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Labour Market Reforms in a
Three-Country World**

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

Claudia Fries*

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Abstract

I extend the model-based literature on spillover effects of labour market reforms on foreign (un-)employment by allowing for third-country effects. When the workhorse two-country model is enlarged to include a third country, a reform causes an additional indirect effect through a terms-of-trade shift between the foreign countries. To quantify the increase or reduction in the overall spillover by means of this channel, simulations based on empirically realistic scenarios are carried out. Thereby, the indirect effect turns out to be too small to overturn the direct effect or to increase it considerably. Differences in the reform spillover effects between foreign countries are mainly due to differences in characteristics which influence the size of the direct impact.

JEL classification: E24, F42

Keywords: Spillover, labour market reforms, third-country effects, indirect effects, dynamic general equilibrium models

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1 Introduction

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

To be more specific, a successful labour market reform in the domestic country results in a relative abundance of domestic goods, implying a decrease in the terms of trade with each of its neighbours. This terms-of-trade effect leads to a positive spillover effect, i.e. to higher employment (and output) for the foreign economies, according to empirical evidence and the majority of model-based studies.¹ If the extent of the terms-of-trade decrease differs among trading partners e.g. because of differing intensities of bilateral trade relations, then the terms of trade between the trading partners themselves need to change as well. Thus, the overall effect of a domestic reform incurred by a neighbouring country consists of the sum of the direct effect generated by changes in the relation with the domestic country and the indirect effect caused by shifts in the relation with other countries. If the foreign country of interest experiences a stronger appreciation in its terms of trade with the domestic country than other countries, it also appreciates with respect to the other countries. In consequence, the aggregated spillover effect exceeds the direct effect. This aspect provides a potential explanation for the puzzle raised by Felbermayr et al. (2012). They claim that empirical evidence by Felbermayr et al. (2013) points to much higher spillovers than their model simulations.² However, if the relative prices of the other countries react stronger, the country of interest needs to depreciate with respect to these countries, creating an opposing effect. It cannot be ruled out a priori, that the indirect effect dominates the direct effect in certain cases, leading to a negative overall spillover.

In this study, the relevant impact factors for the direction and strength of the indirect as well as of the direct and overall effect are examined. The focus is not on the characteristics of the reforming country which have been studied in the two-countries literature but on the

¹Dao (2013a) and Felbermayr et al. (2013) investigate the spillover effects of labour market reforms empirically, based on cross-country panel data. Dao (2013a) evaluates the effect of foreign unit labour costs instrumented with statutory social security contribution rates on domestic employment. Felbermayr et al. (2013) test the impact of domestic and foreign tax wedges on the domestic unemployment rate. Busl and Seymen (2013) provide an overview of the model-based studies on international effects.

²Other model-based studies find spillover effects of a similar size as in Felbermayr et al. (2012), see Busl and Seymen (2013).

characteristics of its trading partners and in particular on differences between these countries which provoke indirect effects. Of course, this study is not the first to include indirect effects by modelling more than two countries. There are several studies based on medium to large scale multi-country models, see e.g. Everaert and Schule (2008) or Gomes et al. (2012), which analyse the (spillover) effects of labour or product market reforms. The scope of these studies is, however, to evaluate the outcome of specific reform scenarios. Thus, they do not address the composition of spillover effects including the relevance of indirect effects.³

The analysis is based on a standard international real business cycle model enhanced by several labour market institutions and fiscal policy parameters. In particular, involuntary unemployment results from search and matching frictions in the labour market. Wages are bargained between firms and workers and taxed on the employees' and employers' side. Crucially for the subject of interest, the economy consists of three countries. International spillovers occur through two channels in the model: international trade in intermediate goods and international financial assets. The main part of the analysis deals with the long-run, i.e. equilibrium, effects of a reform. Therefore, under the assumption that the current account needs to be balanced in equilibrium, only the trade channel matters for the transmission. Trade occurs as each country specialises in the production of its own good, whereas households consume a composite good, which is built up of the intermediate goods of all countries. The three-country setup offers the possibility to appropriately model bilateral and overall trade intensities simultaneously. This is not feasible in a two-country model, but important for a quantitative evaluation because of their influence on the size of the spillover effect. The financial channel matters when the dynamic response to a reform is explored in the last section, to allow for short-term current account deficits or surpluses.

The reform scenario, for which I evaluate direct and indirect spillover effects, is a change in the unemployment benefit scheme. To be specific, I consider a substantial reduction in the unemployment benefit ratio, which is inspired by a German example from the recent past, the so-called Hartz IV reform, and the related debate on the spillover and side effects of such reforms. However, given that the only transmission mechanism in the long run in the model is a change in terms of trade, the qualitative results of the study apply to all kinds of reforms which affect the terms of trade and thus the price competitiveness between countries.

I show that, similar to the results for the two-country scenario in Dao (2013a), a marginal increase in the terms of trade with the reforming as well as with other neighbouring countries triggers an increase in employment. The sign of the indirect effect depends on the direction of the change in the terms of trade with other affected countries. This, in turn, depends—as

³Felbermayr et al. (2012) also work with a three-country model, but they only consider symmetric neighbour countries. In consequence, a reform does not cause shifts between these countries.

well as the size of the direct and indirect effect—on the differences in country characteristics. Thus, I analyse the relevance of several country characteristics by simulating the reform for varying values of the corresponding parameters on an empirically meaningful scale. The baseline calibration is thereby orientated towards the European context and the German reform scenario. I find that the relative openness and bilateral import preferences of countries are of particular relevance for the size of the overall employment spillover and its components, in conjunction with their size. The initial unemployment rate, the unemployment benefit ratio, the capital share, the elasticity of matching, and the employee’s labour tax rate also matter for the magnitude of the overall spillover. However, the size of the indirect effect turns out to be very small in absolute terms. It is negligible vis-à-vis the direct effect in most simulations. In consequence, a negative indirect effect, which is e.g. obtained for relatively small and open countries, does not dominate the positive direct effect. This implies that the aggregated spillover is always positive. The relative size of the overall spillover effect, measured as the ratio between the change of employment in the country of interest and the reforming country, ranges between 0 and 11% for calibrations in an empirically realistic interval. The upper range, which is measured for a very specific calibration with extreme values, is therefore well above the average of 9%, estimated by Felbermayr et al. (2013) for a sample of rich OECD countries. But for an average European country, the spillover turns out to be well below at 1 to 2% (see Table 5).

The rest of the paper is structured as follows: in Section 2, I describe the model details and the baseline calibration of a symmetric three-country world. In Section 3, I briefly summarise the effects triggered by a reform of the unemployment benefit ratio in a symmetrically calibrated model. Subsequently, I explain the mechanism and composition of the direct and indirect spillover effects. The theoretical exposition is followed by a simulation-based analysis of the parameters driving the size and direction of the spillover components. Finally, Section 4 provides an exemplified analysis of the equilibrium effects and the dynamic responses to the German reform for different European countries, namely France, Belgium and Austria. Section 5 concludes.

2 The Model

The model framework builds on a standard international real business cycle model enhanced by search and matching frictions in the labour market, an international bond market and fiscal policy parameters. The model economy consists of three countries which are allowed to differ with respect to their size and their bilateral trade preferences. This property of the model crystallises particularly in the trade relations between countries. As in the two-country version, each country specialises in the production of an internationally traded intermediate

good. Following the preference patterns, the three intermediate goods are combined at the national level to a non-traded final good which is used for consumption and investment of households. This standard intra-industry trade framework maps the trade flows in the European environment in an appropriate way. Shifts in the relative prices of intermediate goods caused by a change in policy parameters are at the heart of the analysis of spillover effects in the following section. Since the focus of the analysis is mainly on the long-run implications of the model, I abstract from any price and wage rigidities.⁴

2.1 Households

Each country is inhabited by representative agents deriving utility from consumption.⁵ At the beginning of each period, agents in each country i maximise their expected lifetime utility without knowing whether they will end up unemployed or not:

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

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

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

$$\begin{aligned} (1 + \tau_i^c) P_{it}^c [N_{it}C_{it}^n + (1 - N_{it})C_{it}^u] + B_{it+1} + P_{it}^c CA_{it} = \\ = N_{it}P_{it}w_{it} (1 - \tau_i^d) + (1 - N_{it}) P_{it}^c b_i + B_{it} (1 + i_t) + T_{it} + \Pi_{it}. \end{aligned} \quad (2)$$

Thereby, household income is composed of labour income w_{it} , subject to taxes τ_i^d or unemployment benefits b_i , respectively, interest payments from bond holdings $B_{it}(1 + i_t)$, government transfers T_{it} and firm profits Π_{it} . Households spend their income on consumption, including a consumption tax τ_i^c , on new bond holdings B_{it+1} , and on a portfolio adjustment cost CA_{it} defined as

$$CA_{it} = \frac{\Phi_b}{2} \left(\frac{B_{it+1}}{P_{it}^c} \right)^2 \quad (3)$$

⁴These features would greatly improve the match with international business cycle statistics, though, as Patureau (2012) shows.

⁵To simplify the analytical analysis of spillover effects, employed persons are assumed to have no labour-leisure choice but to work a fixed amount of time instead. Thus, adjustments in the labour market occur only at the extensive margin.

that is scaled by the factor $\Phi_b > 0$.⁶ In equation (2), P_{it}^c is the price of the local final good while P_{it} represents the price of the local intermediate good. Note that the intermediate good of the domestic country where the reform occurs, i.e. of country 1, is chosen as numéraire, hence $P_{1t} = 1$. Finally, the law of motion of aggregate employment N_{it} is given by

$$N_{it+1} = (1 - s_i) N_{it} + \phi_{it}(1 - N_{it}), \quad (4)$$

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

Thus, the households' optimisation decision problem is summarised by the Bellman equation

$$F_{it}^H = \max_{C_{it}^n, C_{it}^u, B_{it+1}} [N_{it}U(C_{it}^n) + (1 - N_{it})U(C_{it}^u) + \beta E_t(F_{it+1}^H)] \quad (5)$$

which is subject to the budget constraint (2) (with λ_{it} being the Lagrange multiplier) and the law of motion of aggregate employment (4). The first order conditions with respect to consumption and bond holdings are then given by:

$$U'(C_{it}^n) = U'(C_{it}^u) = (1 + \tau_i^c) \lambda_{it} P_{it}^c \quad (6)$$

$$\lambda_{it} \left(1 + \Phi_b \frac{B_{it+1}}{P_{it}^c} \right) = \beta E_t [\lambda_{it+1} (1 + i_{t+1})]. \quad (7)$$

Note that condition (6) implies that the optimal level of consumption does not depend on the agents' employment status, i.e. $C_{it}^c = C_{it}^n = C_{it}^u$. This follows from the assumption of complete income insurance markets.

2.2 Final Good Sector

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

$$D_{it}^c = \left[\kappa_{ii}^{\frac{1}{\eta}} y_{iit}^{\frac{\eta-1}{\eta}} + \kappa_{ji}^{\frac{1}{\eta}} y_{jit}^{\frac{\eta-1}{\eta}} + \kappa_{ki}^{\frac{1}{\eta}} y_{kit}^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}, \quad (8)$$

where $\eta > 0$ is the elasticity of substitution between intermediate goods. y_{jit} denotes the quantity of intermediate input in the final good production of country $i = 1, 2, 3$ stemming

⁶The adjustment cost guarantees the stationarity of the model in the light of its incomplete financial market as discussed in detail by Schmitt-Grohé and Uribe (2003).

from country $j = 1, 2, 3$. $0 < \kappa_{ji} < 1$ is the preference of consumers in country i for products from country j and in particular κ_{ii} represents the preference for domestic goods in domestic spending, the so called home bias. I will refer to κ_{ji} as import or openness preference in the following.

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

$$y_{iit} = \kappa_{ii} \left(\frac{P_{it}^c}{P_{it}} \right)^\eta D_{it}^c \quad (9)$$

$$y_{jit} = \kappa_{ji} \left(\frac{P_{it}^c}{P_{jt}} \right)^\eta D_{it}^c \quad (10)$$

$$y_{kit} = \kappa_{ki} \left(\frac{P_{it}^c}{P_{kt}} \right)^\eta D_{it}^c, \quad (11)$$

where P_{it}^c/P_{it} represents the price of the final good in country i in terms of the intermediate good produced in the same country. I define the terms of trade of country i with any country j as the relation of its import to export prices, i.e. $TOT_{jt}^i = \frac{P_{jt}}{P_{it}}$. Taking the intermediate good demand functions and equation (8) together, the price relation P_{it}^c/P_{it} of country i results to be a combination of the terms of trade with its trading partners j and k :

$$\frac{P_{it}^c}{P_{it}} = \left[\kappa_{ii} + \kappa_{ji} (TOT_{jt}^i)^{\eta-1} + \kappa_{ki} (TOT_{kt}^i)^{\eta-1} \right]^{\frac{1}{1-\eta}} \quad (12)$$

2.3 Intermediate Good Sector

The intermediate good sector in each country consists of a continuum of firms who operate in a perfectly competitive market. Their Cobb-Douglas production function using domestic labour L_{it} and capital K_{it} as input reads as follows:

$$Y_{it} = A_i K_{it}^\alpha N_{it}^{1-\alpha}, \quad (13)$$

where $0 < 1 - \alpha < 1$ is the labour share of income. The level of technology A_i is kept constant as it is of no relevance for analysing the impact of political changes.

The profit of intermediate good firms Π_{it} is given by

$$\Pi_{it} = P_{it} Y_{it} - N_{it} P_{it} w_{it} \left(1 + \tau_i^f \right) - P_{it}^c I_{it}^c - \omega_i P_{it}^c V_{it} - P_{it}^c C I_{it} \quad (14)$$

where, on the cost side, the firm faces wage bills, hiring costs and investment adjustment costs. Labour costs include a payroll tax τ_i^f . Firms need to hire each period to adjust the size of the workforce which shrinks due to exogenous job separation. For each vacant job posted they incur a cost $\omega_i > 0$. The total number of posted vacancies is V_{it} . With q_{it} being the probability of finding an appropriate match, the number of successful matches in the

labour market leading to hirings H_{it} can be expressed as $q_{it}V_{it}$. Hence, we can rewrite the law of motion of aggregate employment in terms of vacancies V_{it} as

$$N_{it+1} = (1 - s_i) N_{it} + q_{it}V_{it}. \quad (15)$$

The costs of adjusting a firms capital stock CI_{it} are given by

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

where $\Phi_I > 0$ is a scaling parameter. The law of motion for capital K_{it} follows

$$K_{it+1} = (1 - \delta) K_{it} + I_{it}^c. \quad (17)$$

Firms' intertemporal optimisation problem with respect to capital and labour can be summarised as

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

subject to the production technology (13), the law of motion of capital (17) and aggregate employment (15).⁷ If we define the shadow price of capital $q_{it}^T = 1 + \Phi_I \frac{I_{it}^c - \delta K_{it}}{K_{it}}$ and $z_{it} = \frac{P_{it}^c}{P_{it}^c} (1 - \alpha) \frac{Y_{it}}{N_{it}}$, the optimality conditions are given by

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

$$\frac{\omega_i}{q_{it}} = \beta E_t \left[\frac{P_{it+1}^c \lambda_{it+1}}{P_{it}^c \lambda_{it}} \left\{ z_{it+1} - \frac{P_{it+1}}{P_{it+1}^c} w_{it+1} (1 + \tau_i^f) + (1 - s_i) \frac{\omega_i}{q_{it+1}} \right\} \right]. \quad (20)$$

2.4 Matching and Bargaining in the Labour Market

The technology of hiring by matching vacancies and unemployed persons follows Pissarides (2000)

$$H_{it} = \chi_i V_{it}^\psi (1 - N_{it})^{1-\psi}, \quad (21)$$

where $\chi_i > 0$ is a parameter that measures the efficiency of the matching process and $0 < \psi < 1$ denotes the elasticity of the matching function with respect to the vacancies. Each period, firms and workers bargain over wages w_{it} within a Nash bargaining framework. The outcome can be calculated by maximising the weighted marginal value of an additional employed in terms of utility for firms and households:

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

⁷The ratio of the future to the present Lagrange multiplier $\lambda_{it+1}/\lambda_{it}$ of household's budget constraint is used to weigh firms' future profit flows, since households are the owners of the firms.

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

$$\frac{\partial F_{it}^H}{\partial N_{it}} = \lambda_{it}(P_{it}w_{it}(1 - \tau_i^d) - P_{it}^c b_i) + (1 - s_i - \phi_{it})\beta E_t \left[\frac{\partial F_{it+1}^H}{\partial N_{it+1}} \right]. \quad (23)$$

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

$$\frac{\partial F_{it}^F}{\partial N_{it}} = P_{it}(1 - \alpha) \frac{Y_{it}}{N_{it}} - (1 + \tau_i^f)P_{it}w_{it} + (1 - s_i)\beta E_t \left[\frac{\lambda_{it+1}}{\lambda_{it}} \frac{\partial F_{it+1}^F}{\partial N_{it+1}} \right]. \quad (24)$$

Defining labour market tightness $\theta_{it} = \frac{V_{it}}{U_{it}}$, optimal labour contracts according to equation (22) imply

$$w_{it} = \frac{1 - \epsilon}{1 + \tau_i^f} \left[\omega_i \frac{P_{it}^c}{P_{it}} \theta_{it} + (1 - \alpha) \frac{Y_{it}}{N_{it}} \right] + \frac{\epsilon}{1 - \tau_i^d} \frac{P_{it}^c}{P_{it}} b_i. \quad (25)$$

2.5 The Government

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

$$\tau_i^c P_{it}^c C_{it}^c + \left(\tau_i^d + \tau_i^f \right) P_{it} N_{it} w_{it} = T_{it} + (1 - N_{it}) P_{it}^c b_i. \quad (26)$$

2.6 Equilibrium

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

$$\pi_1 Y_{1t} = \pi_1 y_{11t} + \pi_2 y_{12t} + \pi_3 y_{13t} \quad (27)$$

$$\pi_2 Y_{2t} = \pi_1 y_{21t} + \pi_2 y_{22t} + \pi_3 y_{23t} \quad (28)$$

$$\pi_3 Y_{3t} = \pi_1 y_{31t} + \pi_2 y_{32t} + \pi_3 y_{33t}, \quad (29)$$

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

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

$$D_{it}^c = C_{it}^c + I_{it}^c + \omega_i V_{it} + C I_{it} + C A_{it}. \quad (30)$$

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

$$\pi_1 B_{1t+1} + \pi_2 B_{2t+1} + \pi_3 B_{3t+1} = 0. \quad (31)$$

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

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

2.7 Baseline Calibration of Symmetric Countries

In my basic setup, I calibrate all three countries symmetrically to match quarterly German data. The parameter values of the baseline scenario are summarised in Table 1. I set the elasticity of substitution for capital α in the production function to 0.34, in line with German data for the past decade. In accordance with the literature, the steady state value of the capital depreciation rate δ is chosen to be 0.025. The discount rate of households is assumed to be $\beta = 0.99$, which according to equation (7) corresponds to an annual real interest rate in the steady state of about 4%. I choose $\epsilon = 0.5$ in line with other studies on labour market rigidities in Europe (see e.g. Dao, 2013b or Faia et al., 2013), which implies that the bargaining power in the Nash-bargaining is equally split between firms and workers. In keeping with the estimates of Petrongolo and Pissarides (2001), the elasticity of vacancies in the matching function ψ is likewise set to 0.5. The probability of filling a vacancy q is set to 0.7 which is at the lower bound of values used in the literature and therefore seems to be adequate for Germany and Europe.

In my baseline calibration, several parameters and steady state values of variables concerning the labour market are matched to German data from 2003, before the labour market reforms were introduced.⁸ The steady state unemployment rate is set to $1 - N = 0.098$ based on the annual harmonised unemployment rates from the *OECD Reference Series*. The steady state (un-)employment level together with the steady state output-capital ratio, derived from equation (19), give intermediate goods output and capital levels. The job finding probability ϕ is computed as the inverse of the average unemployment duration which, according to the German Federal Employment Agency (*Bundesagentur für Arbeit*), amounted to 9.53 month in 2003. The labour market tightness in the steady state is derived from the relationship $\theta = q/\phi$. The job separation rate results from the steady state condition $s = \phi(1 - N)/N$ obtained from equation (4) yielding $s = 0.034$, which is in accordance with empirical estimates (see Hobijn and Şahin, 2009, Gartner et al., 2012 or Kohlbrecher et al., 2013). Based on the steady state relationships in the labour market and the preceding calibration, the parameter for the matching efficiency χ can be calculated.

⁸While the Hartz IV reform only became effective in 2005, it was preceded by three reform laws concerning other aspects of the labour market coming into force in 2003 and 2004.

Table 1: Calibrated and Implied Parameter and Steady State Values

$1 - N$	Unemployment rate	0.098	b/w	Unemployment benefit r.	0.32
ϕ	Job finding probability	0.32	τ^f	Employers' labour tax	0.17
q	Vacancy filling probability	0.70	τ^d	Employees' labour tax	0.17
ψ	Elasticity of vacancies	0.50	τ^c	Consumption tax	0.16
ϵ	Bargaining power firms	0.50	β	Depreciation rate	0.99
α	Capital share	0.34	η	Elast. of substitution	
δ	Discount factor	0.025		btw. intermediate goods	1.5
Φ_I	Scal. invest. adj. costs	7	κ_{ii}	Home bias	0.7
Φ_b/NX	Scal. portfolio adj. costs	0.0038	κ_{ji}	Bil. import preference	0.15
s	Job separation rate	0.034	χ	Matching efficiency	0.47
ω	Vacancy posting cost	2.37	θ	Labour market tightness	0.45
π	Country size	1/3			

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

The steady state value of the unemployment benefit ratio b/w is set equal to the gross replacement rate (GRR) from the *OECD Benefits and Wages: Statistics* in 2003 in order to obtain b .⁹ I use data from several OECD publications (see Table 1) to calibrate employers' and employees' tax rates on wages (τ^f , τ^d) as well as the consumption tax rate τ^c . Given these parameters and the deterministic steady state of equations (20) and (25), the real vacancy posting cost ω can be computed.

The elasticity of internationally traded goods η is set to 1.5 as originally proposed by Backus et al. (1992). Central to the size of spillovers is the calibration of the Armington aggregator weights κ_{ij} , as the following analysis shows. The parameter defining the home bias of consumed products κ_{ii} is set so that the implied steady state import-to-GDP ratio matches the average import share observed in Germany vis-à-vis the world since the introduction of the euro, which corresponds to setting $1 - \kappa_{ii} = 0.3$.¹⁰ For simplicity, I assume that bilateral import preferences are all symmetric in the baseline scenario, i.e. $\kappa_{ji} = 0.15$ for $i, j = 1, 2, 3$ and $i \neq j$.

⁹The GRR data consist of unemployment insurance and unemployment assistance benefits and do not take tax and social security contributions on earnings and benefits into account. Furthermore, the GRR data are based on three different household types. They are a weighted average of the payments over the first five years of unemployment with the first year being weighted more heavily.

¹⁰Intermediate good prices are normalised to one in the deterministic steady state.

For a given output level, the openness preference parameters κ_{ii} and κ_{ji} and the elasticity η determine the demand for intermediate goods. The country sizes π_i are then given by means of equations (27)-(29), summarising the intermediate goods market equilibrium and the normalisation of the world size to one. Of course, in the symmetric baseline scenario all countries are of the same size, i.e. $\pi_i = 1/3$. The relation between the openness preferences and the country sizes implies that a country is the bigger, the larger its home bias κ_{ii} relative to the other countries. In contrast, more open countries are smaller. For the three-country case, asymmetries in bilateral preferences influence country sizes as well. The more a country imports from one country relative to another, the bigger is the first country in comparison to the second. The calibration strategy furthermore implies that the country size is influenced by the relative employment of a country. How the country size depends on the import preferences and employment of countries and how it varies if preferences of one country differ from the baseline case, is illustrated in Appendix A.

Following Patureau (2007), the scaling factor of capital adjustment costs is set to $\Phi_I = 7$, reflecting the volatility of investment (relative to output) in the G7 countries. By setting the ratio of the scaling parameter for portfolio adjustment of households and the steady state exports to $\Phi_b/NX = 0.0038$, as reported by Lane and Milesi-Ferretti (2002), the scaling parameter Φ_b can be calculated.

3 Spillover Effects in a Three-Country Model

The underlying reform scenario in the next subsections consists in a considerable cutback of the unemployment benefits. It is based on the German example of a reform in 2005 called ‘‘Hartz IV’’ which reduced the average unemployment benefit ratio by about 10 percentage points from originally 32 % (see Table 1). In the following the analysis, I focus on the steady state effects of the reform and discuss the factors influencing the direction and strength of spillovers to other countries. As short-run consequences may differ strongly from the long-run effects and are of great importance to get political support for reforms, the dynamic effects are discussed based on an example in the next section.

To start with, I briefly describe the effects of a reduction in unemployment benefits in the baseline setup, i.e. with countries which are all identically calibrated and therefore perfectly symmetric. This specification implies that no indirect effects take place as no shift in relative terms occurs between foreign countries, being all affected to the same extent. In the following subsections, I deviate from the baseline calibration. I analyse how asymmetry in various country characteristics influences the direct spillover effects from the reforming country and triggers indirect effects through a third country. First, I concentrate on asymmetries in the import preferences and the related country sizes. In the consequent experiments, the effect

of variations in other parameters is analysed.

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

3.1 Domestic and Foreign Effects in a Symmetric World

By assuming that all trading partners of the reforming country (labelled country 1) are identical, we obtain a scenario which resembles a two-country world since shifts in the relative prices between foreign countries do not occur. The domestic and foreign effects caused by the reform in the unemployment benefit ratio are only briefly summarised in the following. A more detailed description of reform effects in comparable two-country models is given in Busl and Seymen (2013) or in Dao (2013a).

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

Spillover Effects As the prices in the reforming country drop, the terms of trade of its trading partners (defined as export/import prices) improve. In this subsection, I assume that all trading partners are perfectly symmetric. This implies that the terms of trade change for all foreign countries by the same amount and relative prices, i.e. terms of trade, between these countries do not change. Therefore, all foreign countries are subject to the same direct

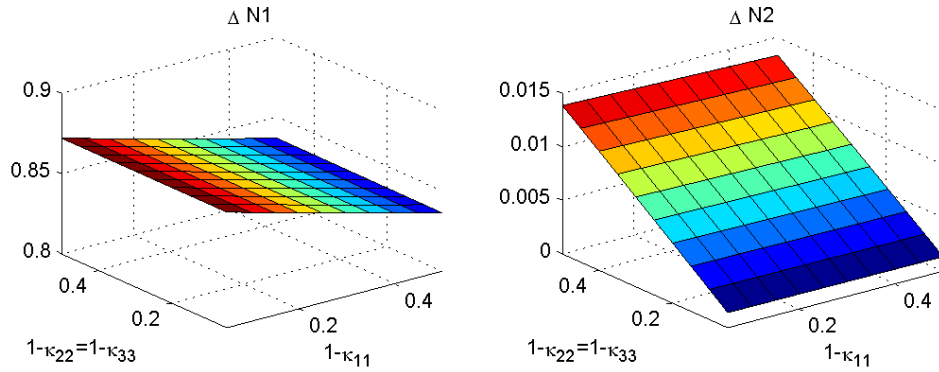
effects stemming from the price changes in country 1 described in the following. However, relative quantities between these countries are not affected by the reform.

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

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

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

The influence of openness and size of the reforming country has already been discussed in previous studies (see Felbermayr et al., 2012). In the present model, the size of a country is strongly linked to its relative openness (see discussion in Subsection 2.7). The size of country 1 decreases with its openness relative to its neighbours. As in Felbermayr et al. (2012) and Felbermayr et al. (2013), the openness and size of the reforming country play a role for the strength of effects at home and abroad. The more open country 1, the smaller the domestic and foreign effects on employment, although the response of foreign employment to the home bias in country 1 is minor. In contrast, if foreign countries are more open, the domestic and foreign effects on employment are strengthened, but the change in the domestic response is minimal. This finding is in line with the empirical results of Dao (2013a), according to which the degree of openness of the domestic country has no impact on the spillover size. It also matches the results of Felbermayr et al. (2013). They find in their model as well as in their empirical analysis that spillovers to more open/central economies (which are characterised by lower trade costs in their model) and to smaller economies are stronger. Figure 1 summarises the growth rates of domestic and foreign employment after the reform for varying overall openness preferences $1 - \kappa_{ii}$. The preferences of the domestic as well as of the foreign countries are allowed to assume values between 0.01 and 0.5, that is from a very small steady state import share of 1% to a share of 50% as e.g. observed in Belgium w.r.t. the other euro area members since the introduction



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

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

of the euro. If both foreign countries are very open, the spillover effect amounts to about 1.6% of the domestic effect, whereas the effect approaches zero for very closed countries. The same relation is observed for output and consumption (not shown), but for the latter changes in response to the countries own preference for openness are much more pronounced. The size of the output (consumption) spillover ranges from about 0.2% (1%) of the domestic effect for relatively closed countries to over 9% (300%) for very open countries.

- *Elasticity of substitution between foreign and domestic goods η :*

This parameter influences the reform effects at home and abroad. The lower η , the stronger is the adjustment in the composition of the final good after an exogenous shock. A greater change in the relative quantities of intermediate goods used to produce the final good implies a more pronounced change in the terms of trade. Therefore, the lower η , the stronger is the increase in output, consumption and employment abroad in the long run, whereas domestic effects are dampened. If country 1 is very open, i.e. there is a high preference for foreign intermediate goods, and the elasticity of substitution η between foreign and domestic goods is low, effects on domestic consumption can even be negative.¹¹ This result is of great relevance for the political feasibility of such a reform in small and very open countries. It also points to the fact that it is very important to model the trade preferences of a reforming country adequately to correctly evaluate reform effects. Unfortunately, the appropriate value for η is hard to

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

pick as there is no observable empirical counterpart available and Hooper et al. (2000), who estimate the income and price elasticities of exports and imports in the G7 on data until 1994, find it to lie in a broad range between 0.8 and 2.3.

3.2 Direct and Indirect Effects in an Asymmetric World

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

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

$$\epsilon_{N_2, TOT_1^2} = \frac{\kappa_{12}}{\omega_2} \frac{s_2 \psi}{\left(s_2 + \chi_2 \theta_2^\psi \right)} \frac{\epsilon \left(\frac{\alpha}{\frac{1}{\beta} - 1 + \delta} \right)^{\frac{\alpha}{1-\alpha}}}{\left[\frac{(1-\beta)(1-s_2)(1-\psi)}{\beta \chi_2} \theta_2^{1-\psi} + (1-\epsilon) \theta_2 \right]} > 0 \quad (32)$$

First, notice that this elasticity is always positive, which is in line with Dao (2013a)'s finding. She proofed that in a two-country world with labour market frictions, an increase in terms of trade for the foreign country always leads to a positive reaction of employment in that country. According to expression (32), import preferences towards country 1 κ_{12} and firms bargaining power ϵ have a positive impact on the elasticity. In contrast, the vacancy posting cost ω_2 and initial labour market tightness θ_2 decrease the response of employment to changes in terms of trade. A higher matching efficiency χ_2 and job survival rate $1 - s_2$ increase the elasticity of labour market tightness with respect to terms of trade $\epsilon_{\theta_2, TOT_1^2}$, whereas their impact on ϵ_{N_2, TOT_1^2} is ambiguous.

While the elasticity of employment w.r.t. a country's terms of trade can be pinned down analytically and its sign and driving factors can be derived unambiguously, the same cannot be said of the change in terms of trade caused by a reform, i.e. there is no analytical expression describing which parameters are relevant and how they impact the change in terms

of trade after a reform. Therefore, I defer the analysis of the factors influencing the resulting change in the terms of trade to the empirical quantification in the consequent subsections.

Indirect Effect If the foreign countries are not identical, the size of the marginal impact of terms of trade changes may differ between country 2 and 3, i.e. $\epsilon_{N_2, TOT_1^2} \neq \epsilon_{N_3, TOT_1^3}$. Furthermore, the extent of the depreciation of country 1's terms of trade with different trading partners may vary, i.e. $\Delta TOT_1^2 \neq \Delta TOT_1^3$. In this case, a contemporaneous shift in the terms of trade between the foreign countries, TOT_3^2 , occurs, which induces an additional indirect effect on N_2 . The size and sign of the indirect effect on N_2 depends on the size and sign of the change in TOT_3^2 and of the elasticity of employment in country 2 w.r.t. to TOT_3^2 , ϵ_{N_2, TOT_3^2} . This elasticity differs from equation (32) only in the import preference parameter in the nominator, where we have κ_{32} instead of κ_{12} (see Appendix C). Hence it is always positive as well. If country 2 has identical preferences for intermediates from country 1 and 3, i.e. $\kappa_{12} = \kappa_{32}$, a marginal change in the terms of trade with one of these countries has exactly the same effect on employment in country 2. While we know that country 2's terms of trade with country 1 always improve after the reform, thus yielding a positive direct spillover effect concerning employment, the same does not necessarily hold true for its terms of trade with country 3. These terms of trade appreciate if the relative prices of country 2 increase to a greater extent than the relative prices of country 3, otherwise they fall. In consequence, whether the indirect effect on employment in country 2 is positive or negative, depends on its relative change in terms of trade.

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

$$\Delta N_2 \approx \underbrace{\epsilon_{N_2, TOT_1^2} * \Delta TOT_1^2}_{direct\ effect} + \underbrace{\epsilon_{N_2, TOT_3^2} * \Delta TOT_3^2}_{indirect\ effect} \quad (33)$$

where Δx is the growth rate of x .¹² Based on equation (33), the total effect can be decomposed and the relevance of differences in country characteristics on the components of ΔN_2 can be separated. The key question is then which country characteristics induce a dampened spillover effect by creating a negative indirect effect, i.e. a decrease in TOT_3^2 and which enhance the spillover through a positive indirect effect. Furthermore, it is of interest how the relevant characteristics for the size and sign of the indirect effect impact on the direct effect. And finally, what are the quantitative implications for the overall spillover effect? How large or small can the spillover become and can the indirect effect possibly dominate the direct effect, turning the aggregated effect negative?

¹²It turns out that the approximation is relative precise in the following evaluations. I find all approximated values to be less than 1% above the true change in N_2 .

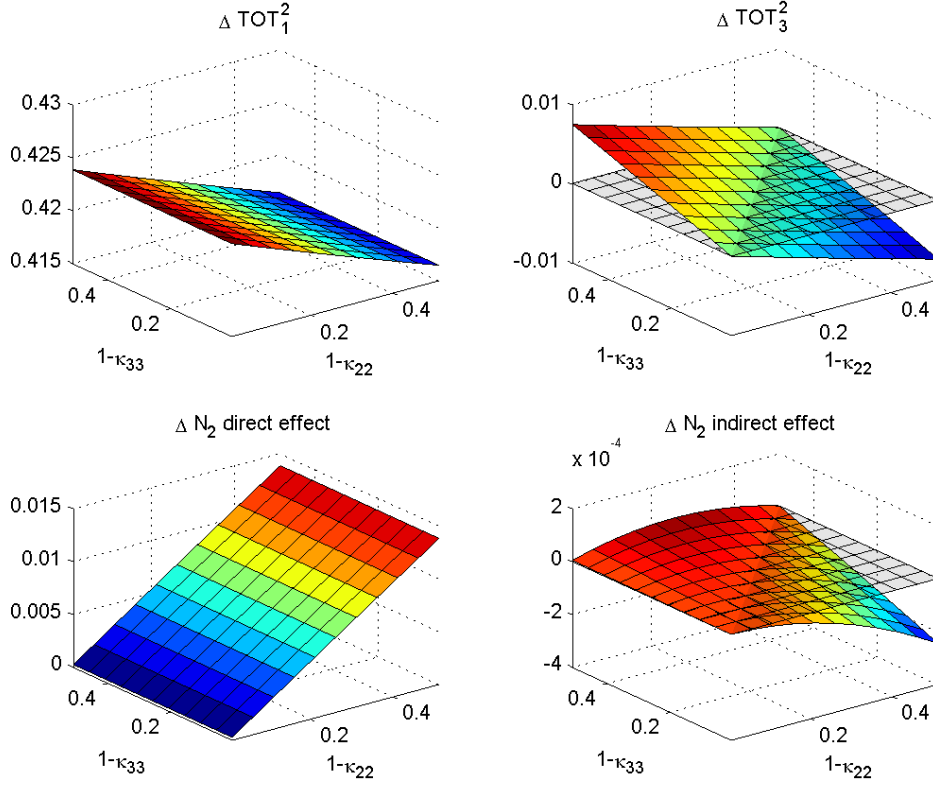
Simulation Procedure In the next subsections, I describe the impact of several country characteristics within their empirically relevant range on ΔN_2 . I proceed by updating the value of the selected parameter in the initial calibration of the model following the approach described in Subsection 2.7. Then, the effect of the reform for the newly calibrated model is calculated. This method entails that the implied parameter values, namely the job separation rate s , the matching efficiency χ and the vacancy posting costs ω , may adjust accordingly, especially when labour market related characteristics are subject of the analysis. The same applies for the country size when import preferences are varied. Alternatively, one could fix these parameters to their values in the baseline calibration and let the initial steady state values of unemployment, the job finding probability and the vacancy filling probability adjust. The drawback of this approach is that the resulting effects on employment between the single calibrations are not comparable anymore as the initial steady state (un-)employment level may differ. Therefore, I stick to the initial calibration assumptions.¹³

The results of the simulations are summarised in Table 2. The starting point is a detailed analysis of the importance of the openness and import preferences of the foreign countries. As these preferences have strong influence on the sign and size of the indirect effect and also on the size of the direct effect, I choose to tailor the consequent experiments to a more specific context. This consists of an open and sizeable reforming country, a small and very open country, for which I study the spillover effects, and a big rest of the world country with a strong home bias (trade within this aggregate is not of relevance). This scenario is far from the baseline case with identical import preferences and country sizes but is more suitable to answer applied questions about the drivers of spillover effects from one country to another, including third-country effects stemming from interaction with the rest of the world. One example is the analysis of the spillover effects of the German Hartz reforms to its neighbours in the European context, to which I refer in Section 4. The possibility to analyse such a scenario distinguishes the three-country model from the standard two-country models tailored for two large countries as well as from small open economy models. As such, the framework would also be suitable to analyse the implications of various reform scenarios discussed in Europe at the moment which need to be evaluated ex-ante as well as ex-post. Therefore, I investigate the impact of further country characteristics based on this asymmetric country constellation in the subsequent section.

3.3 Trade Openness

All asymmetries between country 2 and 3—whether in country 1’s preferences for goods from country 2 and 3 or in their own import preference parameters—have an impact on ΔTOT_3^2 .

¹³In addition, test simulations with this alternative calibration reveal that results do not differ fundamentally.



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

Figure 2: Decomposition of Spillover in Direct and Indirect Effects with Varying Degrees of Openness in Country 2 and 3

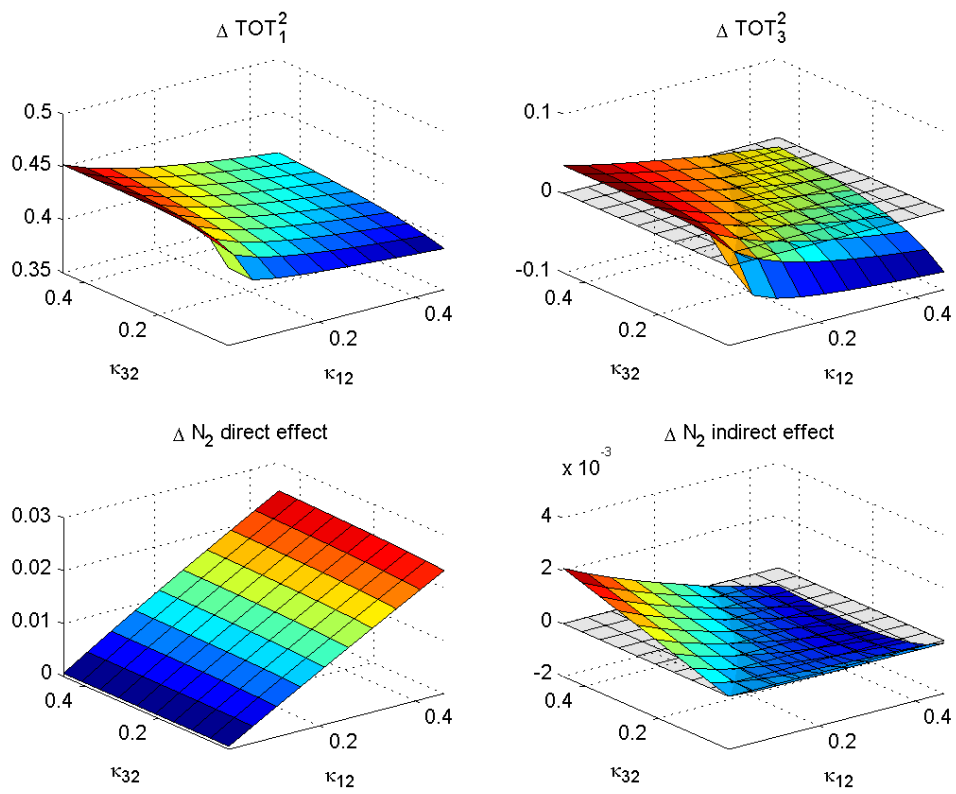
In other words, as long as country 1 has identical preferences for intermediates from country 2 and 3 ($\kappa_{12} = \kappa_{13}$), the trade relation between country 2 and 3 is symmetric ($\kappa_{23} = \kappa_{32}$), and these countries have symmetric preferences for the intermediate of country 1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

First, the impact of overall openness of country 2 ($1 - \kappa_{22}$) and country 3 ($1 - \kappa_{33}$) on the employment spillover to country 2 is analysed. While retaining the openness of country

1 as in the baseline calibration, i.e. $1 - \kappa_{11} = 0.3$, the preferences of country 2 and 3 take values between 0.01 and 0.5 as in Subsection 3.1. Thereby, the bilateral import preferences of each country are kept symmetric, hence $\kappa_{ki} = \kappa_{ji} = (1 - \kappa_{ii})/2$. In Figure 2 the upper two panels show the change of the terms of trade of country 2 with country 1 and 3 due to the reduction in unemployment benefits b_1 as a function of $1 - \kappa_{22}$ and $1 - \kappa_{33}$. The lower panels of Figure 2 show the changes in N_2 separated in the direct and the indirect effect. Recall that the model assumptions imply open countries to be smaller (in terms of output) than relatively closed economies. ΔTOT_1^2 decreases with increasing openness of country 2. The direct effect, in contrast, increases with $(1 - \kappa_{22})$ as the rise in the elasticity due to the increasing openness dominates the terms-of-trade changes. The panels on the right hand side demonstrate the importance of the relative openness and country size between country 2 and 3 for the direction of ΔTOT_3^2 and the indirect effect. For $1 - \kappa_{22} > 1 - \kappa_{33}$, which implies $\pi_2 < \pi_3$, the reform yields a stronger rise of TOT_1^3 than of TOT_1^2 and therefore triggers a depreciation of TOT_3^2 and in consequence a negative indirect effect. The opposite applies if country 2 is more open and bigger than country 3. Independent of the relative openness, the absolute change in TOT_3^2 is relatively small compared to TOT_1^2 . The same applies to the indirect effect compared to the direct effect. It reaches at most 1.75% of the direct effect. Thus, the aggregated effect is very similar to the direct effect. The size of the employment spillover measured relative to the effect in the domestic economy, i.e. $\Delta N_2/\Delta N_1$, ranges between close to 0% for very high κ_{22} and 1.6% for a very open country 2 whose import share adds up to about 50% of output.

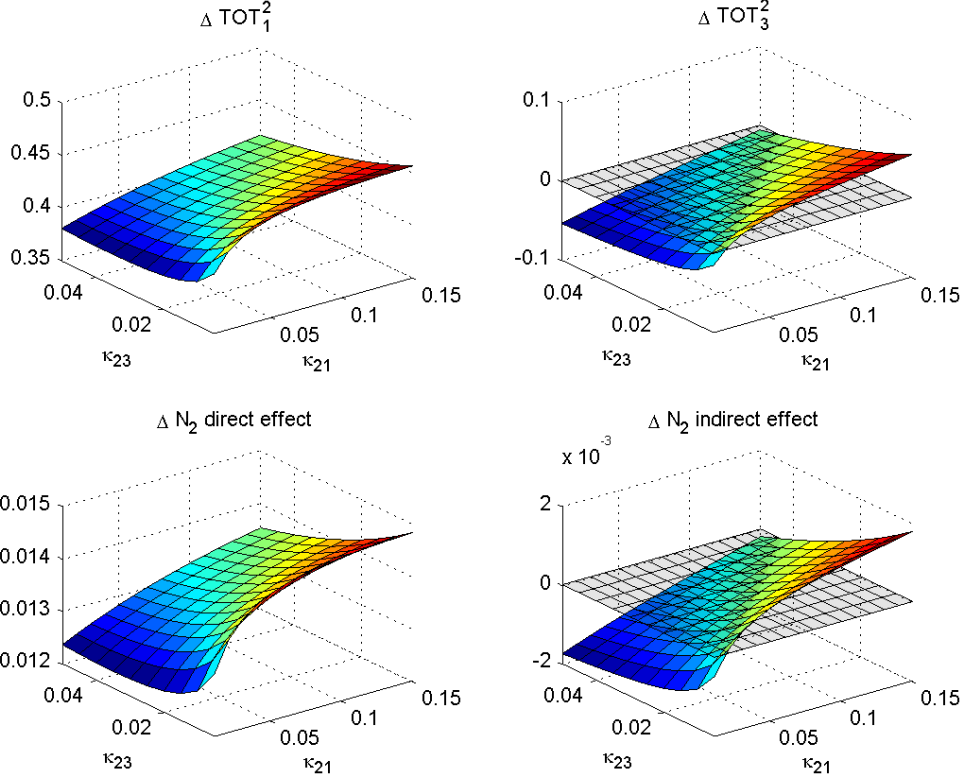
In the second step, the overall openness of country 3 is fixed to $1 - \kappa_{33} = 0.1$ as from now on country 3 is regarded as the large rest-of-the-world aggregate consistent with the empirical questions of interest. Figure 3 sheds light on the importance of the import preferences of country 2, κ_{12} and κ_{32} , which determine $\kappa_{22} = 1 - \kappa_{12} - \kappa_{32}$. Remember that ϵ_{N_2, TOT_1^2} increases in κ_{12} and ϵ_{N_2, TOT_3^2} in κ_{32} . This explains why the direct effect mainly depends on κ_{12} and rises with higher values of κ_{12} , whereas ΔTOT_1^2 decreases in κ_{12} and increases in κ_{32} . The indirect effect is most relevant for very small κ_{12} and relatively high κ_{32} , where it becomes several times as large as the direct effect. In contrast, it is negligible for a high import preference towards country 1 as it is dominated by a strong direct effect of close to 3%. Nevertheless, the absolute size of indirect effects is very small in all scenarios with a maximum value of 0.002%. The range of $\Delta N_2/\Delta N_1$ extends from close to zero for a very closed country 2, i.e. very small κ_{12} and κ_{32} , to about 2.9% for small κ_{22} (see Table 2).

Finally, I also fix $1 - \kappa_{22} = 0.5$, which implies that country 2 represents a country which is more open and smaller than the reforming country. In Figure 4 the import shares of country 1 and 3 from country 2 float up to half of their overall openness while κ_{13} and κ_{31} adjust accordingly. The lower the import preference of country 3, κ_{23} , the higher the



Notes: In this scenario $1 - \kappa_{11} = 0.3$ and $1 - \kappa_{33} = 0.1$. $\epsilon_{N_2, \text{TOT}_1^2}$ increases linear with growing κ_{12} , while $\epsilon_{N_2, \text{TOT}_3^2}$ increase linear with growing κ_{32} .

Figure 3: Decomposition of Spillover in Direct and Indirect Effects for Varying κ_{12} and κ_{32}



Notes: In this scenario $1 - \kappa_{11} = 0.3$, $1 - \kappa_{33} = 0.1$ and $1 - \kappa_{22} = 0.5$. Both elasticities, ϵ_{N_2, TOT_1^2} and ϵ_{N_2, TOT_3^2} , are constant in κ_{21} and κ_{23} .

Figure 4: Decomposition of Spillover in Direct and Indirect Effects for Varying κ_{21} and κ_{23}

direct and indirect effect. The higher the import preference of country 1, κ_{21} , the higher are both effects. In contrast to the other import preference parameters analysed before, κ_{21} and κ_{23} influence the direct and the indirect effect in the same direction. Hence, high direct effects are strengthened by the indirect effect, whereas low values of the direct effect are additionally reduced by the indirect effect. The variation in size of the direct effect relative to ΔN_1 ranges from 1.45% to 1.74%. The indirect effect is still small in comparison, amounting at the utmost to 15% of the direct effect and varying between -0.21% and 0.21% of ΔN_1 . Since ΔN_1 is lowest for high κ_{21} and low κ_{23} , the relative spillover size $\Delta N_2 / \Delta N_1$ reaches with 1.94% its highest values for this constellation. For weak import preferences of country 1 towards country 2 and strong preferences of country 3, the relative size of the effect goes down to 1.24%.

Summarising the results of this subsection, import preferences in conjunction with the country size have a strong impact on the relative and absolute size of spillover effects. Very

open countries having a strong trade relation with the reforming country are likely to be subject to the strongest spillovers. While the direct effects range between close to zero and 3% of the domestic effect, the indirect effects, whether they are positive or negative, are three to four orders of magnitude smaller than the domestic effect. In addition, the import preference parameters having the strongest impact on the size of direct and indirect effects, κ_{12} and κ_{32} , show an opposing impact on direct and indirect effects. Thus, the strongest direct effect is dampened by a negative indirect effect, whereas the weakest direct effect is strengthened by a relatively high positive indirect effect. As a result, negative indirect effects never overturn the direct effect, which yields a positive overall effect in all cases.

3.4 Further Country Characteristics

In the following, the impact of further characteristics of the foreign countries are discussed which are of relevance for the labour market outcome there. Equation (32) suggests that there are many parameters and initial conditions which could potentially have an impact on the direct and indirect spillover effect. I explore these characteristics separately, based on the previously introduced scenario with a small open second country ($\kappa_{22} = 0.5$), and a big and less open third country ($\kappa_{33} = 0.1$) representing the rest-of-the-world aggregate. The bilateral import preferences are assumed to be symmetric, i.e. $\kappa_{ji} = \kappa_{ki}$. This entails $\pi_1 = 0.22$, $\pi_2 = 0.13$ and $\pi_3 = 0.65$ everything else being symmetric as in the baseline calibration. Furthermore, the scenario implies that the indirect effect stemming from the reform is negative and amounts to a decrease in N_2 of 0.191 per mill (cf. Figure 2). While I check for the impact of characteristics of country 2 as well as of country 3 since both may be at the root of asymmetries, in the lower part of Table 2 only those of country 2 are summarised. This choice is based on the fact, that changes in the calibration of country 3 have in quantitative terms only a very limited or no influence at all on the size of employment spillovers to country 2. Detailed figures of the simulation results are provided in Appendix B. In the following, I discuss the consequence of differences in the country characteristics with a focus on those having a quantitative relevant impact.

- *Unemployment benefit ratio b/w :*

A higher level of unemployment benefits in country 2 strengthens the direct spillover effect to employment by increasing the elasticity of employment in response to the change in terms of trade with country 1 ϵ_{N_2, TOT_1} .¹⁴ Since ϵ_{N_2, TOT_3} rises as well, it contemporaneously leads to a stronger negative indirect effect, thus opposing the direct effect. Nevertheless, the aggregated effect is stronger for higher b_2/w_2 as indirect effects

¹⁴A higher unemployment benefit ratio implies a lower cost of vacancy posting for a given level of unemployment in a country.

Table 2: Summary of Simulation Results

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

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

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

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

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

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

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

^f (+ if $\kappa_{33} \ll \kappa_{22}$)

^g (+ if $\kappa_{12} \ll \kappa_{32}$)

only play a minimal role. For a generous unemployment benefit ratio of 40% in country 2, the relative size of the spillover $\Delta N_2/\Delta N_1$ amounts to 2.32%. Unsurprisingly, the unemployment benefit ratio of country 3 has only a slight impact on ΔTOT_3^2 but none on ΔTOT_1^2 as Figure 7 in Appendix B illustrates.

- *Pre-reform steady state unemployment level U :*

Similar to the unemployment benefit ratio, the unemployment rate in country 3 has only a minor impact on ΔTOT_3^2 and the indirect effect (see Figure 8). In contrast, a very high initial unemployment rate in country 2 of about 20% yields a strong change in employment with a direct effect of over 0.036%, a negative indirect effect of -0.002% and a high relative overall effect above 4%. This increase is on the one hand driven by level effects. Higher unemployment in the model is equivalent to a lower number of employed agents and therefore the same absolute change translates into a bigger percentage change based on a lower initial employment rate. On the other hand, a higher initial unemployment rate implies a higher job separation rate in the calibration which in turn leads to a higher responsiveness of N_2 with respect to terms of trade with country 1 and 3 on the simulated value range.¹⁵ For a very low initial U_2 (and high N_2 respectively) the direct and indirect spillover effect are very small.

- *Capital share α :*

Differences in the capital share of income are a very crude but simple approach to account for differences in production technologies between countries, which play an important role for competitiveness. The higher the capital share in country 2, the stronger is the response of employment to changes in the terms of trade on the simulated interval from 20 to 40%. This results in an increase of the absolute as well as the relative size of the spillover to employment as the indirect effect is with -0.7 per mill to 0.3 per mill negligible and the rise in ϵ_{N_2, TOT_1^2} overturns the in α shrinking appreciation of TOT_1^2 . Observe that α contemporaneously influences the relative country size: the country size decreases in capital share of the country. Since the capital share of country 3 diminishes the appreciation of country 3 on the one hand, and increases ΔTOT_1^2 on the other hand, by slightly increasing π_1 and π_2 , it has a small positive impact on the spillover size as well (see Figure 9). Overall, the changes in the absolute and relative spillover size caused by the capital share of both countries are not very pronounced. The relative spillover size ranges between 1.36% and 1.71%.

- *Elasticity of vacancies in the matching function ψ :*

A stronger impact on the relative strength of the spillover to employment is exercised

¹⁵Observe that a higher level of unemployment also implies a slightly smaller country size.

by the elasticity of the matching function ψ . If ψ_2 is well above the benchmark of 0.5, the relative spillover size approaches 2%. For values below 0.3, the relative spillover effect drops under 1%. Given the calibration, higher values of ψ on the value range from 0.2 to 0.8 lead to an increase in the elasticity of employment with respect to the terms of trade with both countries. Furthermore, for a given initial unemployment rate, job finding and vacancy filling probability, higher values of ψ imply a higher matching efficiency χ if the labour markets are not extremely tight, i.e. $\theta < 1$. Thus, the positive effect of ψ on the employment spillover is driven by an increasing direct effect which is marginally dampened by a negative and in ψ falling indirect effect (see Figure 10).

- *Employees' tax rate on wages τ^d :*

If the tax rate on wages paid by the employees in country 2 is higher at the time the reform in country 1 occurs, the overall spillover effect is higher too. Since the level of τ^d is taken into consideration, when wages are bargained (see equation 25), it negatively affects the calibration of the vacancy posting costs. Thus, a higher τ^d leads to higher elasticities of employment with respect to terms of trade which strengthen the direct as well as the indirect spillover effect (see Figure 11). The direct spillover increases from 1.45 to 1.80% of the domestic effect for a low tax rate of 1% to a very high tax rate of 31% while the indirect effect is only slightly affected. In contrast to τ^d , the tax rate employers pay on wages τ^f has no impact on spillover effects.

Unlike the country characteristics just discussed, the pre-reform steady state probability of finding a job ϕ and the bargaining power of the firm ϵ have quantitatively only a limited influence on the size of employment spillovers. A higher job finding probability implies a higher efficiency of matching χ in the model and thus decreases the vacancy posting cost of firms. The productivity increase due to the reform can therefore be mapped more efficiently into new jobs leading to an increase in foreign employment.¹⁶ This effect, however, is of negligible magnitude even for a very high initial probability as reported in Table 2. Similarly, strong changes in the level of ϵ_2 only have a small impact on the aggregated spillover effect, with higher levels of ϵ_2 leading to a slightly higher impact of the reform on foreign employment (see equation 32). The reason is that more of the reform induced productivity gain in country 2 is used to increase employment (in place of wages) if firms have a stronger standing in the Nash bargaining.

To summarise the results for the non-trade related country characteristics, the indirect effect is in most cases very small compared to the direct effect. It reaches 4% of the direct

¹⁶The result resembles a finding by Dao (2013a), that a higher degree of labour market rigidity in a foreign country (introduced by assuming a lower initial job finding rate) leads to higher spillover effects.

effect for a high initial unemployment rate or a high capital share of country 2. Furthermore, in most cases it opposes the direct effect in the sense that it assumes its lowest negative value for a parametrisation where the direct effect is at its maximum and adds positively to the direct effect when it is relatively low. This result implies that the aggregated spillover effect, which is given by the sum of the direct effect and the indirect effect, is positive in all simulations which matches the result of empirical studies by Felbermayr et al. (2013) and Dao (2013a).

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

In the preceding simulations, I started from a specific country scenario and varied one parameter at a time. I found that the relative size of the aggregated spillover effect measured as the ratio between the change of employment in the country of interest and the reforming country ranges between 0 and close to 4% for calibrations in an empirically realistic range. If I use the value from the tested (empirically plausible) range for which I obtained the strongest overall spillover for all analysed parameters and initial conditions,¹⁷ the relative size of the aggregated spillover is more than 11%. This value exceeds the average of 9% estimated by Felbermayr et al. (2013). Thus, under certain conditions the model is able to generate employment spillovers which reach the empirically found average. The driving force of these high spillovers are, however, high direct effects, but not strong positive indirect effects.

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

The three-country framework has an additional advantage over the two-country set-up: in the latter, the trade balance and net foreign asset position of one country has always to

¹⁷I choose $\kappa_{21} = 0.29$, $\kappa_{31} = 0.01$, $\kappa_{12} = 0.4$, $\kappa_{32} = 0.1$, $\kappa_{23} = \kappa_{13} = 0.05$, $U_2 = 0.2$, $\phi_2 = 0.75$, $b_2 = 0.4$, $\tau^d = 0.3$, $\epsilon_2 = 0.8$, $\psi_2 = 0.7$ and $\alpha_2 = 0.4$.

be a perfect mirror image of the second country as the country pair represents the world. A three-country model breaks this strong link between the single countries since effects in the first country do not necessarily trigger effects in the second country. It allows to map bilateral *and* overall trade intensities at the same time as highlighted by Kose and Yi (2006), and is thus the appropriate framework to assess the size of bilateral spillover effects. This becomes evident in the following when presenting the model implications of the reform in the unemployment benefit scheme for three scenarios taking differing German neighbours, namely France, Belgium and Austria, as second country and assuming the third country to be the rest of the euro area 12 (EA12) countries (RoEA in the following). Even though the model is highly stylised, considerable differences between the single countries emerge. The three scenarios demonstrate how strongly the model predicts spillovers to vary in the long as well as in the short-run between heterogeneous countries in empirically relevant scenarios. France, Belgium and Austria are assumed to differ with respect to their calibration of labour market institutions and fiscal policy parameters as summarised in Table 3. While Belgium and France are relatively similar in most aspects, Austria's labour market situation differs strongly with a lower unemployment rate, average unemployment duration and unemployment benefit ratio. With exception of the trade preferences, Germany is parameterised as described in Subsection 2.7. The import preferences parameters for the different scenarios are calibrated to correspond to the respective import shares given in Table 4. In contrast to France, Austria and Belgium are very open countries with a home bias κ_{ii} of only 0.74 and 0.52 respectively. Both have a high import share with respect to Germany, but while Austria's trade relationship is strongly focused on Germany, Belgium trades also heavily with the RoEA. The country sizes implied by these import shares are close but not identical to the countries' GDP weights in the EA12.

The equilibrium effects of the reduction in the unemployment benefit ratio in Germany for Germany and the respective second country are summarised in Table 5. In the long run, the reaction of France resembles much that of the RoEA,¹⁸ whereas spillovers to Belgium and Austria, depending on the outcome of interest, are two to three times the size of the RoEA or France. With respect to employment, I find the spillover effect to the second country to range between 0.3% and 0.8% of the original effect in Germany. France's labour force is the least affected, although its terms of trade change to the same extent as the Belgian.¹⁹ The

¹⁸The results for the three differing EA aggregates vary only slightly with the composition of the RoEA and are very similar to the result for France. Therefore, I refrain from reporting them.

¹⁹Since labour market and fiscal institutions are very similar within these countries, the virtually identical terms-of-trade effects point to the fact that the effects stemming from differences in import preferences cancel out. In particular, the higher Belgian preference for German goods ($\kappa_{12}^{BG} > \kappa_{12}^{FR}$) and German preference for French goods ($\kappa_{21}^{FR} > \kappa_{21}^{BG}$), which would both imply that the French terms-of-trade effect should be higher according to the analysis above, counterbalance the higher Belgian preference for RoEA goods ($\kappa_{32}^{BG} > \kappa_{32}^{FR}$)

Table 3: Calibration of Heterogeneity in the Labour Market Institutions and Fiscal Policy

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

Notes: All numbers are in percentage points except the average duration of unemployment which is given in months and refer to the year 2003 if not stated otherwise.

^a EA average unemployment rate as published by the OECD including Germany.

^b The Belgian as well as the EA average duration of unemployment are approximated by the average duration of unemployment in the EU as published by the OECD owing to a lack of more precise data.

^c 2004 values.

^d These rates are calculated as EA-12 averages excluding Germany using GDP weights at PPP exchange rates of the corresponding year.

Sources: OECD Reference Series, INSEE, OECD Labour Market Statistics, OECD Benefits and Wages: Statistics, OECD Taxing Wages 2003, OECD Recent Tax Policy Trends and Reforms in OECD Countries 2004.

Table 4: Bilateral Import Shares

From				From			
To	Germany	France	RoEA	To	Germany	Belgium	RoEA
Germany	0.8777	0.0248	0.0975	Germany	0.8777	0.0175	0.1048
France	0.0450	0.8661	0.0888	Belgium	0.1359	0.5193	0.3448
RoEA	0.0615	0.0300	0.9086	RoEA	0.0521	0.0189	0.9290

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

Notes: RoEA refers to the EA12 excluding Germany and the respective second country. The reported import shares are mean values over the period 1999-2012.

Sources: IMF Direction of Trade Statistics, World Bank World Development Indicators.

lower responsiveness of employment in France is driven by its less intense trade relationship with Germany relative to Belgium and Austria combined with its bigger country size which implies a smaller relative change in the traded quantities. In Austria, the country specific import preferences lead to a lower responsiveness of terms of trade in comparison to Belgium which is mainly due to stronger preference for RoEA goods in Belgium. The relatively less pronounced reaction of terms of trade due to the import preferences is partially countervailed by a better labour market situation and lower unemployment benefits which induce *ceteris paribus* a stronger increase in the terms of trade vis-à-vis Belgium and France. Because of its strong trade relation to Germany, which outstrips Belgium, and its very small country size, Austria is subject to the strongest percentage changes in terms of output, consumption and wages. Employment, on the contrary, is affected to a weaker extent than in Belgium percentage-wise since it improves from a very high pre-reform level (see Table 3). To give a complete picture of the composition of the spillover effects, the elasticities of employment with respect to the terms of trade calculated at the initial steady state are listed in the lower part of Table 5. Multiplying these elasticities with the respective terms-of-trades changes, reveals that the indirect effects, whether positive or negative, add less than 1% to the direct effect. For France and Belgium we observe a small appreciation vis-à-vis the RoEA. Obviously the strong import preferences of Belgium for German as well as for RoEA and RoEA preference for French goods ($\kappa_{23}^{FR} > \kappa_{23}^{BG}$), which in turn point to a higher terms-of-trade effect in Belgium.

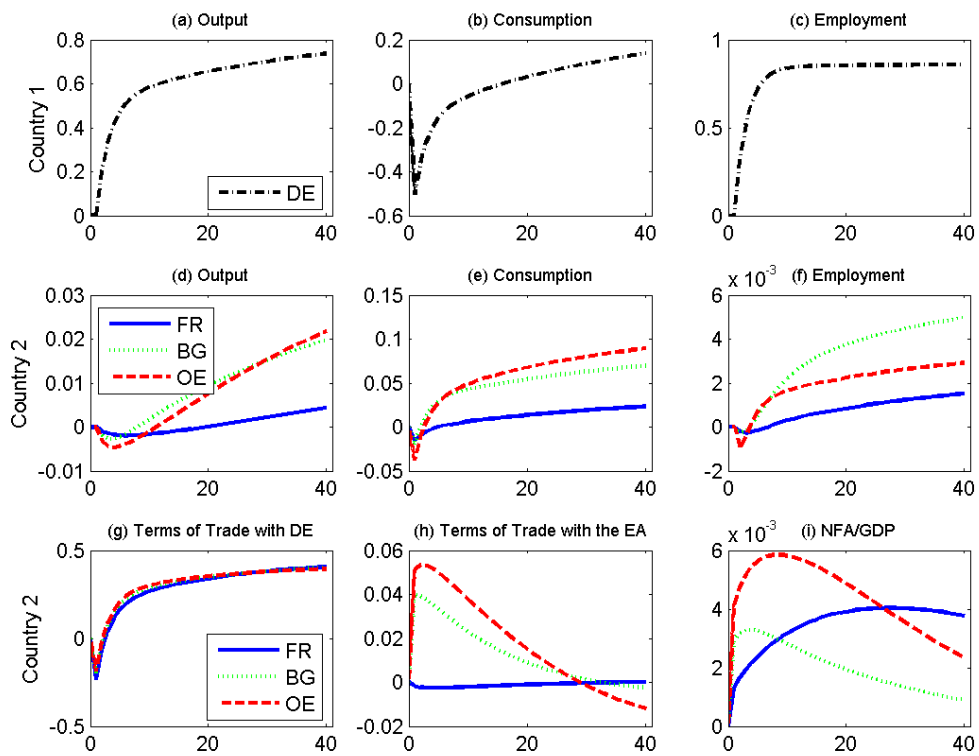
Table 5: Percentage Change in Steady-State after a Reduction in b_1

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

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

products yield a higher elasticity with respect to both terms of trade according to equation (32). Thus, direct and indirect effect on employment are higher compared to France. The tighter Austrian labour market leads to a lower responsiveness of employment to changes in terms of trade there, even though κ_{12} is comparable between Austria and Belgium and κ_{32} between Austria and France. Interestingly, the indirect effect in Austria is negative, i.e. the terms of trade between Germany and Austria are less affected by the reform than between Germany and the RoEA. The negative effect stems from the relative large overall openness of Austria ($\kappa_{22} > \kappa_{33}$, compare Figure 2) and its strong focus on German imports ($\kappa_{12} > \kappa_{32}$, compare Figure 3) in contrast to France and Belgium. Thus, these import preferences imply a depreciation versus the RoEA, but at the same time strong κ_{12} and low κ_{32} mean a higher elasticity for the direct effect and a lower impact of the indirect effect.

The short-run response of selected variables is summarised in Figure 5. The first row shows the adjustments of output, consumption and employment of country 1, i.e. Germany, after a decline in its unemployment benefit ratio by 10 percentage points. Domestic employment and output rise monotonously whereas consumption initially drops due to a reduction in household income and intertemporal preferences, recovering slowly afterwards as described in Subsection 3.1. While the major adjustments in employment occur in the first two years, consumption and output approach the new equilibrium much slower. The same outcomes of country 2 are displayed in the second row of Figure 5 for the three scenarios where country 2 is calibrated to French, Belgian and Austrian data. The third row contains the impulse responses of these countries' terms of trade with Germany and with the RoEA and their net



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

Figure 5: Adjustments in Country 1 and 2 after a Reduction in b_1

foreign asset position as a share of their output. The reduction of unemployment benefits in Germany induces its relative prices with its trading partners to shift. As plot (g) reveals, the long-run appreciation of foreign terms of trade is preceded by a short initial depreciation. This development causes an initial small drop in employment abroad (plot f). Since in the first years after the reform the reaction of Austrian and Belgian terms of trade is stronger than that of the RoEA, these countries appreciate vis-à-vis the RoEA as displayed in plot (h). In contrast to equilibrium, in the short run the third-country terms-of-trade effects are sizeable, amounting to more than 10% of the direct terms-of-trade effect with Germany in these two countries. Thus, they tend to dampen the negative effect on employment.²⁰ For France, being very similar to the RoEA, we observe only a minimal effect on its terms of trade with the RoEA in the short run.

Thus, Austria as a very small country with a strong trade relationship to Germany is initially hit strongest by the adverse effects and profits most in the long run, at least in terms of output and consumption, by the German reforms. In addition, adjustments occur faster in this country as its labour market is tight and unemployment benefits at a low level compared to the other countries. This reflects also in the Austrian net foreign assets as share of output which is initially higher than in the other countries but reverts also fast, especially in comparison to France.

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

5 Conclusion

In this study, I explored the size of spillover effects to employment in a foreign country after a labour market reform in the domestic country. In contrast to previous studies, which mainly focus on two-country scenarios, my analysis considers the presence of a third (large) country. Thus, it explicitly includes indirect spillover effects caused by shifts in the relation of the country of interest and a third country in addition to the direct spillover effect stemming from shifts between the country of interest and the domestic country. In order to assess the direction and strength of these spillover components, I conducted simulations

²⁰In the short run, the impact of the adjustment in terms of trade on employment deviates from the steady state approximation of equation (33). The deviations occur as, on the one hand, out of steady state additional transmission effects arise from the international bond market and, on the other hand, the steady state conditions used when calculating elasticities with respect to terms of trade do not necessarily hold during the convergence process towards the new steady state which does not occur at the same speed for all variables. The out-of-steady-state change in employment in the second country can therefore not simply be decomposed in a direct and indirect effect stemming from the changes in terms of trade.

based on a standard international RBC model with search and matching frictions in the labour market expanded to include a third country. I found that the aggregated spillover size measured relative to the effect in the domestic country may be sizeable. It reaches the empirically estimated size documented by Felbermayr et al. (2012) of about one-tenth for specific country characteristics. Variation in the size of the spillover effects stems, however, mainly from changes in the size of the direct effect. The indirect effect turns out to be small in all calibrations. Hence, neither does it strongly increase the direct effect nor overturn the direct effect to yield a negative aggregated effect.

This result must be interpreted in the light of mechanisms included in the model. The direct and indirect spillover effects in the model are based on shifts in terms of trade, thus on competitiveness in terms of intermediate goods prices. The model does not capture non-price competitiveness factors like product quality. These play an important role in international competition as the study by Estrada et al. (2013) demonstrates and may, therefore, be of relevance for the size of third-country effects. The model also abstracts from shifts in import preferences which may be triggered by a reform. As the simulation results of Subsection 3.3 have shown, these preferences have a big influence on the size of spillover effects. Finally, in the discussion on third-country effects, differences in the sector structure and specialisation between countries may also play a role for the size of direct and indirect effects. I only consider differences in the capital share in the production as a rough approximation. But these do not have major effects on the strength of direct and indirect spillovers. An alternative approach to take structural differences into account is an explicit modelling of a non-tradeable vs. tradeable sector as in Helpman and Itskhoki (2010). Such an extended model could provide additional insights and would therefore be a sensible extension of this study. Furthermore, medium to large-scale policy oriented models such as the QUEST model by the European Commission (Ratto et al., 2009) or the EAGLE model by the European Central Bank (Gomes et al., 2012) typically include three or more countries and allow therefore for indirect spillover effects. It would be interesting to evaluate the magnitude of the indirect effects in such models, as they are not explicitly discussed and quantified in studies like Gomes et al. (2011) or Kollmann et al. (2014).

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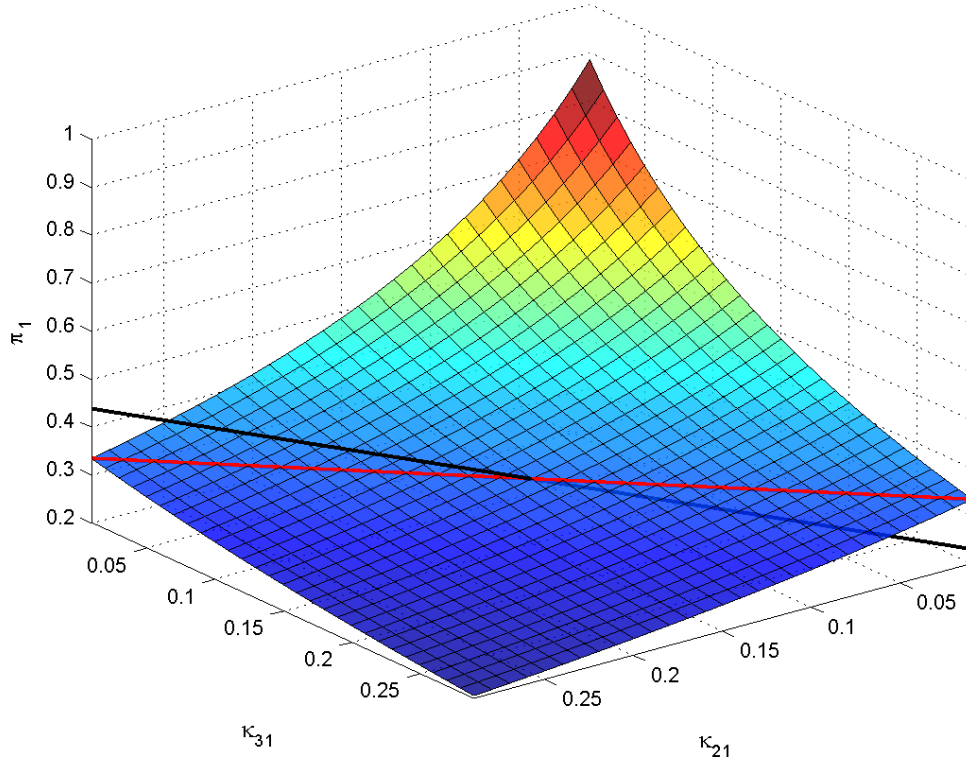
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A Country size

Taking the deterministic steady state of equations (9)-(11) and (27)-(29) and the condition that the value of intermediate goods output equals the value of final goods output in each country and combining them, the size of country 1 can be expressed as a function of relative employment and import preferences:

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

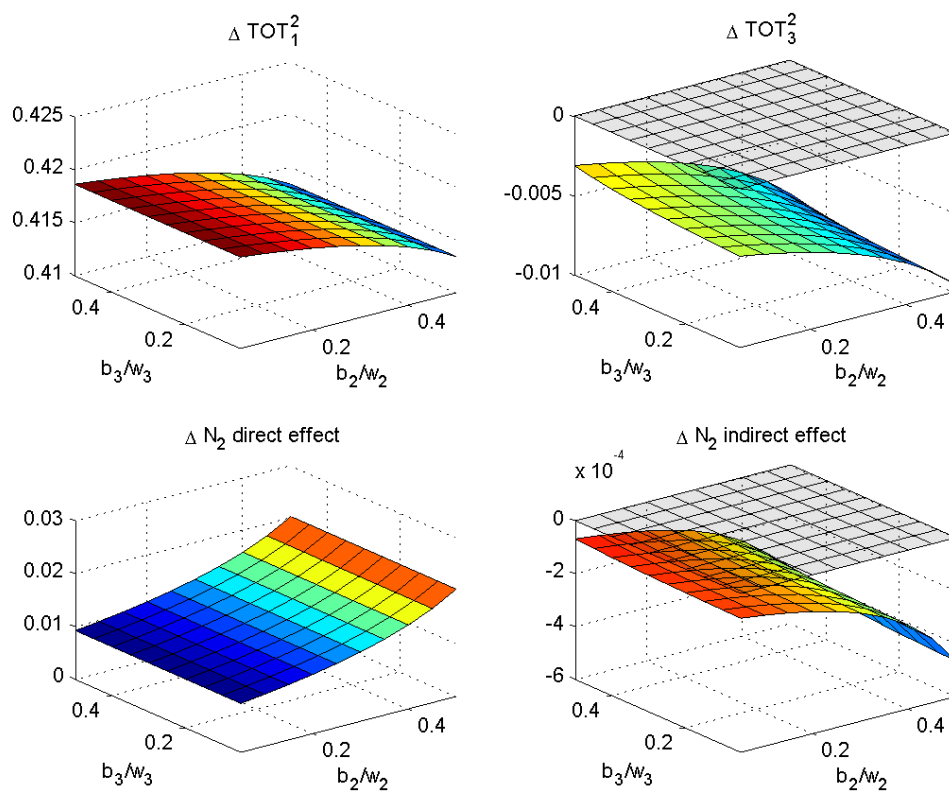
This equation implies that the size of country 1 depends positively on foreign employment N_2, N_3 , its home bias κ_{11} , and the import preferences of the other countries with respect to the domestic good, κ_{12} and κ_{13} . Domestic employment N_1 and import preferences of country 1 for the intermediate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



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

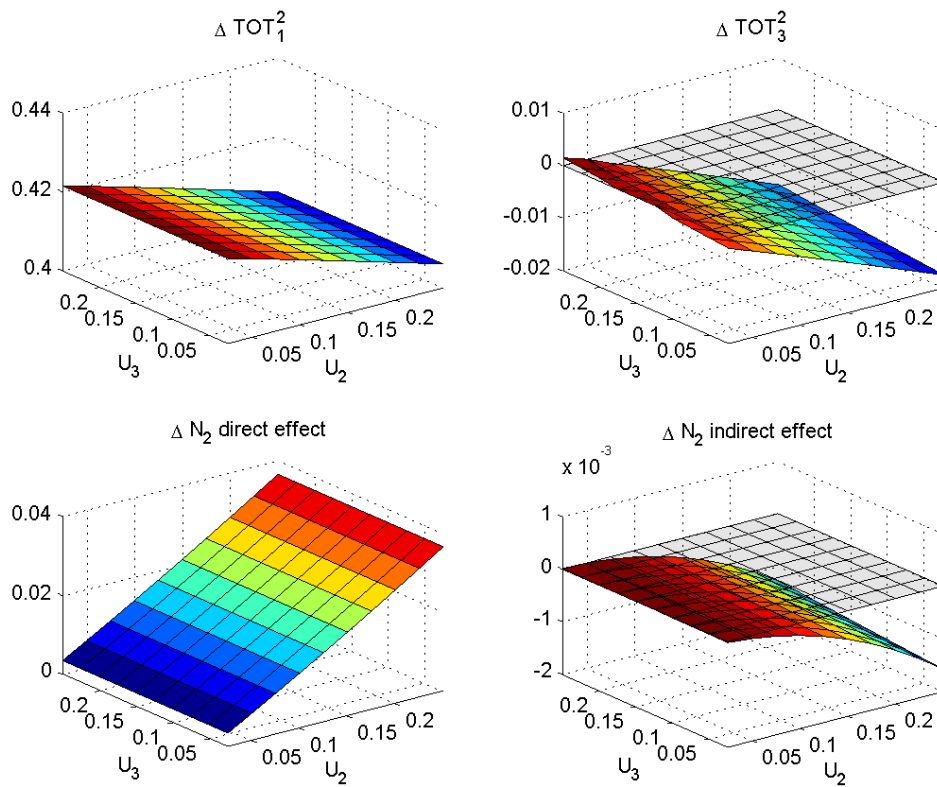
Figure 6: Relation between Country Size and Openness Preferences

B Graphical Appendix



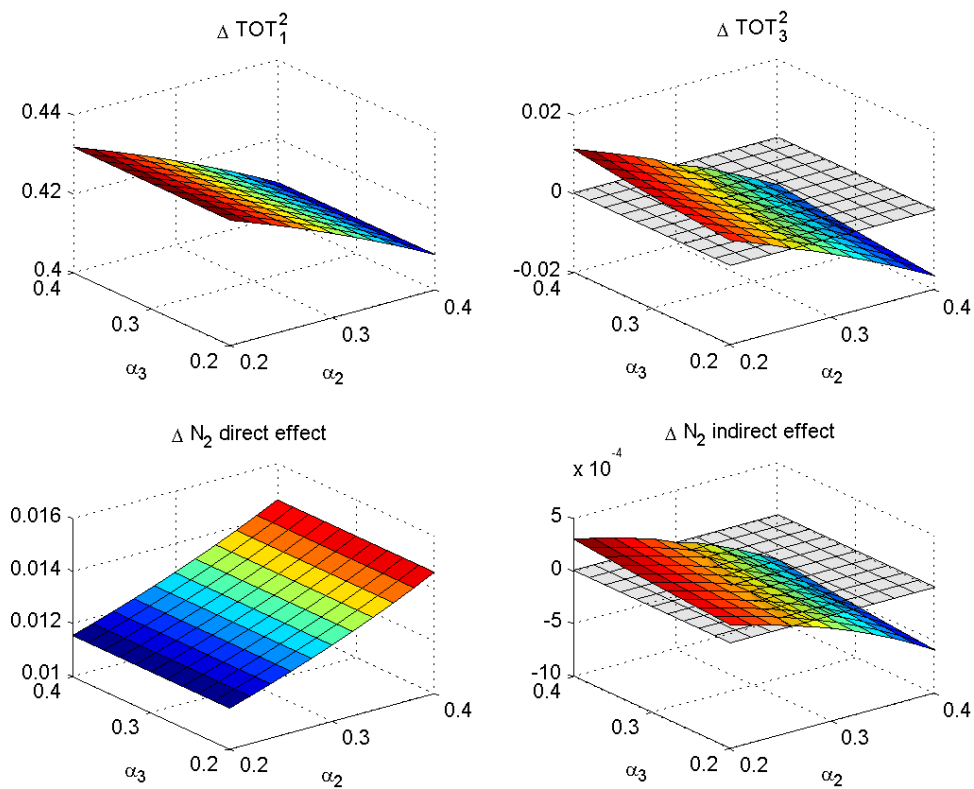
Notes: In this scenario $1 - \kappa_{11} = 0.3$, $1 - \kappa_{33} = 0.1$, $\kappa_{13} = \kappa_{23} = (1 - \kappa_{33})/2$ and $1 - \kappa_{22} = 0.5$, $\kappa_{12} = \kappa_{32} = (1 - \kappa_{22})/2$. Both elasticities, $\epsilon_{N_2, \text{TOT}_1^2}$ and $\epsilon_{N_2, \text{TOT}_3^2}$, increase in b_2/w_2 .

Figure 7: Decomposition of Spillover in Direct and Indirect Effects for Varying b_2/w_2 and b_3/w_3



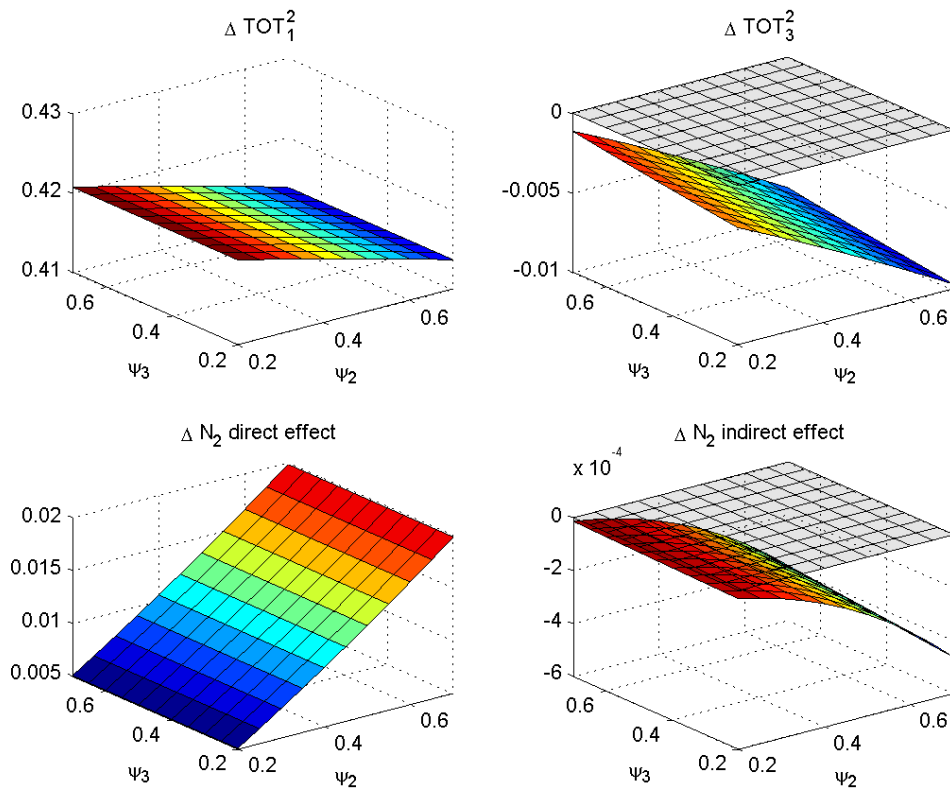
Notes: In this scenario $1 - \kappa_{11} = 0.3$, $1 - \kappa_{33} = 0.1$, $\kappa_{13} = \kappa_{23} = (1 - \kappa_{33})/2$ and $1 - \kappa_{22} = 0.5$, $\kappa_{12} = \kappa_{32} = (1 - \kappa_{22})/2$. Both elasticities, $\epsilon_{N_2, \text{TOT}_1^2}$ and $\epsilon_{N_2, \text{TOT}_3^2}$, increase in U_2 .

Figure 8: Decomposition of Spillover in Direct and Indirect Effects for Varying U_2 and U_3



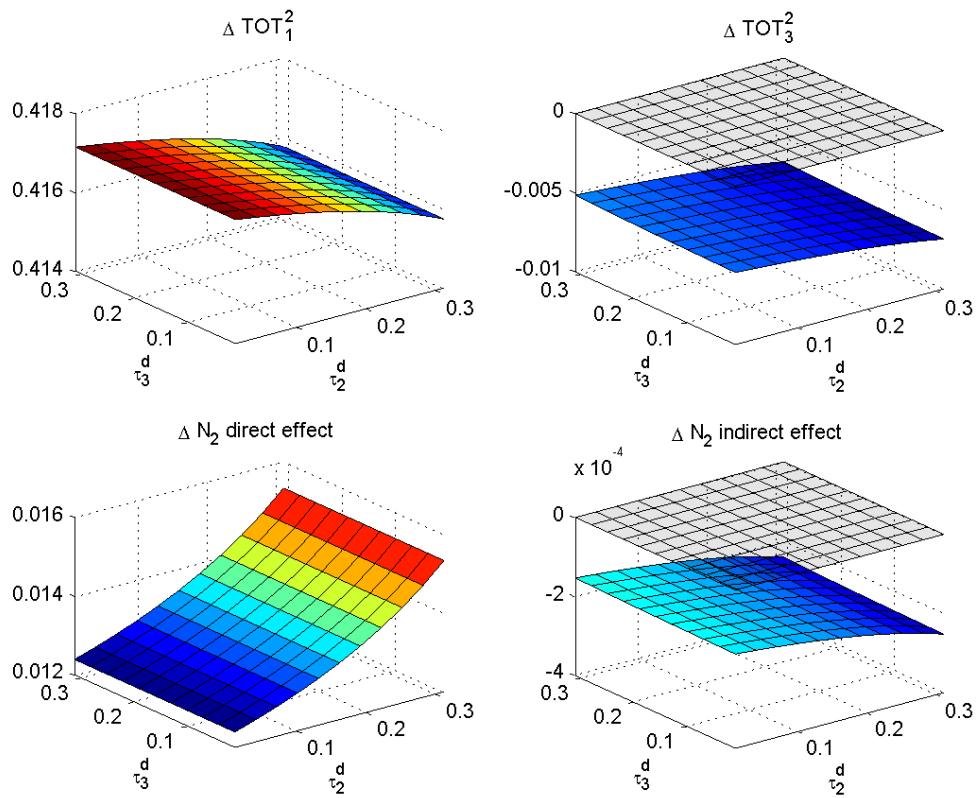
Notes: In this scenario $1 - \kappa_{11} = 0.3$, $1 - \kappa_{33} = 0.1$, $\kappa_{13} = \kappa_{23} = (1 - \kappa_{33})/2$ and $1 - \kappa_{22} = 0.5$, $\kappa_{12} = \kappa_{32} = (1 - \kappa_{22})/2$. Both elasticities, $\epsilon_{N_2, \text{TOT}_1^2}$ and $\epsilon_{N_2, \text{TOT}_3^2}$, increase with growing α_2 .

Figure 9: Decomposition of Spillover in Direct and Indirect Effects for Varying α_2 and α_3



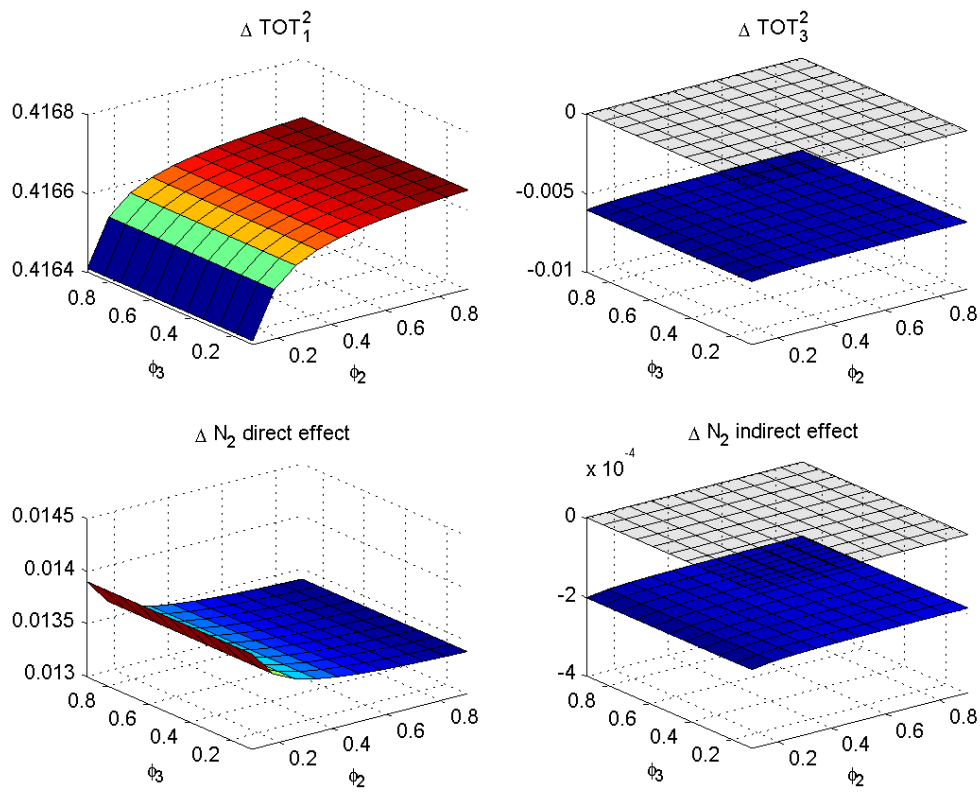
Notes: In this scenario $1 - \kappa_{11} = 0.3$, $1 - \kappa_{33} = 0.1$, $\kappa_{13} = \kappa_{23} = (1 - \kappa_{33})/2$ and $1 - \kappa_{22} = 0.5$, $\kappa_{12} = \kappa_{32} = (1 - \kappa_{22})/2$. Both elasticities, $\epsilon_{N_2, \text{TOT}_1^2}$ and $\epsilon_{N_2, \text{TOT}_3^2}$, increase with growing ψ_2 .

Figure 10: Decomposition of Spillover in Direct and Indirect Effects for Varying ψ_2 and ψ_3



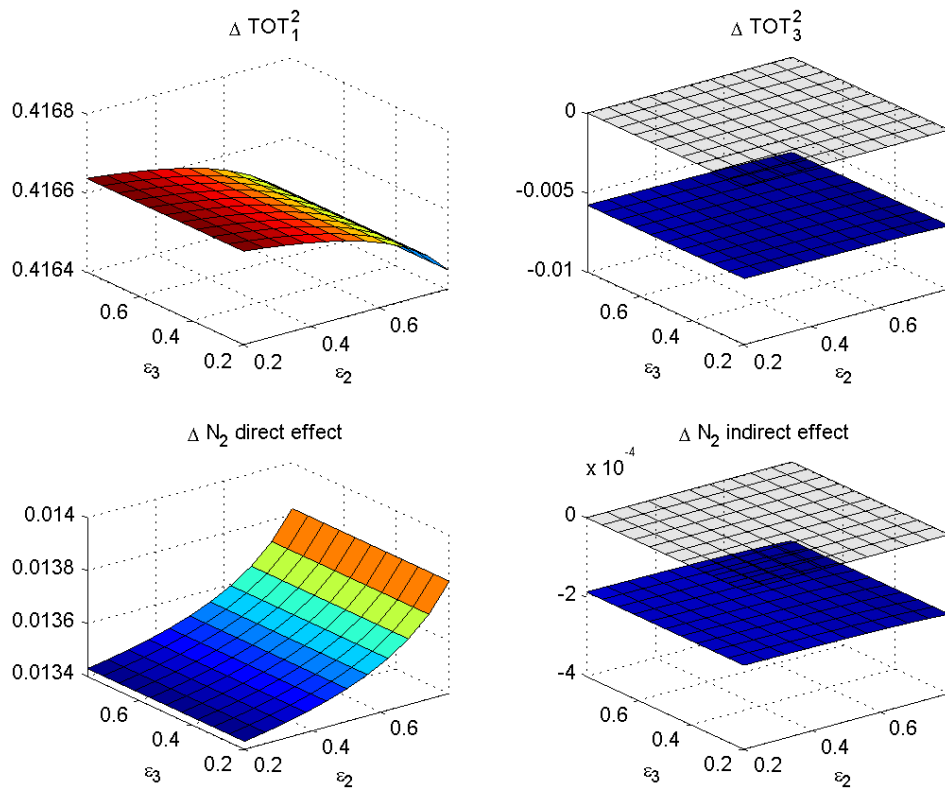
Notes: In this scenario $1 - \kappa_{11} = 0.3$, $1 - \kappa_{33} = 0.1$, $\kappa_{13} = \kappa_{23} = (1 - \kappa_{33})/2$ and $1 - \kappa_{22} = 0.5$, $\kappa_{12} = \kappa_{32} = (1 - \kappa_{22})/2$. Both elasticities, ϵ_{N_2, TOT_1^2} and ϵ_{N_2, TOT_3^2} , increase with growing τ_2^d .

Figure 11: Decomposition of Spillover in Direct and Indirect Effects for Varying τ_2^d and τ_3^d



Notes: In this scenario $1 - \kappa_{11} = 0.3$, $1 - \kappa_{33} = 0.1$, $\kappa_{13} = \kappa_{23} = (1 - \kappa_{33})/2$ and $1 - \kappa_{22} = 0.5$, $\kappa_{12} = \kappa_{32} = (1 - \kappa_{22})/2$. Both elasticities, $\epsilon_{N_2, \text{TOT}_1^2}$ and $\epsilon_{N_2, \text{TOT}_3^2}$, fall with growing ϕ_2 .

Figure 12: Decomposition of Spillover in Direct and Indirect Effects for Varying ϕ_2 and ϕ_3



Notes: In this scenario $1 - \kappa_{11} = 0.3$, $1 - \kappa_{33} = 0.1$, $\kappa_{13} = \kappa_{23} = (1 - \kappa_{33})/2$ and $1 - \kappa_{22} = 0.5$, $\kappa_{12} = \kappa_{32} = (1 - \kappa_{22})/2$. Both elasticities, $\epsilon_{N_2, \text{TOT}_1^2}$ and $\epsilon_{N_2, \text{TOT}_3^2}$, increase with growing ϵ_2 .

Figure 13: Decomposition of Spillover in Direct and Indirect Effects for Varying ϵ_2 and ϵ_3

C Derivation

In this appendix I derive the elasticity of employment in country 2 with respect to its terms of trade with country j ϵ_{N_2, TOT_j^2} and show that it has to be positive. Consider the steady state of the model, where steady state values are expressed as variables without time index. Combining the optimality conditions for vacancy posting and from the wage bargaining, equations (20) and (25), and using the following expression for the capital labour ratio $\frac{K_2}{N_2} = \left(\frac{P_2}{P_2^c} \frac{\alpha}{1/\beta - 1 + \delta} \right)$ derived from optimal bond demand (equation 19), we obtain:

$$\begin{aligned} \frac{(1 - \beta(1 - s_2))}{\beta\chi_2} \theta_2^{1-\psi} + (1 - \epsilon) \theta_2 &= \\ &= \frac{\epsilon}{\omega_2} \left[\left(\frac{P_2}{P_2^c} \right)^{\frac{1}{1-\alpha}} (1 - \alpha) \left(\frac{\alpha}{\frac{1}{\beta} - 1 + \delta} \right)^{\frac{\alpha}{1-\alpha}} - \frac{1 + \tau_2^f}{1 - \tau_2^d} b_2 \right]. \end{aligned} \quad (34)$$

Furthermore, with the help of equation (12), we can express the inverse of the final good price in terms of the intermediate good of country 2 as a function of its terms of trade with its neighbours:

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

Thus, the marginal effects of a change in terms of trade on prices in country 2 in the steady state, where $TOT_1^2 = TOT_3^2 = 1$, are given by κ_{12} and κ_{32} for country 1 and 3, respectively. Based on this knowledge, I apply the implicit function theorem to equation (34) to derive the elasticity of labour market tightness in country 2 with respect to its terms of trade with country 1:

$$\epsilon_{\theta_2, TOT_1^2} = \frac{\delta \theta_2}{\delta TOT_1^2} \frac{1}{\theta_2} = \frac{\frac{\epsilon}{\omega_2} \kappa_{12} \left(\frac{\alpha}{\frac{1}{\beta} - 1 + \delta} \right)^{\frac{\alpha}{1-\alpha}}}{\frac{(1-\beta(1-s_2))(1-\psi)}{\beta\chi_2} \theta_2^{1-\psi} + (1-\epsilon) \theta_2} > 0, \quad (35)$$

which is always positive for $\epsilon, \omega_2, \kappa_{12}, h_2, \delta, \alpha, \chi_2, \theta_2 > 0$, $0 < \beta < 1$, $0 < s_2 < 1$, $0 < \psi < 1$. The elasticity of labour market tightness with respect to the terms of trade with country 3 are given by a very similar expression, the only difference being the preference for imports from country 3, κ_{32} :

$$\epsilon_{\theta_2, TOT_3^2} = \frac{\frac{\epsilon}{\omega_2} \kappa_{32} \left(\frac{\alpha}{\frac{1}{\beta} - 1 + \delta} \right)^{\frac{\alpha}{1-\alpha}}}{\frac{(1-\beta(1-s_2))(1-\psi)}{\beta\chi_2} \theta_2^{1-\psi} + (1-\epsilon) \theta_2} > 0. \quad (36)$$

One can then use the relation between employment N and labour market tightness θ , given by $s_2 N_2 = q_2 V_2 = H_2 = \chi_2 \theta_2^\psi (1 - N_2)$, to derive

$$\frac{\delta N_2}{\delta \theta_2} = \frac{s_2 \psi \chi_2 \theta_2^{\psi-1}}{\left(s_2 + \chi_2 \theta_2^\psi\right)^2} > 0. \quad (37)$$

Finally, by combining equation (35) or (36) with (37), we can write the elasticity of employment with respect to the terms of trade of any trading partner j as:

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

such that

$$\epsilon_{N_2, TOT_j^2} = \frac{\kappa_{j2}}{\omega_2} \frac{s_2 \psi}{\left(s_2 + \chi_2 \theta_2^\psi\right)} \frac{\epsilon \left(\frac{\alpha}{\frac{1}{\beta} - 1 + \delta}\right)^{\frac{\alpha}{1-\alpha}}}{\left[\frac{(1-\beta(1-s_2))(1-\psi)}{\beta \chi_2} \theta_2^{1-\psi} + (1-\epsilon) \theta_2\right]} > 0. \quad (38)$$