaned and re-centered transformation as well as their group mean transformation are used as excluded instruments. In contrast, for a fixed effects 2SLS estimator, where such a transformation is not used, the test is not applicable in this case since the equation is just identified. In addition, we control the first stage F-statistics to prevent using a weak instrument set.

2.3.3 Data Overview

Since the emphasis of our identification approach lies on the within variation in the data, we choose the longest possible sample at the expense of a reduction of the number of country pairs. After the exclusion of South Korea because of its strongly differing synchronisation patterns, there are 16 countries left yielding 120 country pairs.[15] Due to the limitations in time range given by the OECD's bilateral FDI data

[15] These countries are: Austria, Canada, Denmark, Finland, France, Germany, Greece, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden, UK, US.

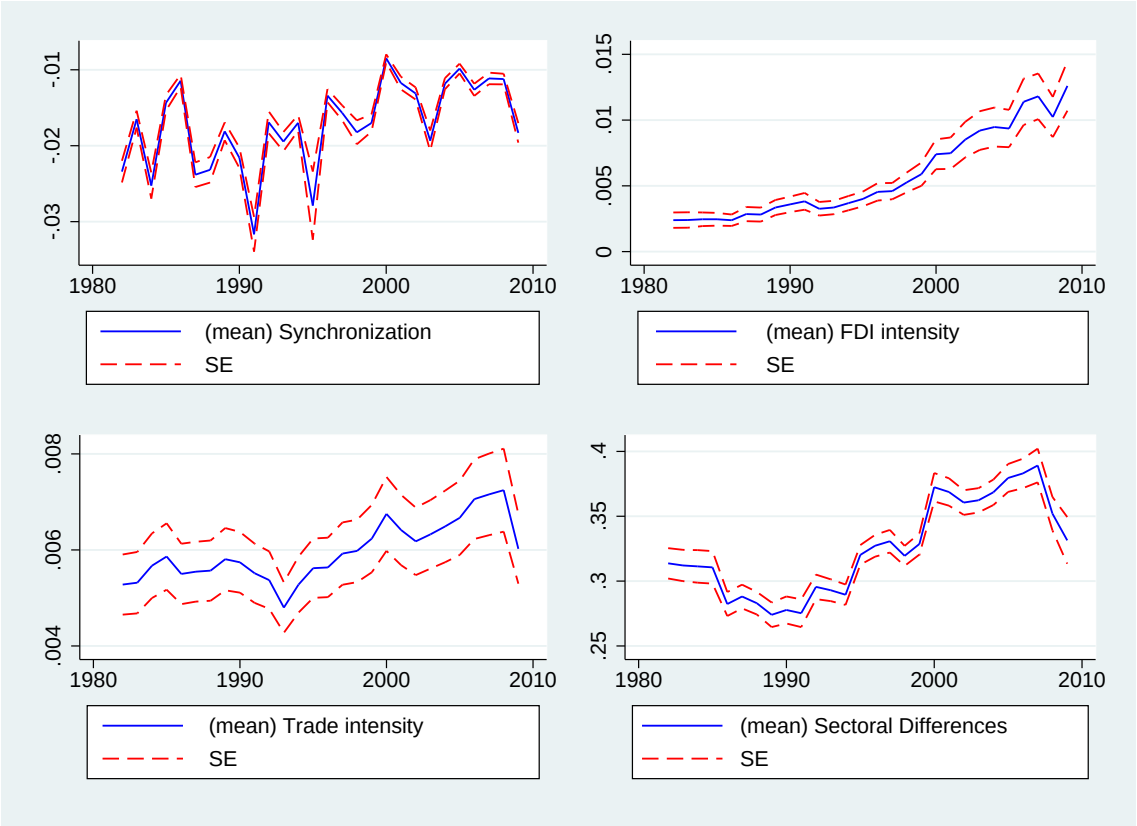


Fig. 2.1. Cross-Sectional Means of Business Cycle Synchronisation and its Endogenous Determinants

and the *OECD STAN* database used to calculate sectoral differences, we obtain a usable data set for the period from 1982 to 2009 at an annual frequency. The panel is unbalanced, however, with an increasing number of observations for more recent years. Descriptive statistics for all variables are included in the Appendix A.1 in Table A.1.

In Figure 2.1 we plot cross-section averages for each point in time of our synchronisation measure and the three endogenous determinants. The plots reveal that all variables but synchronisation exhibit significant changes in levels over time, casting the meaningfulness of long-term averages into doubt as they vary with the underlying period.

2.4 Results

In this section, we briefly report what a cross-section approach would imply for our data set before we present detailed estimation results for the panel dimension.

With respect to the instrumentation, we start with a parsimonious specification where we include one (time-variant) instrument for each endogenous variable. These instruments are the volume-based measure of capital openness, economic similarity and overall economic development.[16] In the following, we discuss and test the choice of instruments by employing the other available instruments discussed before.

2.4.1 Cross-Section

Before conducting panel estimates, we confront our data basis with the cross-section based literature. We do this by estimating the synchronisation equation with cross-section data obtained by averaging the data over time.[17] To make the comparison more appropriate, we additionally include a set of time-invariant exogenous variables. Our identification approach based on time-variant instruments presented in Section 2.3.2 cannot correctly identify effects in the cross-section where fixed effects cannot be taken into account. In such a setting, we obtain low F-statistics for FDI and trade integration in the first stage pointing to weak instruments. Including some time-invariant variables serves to at least partially control for country pair specific characteristics. We use standard gravity variables, namely the distance between the main economic centers and dummy variables for common borders from CEPII's *GRAVITY* dataset[18], as well as the bilateral sum of an index measuring share holder rights provided by La Porta et al. (1998). These additional variables remedy the weak instruments problem in the cross-section raising the F-statistics of first step estimations well above the rule of thumb value of 10. In addition, Hansen's J test does not report problems with the validity of the instruments. Estimations are carried out based on pooled data over the entire period from 1982 to 2009 as well as over the subperiods 1982-1998 and 1999-2009, that is before and after the introduction of the euro.

We find that coefficients—especially those of trade and FDI intensity—vary strongly with the underlying sample period. The shift in the coefficients over time does not necessarily have to be a signal for a change in the strength of the underlying relation between FDI or trade linkages and synchronisation but may simply be

[16] Note, however, that the instruments are not assigned one by one to the single determinants by means of the estimator, but are all together used in each first-stage regression of the endogenous.

[17] This is the common procedure in the cross-section literature for all time-variant variables. Bilateral synchronisation, however, is usually calculated as the Pearson correlation coefficient between business cycles of two countries.

[18] http://www.cepii.fr/CEPII/en/bdd_modele/bdd.asp

driven by the calculation of means over time series containing trends. In addition, multicollinearity between FDI and trade may be a big concern in the cross-section as we will show in detail in the next section. Thus, we refrain from further interpreting the results which are reported in Table A.2 in Appendix A.2.

2.4.2 Panel Approach

In this section we discuss the results of estimating equation (2.1), employing the error component two-stage least squares (EC2SLS) estimator on panel data. All panel estimations include country-pair specific effects and a full set of year dummies if not stated differently. Hence, they focus on the transmission channels of idiosyncratic business cycle shocks.

Basic Specification with Parsimonious Instrument Set

The results of our basic specification with the parsimonious (time-variant) instrument set as described above are reported in Table 2.1 column (1). The estimation points to a significant positive influence of FDI integration implying that the synchronising effect dominates among the various cross-boarder linkages in multinational firms. We do not find a significant impact of trade relations on the comovement of business cycles. As we will show in the following, the coefficient of trade integration is insignificant not only in our basic specification but also in all alternative specifications. Differences in the sectoral structure in turn have a negative significant effect on cyclical comovement implying that the transmission of idiosyncratic shocks between countries is the weaker, the bigger the differences in their sectoral structure. Therefore, FDI and trade possibly exert an indirect influence on business cycle synchronisation by causing changes in the sectoral composition of economies. Differences in monetary policy are estimated to have a negative impact on the cyclical comovement of a country pair implying higher synchronisation in countries with similar short term interest rates. In contrast, differences in the net lending position of governments have a positive effect. This result may arise from the fact that governments incur debts when trying to buffer their country from idiosyncratic shocks.

To validate our identification approach, we first checked the F-statistics of the EC2SLS (and FE2SLS) first stage regressions. These signal no problems of weak instrumentation for any of the endogenous covariates being all two-digit. In addition,

Table 2.1. Business Cycle Synchronisation: EC2SLS with Varying Instruments

	(1)	(2)	(3)	(4)	(5)
Instrumentation	Parsim.	Econ. Diff.	Return Spread	EIA	L.FDI
Period	1982-2009	1982-2009	1982-2009	1988-2005	1983-2009
FDI	0.249	0.269	0.285	0.489	-0.011
	(0.124)**	(0.134)**	(0.123)**	(0.168)***	(0.059)
Trade	-0.157	-0.172	-0.194	-0.204	0.069
	(0.198)	(0.218)	(0.192)	(0.226)	(0.160)
Sectoral Differences	-0.039	-0.037	-0.038	-0.032	-0.040
	(0.009)***	(0.009)***	(0.008)***	(0.009)***	(0.009)***
Monetary Policy	-0.097	-0.095	-0.096	-0.093	-0.083
	(0.024)***	(0.024)***	(0.024)***	(0.026)***	(0.024)***
Fiscal Policy	0.064	0.063	0.064	0.059	0.054
	(0.012)***	(0.012)***	(0.012)***	(0.015)***	(0.012)***
Year Dummies	Yes	Yes	Yes	Yes	Yes
N	1,793	1,793	1,791	1,447	1,750
Hansen's J Test					
χ^2 (d.f.)	19.98 (25)	17.39 (27)	29.59 (27)	26.21 (21)	21.26 (28)
p-value	0.748	0.921	0.333	0.198	0.814

Notes: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

we find F-statistics from FE2SLS to be higher than the single-digit F-statistics of first stage between regressions emphasising that country pair specific effects should not be neglected (see Baltagi, 2008). Second, we test the exogeneity of instruments by means of Hansen's J test which is reported in the lower part of Table 2.1. The degree of freedom of the χ^2 distribution is given by the number of exogenous time-varying variables after the transformation. The result of Hansen's J test on the EC2SLS estimations confirms the validity of our parsimonious instrumentation.

Alternative Instrumentation

In order to test the dependence of our results on the instrumentation, we add the alternative instruments discussed in Subsection 2.3.2 one-by-one to the parsimonious instrument set. In Table 2.1 we report the estimation results as well as the test statistics of Hansen's J Test. We add in turn the measures of differences in economic development (column 2), differences in return spreads (column 3) and the indicator on Economic Integration Agreements (EIA) (column 4) and finally lagged FDI in-

tensity (column 5) to the instrument set.[19] The changes in the instrumentation do not come with significant changes in the results reported for the parsimonious specification except for the FDI coefficient when including EIA or lagged values of FDI. In the first case, the impact of FDI is bigger, which is due to the data limitations of the EIA indicator. As mentioned in Subsection 2.3.2, it stops in 2005 so that the crisis-driven years since 2007 are excluded from the sample. The recent global crisis has provoked a particularly sharp plunge in FDI stocks among industrialised countries (see Figure 2.1 and 1.1) which might be the reason behind the higher coefficients in the shorter sample. When we estimate the parsimonious specification excluding the years from 2007 onwards from the sample, we also obtain a higher coefficient for FDI (0.397) at a 1% significance level but no remarkable changes regarding the other variables (not reported). Including lagged FDI integration as an instrument yields an insignificant effect of FDI integration on business cycle synchronisation.

Relation of FDI and Trade

A potential reason for the insignificant effects of trade integration could be its multicollinearity with FDI. Indeed, in the cross-section we observe an unconditional correlation as high as 0.71 between the two variables, which makes cross-section based estimations including trade and FDI even more questionable. In the panel data the unconditional correlation still amounts to 0.65, but drops to 0.44 when we take country-pair fixed effects into account and to 0.37 when, additionally, year specific effects are included. Considering the correlation between country pairs and within country pairs separately, it emerges that the high correlation is mainly driven by strong relations between trade and FDI across country pairs, but not over time. The correlation between country pairs amounts to 0.69 averaged over all years, whereas the correlation over time adds up to just 0.31 averaged over all country pairs (a detailed statistic on between and within correlation is included in Appendix A.2, Figure A.1 and A.2). This said, multicollinearity seems to be more of an issue when we look at shorter samples or at the cross-section.

As a further test of the importance of multicollinearity for our estimation results, we compute estimations excluding in turn trade and FDI. To stick with our instrumentation approach we drop GDP similarity and global capital openness, respectively, from the instrument set in this step. But very similar results are obtained

[19] In addition, we tried various combinations of bigger instrument sets, but in most of the cases Hansen's J test rejected these bigger instrument sets.

Table 2.2. Business Cycle Synchronisation: EC2SLS Excluding Trade/FDI and Restricted Country-Pair Samples

	(1)	(2)	(3)	(4)	(5)
Country Group	OECD	OECD	OECD	EU	EMU
Period	1982-2009	1982-2009	1988-2009	1988-2009	1988-2009
FDI	0.186		0.249	0.183	0.169
	(0.088)**		(0.115)**	(0.182)	(0.321)
Trade		0.160	-0.137	-0.169	0.116
		(0.128)	(0.183)	(0.267)	(0.435)
Sectoral Differences	-0.037	-0.035	-0.040	-0.050	-0.053
	(0.009)***	(0.009)***	(0.008)***	(0.022)**	(0.027)*
Monetary Policy	-0.089	-0.058	-0.101	-0.172	-0.236
	(0.023)***	(0.023)**	(0.024)***	(0.036)***	(0.055)***
Fiscal Policy	0.063	0.055	0.063	0.089	0.085
	(0.012)***	(0.012)***	(0.012)***	(0.022)***	(0.034)**
Year Dummies	Yes	Yes	Yes	Yes	Yes
N	1,793	1,802	1,763	1,014	574
Hansen's J Test					
χ^2 (d.f.)	18.65 (24)	24.5 (24)	21.14 (23)	14.52 (19)	9.30 (15)
p-value	0.770	0.433	0.573	0.753	0.861

Notes: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

when keeping all instruments from the parsimonious specification. In the first case, we obtain a somewhat smaller but significant coefficient for FDI linkages in the synchronisation equation leaving the remaining results qualitatively unchanged (see Table 2.2, column 1). Excluding FDI instead leads to greater changes: the trade coefficient becomes positive but remains insignificant. If we restrain the sample to more recent years, though, the coefficient becomes significant but results are more sensible to the choice of instruments. These results imply that trade effects are not completely irrelevant for the synchronisation of business cycles. But the impact of trade may be more of the indirect type, i.e., by fostering stronger FDI linkages and influencing the degree of sectoral differences between economies. Taking FDI out of the system eliminates the first of these indirect channels and results in a weak direct impact of trade.

Synchronisation in the EU and EMU

We also investigate whether our conclusions from the entire sample, which is based on OECD countries, hold for the European environment. Therefore, we re-estimate

the equation for two smaller country samples, the first limited to country pairs in the European Union (EU) and the second including only relations between euro area members (EMU). Since before 1988 there is no bilateral inner European data available for some of the variables, we report the results for this shorter time frame for all country groups. Estimated coefficients are presented in Table 2.2 column (3)-(5). They imply very similar results for synchronisation in the EU and the EMU. In contrast to the OECD sample, the impact of FDI is insignificant. Thus, it seems that positive and negative effects of inner European FDI linkages on business cycle synchronisation between member countries cancel out on aggregate. So increasing intensity of FDI neither fosters nor harms convergence of business cycles between European countries.

Since monetary policy in the euro area is uniform after the introduction of the single currency, we re-estimate equation (2.1) without including differences in monetary policy as exogenous explanatory variable. The estimated coefficients change only marginally compared to the baseline specification, therefore we refrain from reporting them for the sake of space.

Subperiods

In contrast to the cross-section, estimates of the baseline specification for the recent period from 1999 to 2009 do not strongly differ from the overall sample (see Table 2.3). In essence, differences in monetary policy are not significant in this subsample, which is not surprising given that 9 out of our 16 countries are subject to the single interest rate of the EMU. In the period before the introduction of the euro we find an insignificant coefficient for fiscal policy and for FDI integration. That FDI linkages have no impact on business cycle synchronisation in the earlier period, fits the data (see Figure 2.1), according to which bilateral FDI relations start to intensify around the mid-nineties. It also goes with the cross-section evidence by Jansen and Stokman (2011) and Keil and Sachs (2012) discussed in Section 2.1. Finally, as described above, the financial crisis had its impact on the strength of the synchronisation effect exerted by FDI integration: the inclusion of the period after 2007 abates the coefficient our FDI intensity measure. Since year-specific effects are already taken into account, this may indicate a more profound change in the relevance of FDI linkages for synchronisation at the current edge. With respect to trade we do not find a significant impact for any subsample. Note, however, that the results based on relatively short samples should be interpreted with care since

Table 2.3. Business Cycle Synchronisation: EC2SLS Parsimonious Specification for Subperiods

	(1)	(2)	(3)
Period	1982-2009	1982-1998	1999-2009
FDI	0.249	0.585	0.199
	(0.124)**	(0.404)	(0.089)**
Trade	-0.157	-0.052	-0.050
	(0.198)	(0.344)	(0.152)
Sectoral Differences	-0.039	-0.053	-0.017
	(0.009)***	(0.013)***	(0.007)**
Monetary Policy	-0.097	-0.137	0.008
	(0.024)***	(0.034)***	(0.029)
Fiscal Policy	0.064	0.021	0.036
	(0.012)***	(0.024)	(0.012)***
Year Dummies	Yes	Yes	Yes
N	1,793	681	1,112
Hansen's J Test			
χ^2 (d.f.)	19.98 (25)	21.19 (16)	15.97 (13)
p-value	.748	.172	.255

Notes: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

multicollinearity of trade and FDI integration could influence the results in these shorter samples as mentioned above.

2.4.3 Sensitivity

To test the sensitivity of our results, we estimate several variations of our basic specification.

Alternative Measures of FDI and Trade Linkages

In a first step, we use alternative measures for FDI and trade intensity which take into account the asymmetry between countries. In case a country pair consists of countries which differ strongly with respect to their economic size, our trade and FDI integration measures may understate the importance of linkages for the small country. Therefore, we repeat our estimations employing a measure where bilateral trade and FDI linkages are scaled by the GDP of the smaller country as proposed by Otto et al. (2001):

Table 2.4. Business Cycle Synchronisation: Sensitivity with Alternative Measures

	(1)	(2)	(3)	(4)	(5)
Sync. measure based on	Δ GDP	Δ GDP	HP-filtered GDP	Residual Δ GDP	Relative Δ GDP
FDI Alternative	0.035				
	(0.018)*				
FDI		0.249	0.139	0.194	12.936
		(0.124)**	(0.113)	(0.136)	(6.248)**
Trade Alternative	-0.029				
	(0.025)				
Trade		-0.157	0.198	-0.012	-9.744
		(0.198)	(0.179)	(0.218)	(10.188)
Sectoral Differences	-0.041	-0.039	-0.049	-0.032	-1.456
	(0.008)***	(0.009)***	(0.008)***	(0.009)***	(0.436)***
Monetary Policy	-0.099	-0.097	0.017	-0.147	-1.820
	(0.022)***	(0.024)***	(0.022)	(0.025)***	(1.039)*
Fiscal Policy	0.061	0.064	0.042	0.056	3.053
	(0.012)***	(0.012)***	(0.011)***	(0.013)***	(0.531)***
Year Dummies	Yes	Yes	Yes	Yes	Yes
N	1,793	1,793	1,793	1,793	1,793
Hansen's J Test					
χ^2 (d.f.)	28.21 (25)	19.98 (25)	73.88 (25)	32.15 (25)	19.6 (25)
p-value	0.298	0.748	0.000	0.154	0.768

Notes: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

$$T_{ijt}^{alt.} = \max\left(\frac{EX_{ijt} + IM_{ijt}}{GDP_{it}}, \frac{EX_{ijt} + IM_{ijt}}{GDP_{jt}}\right) \tag{2.11}$$

$$FDI_{ijt}^{alt.} = \max\left(\frac{Out_{ijt} + In_{ijt}}{GDP_{it}}, \frac{Out_{ijt} + In_{ijt}}{GDP_{jt}}\right). \tag{2.12}$$

Results, displayed in Table 2.4 column (1), are very similar to those in Table 2.1. The main difference lies in lower coefficients for FDI and trade integration, which is natural as the alternative measures are by definition bigger than the measures employed before. FDI linkages have a significant impact, even though significance drops to the 10% level. The coefficient of trade remains insignificant for the alternative measure.

Alternative Measures of Synchronisation

Furthermore, we conduct estimations with alternative synchronisation measures. First, we use our synchronisation measure based on the business cycle computed as HP-filtered output instead of year-on-year growth rates of output. We test this measure as it is the most common measure of the output gap in literature. However, the HP filter implies that this alternative synchronisation measure is smoother and exhibits a high degree of autocorrelation which may be problematic in a static panel approach.

Second, we adopt a measure proposed by Morgan et al. (2004), which is computed in two steps: first, we recover the residuals from of a regression of real GDP growth on country-pair and year specific fixed effects:

$$\Delta Y_{it} = \mu_i + \lambda_t + \varepsilon_{it}. \tag{2.13}$$

Simply speaking, this residual GDP growth captures for a given year a country's deviation from its own long-run GDP growth and from the cross-section average growth rate in that specific year. The alternative synchronisation measure is then constructed in a similar fashion as the basic measure by taking the negative absolute difference between residual GDP growth, i.e.,

$$\rho_{ijt}^{resid.} = -|\varepsilon_{it} - \varepsilon_{jt}|. \tag{2.14}$$

In contrast to our basic measure, this proxy is corrected for changes in the amplitude of fluctuations. Finally, we employ a measure proposed by Mink et al. (2007), which scales our original measure by the size of the average GDP growth rate in the sample and can be expressed as follows:

$$\rho_{ijt}^{relative} = -\frac{|\Delta Y_{it} - \Delta Y_{jt}|}{\frac{1}{n}\sum_{i=1}^{n} |\Delta Y_{it}|}. \tag{2.15}$$

In Table 2.4 we compare the estimated coefficients for these different measurement concepts with column (2) which repeats the result for our standard synchronisation measure. We find that for the latter measure results barely change in qualitative terms (column 5). Quantitatively, the coefficients are all much higher as the relative comovement measure has a much bigger value range (see descriptives in Table A.1 in

Appendix A.1). Using the synchronisation measure based on residual GDP growth, FDI is insignificant in the parsimonious specification but significant for several other instrumentations (not shown), whereas the remaining results persist (see column 4). When the HP-filtered measure is used in column (3), in addition to FDI, monetary policy looses its significance. But the instrumentation seems problematic when the dependent variable is based on HP-filtered GDP. There is no sign of weak instruments, but Hansen's J Test rejects the exogeneity of our parsimonious instrument set as well as of alternative instrumentation. Additionally, autocorrelation coefficients for the residuals strongly exceed those of our original measure of comovement.

Alternative Error Structure

In our basic specification, contemporaneous correlation of the errors across panel individuals arising, e.g. by common shocks hitting the country-pairs, are modelled by common time effects in the error term. To check the robustness of the reported results with respect to this choice, we follow an alternative approach proposed by Pesaran (2006) and include cross-sectional averages of the endogenous variables instead of year dummies in the estimation equations. The cross-sectional averages provide a solution to soak up cross-sectional correlation. The idea of this approach is to model the residuals of the panel equation as being composed of two orthogonal components. The first component comprises common factors that soak up the cross-sectional comovement in the data whereas the second component captures mainly idiosyncratic variable-specific movements. Following Pesaran (2006), we estimate the common factors consistently by cross-sectional averages of the country-specific variables (synchronisation, FDI, trade and sectoral differences) and their lagged values. In general, results are qualitatively very similar to those reported in Table 2.1 with year dummies, the only exception being the parsimonious specification with a negative trade coefficient which is significant at the 10% level (see Appendix A.2 Table A.3). But Hansen's J test rejects the validity of instruments for this specification pointing to inconsistent estimates. Quantitative changes occurred in the FDI coefficient which is about 20% higher in all specification when cross-sectional averages are included.

Estimation in Log-like Transformation

We estimate our model not only in levels but also in a log-like transformation following Levy Yeyati et al. (2007) which for a variable x can be written as[20]

$$loglike(x) = sign(x) * ln(1 + abs(x)).$$

We test this specification as many studies refer to models in logs, even though Kose and Yi (2006) make a strong point for an estimation in levels. Results produced by estimating the transformed system do not differ significantly from the ones of the basic specification and are not reported.

2.5 Conclusion

We readdressed the determinants of business cycle synchronisation in this chapter to test, on the one hand, whether FDI promoting policies may have consequences for the business cycle comovement between countries, and on the other hand, whether more plausible identification strategies change previous results. Understanding the determinants of synchronisation is of great political relevance, since a considerable degree of cyclical comovement is important for the efficiency of a common monetary policy in a currency union. Our results suggest that linkages through foreign direct investment contribute in most cases positively to the synchronisation between country pairs. This implies that policies to attract more FDI from abroad go, in general, hand in hand with an increased similarity of business cycles with these international partners. In the specific case of bilateral synchronisation between EMU members, we do not identify a positive significant effect for the long sample but also no negative one. Thus, our results suggest no conflict of goals between policies to promote FDI and the necessary synchronisation of business cycles in the EMU. In contrast, the beneficial effects of trade integration for the similarity of business cycles are less robust and thus less important for the transmission of idiosyncratic shocks between countries than previously thought. One explanation for this result is, that trade moves together with business cycle synchronisation because of common shocks. Finally, we find that larger differences in the sector structure between two economies result in a bigger gap between their business cycles.

[20] This more complicated transformation is necessary, since FDI positions and in consequence our measure for bilateral FDI intensity can be negative and are therefore not compatible with a simple logarithmic transformation.

3

The German Labour Market Reforms in a European Context: A DSGE Analysis[1]

The preceding chapter empirically analysed the importance of the channels through which spillover effects of idiosyncratic shocks between countries occur. The present and the next chapter, in contrast, investigate how labour market reforms in one country spill over to other countries. They thereby build on a model framework which contains transmission channels standard in the DSGE literature: the terms of trade channel through international trade in intermediate goods and the short-term reallocation through an international bond market. Using this framework, in the present chapter the macroeconomic consequences of the controversially debated German labour market reforms on the national and international level are evaluated.

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. The main components of the reforms consisted in measures to increase the efficiency of matching the unemployed with vacancies in firms and a significant decline in the unemployment benefit ratio. Over the period from 2003 to 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

[1] This chapter is based on joint work with Dr. Atılım Seymen. It is a slightly revised version of ZEW Discussion Paper No. 13-097 (see Busl and Seymen, 2013). An earlier version is WWWforEurope Working Paper no 8.

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 caused wage restraint and consequently consumption dampening in Germany and induced thereby beggar-thy-neighbour effects. The following sections analyse by means of a two-country DSGE model with labour market frictions to what extent the Hartz reforms contributed to the aforementioned developments in the German macroeconomic data. The scope is to assess whether the Hartz reforms are to be blamed for wage restraint and consumption dampening in Germany or whether there must have been other factors at stake.

The rest of the chapter is organised as follows. The literature on the effects of labour market reforms/institutions and the relation of our study to that literature is discussed in the next section. Section 3.2 presents the model in detail. The quantitative results as well as their sensitivity are the subject of Section 3.3. 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 3.3 closes with a discussion of further factors that could—at least partially—have contributed to the trends in the German data. Section 3.4 concludes.

3.1 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.[2] 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.[3] The estimates of Fahr and Sunde (2009), that

[2] 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) uses a similar figure to ours.

[3] 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 particular, the public employment services were modernised in terms of their organisational 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.

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 (2013). 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 broader menu of unemployment benefits. The model of Launov and Wälde (2013) 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 studies 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 Ger-

many, Krebs and Scheffel (2013) 14% and Launov and Wälde (2013) merely 2.8%.[4] 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 unemployment 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

[4] 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 (2013) from 10.5% to 10.2%.

the issue pertaining to the Hartz reforms up to now, several studies deal with the international effects of reforms in labour market institutions as has already been set out in Chapter 1. To sum up the results of these studies, the spillover effects of labour market reforms to employment 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 et al. (2013) refer only to long-run effects. Although few studies such as Dao (2013a), Dao (2013b) and Gomes et al. (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.

3.2 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 et al. (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 complete equation system of the model is provided in Appendix B.1.

3.2.1 Households

Each country is inhabited by an infinitely living mass of agents normalised to unity. Agents maximise 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 maximises its expected life-time utility

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[N_{1t} U(C_{1t}^n, h_{1t}) + (1 - N_{1t}) U(C_{1t}^u) \right], \tag{3.1}$$

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 normalised 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 can be written as

$$U(C_{1t}^n, h_{1t}) = log\,(C_{1t}^n) + \kappa_1^n \frac{(1 - h_{1t})^{1-\xi}}{1 - \xi} \tag{3.2}$$

$$U(C_{1t}^u) = log\,(C_{1t}^u) + \kappa_1^u \tag{3.3}$$

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 $\xi > 0$.

When agents are employed, they receive an income $w_{1t}h_{1t}$ from employment, w_{1t} being the hourly wage rate in terms of the locally produced good, subject to an employees' labour tax τ_1^d. Otherwise, they are eligible for a fixed level of unemployment benefits b_1 evaluated in units of the consumption good. 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}. As owners of the domestic intermediate good firms, households are entitled to the profits Π_{1t} accruing from the domestic firms. 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

$$CA_{1t} = \frac{\Phi_b}{2}\left(\frac{B_{1t+1}}{P_{1t}^c}\right)^2 \tag{3.4}$$

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.[5]

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

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

$$(1+\tau_1^c)\,P_{1t}^c\,[N_{1t}C_{1t}^n+(1-N_{1t})\,C_{1t}^u]+B_{1t+1}+P_{1t}^cCA_{1t}=$$
$$=P_{1t}N_{1t}h_{1t}w_{1t}\left(1-\tau_1^d\right)+(1-N_{1t})\,P_{1t}^cb_1+B_{1t}\,(1+i_t)+T_{1t}+\Pi_{1t} \quad (3.5)$$

with P_{1t}^c being the consumer price index at home. P_{1t} represents the price of the domestic intermediate. Note that we choose the intermediate good of country 1 to be our numéraire and fix its price P_{1t} to unity. The households' optimisation decision problem is summarised by the Bellman equation

$$F_{1t}^H=\max_{C_{1t}^n,C_{1t}^u,B_{1t+1}}\left[N_{1t}U(C_{1t}^n,h_{1t})+(1-N_{1t})U(C_{1t}^u)+\beta E_t\left(F_{1t+1}^H\right)\right] \quad (3.6)$$

which is subject to the budget constraint (3.5) and the law of motion of aggregate employment N_{1t}

$$N_{1t+1}=(1-s_1)\,N_{1t}+\phi_{1t}(1-N_{1t}). \quad (3.7)$$

In this equation, s_1 is the constant job separation rate for employed workers which is exogenously given[6] 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 normalise 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 optimisation 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 (3.5) and derive the first order conditions of the representative agent's optimisation problem (3.6) as follows. With respect to consumption we obtain

$$\frac{1}{C_{1t}^n}=\frac{1}{C_{1t}^u}=(1+\tau_1^c)\,\lambda_{1t}P_{1t}^c. \quad (3.8)$$

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 $C_{1t}^c=C_{1t}^n=C_{1t}^u$ in the following. Regarding the bond holdings, the optimality condition is given by

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

$$\lambda_{1t}\left(1+\Phi_b\frac{B_{1t+1}}{P^c_{1t}}\right)=\beta E_t\left[\lambda_{1t+1}\left(1+i_{t+1}\right)\right]. \tag{3.9}$$

3.2.2 Final Good Sector

In each country there is a competitive final good sector, which produces a non-tradable final good D^c_{1t} used for consumption and investment. The quantity of final goods in country 1 produced by assembling tradeable intermediate goods according to the standard Armington aggregator is given by

$$D^c_{1t}=\left[\kappa^{\frac{1}{\eta}}y_{11t}^{\frac{\eta-1}{\eta}}+(1-\kappa)^{\frac{1}{\eta}}y_{21t}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}, \tag{3.10}$$

where y_{jit} denotes the quantity of intermediate input in the final good production of country $i=1,2$ stemming from country $j=1,2$. $0<\kappa<1$ represents the preference for domestic goods in domestic spending, the so called home bias and $1-\kappa$ is the preference of consumers for products from the other country. $\eta>0$ is the elasticity of substitution between intermediate goods.

Final good producers maximise their profits given by $P^c_{1t}D^c_{1t}-P_{1t}y_{11t}-P_{2t}y_{21t}$. The resulting demand functions for the intermediate goods used in country 1 read

$$y_{11t}=\kappa\left(\frac{P^c_{1t}}{P_{1t}}\right)^{\eta}D^c_{1t} \tag{3.11}$$

$$y_{21t}=(1-\kappa)\left(\frac{P^c_{1t}}{P_{2t}}\right)^{\eta}D^c_{1t}, \tag{3.12}$$

where P^c_{1t}/P_{1t} represents the price of the final good in country 1 in terms of the intermediate good produced in the same country. We define the terms of trade of the foreign country as the relation of its import to export prices, i.e. $TOT_t=\frac{P_{2t}}{P_{1t}}=P_{2t}$; then we can relate the consumer price index P^c_{1t} of country 1 to the terms of trade by combining the intermediate good demand functions with equation (3.10):

$$P^c_{1t}=\left[\kappa+(1-\kappa)\left(TOT_t\right)^{\eta-1}\right]^{\frac{1}{1-\eta}}. \tag{3.13}$$

3.2.3 Intermediate Good Sector

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

$$Y_{1t} = A_1 K_{1t}^{\alpha} \left(N_{1t} h_{1t}\right)^{1-\alpha}, \tag{3.14}$$

where $0 < 1 - \alpha < 1$ is the labour share of income. In addition, the output level depends on the level of 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

$$N_{1t+1} = \left(1 - s_1\right) N_{1t} + q_{1t} V_{1t}. \tag{3.15}$$

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

$$K_{1t+1} = \left(1 - \delta\right) K_{1t} + I_{1t}^c, \tag{3.16}$$

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

$$CI_{1t} = \frac{\Phi_I}{2} \frac{\left(K_{1t+1} - K_{1t}\right)^2}{K_{1t}}, \tag{3.17}$$

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

Firms maximise their profits Π_{1t} given by

$$\Pi_{1t} = P_{1t} Y_{1t} - P_{1t} N_{1t} h_{1t} w_{1t} \left(1 + \tau_1^f\right) - \omega_1 P_{1t}^c V_{1t} - P_{1t}^c I_{1t}^c - P_{1t}^c CI_{1t}. \tag{3.18}$$

Their optimisation problem can be summarised as

$$F_{1t}^F = \max_{K_{1t}, N_{1t}} \left[\Pi_{1t} + \beta E_t \left(\frac{\lambda_{1t+1}}{\lambda_{1t}} F_{1t+1}^F \right) \right], \tag{3.19}$$

subject to the production technology (3.14), and the law of motion of capital (3.16) and aggregate employment (3.15). Firms' future profit flows are weighted by the ratio of the future to the present Lagrange multiplier $\lambda_{1t+1}/\lambda_{1t}$ of households' 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

$$q_{1t}^T = \beta E_t \left[\frac{P_{1t+1}^c \lambda_{1t+1}}{P_{1t}^c \lambda_{1t}} \left\{ \frac{P_{1t+1}}{P_{1t+1}^c} \alpha \frac{Y_{1t+1}}{K_{1t+1}} + q_{1t+1}^T - \delta + \frac{\Phi_I}{2} \left(\frac{I_{1t+1}^c - \delta K_{1t+1}}{K_{1t+1}} \right)^2 \right\} \right] \tag{3.20}$$

and

$$\frac{\omega_1}{q_{1t}} = \beta E_t \left[\frac{P_{1t+1}^c \lambda_{1t+1}}{P_{1t}^c \lambda_{1t}} \left\{ z_{1t+1} - \frac{P_{1t+1}}{P_{1t+1}^c} h_{1t+1} w_{1t+1} \left(1 + \tau_1^f \right) + (1 - s_1) \frac{\omega_1}{q_{1t+1}} \right\} \right], \tag{3.21}$$

where the shadow price of capital is labelled q_{1t}^T and given by

$$q_{1t}^T = 1 + \Phi_I \frac{I_{1t}^c - \delta K_{1t}}{K_{1t}}$$

and z_{1t} is defined as

$$z_{1t} = \frac{P_{1t}}{P_{1t}^c} (1 - \alpha) \frac{Y_{1t}}{N_{1t}}.$$

3.2.4 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):

$$H_{1t} = \chi_1 V_{1t}^{\psi} (1 - N_{1t})^{1-\psi}, \tag{3.22}$$

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 maximising the weighted marginal value of an additional employed in terms of utility for firms and households:

$$\underset{w_{1t},h_{1t}}{max}\left(\lambda_{1t}\frac{\partial F_{1t}^{F}}{\partial N_{1t}}\right)^{\epsilon}\left(\frac{\partial F_{1t}^{H}}{\partial N_{1t}}\right)^{1-\epsilon}, \tag{3.23}$$

where $0<\epsilon<1$ measures the bargaining power of the firm. For the household the marginal value of a match is given by

$$\frac{\partial F_{1t}^{H}}{\partial N_{1t}}=\kappa_1^u-\kappa_1^n\frac{(1-h_{1t})^{1-\xi}}{1-\xi}+\lambda_{1t}(P_{1t}h_{1t}w_{1t}(1-\tau_1^d)-P_{1t}^c b_1)+(1-s_1-\phi_{1t})\beta E_t\left[\frac{\partial F_{1t+1}^{H}}{\partial N_{1t+1}}\right]. \tag{3.24}$$

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

$$\frac{\partial F_{1t}^{F}}{\partial N_{1t}}=P_{1t}(1-\alpha)\frac{Y_{1t}}{N_{1t}h_{1t}}h_{1t}-P_{1t}h_{1t}w_{1t}(1+\tau_1^f)+(1-s_1)\beta E_t\left[\frac{\lambda_{1t+1}}{\lambda_{1t}}\frac{\partial F_{1t+1}^{F}}{\partial N_{1t+1}}\right], \tag{3.25}$$

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 (3.23) imply

$$w_{1t}h_{1t}=\frac{1-\epsilon}{1+\tau_1^f}\frac{P_{1t}^c}{P_{1t}}\left[\omega_1\theta_{1t}+z_{1t}\right]+\frac{\epsilon}{1-\tau_1^d}\left[\frac{P_{1t}^c}{P_{1t}}b_1+\frac{1}{\lambda_{1t}}\left(\kappa_1^u-\kappa_1^n\frac{(1-h_{1t})^{1-\xi}}{1-\xi}\right)\right] \tag{3.26}$$

$$\frac{\kappa_1^n}{\lambda_{1t}}(1-h_{1t})^{-\xi}=\frac{1-\tau_1^d}{1+\tau_1^f}(1-\alpha)\frac{Y_{1t}}{N_{1t}h_{1t}}. \tag{3.27}$$

3.2.5 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

$$\tau_1^c P_{1t}^c C_{1t}^c+\left(\tau_1^d+\tau_1^f\right)P_{1t}N_{1t}h_{1t}w_{1t}=T_{1t}+(1-N_{1t})P_{1t}^c b_1 \tag{3.28}$$

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

3.2.6 Equilibrium

Global equilibrium requires market clearing in financial and goods markets. In the markets of home and foreign intermediate goods, the equilibrium is given by

$$Y_{1t} = y_{11t} + y_{12t} \tag{3.29}$$

$$Y_{2t} = y_{21t} + y_{22t}. \tag{3.30}$$

Market clearing in the composite good markets is obtained if for all countries $i = 1, 2$

$$D^c_{it} = C^c_{it} + I^c_{it} + \omega_i V_{it} + CI_{it} + CA_{it}. \tag{3.31}$$

holds. For the international bond market, the equilibrium is defined as

$$B_{1t+1} + B_{2t+1} = 0. \tag{3.32}$$

The trade balance of country i reads $TB_{it} = P_{it}Y_{it} - P^c_{it}D^c_{it}$. Note that the evolution of the trade balance has to be equal to that of the balance of payments $B_{it+1} - (1 - i_t)B_{it}$ in equilibrium, which can be shown by combining equations (3.5), (3.18), (3.28) and (3.31).

The model is solved by log-linearising the equation system around the deterministic steady state and applying the Newton-Raphson algorithm as implemented in DYNARE for deterministic models.

3.3 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 3.3.4, 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 and productivity growth and consumption and output growth as well as persistent trade surpluses in the German data.

Table 3.1. 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

3.3.1 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 summarised in Table 3.1.

Labour Market

We follow the literature on labour market rigidities in Europe (see e.g. Dao, 2013b or Faia et al., 2013) in choosing $\epsilon = 0.5$, 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.[7] We set the aggregate vacancy posting costs per GDP $\omega V/Y$ to 1.5% as in Fonseca et al. (2009) and show in Subsection 3.3.4 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 et al., 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 and 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.[8] In our benchmark calibration, we set the elasticity of

[7] 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 maximising). It is met when the firm's share of surplus is equal to the elasticity of the matching function with respect to vacancies.

[8] 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 (2013).

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 and the capital depreciation rate δ to 0.025.[9] 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.[10]

Preferences

The discount rate of households is given by $\beta = 0.99$, which corresponds to an annual real interest rate of about 4% in the steady state according to equation (3.9).[11] 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 et al. (2011).[12] 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-à-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).

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

[10] 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.

[11] 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 analysis, 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.

[12] Chetty et al. (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 et al. (2011) show that labour supply elasticities do not differ much across countries.

Table 3.2. 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 2004, OECD Consumption Tax Trends 2012.

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 (EA) situation in 2003.[13] We employ data for the EA-12 countries excluding Germany whenever possible in our calculations but 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 3.2.

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

[13] 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 3.3. Implied Values

		Germany	EA
s	Job separation rate	0.034	0.018
χ	Matching efficiency	0.47	0.36
ω	Vacancy posting cost	0.33	0.63
θ	Labour market tightness	0.45	0.26

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 $\theta = q/\phi$ (see Table 3.3 for implied parameter and steady state values). 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.[14] The data on employers' and employees' tax rates on wages (τ^f, τ^d) as well as the consumption tax rate τ^c stem from several OECD publications (see Table 3.2). 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 (3.7) 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 et al., 2012 or Kohlbrecher et al., 2013).

3.3.2 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 3.2 summarises a few telling observations. First, between 2003 and 2010, the unemployment rate increased by 1.1 percentage points in the EA (including Germany),

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

whereas it decreased by 2.7 percentage points in Germany. Second, the job finding probability increased by roughly 3 percentage points in both regions.[15] 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 3.1 that studies by Fahr and Sunde (2009), Klinger and Rothe (2012) and Hertweck and Sigrist (2013) found a significant increase in the matching efficiency as a 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 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 3.4 which summarises 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 labelled consumption dampening in the introduction. Finally, the terms of trade of Germany in comparison to its EA neighbours declined by 4.9%, computed as the ratio of GDP deflators between Germany and the EA.[16]

[15] 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.

[16] Using the ratio of consumer price indices yields a growth rate of -1.9%.

Table 3.4. 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	-4.86	-0.78	-1.01	-1.63			

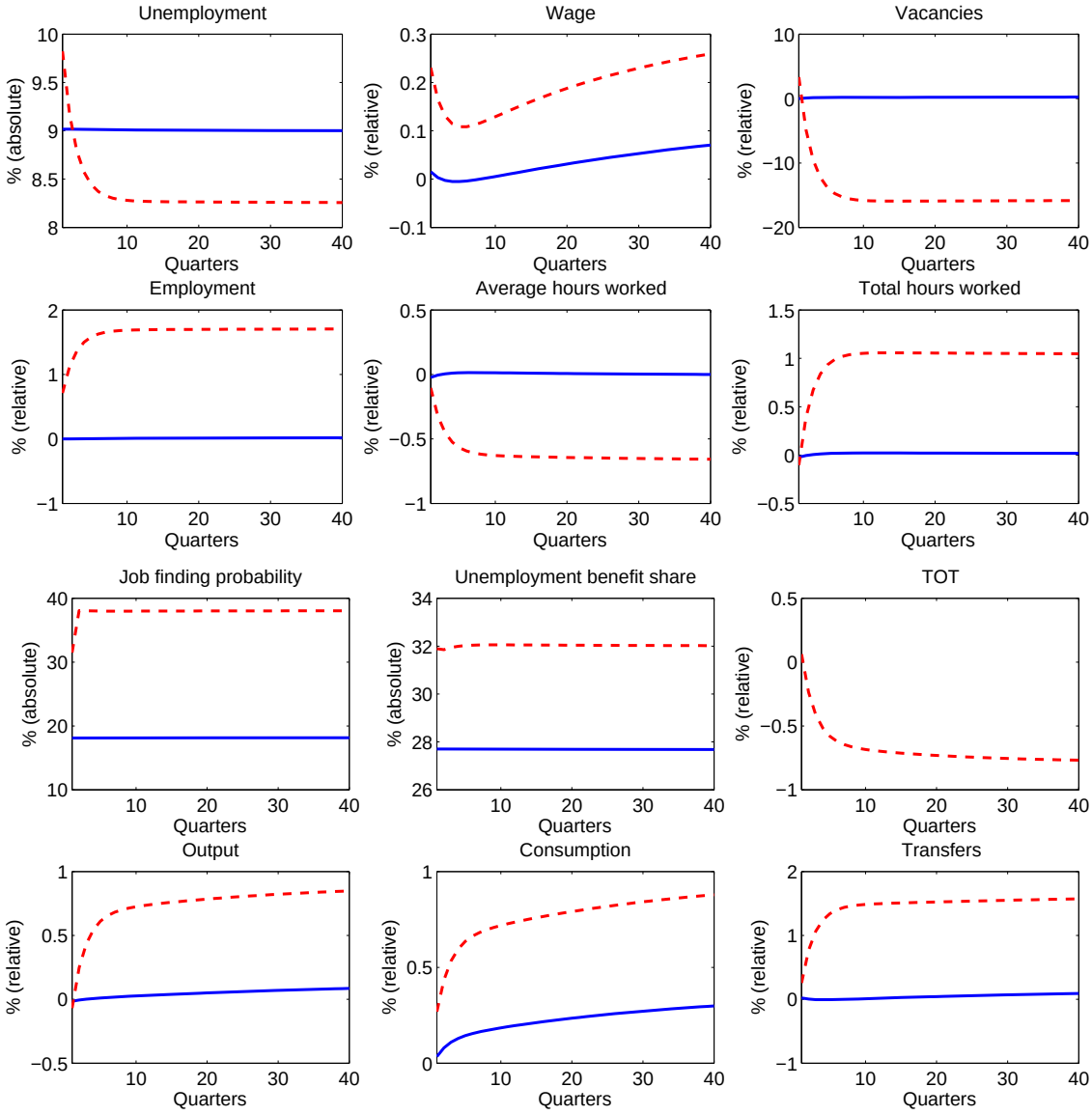
Data source for the first column: OECD.Stat database.

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.

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 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 is an intermediate value between the lowest estimate of 10% reported by Fahr and Sunde (2009) and Klinger and Rothe (2012) and the upper bound of 31% provided by Hertweck and Sigrist (2013). Starting out with the parametrisation of Germany and the EA as described above for 2003, the adjustment paths of the



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 parametrisation follows from the values for Germany and the EA in 2003 given in Table 3.2.

Fig. 3.1. Increasing the Matching Efficiency

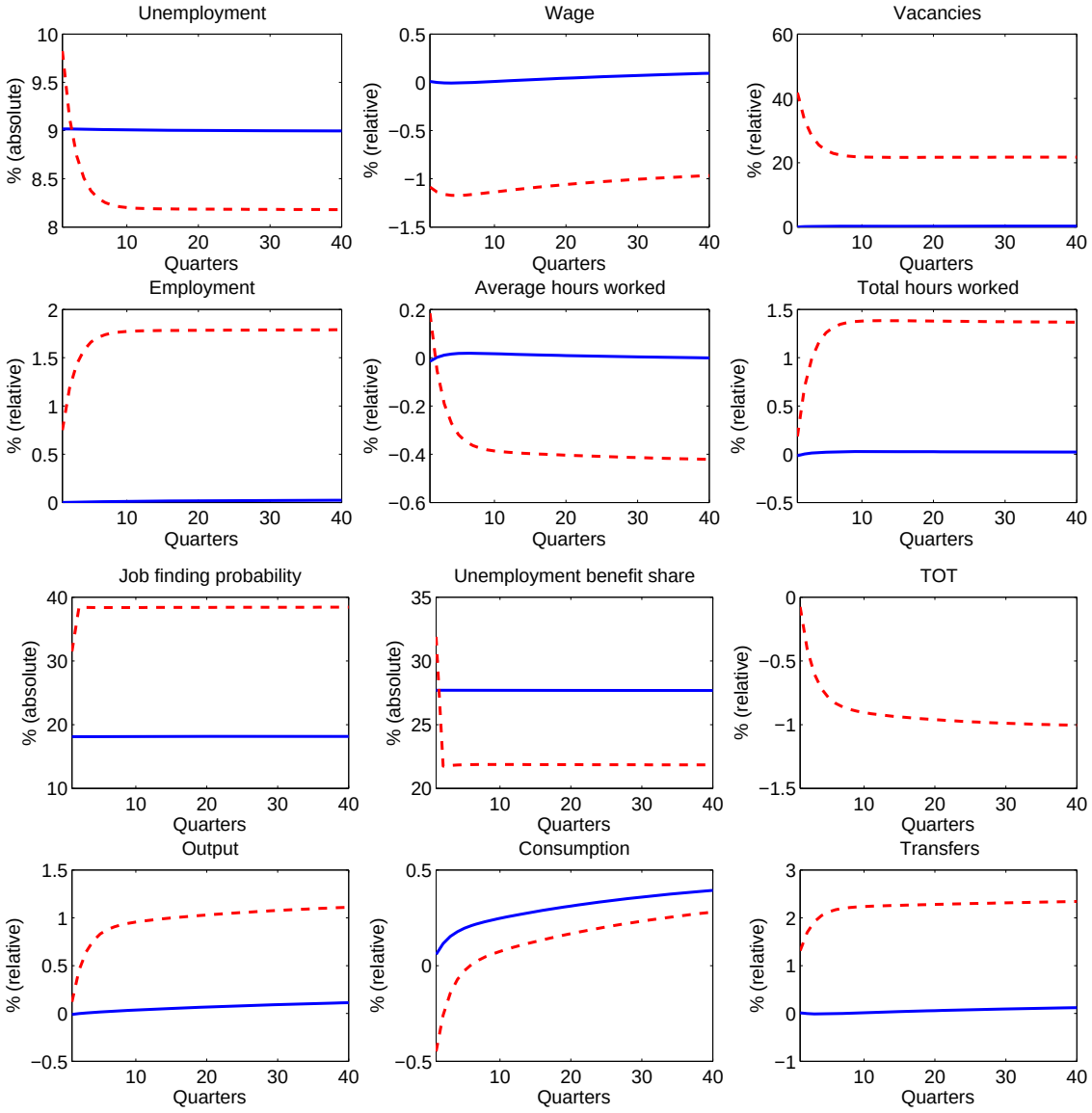
selected variables of both economies are illustrated in Figure 3.1. The corresponding equilibrium effects can be found in the second column of Table 3.4.

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 level of unemployment benefits is 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.

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



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 parametrisation follows from the values for Germany and the EA in 2003 given in Table 3.2.

Fig. 3.2. Decreasing the Unemployment Benefits

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 analyse, 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 3.2 on total wage per employee (wh) as computed with our initial calibration with 2003 values for Germany.[17] 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 3.2 and column (3) of Table 3.4 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 (3.26), 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.[18] This leads firms to post 40% more vacancies than at the former 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.

[17] 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.

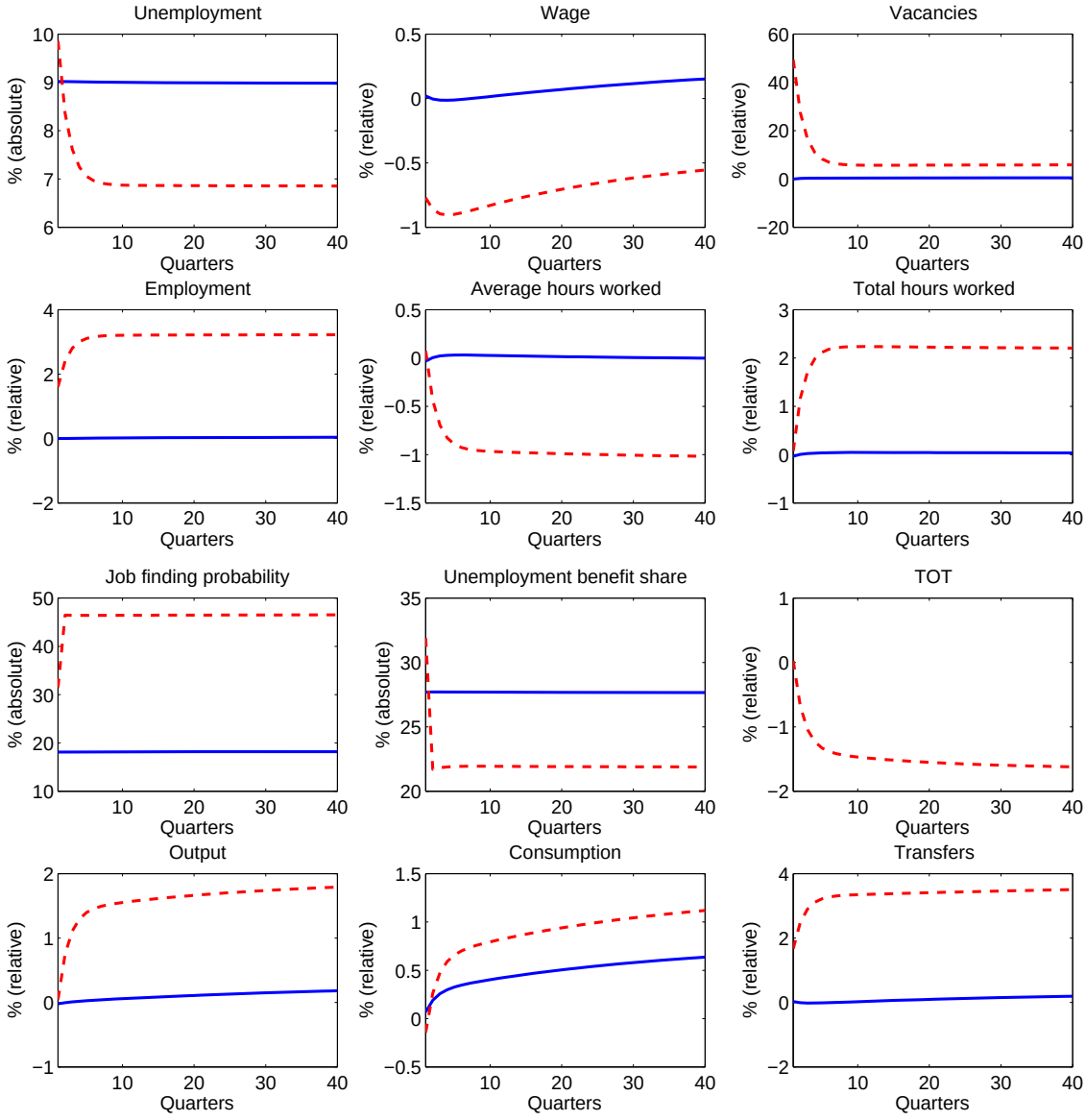
[18] On impact average hours worked rise to compensate the unanticipated reform shock given that employment decisions are predetermined.

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 labour and capital are predetermined and the later adjusts only gradually. 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. Thus, households postpone consumption for the sake of investment, which is needed to rise the capital stock and ensure a higher output and consumption level later on. 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. Hence, 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 launched 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



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 parametrisation follows from the values for Germany and the EA in 2003 given in Table 3.2.

Fig. 3.3. Increasing the Matching Efficiency and Decreasing Unemployment Benefits Simultaneously

of this study, since the findings of Fahr and Sunde (2009), who use data merely until the end of 2004, point to a very quick realisation 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.

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 3.1 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 3.2. 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 3.3 and column (4) of Table 3.4. 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.[19] 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 3.1, which investigate the impact of the Hartz IV reform only, point to an unemployment rate reduction in the range of 2.8%

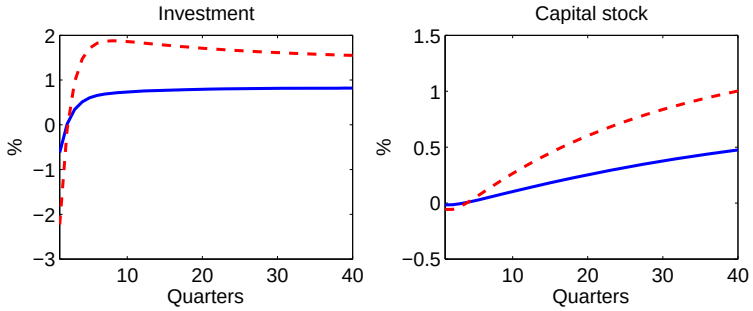
[19] Since the size of the individual reform effects depend on the initial level of the economy, interaction effects arise when at least two reforms packages are launched simultaneously.

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.[20]

The dynamic response to the combined reforms, shown in Figure 3.3 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 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 3.4.

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

[20] 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.



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 parametrisation follows from the values for Germany and the EA in 2003 given in Table 3.2.

Fig. 3.4. Increasing the Matching Efficiency and Decreasing Unemployment Benefits Simultaneously: Investment and Capital

the trade balance and of net foreign assets (see Figure 3.6 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 build up of the capital stock and 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 3.4 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. Ac-

cording 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.[21] 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.[22] 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

[21] If we consider the lower bound of estimates w.r.t. the increase in the matching efficiency the dampening effect turns out somewhat weaker.

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

negatively despite the anti-crisis measures of the German government. We abstract from such effects in the analysis.

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 et al. (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 3.4, 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.

With respect to social welfare, our evaluation can only make a limited contribution as the model does not contain distributional aspects which are of detrimental importance as Krebs and Scheffel (2013) reveal. Our model predicts that aggregate steady-state welfare rises in both countries. In Germany as well as in the EA, this result is driven by the increase in consumption as well as by the reduction in average hours work which imply more utility from leisure combined with the increase in employment.[23]

To sum up, our calibrated model points to significant effects on German employment, output, consumption and wages induced 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 labour 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] In addition to steady-state welfare, we calculated life-time welfare, i.e. taking the adjustment path into account. The results differ only to a negligible extent.

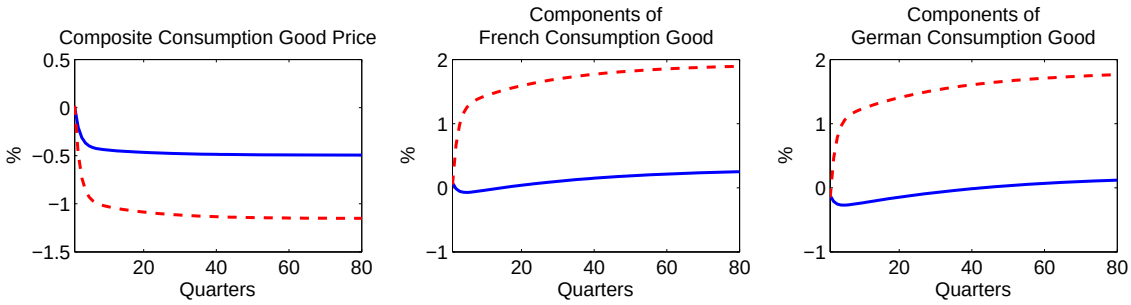
3.3.3 International Spillovers

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 3.4.[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 the decrease 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 3.4. 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.

As indicated by equation (3.13), the decline in the terms of trade of Germany manifests itself as a decline in the prices P^c_{1t} and P^c_{2t} of the composite consumption goods of both regions as shown in the first graph of Figure 3.5. 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,

[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.



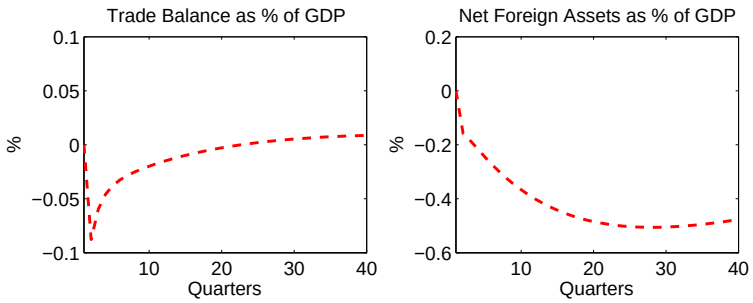
Notes: In the first graph, the red-dashed (blue-solid) line shows the price adjustment in Germany (EA) after a 20% increase in the matching efficiency parameter χ and a 10.35% decline in the unemployment benefit of Germany. In the second and third graphs, red-dashed (blue-solid) lines show the percentage change in the German (EA) components of the EA and German composite goods, respectively. The initial parametrisation follows from the values for Germany and the EA in 2003 given in Table 3.2.

Fig. 3.5. Increasing the Matching Efficiency and Decreasing Unemployment Benefits Simultaneously: Consumption

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 investments in both German and EA economies cheaper.[25] 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 3.4. 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 negative, albeit small, trade balance of the German economy in the first 5-6 years after the introduction of the reforms. It turns slightly positive after that period and approaches gradually zero in the very long run. Thereby, the German net foreign asset position 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 3.6. These assets are liquidated very slowly after that peak and are mainly

[25] 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 with price P^c_{it}.



Notes: The red-dashed line shows the adjustment in Germany after a 20% increase in the matching efficiency parameter χ and a 10.35% decline in the unemployment benefit of Germany. The initial parametrisation follows from the values for Germany and the EA in 2003 given in Table 3.2.

Fig. 3.6. Increasing the Matching Efficiency and Decreasing Unemployment Benefits Simultaneously: Trade Balance and Net Foreign Assets

used for building capital in the euro area. In the long run, the capital stock in the EA increases by a significant 0.8%, which is more than half of the relative increase in the German capital stock of 1.4%.

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 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.

3.3.4 Comparison with the Literature and Sensitivity Analysis

In this subsection, we start by 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 3.5 we summarise

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 $\frac{\omega V}{Y} = 0.015$.

Comparison with the Literature on Spillovers

As pointed out in the literature review in Section 3.1, size and sign of spillovers are influenced by modelling and parametrisation 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 et al. (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 if 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. Hence, 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 et al. (2013) find that the spillover effects of domestic labour market institutions are the 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. In consequence, 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. Furthermore, 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. In Chapter 4 we tackle this issue in a three-country framework comparable to Kose and Yi (2006) which is able to represent the difference between overall openness to trade and bilateral linkages adequately. Note, however, that Everaert and Schule (2008) as well as Gomes et al. (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. The parameters κ and η 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 et al. (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 et al. (2008) and a higher value of 1.5 which has often been used in international real business cycle models starting with Backus et al. (1994).

If we increase κ to 0.88, i.e., the preference for the share of the domestic good in the foreign consumption bundle is weaker (and stronger in the domestic bundle), foreign consumers profit less strongly (and domestic consumers accordingly more strongly) from the price reduction in domestic goods as a result of the reforms than in the baseline scenario (see column (2) of Table 3.5). 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 3.5). 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-à-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 3.5 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 parametrisation 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 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.

3.3.5 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

Table 3.5. Sensitivity Scenarios: Percentage in Selected Variables after Reforming χ and b in Germany

Scenario		(1) Baseline	(2) $\kappa = .88$	(3) $\eta = .85$	(4) $\eta = 1.5$	(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.

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.

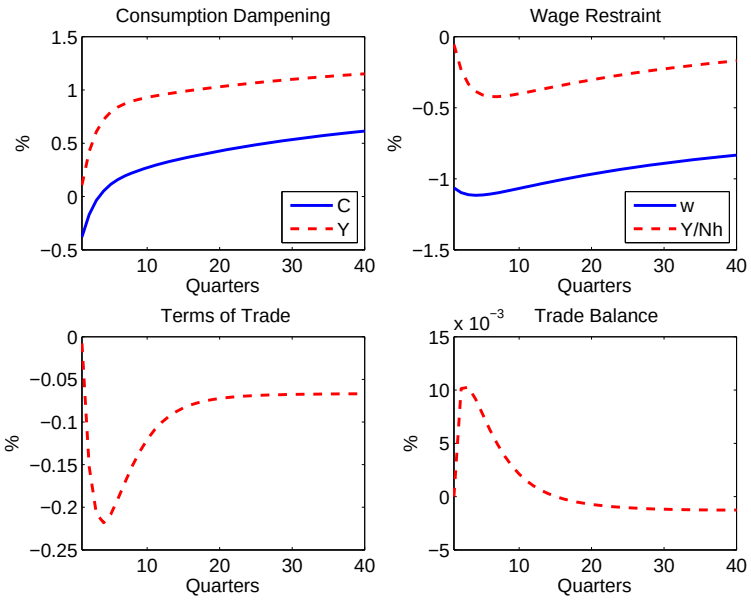
We first turn our attention to the bargaining power of workers ϵ which is another criticial parameter in our model, particularly for labour market outcomes. Recent literature suggests that globalisation has been one of the drivers of the decline in union membership and thus lower bargaining power of unions (see, e.g., Dreher and Gaston, 2007 and Abraham et al., 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.[26] Dustmann et al. (2014) describe the shift in the German union landscape in detail. They argue that the changes have been at the heart of the weak wage development in Germany and even contributed to the decrease in the unemployment rate.

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 3.7, 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 3.7. The response of the terms of trade is still negative, yet much smaller in absolute terms. Moreover, it shows a hump-shaped response in contrast to the foregoing scenario. The German trade account exhibits a small

[26] "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.



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 parametrisation follows from the values for Germany and the EA in 2003 given in Table 3.2. The legends in the upper panel: C – consumption; Y – output; w – wages; Y/Nh – labour productivity.

Fig. 3.7. Decreasing the Bargaining Power of Workers

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.[27] 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 are unable to explain the large and persistent German trade surpluses.

[27] We recognise that the level of decline in the bargaining power as well as the exposure of countries to globalisation 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.

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 et al. (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.[28] Thereby, the authors implicitly see the wage restraint solely as the product of labour market reforms[29] and emphasise 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 et al. (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 et al. (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 et al. (2013) emphasise the importance of a number of non-competitiveness factors as potential driving

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

[29] 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.

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 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.[30]

3.4 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 stimulators, 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 consumption dampening in Germany accompanied by effects harming the country's trade partners.

In the current chapter, the 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—Germany's most important trade partner—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 wage moderation nor 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

[30] Note that a very recent paper by Kollmann et al. (2014) comes to a different result attributing a partial role to the labour market reforms as drivers of the current account surplus. However, their analysis does not include non-price competitiveness factors. The main driver of the current account surplus are according to their findings positive shocks to the German saving rate.

wages and productivity growth and dampens domestic consumption relative to output to a certain extent. Thus, we conclude that additional factors must have contributed to these developments in the data. As we argue in this study, globalisation-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 after 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. A crucial aspect that might affect our long-run comparisons and that we did not address in the model is the 2008-2009 global financial and economic crisis. We reckon 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 emphasised that the German government introduced a number of anti-

crisis measures with a positive impact on labour market outcomes, discussed by e.g. Faia et al. (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 inclusion of the crisis in 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 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 that the reform of 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.

4

Spillover Effects of Labour Market Reforms in a Three-Country World[1]

In contrast to the previous chapter, which builds on the classical two-country model framework to discuss the international consequences of a national labour market reform, the following study explicitly considers a three-country scenario. The main reason behind the choice of this model structure is that it allows for indirect spillover effects, which arise through an alteration in the economic link between two countries after a reform in a third country. The analysis of the relevance of indirect effects, in combination with direct effects, is at the heart of this chapter. As already discussed in Chapter 1, the allowance for indirect effects could potentially increase the overall size of the spillover or, on the flip side, switch its sign from positive to negative.

But the three-country framework has an additional advantage over the two-country set-up: in the latter, the trade balance and net foreign asset position of one country has always to be a perfect mirror image of the second country as the country pair represents the world. A three-country model breaks this strong link between the single countries since effects in the first country do not necessarily trigger effects in the second country. It allows to map bilateral *and* overall trade intensities at the same time as highlighted by Kose and Yi (2006), and is thus the appropriate framework to assess the size of bilateral spillover effects. This becomes evident in the last part of the chapter, which provides an analysis of spillover effects for various European countries. Even though the model is highly stylised, considerable differences between the single countries emerge.

The rest of the chapter is structured as follows: in the next section, I describe the model details and the baseline calibration of a symmetric three-country world. In Section 4.2, I briefly summarise the effects triggered by a reform of the unemployment benefit ratio in a symmetrically calibrated model. Subsequently, I explain the

[1] This chapter is based on a unpublished working paper (see Busl, 2014).

mechanism and composition of the direct and indirect spillover effects. The theoretical exposition is followed by a simulation-based analysis of the parameters driving the size and direction of the spillover components. Finally, Section 4.3 provides an exemplified analysis of the equilibrium effects and the dynamic responses to the German reform for different European countries, namely France, Belgium and Austria. Section 4.4 concludes.

4.1 The Model

This section summarises the model framework which is in many aspects identical to the model described in Section 3.2. It builds on a standard international real business cycle model enhanced by search and matching frictions in the labour market, an international bond market and fiscal policy parameters. The main differences to the previous model are that the world consists of three instead of two countries and that countries are allowed to differ with respect to their size. These properties of the model crystallise most importantly in the trade relations between countries. As in the two-country version, each country specialises in the production of an internationally traded intermediate good. All three intermediate goods are combined nationally to a non-traded final good which is used for consumption and investment of households. Shifts in the relative prices of intermediate goods caused by a change in policy parameters are at the heart of the analysis of spillover effects in the following section.

Since the focus of the analysis is mainly on the long-run implications of the model, I abstract from any price and wage rigidities.[2] To simplify the analytical analysis of spillover effects, I also omit the labour-leisure choice and assume that each employed person works a fixed amount of time instead. Thus, adjustments in the labour market occur only at the extensive margin. In the following, I focus on the aspects of the model that differ from Section 3.2. The complete system of equations characterising the model is set out in Appendix C.1.

4.1.1 Households

At the beginning of each period, agents in each country i maximise their expected lifetime utility without knowing whether they will end up unemployed or not:

[2] These features would improve the match with international business cycle statistics to a big extent, though, as Patureau (2012) shows.

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[N_{it} U(C_{it}^n) + (1 - N_{it}) U(C_{it}^u) \right], \tag{4.1}$$

where $0 < \beta < 1$ is the discount factor and C_{it}^n and C_{it}^u denote consumption in case of employment and unemployment, respectively. Per period utility is derived from consumption alone and given by $U(C_{it}^c) = log\,(C_{it}^c)$. With agents being risk averse and having access to complete income insurance markets, their decisions depend only on the aggregate probability of being employed N_{it} in country i at period t but are independent of their individual labour market outcome.

The budget constraint of the representative household expressed in terms of the intermediate good produced in country i can be written as

$$\begin{aligned} (1 + \tau_i^c)\, P_{it}^c \left[N_{it} C_{it}^n + (1 - N_{it}) C_{it}^u \right] + B_{it+1} + P_{it}^c CA_{it} = \\ = N_{it} P_{it} w_{it} \left(1 - \tau_i^d\right) + (1 - N_{it})\, P_{it}^c b_i + B_{it}\,(1 + i_t) + T_{it} + \Pi_{it}. \end{aligned} \tag{4.2}$$

Similar to Section 3.2, household income is composed by labour income w_{it} subject to taxes τ_i^d or unemployment benefits b_i, respectively, interest payments from bond holdings, government transfers T_{it} and firm profits Π_{it}. Households spend their income on consumption including a consumption tax τ_i^c, on new bond holdings B_{it+1} and portfolio adjustment cost CA_{it} defined as in equation (3.4). In equation (4.2), P_{it}^c is the price of the local final good while P_{it} represents the price of the local intermediate good. Note that the intermediate good of the domestic country where the reform occurs, i.e. of country 1, is chosen as numéraire, hence $P_{1t} = 1$. Finally, the law of motion of aggregate employment N_{it} is given by

$$N_{it+1} = (1 - s_i)\, N_{it} + \phi_{it}(1 - N_{it}), \tag{4.3}$$

with s_i being the constant and exogenous job separation rate of employed workers and ϕ_{it} being the probability of finding a job when being unemployed. Again, I define the number of successful matches which result in hirings as $H_{it} = \phi_{it}(1 - N_{it})$ and the number of unemployed agents as $U_{it} = 1 - N_{it}$, which represents the unemployment rate at the same time normalising the potential workforce to unity.

Thus, the household maximises its life-time utility (4.1), subject to the budget constraint (4.2) (with λ_{it} being the Lagrange multiplier) and the law of motion of aggregate employment (4.3), obtaining the following first order conditions with

respect to consumption and bond holdings:

$$U'(C_{it}^n) = U'(C_{it}^u) = (1+\tau_i^c)\,\lambda_{it} P_{it}^c \tag{4.4}$$

$$\lambda_{it}\left(1+\Phi_b \frac{B_{it+1}}{P_{it}^c}\right) = \beta E_t\left[\lambda_{it+1}\left(1+i_{t+1}\right)\right]. \tag{4.5}$$

Note that condition (4.4) implies that the optimal level of consumption does not depend on the agents' employment status, i.e. $C_{it}^c = C_{it}^n = C_{it}^u$. This follows from the assumption of complete income insurance markets.

4.1.2 Final Good Sector

In each of the three countries there is a competitive final good sector, which produces a non-tradable final good D_{it}^c used for consumption and investment. I follow Kose and Yi (2006) in using the standard Armington aggregator to describe the composition of the final good in terms of the three intermediate goods

$$D_{it}^c = \left[\kappa_{ii}^{\frac{1}{\eta}} y_{iit}^{\frac{\eta-1}{\eta}} + \kappa_{ji}^{\frac{1}{\eta}} y_{jit}^{\frac{\eta-1}{\eta}} + \kappa_{ki}^{\frac{1}{\eta}} y_{kit}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}, \tag{4.6}$$

where $\eta > 0$ is the elasticity of substitution between intermediate goods. y_{jit} denotes the quantity of intermediate input in the final good production of country $i = 1,2,3$ stemming from country $j = 1,2,3$. $0 < \kappa_{ji} < 1$ is the preference of consumers in country i for products from country j and in particular κ_{ii} represents the preference for domestic goods in domestic spending, the so called home bias. I will refer to κ_{ji} as import or openness preference in the following.

The demand functions for intermediate goods used in country i are derived by maximising the profits of final good producers $P_{it}^c D_{it}^c - P_{it} y_{iit} - P_{jt} y_{jit} - P_{kt} y_{kit}$:

$$y_{iit} = \kappa_{ii}\left(\frac{P_{it}^c}{P_{it}}\right)^{\eta} D_{it}^c \tag{4.7}$$

$$y_{jit} = \kappa_{ji}\left(\frac{P_{it}^c}{P_{jt}}\right)^{\eta} D_{it}^c \tag{4.8}$$

$$y_{kit} = \kappa_{ki}\left(\frac{P_{it}^c}{P_{kt}}\right)^{\eta} D_{it}^c, \tag{4.9}$$

where P_{it}^c/P_{it} represents the price of the final good in country i in terms of the intermediate good produced in the same country. Let's define the terms of trade

of country i with any country j as the relation of its import to export prices, i.e. $TOT^i_{jt} = \frac{P_{jt}}{P_{it}}$. Taking the intermediate good demand functions and equation (4.6) together, the price relation P^c_{it}/P_{it} of country i results to be a combination of the terms of trade with its trading partners j and k:

$$\frac{P^c_{it}}{P_{it}} = \left[\kappa_{ii} + \kappa_{ji}\left(TOT^i_{jt}\right)^{\eta-1} + \kappa_{ki}\left(TOT^i_{kt}\right)^{\eta-1}\right]^{\frac{1}{1-\eta}} \tag{4.10}$$

4.1.3 Intermediate Good Sector

In the intermediate good sector only the production function differs from Section 3.2 as the number of hours worked is fixed. It thus reads

$$Y_{it} = A_i K^{\alpha}_{it} N^{1-\alpha}_{it}, \tag{4.11}$$

where $0 < 1-\alpha < 1$ is the labour share of income. The level of technology A_i is kept constant as in the previous analysis. The law of motion of aggregate employment in terms of vacancies V_{it}, the law of motion for capital K_{it} and the costs of adjusting a firms capital stock CI_{it} are as described by equations (3.15), (3.16) and (3.17) in Section 3.2.

The profit of intermediate good firms Π_{it} can then be written as

$$\Pi_{it} = P_{it}Y_{it} - P_{it}w_{it}\left(1+\tau^f_i\right) - P^c_{it}I^c_{it} - \omega_i P^c_{it}V_{it} - P^c_{it}CI_{it} \tag{4.12}$$

with τ^f_i being a payroll tax and ω_i the cost of posting a vacant job. Firms' intertemporal optimisation problem with respect to capital and labour can be summarised as

$$F^F_{it} = \underset{K_{it},N_{it}}{max}\left[\Pi^F_{it} + \beta E_t\left(\frac{\lambda_{it+1}}{\lambda_{it}}F^F_{it+1}\right)\right] \tag{4.13}$$

subject to the production technology (4.11), the law of motion of capital (3.16) and aggregate employment (3.15).[3] If we again define $q^T_{it} = 1 + \Phi_I \frac{I^c_{it}-\delta K_{it}}{K_{it}}$ and $z_{it} = \frac{P_{it}}{P^c_{it}}(1-\alpha)\frac{Y_{it}}{N_{it}}$, the optimality conditions are given by

$$q^T_{it} = \beta E_t\left[\frac{P^c_{it+1}\lambda_{it+1}}{P^c_{it}\lambda_{it}}\left\{P_{it+1}\frac{1}{P^c_{it+1}}\alpha\frac{Y_{it+1}}{K_{it+1}} + q^T_{it+1} - \delta + \frac{\Phi_I}{2}\left(\frac{I_{it+1}-\delta K_{it+1}}{K_{it+1}}\right)^2\right\}\right] \tag{4.14}$$

[3] The ratio of the future to the present Lagrange multiplier $\lambda_{it+1}/\lambda_{it}$ of household's budget constraint is used to weight firms' future profit flows, since households are the owners of the firms.

$$\frac{\omega_i}{q_{it}} = \beta E_t \left[\frac{P^c_{it+1}\lambda_{it+1}}{P^c_{it}\lambda_{it}} \left\{ z_{it+1} - \frac{P_{it+1}}{P^c_{it+1}} w_{it+1} \left(1 + \tau^f_i\right) + (1 - s_i) \frac{\omega_i}{q_{it+1}} \right\} \right]. \tag{4.15}$$

4.1.4 Matching and Bargaining in the Labour Market

The technology of hiring by matching vacancies and unemployed persons follows Pissarides (2000) as in equation (3.22). The Nash bargaining of firms and workers in each period changes insofar as now only wages w_{it} are subject of the negotiation. The outcome can be calculated by maximising the weighted marginal value of an additional employed in terms of utility for firms and households:

$$\underset{w_{it}}{max} \left(\lambda_{it} \frac{\partial F^F_{it}}{\partial N_{it}} \right)^{\epsilon} \left(\frac{\partial F^H_{it}}{\partial N_{it}} \right)^{1-\epsilon} \tag{4.16}$$

with $0 < \epsilon < 1$ measuring the bargaining power of the firm. For the household the marginal value of a match is given by

$$\frac{\partial F^H_{1t}}{\partial N_{it}} = \lambda_{it}(P_{it} w_{it}(1 - \tau^d_i) - P^c_{it} b_i) + (1 - s_i - \phi_{it})\beta E_t \left[\frac{\partial F^H_{it+1}}{\partial N_{it+1}} \right]. \tag{4.17}$$

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

$$\frac{\partial F^F_{it}}{\partial N_{it}} = P_{it}(1 - \alpha)\frac{Y_{it}}{N_{it}} - (1 + \tau^f_i) P_{it} w_{it} + (1 - s_i)\beta E_t \left[\frac{\lambda_{it+1}}{\lambda_{it}} \frac{\partial F^F_{it+1}}{\partial N_{it+1}} \right]. \tag{4.18}$$

Defining labour market tightness $\theta_{it} = \frac{V_{it}}{U_{it}}$, optimal labour contracts according to equation (4.16) imply

$$w_{it} = \frac{1 - \epsilon}{1 + \tau^f_i} \left[\omega_i \frac{P^c_{it}}{P_{it}} \theta_{it} + (1 - \alpha) \frac{Y_{it}}{N_{it}} \right] + \frac{\epsilon}{1 - \tau^d_i} \frac{P^c_{it}}{P_{it}} b_i. \tag{4.19}$$

4.1.5 The Government

The government collects income from its taxation of consumption and labour on the one side, which is spent on benefits for the unemployed and transfer payments on the other side. The government budget constraint reads then as follows

$$\tau^c_i P^c_{it} C^c_{it} + \left(\tau^d_i + \tau^f_i \right) P_{it} N_{it} w_{it} = T_{it} + (1 - N_{it}) P^c_{it} b_i. \tag{4.20}$$

4.1.6 Equilibrium

Global equilibrium requires market clearing in all goods and financial markets. The conditions given below highlight how the three countries in the model are linked to each other. In the markets of intermediate goods, the equilibrium is given by

$$\pi_1 Y_{1t} = \pi_1 y_{11t} + \pi_2 y_{12t} + \pi_3 y_{13t} \tag{4.21}$$

$$\pi_2 Y_{2t} = \pi_1 y_{21t} + \pi_2 y_{22t} + \pi_3 y_{23t} \tag{4.22}$$

$$\pi_3 Y_{3t} = \pi_1 y_{31t} + \pi_2 y_{32t} + \pi_3 y_{33t}, \tag{4.23}$$

where π_i is the exogenous number of households in country i, thus determining the size of the country. The total number of households in the world is normalised to 1, which implies $\sum_{i=1}^{3} \pi_i = 1$.

Market clearing in the final good markets is obtained if for all countries $i = 1, 2, 3$ holds

$$D_{it}^c = C_{it}^c + I_{it}^c + \omega_i V_{it} + CI_{it} + CA_{it}. \tag{4.24}$$

Finally, for the international bond market the equilibrium is defined as

$$\pi_1 B_{1t+1} + \pi_2 B_{2t+1} + \pi_3 B_{3t+1} = 0. \tag{4.25}$$

The trade balance of country i reads then $TB_{it} = P_{it} Y_{it} - P_{it}^c D_{it}^c$ which has to be equal to the balance of payments $B_{it+1} - (1 + i_t) B_{it}$ in equilibrium.

The model is solved by log-linearising the equation system around the deterministic steady state and applying the Newton-Raphson algorithm as implemented in DYNARE for deterministic models.

4.1.7 Baseline Calibration of Symmetric Countries

In my basic setup, I calibrate all three countries symmetrically to match quarterly German data. Therefore, most parameters values are chosen to be the same as in the previous chapter for Germany and will not be discussed further in this section. Omitting the labour-leisure choice from the model leaves me with one more free parameter when calibrating the labour market related parameter. So I back the real vacancy posting cost ω out, which varies widely across the literature. All parameter values of the baseline scenario are summarised in Table 4.1 and Table 4.2. Given

Table 4.1. Calibrated Parameter and Steady State Values

$1-N$	Unemployment rate	0.098	b/w	Unemployment benefit r.	0.32
ϕ	Job finding probability	0.32	τ^f	Employers' labour tax	0.17
q	Vacancy filling probability	0.70	τ^d	Employees' labour tax	0.17
ψ	Elasticity of vacancies	0.50	τ^c	Consumption tax	0.16
ϵ	Bargaining power firms	0.50	β	Depreciation rate	0.99
α	Capital share	0.34	η	Elast. of substitution	
δ	Discount factor	0.025		btw. intermediate goods	1.5
Φ_I	Scal. invest. adj. costs	7	κ_{ii}	Home bias	0.7
Φ_b/NX	Scal. portfolio adj. costs	0.0038	κ_{ji}	Bil. import preference	0.15

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.

these parameters and the deterministic steady state of equations (4.15) and (4.19), one can compute the vacancy posting cost.

Further deviations from the calibration in Chapter 3 occur obviously in the trade related part of the model. Central to the size of spillovers is the calibration of the Armington aggregator weights κ_{ij}, as the following analysis shows. The parameter defining the home bias of consumed products κ_{ii} is set so that the implied steady state import-to-GDP ratio matches the average import share observed in Germany vis-à-vis the world since the introduction of the euro, which corresponds to setting $1-\kappa_{ii}=0.3$.[4] For simplicity, I assume in the baseline scenario that bilateral import preferences are all symmetric, i.e. $\kappa_{ji}=0.15$ for $i,j=1,2,3$ and $i\neq j$.

The elasticity of internationally traded goods η is set to 1.5 as originally proposed by Backus et al. (1992). For a given output level the openness preference parameters κ_{ii} and κ_{ji} and the elasticity η determine the demand for intermediate goods. The country sizes π_i are then given by means of equations (4.21)-(4.23), summarising the intermediate goods market equilibrium and the normalisation of the world size to one. Of course, in the symmetric baseline scenario all countries are of the same size, i.e. $\pi_i=1/3$. The relation between the openness preferences and the country sizes implies that a country is the bigger, the larger its home bias κ_{ii} relative to the other countries. In contrast, more open countries are smaller. For the three-country case, asymmetries in bilateral preferences influence country sizes as well. The more a country imports from one country relative to another, the bigger is the first country

[4] Intermediate good prices are normalised to one in the deterministic steady state.

Table 4.2. Implied Values

s	Job separation rate	0.034
χ	Matching efficiency	0.47
ω	Vacancy posting cost	2.37
θ	Labour market tightness	0.45
π	Country size	1/3

in comparison to the second. How the country size depends on the import preferences of countries and how it varies if preferences of one country differ from the baseline case, is illustrated in Appendix C.2.

In Section 4.2, I first deviate from the symmetry assumption with respect to the openness preferences (and therefore also the size) of the trading partners. Consequently, I additionally vary other country characteristics to test their impact on the direct and indirect spillover effects.

4.2 Spillover Effects in a Three-Country Model

The underlying reform scenario in the next subsections is based on the German example of a reform called Hartz IV which reduced the average unemployment benefit ratio by about 10 percentage points from originally 32 percentage (see Table 4.1). In the main part of the analysis, I focus on the steady state effects of the reform and discuss the factors influencing the direction and strength of spillovers to other countries. The dynamic effects are discussed based on an example in the follwing section, as short-run consequences may differ strongly from the long-run effects and are of great importance to get political support for reforms.

To start with, I briefly describe the effects of a reduction in unemployment benefits in a country (labelled country 1) with trading partners which are all identical and therefore perfectly symmetric. This specification implies that no indirect effects take place as no shift in relative terms occurs between foreign countries, being all affected to the same extent. In the following sections, I analyse how asymmetry in various characteristics influences the direct spillover effects from the reforming country and triggers indirect effects through a third country. First, I concentrate on asymmetries in the import preferences and the related country sizes. The consequent experiments, where I analyse the effect of variations in other parameters, are based on a scenario with asymmetric import preferences. The scenario is chosen to

replicate the spillover effects of Germany to an average European country and the rest of the euro area.

Notice that I select a specific type of reform here, namely a reduction in unemployment benefits. However, the main and only channel in the long run through which spillovers to other countries occur in the model is through changes in the terms of trade between countries. So as long as a reform of labour market institutions or of fiscal institutions spurs production and decreases domestic relative to foreign prices, spillovers are qualitatively comparable and are influenced by very similar factors. In this vein, the following findings may be interpreted in a more general sense.

4.2.1 Domestic and Foreign Effects in a Symmetric World

By assuming that all trading partners of the reforming country are identical, we obtain a scenario which resembles a two-country world since indirect effects do not occur. Therefore, I summarise the domestic and foreign effects caused by the reform in the unemployment benefit ratio only briefly in the following. A more detailed description of reform effects in comparable two-country models is given in Chapter 3 or in Dao (2013a).

Domestic Effects

A reduction of unemployment benefits in country 1 decreases the outside option of workers in the bargaining process with firms and therefore lowers the negotiated wage rates. This boosts labour demand causing firms to post more vacancies and ultimately employment and output to rise. A higher supply of intermediate goods produced in country 1 leads to a drop in relative prices a inducing positive income effect to domestic as well as foreign households. This effect is opposed by income losses of domestic households due to the cut in unemployment benefits and wages. On impact, the second effects dominates even though firm profits and transfers increase and consumption and investment in country 1 fall. Investment recovers immediately at the cost of deferred consumption which increases slowly afterwards when hirings become effective, the capital stock grows and firm profits increase. Whether the long-run effect on consumption is positive and how big it is depends on the international environment as the analysis of the openness preferences at the end of this subsection reveals.

Spillover Effects

As the prices in the reforming country drop, the terms of trade of its trading partners (defined as export/import prices) improve. In this subsection, I assume that all trading partners are perfectly symmetric. This implies that the terms of trade change for all foreign countries by the same amount and relative prices, i.e. terms of trade, between these countries do not change. Therefore, all foreign countries are subject to the same direct effects stemming from the price changes in country 1 described in the following, but relative quantities between these countries are not affected by the reform.

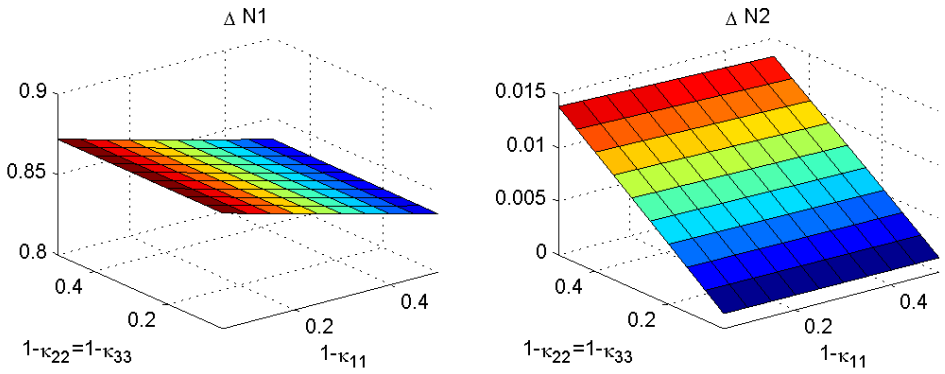
The higher evaluation of goods produced in foreign countries increases the surplus from production there to be shared between foreign workers and firms through Nash bargaining. In consequence, wages and output as well as employment rise in the foreign countries. The fall in prices in country 1 as well as higher wages and a lower share of unemployed in the foreign countries induce households there to consume more. The quantitative evaluation of the model below shows that while the effects on output and consumption can be quite pronounced, the response of foreign employment is on average about two orders of magnitude smaller than in country 1.

Impact of Characteristics of the Domestic Country

To conclude this subsection, I briefly describe the most important characteristics of country 1 determining its relationship with the international environment and driving the strength of domestic and foreign effects while sticking to the assumption that its trading partners are all identical.

- *Openness preference of country 1 ($1 - \kappa_{11}$) relative to foreign countries ($1 - \kappa_{22} = 1 - \kappa_{33}$):*

  The influence of openness and size of the reforming country has already been discussed in previous studies (see Felbermayr et al., 2012). In the present model the size of a country is strongly linked to its relative openness (see discussion in Subsection 4.1.7). The size of country 1 decreases with its openness relative to its neighbours. As in Felbermayr et al. (2012) and Felbermayr et al. (2013), the openness and size of the reforming country play a role for the strength of effects at home and abroad. The more open country 1, the smaller the domestic and foreign effects on employment, although the response of foreign employment to the home bias in country 1 is minimal. In contrast, if foreign countries are



Notes: In this scenario foreign countries are identical. They differ from the domestic country only with respect to their home bias κ_{ii}.

Fig. 4.1. Percentage Change in Employment after a Reduction in b_1 as a Function of $1 - \kappa_{11}$ and $1 - \kappa_{22} = 1 - \kappa_{33}$

more open, the domestic and foreign effects on employment are strengthened, and in this case the change in the domestic response is minimal. This finding is in accordance with the empirical results of Dao (2013a), according to which the degree of openness of the domestic country has no impact on the spillover size. It also matches the results of Felbermayr et al. (2013). They find in their model as well as in their empirical analysis that spillovers to more open/central economies (which are characterised by lower trade costs in their model) and to smaller economies are stronger. Figure 4.1 summarises the results for the baseline calibration with overall openness preferences $1 - \kappa_{ii}$ of the domestic as well as of the foreign countries varying between 0.01 and 0.5, that is from a very small steady state import share of 1% to a share of 50% as e.g. observed in Belgium w.r.t. the other euro area members since the introduction of the euro. If both foreign countries are very open, the spillover effect amounts to about 1.6% of the domestic effect, whereas the effect approaches zero for very closed countries. The same relation is observed for output and consumption (not shown), but for the latter changes in response to the countries own preference for openness are much more pronounced in terms of percentage changes. The size of the output (consumption) spillover ranges from about 0.2% (1%) if all countries are very closed to over 9% (300%) if all countries are very open.

- *Elasticity of substitution between foreign and domestic goods η:*
  This parameter influences the reform effects at home and abroad. The lower η, the

stronger is the adjustment in the composition of the final good after an exogenous shock. A greater change in the relative quantities of intermediate goods used to produce the final good implies a more pronounced change in the terms of trade. Therefore, the lower η, the stronger is the increase in output, consumption and employment abroad in the long run, whereas domestic effects are dampened. If country 1 is very open, i.e. there is a high preference for foreign intermediate goods, and the elasticity of substitution η between foreign and domestic goods is low, effects on domestic consumption can even be negative.[5] This result is of great relevance for the political feasibility of such a reform in small and very open countries. It also points to the fact that it is very important to model the trade preferences of a reforming country adequately to correctly evaluate reform effects. Unfortunately, the appropriate value for η is hard to pick as there is no observable empirical counterpart available and Hooper et al. (2000), who estimate the income and price elasticities of exports and imports in the G7 on data until 1994, find it to lie in a broad range from 0.8 to 2.3.

4.2.2 Direct and Indirect Effects in an Asymmetric World

What drives the size of spillovers to employment in the foreign countries taking the characteristics of the reforming country as given? And how do differences in the characteristics of the foreign countries affect the spillover? As described above, in the long run, changes in the terms of trade are the only channel creating an impact on foreign economic outcomes.

Direct Effect

As long as all foreign countries are identical, the equilibrium effect stems solely from terms of trade changes with the country where reforms occur. This effect is labelled direct effect in the following. The size of the direct effect depends on the strength of the terms of trade change and the elasticity of foreign outcomes—I focus on employment in the following—w.r.t. this terms of trade. As shown in detail in Appendix C.4, one can derive the elasticity of employment in the foreign country of interest (which I call country 2 from now on) w.r.t. the terms of trade between this country and country 1 in steady state, ϵ_{N_2,TOT_1^2}, which is given by the following formula:

[5] Setting e.g. $\eta = 1$ and $1 - \kappa_{11} \geq 0.4$ leads to such effects in the model.

$$\epsilon_{N_2,TOT_1^2} = \frac{\kappa_{12}}{\omega_2} \frac{s_2\psi}{\left(s_2 + \chi_2\theta_2^{\psi}\right)} \frac{\epsilon\left(\frac{\alpha}{\frac{1}{\beta}-1+\delta}\right)^{\frac{\alpha}{1-\alpha}}}{\left[\frac{(1-\beta(1-s_2))(1-\psi)}{\beta\chi_2}\theta_2^{1-\psi} + (1-\epsilon)\,\theta_2\right]} > 0 \tag{4.26}$$

First, notice that this elasticity is always positive, which is in line with the finding in Dao (2013a). She proofed that in a two-country world with labour market frictions, an increase in terms of trade for the foreign country always leads to a positive reaction of employment in that country. According to expression (4.26), import preferences towards country 1 κ_{12} and firms bargaining power ϵ have a positive impact on the elasticity. In contrast, the vacancy posting cost ω_2 and initial labour market tightness θ_2 decrease the response of employment to changes in terms of trade. A higher matching efficiency χ_2 and job survival rate $1 - s_2$ increase the elasticity of labour market tightness with respect to terms of trade $\epsilon_{\theta_2,TOT_1^2}$, whereas their impact on ϵ_{N_2,TOT_1^2} is ambiguous.

While the elasticity of employment w.r.t. a country's terms of trade can be pinned down analytically and its sign and driving factors can be derived unambiguously, the same cannot be done with the change in terms of trade caused by a reform, i.e. there is no analytical expression describing which parameters are relevant and how they impact on the change in terms of trade after a reform. Therefore, I defer the analysis of the factors influencing the resulting change in the terms of trade to the empirical quantification in the consequent subsections.

Indirect Effect

If the foreign countries are not identical, the size of the marginal impact of terms of trade changes may differ between country 2 and 3, i.e. $\epsilon_{N_2,TOT_1^2} \neq \epsilon_{N_3,TOT_1^3}$. Furthermore, it is likely that the reform of country 1 depreciates its terms of trade with different trading partners to a different extent, i.e. $\Delta TOT_1^2 \neq \Delta TOT_1^3$. In this case, a contemporaneous shift in the terms of trade between the foreign countries, TOT_3^2, occurs, which induces an additional indirect effect on N_2. The size and sign of the indirect effect on N_2 depends on the size and sign of the change in TOT_3^2 and of the elasticity of employment in country 2 w.r.t. to the terms of trade between country 2 and 3, ϵ_{N_2,TOT_3^2}. This elasticity differs from equation (4.26) only in the import preference parameter in the nominator, where we have κ_{32} instead of κ_{12} (see Appendix C.4). Hence it is always positive as well. If country 2 has identical

preferences for intermediates from country 1 and 3, i.e. $\kappa_{12} = \kappa_{32}$, a marginal change in the terms of trade with one of these country has exactly the same effect on employment in country 2. While we know that country 2's terms of trade with country 1 always improve after the reform, thus yielding a positive direct spillover effect concerning employment, the same must not hold true for its terms of trade with country 3. These terms of trade appreciate if the relative prices of country 2 increase stronger than the relative prices of country 3, otherwise they fall. In consequence, whether the indirect effect on employment in country 2 is positive or negative, depends on its relative change in terms of trade.

Overall Spillover

An approximation of the total effect on N_2 around the initial steady state i.e. taking the elasticity as constant, can be written as

$$\Delta N_2 \approx \underbrace{\epsilon_{N_2,TOT_1^2} * \Delta TOT_1^2}_{direct\ effect} + \underbrace{\epsilon_{N_2,TOT_3^2} * \Delta TOT_3^2}_{indirect\ effect} \tag{4.27}$$

where Δx is the growth rate of x.[6] Based on equation (4.27) the total effect can be decomposed and the relevance of differences in country characteristics on the components of ΔN_2 can be separated. The key question is then which country characteristics induce a dampened spillover effect by creating a negative indirect effect, i.e. a decrease in TOT_3^2 and which enhance the spillover through a positive indirect effect. Furthermore, it is of interest how the relevant characteristics for the size and sign of the indirect effect impact on the direct effect. And finally what are the quantitative implications for the overall spillover effect? How large or small can the spillover become and can the indirect effect possibly dominate the direct effect, turning the aggregated effect negative?

Simulation Procedure

In the next subsections, I describe the impact of several country characteristics within their empirically relevant range on ΔN_2. I proceed by updating the value of the selected parameter in the initial calibration of the model following the approach described in Subsection 4.1.7. Then, the effect of the reform for the newly calibrated

[6] It turns out that the approximation is relative precise in the following evaluations. I find all approximated values to be less than 1% above the true change in N_2.

model is calculated. This method entails that the implied parameter values, namely the job separation rate s, the matching efficiency χ and the vacancy posting costs ω, may adjust accordingly, especially when labour market related characteristics are subject of the analysis. The same applies for the country size when import preferences are varied. Alternatively, one could fixed these parameters to their values in the basic calibration and let the initial steady state values of unemployment, the job finding probability and the vacancy filling probability adjust. The drawback of this approach is that the resulting effects on employment over the value range of the selected parameter are not comparable anymore as the initial steady state employment level could differ. Therefore, I stick to the initial calibration assumptions.[7]

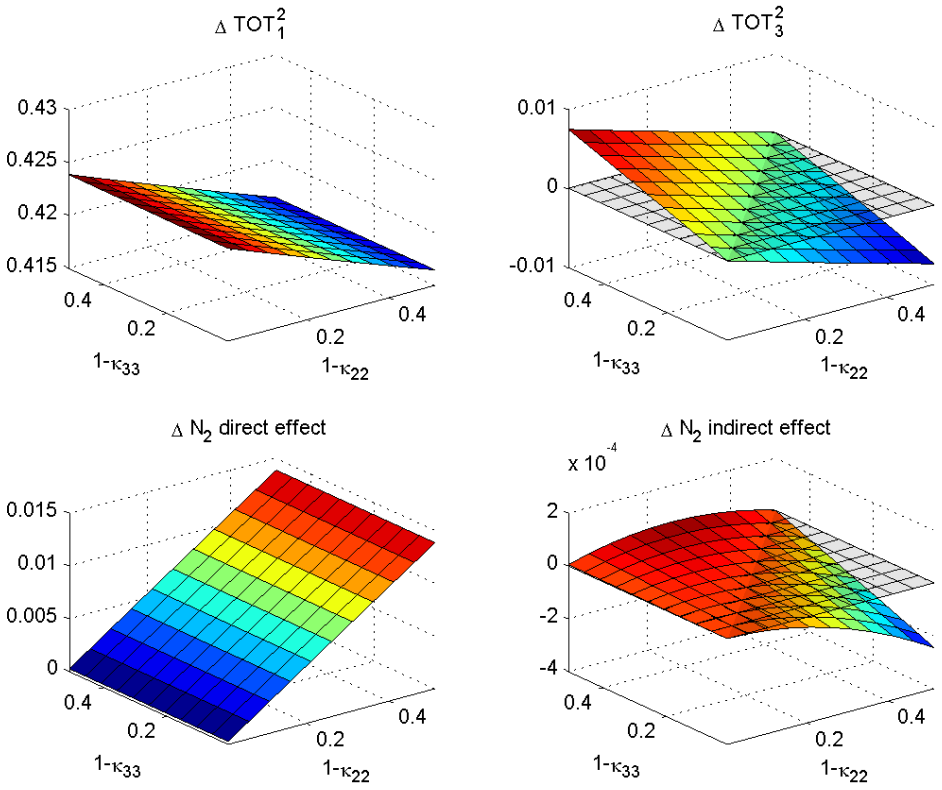
The results of the simulations are summarised in Table 4.3. The starting point is a detailed analysis of the importance of the openness and import preferences of the foreign countries. As these preferences have strong influence on the sign and size of the indirect effect and also on the size of the direct effect, I choose to tailor the consequent experiments to a more specific context. This consists in an open and sizeable reforming country, a small and very open country, for which I study the spillover effects and a big rest of the world country with a strong home bias (trade within this aggregate is not of relevance). This scenario is far from the baseline case with identical import preferences and country sizes but is more suitable to answer applied questions about the drivers of spillover effects from one country to another including third-country effects stemming from interaction with the rest of the world. One example is the analysis of the spillover effects of the German Hartz reforms to its neighbours in the European context, to which I refer in Section 4.3. The possibility to analyse such a scenario distinguishes the three-country model from the standard two-country models tailored for two large countries as well as from small open economy models. As such the framework would also be suited to analyse the implications of various reform scenarios discussed in Europe at the moment which need to be evaluated ex-ante as well as ex-post. Therefore, I investigate the impact of further country characteristics based on this asymmetric country constellation in the subsequent section.

[7] In addition, test simulations with this alternative calibration reveal that results do not differ fundamentally.

4.2.3 Trade Openness

All asymmetries between country 2 and 3 with respect to their own import preference parameters as well as between country 1's preferences for goods from country 2 and country 3 have an impact on ΔTOT_3^2. In other words, as long as country 1 has identical preferences for intermediates from country 2 and 3 ($\kappa_{12} = \kappa_{13}$), the trade relation between country 2 and 3 is symmetric ($\kappa_{23} = \kappa_{32}$), which together implies $\kappa_{22} = \kappa_{33}$, and these countries have symmetric preferences for the intermediate of country 1 ($\kappa_{21} = \kappa_{31}$), there is no indirect effect, given the non-openness related parameters are symmetric as well. In the following, I relax these symmetries stepwise to analyse their implications. As equation (4.26) shows, the marginal effect of a change in terms of trade with country 1 for employment in a country i is characterised by a large set of parameters as well as initial steady state values. Observe that if we assume all these parameters and initial conditions to be equal between countries in the following, with the exception of the import preferences κ_{ij}, then initial unemployment, labour-capital ratio and production have also to be equal.

I start by analysing the impact of overall openness of country 2 ($1 - \kappa_{22}$) and country 3 ($1 - \kappa_{33}$) on the employment spillover to country 2 while keeping the openness of country 1 fixed as in the baseline calibration, i.e. $1 - \kappa_{11} = 0.3$. Thereby, I keep the bilateral import preferences of each country symmetric, hence $\kappa_{ki} = \kappa_{ji} = (1 - \kappa_{ii})/2$. Recall that the model assumptions imply open countries to be smaller (in terms of output) than closed economies. In Figure 4.2 the upper two panels show the change of the terms of trade of country 2 with country 1 and country 3 due to the reduction in unemployment benefits b_1 as a function of $1 - \kappa_{22}$ and $1 - \kappa_{33}$. The lower panels of Figure 4.2 show the changes in N_2 separated in the direct and the indirect effect. ΔTOT_1^2 decreases with increasing openness of country 2. The direct effect, in contrast, increases as the rise in the elasticity due to the increasing openness dominates the terms of trade changes. The panels on the right hand side demonstrate the importance of the relative openness and country size between country 2 and 3 for the direction of ΔTOT_3^2 and the indirect effect. For $1 - \kappa_{22} > 1 - \kappa_{33}$, which implies $\pi_2 < \pi_3$, the reform leads to a stronger rise of TOT_1^3 than of TOT_1^2 and therefore triggers a depreciation of TOT_3^2 and in consequence a negative indirect effect. The opposite applies if country 2 is more open and bigger than country 3. Independent of the relatively openness, the absolute change in TOT_3^2 is relative small compared to TOT_1^2. The same applies to the indirect effect compared to the direct effect. Thus,

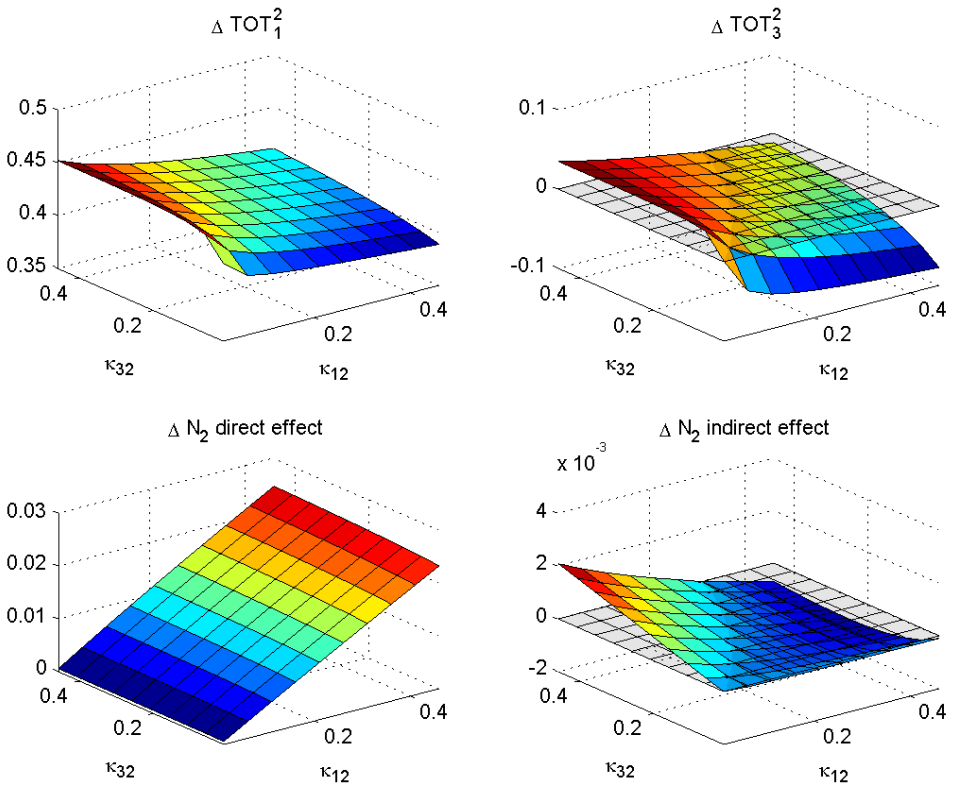


Notes: In this scenario $1 - \kappa_{11} = 0.3$. ϵ_{N_2,TOT_1^2} and ϵ_{N_2,TOT_3^2} increase both linear with growing openness $1 - \kappa_{22} = \kappa_{12} + \kappa_{32}$.

Fig. 4.2. Decomposition of Spillover in Direct and Indirect Effects with Varying Degrees of Openness in Country 2 and 3

the aggregated effect is very similar to the direct effect. The size of the employment spillover measured relative to the effect in the domestic economy, i.e. $\Delta N_2/\Delta N_1$, ranges between close to 0% for very high κ_{22} and 1.6% for a very open country 2 whose import share adds up to about 50% of output.

In the second step, I fix the overall openness of country 3 to $1 - \kappa_{33} = 0.1$ as I regard country 3 from now on as the large rest aggregate consistent with the empirical questions of interest. I vary the import preferences of country 2 κ_{12} and κ_{32} (in conjunction with $\kappa_{22} = 1 - \kappa_{12} - \kappa_{32}$) in Figure 4.3. Remember that ϵ_{N_2,TOT_1^2} increases in κ_{12} and ϵ_{N_2,TOT_3^2} in κ_{32}. This explains why the direct effect mainly depends on κ_{12} and rises with higher values of κ_{12}, whereas ΔTOT_1^2 decreases in κ_{12} and increases in κ_{32}. The indirect effect is most relevant for very small κ_{12} and relatively high κ_{32}, where it becomes several times as large as the direct effect. In

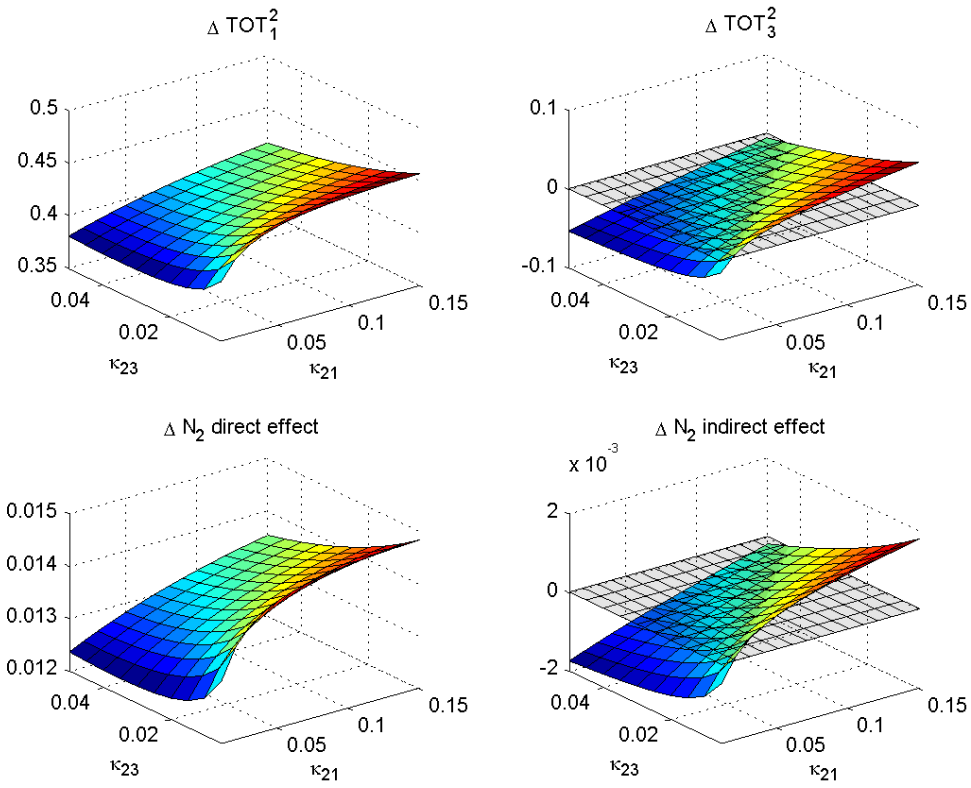


Notes: In this scenario $1 - \kappa_{11} = 0.3$ and $1 - \kappa_{33} = 0.1$. ϵ_{N_2,TOT_1^2} increases linear with growing κ_{12}, while ϵ_{N_2,TOT_3^2} increase linear with growing κ_{32}.

Fig. 4.3. Decomposition of Spillover in Direct and Indirect Effects for Varying κ_{12} and κ_{32}

contrast, it is negligible for a high import preference towards country 1 as it is dominated by a strong direct effect of close to 3%. Nevertheless, the absolute size of indirect effects is with maximal 0.002% very small. The range of $\Delta N_2/\Delta N_1$ extends from close to zero for a very closed country 2, i.e. very small κ_{12} and κ_{32}, to about 2.9% for small κ_{22} (see Table 4.3).

Finally, I also fix $1 - \kappa_{22} = 0.5$, which implies that country 2 represents a country which is more open and smaller than the reforming country. In Figure 4.4 I let the import shares of country 1 and 3 from country 2 float up to half of their overall openness adjusting κ_{13} and κ_{31} accordingly. The lower the import preference of country 3, the higher are the direct and indirect effect. The higher the import preference of country 1, the higher are both effects. In contrast to the other import preferences analysed before, κ_{21} and κ_{23} influence the direct and the indirect effect



Notes: In this scenario $1 - \kappa_{11} = 0.3$, $1 - \kappa_{33} = 0.1$ and $1 - \kappa_{22} = 0.5$. Both elasticities of employment are constant in $\kappa_2 1$ and $\kappa_2 3$.

Fig. 4.4. Decomposition of Spillover in Direct and Indirect Effects for Varying κ_{21} and κ_{23}

in the same direction. Hence, high direct effects are strengthened by the indirect effect, whereas low values of the direct effect are additionally reduced by the indirect effect. But the variation in size of the direct effect relative to ΔN_1 ranges only from 1.45% to 1.74% and the indirect effect is still small in comparison, varying between -0.21% and 0.21% of ΔN_1. Since ΔN_1 is lowest for high κ_{21} and low κ_{23}, the relative spillover size $\Delta N_2/\Delta N_1$ reaches with 1.94% its highest values for this constellation. For weak import preferences of country 1 towards country 2 and strong preferences of country 3, the relative size of the effect goes down to 1.24%.

Summarising the results of this subsection, import preferences in conjunction with the country size have a strong impact on the relative and absolute size of spillover effects. Very open countries with a strong trade relationship to the reforming country are likely to be subject to the strongest spillovers. While the direct effects

vary in a relative broad range, the indirect effects, whether they are positive or negative, are always relatively small. In addition, the import preference parameters having the strongest impact on the size of direct and indirect effects, κ_{12} and κ_{32} have an opposing impact on direct and indirect effects. Thus, the strongest direct effect is dampened by a negative indirect effect, whereas the weakest direct effect is strengthened by a relatively high positive indirect effect. As a result, negative indirect effects never overturn the direct effect, which yields a positive overall effect in all cases.

4.2.4 Further Country Characteristics

In the following, I discuss the impact of further country characteristics of the foreign countries which are of relevance for the labour market outcome there. Equation (4.26) suggests that there are many parameters and initial conditions which could potentially have an impact on the direct and indirect spillover effect. I explore these characteristics separately based on the previously introduced scenario with a small open second country ($\kappa_{22} = 0.5$), and a big and less open third country ($\kappa_{33} = 0.1$) representing the rest aggregate. The bilateral import preferences are assumed to be symmetric, i.e. $\kappa_{ji} = \kappa_{ki}$. This entails $\pi_1 = 0.22$, $\pi_2 = 0.13$ and $\pi_3 = 0.65$ everything else being symmetric as in the baseline calibration. Furthermore, the scenario implies that the indirect effect stemming from the reform is negative and amounts to a decrease in N_2 of 0.191 per mill (cf. Figure 4.2). While I check for the impact of characteristics of country 2 as well as of country 3 since both may be at the root of asymmetries, in the lower part of Table 4.3 only those of country 2 are summarised. This choice is based on the fact, that changes in the calibration of country 3 have in quantitative terms only a very limited or no influence at all on the size of employment spillovers to country 2. Detailed figures of the simulation results are provided in Appendix C.3. In the following, I discuss the consequence of differences in the country characteristics with a focus on those having a quantitative relevant impact.

- *Unemployment benefit ratio b/w:*

  A higher level of unemployment benefits in country 2 strengthens the direct spillover effect to employment by increasing the elasticity of employment in response to the change in terms of trade with country 1 ϵ_{N_2,TOT_1^2}.[8] Since ϵ_{N_2,TOT_3^2}

[8] A higher unemployment benefit ratio implies a lower cost of vacancy posting for a given level of unemployment in a country.

Table 4.3. Summary of Simulation Results

Parameter	Description[a]	Range	Impact on direct effect of ΔN_2		Impact on indirect effect of ΔN_2	
			Direction [b]	Size in % of ΔN_1	Direction [b]	Size in % of ΔN_1
Trade Openness						
$1-\kappa_{22}$	openness of c. 2	$[0.01, 0.5]$	$+$	$[0.03, 1.26]$	$-$ ($+$ if $\kappa_{33} \ll \kappa_{22}$)	$[-0.03, +0.00]$
$1-\kappa_{33}$	openness of c. 3	$[0.01, 0.5]$	0		$+$	
κ_{12} [c]	import pref. for c. 1 goods	$[0.01, 0.5]$	$+$	$[0.06, 2.88]$	$-$	$[-0.10, 0.24]$
κ_{32} [c]	import pref. for c. 3 goods	$[0.01, 0.5]$	$+$		$-$ ($+$ if $\kappa_{12} \ll \kappa_{32}$)	
κ_{21} [d]	import pref. of c. 1	$[0.01, 0.15]$	$+$	$[1.45, 1.74]$	$+$	$[-0.21, 0.21]$
κ_{23} [d]	import pref. of c. 3	$[0.01, 0.05]$	$-$		$-$	
Further Country Characteristics [e]						
b_2/w_2	unemployment benefit ratio	$[0.05, 0.5]$	$+$	$[1.08, 2.38]$	$-$	$[-0.05, -0.01]$
U_2	initial unemployment rate	$[0.03, 0.25]$	$+$	$[0.39, 4.27]$	$-$	$[-0.18, +0.00]$
α_2	capital share	$[0.2, 0.4]$	$+$	$[1.36, 1.71]$	$-$	$[-0.07, 0.03]$
ψ_2	elasticity of vacancies	$[0.2, 0.7]$	$+$	$[0.60, 2.32]$	$-$	$[-0.05, -0.00]$
τ_2^d	employees' labour tax	$[0.01, 0.31]$	$+$	$[1.45, 1.80]$	$-$	$[-0.03, -0.02]$
ϵ_2	bargaining power firms	$[0.2, 0.8]$	$+$	$[1.58, 1.62]$	$-$	$[-0.024, -0.022]$
ϕ_2	initial job finding probability	$[0.1, 0.9]$	$-$	$[1.57, 1.63]$	$+$	$[-0.024, -0.022]$

Notes: If not stated otherwise all parameters and initial values are calibrated symmetrically between countries as in the baseline scenario.

[a] All descriptions refer to country 2 if not explicitly labelled differently.

[b] Direction refers to the sign of the change in ΔN_2 after an increase the respective parameter.

[c] In this scenario $1-\kappa_{33} = 0.1$, $\kappa_{13} = \kappa_{23} = (1-\kappa_{33})/2$ and $\kappa_{22} = 1-\kappa_{12}-\kappa_{32}$.

[d] In this scenario $1-\kappa_{33} = 0.1$, $1-\kappa_{22} = 0.5$, $\kappa_{12} = \kappa_{32} = (1-\kappa_{22})/2$ and $\kappa_{31} = 1-\kappa_{11}-\kappa_{21}$, $\kappa_{13} = 1-\kappa_{33}-\kappa_{23}$.

[e] In these scenarios $1-\kappa_{33} = 0.1$, $\kappa_{13} = \kappa_{23} = (1-\kappa_{33})/2$ and $1-\kappa_{22} = 0.5$, $\kappa_{12} = \kappa_{32} = (1-\kappa_{22})/2$.

rises as well, it contemporaneously leads to a stronger negative indirect effect, thus opposing the direct effect. Nevertheless, the aggregated effect is stronger for higher b_2/w_2 as indirect effects play only a minimal role. For a generous unemployment benefit ratio of 40% in country 2 the relative size of the spillover $\Delta N_2/\Delta N_1$ amounts to 2.32%. Unsurprisingly, the unemployment benefit ratio of country 3 has only a slight impact on ΔTOT_3^2 but none on ΔTOT_1^2 as Figure C.2 in Appendix C.3 illustrates.

- *Pre-reform steady state unemployment level U:*
  Similar to the unemployment benefit ratio the unemployment rate in country 3 has only a minor impact on ΔTOT_3^2 and the indirect effect (see Figure C.3). In contrast, a very high initial unemployment rate in country 2 of about 20% yields a strong change in employment with a direct effect of over 0.036%, a negative indirect effect of -0.002% and a high relative overall effect above 4%. This increase is on the one hand driven by level effects. Higher unemployment in the model is equivalent to a lower number of employed agents and therefore the same absolute change translates into a bigger percentage change based on a lower initial employment rate. On the other hand, a higher initial unemployment rate implies a higher job separation rate in the calibration which in turn leads to a higher responsiveness of N_2 with respect to terms of trade with country 1 and 3 on the simulated value range.[9] For a very low initial U_2 (and high N_2 respectively) the direct and indirect spillover effect are close to zero.
- *Capital share α:*
  Differences in the capital share of income are a very crude but simple approach to account for differences in production technologies between countries. The higher the capital share in country 2, the stronger is the response of employment to changes in the terms of trade on the simulated interval from 20 to 40%. This results in an increase of the absolute as well as the relative size of the spillover to employment as the indirect effect is with -0.7 per mill to 0.3 per mill negligible and the rise in ϵ_{N_2,TOT_1^2} overturns the in α shrinking appreciation of TOT_1^2. Observe that α contemporaneously influences the relative country size: the country size decreases in capital share of the country. Since the capital share of country 3 diminishes the appreciation of country 3, on the one hand, and increases ΔTOT_1^2, on the other hand, by slightly increasing π_1 and π_2, it has a small positive impact on the spillover size as well (see Figure C.4). Overall, the changes in the absolute

[9] Observe that a higher level of unemployment also implies a slightly smaller country size.

and relative spillover size caused by the capital share of both countries is not very big. The relative spillover size ranges between 1.36% and 1.71%.

- *Elasticity of vacancies in the matching function ψ:*
  A stronger impact on the relative strength of the spillover to employment is exercised by the elasticity of the matching function ψ. If ψ_2 is well above the benchmark of 0.5, the relative spillover size approaches 2%, for values below 0.3, the relative spillover effect drops under 1%. Given the calibration, higher values of ψ on the value range from 0.2 to 0.8 lead to an increase in the elasticity of employment with respect to the terms of trade with both countries. Furthermore, for a given initial unemployment rate, job finding and vacancy filling probability, higher values of ψ imply a higher matching efficiency χ if the labour markets are not extremely tight, i.e. $\theta < 1$. Thus, the positive effect of ψ on the employment spillover is driven by an increasing direct effect which is marginally dampened by a negative and in ψ falling indirect effect (see Figure C.5).
- *Employees' tax rate on wages τ^d:*
  If the tax rate on wages paid by the employees in country 2 is higher at the time the reform in country 1 occurs, the overall spillover effect is higher too. Since the level of τ^d is taken into consideration, when wages are bargained (see equation (4.19)), it effects the calibration of the vacancy posting costs negatively. Thus, a higher τ^d leads to higher elasticities of employment with respect to terms of trade which strengthen the direct as well as the indirect spillover effect (see Figure C.6). The direct spillover increases from 1.45 to 1.80% of the domestic effect for a low tax rate of 1% to a very high tax rate of 31% while the indirect is of negligible magnitude. In contrast to τ^d, the tax rate employers pay on wages τ^f has no impact on spillover effects.

Unlike the just discussed country characteristics, the pre-reform steady state probability of finding a job ϕ and the bargaining power of the firm ϵ have quantitatively only a limited influence on the size of employment spillovers. A higher job finding probability implies a higher efficiency of matching χ in the model and thus decreases the vacancy posting cost of firms. The productivity increase due to the reform can therefore be mapped more efficiently into new jobs leading to a increase in foreign employment.[10] This effect, however, is minimal even for a very high initial probability as reported in Table 4.3. Similarly, strong changes in the level of ϵ_2 have only

[10] The result resembles a finding by Dao (2013a), that a higher degree of labour market rigidity in a foreign country (introduced by assuming a lower initial job finding rate) leads to higher spillover effects.

a small impact on the aggregated spillover effect, with higher levels of ϵ_2 leading to a slightly higher impact of the reform on foreign employment (see equation (4.26)). The reason is that more of the reform induced productivity gain in country 2 is used to increase employment (in place of wages) if firms have a stronger standing in the Nash bargaining.

To summarise the results for the non-trade related country characteristics, the indirect effect is in most cases very small compared to the direct effect. Furthermore, in most cases it opposes the direct effect in the sense that it assumes its lowest negative value for a parametrisation where the direct effect is at its maximum and adds positively to the direct effect when it is relatively low (see Table 4.3). This result implies that the aggregated spillover effect, which is given by the sum of the direct effect and the indirect effect, is positive in all simulations which matches the result of empirical studies by Felbermayr et al. (2013) and Dao (2013a).

The analysis has shown that country characteristics as the relative openness and bilateral import preferences, the unemployment rate, the unemployment benefit ratio, the capital share, the elasticity of matching and employee's wage taxes have non negligible effect on the overall size of the spillover and its components. In particular, the more open a country in general, but especially versus the reforming country, and the stronger (weaker) the import preferences of the reforming (third) country for intermediates from country 2, the stronger is the spillover to employment there. Furthermore, countries with high unemployment benefits and high unemployment rates, but also with a relatively high capital share, elasticity of matching or employee's wage tax rate benefit more from a labour market reform of their trading partners in terms of an increase in employment.

In the preceding simulations, I varied one parameter at a time and found that the relative size of the aggregated spillover effect measured as the ratio between the change of employment in the country of interest and the reforming country ranges between 0 and close to 4% for calibrations in an empirically realistic range. If I use for all analysed parameters and initial conditions the value from the tested (empirically plausible) range for which I obtained the strongest overall spillover,[11] the relative size of the aggregated spillover is more than 11%. This value exceeds the average of 9% estimated by Felbermayr et al. (2013). Thus, under certain conditions the model is able to generate employment spillovers which reach the empirically found average.

[11] I choose $\kappa_{21} = 0.29$, $\kappa_{31} = 0.01$, $\kappa_{12} = 0.4$, $\kappa_{32} = 0.1$, $\kappa_{23} = \kappa_{13} = 0.05$, $U_2 = 0.2$, $\phi_2 = 0.75$, $b_2 = 0.4$, $\tau^d = 0.3$, $\epsilon_2 = 0.8$, $\psi_2 = 0.7$ and $\alpha_2 = 0.4$.

The driving force of these high spillovers are, however, high direct effects, but not strong positive indirect effects.

4.3 The German Hartz IV Reform and its Impact on Different Neighbours

Finally, I present the model implications of the reform in the unemployment benefit scheme for three scenarios taking differing German neighbours, namely France, Belgium and Austria, as second country and assuming the third country to be the rest of the euro area 12 (EA12) countries (RoEA in the following). The three scenarios demonstrate how strongly the model predicts spillovers to vary in the long as well as in the short-run between heterogeneous countries in empirically relevant scenarios. France, Belgium and Austria are assumed to differ with respect to their calibration of labour market institutions and fiscal policy parameters as summarised in Table 4.4. While Belgium and France are relatively similar in most aspects, Austria's labour market situation differs strongly with a lower unemployment rate, average unemployment duration and unemployment benefit ratio. With exception of the trade preferences, Germany is parameterised as described in Subsection 4.1.7. The import preferences parameters for the different scenarios are calibrated to correspond to the respective import shares given in Table 4.5. In contrast to France, Austria and Belgium are very open countries with a home bias κ_{ii} of only 0.74 and 0.52 respectively. Both have a high import share with respect to Germany, but while Austria's trade relationship is strongly focused on Germany, Belgium trades also heavily with the RoEA. The country sizes implied by these import shares are close but not identical to the countries' GDP weights in the EA12.

The equilibrium effects of the reduction in the unemployment benefit ratio in Germany for Germany and the respective second country are summarised in Table 4.6. In the long run, the reaction of France resembles much that of the RoEA,[12] whereas spillovers to Belgium and Austria, depending on the outcome of interest, are two to three times the size of the RoEA or France. With respect to employment, I find the spillover effect to the second country to range between 0.3% and 0.8% of the original effect in Germany. France's labour force is the least affected, although its

[12] The results for the three differing EA aggregates vary only slightly with the composition of the RoEA and are very similar to the result for France. Therefore, I refrain from reporting them.

Table 4.4. Calibration of Heterogeneity in the Labour Market Institutions and Fiscal Policy

		Country 2			Country 3
		France	Belgium	Austria	RoEA
$1-N$	Unemployment rate	8.93	8.18	4.29	9.02 [a]
$1/\phi$	Av. duration of unemployment	15.50	16.57 [b]	3.88 [c]	16.57 [b]
ϕ	Job finding probability	19.35	18.11	77.23 [c]	18.11
b/wh	Unemployment benefit ratio	35.66	38.19	28.43	27.70 [d]
τ^f	Employers' labour tax	29.00	23.00	23.00	23.75 [d]
τ^d	Employees' labour tax	10.00	11.00	14.00	9.44 [d]
τ^c	Consumption tax	19.60	21.00	20.00	19.11 [d]

Notes: All numbers are in percentage points except the average duration of unemployment which is given in months and refer to the year 2003 if not stated otherwise.
[a] EA average unemployment rate as published by the OECD including Germany.
[b] The Belgian as well as the EA average duration of unemployment are approximated by the average duration of unemployment in the EU as published by the OECD owing to a lack of more precise data.
[c] 2004 values.
[d] These rates are calculated as EA-12 averages excluding Germany using GDP weights at PPP exchange rates of the corresponding year.
Sources: OECD Reference Series, INSEE, OECD Labour Market Statistics, OECD Benefits and Wages: Statistics, OECD Taxing Wages 2003, OECD Recent Tax Policy Trends and Reforms in OECD Countries 2004.

Table 4.5. Bilateral Import Shares

	From		
To	Germany	France	RoEA
Germany	0.8777	0.0248	0.0975
France	0.0450	0.8661	0.0888
RoEA	0.0615	0.0300	0.9086

	From		
To	Germany	Belgium	RoEA
Germany	0.8777	0.0175	0.1048
Belgium	0.1359	0.5193	0.3448
RoEA	0.0521	0.0189	0.9290

	From		
To	Germany	Austria	RoEA
Germany	0.8777	0.0121	0.1102
Austria	0.1798	0.7412	0.0790
RoEA	0.0510	0.0033	0.9457

Notes: RoEA refers to the EA12 excluding Germany and the respective second country. The reported import shares are mean values over the period 1999-2012.
Sources: IMF Direction of Trade Statistics, World Bank World Development Indicators.

Table 4.6. Percentage Change in Steady-State after a Reduction in b_1

	Country 1	Country 2		
	Germany	France	Belgium	Austria
N	0.866	0.002	0.007	0.004
U	-7.962	-0.024	-0.077	-0.084
ϕ	9.649	0.026	0.084	0.088
w	-0.767	0.010	0.031	0.040
Y	0.839	0.012	0.037	0.043
C	0.293	0.032	0.096	0.118
TOT_1^2		0.431	0.431	0.423
TOT_3^2		0.001	0.001	-0.008
ϵ_{N_2,TOT_1^2}		0.005	0.016	0.009
ϵ_{N_2,TOT_3^2}		0.011	0.040	0.004

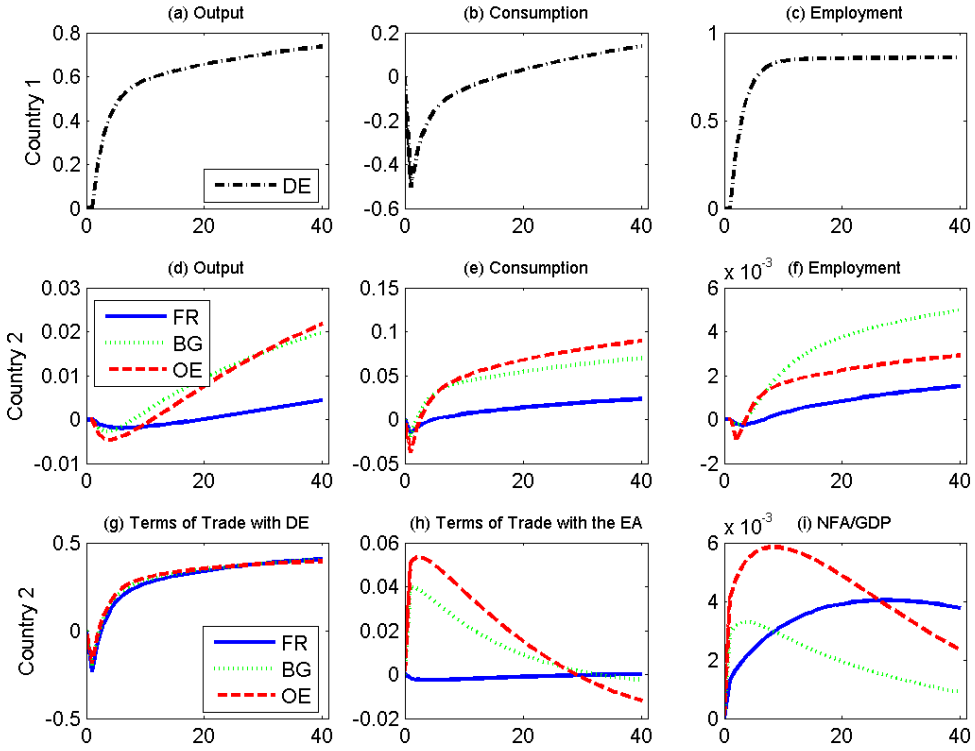
Note: All values in the upper part of the table measure the relative change from the pre-reform steady state to the post-reform steady state. The elasticities in the lower part are calculated at the initial steady state.

terms of trade change to the same extent as the Belgian.[13] The lower responsiveness of employment in France is driven by its less intense trade relationship with Germany relative to Belgium and Austria combined with its bigger country size which implies a smaller relative change in the traded quantities. In Austria, the country specific import preferences lead to a lower responsiveness of terms of trade in comparison to Belgium which is mainly due to stronger preference for RoEA goods in Belgium. The relatively less pronounced reaction of terms of trade due to the import preferences is partially countervailed by a better labour market situation and lower unemployment benefits which induce ceteris paribus a stronger increase in the terms of trade vis-à-vis Belgium and France. Because of its strong trade relation to Germany, which outstrips Belgium, and its very small country size, Austria is subject to the strongest percentage changes in terms of output, consumption and wages. Employment, on the contrary, is affected to a weaker extent than in Belgium percentagewise since it improves from a very high pre-reform level (see Table 4.4). To give a complete picture of the composition of the spillover effects, the elasticities of employment with respect

[13] Since labour market and fiscal institutions are very similar within these countries, the virtually identical terms of trade effects point to the fact that the effects stemming from differences in import preferences cancel out. In particular, the higher Belgian preference for German goods ($\kappa_{12}^{BG} > \kappa_{12}^{FR}$) and German preference for French goods ($\kappa_{21}^{FR} > \kappa_{21}^{BG}$), which would both imply that the French terms of trade effect should be higher according to the analysis above, counterbalance the higher Belgian preference for RoEA goods ($\kappa_{32}^{BG} > \kappa_{32}^{FR}$) and RoEA preference for French goods ($\kappa_{23}^{FR} > \kappa_{23}^{BG}$), which in turn point to a higher terms of trade effect in Belgium.

to the terms of trade calculated at the initial steady state are listed in the lower part of Table 4.6. Multiplying these elasticities with the respective terms of trades changes, reveals that the indirect effects, whether positive or negative, add less than 1% to the direct effect. For France and Belgium we observe a small appreciation vis-à-vis the RoEA, but obviously the strong import preferences of Belgium for German as well as for RoEA products yield a higher elasticity with respect to both terms of trade according to equation (4.26) and thus a higher direct and indirect effect on employment compared to France. The higher level of tightness in the Austrian labour market leads to a lower responsiveness of employment to changes in terms of trade there, even though κ_{12} is comparable between Austria and Belgium and κ_{32} between Austria and France. Interestingly, the indirect effect in Austria is negative, i.e. the terms of trade between Germany and Austria are less affected by the reform than between Germany and the RoEA. The negative effect stems from the relative large overall openness of Austria ($\kappa_{22} > \kappa_{33}$, compare Figure 4.2) and its strong focus on German imports ($\kappa_{12} > \kappa_{32}$, compare Figure 4.3) in contrast to France and Belgium. Thus, these import preferences imply a depreciation versus the RoEA, but at the same time strong κ_{12} and low κ_{32} mean a higher elasticity for the direct effect and a lower impact of the indirect effect.

The short-run response of selected variables is summarised in Figure 4.5. The first row shows the adjustments of output, consumption and employment of country 1, i.e. Germany, after a decline in its unemployment benefit ratio by 10 percentage points. Domestic employment and output rise monotonously whereas consumption initially drops due to a reduction in household income and intertemporal preferences, recovering slowly afterwards as described in Subsection 4.2.1. While the major adjustments in employment occur in the first two years, consumption and output approach the new equilibrium much slower. The same outcomes of country 2 are displayed in the second row of the figure for the three scenarios where country 2 is calibrated to French, Belgian and Austrian data. The third row contains the impulse responses of these countries' terms of trade with Germany and with the RoEA and their net foreign asset position as a share of their output. The reduction of unemployment benefits in Germany induces its relative prices with its trading partners to shift. As plot (g) reveals, the long-run appreciation of foreign terms of trade is preceded by a short initial depreciation. This development causes an initial small drop in employment abroad (plot f). Since in the first years after the reform the reaction of Austrian and Belgian terms of trade is stronger than that of the RoEA,



Note: All variables are expressed in percentage deviations from their pre-reform steady state with the exception of net foreign assets (NFA) which are given as share of output.

Fig. 4.5. Adjustments in Country 1 and 2 after a Reduction in b_1

these countries appreciate vis-à-vis the RoEA as displayed in plot (h). In contrast to equilibrium, in the short run the third-country terms of trade effects are sizeable amounting to more than 10% of the direct terms of trade effect with Germany in these two countries. Thus, they should tend to dampen the negative effect on employment.[14] For France, being very similar to the RoEA, we observe only a minimal effect on its terms of trade with the RoEA in the short run.

Thus, Austria as a very small country with a strong trade relationship to Germany is initially hit strongest by the adverse effects and profits most in the long

[14] In the short run, the impact of the adjustment in terms of trade on employment deviates from the steady state approximation of equation (4.27). The deviations occur as, on the one hand, out of steady state additional transmission effects arise from the international bond market and, on the other hand, the steady state conditions used when calculating elasticities with respect to terms of trade need not to hold during the convergence process towards the new steady state which does not occur at the same speed for all variables. The out-of-steady-state change in employment in the second country can therefore not simply be decomposed in a direct and indirect effect stemming from the changes in terms of trade.

run, at least in terms of output and consumption, by the German reforms. In addition, adjustments occur faster in this country as its labour market is tight and unemployment benefits at a low level compared to the other countries. This reflects also in the Austrian net foreign assets as share of output which is initially higher than in the other countries but reverts also fast, especially compared to France.

To wrap up, this section illustrated how differences in trade linkages as well as in institutions and initial situations among European countries lead to differences in the strength and propagation of spillovers after the same reform.

4.4 Conclusion

In this study, I explored the size of spillover effects to employment in a foreign country after a labour market reform in the domestic country. In contrast to previous studies, which mainly focus on a two-country scenario, my analysis considers the presence of a third (large) country. Thus, it explicitly includes indirect spillover effects caused by shifts in the relation of the country of interest and a third country in addition to the direct spillover effect stemming from shifts between the country of interest and the domestic country. In order to assess the direction and strength of these spillover components, I conducted simulations based on a standard international RBC model expanded to include a third country with search and matching frictions in the labour market. I found that the aggregated spillover size measured relative to the effect in the domestic country can be sizeable. It can reach the empirically estimated size documented by Felbermayr et al. (2012) of about one-tenth for specific country characteristics. Variation in the size of the spillover effects stems, however, mainly from changes in the size of the direct effect. The indirect effect turns out to be small in all calibrations. Hence, neither does it strongly increase the direct effect nor overturn the direct effect to yield a negative aggregated effect.

This result must be interpreted in the light of mechanisms included in the model. The direct and indirect spillover effects in the model are based on shifts in terms of trade, thus on competitiveness in terms of intermediate goods prices. The model does not capture non-price competitiveness factors like product quality. These play an important role in international competition as the study by Estrada et al. (2013) demonstrates and may, therefore, be of relevance for the size of third-country effects. The model also abstracts from shifts in import preferences which may be triggered by a reform. As the simulation results of Subsection 4.2.3 have shown, these preferences

have a big influence on the size of spillover effects. Finally, in the discussion on third-country effects, differences in the sector structure and specialisation between countries may also play a role for the size of direct and indirect effects. I only consider differences in the capital share in the production as a rough approximation. But these do not have major effects on the strength of direct and indirect spillovers. An alternative approach to take structural differences into account is an explicit modelling of a non-tradeable vs. tradeable sector as in Helpman and Itskhoki (2010). Such an extended model could provide additional insights and would therefore be a logical extension of this study.

5

Conclusion and Outlook

This thesis contributes three studies to a better understanding of how globalisation, i.e. the increase in cross-border trade and capital linkages, shapes the economic dependence and interaction between countries.

The first study, which is based on Busl and Kappler (2013), extends the literature on the determinants of business cycle synchronisation by investigating the importance of FDI-induced channels employing a panel approach suited to identify the direct transmission channels of idiosyncratic shocks. The results show that FDI acts as a force enhancing synchronisation between (OECD) countries, whereas trade linkages have no direct significant impact. The latter finding stands in contrast to the literature based on cross-section identification strategies, but is in line with other studies using the time-series dimension (see Kappler, 2011 or Kalemli-Ozcan et al., 2013). Unlike the cross-section methods, a panel approach allows to focus on the transmission of idiosyncratic shocks and to exclude common shocks as driver of comovement, which explains the diverging findings. The results of our analysis are limited to the fact that based on the panel approach with the available data it was not possible to identify indirect effects on the comovement of business cycles. These may arise due to the fact that e.g. FDI linkages have an impact on other determinants, i.e. trade or the similarity of the industry structure between countries. The development of new identification strategies for these indirect channels of synchronisation for the panel dimension is a challenging task for future research. A very important topic would thereby be to disentangle trade and FDI linkages. A promising starting point in the literature are studies which do not confine themselves to the contemporaneous relations but investigate the dynamic linkages exploiting the time-series dimension by means of panel vector autoregressive models and Granger-causality tests (see Aizenman and Noy, 2006 and Kappler, 2011).

The second study, based on Busl and Seymen (2013), was confined to assess the effects of a very specific idiosyncratic shock: the German labour market reforms in 2003-2005. In contrast to previous studies on these reforms, the focus of the analysis was on the macroeconomic national and international effects of the entire reform package. In particular, it addressed the question whether the weak consumption growth and wage increase coupled with the persistent current account surplus in Germany in the last decade were triggered by the reform laws. The analysis based on a two-country real business cycle model points to a partial responsibility of the reforms with respect to the consumption dampening and wage restraint helped by a decrease in the bargaining power of workers. The reforms, however, do not manifest in a (persistent) current account surplus. In the model, current accounts are allowed to be imbalanced through the existence of a simple structure of an incomplete financial market: an international bond market.[1] This might be the reason why a new model-based study by Kollmann et al. (2014) attributes the labour market reforms to have played a role in the German current account surplus. Thereby they challenge the results of the recent literature on the drivers of the current account. It would be an interesting exercise to extend the financial market structure in our model and to add more persistence in the behaviour of the investing agents, e.g. by habit formation, in order to see whether the findings with respect to the current account change. However, even though Kollmann et al. (2014) find the labour market reforms to be in parts responsible for the positive current account, they find only a very modest effect of the reforms on real activity in the euro area. Interestingly, their analysis builds on a three-country framework consisting in Germany, the rest of the euro area, and the rest of the world. Thus, they allow for third-country effects,[2] which are the subject of the third study.

The contribution of the third study, which is based on Busl (2014), lies in the detailed analysis of the potential direction and strength of such an indirect effect after an appreciation of the terms of trade caused by a labour market reform. The analysis was carried out in a standard international real business cycle model with labour market frictions extended to include a third country. The evaluation over varying country characteristics revealed that the indirect spillover effect to employment is very small in this model class and does not overturn the direct spillover, which is

[1] Note that the assumption of incomplete financial markets plays an important role for the international transmission of shocks (see Ghironi, 2006).

[2] In their estimated model, they consider in particular external demand shocks to Germany from the rest of the world.

always positive. A logical extension of this study would be the assessment of indirect effects in other model classes such as the trade models with heterogeneous firms (Ghironi and Melitz, 2005) and models with a sector of non-tradable goods (Helpman and Itskhoki, 2010). The latter type of models exhibits different implications with respect to spillovers already in the two-country case. Furthermore, medium to large-scale policy oriented models such as the QUEST model by the European Commission (Ratto et al., 2009) or the EAGLE model by the European Central Bank (Gomes et al., 2012) typically include three or more countries and allow therefore for indirect spillover effects. It would be interesting to evaluate the magnitude of the indirect effects in such models, as their explicit discussion and quantification is missing in studies like Gomes et al. (2011) or Kollmann et al. (2014).

To conclude, the literature has made great leaps forward to answer the manifold questions raised by the globalisation process. This thesis contributes by investigating three specific questions: the importance of FDI as a transmission channel of business cycle synchronisation, the internationally criticised effects of the German labour market reforms, and the relevance of indirect spillover effects. Finally, as the precedent paragraphs have shown, the effects of globalisation on the economic interplay between countries will offer research topics for the years to come.

A

Appendix to Chapter 2

A.1 Measures and Data Sources

Synchronisation: Negative absolute difference of real GDP growth, see equation (2.6). *Source:* OECD Economic Outlook.

HP-filtered synchronisation measure: Negative absolute difference of HP-filtered GDP. *Source:* OECD Economic Outlook.

Residual synchronisation measure: Negative absolute difference of real residual GDP growth after eliminating time and country-pair effects, see equations (2.13) and (2.14). *Source:* OECD Economic Outlook.

Relative synchronisation measure: Negative absolute difference of real GDP growth divided by average absolute GDP growth, see equation (2.15). *Source:* OECD Economic Outlook.

FDI integration: Sum of bilateral FDI inward and outward positions divided by the sum of nominal GDP, see equation (2.7). *Source:* OECD International Direct Investment Statistics; World Bank, World Development Indicators.

Alternative FDI integration: Sum of bilateral FDI inward and outward positions divided by the sum of total FDI positions, see equation (2.12). *Source:* OECD International Direct Investment Statistics.

Trade integration: Bilateral import and export divided by the sum of nominal GDP, see equation (2.8). *Source:* IMF, Direction of Trade Statistics; World Bank, World Development Indicators.

Alternative trade integration: Bilateral import and export divided by the sum of total trade, see equation (2.11). *Source:* IMF, Direction of Trade Statistics; World Bank, World Development Indicators.

Differences in the sector structure: Sum over negative absolute differences be-

tween value added shares for 41 sectors, see equation (2.9). *Source:* OECD STAN database.

Monetary policy: Absolute difference in short term interest rates (three month nominal interest rate, mainly interbank rates). *Source:* OECD Economic Outlook.

Fiscal policy: Absolute difference in government budget balance. *Source:* IMF, World Economic Outlook April 2012.

Return spreads between share price indices: Absolute difference in growth of share price index. *Source:* IMF, IFS

Volume-based measure of capital openness: Bilateral sum of gross private capital flows ratio to GDP. *Source:* World Bank WDI.

Economic similarity: Indicator based on nominal GDP following Egger (2000), see equation (2.10). *Source:* World Bank, World Development Indicators.

Overall economic development: Bilateral sum of GDP per capita (in PPP). *Source:* World Bank, International Comparison Program database.

Differences in economic development: Absolute differences in GDP per capita (in PPP). *Source:* World Bank, International Comparison Program database.

De jure economic integration: Ranking of bilateral degree of economic integration. *Source:* Baier and Bergstrand (2007), Database on Economic Integration Agreements.

De jure capital openness: Bilateral sum of an index measuring share holder rights. *Source:* La Porta et al. (1998).

Distance between the main economic centers: Mean of (by population) weighted distances between biggest cities/areas. *Source:* CEPII, GRAVITY dataset, http://www.cepii.fr/CEPII/en/bdd_modele/bdd.asp.

Common border: Dummy variables with value 1 if countries have a common border and 0 otherwise. *Source:* CEPII, GRAVITY dataset, http://www.cepii.fr/CEPII/en/bdd_modele/bdd.asp.

Table A.1. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Synchronisation	3360	-0.017	0.017	-0.169	0.000
HP-filtered Sync.	3360	-0.019	0.017	-0.107	0.000
Residual Sync.	3360	-0.017	0.017	-0.177	0.000
Relative Sync.	3360	-0.696	0.691	-4.496	0.000
FDI	2744	0.006	0.012	-0.001	0.119
FDI Alternative	2744	0.034	0.064	-0.002	0.540
Trade	3360	0.006	0.008	0.000	0.039
Trade Alternative	3360	0.033	0.048	0.001	0.549
Sectoral Differences	2685	0.329	0.106	0.107	0.823
Monetary Policy	3360	0.030	0.033	0.000	0.189
Fiscal Policy	2454	0.047	0.044	0.000	0.285
Return Spread	3022	0.173	0.202	0.000	2.115
Capital Openness	3345	-0.001	0.006	-0.036	0.030
Economic Similarity	3360	0.298	0.155	0.021	0.500
Economic Development	3360	5.390	1.104	2.760	9.289
Development Differences	3360	0.583	0.474	0.000	2.71
Economic Integration Agreements	2880	2.833	2.205	0.000	6.000
De Jure Capital Openness	3360	6.125	1.773	2.000	10.00
Distance	3360	3695	3203	379.2	11035
Common Border	3360	0.117	0.321	0.000	1.000

A.2 Additional Tables and Figures

Table A.2. Business Cycle Synchronisation: 2SLS Cross-Section Basic Specification (Including Time-Invariant Instruments)

	(1)	(2)	(3)
Period	1982-2009	1982-1998	1999-2009
FDI	0.118	-0.268	0.312
	(0.164)	(0.398)	(0.175)*
Trade	0.058	0.485	-0.400
	(0.208)	(0.251)*	(0.283)
Sectoral Differences	-0.000	0.004	-0.026
	(0.016)	(0.014)	(0.014)*
Monetary Policy	-0.120	-0.074	-0.135
	(0.037)***	(0.022)***	(0.058)**
Fiscal Policy	-0.029	-0.083	0.054
	(0.034)	(0.036)**	(0.025)**
N	120	102	120
Hansen's J Test			
χ^2 (d.f.)	7.47 (3)	1.62 (3)	2.49 (3)
p-value	.058	.655	.477

Notes: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table A.3. Business Cycle Synchronisation: EC2SLS with Cross-Section Averages instead of Year Dummies

	(1)	(2)	(3)	(4)	(5)
Instrumentation	Pars.	Ec. Diff.	Return Spread	EIA	L.FDI
Period	1983-2009	1983-2009	1983-2009	1988-2005	1983-2009
FDI	0.337	0.350	0.368	0.541	-0.018
	(0.095)***	(0.122)***	(0.122)***	(0.179)***	(0.063)
Trade	-0.248	-0.284	-0.276	-0.255	0.080
	(0.145)*	(0.186)	(0.175)	(0.240)	(0.190)
Sectoral Differences	-0.039	-0.039	-0.039	-0.031	-0.039
	(0.007)***	(0.008)***	(0.008)***	(0.010)***	(0.011)***
Monetary Policy	-0.092	-0.086	-0.084	-0.087	-0.055
	(0.022)***	(0.023)***	(0.023)***	(0.026)***	(0.024)**
Fiscal Policy	0.059	0.062	0.064	0.056	0.053
	(0.012)***	(0.012)***	(0.012)***	(0.015)***	(0.012)***
Cross-Section Averages	Yes	Yes	Yes	Yes	Yes
N	1,788	1,788	1,786	1,447	1,750
Hansen's J Test					
χ^2 (d.f.)	31.58 (13)	21.15 (15)	25.98 (15)	25.1 (15)	16.9 (15)
p-value	.003	.132	.038	.049	.325

Notes: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

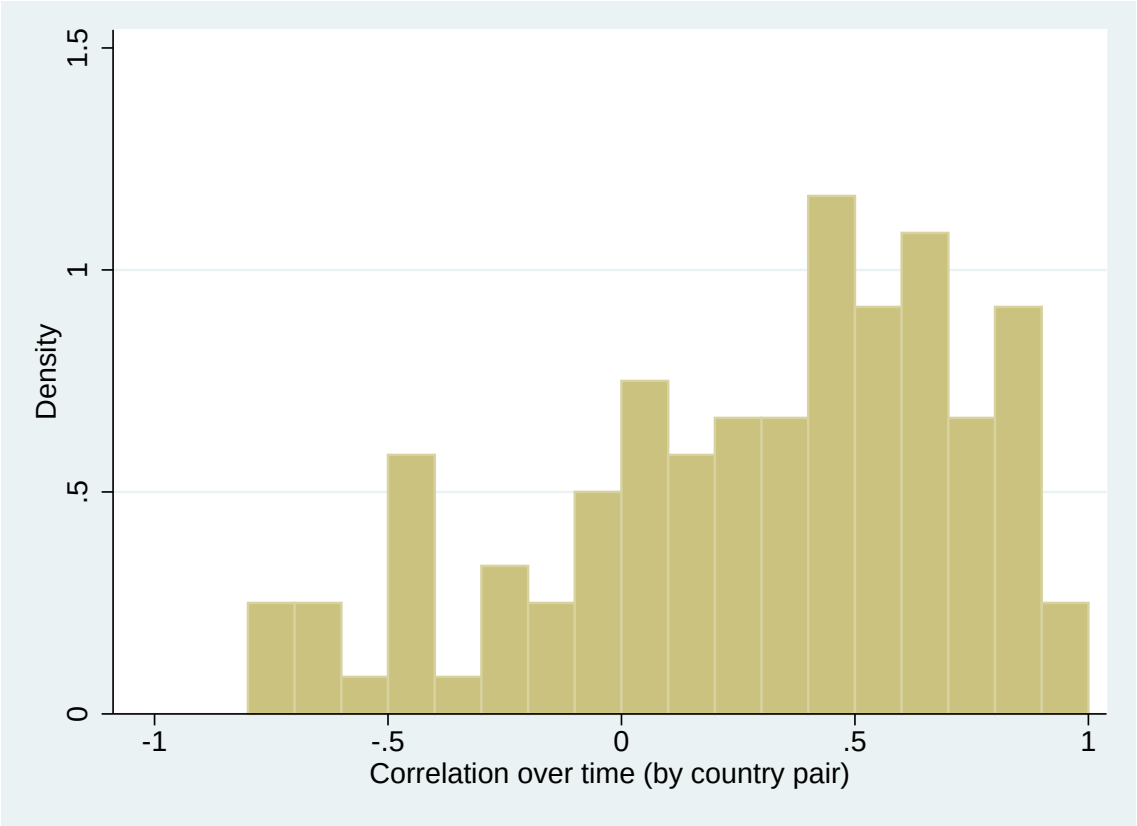


Fig. A.1. Distribution of "Within"-Correlation of Trade and FDI Integration

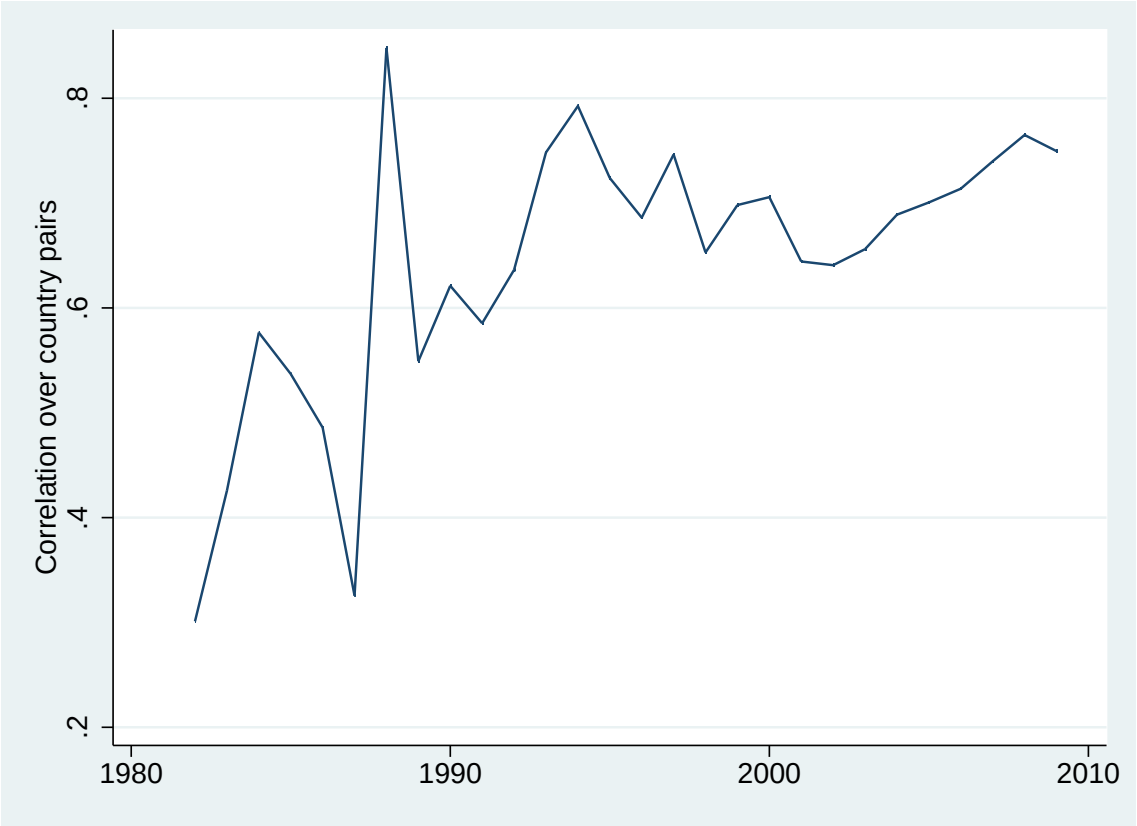


Fig. A.2. Evolution of "Between"-Correlation of Trade and FDI Integration

B

Appendix to Chapter 3

B.1 Equation System

B.1.1 Country 1

$$\left(1+\tau_1^c\right)P_{1t}^c C_{1t}^c + B_{1t+1} + P_{1t}^c \frac{\Phi_b}{2}\left(\frac{B_{1t+1}}{P_{1t}^c}\right)^2 = \\ = P_{1t}N_{1t}h_{1t}w_{1t}\left(1-\tau_1^d\right) + \left(1-N_{1t}\right)P_{1t}^c b_1 + B_{1t}\left(1+i_t\right) + T_{1t} + \Pi_{1t} \quad \text{(B.1)}$$

$$\frac{1}{C_{1t}^c} = \left(1+\tau_1^c\right)\lambda_{1t}P_{1t}^c \quad \text{(B.2)}$$

$$1 + \Phi_b \frac{B_{1t+1}}{P_{1t}^c} = \beta E_t\left[\frac{\lambda_{1t+1}}{\lambda_{1t}}\left(1+i_{t+1}\right)\right] \quad \text{(B.3)}$$

$$D_{1t}^c = \left[\kappa^{\frac{1}{\eta}} y_{11t}^{\frac{\eta-1}{\eta}} + \left(1-\kappa\right)^{\frac{1}{\eta}} y_{21t}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}} \quad \text{(B.4)}$$

$$y_{11t} = \kappa\left(\frac{P_{1t}^c}{P_{1t}}\right)^{\eta} D_{1t}^c \quad \text{(B.5)}$$

$$y_{21t} = \left(1-\kappa\right)\left(\frac{P_{1t}^c}{P_{2t}}\right)^{\eta} D_{1t}^c \quad \text{(B.6)}$$

$$\Pi_{1t} = P_{1t}Y_{1t} - P_{1t}N_{1t}h_{1t}w_{1t}\left(1+\tau_1^f\right) - \omega_1 P_{1t}^c V_{1t} - P_{1t}^c I_{1t}^c - P_{1t}^c \frac{\Phi_I}{2}\frac{\left(K_{1t+1}-K_{1t}\right)^2}{K_{1t}} \quad \text{(B.7)}$$

$$Y_{1t} = A_1 K_{1t}^{\alpha} \left(N_{1t} h_{1t}\right)^{1-\alpha} \tag{B.8}$$

$$N_{1t+1} = \left(1 - s_1\right) N_{1t} + H_{1t} \tag{B.9}$$

$$K_{1t+1} = \left(1 - \delta\right) K_{1t} + I_{1t}^{c} \tag{B.10}$$

$$q_{1t}^{T} = 1 + \Phi_I \frac{I_{1t}^{c} - \delta K_{1t}}{K_{1t}} \tag{B.11}$$

$$z_{1t} = \frac{P_{1t}}{P_{1t}^{c}} \left(1 - \alpha\right) \frac{Y_{1t}}{N_{1t}} \tag{B.12}$$

$$q_{1t}^{T} = \beta E_t \left[\frac{P_{1t+1}^{c} \lambda_{1t+1}}{P_{1t}^{c} \lambda_{1t}} \left\{ \frac{P_{1t+1}}{P_{1t+1}^{c}} \alpha \frac{Y_{1t+1}}{K_{1t+1}} + q_{1t+1}^{T} - \delta + \frac{\Phi_I}{2} \left(\frac{I_{1t+1}^{c} - \delta K_{1t+1}}{K_{1t+1}} \right)^2 \right\} \right] \tag{B.13}$$

$$\frac{\omega_1}{H_{1t}/V_{1t}} = \\ = \beta E_t \left[\frac{P_{1t+1}^{c} \lambda_{1t+1}}{P_{1t}^{c} \lambda_{1t}} \left\{ z_{1t+1} - \frac{P_{1t+1}}{P_{1t+1}^{c}} h_{1t+1} w_{1t+1} \left(1 + \tau_1^{f}\right) + \left(1 - s_1\right) \frac{\omega_1}{H_{1t+1}/V_{1t+1}} \right\} \right] \tag{B.14}$$

$$H_{1t} = \chi_1 V_{1t}^{\psi} \left(1 - N_{1t}\right)^{1-\psi} \tag{B.15}$$

$$w_{1t} h_{1t} = \frac{1 - \epsilon}{1 + \tau_1^{f}} \frac{P_{1t}^{c}}{P_{1t}} \left[\omega_1 \theta_{1t} + z_{1t}\right] + \frac{\epsilon}{1 - \tau_1^{d}} \left[\frac{P_{1t}^{c}}{P_{1t}} b_1 + \frac{1}{\lambda_{1t}} \left(\kappa_1^{u} - \kappa_1^{n} \frac{\left(1 - h_{1t}\right)^{1-\xi}}{1 - \xi} \right) \right] \tag{B.16}$$

$$\frac{\kappa_1^{n}}{\lambda_{1t}} \left(1 - h_{1t}\right)^{-\xi} = \frac{1 - \tau_1^{d}}{1 + \tau_1^{f}} \left(1 - \alpha\right) \frac{Y_{1t}}{N_{1t} h_{1t}} \tag{B.17}$$

$$\theta_{1t} = V_{1t}/\left(1 - N_{1t}\right) \tag{B.18}$$

$$\tau_1^{c} P_{1t}^{c} C_{1t}^{c} + \left(\tau_1^{d} + \tau_1^{f}\right) P_{1t} N_{1t} h_{1t} w_{1t} = T_{1t} + \left(1 - N_{1t}\right) P_{1t}^{c} b_1 \tag{B.19}$$

$$U_{1t} = 1 - N_{1t} \tag{B.20}$$

$$\phi_{1t} = H_{1t}/U_{1t} \tag{B.21}$$

$$TB_{1t} = P_{1t} Y_{1t} - P_{1t}^{c} D_{1t}^{c} \tag{B.22}$$

B.1.2 Country 2

$$\left(1 + \tau_2^{c}\right) P_{2t}^{c} C_{2t}^{c} + B_{2t+1} + P_{2t}^{c} \frac{\Phi_b}{2} \left(\frac{B_{2t+1}}{P_{2t}^{c}} \right)^2 = \\ = P_{2t} N_{2t} h_{2t} w_{2t} \left(1 - \tau_2^{d}\right) + \left(1 - N_{2t}\right) P_{2t}^{c} b_2 + B_{2t} \left(1 + i_t\right) + T_{2t} + \Pi_{2t} \tag{B.23}$$

$$\frac{1}{C_{2t}^c} = (1+\tau_2^c)\,\lambda_{2t} P_{2t}^c \tag{B.24}$$

$$1+\Phi_b \frac{B_{2t+1}}{P_{2t}^c} = \beta E_t\left[\frac{\lambda_{2t+1}}{\lambda_{2t}}\,(1+i_{t+1})\right] \tag{B.25}$$

$$D_{2t}^c = \left[\kappa^{\frac{1}{\eta}} y_{22t}^{\frac{\eta-1}{\eta}} + (1-\kappa)^{\frac{1}{\eta}}\, y_{12t}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}} \tag{B.26}$$

$$y_{12t} = (1-\kappa)\left(\frac{P_{2t}^c}{P_{1t}}\right)^{\eta} D_{2t}^c \tag{B.27}$$

$$y_{22t} = \kappa\left(\frac{P_{2t}^c}{P_{2t}}\right)^{\eta} D_{2t}^c \tag{B.28}$$

$$\Pi_{2t} = P_{2t}Y_{2t} - P_{2t}N_{2t}h_{2t}w_{2t}\left(1+\tau_2^f\right) - \omega_2 P_{2t}^c V_{2t} - P_{2t}^c I_{2t}^c - P_{2t}^c \frac{\Phi_I}{2}\frac{\left(K_{2t+1}-K_{2t}\right)^2}{K_{2t}} \tag{B.29}$$

$$Y_{2t} = A_2 K_{2t}^{\alpha}\left(N_{2t}h_{2t}\right)^{1-\alpha} \tag{B.30}$$

$$N_{2t+1} = (1-s_2)\,N_{2t} + H_{2t} \tag{B.31}$$

$$K_{2t+1} = (1-\delta)\,K_{2t} + I_{2t}^c \tag{B.32}$$

$$q_{2t}^T = 1 + \Phi_I \frac{I_{2t}^c - \delta K_{2t}}{K_{2t}} \tag{B.33}$$

$$z_{2t} = \frac{P_{2t}}{P_{2t}^c}\,(1-\alpha)\,\frac{Y_{2t}}{N_{2t}} \tag{B.34}$$

$$q_{2t}^T = \beta E_t\left[\frac{P_{2t+1}^c\lambda_{2t+1}}{P_{2t}^c\lambda_{2t}}\left\{\frac{P_{2t+1}}{P_{2t+1}^c}\alpha\frac{Y_{2t+1}}{K_{2t+1}} + q_{2t+1}^T - \delta + \frac{\Phi_I}{2}\left(\frac{I_{2t+1}^c - \delta K_{2t+1}}{K_{2t+1}}\right)^2\right\}\right] \tag{B.35}$$

$$\frac{\omega_2}{H_{2t}/V_{2t}} = \\ = \beta E_t\left[\frac{P_{2t+1}^c\lambda_{2t+1}}{P_{2t}^c\lambda_{2t}}\left\{z_{2t+1} - \frac{P_{2t+1}}{P_{2t+1}^c}h_{2t+1}w_{2t+1}\left(1+\tau_2^f\right) + (1-s_2)\,\frac{\omega_2}{H_{2t+1}/V_{2t+1}}\right\}\right] \tag{B.36}$$

$$H_{2t} = \chi_2 V_{2t}^{\psi}\left(1-N_{2t}\right)^{1-\psi} \tag{B.37}$$

$$w_{2t}h_{2t} = \frac{1-\epsilon}{1+\tau_2^f}\frac{P_{2t}^c}{P_{2t}}\left[\omega_2\theta_{2t} + z_{2t}\right] + \frac{\epsilon}{1-\tau_2^d}\left[\frac{P_{2t}^c}{P_{2t}}b_2 + \frac{1}{\lambda_{2t}}\left(\kappa_2^u - \kappa_2^n\frac{(1-h_{2t})^{1-\xi}}{1-\xi}\right)\right] \tag{B.38}$$

$$\frac{\kappa_2^n}{\lambda_{2t}}\left(1-h_{2t}\right)^{-\xi}=\frac{1-\tau_2^d}{1+\tau_2^f}\left(1-\alpha\right)\frac{Y_{2t}}{N_{2t}h_{2t}} \tag{B.39}$$

$$\theta_{2t}=V_{2t}/(1-N_{2t}) \tag{B.40}$$

$$\tau_2^c P_{2t}^c C_{2t}^c+\left(\tau_2^d+\tau_2^f\right)P_{2t}N_{2t}h_{2t}w_{2t}=T_{2t}+\left(1-N_{2t}\right)P_{2t}^c b_2 \tag{B.41}$$

$$U_{2t}=1-N_{2t} \tag{B.42}$$

$$\phi_{2t}=H_{2t}/U_{2t} \tag{B.43}$$

$$TB_{2t}=P_{2t}Y_{2t}-P_{2t}^c D_{2t}^c \tag{B.44}$$

B.1.3 Equilibrium

$$Y_{1t}=y_{11t}+y_{12t} \tag{B.45}$$

$$\left(Y_{2t}=y_{21t}+y_{22t}\right) \tag{B.46}$$

$$B_{1t+1}+B_{2t+1}=0 \tag{B.47}$$

$$D_{1t}^c=C_{1t}^c+I_{1t}^c+\omega_1 V_{1t}+\frac{\Phi_I}{2}\frac{\left(K_{1t+1}-K_{1t}\right)^2}{K_{1t}}+\frac{\Phi_b}{2}\left(\frac{B_{1t+1}}{P_{1t}^c}\right)^2 \tag{B.48}$$

$$D_{2t}^c=C_{2t}^c+I_{2t}^c+\omega_2 V_{2t}+\frac{\Phi_I}{2}\frac{\left(K_{2t+1}-K_{2t}\right)^2}{K_{2t}}+\frac{\Phi_b}{2}\left(\frac{B_{2t+1}}{P_{2t}^c}\right)^2 \tag{B.49}$$

C

Appendix to Chapter 4

C.1 Equation System

C.1.1 Country 1

$$\left(1+\tau_1^c\right)P_{1t}^c C_{1t}^c + B_{1t+1} + P_{1t}^c \frac{\Phi_b}{2}\left(\frac{B_{1t+1}}{P_{1t}^c}\right)^2 = \\ = P_{1t}N_{1t}w_{1t}\left(1-\tau_1^d\right) + \left(1-N_{1t}\right)P_{1t}^c b_1 + B_{1t}\left(1+i_t\right) + T_{1t} + \Pi_{1t} \quad \text{(C.1)}$$

$$\frac{1}{C_{1t}^c} = \left(1+\tau_1^c\right)\lambda_{1t}P_{1t}^c \quad \text{(C.2)}$$

$$1 + \Phi_b \frac{B_{1t+1}}{P_{1t}^c} = \beta E_t\left[\frac{\lambda_{1t+1}}{\lambda_{1t}}\left(1+i_{t+1}\right)\right] \quad \text{(C.3)}$$

$$D_{1t}^c = \left[\kappa_{11}^{\frac{1}{\eta}} y_{11t}^{\frac{\eta-1}{\eta}} + \kappa_{21}^{\frac{1}{\eta}} y_{21t}^{\frac{\eta-1}{\eta}} + \kappa_{31}^{\frac{1}{\eta}} y_{31t}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}} \quad \text{(C.4)}$$

$$y_{11t} = \kappa_{11}\left(\frac{P_{1t}^c}{P_{1t}}\right)^{\eta} D_{1t}^c \quad \text{(C.5)}$$

$$y_{21t} = \kappa_{21}\left(\frac{P_{1t}^c}{P_{2t}}\right)^{\eta} D_{1t}^c \quad \text{(C.6)}$$

$$y_{31t} = \kappa_{31}\left(\frac{P_{1t}^c}{P_{3t}}\right)^{\eta} D_{1t}^c \quad \text{(C.7)}$$

$$\Pi_{1t} = P_{1t}Y_{1t} - P_{1t}N_{1t}w_{1t}\left(1+\tau_1^f\right) - \omega_1 P_{1t}^c V_{1t} - P_{1t}^c I_{1t}^c - P_{1t}^c \frac{\Phi_I}{2}\frac{\left(K_{1t+1}-K_{1t}\right)^2}{K_{1t}} \quad \text{(C.8)}$$

$$Y_{1t} = A_1 K_{1t}^{\alpha} N_{1t}^{1-\alpha} \tag{C.9}$$

$$N_{1t+1} = (1 - s_1) N_{1t} + H_{1t} \tag{C.10}$$

$$K_{1t+1} = (1 - \delta) K_{1t} + I_{1t}^c \tag{C.11}$$

$$q_{1t}^T = 1 + \Phi_I \frac{I_{1t}^c - \delta K_{1t}}{K_{1t}} \tag{C.12}$$

$$z_{1t} = \frac{P_{1t}}{P_{1t}^c} (1 - \alpha) \frac{Y_{1t}}{N_{1t}} \tag{C.13}$$

$$q_{1t}^T = \beta E_t \left[\frac{P_{1t+1}^c \lambda_{1t+1}}{P_{1t}^c \lambda_{1t}} \left\{ \frac{P_{1t+1}}{P_{1t+1}^c} \alpha \frac{Y_{1t+1}}{K_{1t+1}} + q_{1t+1}^T - \delta + \frac{\Phi_I}{2} \left(\frac{I_{1t+1}^c - \delta K_{1t+1}}{K_{1t+1}} \right)^2 \right\} \right] \tag{C.14}$$

$$\frac{\omega_1}{H_{1t}/V_{1t}} = \beta E_t \left[\frac{P_{1t+1}^c \lambda_{1t+1}}{P_{1t}^c \lambda_{1t}} \left\{ z_{1t+1} - \frac{P_{1t+1}}{P_{1t+1}^c} w_{1t+1} \left(1 + \tau_1^f \right) + (1 - s_1) \frac{\omega_1}{H_{1t+1}/V_{1t+1}} \right\} \right] \tag{C.15}$$

$$H_{1t} = \chi_1 V_{1t}^{\psi} (1 - N_{1t})^{1-\psi} \tag{C.16}$$

$$w_{1t} = \frac{1 - \epsilon}{1 + \tau_1^f} \frac{P_{1t}^c}{P_{1t}} [\omega_1 \theta_{1t} + z_{1t}] + \frac{\epsilon}{1 - \tau_1^d} \frac{P_{1t}^c}{P_{1t}} b_1 \tag{C.17}$$

$$\theta_{1t} = V_{1t}/(1 - N_{1t}) \tag{C.18}$$

$$\tau_1^c P_{1t}^c C_{1t}^c + \left(\tau_1^d + \tau_1^f \right) P_{1t} N_{1t} w_{1t} = T_{1t} + (1 - N_{1t}) P_{1t}^c b_1 \tag{C.19}$$

$$U_{1t} = 1 - N_{1t} \tag{C.20}$$

$$\phi_{1t} = H_{1t}/U_{1t} \tag{C.21}$$

$$TB_{1t} = P_{1t} Y_{1t} - P_{1t}^c D_{1t}^c \tag{C.22}$$

C.1.2 Country 2

$$(1 + \tau_2^c) P_{2t}^c C_{2t}^c + B_{2t+1} + P_{2t}^c \frac{\Phi_b}{2} \left(\frac{B_{2t+1}}{P_{2t}^c} \right)^2 =$$
$$= P_{2t} N_{2t} w_{2t} \left(1 - \tau_2^d \right) + (1 - N_{2t}) P_{2t}^c b_2 + B_{2t} (1 + i_t) + T_{2t} + \Pi_{2t} \tag{C.23}$$

$$\frac{1}{C_{2t}^c} = (1+\tau_2^c)\,\lambda_{2t} P_{2t}^c \tag{C.24}$$

$$1+\Phi_b \frac{B_{2t+1}}{P_{2t}^c} = \beta E_t\left[\frac{\lambda_{2t+1}}{\lambda_{2t}}\,(1+i_{t+1})\right] \tag{C.25}$$

$$D_{2t}^c = \left[\kappa_{12}^{\frac{1}{\eta}} y_{12t}^{\frac{\eta-1}{\eta}} + \kappa_{22}^{\frac{1}{\eta}} y_{22t}^{\frac{\eta-1}{\eta}} + \kappa_{32}^{\frac{1}{\eta}} y_{32t}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}} \tag{C.26}$$

$$y_{12t} = \kappa_{12}\left(\frac{P_{2t}^c}{P_{1t}}\right)^{\eta} D_{2t}^c \tag{C.27}$$

$$y_{22t} = \kappa_{22}\left(\frac{P_{2t}^c}{P_{2t}}\right)^{\eta} D_{2t}^c \tag{C.28}$$

$$y_{32t} = \kappa_{32}\left(\frac{P_{2t}^c}{P_{3t}}\right)^{\eta} D_{2t}^c \tag{C.29}$$

$$\Pi_{2t} = P_{2t}Y_{2t} - P_{2t}N_{2t}w_{2t}\left(1+\tau_2^f\right) - \omega_2 P_{2t}^c V_{2t} - P_{2t}^c I_{2t}^c - P_{2t}^c \frac{\Phi_I}{2}\frac{\left(K_{2t+1}-K_{2t}\right)^2}{K_{2t}} \tag{C.30}$$

$$Y_{2t} = A_2 K_{2t}^{\alpha} N_{2t}^{1-\alpha} \tag{C.31}$$

$$N_{2t+1} = (1-s_2)\,N_{2t} + H_{2t} \tag{C.32}$$

$$K_{2t+1} = (1-\delta)\,K_{2t} + I_{2t}^c \tag{C.33}$$

$$q_{2t}^T = 1 + \Phi_I \frac{I_{2t}^c - \delta K_{2t}}{K_{2t}} \tag{C.34}$$

$$z_{2t} = \frac{P_{2t}}{P_{2t}^c}\,(1-\alpha)\,\frac{Y_{2t}}{N_{2t}} \tag{C.35}$$

$$q_{2t}^T = \beta E_t\left[\frac{P_{2t+1}^c \lambda_{2t+1}}{P_{2t}^c \lambda_{2t}}\left\{\frac{P_{2t+1}}{P_{2t+1}^c}\alpha\frac{Y_{2t+1}}{K_{2t+1}} + q_{2t+1}^T - \delta + \frac{\Phi_I}{2}\left(\frac{I_{2t+1}^c - \delta K_{2t+1}}{K_{2t+1}}\right)^2\right\}\right] \tag{C.36}$$

$$\frac{\omega_2}{H_{2t}/V_{2t}} = \beta E_t\left[\frac{P_{2t+1}^c \lambda_{2t+1}}{P_{2t}^c \lambda_{2t}}\left\{z_{2t+1} - \frac{P_{2t+1}}{P_{2t+1}^c} w_{2t+1}\left(1+\tau_2^f\right) + (1-s_2)\,\frac{\omega_2}{H_{2t+1}/V_{2t+1}}\right\}\right] \tag{C.37}$$

$$H_{2t} = \chi_2 V_{2t}^{\psi} \left(1 - N_{2t}\right)^{1-\psi} \tag{C.38}$$

$$w_{2t} = \frac{1-\epsilon}{1+\tau_2^f} \frac{P_{2t}^c}{P_{2t}} \left[\omega_2 \theta_{2t} + z_{2t}\right] + \frac{\epsilon}{1-\tau_2^d} \frac{P_{2t}^c}{P_{2t}} b_2 \tag{C.39}$$

$$\theta_{2t} = V_{2t}/(1 - N_{2t}) \tag{C.40}$$

$$\tau_2^c P_{2t}^c C_{2t}^c + \left(\tau_2^d + \tau_2^f\right) P_{2t} N_{2t} w_{2t} = T_{2t} + \left(1 - N_{2t}\right) P_{2t}^c b_2 \tag{C.41}$$

$$U_{2t} = 1 - N_{2t} \tag{C.42}$$

$$\phi_{2t} = H_{2t}/U_{2t} \tag{C.43}$$

$$TB_{2t} = P_{2t} Y_{2t} - P_{2t}^c D_{2t}^c \tag{C.44}$$

$$TOT_{3t}^2 = P_{3t}/P_{2t} \tag{C.45}$$

C.1.3 Country 3

$$\left(1 + \tau_3^c\right) P_{3t}^c C_{3t}^c + B_{3t+1} + P_{3t}^c \frac{\Phi_b}{2} \left(\frac{B_{3t+1}}{P_{3t}^c}\right)^2 =$$
$$= P_{3t} N_{3t} w_{3t} \left(1 - \tau_3^d\right) + \left(1 - N_{3t}\right) P_{3t}^c b_3 + B_{3t} \left(1 + i_t\right) + T_{3t} + \Pi_{3t} \tag{C.46}$$

$$\frac{1}{C_{3t}^c} = \left(1 + \tau_3^c\right) \lambda_{3t} P_{3t}^c \tag{C.47}$$

$$1 + \Phi_b \frac{B_{3t+1}}{P_{3t}^c} = \beta E_t \left[\frac{\lambda_{3t+1}}{\lambda_{3t}} \left(1 + i_{t+1}\right)\right] \tag{C.48}$$

$$D_{3t}^c = \left[\kappa_{13}^{\frac{1}{\eta}} y_{13t}^{\frac{\eta-1}{\eta}} + \kappa_{23}^{\frac{1}{\eta}} y_{23t}^{\frac{\eta-1}{\eta}} + \kappa_{33}^{\frac{1}{\eta}} y_{33t}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}} \tag{C.49}$$

$$y_{13t} = \kappa_{13} \left(\frac{P_{3t}^c}{P_{1t}}\right)^{\eta} D_{3t}^c \tag{C.50}$$

$$y_{23t} = \kappa_{23} \left(\frac{P_{3t}^c}{P_{2t}}\right)^{\eta} D_{3t}^c \tag{C.51}$$

$$y_{33t} = \kappa_{33} \left(\frac{P_{3t}^c}{P_{3t}}\right)^{\eta} D_{3t}^c \tag{C.52}$$

$$\Pi_{3t} = P_{3t} Y_{3t} - P_{3t} N_{3t} w_{3t} \left(1 + \tau_3^f\right) - \omega_3 P_{3t}^c V_{3t} - P_{3t}^c I_{3t}^c - P_{3t}^c \frac{\Phi_I}{2} \frac{\left(K_{3t+1} - K_{3t}\right)^2}{K_{3t}} \tag{C.53}$$

$$Y_{3t} = A_3 K_{3t}^{\alpha} N_{3t}^{1-\alpha} \tag{C.54}$$

$$N_{3t+1} = (1 - s_3) N_{3t} + H_{3t} \tag{C.55}$$

$$K_{3t+1} = (1 - \delta) K_{3t} + I_{3t}^{c} \tag{C.56}$$

$$q_{3t}^{T} = 1 + \Phi_I \frac{I_{3t}^{c} - \delta K_{3t}}{K_{3t}} \tag{C.57}$$

$$z_{3t} = \frac{P_{3t}}{P_{3t}^{c}} (1 - \alpha) \frac{Y_{3t}}{N_{3t}} \tag{C.58}$$

$$q_{3t}^{T} = \beta E_t \left[\frac{P_{3t+1}^{c} \lambda_{3t+1}}{P_{3t}^{c} \lambda_{3t}} \left\{ \frac{P_{3t+1}}{P_{3t+1}^{c}} \alpha \frac{Y_{3t+1}}{K_{3t+1}} + q_{3t+1}^{T} - \delta + \frac{\Phi_I}{2} \left(\frac{I_{3t+1}^{c} - \delta K_{3t+1}}{K_{3t+1}} \right)^2 \right\} \right] \tag{C.59}$$

$$\frac{\omega_3}{H_{3t}/V_{3t}} = \beta E_t \left[\frac{P_{3t+1}^{c} \lambda_{3t+1}}{P_{3t}^{c} \lambda_{3t}} \left\{ z_{3t+1} - \frac{P_{3t+1}}{P_{3t+1}^{c}} w_{3t+1} \left(1 + \tau_3^{f} \right) + (1 - s_3) \frac{\omega_3}{H_{3t+1}/V_{3t+1}} \right\} \right] \tag{C.60}$$

$$H_{3t} = \chi_3 V_{3t}^{\psi} (1 - N_{3t})^{1-\psi} \tag{C.61}$$

$$w_{3t} = \frac{1 - \epsilon}{1 + \tau_3^{f}} \frac{P_{3t}^{c}}{P_{3t}} \left[\omega_3 \theta_{3t} + z_{3t} \right] + \frac{\epsilon}{1 - \tau_3^{d}} \frac{P_{3t}^{c}}{P_{3t}} b_3 \tag{C.62}$$

$$\theta_{3t} = V_{3t} / (1 - N_{3t}) \tag{C.63}$$

$$\tau_3^{c} P_{3t}^{c} C_{3t}^{c} + \left(\tau_3^{d} + \tau_3^{f} \right) P_{3t} N_{3t} w_{3t} = T_{3t} + (1 - N_{3t}) P_{3t}^{c} b_3 \tag{C.64}$$

$$U_{3t} = 1 - N_{3t} \tag{C.65}$$

$$\phi_{3t} = H_{3t} / U_{3t} \tag{C.66}$$

$$TB_{3t} = P_{3t} Y_{3t} - P_{3t}^{c} D_{3t}^{c} \tag{C.67}$$

C.1.4 Equilibrium

$$\pi_1 Y_{1t} = \pi_1 y_{11t} + \pi_2 y_{12t} + \pi_3 y_{13t} \tag{C.68}$$

$$\pi_2 Y_{2t} = \pi_1 y_{21t} + \pi_2 y_{22t} + \pi_3 y_{23t} \tag{C.69}$$

$$(\pi_3 Y_{3t} = \pi_1 y_{31t} + \pi_2 y_{32t} + \pi_3 y_{33t}) \tag{C.70}$$

$$\pi_1 B_{1t+1} + \pi_2 B_{2t+1} + \pi_3 B_{3t+1} = 0 \tag{C.71}$$

$$D^c_{1t} = C^c_{1t} + I^c_{1t} + \omega_1 V_{1t} + \frac{\Phi_I}{2}\frac{\left(K_{1t+1} - K_{1t}\right)^2}{K_{1t}} + \frac{\Phi_b}{2}\left(\frac{B_{1t+1}}{P^c_{1t}}\right)^2 \tag{C.72}$$

$$D^c_{2t} = C^c_{2t} + I^c_{2t} + \omega_2 V_{2t} + \frac{\Phi_I}{2}\frac{\left(K_{2t+1} - K_{2t}\right)^2}{K_{2t}} + \frac{\Phi_b}{2}\left(\frac{B_{2t+1}}{P^c_{2t}}\right)^2 \tag{C.73}$$

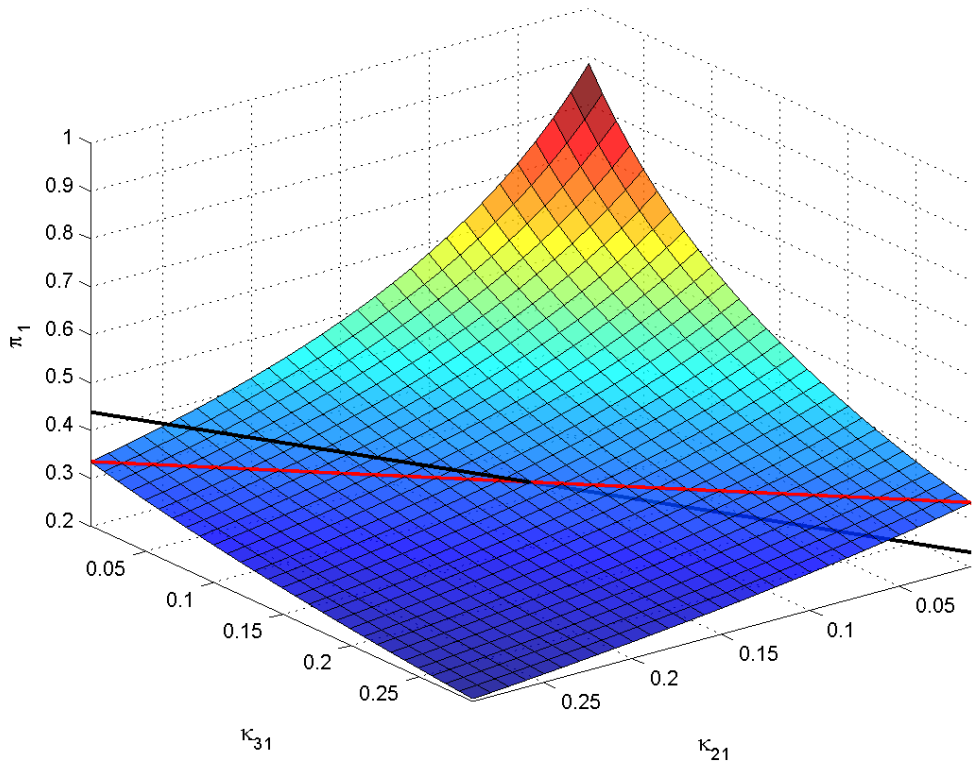
$$D^c_{3t} = C^c_{3t} + I^c_{3t} + \omega_3 V_{3t} + \frac{\Phi_I}{2}\frac{\left(K_{3t+1} - K_{3t}\right)^2}{K_{3t}} + \frac{\Phi_b}{2}\left(\frac{B_{3t+1}}{P^c_{3t}}\right)^2 \tag{C.74}$$

C.2 Country Size

Taking the deterministic steady state of equations (4.7)-(4.9) and (4.21)-(4.23) and the condition that intermediate goods output equals final goods output in each country and combining them the size of country 1 can be expressed as a function of relative employment and import preferences:

$$\pi_1 = \frac{(\kappa_{12}\kappa_{23} + \kappa_{13}(\kappa_{12} + \kappa_{32}))}{((1-\kappa_{11})(\kappa_{12}+\kappa_{32}) - \kappa_{21}\kappa_{12})\frac{N_1}{N_3} + (\kappa_{23}(1-\kappa_{11}) + \kappa_{21}\kappa_{13})\frac{N_1}{N_2} + (\kappa_{12}\kappa_{23} + \kappa_{13}(\kappa_{12}+\kappa_{32}))}$$

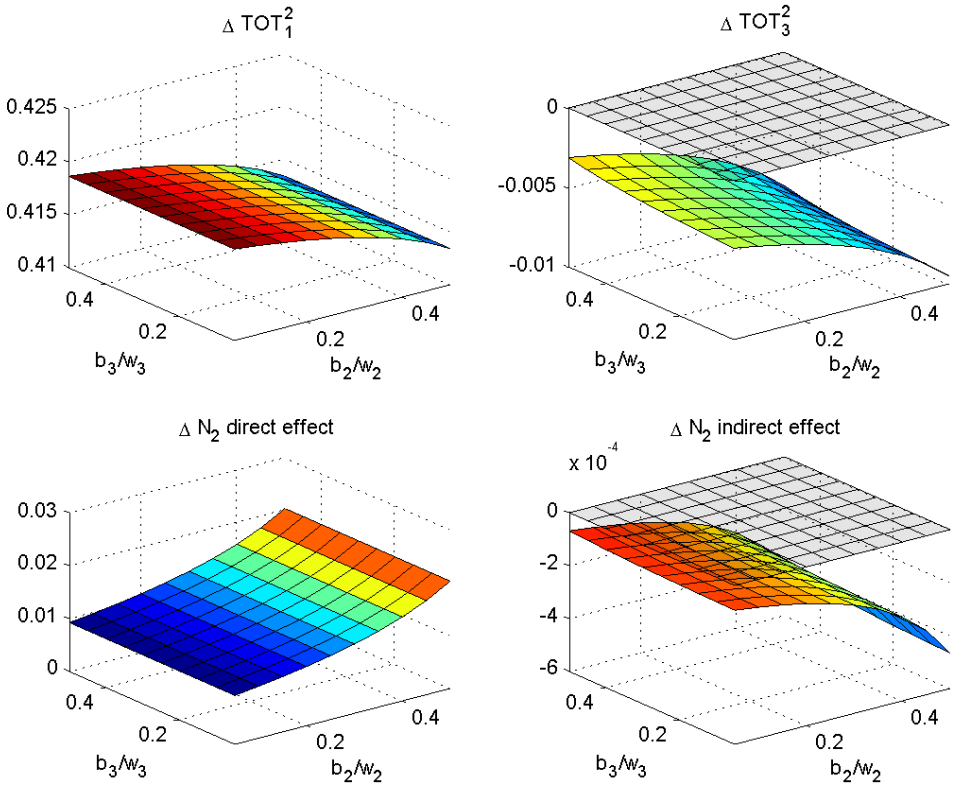
This equation implies that the size of country 1 depends positively on foreign employment N_2, N_3, its home bias κ_{11} and the import preferences of the other countries with respect to the domestic good κ_{12} and κ_{13}. Domestic employment N_1 and import preferences of country 1 for the intermediate goods of the other countries κ_{21} and κ_{31} have a negative impact on π_1.



Notes: The surface of this graph displays how the size of a country (e.g. country 1) varies with its bilateral import preferences. It deviates from the baseline calibration only for the openness preferences of country 1. The figure implicitly contains the overall preference towards openness which is given by the sum of κ_{21} and κ_{31}. For the case of symmetric preferences between country 2 and 3, i.e. when $\kappa_{21} = \kappa_{31}$, the overall preference towards openness is given by the diagonal from north to south. So the higher the preference, the smaller the country. The same applies for the individual preferences. The red horizontal diagonal (which lies in the surface) displays all scenarios where $1 - \kappa_{11} = 0.3$, i.e. as in the baseline calibration, which implies that the size of country 1 $\pi_1 = 1/3$, although import preferences of country 1 do not have to be symmetric. Asymmetries in bilateral import preferences in turn influence the size of the trade partners. The black line represents the size of country 2 π_2 for the case that $\kappa_{11} = \kappa_{22} = \kappa_{33} = 0.3$. The higher the preference of country 1 for goods from country 2 relative to country 3, all other bilateral preferences being symmetric, the bigger country 2 relative to country 3.

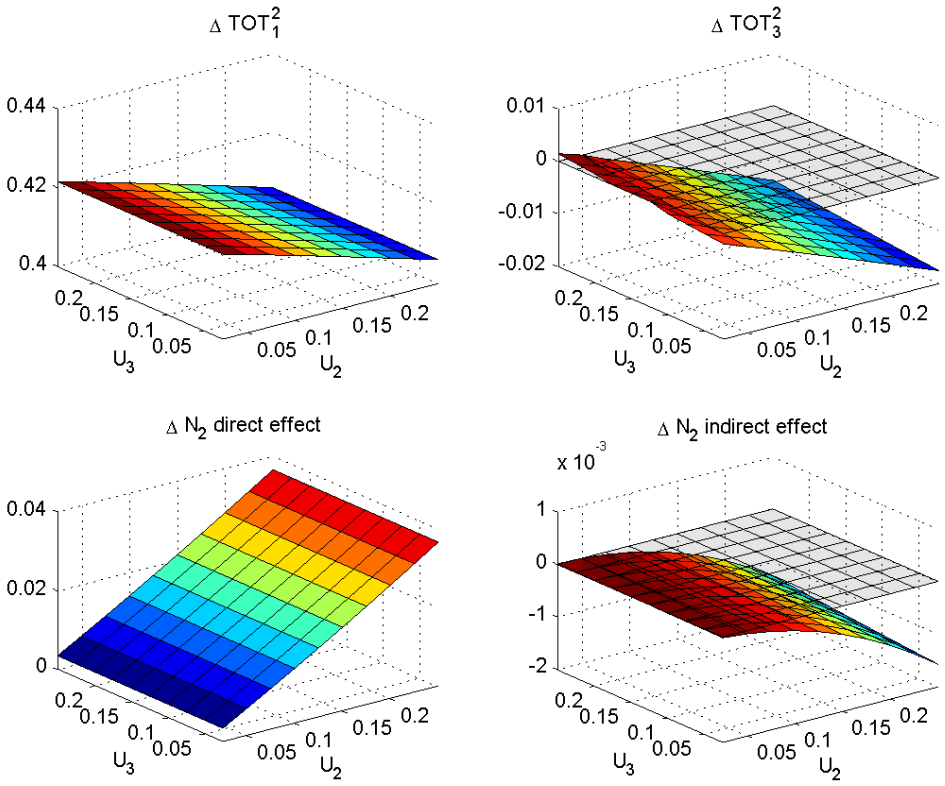
Fig. C.1. Relation between Country Size and Openness Preferences

C.3 Graphical Appendix



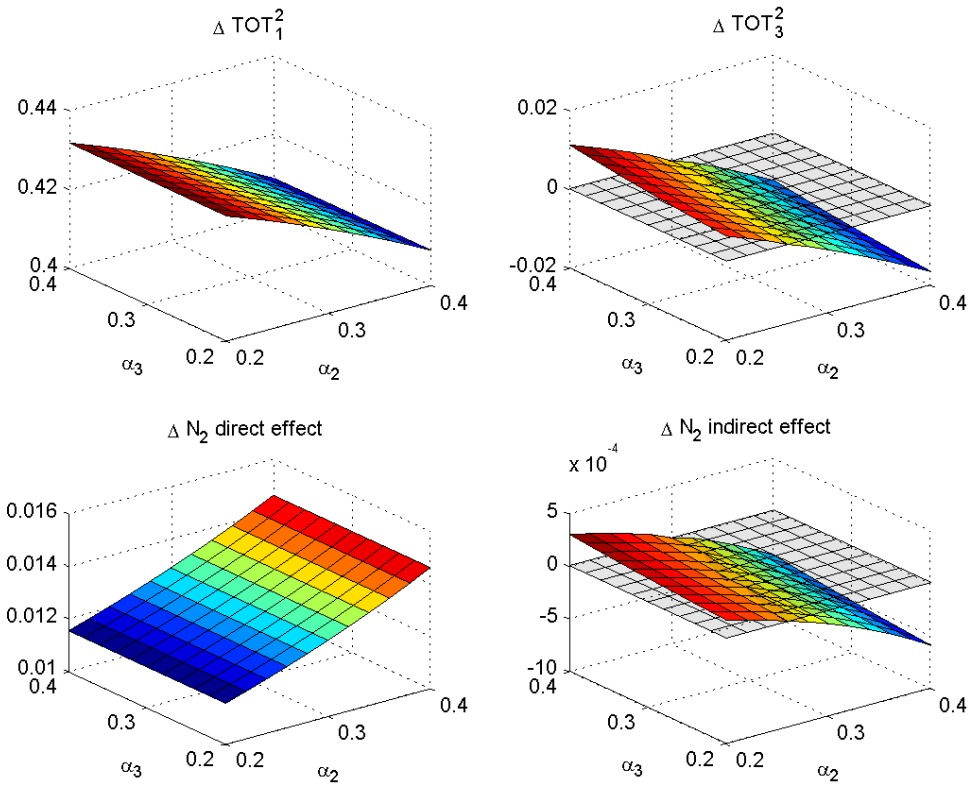
Notes: In this scenario $1 - \kappa_{11} = 0.3$, $1 - \kappa_{33} = 0.1$, $\kappa_{13} = \kappa_{23} = (1 - \kappa_{33})/2$ and $1 - \kappa_{22} = 0.5$, $\kappa_{12} = \kappa_{32} = (1 - \kappa_{22})/2$. Both elasticities increase in b_2/w_2.

Fig. C.2. Decomposition of Spillover in Direct and Indirect Effects for Varying b_2/w_2 and b_3/w_3



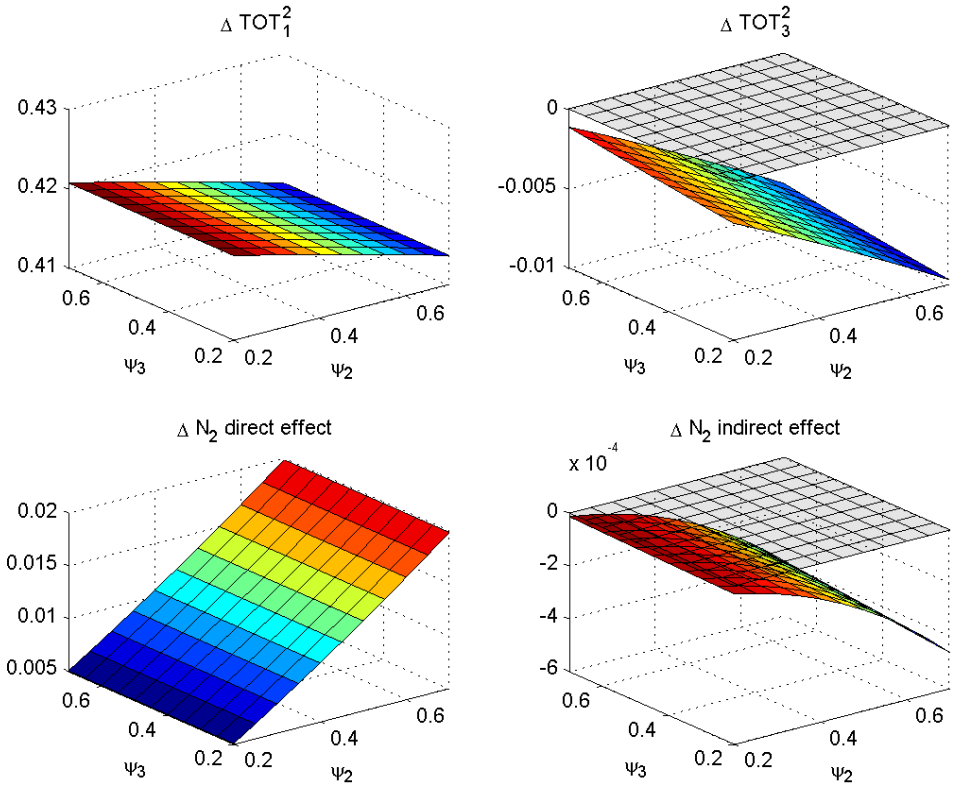
Notes: In this scenario $1 - \kappa_{11} = 0.3$, $1 - \kappa_{33} = 0.1$, $\kappa_{13} = \kappa_{23} = (1 - \kappa_{33})/2$ and $1 - \kappa_{22} = 0.5$, $\kappa_{12} = \kappa_{32} = (1 - \kappa_{22})/2$. Both elasticities of employment increase in U_2.

Fig. C.3. Decomposition of Spillover in Direct and Indirect Effects for Varying U_2 and U_3



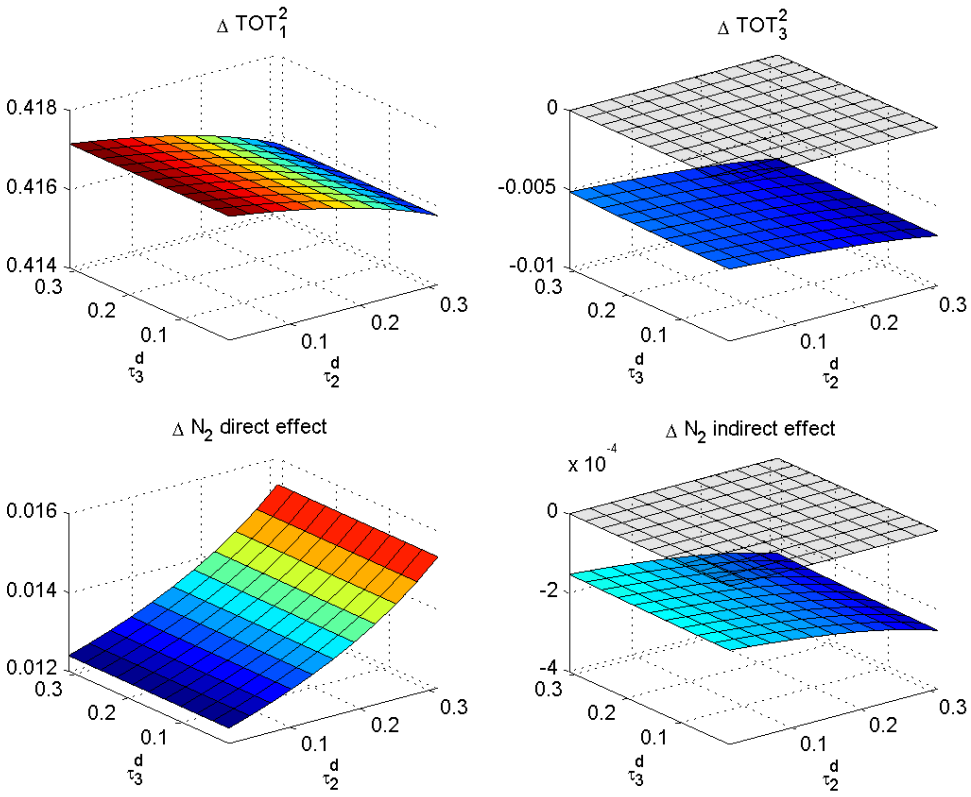
Notes: In this scenario $1 - \kappa_{11} = 0.3$, $1 - \kappa_{33} = 0.1$, $\kappa_{13} = \kappa_{23} = (1 - \kappa_{33})/2$ and $1 - \kappa_{22} = 0.5$, $\kappa_{12} = \kappa_{32} = (1 - \kappa_{22})/2$. ϵ_{N_2,TOT_1^2} and ϵ_{N_2,TOT_3^2} increase both with growing α_2.

Fig. C.4. Decomposition of Spillover in Direct and Indirect Effects for Varying α_2 and α_3



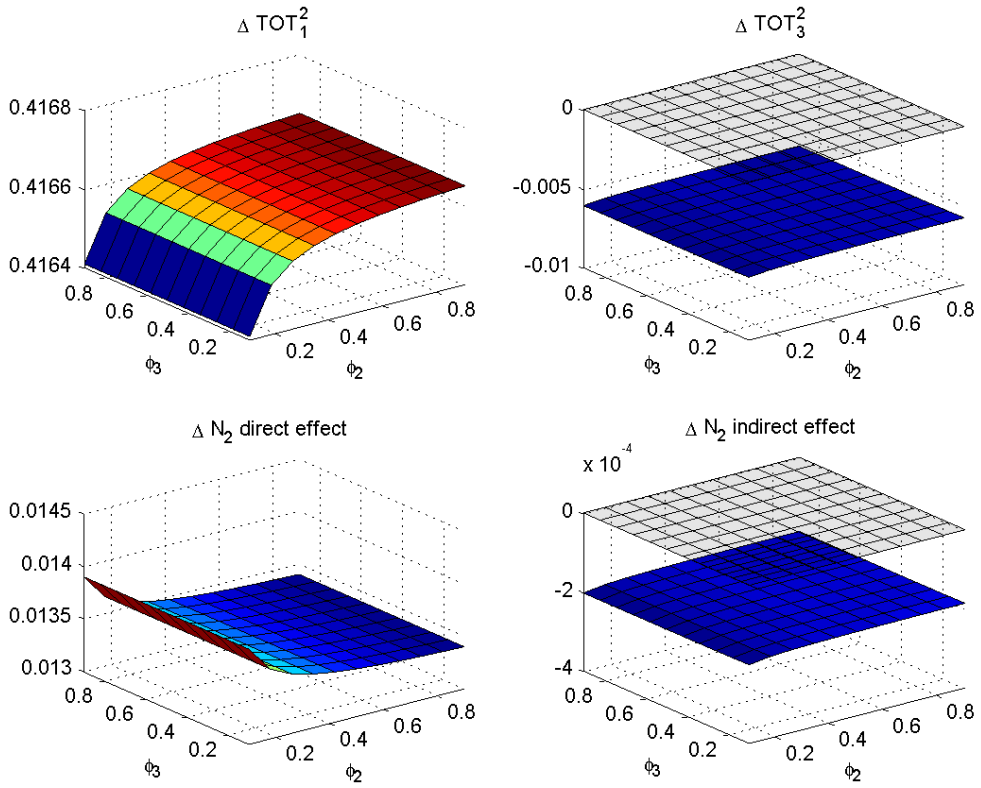
Notes: In this scenario $1 - \kappa_{11} = 0.3$, $1 - \kappa_{33} = 0.1$, $\kappa_{13} = \kappa_{23} = (1 - \kappa_{33})/2$ and $1 - \kappa_{22} = 0.5$, $\kappa_{12} = \kappa_{32} = (1 - \kappa_{22})/2$. ϵ_{N_2,TOT_1^2} and ϵ_{N_2,TOT_3^2} increase both with growing ψ_2.

Fig. C.5. Decomposition of Spillover in Direct and Indirect Effects for Varying ψ_2 and ψ_3



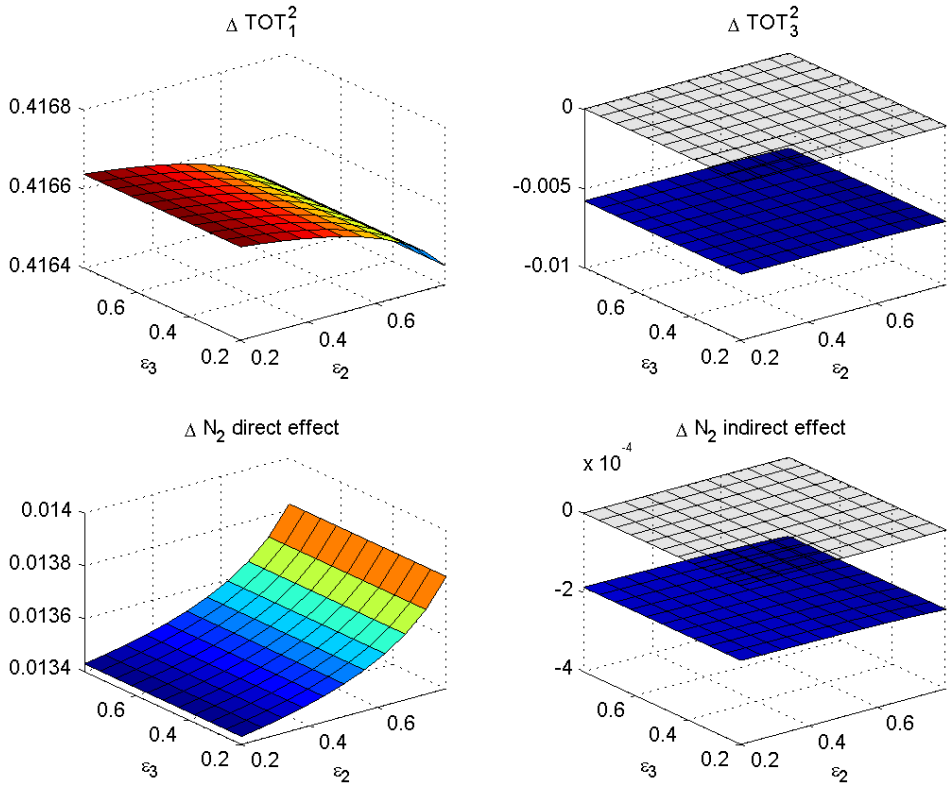
Notes: In this scenario $1-\kappa_{11}=0.3$, $1-\kappa_{33}=0.1$, $\kappa_{13}=\kappa_{23}=(1-\kappa_{33})/2$ and $1-\kappa_{22}=0.5$, $\kappa_{12}=\kappa_{32}=(1-\kappa_{22})/2$. ϵ_{N_2,TOT_1^2} and ϵ_{N_2,TOT_3^2} increase both with growing τ_2^d.

Fig. C.6. Decomposition of Spillover in Direct and Indirect Effects for Varying τ_2^d and τ_3^d



Notes: In this scenario $1 - \kappa_{11} = 0.3$, $1 - \kappa_{33} = 0.1$, $\kappa_{13} = \kappa_{23} = (1 - \kappa_{33})/2$ and $1 - \kappa_{22} = 0.5$, $\kappa_{12} = \kappa_{32} = (1 - \kappa_{22})/2$. ϵ_{N_2,TOT_1^2} and ϵ_{N_2,TOT_3^2} fall both with growing ϕ_2.

Fig. C.7. Decomposition of Spillover in Direct and Indirect Effects for Varying ϕ_2 and ϕ_3



Notes: In this scenario $1 - \kappa_{11} = 0.3$, $1 - \kappa_{33} = 0.1$, $\kappa_{13} = \kappa_{23} = (1 - \kappa_{33})/2$ and $1 - \kappa_{22} = 0.5$, $\kappa_{12} = \kappa_{32} = (1 - \kappa_{22})/2$. ϵ_{N_2,TOT_1^2} and ϵ_{N_2,TOT_3^2} increase both with growing ϵ_2.

Fig. C.8. Decomposition of Spillover in Direct and Indirect Effects for Varying ϵ_2 and ϵ_3

C.4 Proof

In this appendix I derive the elasticity of employment in country 2 with respect to its terms of trade with country j ϵ_{N_2,TOT_j^2} and show that it has to be positive. Consider the steady state of the model, where steady state values are expressed as variables without time index. Combining the optimality conditions for vacancy posting and from the wage bargaining, equations (4.15) and (4.19), and using the following expression for the capital labour ratio $\frac{K_2}{N_2} = \left(\frac{P_2}{P_2^c}\frac{\alpha}{1/\beta-1+\delta}\right)$ derived from optimal bond demand (equation 4.14), we obtain:

$$\frac{(1-\beta(1-s_2))}{\beta\chi_2}\theta_2^{1-\psi} + (1-\epsilon)\theta_2 = \\ = \frac{\epsilon}{\omega_2}\left[\left(\frac{P_2}{P_2^c}\right)^{\frac{1}{1-\alpha}}(1-\alpha)\left(\frac{\alpha}{\frac{1}{\beta}-1+\delta}\right)^{\frac{\alpha}{1-\alpha}} - \frac{1+\tau_2^f}{1-\tau_2^d}b_2\right]. \quad \text{(C.75)}$$

Furthermore, with the help of equation (4.10), we can express the inverse of the final good price in terms of the intermediate good of country 2 as a function of its terms of trade with its neighbours:

$$\frac{P_2}{P_2^c} = \left[\kappa_{12}TOT_1^{2\ \eta-1} + \kappa_{22} + \kappa_{32}TOT_3^{2\ \eta-1}\right]^{\frac{1}{\eta-1}}.$$

The marginal effects of a change in terms of trade on prices in country 2 in the steady state, where $TOT_1^2 = TOT_3^2 = 1$, read κ_{12} and κ_{32} for country 1 and 3, respectively. Based on this knowledge, I apply the implicit function theorem to equation (C.75) to derive the elasticity of labour market tightness in country 2 with respect to its terms of trade with country 1:

$$\epsilon_{\theta_2,TOT_1^2} = \frac{\delta\theta_2}{\delta TOT_1^2}\frac{1}{\theta_2} = \frac{\frac{\epsilon}{\omega_2}\kappa_{12}\left(\frac{\alpha}{\frac{1}{\beta}-1+\delta}\right)^{\frac{\alpha}{1-\alpha}}}{\frac{(1-\beta(1-s_2))(1-\psi)}{\beta\chi_2}\theta_2^{1-\psi} + (1-\epsilon)\theta_2} > 0, \quad \text{(C.76)}$$

which is always positive for $\epsilon, \omega_{2,}, \kappa_{12}, h_2, \delta, \alpha, \chi_2, \theta_2 > 0$, $0 < \beta < 1$, $0 < s_2 < 1$, $0 < \psi < 1$. The elasticity of labour market tightness with respect to the terms of trade with country 3 are given by a very similar expression, the only difference being the preference for imports from country 3 κ_{32}:

$$\epsilon_{\theta_2,TOT_3^2} = \frac{\frac{\epsilon}{\omega_2}\kappa_{32}\left(\frac{\alpha}{\frac{1}{\beta}-1+\delta}\right)^{\frac{\alpha}{1-\alpha}}}{\frac{(1-\beta(1-s_2))(1-\psi)}{\beta\chi_2}\theta_2^{1-\psi}+(1-\epsilon)\,\theta_2} > 0. \tag{C.77}$$

One can then use the relation between employment N and labour market tightness θ, given by $s_2N_2 = q_2V_2 = H_2 = \chi_2\theta_2^{\psi}\,(1-N_2)$, to derive

$$\frac{\delta N_2}{\delta\theta_2} = \frac{s_2\psi\chi_2\theta_2^{\psi-1}}{\left(s_2+\chi_2\theta_2^{\psi}\right)^2} > 0. \tag{C.78}$$

Finally, by combining equation (C.76) or (C.77) with (C.78), we can write the elasticity of employment with respect to the terms of trade of any trading partner j as:

$$\epsilon_{N_2,TOT_j^2} = \frac{\delta N_2}{\delta\theta_2}\frac{\delta\theta_2}{\delta TOT_j^2}\frac{1}{N_2} = \frac{s_2\psi}{\left(s_2+\chi_2\theta_2^{\psi}\right)}\epsilon_{\theta_2,TOT_j^2},$$

such that

$$\epsilon_{N_2,TOT_j^2} = \frac{\kappa_{j2}}{\omega_2}\frac{s_2\psi}{\left(s_2+\chi_2\theta_2^{\psi}\right)}\frac{\epsilon\left(\frac{\alpha}{\frac{1}{\beta}-1+\delta}\right)^{\frac{\alpha}{1-\alpha}}}{\left[\frac{(1-\beta(1-s_2))(1-\psi)}{\beta\chi_2}\theta_2^{1-\psi}+(1-\epsilon)\,\theta_2\right]} > 0. \tag{C.79}$$

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