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Global Perspective on Structural Labour Market Reforms in Europe

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Global Perspective on Structural Labour Market Reforms in Europe*

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Abstract

Recent turbulent times have once again demonstrated how important flexible product and labour markets are to dampen the effects of adverse economic shocks. A number of labour market reforms have been implemented to enhance economic resilience and flexibility. However, accounting for the efficacy of policy interventions requires going beyond national boundaries and evaluating international interactions and global interdependencies, which may strengthen or weaken economic responses. Concentrating on open European economies, this paper deals with labour market institutions and structural reforms in a general equilibrium framework, which allows to analyse the intricate connections between labour policy choices and international trade (openness), paying special attention to labour market policy shocks. Amid discussions about a fiscal union in Europe, we empirically demonstrate that labour market policies can have positive and negative spillovers to trading partners, thereby calling for coordinated policies within a trading bloc. We answer three types of questions: what would have happened had all economies implemented structural labour market reforms simultaneously? How heterogeneous are responses in a single economy to shocks conducted in every other country? Relatedly, how heterogeneous are responses by all economies to a reform in one given economy?

Keywords: Labour structural reforms, global VAR, regional integration, spillovers
JEL Classification: C32, C33, E24, F12, F16

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However fragmented the world, however intense the national rivalries, it is an inexorable fact that we become more interdependent every day. (Jacques Yves Cousteau)

1 Introduction

Recent financial and European sovereign debt crises have intensified discussions on the need to complement the European monetary union with the fiscal union. This paper analyses one particular aspect of a real economy, namely responses to changes in structural labour market reforms when economies are open and interdependent. Despite having a common body of law, *acquis communautaire*, and being part of the Economic and Monetary Union (henceforth EMU),[1] the European Union (henceforth EU) members possess substantial freedom in fiscal decisions.[2] We explore how structural labour market policies, set discretionary by an individual country, affect not only the economy undergoing a reform, but also the entire union. A counterfactual of a joint shock is implemented in the global vector autoregression (henceforth GVAR) framework – we interpret its results as a counterfactual of joint labour market decisions in all member states.

Varying levels of openness, fiscal policies, labour market institutions and economic structure all have an impact on the ways economies react to changes in labour market policies. The old issue of high unemployment in Europe has spurred research on institutional conditions, summarised by "Eurosclerosis" and understood as a combination of high unemployment, low mobility and rigid labour markets. However, Europe remains far from homogenous, despite common market and free labour mobility. Indeed, as evidenced by Bentolila et al. (2010), the unemployment situation during the recent recession has differed significantly across countries. For example, French unemployment has hardly increased, while the unemployment in neighbouring and institutionally similar Spain has skyrocketed.[3] A model case is Germany the success of which is usually ascribed to the so-called "Kurzarbeit" reduced working hours programme and Hartz reforms.[4] Yet a simple argument of more flexible labour markets conceals much of the institutional contents of flexibility, especially in an ever interdependent world. Indeed, in 2006-2007 the EU responded by putting forward the *flexicurity* approach[5]

[1] All European Union member states are part of the EMU. There is, however, the so-called third stage of EMU when an economy adopts a common currency, the euro. All member states committed themselves to join the euro zone eventually, apart from concessions for the United Kingdom and Denmark. We will, therefore, sometimes refer to the EU as a monetary union without specifying the "stage" of EMU that our analysed countries have reached (we thus do include the United Kingdom and Denmark to our empirical exercise; in the Online Appendix we implement shocks with and without the United Kingdom).

[2] There are, of course, requirements when it comes to such measures as debt or deficit as stipulated, for instance, in the Stability and Growth Pact, but there have been violations of requirements by a number of countries. Each member is discretionary when it comes to regulating labour markets, and that is the focus of our paper. We will use this discretion to explore how one country choice affects remaining members of the union.

[3] Spanish experience has also been documented by Dolado and Stucchi (2008).

[4] See OECD (2010) for more details. Moeller (2010) argues that the specific type of German flexibility does not stem from high labour turnover rates (hiring and firing), but through an unprecedented level of buffer capacity within firms. Faia et al. (2012) confirm that unlike the standard demand stimuli, "Kurzarbeit" policies yield large fiscal multipliers, as they stimulate job creation and employment. Another relevant account can be found in Burda and Hunt (2011), also see Lastauskas and Tatsi (2013) for the spatial account of Germany's unemployment reaction to productivity shocks.

[5] Flexicurity is understood as "an integrated strategy involving active labour market policies, lifelong learning, modern labour laws and social security systems, which facilitates transitions during the life cycle and is conducive to job creation and social cohesion", European Commission (2010).

as the right policy "recipe", *inter alia*, to counteract the segmentation of labour markets.[6] In short, it is the combination of labour market flexibility in a dynamic economy and security for workers. However, acting within a monetary union necessitates to evaluate the effects from changing labour market institutions at home to all other member states. In particular, changes in the labour market are embedded in competitiveness and international prices, and they can create or divert trade and even result in an undesirable result for the union as a whole. As is duly summarised by Blanchard (2006), "it is one thing to say that labour market institutions matter, and another to know exactly which ones and how." Theoretically, there is no consensus what response should be expected: a positive correlation between bad labour market institutions at home and abroad is predicted by Felbermayr et al. (2013); to the contrary, a country harms its trading partner by reducing its labour market frictions in Helpman and Itskhoki (2010); Alessandria and Delacroix (2008), in turn, obtain that a rigid economy increases a country's welfare, whereas a flexible one suffers due to the terms of trade effects. Therefore, it is of interest to quantify major labour market institutions in a trading economy and their effects on macroeconomic performance while allowing for the effects to act not only domestically, but also union-wide.

We find that an individual country's change in its own labour market policies can transmit to other members of the monetary union, sometimes featuring unintended consequences. For instance, active labour market policies in Germany increases its employment and GDP, but adversely affects the Greek economy; an increase in a tax wedge in Italy might help to improve Spanish employment, whereas unemployment benefits in Ireland reduce employment both domestically and inside the union (for instance, in Austria, France, the Netherlands). Interestingly, the United Kingdom (UK), a country outside the euro zone, emerged as an economy whose reaction to labour market reforms in other European economies has frequently been negatively related to the effects in the reforming economy. This emphasises two points: that British economy is quite distinct from the rest of Europe, and that a monetary union helps to (at least to an extent) synchronise responses to fiscal policy shocks.

To the contrary, once a shock is implemented for all economies together – they all go through a single fiscal decision, as would have been the case had a fiscal union existed – the effect for all economies is way more comparable and mainly follows theoretical predictions. In addition to being more homogenous, reaction is also quite often strengthened as compared to the attempts to make a policy reform individually. We, therefore, interpret this result as an argument in favour of a coordinated fiscal policy case, which dampens the spillover effects, otherwise caused by the competitiveness and structural changes. It is important to stress, however, that employment and GDP suffer from heterogeneity, but openness, for instance, does not. Therefore, a policy implication, regarding a fiscal union, hinges on the choice of macroeconomic variables that matter most.[7]

1.1 Questions and Brief Literature Review

Our main focus is on the transmission of policy effects and efficacy of labour market institutions in a trading world with interactions between goods and labour markets. More precisely, we analyse the effect of labour market institutions on domestic macro variables,

[6] It has been over a decade that the EU attempts to tackle unemployment. The Luxembourg Extraordinary European Council Meeting on Employment took place in 1997 and led to the European Employment Strategy, which was incorporated into the broader Lisbon Strategy, designed to turn Europe into a more competitive and dynamic economy, with more and better jobs. However, reality mismatches with the goals quite miserably. Record high unemployment rates have been announced in 2013, reaching almost 27 per cent for Spain, see Eurostat.

[7] It is important to note that we do not model other dimensions, which are important for drawing con-

both from decisions made within the economy and shocks transmission, had all economies been integrated into a synchronised unit. We also address the role of trade in spreading labour market shocks and account for spatial interdependence. Historically labour literature has been focusing on one country analysis conducted in a partial equilibrium – we, therefore, have to introduce a dynamic, general equilibrium framework, which takes into account common technology, wage differences on both, trade patterns and domestic labour markets, and their spillover effects.[8] For this reason, we will draw from a number of literatures, including international trade, labour with differing institutional details, and global macroeconometric modelling.

Trade and unemployment have been analysed quite substantially, yet mainly on purely theoretical grounds, employing a two-country (mainly symmetric) case.[9] A closer to ours and more policy-oriented approach has been offered by Felbermayr et al. (2013) which analyse two-country Armingtonian trade model with frictions on the goods and labour markets in an interdependent environment. Effectively, it is a combination of a heterogeneous firms trade model of Melitz (2003) with the search and matching approach of Mortensen and Pissarides (1994). Felbermayr et al. (2013) map international spillovers of labour market institutions across two asymmetric countries to estimating equations. Though the model is inherently static, it is an important step towards multi-country analyses. We will deviate from them both theoretically and empirically; unlike panel analysis, which assumes homogeneity in responses of shocks across economies, we will allow for spatial heterogeneity. Moreover, we will analyse dynamic responses, adding a possibility for cointegration within and across economies. The inconsistency results of neglected heterogeneity in a panel framework has been emphasised by Pesaran and Smith (1995).

As we plan to focus on the dynamic effects of labour market institutions for trading economies, a dynamic extension of Helpman et al. (2010) with a richer labour market's setting, in particular, with a number of labour market policies, has been employed. We want to learn about the labour market's vigour and responses to different institutional measures, namely financial incentives and activation schemes, and their transmission channels once countries engage in international trade. Our dynamic extension features stochastic, rather than deterministic, production functions in each economy. Due to a shared dynamic factor (it can proxy for an economic and monetary union which aims at converging the economies of all member states), economies are interlinked and susceptible to a global econometric treatment. We draw from the literature on global macroeconomic modelling (see Pesaran et al. (2004) and Garratt et al. (2006) for pioneering work in the area) with explicitly modelled cross-sectional dependence. A natural vehicle for testing the question of intervention effects on unemployment as one of the central impetuses is to use the global vector autoregressive modelling framework.

We estimate country specific models for each European economy in the GVAR with the main components of the structural model (trade, unemployment, terms of trade, intens-

clusions, such as labour migration and capital movements.

[8]There is, of course, literature beyond pure labour studies that accounts for macroeconomic effects. For instance, macro-labour literature deals with real business cycles and labour market frictions as in, among others, Cacciatore and Fiori (2014) which use the euro area at the aggregate level; Stähler and Thomas (2012) work with a two-country model and fiscal policy simulations; Perotti (2005) deals with fiscal policy for 5 OECD countries in the structural VAR setting. These are important contributions going beyond one country setting – yet our value added is a consideration of a larger set of countries in one coherent framework with heterogeneous rather than homogenous responses, and a union-wide counterfactual analysis.

[9]Recent contributions by Helpman et al. (2010); Helpman and Itskhoki (2010), Felbermayr et al. (2011a,b) have shed new light on complex interactions between trade liberalisation, unemployment, and inequality.

ive and extensive margins, and a set of labour market institutions) and examine how the global system responds. A global econometric approach, afforded by the GVAR methodology, enables to deal with a stochastic dynamic economic system in a parsimonious way. Interdependencies are then accounted through global factors, international co-movements of business cycles, direct and indirect (through error terms) influences of the variables and short-run feedback effects. Indeed, as has recently been demonstrated by Gnocchi et al. (2015), business cycle fluctuations correlate with labour market institutions, and need to be addressed jointly. Our framework can handle temporal variation and shed light on the role of global linkages, an aspect largely missing in the macro-labour literature.

Next, we map our stochastic trade-labour setting, combined with the labour market institutions, into an estimating system. Methodologically, we introduce weakly exogenous variables – labour market policies – which are subject to shocks and are not determined from within the economy, but can be freely set by policy makers.[10] All other aggregate variables are endogenous, as suggested by the theory, and are linked to other countries because of trade. The theoretical and empirical setting revolves around three major questions. We first ask what is the connection between different labour market institutions, and responsiveness in openness, GDP, real exchange rate, and unemployment. Further, we conduct counterfactual exercises on labour markets and long run effects on all economies when there is an implementation of fiscal programmes by a single country. Moreover, a simultaneous implementation by all member states (a global shock) is interpreted as a counterfactual shock of the European fiscal union, that is, what responses would have been observed had there been a joint decision on labour market policies. Indeed, we find that fiscal policies embedded in the labour market policies must be coordinated for them to be effective and achieve the desired results – in other words, the global linkages cannot be addressed by local policy tools. One externality concerns international dimension – changes in competitiveness affect trade patterns which, in turn, influence not only international prices but also the entire linkages among economies. Ignoring these channels might create unintended consequences for the reforming country as well as for the entire monetary union.

Our plan of the paper is as follows. In Section 2, we motivate our work drawing a number of instances on how governments reacted to adverse shocks by changing labour market institutions. We also report the major policies employed, their implementation in different countries and explore the significance of spatial heterogeneity. Section 3 lays down a simple version of a dynamic model featuring labour market institutions and exporting opportunities. We introduce a common unobserved factor in production to link all economies, in addition to international prices that account for imported goods. In other words, we allow for technology interlinkages and multilateral terms, reflecting real exchange rates in the European Union. All aggregate variables derived from the theory and their empirical implications are covered in Section 4. We discuss an estimating system of equations and major results in Section 5. Finally, Section 6 concludes and specifies both, policy implications and directions for further research. Appendices collect all supporting material; in addition, there is an online document which reports all major results from the estimation of our preferred empirical models.[11]

[10] One could in principle connect policy variables to endogenous variables through policy maker's objective function that depends on the system variable. However, we do not add this additional – government's sector – both to reduce complexity (as we also do not know the functional form of the objective function) and because we are driven by observation that choices are more need based, far from smoothly changing with the endogenous macro variables.

[11] All the codes and data are available upon request or from the authors' websites.

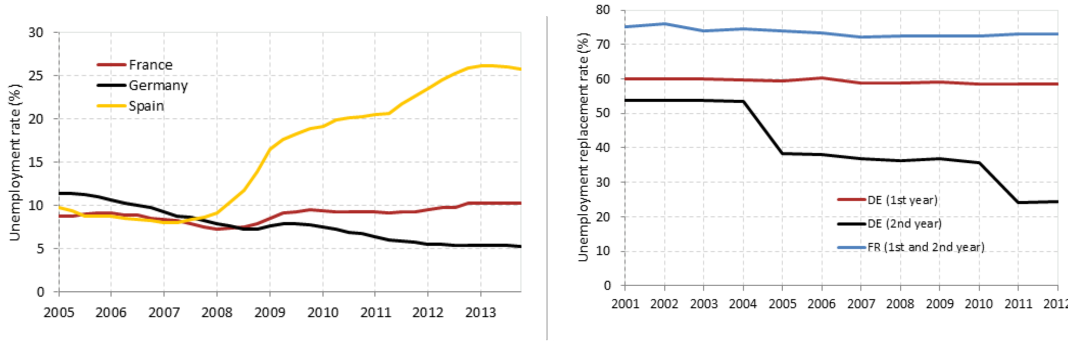


Figure 2.1: Unemployment rate dynamics in European countries (Germany's unemployment miracle)

2 Motivation

European unemployment has been scrutinised for years to understand its persistently high level (Blanchard and Wolfers, 2000; Blanchard, 2006). Recently, Bentolila et al. (2012) analysed a situation when France and Spain, having similar labour market institutions (employment protection legislation (EPL), unemployment benefits, wage bargaining, etc) and unemployment rates (around 8%) just before the Great Recession, subsequently experienced substantially different outcomes with the around 10% unemployment in France and 23% in Spain. Authors attributed the difference to *de facto* protection of temporary jobs between two countries and differing labour (geographical) mobility (refer to Figure 2.1).

Introducing Germany into discussion requires additional arguments to explain unemployment patterns. Three neighbours, Spain, France, and Germany, diverged in unemployment outcomes from the onset of the financial crisis. The success of Germany is commonly attributed to the so-called Hartz reforms (Krebs and Scheffel, 2013). Note that they have been introduced over the period 2003-2005, well before the crisis. As demonstrated in the second graph of Figure 2.1, the unemployment benefits have been reduced substantially for the long-term unemployed workers (refer to the black line showing the average benefits for the unemployed in the second consecutive year). Therefore, institutional differences and policy responses constitute major arguments.[12] We thus also focus on discretionary policy responses and explore their effects on macroeconomic variables. As noted by Boeri (2011a), labour market institutions have been subjected to frequent policy changes and the largest transformations have taken place in Europe. Our interest lies in policies, adopted during the financial crisis, but this is not to imply that reforms are not implemented at other times.[13]

2.1 Fiscal Policies

Between 2008 and 2009, countries in Europe attempted a number of policy recipes to dampen the negative effects of the financial crisis. In labour markets, many adopted wage subsidies,

[12] A more structural approach concerns compositional differences of labour markets. These include flexibility of different segments of the labour force. Jahn et al. (2012) find that flexibility lowers attachment to the firm which in turn may reduce workers' incentives to invest in firm-specific human capital, which reduces worker and firm productivity. We limit our analysis to the homogenous labour market as the comparable data on compositional aspects across countries are largely lacking. However, our take can account for the international dimension and a number of channels through which institutional changes spill over the borders of national economies.

[13] In other words, frequent policy reforms can be thought of as discretionary, not functionally related to some particular times, good or bad. Another dimension to timing is the method or policy contents; this

Table 2.1: Types of wage subsidies

	Countries	
Wage subsidy type	*Targeted*	*Untargeted*
Social security contributions reduced (temporary)	France, Romania, Italy	Estonia, Latvia
Social security contributions reduced (permanent)	Spain, Sweden	Bulgaria, Czech Republic, Germany, Hungary, Poland
Hiring subsidies	United Kingdom	

mainly through reductions in social security contributions, and often targeted at small enterprises or disadvantaged groups. As evidenced by a survey from the International Labour Organisation (ILO), several European countries (Bulgaria, Czech Republic, Germany, Hungary, Poland, Spain, Sweden, and Turkey) decreased their social security contributions during the crisis on a permanent basis. The nature of fiscal policies varied from country to country, thus supporting the fact of discretionary policies and the absence of coordinated responses. France, for instance, reduced employer social security contributions for firms with less than ten employees hiring new low-wage workers in 2009.[14] In Germany, there was a reduction of employee and employer contributions to the unemployment insurance system. Spain reduced employer social contributions for the first two years of employment for unemployed people with children who transit to full-time permanent contracts, and also implemented a reduction in social security contributions for youth or disabled workers who start a business as self-employed. A different approach was taken in the United Kingdom, where companies received 2,500 pounds for hiring workers who were unemployed for more than six months.[15] For eight countries (Bulgaria, Czech Republic, Estonia, Germany, Hungary, Latvia, Sweden, and Turkey), the decrease in social security contributions was across the board, e.g., for all employees or all newly hired employees. For eleven countries, the decrease was targeted towards long-term jobseekers (Romania, Spain, Sweden, the), SMEs (France, Poland, Spain), youth (Spain, Sweden), older workers (Italy, Spain). For Bulgaria, Czech Republic, Germany, Hungary, Poland, and Turkey, the decrease in social security contributions was both permanent and untargeted. The summary is depicted in Table 2.1. There are also other implemented policies, but since they are not addressed theoretically and empirically, we do not report them here.[16]

2.2 Empirical Evidence of Labour Market Policies

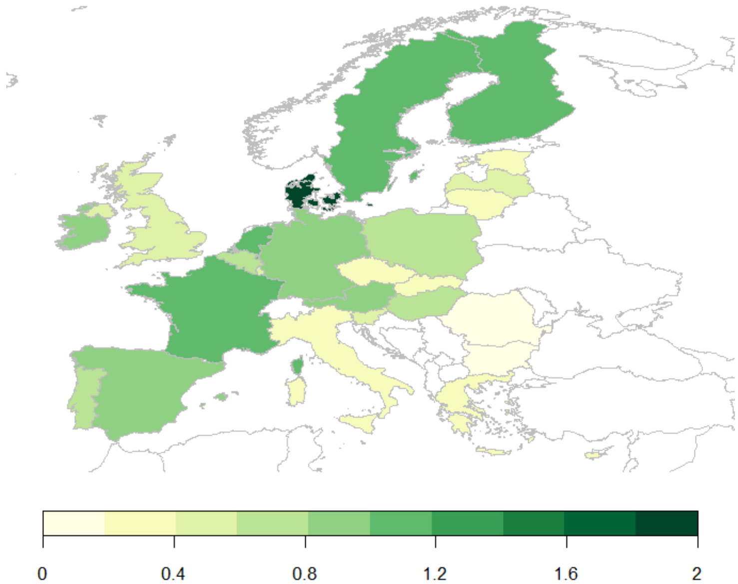
Having reviewed the policy choices employed, we base our empirical motivation on several major points. First, there is a fairly large amount of empirical evidence supporting that

is again discretionary and, as evidence demonstrates, many substantially different policy choices have been made in European economies.

[14]The reduction was the largest for workers hired at the minimum wage and declined as the wage increased up to 1.6 times the minimum wage.

[15]Across the board, hiring subsidies were set to be phased out in early 2011.

[16]However, see the non-publishable appendix, which collects more evidence on the other policy choice, namely minimum wage. Other policy instruments, such as employment protection legislation, cannot be employed for the empirical study due to temporal dimension and little variation, there are also theoretical difficulties to capture all important aspects of protection, which are embedded in law.



Source: Eurostat data

Figure 2.2: Expenditure on active labour market policies across the EU27 countries in 2010 (% of GDP)

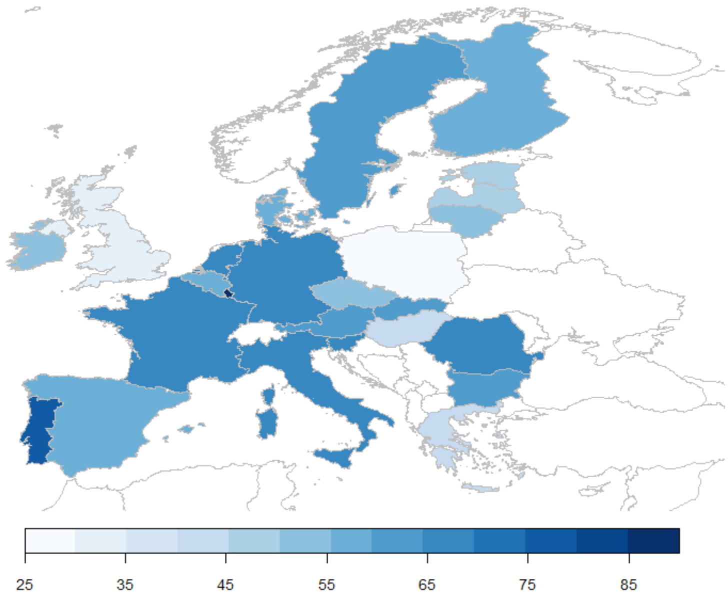
labour market policies and institutions influence labour market outcomes. For example, replacement rates generally have a positive effect on unemployment (Bassanini and Duval, 2006; Nickell et al., 2005). Increasing labour tax wedge, which is understood as the total labour tax burden,[17] increases unemployment (Bassanini and Duval, 2006; Orlandi, 2012). In contrast, the estimated effect of expenditure on active labour market policies (hereafter ALMP) is rather mixed. Orlandi (2012) finds that ALMP are effective in helping to reduce unemployment. However, Bassanini and Duval (2006) obtain statistically significant estimates only for ALMP interacted with other variables,[18] also state that expenditure on some ALMP categories (such as training) is more effective than others. The heterogeneity of these policy variables is visualised in Figures 2.2 and 2.3. Certain clusters emerge as, absent spatial dependence, the colouring is expected to be purely random. Central Europe is least keen in investing in ALMP whereas Scandinavia and the South are bigger spenders. Unemployment benefits are more diverse: it seems that the North is less generous than the South in terms of replacement payments.[19]

Second, we find that cross-country dependence is an important factor governing European economies. Foreign trade is one of the potential shock transmission channels in the EU. To better understand the effect of labour market policies and institutions on unemployment, we

[17]It is defined as income tax plus employee social security contributions (SSC) plus employer SSC (including payroll taxes) less cash transfers related to income level and family characteristics, as a percentage of total labour costs (defined as gross wages plus employer SSC).

[18]This raises a a question of the robustness of such a result, in particular how much of it is being generated by a genuine ALMP variation.

[19]Refer to a recent study by Hagedorn et al. (2015) which uses policy discontinuity at the state borders of the United States to control for endogeneity between unemployment and benefits and proves substantial effect stemming from unemployment benefits to wages, vacancies, and employment.



Source: van Vliet and Caminada (2012) data

Figure 2.3: Unemployment benefits across the EU27 in 2009

estimate the following baseline regression[20]

$$\ln \text{Unemployment}_{it} = \mu_i + \alpha \times \text{OutputGap}_{it} + \beta \times \ln \text{ReplacementRate}_{it}$$
$$+\gamma \times \ln \text{ALMP}_{it} + \delta \times \ln \text{TaxWedge}_{it} + D_t \times \text{TimeDummies}_t + \theta \times \text{Germany's unification}_t + \varepsilon_{it}. \tag{2.1}$$

In the spatial extension, we also include the so-called foreign variables, which are weighted (using bilateral trade flows) cross-sectional averages of the unemployment and output gap.[21] The results are reported in Table 2.2. We control for the output gap, fixed and time effects. Both active labour market policies and tax wedge turn out to be statistically significant policy variables. Traditionally, microeconometric studies have yielded mixed results on the effect of active labour market policies on employment, refer to Card et al. (2015) for an extensive meta analysis. In line with Felbermayr et al. (2013), we find that the domestic unemployment rate is determined not only by domestic labour market variables, but also by shocks in the trading partner countries. However, opposite expectations, foreign output gap, proxying for foreign demand, does not have sufficient explanatory power. This is, however, compatible with the findings in Felbermayr et al. (2013). We have also run a robustness check with slight changes in variable definitions, and have obtained largely consistent results (though the foreign output gap becomes statistically significant at 10% level, refer to the online Appendix). Moreover, Appendix B collects evidence on the Moran I statistic (spatial autocorrelation) once trade weights are used, therefore helping to establish that international trade contributes to transmitting shocks across labour markets. However, unlike this quite

[20] Definitions of the variables used in the regression can be found in Appendix A.1.

[21] To be precise, Foreign $\ln u_{it}$ is defined as $\sum_j w_{ij,t} \ln u_{jt}$ and Foreign output gap is $\sum_j w_{ij,t} \ln \text{OutputGap}_{jt}$. This definition is consistent with the GVAR framework where endogenous variables – here log of unemployment and output gap – are combined (weighted) into foreign variables. One could in principle first weigh variables and later take log but that would have a different interpretation and

Table 2.2: Panel regression of unemployment and policy variables

Dependent variable: $\ln u_{it}$	Aspatial Panel	Spatial Panel
Output gap	-0.0467***	-0.0384***
	(0.0127)	(0.0107)
Foreign output gap		-0.0800
		(0.0827)
Foreign $\ln u_{it}$		1.0570**
		(0.4480)
$\ln \text{TaxWedge}_{it}$	0.3298***	0.2693***
	(0.0563)	(0.0654)
$\ln \text{ALMP}_{it}$	-0.4317***	-0.4599***
	(0.0606)	(0.0612)
$\ln \text{ReplacementRate}_{it}$	0.0513	0.0535
	(0.0614)	(0.0588)
R^2	0.60	0.64

Note: 387 observations for 15 countries. Results with country fixed effects and time fixed effects, ranging from 1985 to 2011. Constant included in both cases as is the dummy for Germany's unification. Robust standard errors in parentheses and p-values in brackets. *, **, *** denote significance at 10%, 5% and 1% respectively.

naïve approach, we want to use trade as the basis for connecting each economy, and allow for heterogeneous responses to all variables. Before dealing with an empirical setup, we first sketch a theoretical motivation.

3 Labour Market Institutions in a Trade Model

As is evidenced by Boeri (2011b), it seems there has been the so-called "sigma convergence" in labour markets, i.e., a reduced cross-sectional variation in the level of labour market indicators within Europe.[22] Interestingly, European countries are also those that have implemented the largest institutional transformations (the exception is taxes on low pay) over the period 1985 – 2008.[23] These ongoing reforms with somewhat converging labour market institutional measures require a theoretical account where economies are interconnected and can transmit their institutions to neighbouring and trading countries. We therefore sketch a simple version of dynamic trade model with labour market frictions. We cover a basic environment with agents and firms, and the resulting equilibrium. We also discuss the major channels through which labour market institutions operate in an open economy.

would not be consistent with the global system.

[22]Further, Boeri (2011b) claims that European labour market reforms are mainly partial ones, creating long-lasting asymmetries in the enforcement of labour market institutions. A traditional approach is that engineering two-tier reforms is generally a device for governments to win political obstacles to sizeable regulatory changes. A theoretical account of dual or two-tier labour markets in the closed economy setting is given in Saint-Paul (1996a,b, 1991).

[23]At least judging from the average rate of a change in the value of the labour market indicators over the period.

3.1 Agents and Preferences

This part follows Helpman et al. (2010) and its many components are therefore skipped. It is worthwhile mentioning that there are two sectors, frictionless homogeneous and differentiated (used for closing the model and pinning down the equilibrium wage), and risk neutral homothetic preferences. The real consumption index for the sector (Q_{it}) is defined as follows:

$$Q_{it} = \left[\int_{\omega \in J} q_{it}(\omega)^{\beta} d\omega\right]^{\frac{1}{\beta}}, \tag{3.1}$$

where ω indexes differentiated varieties, J is the set of varieties within the sector, $q_{it}(\omega)$ denotes consumption of variety ω, and β controls the elasticity of substitution between varieties.

3.2 Firms and Technology

Given the specification of sectoral demand in (3.1), the equilibrium revenue of a firm, $r_{it}(\omega)$, is:

$$r_{it}(\omega) = p_{it}(\omega) q_{it}(\omega) = A_{it} q_{it}(\omega)^{\beta}, \tag{3.2}$$

where $p_{it}(\omega)$ is a price of a brand ω, $q_{it}(\omega)$ is the demanded quantity, $A_{it} \equiv E_{it}^{1-\beta} P_{it}^{\beta}$ is a demand-shifter for the sector, i.e., $q_{it}(\omega) = (A_{it}/p_{it}(\omega))^{\frac{1}{1-\beta}} = \left(p_{it}(\omega)/P_{it}^{\beta}\right)^{\frac{1}{\beta-1}} E_{it}$, and E_{it} is the total expenditure on varieties within the differentiated sector while P_{it} is the differentiated sector's ideal price index. After a firm observes its productivity φ, which is independently distributed and drawn from a Pareto distribution $G(\varphi) = 1 - (\varphi_{min}/\varphi)^{z}$ for $\varphi \geq \varphi_{min} > 0$ and $z > 1$, the firm chooses to exit or enter the sector and whether to produce solely domestically or for both the domestic and the export markets.

A firm incurs the production fixed cost, f_d, as well as the fixed cost of exporting, f_x, both f_d and f_x being expressed in terms of units of the numeraire. Additionally, there is an iceberg variable trade cost, $\tau > 1$, measuring extra goods to be shipped for one unit to arrive in the foreign market. Output of each variety (y) depends on the idiosyncratic productivity of the firm (φ), the measure of workers hired (h), and the general (global economy-wide) productivity ($\mathcal{A}_t$):

$$y_{it}(\varphi) = \varphi h_{it}(\varphi) \mathcal{A}_t^{\lambda_i}, \tag{3.3}$$

and λ_i is country i's factor loading (access to the global technology, $\mathcal{A}_t$). To pin down the prices for any variety j, use the expression for $q_{it}(\omega)$ to arrive at the inverse demand function for a firm

$$p_{it}(\omega) = E_{it}^{1-\beta} P_{it}^{\beta} q_{it}(\omega)^{-(1-\beta)}.$$

Given technology, we know that

$$p_{it}(\omega) = \tfrac{r_{it}(\omega)}{q_{it}(\omega)} = \varphi^{\beta-1} h_{it}^{\beta-1} \mathcal{A}_t^{\lambda_i(\beta-1)}. \tag{3.4}$$

Because of consumers' love of variety and a fixed production cost, no firm will ever serve the export market without also serving the domestic market. Variable $\Upsilon_{it}(\varphi)$ captures a firm's 'market access', which depends on whether it chooses to serve both the domestic and foreign markets or only the domestic market,

$$\Upsilon_{ij,t}(\varphi) \equiv 1 + \mathcal{I}_x(\varphi) \tau^{-\frac{\beta}{1-\beta}} \left(\frac{A_{jt}}{A_{it}}\right)^{\frac{1}{1-\beta}} \geq 1, \tag{3.5}$$

where $\mathcal{I}_x(\varphi)$ is an indicator variable that equals one if the firm exports and zero otherwise (a generic $\Upsilon_x(\varphi)$ denotes 'market access' when $\mathcal{I}_x(\varphi) = 1$).

Combining the production technology with equilibrium wage and hiring rates with revenue function and market access equation in (3.5), the net profit maximisation problem can be expressed as:

$$\pi_{it}(\varphi) = \max_{\substack{h_{it} \geq 0 \\ \mathcal{I}_x \in \{0,\, 1\}}} \left\{ \sum_j \left[1 + \mathcal{I}_{x,j}(\varphi)\, \tau^{-\frac{\beta}{1-\beta}} \left(\frac{A_{jt}}{A_{it}} \right)^{\frac{1}{1-\beta}} \right]^{1-\beta} A_{it} \left(\varphi h_t \mathcal{A}_t^{\lambda_i} \right)^{\beta} - w_{it} h_{it} - f_d - \mathcal{I}_x f_x \right\}. \tag{3.6}$$

Given that a large part of empirical literature finds evidence of selection into export markets, where only the most productive firms export, we focus on values of trade costs for which $\varphi_x > \varphi_d > \varphi_{min}$. Despite our macroeconomic data, we cover firm heterogeneity to learn how trade openness changes with labour market institutions, i.e., extensive margin exists only if part of firms engage in trade.

3.3 Frictional Labour Market

We base this section using some notation from Boeri (2011b) and Hawkins and Acemoglu (2014). The labour market is imperfectly competitive due to the existence of search frictions.[24] Consistently with much of the empirical literature estimating matching functions (Petrongolo and Pissarides, 2001), it is assumed that matching occurs at constant returns to scale:

$$x_{it}(\theta_{it}) = \left(\frac{u_{it}}{v_{it}} \right)^{1-\eta} = \theta_{it}^{\eta-1},\ 1 > \eta > 0, \tag{3.7}$$

where the job finding (or the vacancy filling rate) depends uniquely on the ratio of the number of vacancies, v_{it}, to the number of unemployed, u_{it}, that is, on the degree of labour market tightness, $\theta_{it} \equiv v_{it}/u_{it}$. Clearly, when $\eta = 1$, there is no weight attached to externality due to unemployment, and matching is frictionless and perfect. Further, notice that v refers to the aggregate (average) vacancy rate (as with heterogeneous firms, their vacancy rates are potentially different).

For production to occur, a worker must be matched with a job. As in the seminal contribution by Melitz (2003), firm's productivity is subject to death shocks, occurring at a (Poisson) frequency δ. In addition to a firm's death, there is also a probability of separating from employment relationship even if the firm keeps producing. We denote probability of separation by s.

Gross flows in the labour market occur even when unemployment is constant. An increase in unemployment comes from employed agents losing their jobs either due to exogenous separations s and/or firm-destruction shock δ, and decreases from successful matches, denoted by m_i. Indeed, equating a change to zero and solving for the steady state, one obtains

$$u_i = 1 - \frac{m_i}{\delta + s} = \frac{\delta + s}{\theta_i x_i(\theta_i) + \delta + s} = \frac{\delta + s}{\theta_i^{\eta} + \delta + s}. \tag{3.8}$$

This equation for unemployment is also known as the Beveridge curve. The key (endogenous) variable determining the evolution of gross flows in the labour market is the (differentiated

[24] For an extension using firing taxes within a "two-tier" institutional framework, see Boeri (2011b) and

sector's) market tightness θ_i (affecting the job creation margin). Assuming frictionless homogeneous sector, the unemployment above refers to the national (aggregate) level.

3.3.1 Labour Market Institutions

We will consider two labour market policies that can affect equilibrium outcomes in the economy. Namely, we analyse unemployment benefits as the proportion of the certain wage in the homogenous sector, ω_{it}, i.e., $b_{it} = \varrho_{it}\omega_i$, and an employment conditional incentive e_{it}. To be more precise, we consider an unemployment benefit such that $b_{it}/\omega_i = \varrho_{it} < 1$, which is offered as a replacement of earnings during an unemployment spell. For the sake of simplicity, we employ a flat income replacement scheme providing jobless people with the fraction $0 < \varrho_{it} < 1$ of the homogenous sector's labour income, $\omega_i = 1$, independently of the past earnings history of the worker. The policy parameter ϱ_{it}, in particular, measures the generosity of unemployment benefits. Benefits are assumed to be open-ended and provided conditional on unemployment status. Notice that the government sector is not introduced, so we implicitly assume that all the payments to cover these policies are financed from firms by exogenously changing production taxes (there is a frictionless distribution of these payments to the targeted agents e.g., unemployed, job searchers, etc.).

In the motivation part, our focus has also been on the active labour market policies, framed as an employment conditional incentive, e_{it}, which is provided to job-holders on a flow basis as a measure to increase rewards from participation. This policy instrument can be thought of as a wage subsidy. Traditionally, labour literature dealt with partial effects of labour market institutions in isolation from the macroeconomy. A complete reform, on the other hand, is bound to have effects on the labour market aggregates, i.e., a change in any of the above policy parameters, ϱ_{it} and e_{it}, may affect all potentially eligible groups, that is, all the unemployed (ϱ_{it}) or all the employees (e_{it}), and through price mechanism can be transmitted to goods (or other) markets. Since the two covered institutions act as taxes being borne by firms, we also analyse an empirical measure of a tax wedge, which introduces a wedge in wages paid to employees and firm labour costs. We will explore how they affect equilibrium wages, and, therefore, prices and aggregate variables. Moreover, we will have an international dimension – a global factor and international trade connecting economies, therefore, transmitting all the effects through international prices.

3.3.2 Wages

Obviously, the introduction of labour market institutions affects wages and prices which, in turn, affect the entire macroeconomy. As our goal here is to derive solely a wage as a major component that drives aggregate variables, we will skip all the details associated with a full set of Hamilton-Jacobi-Bellman (HJB) equations.[25]

Consistently with the current trade literature, wages are assumed to be paid by firms to workers as the incremental surplus generated by their employment relationship following arguments due to Stole and Zwiebel (1996a,b). Suppose $0 \leq \kappa \leq 1$ of the surplus goes to a firm, and $1 - \kappa$ to the employee. As the solution of HJB equations in an open economy is lengthy, we sketch a derivation in the Online Appendix, and report the ultimate expression,

$$w_{it}\left(h_{it};\varphi\right) = \kappa \frac{\Gamma_{it}\varphi^{\beta}}{\gamma\kappa\beta+1-\kappa} h_{it}^{\gamma\beta-1} + (1-\kappa)\left(b_{it} - e_{it} + \frac{\kappa}{1-\kappa}\theta_{it}\right). \tag{3.9}$$

Costain et al. (2010).

[25]Refer to Hawkins and Acemoglu (2014) for closed economy environment where HJB equations are set out and solved.

Just notice that the current expression involves the employment level h_{it}, which is still an endogenous object and varies with the firm productivity. The above equation shows that when κ approaches 0, that is, workers have no bargaining power, wages collapse to the unemployment benefit net of the employment conditional incentive, which is indeed a measure aimed at reducing disincentives to accept low-paid jobs. When, instead, κ approaches 1, wages in (3.9) appropriate the entire match productivity and are augmented by the recruitment cost net of the hiring subsidy and the discounted value of the firing tax (which is a lump-sum payment). Under such conditions, however, it would be unprofitable to open up a vacancy (the recruitment costs, net of the hiring subsidy, could not be covered by any ensuing flow of net revenues at match formation). Hence, we need to impose that κ is strictly lower than 1. These insights lead to the first result.

Claim 1. Wages are increasing in the unemployment benefits and decreasing in the employment-conditional incentive, holding firm's employment constant. In particular,

$$\frac{\partial w_{it}(h_{it};\varphi)}{\partial b_{it}} = 1-\kappa > 0,$$
$$\frac{\partial w_{it}(h_{it};\varphi)}{\partial e_{it}} = -(1-\kappa) < 0,$$

The intuition for the Claim 1 is quite straightforward. The benefits increase the attractiveness of the outside option to opt for unemployment for the workers, thereby pushing the employment compensation up. The increase in the wage subsidy reduces the wage related costs. However, these effects still lack the channel from employment as it also changes with labour market institutions. Therefore, substituting for the employment, wage rate becomes

$$w_{it}\left(h_{it};\,\varphi\right) = w_{it} = b_{it} - e_{it} + \tfrac{\kappa}{1-\kappa}\left(\theta_{it} + \left(r+\delta+s\right)\theta_{it}^{1-\eta}\right). \tag{3.10}$$

The wage is identical across the firms, despite the productivity of the firm as vacancy posting costs are linear. Wages are increasing in benefits b_{it}, decreasing in employment-contingent subsidies e_{it}, and increasing in the labour market tightness θ_{it}, *ceteris paribus*. We do not delve into developments in the labour market (i.e., do not cover how equilibrium tightness is determined), but rather turn our attention to trade openness. It is affected by labour market institutions through firm reallocations and changes in prices, arising from adjustments in wages.

3.4 Equilibrium

The model is solved, as in Helpman et al. (2010), exploiting its recursive structure. After determining labour market outcomes, the remaining endogenous objects include zero-profit productivity cutoffs which determine aggregate variables – demand shifters A_{it} (and hence expenditure E_{it}), dual price index P_{it}, the real consumption index Q_{it}, the mass of firms M_{it}, and the size of the labour force L_{it}. Since our emphasis is on aggregate implications, we will skip the firm level structure (though refer to Appendix C.1 for more details).

The result that relates international trade and labour market institutions is summarised as follows:

Lemma 1. *The structure of active firms changes with labour market policies: share of exporters increases with a rise in unemployment benefits and decreases with employment contingent incentives, holding labour market tightness constant.*

Proof. See Appendix C.1.1. □

The intuition for the results stated in the lemma is quite simple: since benefits are covered by firms, that makes production costlier and thus increases the threshold productivity. The subsidy works just in an opposite way – it can be thought of as an exogenous reduction in the production costs. The change in labour market tightness causes a positive change in the domestic productivity cutoff, denoted by $\varphi_{i,d}$. Hence, the results in Lemma 1 can be extended to varying θ_i but then depend on the relative magnitudes of unemployment benefits and subsidies, as will be covered in the following Section.[26] In other words, the full, rather than partial, effect admits both signs - this is consistent with heterogeneous impulse responses that we cover in the empirical part of the paper. Interestingly, the impulse responses from a counterfactual of joint changes in labour market regulation comply to the theoretical partial effect.

3.4.1 Reallocations and Labour Market Policies

To understand the main mechanisms that will generate macro level results, shut off the channel of the labour market tightness for a moment, and recall that cutoff productivities are positively related to the unemployment benefits. This implies that paying larger benefits hurts relatively inefficient firms more and makes survival more difficult. However, an opposite effect is being brought, recalling that wages are constant across firms. An increase in benefits causes a rise in wages, which must be counteracted by a drop in labour market tightness. To see this, differentiate the equilibrium wage rate in (3.10) with respect to unemployment benefit b_{it}, thus arriving at

$$\frac{\partial \theta_{it}}{\partial b_{it}} = -\frac{1}{\frac{\kappa}{1-\kappa}\left(1 + (r+\delta+s)(1-\eta)\,\theta_{it}^{-\eta}\right)}.$$

This effect, which makes survival easier due to the less tight labour market, does not dominate the direct effect of increased costs to cover benefits. Intuition is based on the standard Melitz-type reallocations. Only instead of trade costs, we consider exogenous changes in labour market regulation. Same as in Melitz (2003), the labour market plays a crucial role as all the adjustments are through changes in relative prices. A decrease in the price index has made sure that real wages have risen and driven the least productive firms away from the market. Clearly, institutional measures in the labour markets affect prices which, in turn, change welfare and all real aggregates in the economy.

A simple alternative way to see the results is to recall that the government sector is not modelled; hence, policies are funded by active firms, and the reallocation is similar to changes in production costs. To see this, consider the full effect on wages:

$$\begin{aligned}\tfrac{dw_{it}}{d\Theta_{it}} &= 1 + \kappa(1-\eta)\left(\tfrac{r+\delta+s}{1-\kappa}\right)\theta_{it}^{-\eta}\tfrac{d\theta_{it}}{d\Theta_{it}} \\ &= 1 + (1-\eta)(r+\delta+s)\,\theta_{it}^{-\eta} > 0.\end{aligned}$$

It is then clear that $\frac{dp_{it}^{\frac{\beta}{\beta-1}}(\varphi_{i,d})}{d\Theta_{it}} = \frac{\beta}{\beta-1}p_{it}^{\frac{1}{\beta-1}}(\varphi_{i,d})\frac{dp_{it}(\varphi_{i,d})}{d\Theta_{it}}$, therefore, $\frac{dp_{it}(\varphi_{i,d})}{d\Theta_{it}} < 0$ which leads to $\frac{dp_{it}(\varphi_{i,d})}{db_{it}} < 0$ and $\frac{dp_{it}(\varphi_{i,d})}{de_{it}} > 0$. Domestic prices rise with subsidies and decrease with benefits – competition is fiercer once benefits are covered by firms, whereas subsidies are an exogenous drop in production costs. These results rely on the wages being positive with the sufficient condition (though not necessary) being $b_i > e_i$. It is of course an empirical

[26] It also depends on relative sizes of parameters β and κ.

question whether benefits are larger than incentives, though at least this seems to be the case on average (see Appendix A.3 for summary statistics). It is, therefore, of interest to learn the heterogeneity of responses in real economies.

3.4.2 Aggregate Variables

We turn to briefly describing major aggregate variables which are observables and, therefore, susceptible to empirical analysis. The free entry condition solves for the demand-shifter of the sector A_{it} as a function of parameters, all the labour market institutions, fixed and sunk costs, for given values of foreign demand shifter A_{jt}. The latter affects the solution only through the intensive margin of trade, $\Upsilon_{ij,t}$. This solution can then be used to solve for the price index P_{it}, recalling that $z > \beta/(1-\beta)$.

From equation (3.2) we know that $q_{it}(\varphi) = (A_{it}/p_{it}(\varphi))^{\frac{1}{1-\beta}}$. As a result the real consumption index for the differentiated sector, Q_{it}, equation (3.1) can be re-expressed as

$$Q_{it} = \left[\int_{\omega \in J} q_{it}(\omega)^{\beta} d\omega\right]^{\frac{1}{\beta}} = \left[\int_{\omega \in J} p_{it}^{\frac{\beta}{\beta-1}}(\omega)\, d\omega\right]^{\frac{\beta-1}{\beta}\frac{1}{\beta-1}} A_{it}^{\frac{1}{1-\beta}} = P_{it}^{\frac{1}{\beta-1}} A_{it}^{\frac{1}{1-\beta}}, \tag{3.11}$$

hence, we can solve for Q_{it} as the function of the demand shifter and the ideal price index P_{it}, i.e., $Q_{it} = A_{it}^{\frac{1}{1-\beta}} P_{it}^{-\frac{1}{1-\beta}}$. The price level P_{it} can be expressed as

$$\begin{aligned} P_{it} &= \left[\int_{\omega \in J} p_{it}(\omega)^{-\frac{\beta}{1-\beta}} d\omega\right]^{-\frac{1-\beta}{\beta}} \qquad (3.12) \\ &= \left[\mathcal{A}_t^{\lambda_i \frac{\beta}{1-\beta}} \left(\frac{\beta\gamma}{\kappa\beta + 1 - \kappa}\right)^{\frac{\beta}{1-\beta}} \left[M_{ii}\left[\Theta_{it} + \left(\frac{r+\delta+s}{1-\kappa}\right)\theta_{it}^{1-\eta}\right]^{\frac{\beta}{\beta-1}} A_{it}^{\frac{\beta}{1-\beta}} V(\varphi_{i,dt})\right.\right. \\ &\quad \left.\left. + \sum_{j \neq i} \mathcal{A}_t^{(\lambda_j - \lambda_i)\frac{\beta}{1-\beta}} \tau_{ji,t}^{-\frac{\beta}{1-\beta}} M_{ji}\left[\Theta_{jt} + \left(\frac{r+\delta+s}{1-\kappa}\right)\theta_{jt}^{1-\eta}\right]^{\frac{\beta}{\beta-1}} A_{jt}^{\frac{\beta}{1-\beta}} \Upsilon_{ji,t}^{\beta}(\varphi)\, \rho_{ij,t}^{z} V(\varphi_{ji,t})\right]\right]^{-\frac{1-\beta}{\beta}}, \end{aligned}$$

where $V(\varphi_{i,dt}) \equiv \int_{\varphi_{dt}}^{\infty} \varphi^{\frac{\beta}{1-\beta}} \frac{dG(\varphi)}{1-G(\varphi_{dt})} = \frac{z(1-\beta)}{z(1-\beta)-\beta}\varphi_{i,dt}^{\frac{\beta}{1-\beta}}$ and $V(\varphi_{ji,t}) = \frac{z(1-\beta)}{z(1-\beta)-\beta}\varphi_{ji,t}^{\frac{\beta}{1-\beta}}$ are defined similarly to Helpman et al. (2008) to capture potentially zero trade flows, also $z > \frac{\beta}{1-\beta}$ must hold for the integral of aggregates to be bounded. The probability of importing into the domestic economy from abroad is $\rho_{ij,t}^{z} \equiv \frac{1-G(\varphi_{ji,t})}{1-G(\varphi_{i,dt})} = \left(\frac{\varphi_{i,dt}}{\varphi_{ji,t}}\right)^{z}$, and is the measure of an extensive margin of trade.

The change in the price index is related to the changes in labour market institutions, aggregate (global) technology, intensive and extensive trade margins, and changes in firms' reallocation between exporting and purely domestic sectors. Notice that a common unobserved factor $\mathcal{A}_t$ is featured in the general price index. Therefore, co-trending implies that factor loadings λ are all equal among themselves, i.e., $\lim_{h\to\infty} \mathcal{A}_{t+h}^{(\lambda_j-\lambda_i)}$ is bounded to 1. Clearly, the labour market institutions drive the general price index which also demonstrates that effects from foreign countries can be "imported" through the goods market. The indirect effect refers to threshold productivities. In other words, *the very composition of domestic producers and exporters react to changes in labour market policies* (also refer to equations (C.1) and (C.2) in the Appendix).

As mentioned, the price index is crucial for the welfare implications, also for understanding reallocations of firms. The reduction in it implies, *ceteris paribus*, an increase in welfare, which can be caused by an increase in the shared common technology $\mathcal{A}_t^{\lambda_i}$, decrease in transport costs τ_t, and changes in labour market institutions, among others. The direct effect, Θ_{it}, comes from the equilibrium employment, which reacts to labour market policies. Another effect is embedded in $V(\varphi_{dt})$, and comes from firms reallocations domestically. Finally, the international dimension is subsumed within the extensive margin ρ_t and the term $V(\varphi_{xt})$, because they both would change through the exporting cutoff productivity, φ_{xt}.[27]

Accounting for general equilibrium and the international dimension is challenging – the uncertainty about labour market tightness would be encountered again. The partial direct effect through hiring reveals that

$$\left.\frac{\partial P_{it}}{\partial \Theta_{it}}\right|_{\text{else constant}} \propto \left[\Theta_{it} + \left(\frac{r+\delta+s}{1-\kappa}\right)\theta_{it}^{1-\eta}\right]^{\frac{\beta}{\beta-1}-1}, \ \left.\frac{\partial P_{it}}{\partial \Theta_{jt}}\right|_{\text{else constant}} \propto \left[\Theta_{jt} + \left(\frac{r+\delta+s}{1-\kappa}\right)\theta_{jt}^{1-\eta}\right]^{\frac{\beta}{\beta-1}-1}.$$

Hence, an increase in benefits would increase the price index, *ceteris paribus*, whereas the opposite would happen with an increase in the employment-conditional incentives. This is in line with the previous results. Positive changes in benefits would relatively increase the measure of domestic producers and their profitability, because prices would go up. This makes real wages lower, and, thus, competition less fierce. Due to the free entry condition, the exporters' sector would suffer, as relatively fewer firms would be able to export. The opposite would happen with an increase in employment incentives. The changes in foreign countries labour market would be transmitted to the domestic economy through imported varieties, and changes in their prices.

4 A Few Empirical Implications

We seek to operationalise our theoretical setting to a global dynamic econometric framework. We first derive a few results regarding major macroeconomic variables.[28] We then conduct a number of comparative statics exercises which help to build intuition before turning to the empirical results.

4.1 Real Exchange Rate

In order to understand how the major important international price, that is a real exchange rate, behaves, we first briefly cover a simpler alternative to it, terms of trade. It focuses on the intensive margin of trade, i.e., $ToT_{ij} \equiv \varepsilon_{ij} p_j / p_i$ where prices, due to isoelastic aggregators, reflect the standard form of markups over marginal costs (here ε_{ij} denotes the bilateral nominal exchange rate, which is not modelled and treated as given). As it only includes traded goods, a decrease in ToT leads to fewer exports being given up in exchange for a given volume of imports. Since everything is denominated in terms of labour price (wage), the exchange rate is just the relative price of foreign labour in terms of home labour units (see Corsetti et al. (2007) for the analysis of trade margins and productivity spillovers).

[27] Previously, we thought of φ_{xt} as exporting rather than importing cutoff; however, in a steady state with no trade imbalances, also in symmetrical countries, the two are mirrors of each other. Given differences in economies, the cutoffs need not be the same, but the balancedness of trade would make sure that labour market institutions bear implications for importers and exporters.

[28] We analyse the aggregate model at the global level though the theory is richer than that and can be adapted to firm level or sectoral analysis. In particular, we seek to uncover an estimable macro model with micro-foundations. We leave to empirically assess the micro level implications for future research.

Formally,

$$ToT_{ij,t} \equiv \varepsilon_{ij,t} \frac{p_{jt}}{p_{it}} = \varepsilon_{ij,t} \left(\frac{\varphi_{i,x}}{\varphi_{j,x}}\right)^{1-\beta} \left(\frac{h_{it}}{h_{jt}}\right)^{1-\beta} \mathcal{A}_t^{(\lambda_j-\lambda_i)(\beta-1)}.$$

Therefore, co-trending makes sure the $ToT_{ij,t}$ is stationary, as in that case the global effect is eliminated. Evaluating the terms of trade at average prices (denoted by productivities with a tilde), one obtains

$$\begin{aligned} ToT_{ij,t}\left(\tilde{\varphi}_{i,x},\, \tilde{\varphi}_{j,x}\right) &= \varepsilon_{ij,t} \left(\tfrac{\tilde{\varphi}_{i,x}}{\tilde{\varphi}_{j,x}}\right)^{1-\beta} \left(\tfrac{h_{it}}{h_{jt}}\right)^{1-\beta} \mathcal{A}_t^{(\lambda_j-\lambda_i)(\beta-1)} \\ &= \varepsilon_{ij,t} \left(\tfrac{\tilde{\varphi}_{i,x}}{\tilde{\varphi}_{j,x}}\right) \left(\tfrac{\Upsilon_{i,x}}{\Upsilon_{j,x}}\right)^{1-\beta} \tfrac{A_{it}}{A_{jt}} \tfrac{\Theta_{jt}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{jt}^{-1}}{\Theta_{it}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{it}^{-1}} \mathcal{A}_t^{-(\lambda_j-\lambda_i)}. \end{aligned} \tag{4.1}$$

This leads to the following result.

Lemma 2. *Terms of trade are stationary, provided outputs are co-trending,* $\lambda_j = \lambda_i$ *for all pairs* $i \neq j$. *A change in labour market policies is directly transmitted through prices and indirectly through the exporters' average productivity. Assuming no change in firms' composition abroad after a change in home's labour market institutions, one obtains that terms of trade increase with employment contingent subsidies,* e, *and decrease with unemployment benefits,* b.

Proof. Differentiating (4.1) with respect to Θ yields the desired result,

$$\begin{gathered} \frac{\partial \tilde{ToT}_{ij,t}}{\partial \Theta_{it}} \frac{\Theta_{it}}{\tilde{ToT}_{ij,t}} = \frac{\Theta_{it}}{\tilde{\varphi}_{i,x}} \frac{\partial \tilde{\varphi}_{i,x}}{\partial \Theta_{it}} - \frac{\Theta_{it}}{\Theta_{it}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{it}^{-1}} < 0 \\ \frac{\partial \tilde{ToT}_{ij,t}}{\partial \Theta_{it}} \frac{\partial \Theta}{\partial b} < 0,\; \frac{\partial \tilde{ToT}_{ij,t}}{\partial \Theta_{it}} \frac{\partial \Theta}{\partial e} > 0. \end{gathered}$$

□

Hence, higher exports are needed to cover the same volume of imports when there is an increase in employment contingent subsidies, e_i, and the opposite – lower exports – when there is an increase in unemployment benefits. These results may be overturned for the real exchange rate, since the extensive margin of trade is disregarded in the terms of trade. The welfare-based real exchange rate, $RER_{ij,t} \equiv \varepsilon_{ij,t} P_{jt}/P_{it}$, compares price levels where domestic producers are included, and whose increase can be interpreted as an increase in the purchasing power of domestic residents. This leads to

$$RER_{ij}^{\frac{\beta}{1-\beta}} = \varepsilon_{ij,t}^{\frac{\beta}{1-\beta}} \mathcal{A}_t^{(\lambda_i-\lambda_j)\frac{\beta}{1-\beta}} \left(\tfrac{\varphi_{i,d}}{\varphi_{j,d}}\right)^{\frac{\beta}{1-\beta}}$$

$$\times \frac{M_{ii}\left[\Theta_{it}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{it}^{-1}\right]^{\frac{\beta}{\beta-1}} A_{it}^{\frac{\beta}{1-\beta}} + \sum_{j\neq i} \mathcal{A}_t^{\left(\lambda_j-\lambda_i\right)\frac{\beta}{1-\beta}} \tau_{ji}^{-\frac{\beta}{1-\beta}} M_{ji}\left[\Theta_{jt}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{jt}^{-1}\right]^{\frac{\beta}{\beta-1}} A_{jt}^{\frac{\beta}{1-\beta}} \Upsilon_x^{\beta}(\varphi) \left(\frac{\varphi_{i,d}}{\varphi_{j,x}}\right)^{z-\frac{\beta}{1-\beta}}}{M_{jj}\left[\Theta_{jt}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{jt}^{-1}\right]^{\frac{\beta}{\beta-1}} A_{jt}^{\frac{\beta}{1-\beta}} + \sum_{\ell\neq j} \mathcal{A}_t^{\left(\lambda_\ell-\lambda_j\right)\frac{\beta}{1-\beta}} \tau_{\ell j}^{-\frac{\beta}{1-\beta}} M_{\ell j}\left[\Theta_{\ell t}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{\ell t}^{-1}\right]^{\frac{\beta}{\beta-1}} A_{\ell t}^{\frac{\beta}{1-\beta}} \Upsilon_x^{\beta}(\varphi) \left(\frac{\varphi_{j,d}}{\varphi_{\ell,x}}\right)^{z-\frac{\beta}{1-\beta}}},$$

and its stability is governed by diffusion of the common unobserved factor. Under co-trending among all pairs of trading economies, the real exchange rate becomes stable. It obviously depends on both intensive and extensive margins of trade. Hence, a change in home labour market institutions (with no direct effect on foreign cutoff productivities) yields an ambiguous result because a change in home prices might be altered by effects from foreign countries. There are three major channels at work: the effect through domestic productivity, which alters firm structure (non-exporters vs exporters), the direct effect on prices, and the indirect effect on prices of exportables through the changed productivity level. It becomes an empirical question, which force is dominating (refer to Appendix C.2 for theoretical results). Indeed, to see whether theoretical predictions manifest in data, we conduct shocks in labour market policies and track how each economy's real exchange rate reacts. We expect substantial heterogeneity as each economy potentially differs in terms of the three channels described above. Refer to Appendix D where Figure D.1 depicts reactions to changes in active labour market policies, implemented separately by each economy. There is a tendency for more and less open economies to cluster together.

4.2 Employment

Since we want to explore the evolution of employment (or unemployment), we use the equilibrium condition of imperfect matching (refer to (3.8)), namely[29]

$$\begin{aligned} 1-u_{it} &= \frac{E_{it}}{\left(\frac{\kappa\beta+1-\kappa}{\beta}\right)\left(b_{it}-e_{it}+\frac{\kappa}{1-\kappa}\theta_{it}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{it}^{-1}\right)(\delta+s)} \\ &= \frac{\beta}{\delta+s}\frac{E_{it}}{E_{it}^{1-\beta}P_{it}^{\beta}\mathcal{A}_t^{\lambda_i}\Upsilon_{it}^{1-\beta}} = \frac{\beta}{\delta+s}\mathcal{A}_t^{-\lambda_i}\Upsilon_{it}^{\beta-1}\left(\frac{E_{it}}{P_{it}}\right)^{\beta}. \end{aligned} \tag{4.2}$$

Equation (4.2) captures the major forces embedded in the model: global dynamic factor ($\mathcal{A}_t$), intensive margin of trade Υ_{it}, real expenditure (aggregate quantity) (E_{it}/P_{it}), and primitive parameters. To sign a change in employment, we shall consider two channels, the intensive margin and the aggregate quantity (utility):

$$\begin{aligned} \frac{\partial(1-u_{it})}{\partial e_{it}} &= \frac{\beta}{\delta+s}\mathcal{A}_t^{-\lambda_i}\Upsilon_{it}^{\beta-1}\left(\frac{E_{it}}{P_{it}}\right)^{\beta}\left[(\beta-1)\,\Upsilon_{it}^{-1}\frac{\partial\Upsilon_{it}}{\partial e_{it}}+\beta\left(\frac{E_{it}}{P_{it}}\right)^{-1}\frac{\partial(E_{it}/P_{it})}{\partial e_{it}}\right] \\ &= (1-u_{it})\left[(\beta-1)\,\Upsilon_{it}^{-1}\frac{\partial\Upsilon_{it}}{\partial e_{it}}+\beta\left(\frac{E_{it}}{P_{it}}\right)^{-1}\frac{\partial(E_{it}/P_{it})}{\partial e_{it}}\right] > 0. \end{aligned} \tag{4.3}$$

Using the steady state unemployment in (3.8) and labour market tightness in Section (3.4.1), we can infer that $\partial u_{it}/\partial e_{it} < 0$. This is useful for learning about the effect of labour market policies (here, subsidies e_{it}) on utility (Q_{it}), i.e.,

$$\frac{\partial\left(E_{it}/P_{it}\right)}{\partial e_{it}} > \left(\frac{\beta}{1-\beta}\right)^{-1}\Upsilon_{it}^{-1}\frac{\partial\Upsilon_{it}}{\partial e_{it}}\frac{E_{it}}{P_{it}}. \tag{4.4}$$

Since the right-hand side is negative, we assume that the effect on utility is either negative or slightly positive (we will clarify the assumption in the following section). We are effectively saying that the expenditure on active labour market policies, by reducing the costs to produce and, therefore, average productivity, can result in a negative or a positive real expenditure, as long as the effect is not too negative.

4.3 Multi-country Trade Flows

Further, we account for the global structure of the model by computing trade flows among included countries. Recent contributions in gravity modelling have emphasised multilateral

[29]In principle, we could use the equation for equilibrium hiring, and combine it with the wage equation. However, we do not have comparable data across countries for hiring rates at domestic producers or exporters. Instead, we use the version of firm price (3.4), and apply the constant elasticity of substitution that comes from monopolistic competition. That helps to get rid of productivity shock, and allows mapping the labour market variables into aggregates. To be precise, $p_{it}(\varphi) = \frac{\kappa\beta+1-\kappa}{\beta\gamma}\varphi^{-1}\left[\frac{b_{it}-e_{it}+\frac{\kappa}{1-\kappa}\theta_{it}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{it}^{-1}}{A_t\mathcal{A}_t^{\lambda_i}\Upsilon_{it}(\varphi)^{1-\beta}}\right] = \frac{w_{it}}{\beta\varphi} = \frac{1}{\beta\varphi}$, therefore, yielding $b_{it}-e_{it}+\frac{\kappa}{1-\kappa}\theta_{it}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{it}^{-1} = \frac{1}{\kappa\beta+1-\kappa}E_{it}^{1-\beta}P_{it}^{\beta}\mathcal{A}_t^{\lambda_i}\Upsilon_{it}^{1-\beta}$.

resistance terms – or general equilibrium results embedded in the trade model even considering bilateral trade flows (see Anderson and van Wincoop, 2003). The gravity model has further been augmented to account for a firm heterogeneity and the resulting firm selection in Helpman et al. (2008).

We proceed by using prices in (3.4) and demand as summarised in the revenue function (3.2) to obtain total exports from country i (a sum of bilateral flows),

$$\begin{aligned} EX_{it} &\equiv \textstyle\sum_{j\neq i} \int_{\varphi_{ij,x}}^{\infty} r_{ij,t}(\omega) \frac{dG(\varphi)}{1-G(\varphi_{ij,x})} = \sum_{j\neq i} \int_{\varphi_{ij,x}}^{\infty} \varphi^{\beta} h_{it}^{\beta} \mathcal{A}_t^{\lambda_i \beta} \frac{dG(\varphi)}{1-G(\varphi_{ij,x})} \\ &= \textstyle\sum_{j\neq i} \frac{\tau_{ij}^{\frac{\beta}{\beta-1}} \mathcal{A}_t^{\lambda_i \frac{\beta}{1-\beta}}}{P_{jt}^{\frac{\beta}{\beta-1}}} \left(\frac{\beta\gamma A_{it}}{\kappa\beta+1-\kappa}\right)^{\frac{\beta}{1-\beta}} \left[\Theta_{it} + \left(\frac{r+\delta+s}{1-\kappa}\right) x_{it}^{-1}\right]^{\frac{\beta}{\beta-1}} E_{jt} \Upsilon_{ij,x}^{\beta} V(\varphi_{j,x}) \\ &= \textstyle\frac{z(1-\beta)}{z(1-\beta)-\beta} \sum_{j\neq i} \left(\frac{\tau_{ij} p_{jt}(\varphi_{ij,x})}{P_{jt}}\right)^{\frac{\beta}{\beta-1}} E_{jt}. \end{aligned} \tag{4.5}$$

It is certainly a function of price indices at home and abroad (real exchange rate), bilateral trade costs τ that a country i needs to cover when trading with all countries j, GDP in all trading partners,[30] and the labour market policies, which enter through the cutoff productivity level $\varphi_{ij,x}$, and determine how competitive an economy is in the world market. Hence, an aggregate gravity-type relationship entails variables, which are all endogenous, and must be modelled simultaneously.

To determine the openness ratio, we express exports in (4.5) as

$$\begin{aligned} EX_{it}/E_{it} &= \textstyle\frac{z(1-\beta)}{z(1-\beta)-\beta} \left(\frac{\beta\gamma}{\kappa\beta+1-\kappa}\right)^{\frac{\beta}{1-\beta}} \left[\Theta_{it} + \left(\frac{r+\delta+s}{1-\kappa}\right) x_{it}^{-1}\right]^{\frac{\beta}{\beta-1}} (E_{it}/P_{it})^{\beta-1} P_{it}^{\frac{\beta}{1-\beta}} \Pi_{it} \\ &= \textstyle\frac{z(1-\beta)}{z(1-\beta)-\beta} \beta^{\frac{\beta}{1-\beta}} \Upsilon_{it}^{-\beta} \mathcal{A}_t^{\lambda_i \frac{\beta}{\beta-1}} (E_{it}/P_{it})^{-1} \Pi_{it}, \end{aligned} \tag{4.6}$$

where Π_{it} is an endogenous multilateral resistance term, defined as

$$\Pi_{it} \equiv \sum_{j\neq i} \left(\frac{\tau_{ij,t}/\varphi_{ijt,x}}{P_{jt}}\right)^{\frac{\beta}{\beta-1}} \left(\frac{P_{it}}{P_{jt}}\right) \left(\frac{E_{jt}}{P_{jt}}\right) \Upsilon_{ijt,x}^{\beta}. \tag{4.7}$$

This term affects all trading economies, and is time varying. It can be thought of as a weighted average of major endogenous variables, including the real exchange rate (the ratio of price indices), real GDP, trade costs, and trade margins.

An empirical implication is that, if aggregate variables do not change, the effect on openness, EX_{it}/E_{it}, acts through the intensive margin Υ_{it}, see equation (4.6). The effect of a change in structural labour markets would differ, depending on the general equilibrium term Π_{it}, which is a function of macro variables in all trading partners. Consider a partial change in labour market subsidies (ALMP):

$$\frac{\partial (EX_{it}/E_{it})}{\partial e_{it}} \propto -\beta \Upsilon_{it}^{-\beta-1} \frac{\partial \Upsilon_{it}}{\partial e_{it}} > 0. \tag{4.8}$$

The sign follows from the free entry condition that relates intensive and extensive margins of trade.[31] Keeping fixed costs exogenous, an increase in expenditure e_{it} reduces the average firms' productivity (it becomes easier to produce). Recall Lemma (1) on the structural

[30] To be precise, E_{it} refers to the differentiated sector's expenditure, not the entire economy which shall also include the homogenous sector. However, the latter is always fixed by the population since its wage is normalised to one.

[31] Divide cutoff productivities, as described in the Appendix; also refer to the equation (C.3).

changes in an economy. Due to a drop in the domestic productivity cutoff, extensive margin drops (φ_x/φ_d increases), and, to keep the fixed costs unchanged, there should be a drop in Υ_{it}. It then follows that the openness increases, keeping other aggregate variables constant.

A change in the aggregate quantity, $E_{it}/P_{it} \equiv Q_{it}$, can alter the above prediction. We therefore need to apply an expression in equation (3.11), and evaluate

$$\left.\frac{\partial (EX_{it}/E_{it})}{\partial e_{it}}\right|_{\Pi_{it}\text{ fixed}} = -\left(EX_{it}/E_{it}\right)\left[\beta\Upsilon_{it}^{-1}\left(\partial\Upsilon_{it}/\partial e_{it}\right) - \left(E_{it}/P_{it}\right)^{-1}\frac{\partial (E_{it}/P_{it})}{\partial e_{it}}\right] > 0. \tag{4.9}$$

The sign depends one the partial effect of E_{it}/P_{it} in the equation (4.4). The derivative is positive, provided that the partial effect in (4.4) is negative. Indeed, even if it was slightly positive, i.e., $\partial\left(E_{it}/P_{it}\right)/\partial e_{it} > 0$, there exists a range of parameters that yield a positive effect. Finally, there is a third channel, which is even harder to evaluate theoretically – international spillover effects are embedded in Π_{it}. We let data speak as to whether they are strong enough to change the predictions on openness.

To finalise, substitution of employment into the aggregate gravity relationship, yields an estimating equation

$$EX_{it}/E_{it} = \frac{z\left(1-\beta\right)}{z\left(1-\beta\right)-\beta}\left(\delta+s\right)^{\frac{\beta}{1-\beta}}\left(1-u_{it}\right)^{\frac{\beta}{1-\beta}}\left(E_{it}/P_{it}\right)^{\beta\left(\frac{\beta}{\beta-1}\right)-1}\Pi_{it}. \tag{4.10}$$

The statistical modelling of the openness dimension clearly depends on the assumptions about Π_{it}. We discuss two solutions to deal with it.

4.4 Estimating Specifications

What regards the general equilibrium term Π_{it}, we concentrate on two ways to address it empirically, namely using a proxy and linearising it around $\beta = 0$ (in Appendix D, we also report a few other modelling alternatives).[32]

4.4.1 Model I: Real Effective Exchange Rate

Our first solution is to observe that (4.7) can be written as $\Pi_{it} = \sum_{j\neq i}\varpi_{ij,t}\left(\frac{P_{it}}{P_{jt}}\right)$, where the weight $\varpi_{ij,t}$ on the relative prices accounts for trade openness, market access, and real GDP. This yields a weighted sum of exchange rates – any such average we call a real effective exchange rate, *reer*. As we cannot empirically uncover the weight, we assume it is multiplicatively separable, so that $\Pi_{it} = F_t^{\lambda_i}\sum_{j\neq i}\varpi_j\left(\frac{P_{it}}{P_{jt}}\right) = F_t^{\lambda_i} \times reer_{it}$ where $F_t^{\lambda_i}$ is rooted in a global technology $\mathcal{A}_t$, inherent in income definition, and modelled as a dynamic factor. Using such a specification, the estimating relationship becomes

$$\ln\left(\frac{EX_{it}}{E_{it}}\right) = \tilde{\beta}_i + \frac{\beta}{1-\beta}\ln\left(1-u_{it}\right) + \left(\beta\left(\frac{\beta}{\beta-1}\right)-1\right)\ln\left(\frac{E_{it}}{P_{it}}\right)$$
$$+\lambda_i\ln\left(\frac{EX_{it}}{E_{it}}\right)^\star - \lambda_i\frac{\beta}{1-\beta}\ln\left(1-u_{it}\right)^\star - \lambda_i\left(\beta\left(\frac{\beta}{\beta-1}\right)-1\right)\ln\left(\frac{E_{it}}{P_{it}}\right)^\star - \lambda_i\ln reer_{it}^\star + \ln reer_{it}.$$

Econometrically, we introduce openness, employment, real GDP, real exchange rates, and their cross-sectional averages.[33] Note that labour market institutions, chosen discretionarily by policy makers, affect all these variables.

[32] In Appendix D we report a possibility to use a global unobserved factor, and the fourth variant, where we deal with unemployment rather than employment, a more traditional but less theoretically motivated specification.

[33] The cross-sectional averages are defined as $\ln\left(EX_{it}/E_{it}\right)^\star = \frac{\sum\omega_i\ln(EX_{it}/E_{it})}{\sum\omega_i\gamma_i}$, $\ln\left(1-u_{it}\right)^\star =$

4.4.2 Model II: Linearisation (no global technology)

We linearise the multilateral term around $\beta = 0$, thus treating the term as a function of elasticity of substitution, namely $f(\beta) = \ln \Pi_{it}$.[34] Some calculus yields

$$\ln \Pi_{it} = \ln reer_{it} + \beta \sum_{j\neq i} \frac{rer_{ji,t}}{reer_{it}} \ln \Upsilon_{ijt,x} - (\beta - 1) \sum_{j\neq i} \frac{rer_{ji,t}}{reer_{it}} \ln \left(\frac{EX_{ij,t}}{E_{jt}}\right),$$

which, combined with the linearisation of the main part, gives

$$\begin{gathered} \ln\left(\frac{EX_{it}}{E_{it}}\right) = \ln\left(\frac{E_{it}}{P_{it}}\right)^{-1} + \beta \ln(1-u_{it}) + \ln reer_{it} \\ +\beta \sum_{j\neq i} \frac{rer_{ji,t}}{reer_{it}} \ln \Upsilon_{ijt,x} - (\beta-1) \sum_{j\neq i} \frac{rer_{ji,t}}{reer_{it}} \ln\left(\frac{EX_{ij,t}}{E_{jt}}\right). \end{gathered}$$

Since the unobservable market access can be mapped to observables, we finally obtain

$$\begin{gathered} \ln reer_{it} = \frac{\beta}{1-\beta} \ln\left(\frac{\beta}{\delta+s}\right) \sum_{j\neq i} \frac{rer_{ji,t}}{reer_{it}} + \left[\ln\left(\frac{E_{it}}{P_{it}}\right)^{-1} - \frac{\beta}{\beta-1} \sum_{j\neq i} \frac{rer_{ji,t}}{reer_{it}} \ln\left(\frac{E_{jt}}{P_{jt}}\right)^{\beta}\right] \\ + \left[\ln(1-u_{it})^{\beta} - \frac{1}{1-\beta} \sum_{j\neq i} \frac{rer_{ji,t}}{reer_{it}} \ln(1-u_{jt})^{\beta}\right] - \left[\ln\left(\frac{EX_{it}}{E_{it}}\right) - (1-\beta) \sum_{j\neq i} \frac{rer_{ji,t}}{reer_{it}} \ln\left(\frac{EX_{ij,t}}{E_{jt}}\right)\right]. \end{gathered}$$

This is somewhat similar to the previous specifications, only with the weighting being driven by changes in international prices, rather than a bilateral trade.

Note that all aggregate variables are functions of a cutoff productivity (see (3.12) for prices, (4.2) for employment, and (4.5) for openness). Productivities are, in turn, determined by labour market institutions (see equations (C.1) and (C.2) in the Appendix). We discuss the econometric framework, which incorporates endogeneity of aggregate variables and the exogeneity of labour market policies, together with the international dimension, in a single framework.

5 Econometric Framework and Results

Our model accounts for two international aspects – firm reallocations and price changes. The two are related through endogenous firm restructuring, and react because of both domestic and international policy changes. Due to the general equilibrium structure of the model, we will treat all variables, except for policy and cross-sectional ones, as endogenous. Policy variables are determined outside the model, whereas cross-sectional averages are weakly exogenous with respect to the parameters of interest.

The idea to use cross-sectional averages to model a global economy is to be found in Pesaran et al. (2004), Pesaran (2006) and Dees et al. (2007), which produced a coherent framework to model global economic linkages (this strategy has roots in Mundlak-Chamberlain projections to relax random effects in panel data models). Provided that the global system is constructed so that the chosen weights are "granular" in the sense of Chudik and Pesaran (2011),[35] then the constructed global (or foreign) variables are weakly exogen-

$\frac{\ln \sum \omega_i (1-u_{it})}{\sum \omega_i \gamma_i}$, $\ln (E_{it}/P_{it})^\star = \frac{\sum \omega_i \ln(E_{it}/P_{it})}{\sum \omega_i \gamma_i}$, and $\ln reer^\star_{it} = \frac{\sum \omega_i \ln reer_{it}}{\sum \omega_i \gamma_i}$. See Appendix C.3 for full details and a discussion of other more constraining specifications.

[34] Behrens et al. (2012) based their econometric specification of gravity on similar linearisation. Notice that the use of elasticity of substitution $1/(1-\beta) = 1$ as a benchmark was already applied by Kmenta (1967).

[35] Effectively, Chudik and Pesaran (2011) state that the weight matrices $\boldsymbol{W}_{in}$ are such that $\boldsymbol{W}_{in} = \left(\omega^1_{in}, \ldots, \omega^k_{in}\right)'$ with $\omega_{ii} = 0$ and $\sum_{n=0}^{N} \omega_{in} = 1$ and that "granularity" conditions are as follows: $\|\boldsymbol{W}\| = O\left(N^{-\frac{1}{2}}\right)$, $\boldsymbol{\omega}^k \|\boldsymbol{W}\|^{-1} = O\left(N^{-\frac{1}{2}}\right)$ for all k, and $\lim_{N\to\infty} Var(\boldsymbol{W}\mathbf{x}_t) = 0$ for all t. Then, it is said that x_{it} is

ous. To be concrete, let the weights be defined as

$$\omega_{ij,t} = \frac{IM_{ji,t}+EX_{ij,t}}{\sum_{j\neq i} IM_{ji,t}+\sum_{j\neq i} EX_{ij,t}}, \quad \text{Model I,}$$
$$\omega_{ij,t} = \frac{rer_{ji,t}}{reer_{it}}, \qquad \text{Model II,}$$

and be constructed from the flows data for imports (IM) and exports (EX) whereas rer and $reer$ are real exchange and real effective exchange rates, constructed from the unit labour cost data. Following our discussion in Section 2.2 (as well as evidence in Appendix B), trade seems to be an important channel to transmit labour market institutions (standard weights capture trade directly, whereas Model II captures competitiveness effects embodied in prices and has not yet been used in the literature).

As mentioned, the effects of labour market policies domestically, as well as globally, were evaluated using the GVAR methodology. We extended the GVAR framework where all variables are treated endogenously to accommodate exogenous labour market policy variables. We consider labour market policy variables being set independently and discretionary by a policy maker in each economy, that is, we rule out a mechanical mapping from an economy into the policy reaction.[36] Our choice also conveniently allows to obtain structural exogenous shocks, instead of calculating generalised impulse responses as it is common in the GVAR literature (see Online Appendix for a technical discussion).

The GVAR model, which we use for the empirical labour market policy evaluation, consists of country specific VARX (VAR with weakly exogenous variables) models, which in the vector error correction model, VECMX, form can be written as

$$\Delta \mathbf{x}_{it} = c_{i0} + \boldsymbol{\alpha}_i \boldsymbol{\beta}_i'(\mathbf{z}_{i,t-1} - \gamma_i(t-1)) + \boldsymbol{\Lambda}_{i0}\Delta(\mathbf{x}^{\star}_{it}, \mathbf{y}'_{it})' + \boldsymbol{\Phi}_i(L)\Delta \mathbf{z}_{i,t-1} + u_{i,t}, \tag{5.1}$$

where $\mathbf{x}_{it} = (rgdp_{it},\, 1-u_{it},\, open_{it},\, rer_{it})'$ is a vector of the country's endogenous variables (real gross domestic product, unemployment rate, trade openness, real effective exchange rate), $y^*_{i,t}$ corresponds to foreign counterparts of the endogenous variables (constructed by taking trade weighted averages), $\mathbf{y}_{it} = (almp_{it},\, tw_{it},\, benefits_{it})'$ is a vector of country's labour market variables (expenditure on active labour market policies, tax wedge, unemployment replacement rate), $\mathbf{z}_{it} = (\mathbf{x}'_{it},\, \mathbf{x}^{\star\prime}_{it},\, \mathbf{y}'_{it})'$, $\boldsymbol{\Lambda}_{i0}$ and $\boldsymbol{\Phi}_i(L)$ are parameter matrices of short run adjustments with lag structure L, $\boldsymbol{\alpha}_i$ is a $k_i \times r_i$ matrix of rank r_i and $\boldsymbol{\beta}_i$ is a $(k_i + k_i^* + k_{x,i}) \times r_i$ matrix of rank r_i, $i = 1...15$ (all euro area OECD countries).[37]

The cross-sectional means $\mathbf{x}^{\star}_{it}$ are defined as weighted averages in terms of pre-determined weight matrices $\mathbf{W}_{ij,t}$ of order $k_i^{\star} \times k_j$ at time t given by

$$\mathbf{x}^{\star}_{it}\left(\boldsymbol{W}_{i,\tau(t)}\right) = \sum_{j=0}^{N} \boldsymbol{W}_{ij,\tau(t)}\mathbf{x}_{jt} = \boldsymbol{W}_{i,\tau(t)}\mathbf{x}_t, \tag{5.2}$$

where $\mathbf{x}_t = (\mathbf{x}'_{0t},\, \mathbf{x}'_{1t}, \ldots,\, \mathbf{x}'_{Nt})'$ is a $k \times 1$ vector of the endogenous variables ($k = \sum_{i=0}^{N} k_i$), and $\boldsymbol{W}_{it} = (\boldsymbol{W}_{i0,t},\, \boldsymbol{W}_{i1,t}, \ldots,\, \boldsymbol{W}_{iN,t})$. When the same set of weights is used across all variables

the covariance stationary process which is also cross-sectionally weakly dependent. This makes sure that the "idiosyncratic" shocks of the individual country models should be cross-sectionally "weakly correlated", so that $\mathbb{E}\left(\boldsymbol{W}\mathbf{x}_{t},\varepsilon_t\right) \to 0$, with $N \to \infty$, and, as a result, the weak exogeneity of the foreign variables is ensured.

[36]This could be an interesting extension to compare our results with an endogenously set policy. However, it would require another block for the policy maker in our model and further assumptions about her objective function. We thus leave it for future research.

[37]The specification and estimation of the model was based on GVAR Toolbox 2.0 (Smith and Galesi). The lag order and number cointegrating relations in country specific models were initially selected according to

in a given economy, then the $k_i^\star$ rows of $\boldsymbol{W}_{i,\tau(t)}$ will be identical, except for possible differences in scaling.[38] It is important that for each choice of the weights, $\boldsymbol{W}_{i,\tau(t)}$, $\mathbf{x}_{it}^\star\left(\boldsymbol{W}_{i,\tau(t)}\right)$ and its lagged value are constructed according to (5.2), and it is not necessarily the case that $\mathbf{x}_{it-1}^\star$ is equal to the lagged value of $\mathbf{x}_{it}^\star$. This is the case only if the weights are fixed across all time periods.[39]

Notice that labour market policy variables enter the cointegrating relations as well, thus, they can potentially have an effect on long-term developments. This is because the adjustment in the model takes place through firm reallocation, as in Melitz (2003). The cutoff productivity levels (see equations (C.1) and (C.2) in the Appendix) depend on the labour market policies (through average revenues per employee), and thereby affect all the aggregate variables through the general equilibrium (price) effects.

We examine the effect of labour market policy variables by increasing one of the variables in a specific country by 1% and keeping it higher for the whole forecasting horizon (40 quarters). We measure the impact by comparing the outcome of endogenous variables in the case of the shock and the baseline scenario (a case without the policy change). As we are mainly interested in the effect of labour market policies on unemployment, we mostly focus on developments in the labour market. The subsequent impulse response functions, depict median outcome estimates of 10000 bootstrap replications together with their 90% confidence intervals. We report results from the first and second solutions of the multilateral term discussed above, and refer the reader to Appendix D for the third model, and an extension where unemployment is used instead of employment.

5.1 Empirical Results

Due to the global nature of the exercise, we cover a subset of results, which illustrate theoretical implications and prove the existence of spillover effects (for data coverage and descriptions, see Appendix A; results for a full set of countries are produced in the Online Appendix). First, we demonstrate that labour market policies affect domestic employment as suggested by the theory. We pick Portugal, Italy, and Ireland for illustration. Among them, spillover effects are more evident for labour market policies in Portugal and unemployment benefits in Ireland. There is some evidence of geographical proximity, and economic linkages playing a role for the strength of a spillover. Next, we analyse how a response would have changed had there been a fiscal union in place. To strengthen our argument, we gather individual reactions and exemplify a large heterogeneity of responses in all economies to reforms in one country; we also cover responses in one selected economy to reforms in all the member states (though shocks are conducted separately in each country). Note that, unless stated otherwise, the reported results are produced by Model I, which is our benchmark model.

Before delving into a few country-specific results, we overview the distribution of employment, GDP, openness and real effective exchange rate sign responses to positive shocks on expenditure for active labour market policies (Table 5.1), unemployment benefits (Table

the Akaike criteria and Johansen's rank test respectively. However, for several countries the cointegrating rank found by Johansen's test had to be reduced to obtain a stable GVAR model.

[38]For instance, three year moving average trade weights could be used with the weights re-set at the start of each year and kept fixed through a given year, which can be specified in terms of $\tau(t)$. If a fixed set of weights are used over time then $\tau(t)$ will be fixed and will not change with t.

[39]To see this, rewrite $\triangle\mathbf{x}_{it}^\star = \mathbf{x}_{it}^\star - \mathbf{x}_{it-1}^\star = \boldsymbol{W}_{i,\tau(t)}\mathbf{x}_t - \boldsymbol{W}_{i,\tau(t-1)}\mathbf{x}_{t-1}$. The change in foreign variables could be caused by a change in domestic variables and/or the change in trade weights. For the technical details, we refer to the Online Appendix, and the textbook treatment in Garratt et al. (2006).

Table 5.1: Distribution of the signs of impulse responses after one period to a positive shock on expenditure for active labour market policies

Source of a shock	ΔEmployment +	ΔEmployment -	ΔGDP +	ΔGDP -	ΔOpenness +	ΔOpenness -	ΔREER +	ΔREER -
Austria	11	4	1	14	3	12	13	2
Belgium	6	9	0	15	1	14	11	4
Denmark	5	10	15	0	5	10	14	1
Finland	2	13	0	15	1	14	13	2
France	4	11	7	8	0	15	14	1
Germany	13	2	14	1	15	0	1	14
Greece	13	2	1	14	3	12	13	2
Ireland	0	15	0	15	0	15	1	14
Italy	13	2	15	0	3	12	15	0
Luxembourg	1	14	0	15	2	13	1	14
Netherlands	14	1	15	0	10	5	15	0
Portugal	15	0	15	0	13	2	15	0
Spain	14	1	12	3	14	1	2	13
Sweden	0	15	2	13	0	15	13	2
United Kingdom	0	15	0	15	8	7	0	15

Note: the first column of the table indicates a country in which shock is observed. We count the cases when the shock induced positive/negative changes in one of the variables in 15 analysed countries 1 quarter after the shock.

Table 5.2: Distribution of the signs of impulse responses after one period to a positive shock on unemployment benefits

Source of a shock	ΔEmployment +	ΔEmployment -	ΔGDP +	ΔGDP -	ΔOpenness +	ΔOpenness -	ΔREER +	ΔREER -
Austria	1	14	3	12	5	10	1	14
Belgium	6	9	15	0	13	2	5	10
Denmark	15	0	14	1	14	1	14	1
Finland	0	15	0	15	3	12	0	15
France	2	13	0	15	4	11	1	14
Germany	15	0	15	0	13	2	15	0
Greece	0	15	0	15	2	13	1	14
Ireland	13	2	3	12	2	13	14	1
Italy	4	11	0	15	5	10	3	12
Luxembourg	-	-	-	-	-	-	-	-
Netherlands	0	15	0	15	2	13	0	15
Portugal	15	0	15	0	14	1	4	11
Spain	11	4	14	1	14	1	3	12
Sweden	1	14	14	1	7	8	4	11
United Kingdom	0	15	0	15	4	11	0	15

Note: the first column of the table indicates a country in which shock is observed. We count the cases when the shock induced positive/negative changes in one of the variables in 15 analysed countries 1 quarter after the shock.

Table 5.3: Distribution of the signs of impulse responses after one period to a positive shock on labour tax wedge

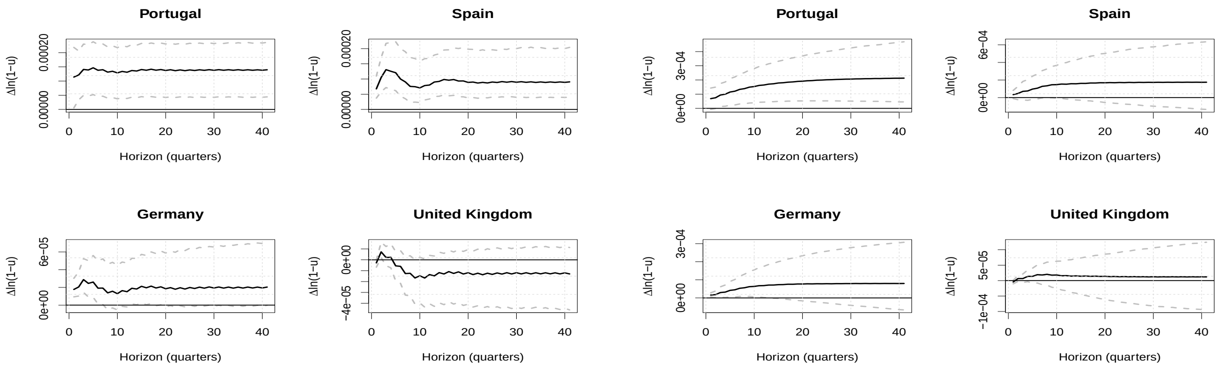
Source of a shock	ΔEmployment +	ΔEmployment -	ΔGDP +	ΔGDP -	ΔOpenness +	ΔOpenness -	ΔREER +	ΔREER -
Austria	4	11	14	1	12	3	3	12
Belgium	0	15	13	2	8	7	3	12
Denmark	10	5	15	0	14	1	4	11
Finland	0	15	0	15	2	13	8	7
France	15	0	15	0	13	2	4	11
Germany	15	0	15	0	14	1	7	8
Greece	4	11	0	15	2	13	8	7
Ireland	14	1	1	14	4	11	13	2
Italy	2	13	13	2	13	2	1	14
Luxembourg	5	10	13	2	13	2	1	14
Netherlands	14	1	15	0	13	2	15	0
Portugal	14	1	15	0	13	2	15	0
Spain	0	15	3	12	0	15	13	2
Sweden	11	4	15	0	8	7	14	1
United Kingdom	0	15	0	15	0	15	0	15

Note: the first column of the table indicates a country in which shock is observed. We count the cases when the shock induced positive/negative changes in one of the variables in 15 analysed countries 1 quarter after the shock.

Table 5.4: Distribution of the signs of a positive regional shock after one period to one of the labour market policy variables

Shock to	ΔEmployment +	ΔEmployment -	ΔGDP +	ΔGDP -	ΔOpenness +	ΔOpenness -	ΔREER +	ΔREER -
Expenditure on ALMP	7	8	5	10	2	13	14	1
Unemployment Benefits	9	6	12	3	14	1	2	13
Labour Tax Wedge	5	10	14	1	14	1	3	12

Note: we count the cases when the shock induced positive/negative changes in one of the variables in 15 analysed countries 1 quarter after the shock.



Model I **Model II**

Figure 5.1: Change in the employment rate in various countries due to the increase in expenditure on active labour market policies in Portugal

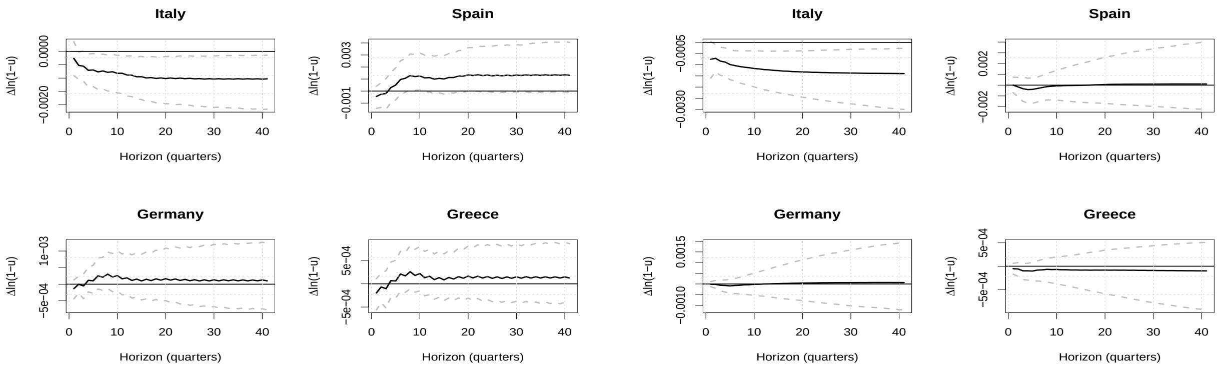
5.2), and labour tax wedge (Table 5.3).[40] The heterogeneity is quite staggering: a positive shock of a labour market policy in one economy can be associated with both positive and negative responses in other EU member states. One exception, however, is the United Kingdom. Shocks that originate in the UK are mainly related to the reactions of the same sign in all remaining economies. To learn the effects once we implement a joint change in all member states, we track the counterfactuals as if the fiscal union existed. As is reported in Table 5.4, though heterogeneity is still observable for the one period responses, the increase in spending on active labour market policies yields a drop in openness and an increase in REER, with a clear opposite result if benefits were increased. The changes in tax wedge are associated with very homogeneous responses even after the first period.

Turning to a few specific examples, we first describe results on the employment. The theory hints that employment shall increase with subsidies and decrease with benefits, once spillover effects are ignored (refer to the equation (4.3)). Firstly, we study the increase of expenditure on active labour market policies in Portugal. As can be seen in Figure 5.1 for the benchmark Model I, the increase of labour market policy spending in Portugal, statistically significantly increases its domestic employment rate. The result is expected, but what is more interesting is that we can see the effect spilling over to neighbouring Spain and, to a smaller extent, even to Germany. On the other hand, the effect on employment in United Kingdom is mostly unaffected (or might even have a negative effect) due to weaker economic relations between the countries. Using a very different weighting scheme in Model II, all the effects remain comparable (it is worthwhile mentioning, the effect on UK becomes positive though insignificant), thus making results robust to the choice of weights.[41]

We further investigate the impact of changes in labour market environment considering the increase of the tax wedge in Italy. Although we see some interesting reverse movements in Spain's employment rate in Figure 5.2, among the countries analysed, Italy is the only

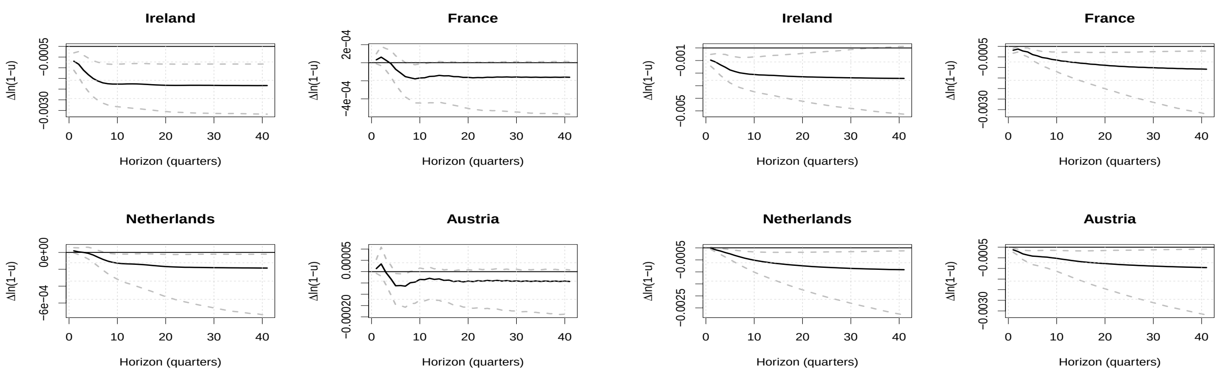
[40] The signs are collected from one period responses; however, we also conduct a similar exercise and track signs after 10 periods. We report the results in the Online Appendix.

[41] Indeed, Chudik and Pesaran (2011) show that granular weights are of secondary importance asymptotically; yet, in finite samples, results are usually quite sensible to the choice of weighting scheme, so our results are quite reassuring. Though it is worthwhile mentioning that using the real exchange rate, instead of trade weights, yields more comparable impulse responses among themselves as the country size effect is barely accounted for (though larger countries tend to have somewhat lower price indices due to a larger basket of importables).



Model I **Model II**

Figure 5.2: Change in the employment rate in various countries due to the increase in the tax wedge in Italy



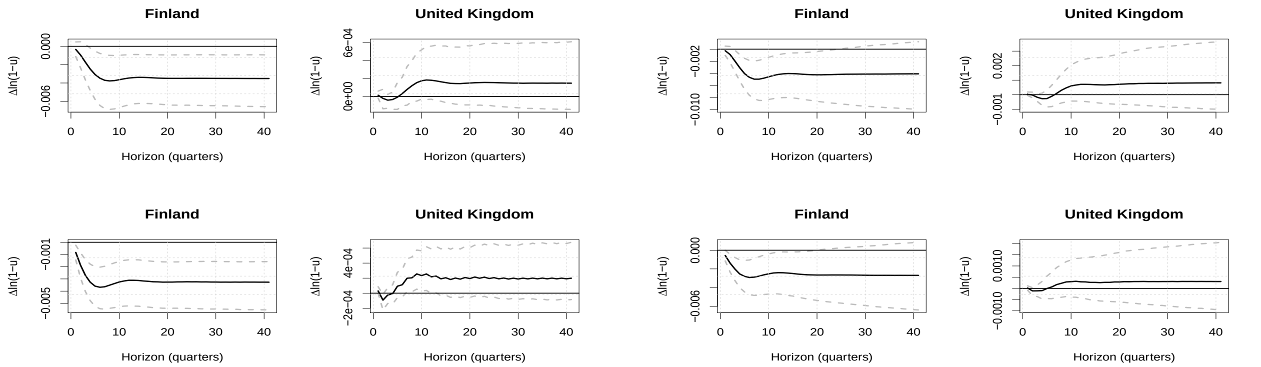
Model I **Model II**

Figure 5.3: Change in employment rate in various countries due the increase in unemployment benefits in Ireland

one with statistically significant differences in employment due to the shock. In this case, spillovers between the countries were not as considerable, compared to the previous scenario – the obvious explanation being that the change in the labour market policy variable did not result in such a strong initial domestic response as in the previous case. Using Model II and real exchange rates as weights, the effect on Italy remains intact, and other spillovers are even less significant.

In the motivational part of our paper (Section 2), using panel regression, we have estimated the unemployment replacement rate, on average, to have a statistically insignificant effect on the unemployment rate. Naturally, such a result does not preclude unemployment benefits to be an important factor governing unemployment rate in some of the countries. Figure 5.3 shows that in Ireland, an increase in unemployment benefits not only statistically significantly reduces domestic employment, but has spillover effects to other European countries as well. Model II confirms the directions of impulse responses, and makes them even more profound and significant.

We also explore the finding about the shocks associated with the UK. As was clear from the Tables 5.1-5.3 on signs distribution, the rest of the EU reacts very similarly to changes in British economy. It is, therefore, of interest to see how UK reacts to policy reforms in one selected European economy. In Figure 5.4 we track how the UK responds



Model I. Shock in tax wedge (first row), Shock in unemployment benefits (second row)

Model II. Shock in tax wedge (first row) Shock in unemployment benefits (second row)

Figure 5.4: Finnish and UK responses of the employment rate to policy shocks originating in Finland

to the Finnish labour market reforms. It is clear that the reactions of two economies are substantially asynchronous: what makes Finland increase its employment leads to a drop in British employment. This emphasises two points: that the British economy is quite distinct from the rest of Europe, and builds a further argument for the investigation of what would have happened if the EU conducted a single policy change.

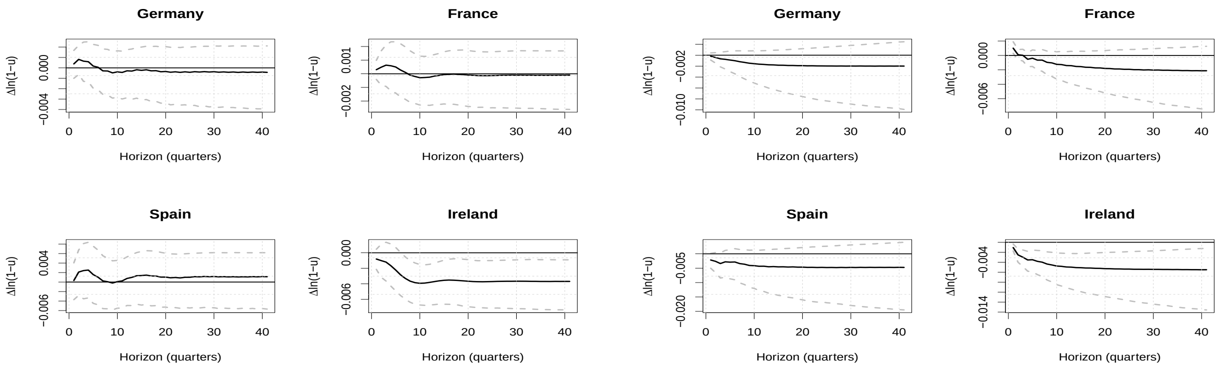
We thus now turn to using our model for a regional counterfactual analysis and continue exploring heterogeneity of individual country responses. We cover three types of questions: what would have happened had all economies implemented structural labour market reforms simultaneously (as compared to a case of an individual economy undergoing reforms)?[42] Further, we seek to answer the following: how heterogeneous are responses in a single economy to shocks conducted in every other country? Relatedly, how heterogeneous are responses by all economies to a reform in one given economy?

5.2 Counterfactual of a Fiscal Union

We have already witnessed that a labour market policy shock in one country can have a substantial spillover effect to other countries as well. This rather straightforward result leads one to wonder if coordinated measures of all monetary union countries would be more successful in tackling some of the European labour market issues.

We define a regional labour market policy shock as a contemporaneous and lasting increase in labour market policy variable in all of the countries (this translates to performing one of the previous subsection's scenarios in all of the countries at once). We have per-

[42] As a topical extension we also consider a fiscal union of all European economies but the United Kingdom (UK). Not only discussions about a potential British movement away from the EU, but also empirical evidence in Tables 5.1-5.3 constitute a reason to explore how the European economy evolved under two different scenarios. We thus compare two cases: with and without the UK undergoing labour market reforms (in both of them, all other economies are implementing the reforms). The difference in responses, with and without the UK, is always negative for the tax wedge and unemployment benefits, indicating that employment tends to react more negatively, with the UK being a part of the regional shock. When it comes to active labour market policies, results are less clear-cut. There are economies whose employment increases and decreases once the UK is included in the counterfactual of the fiscal union. Our approach can therefore provide some insights into the development of the EU had Britain decided to separate itself from the potential European fiscal union. Further details can be found in the Online Appendix.



Model I **Model II**

Figure 5.5: Change in the employment rate in various countries due the regional unemployment benefits shock

formed a regional shock of 1% increase in unemployment benefits. The results in Figure 5.5 indicate that such a regional shock can statistically significantly decrease employment in Ireland. Notice that the effect has substantially increased compared to the previous case when unemployment benefits have been increased only to Ireland.

It is also interesting to compare the results in Figure 5.5 with our earlier panel regression estimates and also with panel regressions in general. In this regional shock exercise we try to estimate the effect of a particular labour market variable (unemployment benefits) on employment. The task is in nature the same as in Section 2, motivating the study. It should be noted, however, that this time we are accounting for dynamic and spatial developments of countries, as well as their sizes, once the global (regional) dimension is accounted for. In other words, GVAR allows to include not only spatial averages in a consistent manner, but also exogenous policy variables, global variables, and non-zero contemporaneous dependence of shocks across economies.

5.3 Response to Individual Country Reforms

In addition to the union-wide response, Figure 5.6 depicts reaction in employment in Belgium due to structural changes in active labour market policies in each European economy. To build a case for a fiscal union, we need to have the evidence of economies within a monetary union transmitting positive and negative effects on the economy which is not undergoing any reforms.

Figure 5.6 vividly demonstrates the point: had Belgium increased its expenditure on active labour market policies, its employment would have increased. The same would have happened even if it has not invested in ALMP but, among others, the Netherlands did. However, had Finland, Ireland or the UK wanted to invigorate their labour markets through ALMP, there would be a negative spillover and a drop in Belgium's employment. Thus, this evidence adds an additional argument favouring coordinated responses, at least if employment constituted an important objective variable.

An alternative way to see the effects of spillovers is, instead of shocking all economies one by one as in Figure 5.6, to shock one economy and explore how homogeneous or heterogeneous responses by other countries are. We shock the tax wedge in the Netherlands, thus making the Dutch labour market more frictional (there is a larger difference in what employer pays and employee receives). As is clear, Dutch employment suffers, as does that of Great Britain.

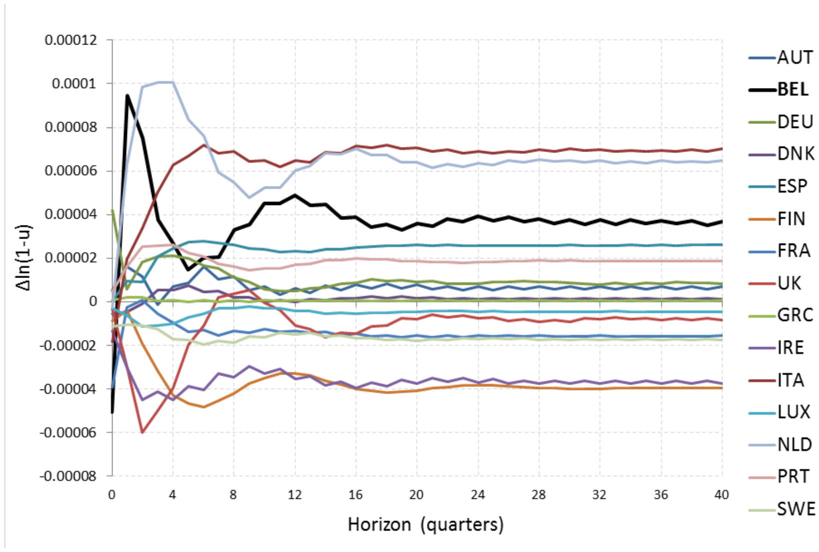


Figure 5.6: Employment responses in Belgium to shocks in active labour market policies implemented separately by every economy

However, Spanish employment increases quite substantially and persistently. A number of other economies are also affected positively.

So far we have considered small open economies. It is, however, of interest to learn how the largest economy of the EU is affecting other countries. We therefore collect evidence on how GDP and openness react to an increase in the expenditure of active labour market policies in Germany. For the theoretical predictions, recall that openness shall increase with subsidies once we ignore spillovers (refer to equations (4.8) and (4.9)) and quite uncertain result on GDP, as summarised in equation (4.4). Results are quite remarkable: GDP increases in Germany on impact, but the effect fades quite quickly. Austria's GDP reacts even more strongly than that of Germany – it is a small open economy that is most reliant on Germany' economic performance. On the opposite side, however, Greek GDP suffers most and the decline in GDP is prolonged. When it comes to openness, Germany is getting the most substantial effect, becoming a more open economy. Notice that if openness was the variable of most importance to policy makers, then an argument in favour of a fiscal union would not be that convincing. All economies reacted the same way and all of them got exposed to a larger volume of trade.[43]

[43] Of course, our emphasis is on heterogeneity in signs; the change in magnitude can be also considered, but requires more details on policy makers' objective function to draw informative implications.

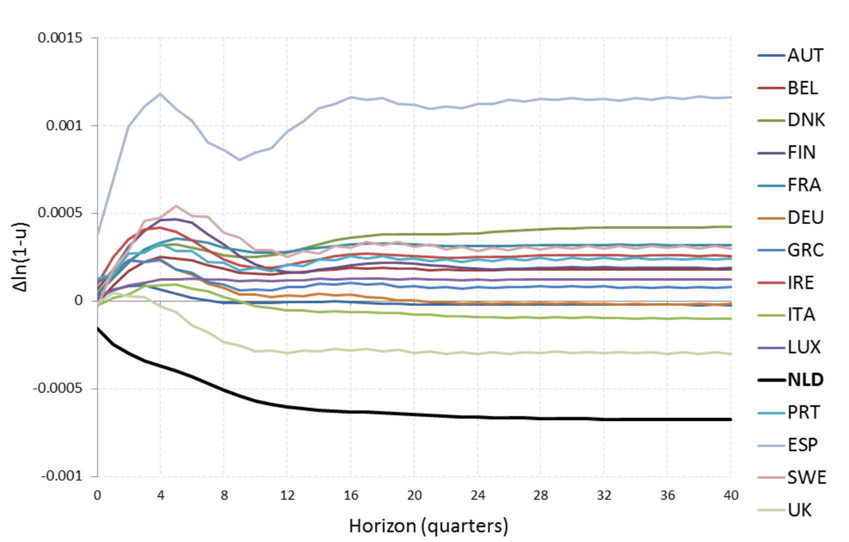


Figure 5.7: Responses in all economies to a change in tax wedge in the Netherlands

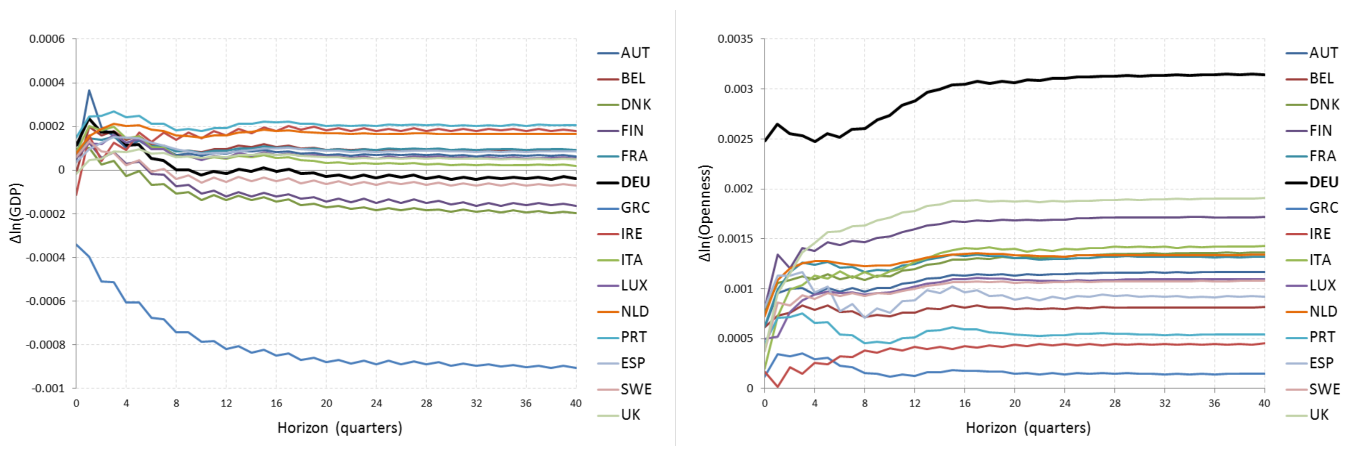


Figure 5.8: Responses to changes in German active labour market policies on GDP and openness in every economy

6 Conclusions

Recent turbulent times have once again reminded us how important timely and effective reactions are to dampen the effects of negative shocks. We analysed European unemployment and policy intervention from the global perspective. European economies are open, interdependent, and may transmit labour market policies either through international prices, reallocation of resources, structure of exporters, and access to a global unobserved factor.

Having laid a simple model, we established a number of channels through which labour market policies affect the macroeconomy. Theory reveals that unemployment benefits tend to increase wage costs which, in turn, affect the least productive domestic firms most severely. This makes survival of non-exporters more difficult, and affects the aggregate openness of the economy. At the same time, labour market tightness features a dampening effect. Similarly to a famous model by Melitz (2003), a change in the price index makes sure that real wages adjust and change the very composition of domestic producers and exporters. This clearly affects the real exchange rate, and thus calls for the empirical analysis that admits international prices, employment, and openness in a single macroeconomic model.

We compute aggregate variables and map them into an estimating spatio-temporal econometric framework. Observing that all aggregate variables are linked through firm threshold productivities, we treat them all as endogenous, except for the variables describing labour market policies and cross-sectionally averaged variables. The latter are used to proxy a global factor and motivate a global VAR model. We extend the GVAR framework to accommodate policy variables, which then allows us computing structural exogenous shocks. We find that labour market policy shock in one country can have a substantial spillover effect to other countries as well. With our framework at hand, we seek to answer three types of questions: a counterfactual of a fiscal union, the degree of heterogeneity of responses in a single economy to shocks conducted in every other country, and heterogeneity of responses by all economies to a reform in one given economy.

Policy implications from the counterfactual exercises are important. We find evidence that domestic labour market policies, which are used to solve local problems, also generate unintended effects in the entire trading bloc. Theoretically, resource reallocation leads to a different structure of the economy, as reflected in trade margins. An improvement in one country can hurt other trading partners and be channeled back to the reforming economy. Failure to account for these effects could lead to poor policies or even harm other member states of a monetary union. A few counterfactuals of a fiscal union (with and without the United Kingdom) are also conducted, which yield more homogenous and often stronger responses than under a current arrangement of uncoordinated fiscal houses.

Lastly, our enquiry into the global dimension of labour markets in a trading bloc can be extended in a number of directions. Labour market compositional effects seem to be of particular interest; the main obstacle lies in comparable data with decent time dimension across countries. We could then use generalised spatio-temporal impulse responses[44] to track how government policies affect home and foreign markets, transmit across trading partners, and how this maps into labour force composition. We can also relate changes to the labour market to long run growth through productivity changes (as in Helpman and Itskhoki (2010) where worker's productivity affects total factor productivity which can then be mapped into technical progress). Interaction between technology and the labour force would be another exciting track for future research, as well as exploration of other sources of interdependence, including capital flows, migration, and technology diffusion.

[44]As proposed and implemented by Holly et al. (2010, 2011).

References

Alessandria, George and Alain Delacroix, “Trade and the (dis)incentive to reform labor markets: The case of reform in the European Union,” *Journal of International Economics*, 2008, *75* (1), 151–166.

Anderson, James E. and Eric van Wincoop, “Gravity with Gravitas: A Solution to the Border Puzzle,” *American Economic Review*, 2003, *93(1)*, 170–192.

Bassanini, Andrea and Romain Duval, “Employment Patterns in OECD Countries: Reassessing the Role of Policies and Institutions,” OECD Economics Department Working Papers 486, OECD Publishing June 2006.

Behrens, Kristian, Cem Ertur, and Wilfried Koch, “’Dual’ Gravity: Using Spatial Econometrics To Control For Multilateral Resistance,” *Journal of Applied Econometrics*, 08 2012, *27* (5), 773–794.

Bentolila, Samuel, Pierre Cahuc, Juan J. Dolado, and Thomas Le Barbanchon, “Two-Tier Labor Markets In The Great Recession: France Vs. Spain,” Working Papers, CEMFI 2010.

_ , _ , _ , and Thomas Le Barbanchon, “Two-Tier Labour Markets in the Great Recession: France Versus Spain,” *The Economic Journal*, 2012, *122* (562), F155–F187.

Blanchard, Olivier, “European unemployment: the evolution of facts and ideas,” *Economic Policy*, 2006, *21(45)*, 5–59.

_ and Justin Wolfers, “The Role of Shocks and Institutions in the Rise of European Unemployment: The Aggregate Evidence,” *The Economic Journal*, 2000, *110 (March)*, C1–C33.

Boeri, Tito, *Institutional Reforms and Dualism in European Labor Markets*, Vol. 4 of *Handbook of Labor Economics*, Elsevier, October

_ , *Institutional Reforms and Dualism in European Labor Markets*, North Holland: Great Britain,

Burda, Michael C. and Jennifer Hunt, “What Explains the German Labor Market Miracle in the Great Recession?,” Working Paper 17187, National Bureau of Economic Research June 2011.

Cacciatore, Matteo and Giuseppe Fiori, “The Macroeconomic Effects of Goods and Labor Markets Deregulation,” Technical Report, HEC Montréal and North Carolina State University December 2014.

Card, David, Jochen Kluve, and Andrea Weber, “What Works? A Meta Analysis of Recent Active Labor Market Program Evaluations,” Working Paper 21431, National Bureau of Economic Research July 2015.

Chamberlain, Gary, “Analysis of Covariance with Qualitative Data,” *The Review of Economic Studies*, 1980, *47* (1), 225–238.

Chudik, Alexander and M. Hashem Pesaran, “Infinite-Dimensional VARs and Factor Models,” *Journal of Econometrics*, 2011, *163* (1), 4–22.

Commission, European, "Employment in Europe 2010," Technical Report, Directorate-General for Employment and Social Affairs and Equal Opportunities 2010.

Corsetti, Giancarlo, Philippe Martin, and Paolo Pesenti, "Productivity, terms of trade and the 'home market effect'," *Journal of International Economics*, 2007, *73* (1), 99–127.

Costain, James, Juan Francisco Jimeno Serrano, and Carlos Thomas, "Employment fluctuations in a dual labor market," DIALNET OAI Articles [http://dialnet.unirioja.es/oai/OAIHandler] (Spain) 1013, Banco de Espana 2010.

Dees, S., F. Di Mauro, M. H. Pesaran, and L. V. Smith, "Exploring The International Linkages of the Euro Area: A Global VAR Analysis," *Journal of Applied Econometrics*, 2007, *22(1)*, 1–38.

Dolado, Juan José and Rodolfo Stucchi, "Do Temporary Contracts Affect TFP? Evidence from Spanish Manufacturing Firms," IZA Discussion Papers 3832, Institute for the Study of Labor (IZA) November 2008.

Faia, Ester, Wolfgang Lechthaler, and Christian Merkl, "Fiscal Stimulus and Labor Market Policies in Europe," *Journal of Economic Dynamics and Control*, 2012, *37* (3), 483–499.

Felbermayr, Gabriel J., Mario Larch, and Wolfgang Lechthaler, "Unemployment in an Interdependent World," *American Economic Journal: Economic Policy*, September 2013, *5* (1), 262–301.

Felbermayr, Gabriel, Julien Prat, and Hans-Jörg Schmerer, "Globalization and labor market outcomes: Wage bargaining, search frictions, and firm heterogeneity," *Journal of Economic Theory*, 2011, *146* (1), 39–73.

_ , _ , and _ , "Trade and unemployment: What do the data say?," *European Economic Review*, 2011.

Garratt, Anthony, Kevin Lee, M. Hashem Pesaran, and Yongcheol Shin, *Global and National Macroeconometric Modelling: A Long-Run Structural Approach*, Oxford University Press, 2006.

Gnocchi, Stefano, Andresa Lagerborg, and Evi Pappa, "Do labor market institutions matter for business cycles?," *Journal of Economic Dynamics and Control*, 2015, *51*, 299 – 317.

Hagedorn, Marcus, Fatih Karahan, Iourii Manovskii, and Kurt Mitman, "Unemployment Benefits and Unemployment in the Great Recession: Unemployment Benefits and Unemployment in the Great Recession: The Role of Macro Effects," Staff Report 646, Federal Reserve Bank of New York 2015.

Hawkins, William B. and Daron Acemoglu, "Search with multi-worker firms," *Theoretical Economics*, 2014.

Helpman, E., M. J. Melitz, and Y. Rubinstein, "Estimating Trade Flows: Trading Partners and Trading Volumes," *Quarterly Journal of Economics*, 2008, *123(2)*, 441–487.

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

_ , _ , **and Stephen J. Redding**, "Web-based Technical Appendix to Inequality and Unemployment in a Global Economy," 2010.

_ , _ , **Marc-Andreas Muendler, and Stephen J. Redding**, "Trade and Inequality: From Theory to Estimation," Working Paper 17991, National Bureau of Economic Research April 2012.

Holly, Sean, M. Hashem Pesaran, and Takashi Yamagata, "A spatio-temporal model of house prices in the USA," *Journal of Econometrics*, 2010, *158* (1), 160–173. Twenty Years of Cointegration.

_ , _ , **and** _ , "The spatial and temporal diffusion of house prices in the UK," *Journal of Urban Economics*, 2011, *69* (1), 2–23.

Jahn, Elke J., Regina T. Riphahn, and Claus Schnabel, "Feature: Flexible Forms of Employment: Boon and Bane," *The Economic Journal*, 2012, *122* (562), F115–F124.

Kmenta, J., "On Estimation of the CES Production Function," *International Economic Review*, 1967, *8* (2), 180–189.

Krebs, Tom and Martin Scheffel, "Macroeconomic Evaluation of Labor Market Reform in Germany," *IMF Economic Review, Palgrave Macmillan*, December 2013, *61* (4), 664–701.

Lastauskas, Povilas and Eirini Tatsi, "Spatial Nexus in Crime and Unemployment in Times of Crisis: Evidence from Germany," Cambridge Working Papers in Economics No. 1359, University of Cambridge 2013.

Melitz, M. J., "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," *Econometrica*, 2003, *71(6)*, 1695–1725.

Moeller, Joachim, "Germany's Job Miracle in the World Recession - Shock-Absorbing Institutions in the Manufacturing Sector," *Applied Economics Quarterly (formerly: Konjunkturpolitik)*, 2010, *61* (Supplement), 9–28.

Mortensen, Dale T. and Christopher A. Pissarides, "Job Creation and Job Destruction in the Theory of Unemployment," *The Review of Economic Studies*, 1994, *61(3)*, 397–415.

Mundlak, Yair, "On the Pooling of Time Series and Cross Section Data," *Econometrica*, 1978, *46* (1), pp. 69–85.

Nickell, Stephen, Luca Nunziata, and Wolfgang Ochel, "Unemployment in the OECD Since the 1960s. What Do We Know?," *Economic Journal*, 01 2005, *115* (500), 1–27.

OECD, "OECD Employment Outlook-How does Germany compare?," 2010. OECD Employment Outlook.

Orlandi, Fabrice, "Structural unemployment and its determinants in the EU countries," European Economy - Economic Papers 455, Directorate General Economic and Monetary Affairs (DG ECFIN), European Commission May 2012.

Perotti, Roberto, "Estimating the effects of fiscal policy in OECD countries," *Proceedings*, 2005.

Pesaran, M. Hashem, "Estimation and Inference in Large Heterogeneous Panels with a Multifactor Error Structure," *Econometrica*, 2006, *74* (4), 967–1012.

_ **and Ron Smith**, "Estimating long-run relationships from dynamic heterogeneous panels," *Journal of Econometrics*, July 1995, *68* (1), 79–113.

_ **, T. Schuermann, and S. M. Weiner**, "Modeling Regional Interdependencies Using a Global Error-Correcting Macroeconometric Model," *Journal of Business and Economic Statistics*, 2004, *22(2)*, 129–162.

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

Saint-Paul, Gilles, "Dynamic labor demand with dual labor markets," *Economics Letters*, June 1991, *36* (2), 219–222.

_ , *Dual Labor Markets: A Macroeconomic Perspective*, The MIT Press, 1996.

_ , "Exploring the Political Economy of Labour Market Institutions," *Economic Policy*, 1996, *11(23)*, 263–315.

Smith, L.V. and A. Galesi, "GVAR Toolbox 2.0," 2014.

Stähler, Nikolai and Carlos Thomas, "FiMod — A DSGE model for fiscal policy simulations," *Economic Modelling*, 2012, *29* (2), 239–261.

Stole, Lars A. and Jeffrey Zwiebel, "Intra-Firm Bargaining under Non-Binding Contracts," *Review of Economic Studies*, 1996, *63(3)*, 375–410.

_ **and** _ , "Organizational Design and Technology Choice under Intrafirm Bargaining," *American Economic Review*, 1996, *86(1)*, 195–222.

van Vliet, Olaf and Koen Caminada, "Unemployment Replacement Rates Dataset Among 34 Welfare States, 1971-2009: An Update, Extension and Modification of the Scruggs' Welfare State Entitlements Data Set," NEUJOBS Special Report 2, Leiden University 2012.

Appendix

Refer to the Online Appendix, which collects evidence on other labour market reforms with more limited time span that precluded us from using in the empirical exercise. Moreover, the online document also reports theoretical results on econometrics of estimation, model building, and impulse responses. We also collect all the impulse responses from our preferred specifications for all the countries in that document.

A Data

A.1 Description and Sources

Table A.1: Data definitions and sources

Variable	Definition	Measure	Source	Adjustments
Public expenditure on active labour market policies	Expenditure on public interventions, which are explicitly targeted at groups of persons with difficulties in the labour market: the unemployed, the employed at risk of involuntary job loss and inactive persons who would like to enter the labour market. Total expenditure on active measures can be broken down into 7 categories, which include labour market policy (LMP) services (category 1) and LMP measures (categories 2-7). LMP measures cover activation measures for the unemployed and other target groups including the categories of training, job rotation and job sharing, employment incentives, supported employment and rehabilitation, direct job creation, and start-up incentives.	Expenditure per number of unemployed (we take the number of unemployed in the previous year) divided by GDP per capita	OECD, Eurostat	Due to missing values in some time periods, data for some LMP categories were linearly interpolated. Expenditure on labour market services for Greece during 2004-2010 was obtained from Eurostat Labour database. For Italy, expenditure on labour market services during 1990-2003 was equated to average expenditure during 2004-2011. In order to keep Italy in the country dataset, the total LMP data for Italy during 1985-1989 was equated to the first available data point for Italy in 1990. Also, Denmark's LMP expenditure in 1985 was equated to expenditure in 1986. In the GVAR setting, quarterly data was obtained from the annual values using Denton's interpolation method. The data was also logarithmically transformed.
Population	Resident population, i.e. all persons, regardless of citizenship, who have a permanent place of residence in the country.	1000s	OECD	
Real effective exchange rate	Weighted average of a country's currency relative to an index or basket of other major currencies adjusted for variations in relative prices using unit labour costs in manufacturing (for Greece, we used HICP). The weights are determined by comparing the relative trade balances, in terms of one country's currency, with each other country within the index.	Index (2000=100)	OECD, Eurostat (for Greece)	The data was logarithmically transformed.

Variable	Definition	Measure	Source	Adjustments
Real gross domestic product	Value of all final goods and services produced within an economy per quarter/year, taking into account changes in the general price level.	Index (2000=100)	GVAR 2013 Vintage database, IMF International Financial Statistics database, OECD National Accounts database, Eurostat	The primary source is the GVAR 2013 Vintage database. The IMF International Financial Statistics (IFS) database was also consulted for Portugal and Denmark, GDP Volume (2005=100). Data for Denmark were seasonally adjusted using the U.S. Census Bureu's ARIMA X12. Statistics for Luxembourg and Ireland, were obtained from OECD National Accounts database. The most extensive adjustments were made to data pertinent to Greece. Data for 1980-1994 were obtained from OECD National Accounts database. The base year was adjusted (2000=100) with a backward extrapolation till Q1 1980 using quarterly growth rates based on the OECD estimates. Data from 1995 onwards were extracted from Eurostat and seasonally adjusted with ARIMA X12. The data was also logarithmically transformed.
Tax wedge	Income tax plus employee and employer social security contributions less cash benefits as % of labour cost. In the data sources, tax wedge is calculated for a one-earner married couple at 100% of average earnings having 2 children.	Percentage	OECD database, Taxing Wages 2004	The data was spliced using 2 data sources: OECD database and Taxing Wages 2004. Biannual data until 2000 was linearly interpolated. In the GVAR setting, data was interpolated to quarterly frequency using Denton's method. Lastly, the data was logarithmically transformed.
Output gap		Percentage of potential GDP	IMF, World Economic Outlook Database, April 2014	
Openness	Ratio of nominal trade to nominal GDP		Authors' computation using data from Eurostat, OECD	Where quarterly data was not available, data was constructed interpolating annual data (Denton's method).

Variable	Definition	Measure	Source	Adjustments
Unemployment rate	Number of unemployed persons as a percentage of the labour force with a seasonal adjustment.	Percentage	Eurostat Labour Market database, IMF International Financial Statistics database, OECD Labour database	Q1 1983 - Q2 1998 data for Greece was interpolated from OECD annual data using Denton's interpolation method. For Austria, Finland and Germany, where Eurostat quarterly unemployment data was not available, it was constructed from annual IMF data using Chow-Lin interpolation method (quarterly indicator series was constructed from quarterly registered unemployed series and interpolated annual labour force series). In case of Spain, as Eurostat and OECD annual data for this country exhibits certain differences, Eurostat annual data were extrapolated using annual OECD data and then the latter annual series was interpolated using Chow-Lin method (quarterly indicator series was constructed from quarterly registered unemployed series and interpolated annual labour force series). The data was also logarithmically transformed.
Unemployment replacement rate	Proportion of net in-work income that is maintained when unemployed. The OECD summary measure is defined as the average of the gross unemployment benefit replacement rates for two earnings levels, three family situations and three durations of unemployment. For further details, see OECD (1994), The OECD Jobs Study (chapter 8) and Martin J. (1996), "Measures of Replacement Rates for the Purpose of International Comparisons: A Note", OECD Economic Studies, No. 26. Pre-2003 data have been revised.	Rate, values between 0 and 1	OECD	Biannual data was linearly interpolated to annual data. In the GVAR setting, data was also interpolated to quarterly frequency using Denton's method. Data was spliced from two OECD measurements, keeping original data till 2005 and rescaling after 2005. The data was also logarithmically transformed.

A.2 Construction of Weight Matrices

GVAR estimation was executed using a user-built time-varying matrix (1980-2012). The weights were constructed from IMF Direction of Trade Statistics (DOTS) database. Missing data for Belgium (1980-1997) were extrapolated from trade statistics on Belgium-Luxembourg. Also, data for Luxembourg (1980-1997) were extrapolated from trade weights in year 1997. Weights pertinent to Sweden's trade (1980-1995) with Denmark, where Denmark is the partner country, were constructed on assumption that Denmark's trade weights with Sweden, the latter as a partner country, are equal to weights where Sweden is the reporting country.

A.3 Summary Statistics

Refer to the Table A.2.

Table A.2: Basic summary statistics for labour market policy variables

Country	Expenditure on active labour market policies				Unemployment benefits				Labour tax wedge			
	mean	**sd**	**min**	**max**	**mean**	**sd**	**min**	**max**	**mean**	**sd**	**min**	**max**
Austria	10.09	0.25	9.50	10.72	-1.18	0.05	-1.34	-1.11	3.51	0.11	3.32	3.66
Belgium	10.23	0.20	9.90	10.74	-0.90	0.04	-0.96	-0.84	3.72	0.04	3.63	3.78
Denmark	10.72	0.46	9.99	11.46	-0.60	0.08	-0.71	-0.42	3.44	0.07	3.34	3.62
Finland	10.13	0.37	9.74	11.24	-1.04	0.05	-1.12	-0.94	3.64	0.06	3.48	3.75
France	10.14	0.20	9.73	10.43	-0.96	0.05	-1.09	-0.82	3.61	0.18	3.10	3.76
Germany	10.27	0.34	9.55	11.12	-1.32	0.07	-1.45	-1.22	3.58	0.04	3.49	3.68
Greece	8.64	0.39	7.24	9.35	-2.10	0.27	-2.67	-1.75	3.64	0.12	3.19	3.78
Ireland	10.11	0.28	9.69	10.77	-1.17	0.14	-1.35	-0.73	2.68	0.88	0.34	3.42
Italy	9.32	0.40	8.72	10.00	-2.25	1.59	-6.21	-0.91	3.74	0.11	3.57	3.88
Luxembourg	10.17	0.42	9.41	10.95	-	-	-	-	2.64	0.21	2.26	3.07
Netherlands	10.84	0.46	10.15	11.90	-0.72	0.18	-1.09	-0.57	3.42	0.07	3.32	3.55
Portugal	9.70	0.54	8.30	10.43	-1.01	0.18	-1.64	-0.78	3.39	0.08	3.23	3.60
Spain	9.17	0.50	8.25	9.93	-1.06	0.03	-1.16	-1.02	3.52	0.03	3.46	3.59
Sweden	11.10	0.67	10.15	12.47	-1.16	0.16	-1.44	-0.89	3.76	0.07	3.62	3.87
United Kingdom	9.25	0.33	8.70	9.88	-1.76	0.08	-1.90	-1.56	3.41	0.09	3.23	3.53

Note: the variables are quarterly, spanning from Q1 1985 to Q4 2009 (100 observations per variable). The summary statistics are calculated for log levels.

B Cross Sectional Dependence

To motivate our interest in trade as a shock transmission channel, we use Moran's I statistics to measure spatial correlation among variables of different EU countries. The test statistic is defined as

$$I = \frac{N}{\sum_i \sum_j w_{ij}} \frac{\sum_i \sum_j w_{ij}(x_i - \overline{x})(x_j - \overline{x})}{\sum_i (x_i - \overline{x})^2},$$

where $w_{i,j} = \frac{\text{Country's } i \text{ trade with country } j}{\text{Country's } i \text{ trade with the world}}$. Under no spatial autocorrelation, $\mathbb{E}(I) = \frac{-1}{N-1}$, where N is the number of countries considered. Having identical weights, they can be taken out from the summation, and the resulting expression would be equal to zero. Hence, a statistically significant relationship demonstrates whether the chosen weighting scheme can be attributed as a factor generating spatial correlation. We examine macro variables for 28 EU countries with w_{ij} constructed using Direction of Trade Statistics in 2005.

We plot the p-values for the Moran's I statistic in Figure B.1. The lower the value, the more evidence there is to reject the null of no spatial autocorrelation. Evidently, GDPs tend to be spatially autocorrelated in all periods but the financial crisis. In contrast, unemployment seems to be more strongly associated in space in the last years.

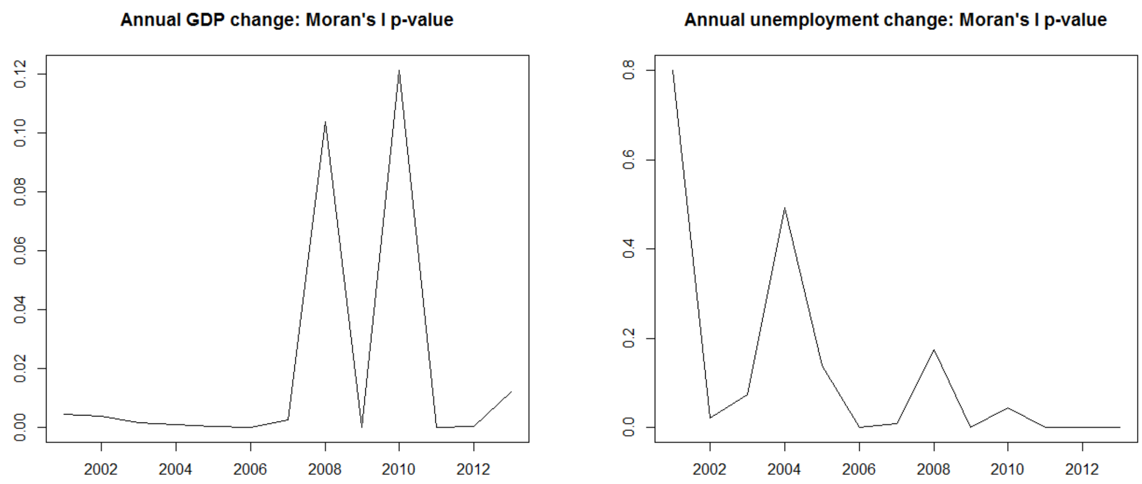


Figure B.1: Annual changes in GDP and unemployment

C Proofs and Derivations

C.1 Firm Level Variables

C.1.1 Cutoff Productivities

A φ-productivity firm with the measure of hired workers, $h_{it}(\varphi)$, pays an equilibrium wage w_{it}. The free entry condition implies that the firm's value, in expected value terms, must equal the sunk entry costs.[45] The zero profit condition for the domestic producer can be related to revenues $r(\varphi_d)$ by

$$\pi(\varphi_d) = (1-\beta) r_{it}(\varphi_d) + \theta_{it}^{1-\eta} h_{it}(\varphi_d) - f_d = 0,$$

or, after a few modifications,

$$\varphi_d^{\frac{\beta}{1-\beta}} = \frac{f_d}{A_{it}^{\frac{1}{1-\beta}} \mathcal{A}_t^{\lambda_i \frac{\beta}{1-\beta}} \left[(1-\beta)(r_{it}/h_{it})^{\frac{\beta}{\beta-1}} + \theta_{it}^{1-\eta} (r_{it}/h_{it})^{\frac{1}{\beta-1}} \right]}, \tag{C.1}$$

where we used the fact that $\varphi_d = \varphi_x$ for the marginal exporter (the one at the exporting threshold who is indifferent between exporting and remaining solely a domestic producer). This leads to the following lemma that relates extensive margin and labour market institutions.

Lemma 3. *The structure of active firms changes with labour market policies: share of exporters increases with a rise in unemployment benefits and decreases with employment contingent incentives, holding labour market tightness constant, in particular,* $\frac{\partial \varphi_d^{\frac{\beta}{1-\beta}}}{\partial \Theta_i} \frac{\partial \Theta_i}{\partial b_i} > 0$, $\frac{\partial \varphi_d^{\frac{\beta}{1-\beta}}}{\partial \Theta_i} \frac{\partial \Theta_i}{\partial e_i} < 0$, *where* $\Theta_i \equiv b_i - e_i + \frac{\kappa}{1-\kappa}\theta_i$.

[45] The value function for a firm $\mathcal{J}^F$, averaged by all firms, shall equal to the entry costs f_e, i.e., $\int_0^\infty \mathcal{J}_{it}^F(h_{it};\varphi)\, dG(\varphi) = f_e$. As is usual, we can use this result to derive the equilibrium measure of active firms in the economy. However, our aggregate data do not allow us to operationalise this equilibrium res-

Proof. To prove the lemma's statement, start with differentiating threshold productivity for the domestic producer (disregarding country notation),

$$\frac{\partial \varphi_d^{\frac{\beta}{1-\beta}}}{\partial \Theta} = -(1-\kappa)\left(\frac{\beta\gamma A_t \mathcal{A}_t^{\lambda_i \beta}}{\kappa\beta+1-\kappa}\right)^{\frac{1}{1-\beta}}\left[\Theta+\left(\frac{r+\delta+s}{1-\kappa}\right)x^{-1}\right]^{\frac{1}{\beta-1}}\left[(1-\beta)\Theta+\left(\frac{r+\delta+s}{1-\kappa}\right)x^{-1}\right]$$
$$\times\frac{\left[\frac{1}{\beta-1}\left[\Theta+\left(\frac{r+\delta+s}{1-\kappa}\right)x^{-1}\right]^{-1}+(1-\beta)\left[(1-\beta)\Theta+\left(\frac{r+\delta+s}{1-\kappa}\right)x^{-1}\right]^{-1}\right]}{\left[(1-\kappa)\left(\frac{\beta\gamma A_t \mathcal{A}_t^{\lambda_i \beta}}{\kappa\beta+1-\kappa}\right)^{\frac{1}{1-\beta}}\left[\Theta+\left(\frac{r+\delta+s}{1-\kappa}\right)x^{-1}\right]^{\frac{1}{\beta-1}}\left[(1-\beta)\Theta+\left(\frac{r+\delta+s}{1-\kappa}\right)x^{-1}\right]\right]^2}$$
$$=\frac{-\left[\frac{1}{\beta-1}\left[\Theta+\left(\frac{r+\delta+s}{1-\kappa}\right)x^{-1}\right]^{-1}+(1-\beta)\left[(1-\beta)\Theta+\left(\frac{r+\delta+s}{1-\kappa}\right)x^{-1}\right]^{-1}\right]}{(1-\kappa)\left(\frac{\beta\gamma A_t \mathcal{A}_t^{\lambda_i \beta}}{\kappa\beta+1-\kappa}\right)^{\frac{1}{1-\beta}}\left[\Theta+\left(\frac{r+\delta+s}{1-\kappa}\right)x^{-1}\right]^{\frac{1}{\beta-1}}\left[(1-\beta)\Theta+\left(\frac{r+\delta+s}{1-\kappa}\right)x^{-1}\right]}$$
$$=\frac{-\left[\frac{1}{\beta-1}\left[\Theta+\left(\frac{r+\delta+s}{1-\kappa}\right)x^{-1}\right]^{-1}+(1-\beta)\left[(1-\beta)\Theta+\left(\frac{r+\delta+s}{1-\kappa}\right)x^{-1}\right]^{-1}\right]}{\beta f_d}\varphi_d^{\frac{\beta}{1-\beta}}.$$

Hence, elasticity is given by

$$\epsilon_{\varphi_d,\Theta} = \Theta\frac{-\left[\left[(1-\beta)\Theta+\left(\frac{r+\delta+s}{1-\kappa}\right)x^{-1}\right]^{-1}-\left(\frac{1}{1-\beta}\right)^2\left[\Theta+\left(\frac{r+\delta+s}{1-\kappa}\right)x^{-1}\right]^{-1}\right]}{f_d}.$$

Note that

$$\frac{1}{\beta-1}\left[\Theta+\left(\frac{r+\delta+s}{1-\kappa}\right)x^{-1}\right]^{-1}+(1-\beta)\left[(1-\beta)\Theta+\left(\frac{r+\delta+s}{1-\kappa}\right)x^{-1}\right]^{-1}<0,$$

because $\beta < 1$ and

$$\left[\Theta+\left(\frac{r+\delta+s}{1-\kappa}\right)x^{-1}\right]^{-1} > (1-\beta)^2\left[(1-\beta)\Theta+\left(\frac{r+\delta+s}{1-\kappa}\right)x^{-1}\right]^{-1}$$

is satisfied for any value of $\beta \in (0,\, 1]$. However, the qualification for the last result is that the terms in brackets are positive (the sufficient condition is $b > e$). It then trivially follows from $\Theta \equiv b - e + \frac{\kappa}{1-\kappa}\theta$ that

$$\frac{\partial \varphi_d^{\frac{\beta}{1-\beta}}}{\partial \Theta} > 0, \frac{\partial \varphi_d^{\frac{\beta}{1-\beta}}}{\partial \Theta}\frac{\partial \Theta}{\partial b} > 0, \frac{\partial \varphi_d^{\frac{\beta}{1-\beta}}}{\partial \Theta}\frac{\partial \Theta}{\partial e} < 0, \frac{\partial \varphi_d^{\frac{\beta}{1-\beta}}}{\partial \Theta}\frac{\partial \Theta}{\partial \theta} > 0.$$

□

The intuition for the results stated in the lemma is quite simple: since benefits are covered by firms, that makes production costlier and thus increases the threshold productivity. The subsidy works just in an opposite way - it can be thought of as an exogenous reduction in the production costs. The change in labour market tightness causes a positive change in the domestic productivity cutoff, i.e., $\frac{\partial \varphi_d^{\frac{\beta}{1-\beta}}}{\partial \Theta_i}\frac{\partial \Theta_i}{\partial \theta_i} > 0$. Hence, the results in Lemma 3 can be extended to varying θ_i but then depend on the relative magnitudes of unemployment benefits and subsidies, as will be covered in the following Section.[46] In other words, the full rather than a partial effect admits both signs - this is consistent with heterogeneous impulse responses we cover in the empirical part of the paper. Interestingly, the impulse responses

ult. For the derivation, we split the value generated by domestic sales and exports and note that only a per-period profit matters when there is no adjustment in the employment.

[46]It also depends on relative sizes of parameters β and κ.

from a counterfactual of joint changes in labour market regulation comply to the theoretical partial effect.

Similarly, by considering equation revenue function and the zero profit condition for the exporter, we obtain the export margin for a generic exporter, defined as

$$\pi\left(\varphi_x\right) = \left(1-\beta\right) r_{it}\left(\varphi_x\right) + \theta_{it}^{1-\eta} h_{it}\left(\varphi_x\right) = f_d + f_x,$$

therefore, yielding

$$\varphi_x^{\frac{\beta}{1-\beta}} = \frac{f_x}{\left(\Upsilon_x - 1\right) A_{it}^{\frac{1}{1-\beta}} \mathcal{A}_t^{\lambda_i \frac{\beta}{1-\beta}} \left(\left(1-\beta\right)\left(r_{it}/h_{it}\right)^{\frac{\beta}{\beta-1}} + \theta_{it}^{1-\eta}\left(r_{it}/h_{it}\right)^{\frac{1}{\beta-1}}\right)}, \tag{C.2}$$

where we substituted f_d from equation (C.1) evaluated at φ_x. Let's denote $\rho \equiv \varphi_d/\varphi_x \in [0,\, 1]$ to stand for an *extensive margin* of trade – it determines the fraction of exporting firms, $\rho^z = \left(1 - G\left(\varphi_x\right)\right)\left(1 - G\left(\varphi_d\right)\right)^{-1}$. The *intensive margin* of trade openness, as captured by the market access variable, $\Upsilon_x > 1$, determines the ratio of revenues from domestic sales and exporting. These two dimensions of trade openness are linked through the relationship between the productivity cutoffs. Divide threshold productivities to obtain

$$\left(\Upsilon_x - 1\right)\left(\frac{\varphi_x}{\varphi_d}\right)^{\frac{\beta}{1-\beta}} = \frac{f_x}{f_d}. \tag{C.3}$$

C.1.2 Labour Market Tightness and Productivity

We follow Felbermayr et al. (2011a) which derived the job creation curve using a marginal revenue condition in the wage curve in a one sector trade model. Our approach is similar – notice that the term $\Gamma_{it}\varphi^{\beta} h_{it}^{\beta-1}$ is the marginal revenue (refer to above, in particular Online Appendix for full derivations). Having the isoelastic demand structure, differentiate revenue function $r_{it}\left(\varphi\right) = \Upsilon_{it}\left(\varphi\right)^{1-\beta} A_{it}\varphi^{\beta} h_{it}^{\beta}\mathcal{A}_t^{\beta\lambda_i}$ with respect to h_{it} to arrive at

$$\begin{aligned}\Gamma_{it}\varphi^{\beta} h_{it}^{\beta-1} &= \beta E_{it}^{1-\beta} P_{it}^{\beta} y_{it}^{\beta-1}\left(\varphi\right)\tfrac{\partial y_{it}(\varphi)}{\partial h_{it}} \\ &= \beta E_{it}^{1-\beta} P_{it}^{\beta} y_{it}^{\beta-1}\left(\varphi\right)\varphi\mathcal{A}_t^{\lambda_i} = \beta p_{it}\left(\tilde{\varphi}\right)\tilde{\varphi}\mathcal{A}_t^{\lambda_i} = \beta\tilde{\varphi}\mathcal{A}_t^{\lambda_i},\end{aligned}$$

where one could use a convenient normalisation, as in Felbermayr et al. (2011a), and defined average productivity $\tilde{\varphi}$ such that $p_{it}\left(\tilde{\varphi}\right) = 1$. Hence, the job creation curve is given by

$$w_{it}\left(\varphi\right) = \frac{\beta\kappa}{1+\kappa\beta-\kappa}\tilde{\varphi}\mathcal{A}_t^{\lambda_i} + \left(1-\kappa\right)\left(b_{it} - e_{it} + \frac{\kappa}{1-\kappa}\theta_{it}\right). \tag{C.4}$$

Recalling the Harris-Todaro condition, we can establish a relationship between labour market tightness and the average productivity in the economy, namely

$$\left(1-\kappa\right)\left(b_{it} - e_{it} + \frac{\kappa}{1-\kappa}\theta_{it}\right) = 1 - \frac{\beta\kappa}{1+\kappa\beta-\kappa}\tilde{\varphi}\mathcal{A}_t^{\lambda_i}.$$

Obviously, there is a negative relationship between the average productivity and labour market tightness. A more direct approach would be to observe such a relationship from wage equation, which is valid for all productivity levels, so also for the average one.

C.2 Aggregate Variables

C.2.1 Steady-state Unemployment

$$
\begin{aligned}
u_i &= \frac{1}{\left[\frac{s}{(\delta+s)^{\frac{2-\eta}{\eta}} w_i(h;\varphi)}\right]^{\frac{\eta}{2-\eta}}+1} \\
&= \frac{1}{\left[\frac{s}{(\delta+s)^{\frac{2-\eta}{\eta}}\left(b_i-e_i+\frac{\kappa}{1-\kappa}\left(\theta_i+(r+\delta+s)x_i^{-1}\right)\right)}\right]^{\frac{\eta}{2-\eta}}+1} \\
&= \frac{1}{\left[\frac{s}{(\delta+s)^{\frac{2-\eta}{\eta}}\left(\Theta_i+(r+\delta+s)\frac{\kappa}{1-\kappa}x_i^{-1}\right)}\right]^{\frac{\eta}{2-\eta}}+1}.
\end{aligned}
$$

C.2.2 General Price Index

To derive the general price index, we start with the aggregator $P=\left[\int_{\omega\in J} p\left(\omega\right)^{-\frac{\beta}{1-\beta}}\,d\omega\right]^{-\frac{1-\beta}{\beta}}$ which leads to

$$
\begin{aligned}
P_{it} = \left[\int_{\omega\in J} p_{it}\left(\omega\right)^{-\frac{\beta}{1-\beta}}\,d\omega\right]^{-\frac{1-\beta}{\beta}} &= \left[\int_{\varphi_{i,d}}^{\infty}\left(\varphi^{\beta-1}h_{it}^{\beta-1}\mathcal{A}_t^{\lambda_i(\beta-1)}\right)^{-\frac{\beta}{1-\beta}} M_{ii}\frac{g(\varphi)}{1-G\left(\varphi_{i,d}\right)}d\varphi\right. \\
&\left. + \sum_{j\neq i}\int_{\varphi_{j,x}}^{\infty}\left(\tau_{ji}\varphi^{\beta-1}h_{jt}^{\beta-1}\mathcal{A}_t^{\beta-1}\right)^{-\frac{\beta}{1-\beta}} M_{ji}\frac{g(\varphi)}{1-G(\varphi_{j,x})}\frac{1-G(\varphi_{j,x})}{1-G\left(\varphi_{i,d}\right)}d\varphi\right]^{-\frac{1-\beta}{\beta}} \\
&= \left[\left(\frac{\varphi_{i,d}}{\varphi_{min}}\right)^{z}\mathcal{A}_t^{\lambda_i\beta}\int_{\varphi_{i,d}}^{\infty}\left(\varphi^{\beta-1}h_{it}^{\beta-1}\right)^{-\frac{\beta}{1-\beta}} M_{ii}z\frac{\varphi_{min}^{z}}{\varphi^{z+1}}d\varphi\right. \\
&\left. + \sum_{j\neq i}\mathcal{A}_t^{\lambda_j\beta}\tau_{ji}^{-\frac{\beta}{1-\beta}}\left(\frac{\varphi_{i,x}}{\varphi_{min}}\right)^{z}\int_{\varphi_{j,x}}^{\infty}\left(\varphi^{\beta-1}h_{jt}^{\beta-1}\right)^{-\frac{\beta}{1-\beta}} M_{ji}z\frac{\varphi_{min}^{z}}{\varphi^{z+1}}\left(\frac{\varphi_{i,d}}{\varphi_{j,x}}\right)^{z}d\varphi\right]^{-\frac{1-\beta}{\beta}} \\
&= \left[\mathcal{A}_t^{\lambda_i\beta}z\left[M_{ii}\varphi_{i,d}^{z}\int_{\varphi_{i,d}}^{\infty}h_{it}^{\beta}\varphi^{\beta-z-1}d\varphi + \sum_{j\neq i}\mathcal{A}_t^{(\lambda_j-\lambda_i)\beta}\tau_{ji}^{-\frac{\beta}{1-\beta}}\varphi_{j,x}^{z}M_{ji}\left(\frac{\varphi_{i,d}}{\varphi_{j,x}}\right)^{z}\int_{\varphi_{j,x}}^{\infty}h_{jt}^{\beta}\varphi^{\beta-z-1}d\varphi\right]\right]^{-\frac{1-\beta}{\beta}},
\end{aligned}
$$

and upon substituting the equilibrium (linear) employment level,

$$
\begin{aligned}
P_{it} &= \left[\mathcal{A}_t^{\lambda_i\beta}z\left[M_{ii}\left[\Theta_{it}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{it}^{-1}\right]^{\frac{\beta}{\beta-1}}\left(\frac{\beta\gamma A_t\mathcal{A}_t^{\lambda_i\beta}}{\kappa\beta+1-\kappa}\right)^{\frac{\beta}{1-\beta}}\frac{1-\beta}{z(1-\beta)-\beta}\varphi_{i,d}^{\frac{\beta}{1-\beta}}\right.\right. \\
&\left.\left. + \sum_{j\neq i}\mathcal{A}_t^{(\lambda_j-\lambda_i)\beta}\tau_{ji}^{-\frac{\beta}{1-\beta}}M_{ji}\left[\Theta_{jt}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{jt}^{-1}\right]^{\frac{\beta}{\beta-1}}\left(\frac{\beta\gamma A_t\mathcal{A}_t^{\lambda_j\beta}}{\kappa\beta+1-\kappa}\right)^{\frac{\beta}{1-\beta}}\Upsilon_x^{\beta}\left(\varphi\right)\frac{1-\beta}{z(1-\beta)-\beta}\left(\frac{\varphi_{i,d}}{\varphi_{j,x}}\right)^{z}\varphi_{j,x}^{\frac{\beta}{1-\beta}}\right]\right]^{-\frac{1-\beta}{\beta}} \\
&= \left[\frac{z(1-\beta)}{z(1-\beta)-\beta}\left[M_{ii}p_{it}^{\frac{\beta}{\beta-1}}\left(\varphi_{i,d}\right)+\sum_{j\neq i}\tau_{ji}^{-\frac{\beta}{1-\beta}}M_{ji}p_{jt}^{\frac{\beta}{\beta-1}}\left(\varphi_{j,x}\right)\right]\right]^{-\frac{1-\beta}{\beta}},
\end{aligned}
$$

where firm's prices are evaluated at cutoff levels of productivities, namely

$$
\begin{aligned}
p_{it}^{\frac{\beta}{\beta-1}}\left(\varphi_{i,d}\right) &= \left(\frac{\kappa\beta+1-\kappa}{\beta\gamma}\right)^{\frac{\beta}{\beta-1}}\left[\frac{\Theta_{it}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{it}^{-1}}{A_t\mathcal{A}_t^{\lambda_i}}\right]^{\frac{\beta}{\beta-1}}\varphi_d^{-\frac{\beta}{\beta-1}}, \\
p_{jt}^{\frac{\beta}{\beta-1}}\left(\varphi_{j,x}\right) &= \left(\frac{\kappa\beta+1-\kappa}{\beta\gamma}\right)^{\frac{\beta}{\beta-1}}\left[\frac{\Theta_{jt}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{jt}^{-1}}{A_t\mathcal{A}_t^{\lambda_j}\Upsilon_x(\varphi)^{1-\beta}}\right]^{\frac{\beta}{\beta-1}}\left(\frac{\varphi_{i,d}}{\varphi_{j,x}}\right)^{z}\varphi_{j,x}^{-\frac{\beta}{\beta-1}}.
\end{aligned}
$$

C.2.3 Terms of Trade

To derive the terms of trade, first produce the average productivities for non-exporters and exporters. Namely,

$$\tilde{\varphi}_d \equiv \left(\int_{\varphi_d}^{\infty} \varphi^{\frac{\beta}{1-\beta}} \frac{dG(\varphi)}{1-G(\varphi_d)}\right)^{\frac{1-\beta}{\beta}} = \left(\frac{z(1-\beta)}{z(1-\beta)-\beta}\varphi_d^{\frac{\beta}{1-\beta}}\right)^{\frac{1-\beta}{\beta}}, \; z > \frac{\beta}{1-\beta},$$

$$\tilde{\varphi}_x \equiv \left(\int_{\varphi_x}^{\infty} \varphi^{\frac{\beta}{1-\beta}} \frac{dG(\varphi)}{1-G(\varphi_x)}\right)^{\frac{1-\beta}{\beta}} = \left(\frac{z(1-\beta)}{z(1-\beta)-\beta}\varphi_x^{\frac{\beta}{1-\beta}}\right)^{\frac{1-\beta}{\beta}}.$$

Evaluating prices of importables and exportables at averages,

$$ToT_{ij,t} = \varepsilon_{ij,t}\left(\frac{\tilde{\varphi}_{i,x}}{\tilde{\varphi}_{j,x}}\right)^{1-\beta}\left(\frac{h_{it}(\tilde{\varphi}_{i,x})}{h_{jt}(\tilde{\varphi}_{j,x})}\right)^{(1-\beta)}\mathcal{A}_t^{(\lambda_j-\lambda_i)(\beta-1)}$$

$$= \varepsilon_{ij,t}\left(\frac{\tilde{\varphi}_{i,x}}{\tilde{\varphi}_{j,x}}\right)^{1-\beta}\left(\frac{\left(\frac{\Gamma_{it}\tilde{\varphi}_{i,x}^{\beta}}{\kappa\beta+1-\kappa}\right)^{\frac{1}{1-\beta}}\left[\Theta_{it}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{it}^{-1}\right]^{\frac{1}{\beta-1}}}{\left(\frac{\Gamma_{jt}\tilde{\varphi}_{j,x}^{\beta}}{\kappa\beta+1-\kappa}\right)^{\frac{1}{1-\beta}}\left[\Theta_{jt}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{jt}^{-1}\right]^{\frac{1}{\beta-1}}}\right)^{(1-\beta)}\mathcal{A}_t^{(\lambda_j-\lambda_i)(\beta-1)}$$

$$= \varepsilon_{ij,t}\left(\frac{\tilde{\varphi}_{i,x}}{\tilde{\varphi}_{j,x}}\right)\frac{\Gamma_{it}}{\Gamma_{jt}}\frac{\Theta_{jt}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{jt}^{-1}}{\Theta_{it}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{it}^{-1}}\mathcal{A}_t^{(\lambda_j-\lambda_i)(\beta-1)}$$

$$= \varepsilon_{ij,t}\left(\frac{\tilde{\varphi}_{i,x}}{\tilde{\varphi}_{j,x}}\right)\frac{\Upsilon_{i,x}(\varphi)^{1-\beta}A_{it}}{\Upsilon_{j,x}(\varphi)^{1-\beta}A_{jt}}\frac{\Theta_{jt}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{jt}^{-1}}{\Theta_{it}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{it}^{-1}}\mathcal{A}_t^{-(\lambda_j-\lambda_i)}.$$

C.2.4 Real Exchange Rate

Using general price indices,

$$RER_{ij,t}^{\frac{\beta}{1-\beta}} = \varepsilon_{ij,t}^{\frac{\beta}{1-\beta}}\mathcal{A}_t^{(\lambda_i-\lambda_j)\frac{\beta}{1-\beta}}\left(\frac{\varphi_{i,d}}{\varphi_{j,d}}\right)^{\frac{\beta}{1-\beta}}$$

$$\times\frac{M_{ii}\left[\Theta_{it}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{it}^{-1}\right]^{\frac{\beta}{\beta-1}}A_{it}^{\frac{\beta}{1-\beta}}+\sum_{j\neq i}\mathcal{A}_t^{\left(\lambda_j-\lambda_i\right)\frac{\beta}{1-\beta}}\tau_{ji}^{-\frac{\beta}{1-\beta}}M_{ji}\left[\Theta_{jt}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{jt}^{-1}\right]^{\frac{\beta}{\beta-1}}A_{jt}^{\frac{\beta}{1-\beta}}\Upsilon_x^{\beta}(\varphi)\left(\frac{\varphi_{i,d}}{\varphi_{j,x}}\right)^{z-\frac{\beta}{1-\beta}}}{M_{jj}\left[\Theta_{jt}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{jt}^{-1}\right]^{\frac{\beta}{\beta-1}}A_{jt}^{\frac{\beta}{1-\beta}}+\sum_{\ell\neq j}\mathcal{A}_t^{\left(\lambda_\ell-\lambda_j\right)\frac{\beta}{1-\beta}}\tau_{\ell j}^{-\frac{\beta}{1-\beta}}M_{\ell j}\left[\Theta_{\ell t}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{\ell t}^{-1}\right]^{\frac{\beta}{\beta-1}}A_{\ell t}^{\frac{\beta}{1-\beta}}\Upsilon_x^{\beta}(\varphi)\left(\frac{\varphi_{j,d}}{\varphi_{\ell,x}}\right)^{z-\frac{\beta}{1-\beta}}}.$$

Taking partial derivatives with respect to Θ, and rearranging into elasticities, give

$$\epsilon_{RER_{ij,t},\Theta_{it}} = \epsilon_{\varphi_{i,d},\Theta_{it}} + \frac{M_{ii}\left[\Theta_{it}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{it}^{-1}\right]^{\frac{1}{\beta-1}}A_{it}^{\frac{\beta}{1-\beta}}\Theta_{it}}{\triangle}$$

$$-\frac{\left(\frac{z(1-\beta)-\beta}{\beta}\right)\sum_{j\neq i}\mathcal{A}_t^{\left(\lambda_j-\lambda_i\right)\frac{\beta}{1-\beta}}\tau_{ji}^{-\frac{\beta}{1-\beta}}M_{ji}\left[\Theta_{jt}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{jt}^{-1}\right]^{\frac{\beta}{\beta-1}}A_{jt}^{\frac{\beta}{1-\beta}}\Upsilon_x^{\beta}(\varphi)\left(\frac{\varphi_{i,d}}{\varphi_{j,x}}\right)^{z-\frac{\beta}{1-\beta}}\epsilon_{\varphi_{i,d},\Theta_{it}}}{\triangle}$$

$$= \epsilon_{\varphi_{i,d},\Theta_{it}} + \frac{M_{ii}\left[\Theta_{it}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{it}^{-1}\right]^{\frac{1}{\beta-1}}A_{it}^{\frac{\beta}{1-\beta}}\Theta_{it}}{P_{it}^{\frac{\beta}{\beta-1}}\mathcal{A}_t^{-\lambda_i\frac{\beta}{1-\beta}}\left(\frac{z(1-\beta)}{z(1-\beta)-\beta}\right)^{-1}\left(\frac{\beta\gamma}{\kappa\beta+1-\kappa}\right)^{-\frac{\beta}{1-\beta}}\varphi_{i,d}^{-\frac{\beta}{1-\beta}}}$$

$$-\frac{\left(\frac{z(1-\beta)-\beta}{\beta}\right)\sum_{j\neq i}\mathcal{A}_t^{\left(\lambda_j-\lambda_i\right)\frac{\beta}{1-\beta}}\tau_{ji}^{-\frac{\beta}{1-\beta}}M_{ji}\left[\Theta_{jt}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{jt}^{-1}\right]^{\frac{\beta}{\beta-1}}A_{jt}^{\frac{\beta}{1-\beta}}\Upsilon_x^{\beta}(\varphi)\left(\frac{\varphi_{i,d}}{\varphi_{j,x}}\right)^{z-\frac{\beta}{1-\beta}}\epsilon_{\varphi_{i,d},\Theta_{it}}}{P_{it}^{\frac{\beta}{\beta-1}}\mathcal{A}_t^{-\lambda_i\frac{\beta}{1-\beta}}\left(\frac{z(1-\beta)}{z(1-\beta)-\beta}\right)^{-1}\left(\frac{\beta\gamma}{\kappa\beta+1-\kappa}\right)^{-\frac{\beta}{1-\beta}}\varphi_{i,d}^{-\frac{\beta}{1-\beta}}}$$

$$= \epsilon_{\varphi_{i,d},\Theta_{it}} + \frac{z(1-\beta)}{z(1-\beta)-\beta}\frac{M_{ii}\left[\Theta_{it}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{it}^{-1}\right]^{\frac{\beta}{\beta-1}-1}A_{it}^{\frac{\beta}{1-\beta}}\Theta_{it}}{P_{it}^{\frac{\beta}{\beta-1}}\mathcal{A}_t^{-\lambda_i\frac{\beta}{1-\beta}}\left(\frac{\beta\gamma}{\kappa\beta+1-\kappa}\right)^{-\frac{\beta}{1-\beta}}\varphi_{i,d}^{-\frac{\beta}{1-\beta}}}$$

$$-\frac{z(1-\beta)}{\beta}\frac{\sum_{j\neq i}\mathcal{A}_t^{\left(\lambda_j-\lambda_i\right)\frac{\beta}{1-\beta}}\tau_{ji}^{-\frac{\beta}{1-\beta}}M_{ji}\left[\Theta_{jt}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{jt}^{-1}\right]^{\frac{\beta}{\beta-1}}A_{jt}^{\frac{\beta}{1-\beta}}\Upsilon_x^{\beta}(\varphi)\left(\frac{\varphi_{i,d}}{\varphi_{j,x}}\right)^{z-\frac{\beta}{1-\beta}}\epsilon_{\varphi_{i,d},\Theta_{it}}}{P_{it}^{\frac{\beta}{\beta-1}}\mathcal{A}_t^{-\lambda_i\frac{\beta}{1-\beta}}\left(\frac{\beta\gamma}{\kappa\beta+1-\kappa}\right)^{-\frac{\beta}{1-\beta}}\varphi_{i,d}^{-\frac{\beta}{1-\beta}}},$$

where

$$\triangle \equiv M_{ii}\left[\Theta_{it}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{it}^{-1}\right]^{\frac{\beta}{\beta-1}}A_{it}^{\frac{\beta}{1-\beta}} + \sum_{j\neq i}\mathcal{A}_t^{(\lambda_j-\lambda_i)\frac{\beta}{1-\beta}}\tau_{ji}^{-\frac{\beta}{1-\beta}}M_{ji}\left[\Theta_{jt}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{jt}^{-1}\right]^{\frac{\beta}{\beta-1}}A_{jt}^{\frac{\beta}{1-\beta}}\Upsilon_x^{\beta}(\varphi)\left(\frac{\varphi_{i,d}}{\varphi_{j,x}}\right)^{z-\frac{\beta}{1-\beta}}.$$

Though the elasticity of the cutoff productivity level with respect to Θ_{it} is positive, the subtracted term is either larger or smaller than the first two terms. This confirms the claim in the main text.

C.2.5 Multi-country Trade Flows

The total revenue of exports is defined as $EX_{it} = \sum_{j\neq i}\int_{\varphi_{ij,x}}^{\infty} \frac{p_{ij,t}^{\frac{\beta}{\beta-1}}}{P_{jt}^{\frac{\beta}{\beta-1}}} E_{jt}\frac{dG(\varphi)}{1-G(\varphi_{ij,x})}$, which leads to

$$EX_{it} = \sum_{j\neq i}\int_{\varphi_{ij,x}}^{\infty} \frac{p_{ij,t}^{\frac{\beta}{\beta-1}}}{P_{jt}^{\frac{\beta}{\beta-1}}} E_{jt}\frac{dG(\varphi)}{1-G(\varphi_{ij,x})} = \sum_{j\neq i}\int_{\varphi_{ij,x}}^{\infty} \frac{\tau_{ij}^{\frac{\beta}{\beta-1}}\varphi^{\beta}h_{it}^{\beta}\mathcal{A}_t^{\lambda_i\beta}}{P_{jt}^{\frac{\beta}{\beta-1}}} E_{jt}\frac{dG(\varphi)}{1-G(\varphi_{ij,x})}$$
$$= \sum_{j\neq i}\frac{\tau_{ij}^{\frac{\beta}{\beta-1}}\mathcal{A}_t^{\lambda_i\beta}}{P_{jt}^{\frac{\beta}{\beta-1}}} E_{jt}\int_{\varphi_{ij,x}}^{\infty}\varphi^{\beta}h_{it}^{\beta}\frac{z\varphi_{min}^{z}\varphi^{-z-1}d\varphi}{1-G(\varphi_{ij,x})}$$
$$= \sum_{j\neq i}\frac{\tau_{ij}^{\frac{\beta}{\beta-1}}\mathcal{A}_t^{\lambda_i\beta}}{P_{jt}^{\frac{\beta}{\beta-1}}}\left(\frac{\beta A_{it}\mathcal{A}_t^{\lambda_i\beta}}{\kappa\beta+1-\kappa}\right)^{\frac{\beta}{1-\beta}}\left[\Theta_{it}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{it}^{-1}\right]^{\frac{\beta}{\beta-1}} E_{jt}\left(\frac{1}{\varphi_{ij,x}}\right)^{-z} z\Upsilon_{ij,x}^{\beta}\frac{1-\beta}{z(1-\beta)-\beta}\varphi_{ij,x}^{\frac{\beta}{1-\beta}-z}$$
$$= \sum_{j\neq i}\frac{\tau_{ij}^{\frac{\beta}{\beta-1}}\mathcal{A}_t^{\lambda_i\frac{\beta}{1-\beta}}}{P_{jt}^{\frac{\beta}{\beta-1}}}\left(\frac{\beta A_{it}}{\kappa\beta+1-\kappa}\right)^{\frac{\beta}{1-\beta}}\left[\Theta_{it}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{it}^{-1}\right]^{\frac{\beta}{\beta-1}} E_{jt}\Upsilon_{ij,x}^{\beta}\frac{z(1-\beta)}{z(1-\beta)-\beta}\varphi_{ij,x}^{\frac{\beta}{1-\beta}}$$
$$= \frac{z(1-\beta)}{z(1-\beta)-\beta}\sum_{j\neq i}\left(\frac{\tau_{ij}p_{jt}(\varphi_{ij,x})}{P_{jt}}\right)^{\frac{\beta}{\beta-1}} E_{jt}.$$

Hence, the openness ratio is

$$\frac{EX_{it}}{E_{it}} = \frac{z(1-\beta)}{z(1-\beta)-\beta}\left[\Theta_{it}+\left(\frac{r+\delta+s}{1-\kappa}\right)x_{it}^{-1}\right]^{\frac{\beta}{\beta-1}}\mathcal{A}_t^{\lambda_i\frac{\beta}{1-\beta}}\left(\frac{\beta\gamma A_{it}}{\kappa\beta+1-\kappa}\right)^{\frac{\beta}{1-\beta}}\sum_{j\neq i}\frac{E_{jt}}{E_{it}}\left(\frac{\tau_{ij}/\varphi_{ij,x}}{P_{jt}}\right)^{\frac{\beta}{\beta-1}}\Upsilon_{ij,x}^{\beta}.$$

C.3 From Theory to Empirics

C.3.1 Model III: Global Unobserved Factor

As mentioned in the main text, we could have used another solution for the unobserved multilateral term. We can also proxy Π_{it} with a global factor with a varying factor loading, depending on the particular economy. In other words, we account for the country specific and time-varying effect using a common factor approach, i.e., $\ln\Pi_{it}\approx\gamma_i\ln F_t$, while keeping in mind that Π_{it} is a function of aggregates already included in the specification. Plugging this back into equation (4.10), taking logs, summing, and simplifying yield

$$\ln(EX_{it}/E_{it}) = \tilde{\beta}_i + \left(\frac{\beta}{1-\beta}\right)\ln(1-u_{it}) + \left(\beta\left(\frac{\beta}{\beta-1}\right)-1\right)\ln(E_{it}/P_{it})$$
$$-\gamma_i\ln(EX_{it}/E_{it})^{\star} - \frac{\beta}{1-\beta}\gamma_i\ln(1-u_{it})^{\star} - \gamma_i\left(\beta\left(\frac{\beta}{\beta-1}\right)-1\right)\ln(E_{it}/P_{it})^{\star}.$$

This specification tells that openness is related to employment, real GDP, and cross-sectional averages of openness, employment, and real GDP. This method loses some information contained in the unobservable term, and therefore emphasise other solutions more. However, empirical results, which are largely comparable to the benchmark model, can be obtained from the authors.

C.3.2 Real Effective Exchange Rate

Rewrite the aggregate gravity in (4.10) as

$$\ln\left(\frac{EX_{it}}{E_{it}}\right) = \ln\frac{z(1-\beta)}{z(1-\beta)-\beta}(\delta+s)^{\frac{\beta}{1-\beta}} + \ln(1-u_{it})^{\frac{\beta}{1-\beta}} + \ln\left(\frac{E_{it}}{P_{it}}\right)^{\beta\left(\frac{\beta}{\beta-1}\right)-1} + \lambda_i\ln F_t + \ln reer_{it},$$

take cross-sectional averages

$$\sum_i \omega_i \ln\left(\frac{EX_{it}}{E_{it}}\right) = \ln \frac{z(1-\beta)}{z(1-\beta)-\beta}\left(\delta+s\right)^{\frac{\beta}{1-\beta}}\sum_i \omega_i$$
$$+\sum_i \omega_i \ln\left(1-u_{it}\right)^{\frac{\beta}{1-\beta}} + \sum_i \omega_i \ln\left(\frac{E_{it}}{P_{it}}\right)^{\beta\left(\frac{\beta}{\beta-1}\right)-1} + \ln F_t \sum_i \omega_i\lambda_i + \sum_i \omega_i \ln reer_{it},$$

and express the unobserved dynamic factor as

$$\ln F_t = \left(\sum_i \omega_i\lambda_i\right)^{-1}\left(\sum_i \omega_i \ln\left(\frac{EX_{it}}{E_{it}}\right) - \ln \frac{z(1-\beta)}{z(1-\beta)-\beta}\left(\delta+s\right)^{\frac{\beta}{1-\beta}}\right.$$
$$\left.-\sum_i \omega_i \ln\left(1-u_{it}\right)^{\frac{\beta}{1-\beta}} - \sum_i \omega_i \ln\left(\frac{E_{it}}{P_{it}}\right)^{\beta\left(\frac{\beta}{\beta-1}\right)-1} - \sum_i \omega_i \ln reer_{it}\right).$$

After substituting back, this procedure yields

$$\ln\left(\frac{EX_{it}}{E_{it}}\right) = \left(1-\frac{\lambda_i}{\sum_i \omega_i\lambda_i}\right)\ln \frac{z(1-\beta)}{z(1-\beta)-\beta}\left(\delta+s\right)^{\frac{\beta}{1-\beta}} + \frac{\beta}{1-\beta}\ln\left(1-u_{it}\right) + \left(\beta\left(\frac{\beta}{\beta-1}\right)-1\right)\ln\left(\frac{E_{it}}{P_{it}}\right)$$
$$+\frac{\lambda_i}{\sum_i \omega_i\lambda_i}\left(\sum_i \omega_i \ln\left(\frac{EX_{it}}{E_{it}}\right) - \frac{\beta}{1-\beta}\sum_i \omega_i \ln\left(1-u_{it}\right) - \left(\beta\left(\frac{\beta}{\beta-1}\right)-1\right)\sum_i \omega_i \ln\left(\frac{E_{it}}{P_{it}}\right) - \sum_i \omega_i \ln reer_{it}\right)$$
$$+\ln reer_{it}.$$

C.3.3 Global Unobserved Factor

Rewrite the aggregate gravity in (4.10) as

$$\ln EX_{it}/E_{it} = \ln \frac{z\left(1-\beta\right)}{z\left(1-\beta\right)-\beta}\left(\delta+s\right)^{\frac{\beta}{1-\beta}} + \frac{\beta}{1-\beta}\ln\left(1-u_{it}\right) + \left(\beta\left(\frac{\beta}{\beta-1}\right)-1s\right)\ln\left(E_{it}/P_{it}\right) + \gamma_i \ln F_t. \tag{C.5}$$

Taking cross-sectionally weighted averages yields

$$\sum \omega_i \ln\left(EX_{it}/E_{it}\right) = \ln \frac{z(1-\beta)}{z(1-\beta)-\beta}\left(\delta+s\right)^{\frac{\beta}{1-\beta}}\sum \omega_i$$
$$+\sum \omega_i \ln\left(1-u_{it}\right)^{\frac{\beta}{1-\beta}} + \sum \omega_i \ln\left(E_{it}/P_{it}\right)^{\beta\left(\frac{\beta}{\beta-1}\right)-1} + \sum \omega_i\gamma_i \ln F_t,$$

therefore, helping to express the unobservable dynamic factor as

$$\ln F_t = \left(\sum \omega_i\gamma_i\right)^{-1}\left(\sum \omega_i \ln\left(EX_{it}/E_{it}\right) - \ln \frac{z(1-\beta)}{z(1-\beta)-\beta}\left(\delta+s\right)^{\frac{\beta}{1-\beta}}\sum \omega_i\right.$$
$$\left.-\sum \omega_i \frac{\beta}{1-\beta}\ln\left(1-u_{it}\right) - \sum \omega_i\left(\beta\left(\frac{\beta}{\beta-1}\right)-1\right)\ln\left(E_{it}/P_{it}\right)\right).$$

Plugging into (C.5) yields

$$\ln\left(EX_{it}/E_{it}\right) = \ln \frac{z(1-\beta)}{z(1-\beta)-\beta}\left(\delta+s\right)^{\frac{\beta}{1-\beta}} + \left(\frac{\beta}{1-\beta}\right)\ln\left(1-u_{it}\right) + \left(\beta\left(\frac{\beta}{\beta-1}\right)-1\right)\ln\left(E_{it}/P_{it}\right)$$
$$-\gamma_i\frac{\sum \omega_i \ln(EX_{it}/E_{it})}{\sum \omega_i\gamma_i} - \ln \frac{z(1-\beta)}{z(1-\beta)-\beta}\left(\delta+s\right)^{\frac{\beta}{1-\beta}}\frac{\gamma_i}{\sum \omega_i\gamma_i} - \frac{\beta}{1-\beta}\gamma_i\frac{\ln\sum \omega_i(1-u_{it})}{\sum \omega_i\gamma_i} - \gamma_i\frac{\sum \omega_i\left(\beta\left(\frac{\beta}{\beta-1}\right)-1\right)\ln(E_{it}/P_{it})}{\sum \omega_i\gamma_i},$$

which is as reported in the main text, just using a simpler notation for cross-sectionally weighted variables.

C.3.4 Linearisation (no global technology)

Define the multilateral resistance term as

$$\ln \Pi_{it} = \ln \sum_{j\neq i}\left(\frac{\tau_{ij,t}/\varphi_{ijt,x}}{P_{jt}}\right)^{\frac{\beta}{\beta-1}}\left(\frac{P_{it}}{P_{jt}}\right)\frac{E_{jt}}{P_{jt}}\Upsilon^{\beta}_{ijt,x}\ ,$$

then linearisation yields

$$f(\beta) = f(0) + (\beta - 0) f'(0)$$
$$= \ln \sum_{j\neq i} \left(\frac{P_{it}}{P_{jt}}\right) \frac{E_{jt}}{P_{jt}} + \beta \frac{\sum_{j\neq i}\left(\left(\frac{P_{it}}{P_{jt}}\right)\frac{E_{jt}}{P_{jt}}\left(\ln \Upsilon_{ijt,x} - \ln\left(\frac{\tau_{ij,t}/\varphi_{ijt,x}}{P_{jt}}\right)\right)\right)}{\sum_{j\neq i}\left(\frac{P_{it}}{P_{jt}}\right)\frac{E_{jt}}{P_{jt}}}$$
$$= \ln reer_{it} + \beta \frac{\sum_{j\neq i}\left(\left(\frac{P_{it}}{P_{jt}}\right)\frac{E_{jt}}{P_{jt}}\left(\ln \Upsilon_{ijt,x} - \ln\left(\frac{\tau_{ij,t}/\varphi_{ijt,x}}{P_{jt}}\right)\right)\right)}{reer_{it}}$$
$$= \ln reer_{it} + \beta \sum_{j\neq i}\left(\frac{rer_{ji,t}}{reer_{it}}\left(\ln \Upsilon_{ijt,x} - \frac{\beta-1}{\beta}\ln\left(\frac{EX_{ij,t}}{E_{jt}}\right)\right)\right).$$

Linearising the main part gives

$$\ln\left(EX_{it}/E_{it}\right) = \ln\left(E_{it}/P_{it}\right)^{-1} + \beta\ln\left(1-u_{it}\right) + \ln reer_{it}$$
$$+\beta\sum_{j\neq i}\frac{rer_{ji,t}}{reer_{it}}\ln\Upsilon_{ijt,x} - (\beta-1)\sum_{j\neq i}\frac{rer_{ji,t}}{reer_{it}}\ln\left(\frac{EX_{ij,t}}{E_{jt}}\right),$$

since $\frac{d\ln(EX_{it}/E_{it})}{d\beta} = \frac{1}{(1-\beta)^2}\ln\left(1-u_{it}\right) + \left(\frac{(\beta-2)\beta}{(\beta-1)^2}\right)\ln\left(E_{it}/P_{it}\right)$. Since market access term $\Upsilon_{ijt,x}$ is unobservable, we proxy for it using a real exchange rate (see Helpman et al. (2012), where it is noted that the market access term is affected by fluctuations in real exchange rate (due to dependence on conditions in both markets, and frictions between them). We therefore finally arrive at

$$\ln\left(\frac{EX_{it}}{E_{it}}\right)$$
$$= \ln\left(\frac{E_{it}}{P_{it}}\right)^{-1} + \beta\ln\left(1-u_{it}\right) + \ln reer_{it} + \beta\sum_{j\neq i}\frac{rer_{ji,t}}{reer_{it}}\ln\Upsilon_{ijt,x} - (\beta-1)\sum_{j\neq i}\frac{rer_{ji,t}}{reer_{it}}\ln\left(\frac{EX_{ij,t}}{E_{jt}}\right)$$
$$= \ln\left(\frac{E_{it}}{P_{it}}\right)^{-1} + \beta\ln\left(1-u_{it}\right) + \ln reer_{it} + \frac{\beta}{1-\beta}\sum_{j\neq i}\frac{rer_{ji,t}}{reer_{it}}\ln\left(\frac{\beta}{\delta+s}\right) + \frac{\beta}{1-\beta}\sum_{j\neq i}\frac{rer_{ji,t}}{reer_{it}}\ln\left(\frac{E_{jt}}{P_{jt}}\right)^{\beta}$$
$$-\frac{\beta}{1-\beta}\sum_{j\neq i}\frac{rer_{ji,t}}{reer_{it}}\ln\left(1-u_{jt}\right) - (\beta-1)\sum_{j\neq i}\frac{rer_{ji,t}}{reer_{it}}\ln\left(\frac{EX_{ij,t}}{E_{jt}}\right),$$

which, after manipulation, yields

$$\ln reer_{it} = \frac{\beta}{1-\beta}\ln\left(\frac{\beta}{\delta+s}\right)\sum_{j\neq i}\frac{rer_{ji,t}}{reer_{it}} + \left[\ln\left(\frac{E_{it}}{P_{it}}\right)^{-1} - \frac{\beta}{\beta-1}\sum_{j\neq i}\frac{rer_{ji,t}}{reer_{it}}\ln\left(\frac{E_{jt}}{P_{jt}}\right)^{\beta}\right]$$
$$+\left[\ln\left(1-u_{it}\right)^{\beta} - \frac{1}{1-\beta}\sum_{j\neq i}\frac{rer_{ji,t}}{reer_{it}}\ln\left(1-u_{jt}\right)^{\beta}\right] - \left[\ln\left(\frac{EX_{it}}{E_{it}}\right) - (1-\beta)\sum_{j\neq i}\frac{rer_{ji,t}}{reer_{it}}\ln\left(\frac{EX_{ij,t}}{E_{jt}}\right)\right].$$

D Further Empirical Results

More results on the validity of the model and a number of statistical tests are available from the authors upon request. We report more shocks in labour market policies, also major diagnostics, i.e., weak exogeneity, number of cointegrating relations, residual correlations, and persistence profiles, computed for the benchmark Model I. Refer to Online Appendix for further results.

We start with the Figure D.1 where we plot changes in real exchange rate due to reforms in domestic active labour market policies implemented separately by each economy. There is a tendency for more and less open economies to cluster together. The wide heterogeneity in responses – both positive and negative sides – complies to the result in Section 4.1. According to the theory, there are three major channels at work: the effect through domestic productivity which alters firm's structure (non-exporters vs exporters), the direct effect on prices, and the indirect effect on prices of exportables through the changed productivity level.

D.1 Additional Models

There are no substantial differences in the results of the further models compared to Model I and II, reported in the main text.

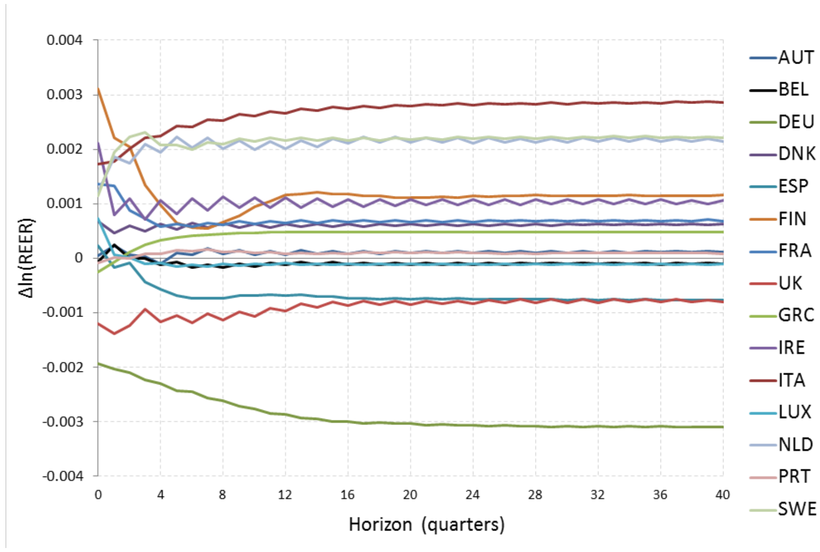
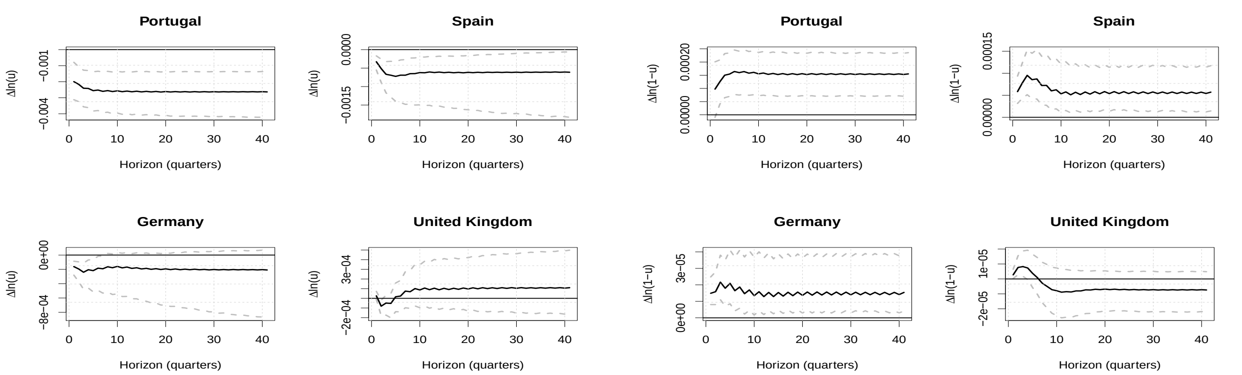


Figure D.1: Changes in REER due to shocks in domestic active labour market policies



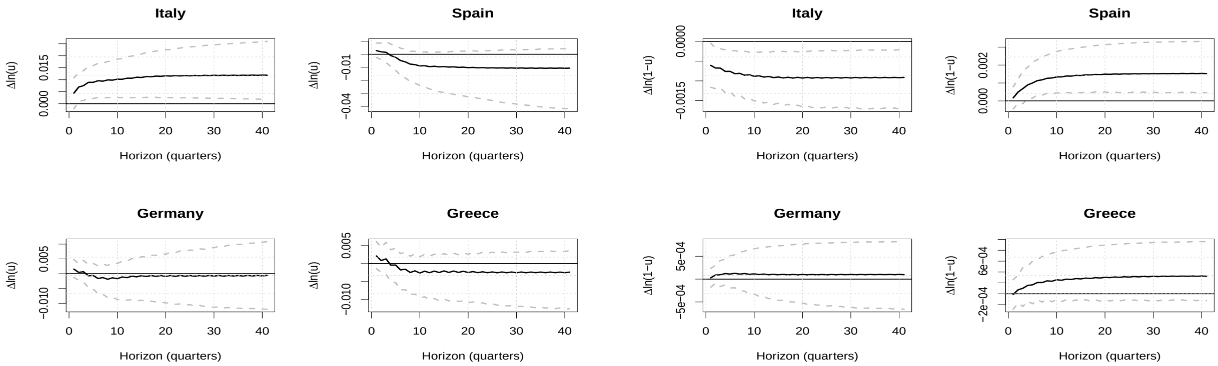
Model I ($\ln u_{it}$ **instead of** $\ln(1-u_{it})$) **Model III**

Figure D.2: Change in unemployment rate in various countries due the increase in expenditure on labour market policies in Portugal

First, note that the first part of the figure refers to Model I with employment being changed to unemployment. Therefore, one should expect opposite direction to what we saw on all other models. All the directions remain comparable for Model III in Figure D.2 – the only difference is that employment in Germany tends to increase significantly, thus making the spillover effect even more pronounced. The results for Model I with $\ln u_{it}$ are largely comparable with impulse responses looking "inverted" as compared to Model I.

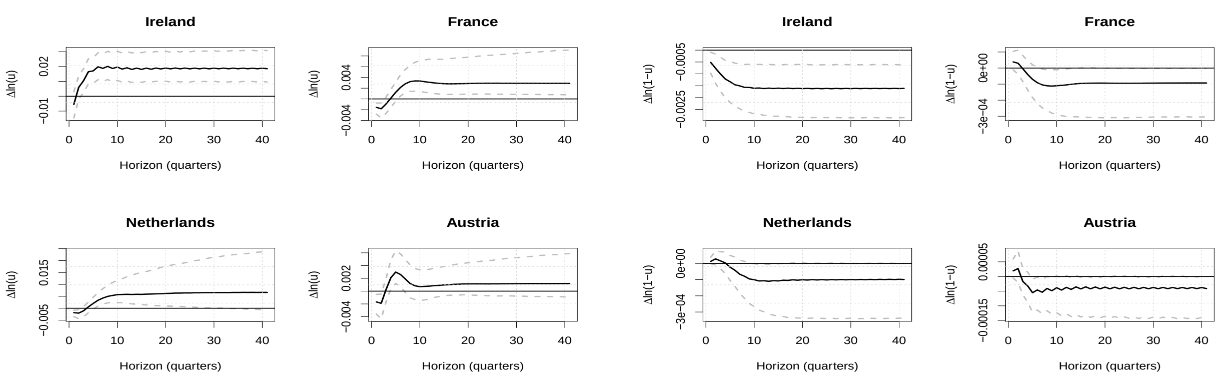
Similarly, Figure D.3 demonstrates that a higher tax wedge in Italy (difference in the employer's and employee's wage) decreases its employment but tends to increase employment in Spain. Somewhat positive effects are exerted on Germany and Greece but they are not significant. Similar significance with opposite directions remain true for Model I with unemployment.

Unemployment benefits, as before, affect Irish employment as well as spill over to other economies, where they tend to increase employment on impact, but later converge to a negative sign. Similar behaviour is reported in the model with unemployment – the impact is the reduction of unemployment but this effect is dominated by an increase in unemployment



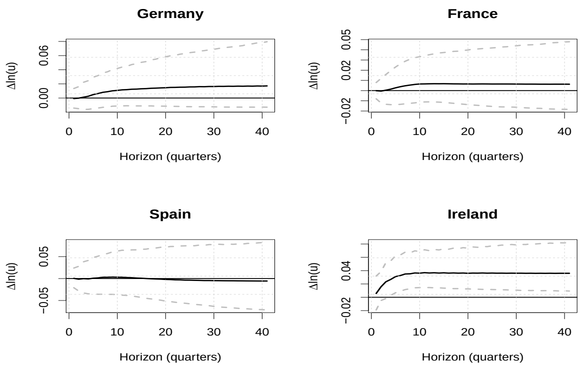
Model I ($\ln u_{it}$ **instead of** $\ln(1-u_{it})$) **Model III**

Figure D.3: Change in unemployment rate in various countries due the increase in tax wedge in Italy

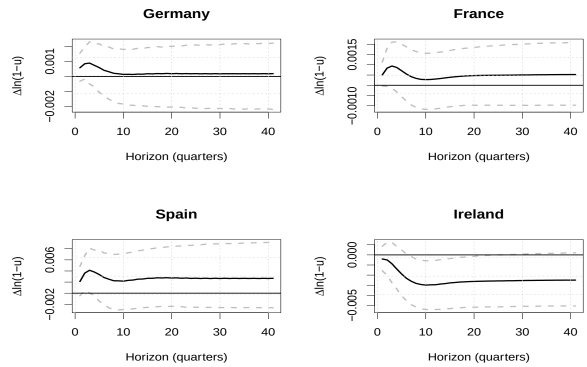


Model I ($\ln u_{it}$ **instead of** $\ln(1-u_{it})$) **Model III**

Figure D.4: Change in unemployment rate in various countries due the increase in unemployment benefits in Ireland



Model I ($\ln u_{it}$ **instead of** $\ln(1 - u_{it})$)



Model III

Figure D.5: Change in unemployment rate in various countries due the regional unemployment benefits shock

over time.

As in the main text, the regional shock is most pronounced on Ireland, but not significant for the largest European economies. The Irish economy has reacted more profoundly to the regional shock than to its individual one, consistent with the findings previously.

D.2 More Diagnostics

Table D.1: F statistics for testing weak exogeneity of foreign variables in the country specific models (Model I)

Country	F test's critical value (5% significance)	Foreign variables		
		GDP	REER	Employment
Austria	3.10	0.71	0.39	0.08
Belgium	3.95	0.00	0.00	1.69
Denmark	3.10	1.12	0.19	1.60
Finland	3.10	1.29	0.33	0.50
France	3.10	0.26	0.31	0.24
Germany	3.10	0.48	0.20	0.02
Greece	3.10	0.30	0.58	0.99
Ireland	3.95	1.59	0.08	0.09
Italy	3.10	1.63	1.97	0.30
Luxembourg	3.10	1.41	0.02	0.18
Netherlands	3.95	2.33	0.13	0.02
Portugal	3.95	0.34	0.26	1.26
Spain	3.10	1.18	1.17	0.78
Sweden	3.10	0.86	0.54	0.12
United Kingdom	3.10	2.91	2.23	0.20

Note: our country specific models do not include openness as a foreign variable, therefore we do not test weak exogeneity of openness.

Table D.2: Specifications of country specific models (Model I)

Country	VARX(p_i,q_i)		Cointegrating relations
	p_i	q_i	
Austria	2	1	2
Belgium	1	1	1
Denmark	1	1	2
Finland	2	1	2
France	2	1	2
Germany	2	1	2
Greece	1	1	2
Ireland	2	1	1
Italy	2	1	2
Luxembourg	2	1	2
Netherlands	2	1	1
Portugal	1	1	1
Spain	2	1	2
Sweden	2	1	2
United Kingdom	2	1	2

To achieve stability of the GVAR model the number of cointegrating relations was reduced in some countries from what was suggested by Johansen's test trace statistic. Specifically, we reduced the number of cointegrating relations in these cases: Ireland from 2 to 1, Greece from 3 to 2, and Spain from 3 to 2.

Table D.3: F statistics for testing residual serial correlation in country specific models (Model I)

Country	F test's critical value (5% significance)	Endogenous variables			
		GDP	REER	Employment	Openness
Austria	2.48	1.02	2.01	4.15	2.49
Belgium	2.48	0.97	0.22	2.73	1.24
Denmark	2.48	2.30	1.01	2.97	2.54
Finland	2.48	2.17	1.49	0.58	5.07
France	2.48	0.60	0.52	2.06	1.40
Germany	2.48	1.30	0.58	1.49	1.46
Greece	2.48	1.16	0.34	1.46	3.06
Ireland	2.48	0.52	0.54	5.97	0.30
Italy	2.48	2.39	0.78	0.87	2.87
Luxembourg	2.48	0.15	0.84	0.80	0.85
Netherlands	2.48	0.77	2.24	2.65	3.72
Portugal	2.48	1.01	0.39	1.08	2.63
Spain	2.48	2.54	2.66	0.38	1.71
Sweden	2.48	0.33	0.28	0.19	2.32
United Kingdom	2.48	0.56	1.47	1.32	2.70

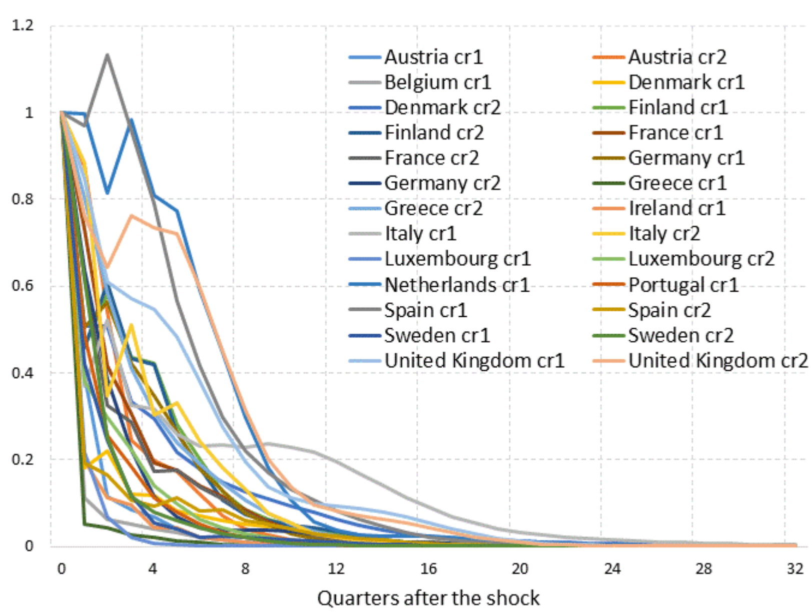


Figure D.6: Persistence profiles of the effect of system-wide shock to the cointegrating relations (Model I)