

International Trade and Unemployment: A Quantitative Framework

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Abstract

Quantifying the welfare effects of trade liberalization is a core issue in international trade. Existing frameworks assume perfect labor markets and therefore ignore the effects of aggregate employment changes for welfare. We develop a quantitative trade framework which explicitly models labor market frictions. To illustrate, we assess the effects of trade and labor market reforms for 28 OECD countries. Welfare effects of trade agreements are magnified when accounting for employment changes. While employment and welfare increase in most countries, some experience higher unemployment and lower welfare. Labor market reforms in one country have small positive spillover effects on trading partners.

Keywords: International trade; unemployment; trade costs; structural estimation; gravity equation

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The quantification of the welfare effects of trade liberalization is one of the core issues in empirical international trade. All empirical frameworks for evaluating welfare effects of trade policies so far assume perfect labor markets with full employment. This implies that changes in real welfare are due to changes in relative prices but neglect changes in the total number of employed workers. Although this has deepened our understanding of the effects of trade liberalization, it does not speak to the concerns expressed by the public about the impact of international trade on domestic employment prospects.

To capture these concerns, we derive a simple quantitative framework for bilateral trade flows based on recently developed models of international trade with search and matching labor market frictions. Our framework allows us to take into account *price and aggregate employment* changes and to calculate counterfactual trade flow, GDP, employment, and welfare changes due to changes in both trade and labor market policies. The additional benefit of incorporating labor market frictions into a quantitative trade model comes at minimal cost: it only requires knowledge of the elasticity of the matching function. Hence, our framework is easily applied to all topics where trade flow effects are inferred, such as free trade agreements, currency unions, borders and ethnic networks. In addition, similar to Arkolakis, Costinot and Rodríguez-Clare (2012), we derive simple sufficient statistics for welfare, which relate welfare changes to employment changes, changes in the share of spending on domestic goods and the (partial) import trade elasticity.

We apply our framework to a sample of 28 OECD countries from 1950 to 2006 in order to evaluate two scenarios. First, we calculate the effects of introducing preferential trade agreements (PTAs) starting from a counterfactual world without any PTAs. Second, we evaluate the effects of a hypothetical labor market reform in the United States. We find that, on average, introducing PTAs as observed in 2006 increases GDP about four percent more when accounting for employment effects arising from imperfect labor markets. Countries with only small increases in GDP, however, experience negative em-

ployment effects. On average, welfare effects are eight percent larger when allowing for imperfect labor markets. Our second counterfactual experiment analyzes a hypothetical improvement of labor market institutions in the United States. As expected, GDP and welfare increase in the United States but also improve for its trading partners due to positive spillover effects of the labor market reform.

In our framework, changes in trade costs or labor market policies affect labor market outcomes through changes in relative prices and income. When trade costs fall, imports of foreign varieties become cheaper, leading to a lower consumer price index in the corresponding country. When labor markets are characterized by search frictions, firms have to incur costs to post vacancies in order to find workers. The lower price level translates one-to-one into lower recruiting costs for domestic firms. Hence, firms will *ceteris paribus* create more vacancies, so that more workers find a job and unemployment is reduced.

A unilateral labor market reform which for example increases the matching efficiency will increase the number of successful matches between workers and firms and thus rise employment, GDP, and welfare in the corresponding country. As workers spend part of their income on foreign varieties, the increase in income leads to higher import demand for all trading partners. This translates into lower unemployment in the trading partners, leading to a positive correlation between changes in unemployment rates across countries.

The changes in employment and GDP directly affect bilateral trade flows. Within our framework, bilateral trade flows can be described by a gravity equation. The gravity equation in international trade captures the key stylized facts that trade increases with market size and decreases with distance. The empirical success of the gravity equation spurred a great deal of interest in its theoretical underpinnings. Anderson (1979) and Bergstrand (1985) address the role of multilateral price effects for trade flows. A more recent contribution by Eaton and Kortum (2002) develops a quantifiable Ricardian model of international trade to investigate the role of comparative advantage and geography for bilateral trade flows. Anderson and van Wincoop (2003) refine the gravity equation's theoretical foundations by including average trade barriers

to capture multilateral resistance and highlight the importance of proper empirical comparative static analysis. Fieler (2011) introduces non-homothetic preferences into the Ricardian framework of Eaton and Kortum (2002) to rationalize the fact that bilateral trade is large between rich countries and small between poor countries. Waugh (2010) provides a complementary framework with asymmetric trade costs to explain the cross-country-pair differences in bilateral trade volumes and income levels. Anderson and Yotov (2010) elaborate on the incidence of bilateral trade costs in the Anderson and van Wincoop (2003) framework. These theoretical developments allow to employ the gravity equation to infer the GDP and welfare effects of counterfactual trade liberalization scenarios accounting for general equilibrium effects, which is a core issue in empirical work on international trade.

Despite this multitude of theoretical foundations for the gravity equation, to date all of them assume perfect labor markets. Crucially, this implies that changes in real welfare ignore changes in the total number of employed workers due to trade liberalization or labor market reforms. A recent, different strand of the theoretical trade literature stresses various channels through which trade liberalization affects (un)employment. Brecher (1974), Davis (1998), and Egger, Egger and Markusen (2012) focus on minimum wages to analyze the interactions between trade and labor market policies. A binding minimum wage prevents downward wage adjustments when a country opens up to trade. Instead, firms adjust the number of employed workers. Others have stressed labor market frictions arising due to fair wages or efficiency wages (Amiti and Davis 2012; Davis and Harrigan 2011; Egger and Kreickemeier 2009). Fair wages or efficiency wages lead firms to pay wages above the market clearing level in order to ensure compliance of workers. When trade is liberalized, average productivity of firms increases which leads to an increase of the fair or efficiency wage due to rent-sharing as well as an increase in unemployment. Finally, search-theoretic foundations of labor market frictions are introduced into trade models (Davidson, Martin and Matusz 1988, 1999; Felbermayr, Prat and Schmerer 2011*a*; Helpman, Itskhoki and Redding 2010; Helpman and Itskhoki 2010). In these models, workers search for jobs and firms for workers.

Once a firm-worker match is established, they bargain over the match-specific surplus. Trade and labor markets interact via relative prices of hiring workers and goods prices which affect search and recruitment efforts. While our framework relies on a search-theoretical foundation of labor market frictions, we employ different approaches to divide the rent between workers and firms like minimum wages, efficiency wages, and bargaining.

Theoretically, the effects of trade liberalization on (un)employment are ambiguous, but Dutt, Mitra and Ranjan (2009) as well as Felbermayr, Prat and Schmerer (2011*b*) provide reduced-form evidence that more open economies have lower unemployment rates on average. In contrast to these reduced-form approaches, our structural empirical framework accounts for country-specific general equilibrium effects and allows to quantify employment, GDP, and welfare effects of policies.

The remainder of the paper is structured as follows: Section 1 presents the structural gravity model accounting for employment effects and also includes a discussion of how to calculate counterfactual employment, GDP, trade flow, and welfare changes. Section 2 discusses the parameter estimation. Section 3 evaluates the effects of preferential trade agreements and labor market reforms for a sample of 28 OECD countries. Section 4 concludes.

1 A quantitative framework for trade and unemployment

While there are a great many of excellent quantitative frameworks to analyze trade flows, we use the simplest possible way to provide a rationale for bilateral trade between similar countries based on preferences à la Armington (1969).¹ To allow for imperfections in the labor market, we introduce a simple production structure where firms search for workers to produce a homogeneous good. Once a firm and a worker have met, wages are determined by bargaining. As

¹Consequently, we deliberately abstract from distinguishing between the intensive and extensive margin of international trade as for example in Chaney (2008) or Helpman, Melitz and Rubinstein (2008).

alternative wage determination mechanisms, we cover minimum wages and efficiency wages in the Appendix. Both approaches are observationally equivalent in our setting. We also demonstrate in the Appendix that our framework and counterfactual analysis are isomorphic to a Ricardian model of international trade along the lines of Eaton and Kortum (2002).

1.1 Goods market

The representative consumer in country j is characterized by the utility function U_j . We assume that goods are differentiated by country of origin. The quantity of purchased goods from country i is given by q_{ij} , leading to the following utility function

$$U_j = \left[\sum_{i=1}^n \beta_i^{\frac{1-\sigma}{\sigma}} q_{ij}^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \quad (1)$$

where n is the number of countries, σ is the elasticity of substitution in consumption, and β_i is a positive preference parameter.

International trade of goods from i to j imposes iceberg trade costs $t_{ij} > 1$. Profit maximization then implies that $p_{ij} = p_i t_{ij}$, where p_i denotes the factory gate price of the good in country i .

The representative consumer maximizes Equation (1) subject to the budget constraint $\tilde{y}_j = \sum_{i=1}^n p_i t_{ij} q_{ij}$, where $\tilde{y}_j = y_j(1 + d_j)$, with y_j denoting nominal income in country j and d_j the share of the exogenously given trade deficit (if $d_j > 0$) or surplus (if $d_j < 0$) of country j in terms of GDP.² The value of aggregate exports from i to j can then be expressed as

$$x_{ij} = p_i t_{ij} q_{ij} = \left(\frac{\beta_i p_i t_{ij}}{P_j} \right)^{1-\sigma} \tilde{y}_j, \quad (2)$$

and P_j is the standard CES price index given by $P_j = [\sum_{i=1}^n (\beta_i p_i t_{ij})^{1-\sigma}]^{1/(1-\sigma)}$.

²We allow for trade imbalances following Dekle, Eaton and Kortum (2007). We also conducted all counterfactual scenarios assuming balanced trade, but our results changed very little. Detailed results can be found in the Appendix of this paper.

In general equilibrium, the total amount of exports corresponds to nominal income, i.e., $y_i = \sum_{j=1}^n x_{ij}$. Assuming labor to be the only factor of production, GDP in a world with imperfect labor markets is given by the wage bill of all employed workers, i.e., $y_i = w_i(1 - u_i)L_i$. We next describe the labor market, which determines wages w_i and the unemployment rate u_i .

1.2 Labor market

We model the labor market using a one-shot version of the search and matching framework (SMF, see Mortensen and Pissarides, 1994 and Pissarides, 2000).³ Search-theoretic frameworks fit stylized facts of labor markets in developed economies as for example the simultaneous existence of unfilled vacancies and unemployed workers.⁴

The labor market is characterized by frictions. All potential workers in country j , L_j , have to search for a job, and firms post vacancies V_j at a unit cost of $c_j P_j$ (measured in terms of the final output good) in order to find workers. The number of successful matches between an employer and a worker, M_j , is given by $M_j = m_j L_j^\mu V_j^{1-\mu}$, where $\mu \in (0, 1)$ is the elasticity of the matching function and m_j measures the overall efficiency of the labor market.⁵ Only a fraction of open vacancies will be filled, $M_j/V_j = m_j (V_j/L_j)^{-\mu} = m_j \vartheta_j^{-\mu}$, and only a fraction of all workers will find a job, $M_j/L_j = m_j (V_j/L_j)^{1-\mu} = m_j \vartheta_j^{1-\mu}$, where $\vartheta_j \equiv V_j/L_j$ denotes the degree of labor market tightness in country j . This implies that the unemployment rate is given by⁶

$$u_j = 1 - m_j \vartheta_j^{1-\mu}. \quad (3)$$

³See Rogerson, Shimer and Wright (2005) for a survey of search and matching models, including an exposition of the simplified one-shot version. For recent trade models using a similar static approach, see for example Helpman and Itskhoki (2010).

⁴They are less successful in explaining the cyclical behavior of unemployment and vacancies, see Shimer (2005). This deficiency is not crucial in our case as we purposely focus on the steady state.

⁵Note that we assume a constant returns to scale matching function in line with empirical studies, see Petrongolo and Pissarides (2001).

⁶Note that the matching efficiency has to be sufficiently low to ensure job finding rates and job filling rates between 0 and 1.

After a match has been established, the firm and the worker bargain over the match surplus. The worker's surplus from the match is the difference between the wage the worker earns while being employed and the unemployment benefits (b_j) she receives when she is unemployed.

Denote by J_j^v the value of expected profit from a vacant job and J_j^o the value of expected profit from an occupied job. J_j^v is given by $-P_j c_j + M_j/V_j(J_j^o - J_j^v)$, i.e., by the sum of the recruiting cost and the probability of filling the vacancy multiplied with the surplus of filling it. J_j^o is given by $J_j^o = p_j - w_j$, i.e., by the difference of marginal revenues and marginal costs of an employed worker. Firms post vacancies until all profit opportunities are exploited, hence $J_j^v = 0$ in equilibrium. This implies that $p_j - w_j = P_j c_j V_j / M_j$. Hence, the worker's wage has to be strictly smaller than the value of output of the firm.

Rewriting, one finds the **job creation curve** $w_j = p_j - P_j c_j / (m_j \vartheta_j^{-\mu})$. It is increasing in the value of output and decreasing in the expected recruiting costs $P_j c_j / (m_j \vartheta_j^{-\mu})$.

We use a generalized Nash bargaining solution to determine the surplus splitting rule. Hence, wages w_j are chosen to maximize $(w_j - b_j)^{\xi_j} (J_j^o - J_j^v)^{1-\xi_j}$, where the bargaining power of the worker is given by $\xi_j \in (0, 1)$, $J_j^o = p_j$, and $J_j^v = w_j$. The unemployment benefits are expressed as a fraction γ_j of the market wage rate. Note that both the worker and the firm neglect the fact that in general equilibrium, higher wages lead to higher unemployment benefits, i.e., they both treat the replacement rate as exogenous (see Pissarides 2000). The first order conditions of the bargaining problem yield $w_j - \gamma_j w_j = \xi_j / (1 - \xi_j) (p_j - w_j)$. Solving for w_j results in the **wage curve** $w_j = \xi_j / (1 + \gamma_j \xi_j - \gamma_j) p_j$. Due to the one-shot matching, the wage curve does not depend on ϑ_j . The bargained wage increases in the value of output p_j , in the worker's bargaining power ξ_j , and in the replacement rate γ_j .

Combining the job creation and wage curves determines the equilibrium labor market tightness as

$$\vartheta_j = \left(\frac{p_j}{P_j} \right)^{1/\mu} \left(\frac{c_j}{m_j} \Omega_j \right)^{-1/\mu}, \quad (4)$$

where $\Omega_j \equiv \frac{1-\gamma_j+\gamma_j\xi_j}{1-\gamma_j+\gamma_j\xi_j-\xi_j} \geq 1$ summarizes the effective bargaining power of workers. Ω_j is increasing in the worker's bargaining power ξ_j and in the replacement rate γ_j . Labor market tightness decreases and the unemployment rate increases when m_j or c_j decrease or Ω_j increases.

The relative price p_j/P_j is determined by the demand and the supply of goods. It therefore provides the link between the labor and goods market. This can best be seen by using the wage curve to replace wages w_j and Equations (3) and (4) to replace u_j in $y_j = w_j(1 - u_j)L_j$ which leads to the following expression for GDP:

$$y_j = \frac{\xi_j}{1 + \gamma_j\xi_j - \gamma_j} p_j m_j \left(\frac{p_j}{P_j} \right)^{\frac{1-\mu}{\mu}} \left(\frac{c_j}{m_j} \Omega_j \right)^{\frac{\mu-1}{\mu}} L_j. \quad (5)$$

Changes in trade costs will affect the relative price and therefore influence labor market outcomes. Decreasing trade costs for country j will directly lower the country's consumer price index P_j , while the price of domestic goods p_j is only affected indirectly by general equilibrium effects. An increase of p_j/P_j increases the marginal revenue of an additional worker relative to the cost of recruiting her. Hence, firms will recruit more workers, thereby increasing labor market tightness and lowering unemployment.

Given trade costs t_{ij} , labor endowments L_j , and parameters, we can use (2), (5), the definition of the price index P_j , and the general-equilibrium adding-up constraint $y_i = \sum_{j=1}^n x_{ij}$ to solve for the variety prices p_j and subsequently for relative prices p_j/P_j , wages w_j , trade flows x_{ij} , GDPs y_j , and the unemployment rates u_j .

1.3 Derivation of the gravity equation

Our quantitative framework implies a gravity equation for bilateral trade flows, which we derive in this section. We first use $y_i = \sum_{j=1}^n x_{ij}$ which summarizes the general equilibrium nature of our model and implies market clearing, i.e.,

$$y_i = \sum_{j=1}^n x_{ij} = \sum_{j=1}^n \left(\frac{\beta_i t_{ij} p_i}{P_j} \right)^{1-\sigma} \tilde{y}_j = (\beta_i p_i)^{1-\sigma} \sum_{j=1}^n \left(\frac{t_{ij}}{P_j} \right)^{1-\sigma} \tilde{y}_j. \quad (6)$$

Solving for scaled prices $\beta_i p_i$ and defining $y^W \equiv \sum_j y_j$, $\tilde{y}^W \equiv \sum_j \tilde{y}_j$ and income shares $\theta_j \equiv y_j/y^W$ and $\tilde{\theta}_j \equiv \tilde{y}_j/\tilde{y}^W$, we can write bilateral trade flows as given in Equation (2) as

$$x_{ij} = \frac{y_i \tilde{y}_j}{y^W} \left(\frac{t_{ij}}{\tilde{\Pi}_i \tilde{P}_j} \right)^{1-\sigma}, \quad \text{where} \quad (7)$$

$$\tilde{\Pi}_i \equiv \left(\sum_{j=1}^n \left(\frac{t_{ij}}{\tilde{P}_j} \right)^{1-\sigma} \tilde{\theta}_j \right)^{1/(1-\sigma)}, \quad \tilde{P}_j \equiv \left(\sum_{i=1}^n \frac{y^W}{\tilde{y}^W} \left(\frac{t_{ij}}{\tilde{\Pi}_i} \right)^{1-\sigma} \theta_i \right)^{1/(1-\sigma)}, \quad (8)$$

while we substituted equilibrium scaled prices into the definition of the price index to obtain the multilateral resistance terms \tilde{P}_j .

Note that this system of equations exactly corresponds to the system given in Equations (9)-(11) in Anderson and van Wincoop (2003) or Equations (5.32) and (5.35) in Feenstra (2004) assuming balanced trade, $d_i = 0$ for all i , even when labor markets are imperfect.⁷

The intuition for this result is that GDPs appear in Equation (7). Observed GDPs already include the actual number of employed people. Hence, it still holds that total spending equals total production. The only difference is that now total production is achieved by *employed workers*, not all workers, as is assumed with perfect labor markets. Hence, even with labor market frictions, we can use established methods to estimate trade costs using the gravity equation. We summarize this result in Implication 1:

Implication 1 *The estimation of trade costs is unchanged when allowing for imperfect labor markets.*

1.4 Counterfactual analysis

While trade cost parameters can be recovered without assumptions concerning the labor market according to Implication 1, most researchers estimate

⁷Symmetric trade costs, i.e., $t_{ij} = t_{ji}$, imply $\tilde{\Pi}_i = \tilde{P}_i$ (see Anderson and van Wincoop, 2003); if trade is balanced, $\tilde{\Pi}_i = \Pi_i$ and $\tilde{P}_i = P_i$.

gravity equations in order to evaluate counterfactual policy changes. In order to calculate the counterfactual situation of a policy change, one needs to take into account changes in GDP. When calculating counterfactual GDP, all approaches to date neglect changes in the total number of employed workers.

For example, in the framework of Anderson and van Wincoop (2003) with perfect labor markets, calculating GDP and corresponding shares in world GDP is easy as “*quantities produced are assumed fixed*” (p. 190). However, this assumption is also very restrictive, as it implies that GDP and welfare changes are solely due to changes in (real) prices. Hence, changes in a country’s GDP only translate into price changes in the perfect labor market framework. Similarly, in Eaton and Kortum (2002) the number of employed workers remains constant.

In contrast, our model also leads to *employment* adjustments. When GDP falls, unemployment will rise, which in turn will impact wages. In essence, our model allows labor market variables to affect income. Hence, assuming perfect or imperfect labor markets matters for the proper counterfactual analysis.

We derive and discuss in turn counterfactual (un)employment, GDP, and trade flows. Afterwards, we discuss how to calculate welfare and derive sufficient statistics for welfare along the lines of Arkolakis, Costinot and Rodríguez-Clare (2012).

1.4.1 Counterfactual (un)employment

Noting that variety prices p_j are not observed, we follow Anderson and van Wincoop (2003) and use Equation (6) to solve for scaled prices as follows:

$$(\beta_j p_j)^{1-\sigma} = \frac{y_j}{\sum_{i=1}^n \left(\frac{t_{ji}}{P_i}\right)^{1-\sigma} \tilde{y}_i} = \frac{y^W}{\tilde{y}^W} \theta_j \tilde{\Pi}_j^{\sigma-1} = \frac{y^W}{\tilde{y}^W} \mathfrak{k}_j, \quad (9)$$

where $\mathfrak{k}_j \equiv \theta_j \tilde{\Pi}_j^{\sigma-1}$. We then use the definition of u_j given in Equation (3), replacing ϑ_j by the expression given in Equation (4) and defining $\Xi_j \equiv m_j \left(\frac{c_j}{m_j} \Omega_j\right)^{\frac{\mu-1}{\mu}}$ and $\hat{\kappa}_j \equiv \Xi_j^c / \Xi_j$, where superscript c denotes counterfactual

values:

$$\frac{e_j^c}{e_j} \equiv \frac{1 - u_j^c}{1 - u_j} = \hat{\kappa}_j \left(\frac{p_j^c}{p_j} \right)^{\frac{1-\mu}{\mu}} \left(\frac{\tilde{P}_j}{\tilde{P}_j^c} \right)^{\frac{1-\mu}{\mu}}, \quad (10)$$

where e_j denotes the employment rate. Noting the derivation of Equation (9) and remembering that $\tilde{P}_j^{1-\sigma} = \sum_i (y^W/\tilde{y}^W) t_{ij}^{1-\sigma} \mathfrak{t}_i$ (see the definition of the price index and (9)), we can express the ratios of the prices and price indices as functions of \mathfrak{t}_i to end up with counterfactual (un)employment levels summarized in the following implication:

Implication 2 *Whereas in the setting with perfect labor markets (un)employment effects are zero by assumption, the (un)employment effects in our gravity system with imperfections on the labor market are given by:*

$$\begin{aligned} \hat{e}_j &\equiv \frac{e_j^c}{e_j} = \hat{\kappa}_j \left(\frac{\mathfrak{t}_j^c}{\mathfrak{t}_j} \right)^{\frac{1-\mu}{\mu(1-\sigma)}} \left(\frac{\sum_i t_{ij}^{1-\sigma} \mathfrak{t}_i}{\sum_i (t_{ij}^c)^{1-\sigma} \mathfrak{t}_i^c} \right)^{\frac{1-\mu}{\mu(1-\sigma)}}, \\ \Delta u_j &\equiv u_j^c - u_j = (1 - u_j)(1 - \hat{e}_j). \end{aligned}$$

Implication 2 reveals that a country can directly affect its (un)employment level by changes in its labor market institutions, as reflected by changes in $\hat{\kappa}_j$.⁸ In addition, all trading partners are affected by such a labor market reform due to changes in prices as reflected by \mathfrak{t}_i . Direct effects are scaled by changes in relative prices p_j/\tilde{P}_j which are proportional to $(\mathfrak{t}_j/\sum_i t_{ij}^{1-\sigma} \mathfrak{t}_i)^{1/(1-\sigma)}$, reflecting the spillovers of labor market reforms to other countries. Changes of relative prices due to trade liberalization therefore provide the link to the labor market.

Even with imperfect labor markets we just need one additional parameter alongside σ , namely μ , the elasticity of the matching function, in order to calculate counterfactual values. Note that μ plays a crucial role for the importance of the labor market frictions. As μ approaches one, frictions of the labor market disappear and the (un)employment effects vanish. A lower μ , i.e., higher labor market frictions, leads to larger changes in (un)employment

⁸Note that employment changes are homogeneous of degree zero in prices, implying that a normalization does not matter for the employment effects.

for given relative price changes. Additionally, all (potential) changes in labor market policies are succinctly summarized in a reduced-form fashion in $\hat{\kappa}_j$.

1.4.2 Counterfactual GDP

We next derive counterfactual GDPs. Using the definition of Ξ_j , we can write Equation (5) as $y_j = \xi_j/(1 + \gamma_j\xi_j - \gamma_j)p_j \left(p_j/\tilde{P}_j\right)^{(1-\mu)/\mu} \Xi_j L_j$. Now take the ratio of counterfactual GDP, y_j^c , and observed GDP, y_j , define $v_j \equiv \xi_j/(1 + \gamma_j\xi_j - \gamma_j)$ and $\hat{v}_j \equiv v_j^c/v_j$. Noting that labor endowments L_j stay constant, using (9), and $\tilde{P}_j^{1-\sigma} = \sum_i (y^W/\tilde{y}^W) t_{ij}^{1-\sigma} \mathbf{t}_i$, we arrive at the following implication:

Implication 3 *Counterfactual GDPs are given by:*

$$\begin{aligned} \text{imperfect labor markets: } \hat{y}_j &= \left(\hat{D}^W\right)^{\frac{1}{1-\sigma}} \hat{v}_j \hat{\kappa}_j \left(\frac{\mathbf{t}_j^c}{\mathbf{t}_j}\right)^{\frac{1}{\mu(1-\sigma)}} \left(\frac{\sum_i t_{ij}^{1-\sigma} \mathbf{t}_i}{\sum_i (t_{ij}^c)^{1-\sigma} \mathbf{t}_i^c}\right)^{\frac{1-\mu}{\mu(1-\sigma)}} \\ \text{perfect labor markets: } \hat{y}_j &= \left(\hat{D}^W\right)^{\frac{1}{1-\sigma}} \left(\frac{\mathbf{t}_j^c}{\mathbf{t}_j}\right)^{\frac{1}{1-\sigma}} \end{aligned}$$

with $\hat{D}^W \equiv (y^{W,c}\tilde{y}^W)/(\tilde{y}^{W,c}y^W)$ indicating the endogenous change in the world trade deficit to keep trade deficit GDP shares d_j s constant. It equals one in the case of balanced trade. In order to ensure a common numéraire, we normalize $\tilde{P}_1 = \tilde{P}_1^c = 1$, i.e., GDP changes are in terms of the price level of the first importer in the data set.⁹ If we assume $\mu = 1$ and balanced trade, we end up with the case of perfect labor markets employed by Anderson and van Wincoop (2003).

⁹As mentioned in footnote 12 in Anderson and van Wincoop (2003), the solution of the multilateral resistance terms (MRTs) adopts a particular normalization. In general, this applied normalization may vary between the baseline MRTs and the counterfactual MRTs. In order to ensure the same normalization for the baseline and counterfactual scenario, we normalize $\tilde{P}_1 = \tilde{P}_1^c = 1$.

We can now go a step further and decompose the change in GDP as follows:

$$\hat{y}_j = \left(\hat{D}^W\right)^{\frac{1}{1-\sigma}} \hat{v}_j \underbrace{\left(\frac{\mathfrak{t}_j^c}{\mathfrak{t}_j}\right)^{\frac{\mu}{\mu(1-\sigma)}}}_{\text{price change}} \underbrace{\hat{\kappa}_j \left(\frac{\mathfrak{t}_j^c}{\mathfrak{t}_j}\right)^{\frac{1-\mu}{\mu(1-\sigma)}} \left(\frac{\sum_i t_{ij}^{1-\sigma} \mathfrak{t}_i}{\sum_i (t_{ij}^c)^{1-\sigma} \mathfrak{t}_i^c}\right)^{\frac{1-\mu}{\mu(1-\sigma)}}}_{\text{employment change}}, \quad (11)$$

with the price change and the employment change as defined in Implication 2.

Let us focus on the numéraire country for a moment. As we use its price index as our numéraire, the last expression in brackets of Equation (11) is equal to one. Then, the equation simplifies to the change in v_j (which is solely driven by changes in exogenous parameters), to the change in the world deficit, and to two terms that are equal except for their exponents: the price change term rises to the power of μ and the employment change term to the power of $1 - \mu$. Hence, the relative importance of price and employment changes only depends on μ . If μ approaches zero, the labor market rigidities vanish, and the total GDP change is due to the price change, as in models assuming perfect labor markets. With any value of μ between zero and one, the share of the GDP change attributable to the price change is μ and the share due to the employment change $1 - \mu$. Hence, with $\mu = 0.75$, three-quarters of the change in GDP are due to the price change and one-quarter is due to the employment change. In all other countries, changes in price indices lead to a more complex relationship. A lower price index lowers recruiting costs and thus spurs employment. This effect is captured by the last bracket in Equation (11). On the other hand, lower variety prices render recruiting less attractive, which is reflected by the first term of the employment change. Hence, the overall effect is ambiguous.

Taking logs, we can attribute the share of log change in GDP divided by $\left(\hat{D}^W\right)^{\frac{1}{1-\sigma}}$, \hat{y}_j^* , due to changes in institutions, prices, and employment as follows:

$$1 = \frac{\ln \hat{v}_j}{\ln \hat{y}_j^*} + \frac{\ln \hat{p}_j}{\ln \hat{y}_j^*} + \frac{\ln \hat{e}_j}{\ln \hat{y}_j^*}. \quad (12)$$

Alongside GDP changes, we will report this decomposition in all our counterfactual exercises.

1.4.3 Counterfactual trade flows

Given estimates of t_{ij} , data on y_i , and a value for σ , we can calculate (scaled) baseline trade flows as $x_{ij}y^W/(y_i\tilde{y}_j) = (t_{ij}/(\tilde{\Pi}_i\tilde{P}_j))^{1-\sigma}$, where $\tilde{\Pi}_i$ and \tilde{P}_j are given by Equation (8). With counterfactual GDPs given by Implication 3, we can calculate counterfactual trade flows as $x_{ij}^c y^{W,c}/(y_i^c \tilde{y}_j^c) = (t_{ij}^c/(\tilde{\Pi}_i^c \tilde{P}_j^c))^{1-\sigma}$, where $\tilde{\Pi}_i^c$ and \tilde{P}_j^c are defined analogously to their counterparts in the baseline scenario given in Equation (8).¹⁰ Due to direct effects of changes in trade costs via t_{ij} and non-trivial changes in $\tilde{\Pi}_i$ and \tilde{P}_j , trade may change more or less when assuming imperfect labor markets in comparison with the baseline case of perfect labor markets.

1.4.4 Calculating welfare effects

We can express the equivalent variation in percent as follows:

$$EV_i = \frac{\tilde{y}_i^c \frac{\tilde{P}_i}{\tilde{P}_i^c} - \tilde{y}_i}{\tilde{y}_i} = \frac{\tilde{y}_i^c}{\tilde{y}_i} \frac{\tilde{P}_i}{\tilde{P}_i^c} - 1 = \hat{\tilde{y}}_i \frac{\tilde{P}_i}{\tilde{P}_i^c} - 1. \quad (13)$$

We next derive sufficient statistics for the welfare effects of trade liberalization similar to those of Arkolakis, Costinot and Rodríguez-Clare (2012). We therefore consider a foreign shock that leaves the ability to serve the own market, t_{jj} , unchanged as in Arkolakis, Costinot and Rodríguez-Clare (2012). Additionally, we follow their normalization and set the wage in country j , w_j , equal to one. We then come up with the following sufficient statistics (see Appendix B for the derivation):

¹⁰Note that \tilde{P}_j and \tilde{P}_j^c are homogeneous of degree one in prices while $\tilde{\Pi}_i$ and $\tilde{\Pi}_i^c$ are homogeneous of degree minus one. Hence, scaled trade flows $x_{ij}y^W/(y_i\tilde{y}_j)$ and $x_{ij}^c y^{W,c}/(y_i^c \tilde{y}_j^c)$ are homogeneous of degree zero in prices. In other words, they do not depend on the normalization chosen.

Implication 4 *Welfare effects of trade liberalization in our model with imperfect labor markets can be expressed as*

$$\hat{W}_j = \hat{e}_j \hat{\lambda}_{jj}^{\frac{1}{1-\sigma}}.$$

Hence, welfare depends on the employment change, \hat{e}_j , the change in the share of domestic expenditures, $\hat{\lambda}_{jj}$, and the partial elasticity of imports with respect to variable trade costs, given in our case by $1/(1-\sigma)$. Note that in the case of perfect labor markets $\hat{e}_j = 1$ and $\hat{W}_j = \hat{\lambda}_{jj}^{1/(1-\sigma)}$, which is exactly Equation (6) in Arkolakis, Costinot and Rodríguez-Clare (2012).

When $\hat{\lambda}_{jj}$ is observed, assuming imperfect or perfect labor markets would lead to different welfare predictions. The difference in the welfare change is given by \hat{e}_j . Hence, assuming perfect labor markets neglects the effects on employment and the corresponding welfare effects. Whether welfare increases or decreases in a particular country depends on the relative magnitude of trade creation and diversion.

2 Parameter estimation

Having set out our structural model and described how to obtain counterfactual GDPs, trade flows, employment levels, and welfare, we next describe our estimation strategy for the gravity variables and the key parameters needed for the counterfactual analysis, the elasticity of substitution, σ , and the elasticity of the matching function, μ .

2.1 Estimating the gravity variables

We start by writing (7) in stochastic form as follows

$$z_{ij} \equiv \frac{x_{ij}}{y_i \tilde{y}_j} = \exp \left(k - (1-\sigma) \ln t_{ij} - \ln \tilde{\Pi}_i^{1-\sigma} - \ln \tilde{P}_j^{1-\sigma} + \varepsilon_{ij} \right), \quad (14)$$

where ε_{ij} is a random disturbance term or measurement error of exports, assumed to be identically distributed and mean-independent of the remaining

terms on the right-hand side of Equation (14), and k is a constant capturing the logarithm of world GDP. We employ country-specific importer and exporter fixed effects to control for the outward and inward multilateral resistance terms $\tilde{\Pi}_i$ and \tilde{P}_j , respectively, as suggested by Anderson and van Wincoop (2003) and Feenstra (2004). We then solve for the multilateral resistance terms based on the fixed effects trade friction parameter estimates.¹¹

Additionally to estimating Equation (14) in log-linear form, we also use the approach suggested by Santos Silva and Tenreyro (2006) and estimate the multiplicative version of the model using a Poisson pseudo-maximum-likelihood estimator.

2.2 Estimating the elasticity of substitution

In principle, we could follow most of the gravity literature and merely assume a plausible value for the elasticity of substitution as the main contribution of this paper is providing a structural gravity framework allowing for imperfect labor markets. However, recently Bergstrand, Egger and Larch (2012) show how to obtain estimates for σ within their proposed framework without relying on additional data. We show here that their approach, which only relies on trade flows and observed baseline variables, is also applicable when assuming imperfect labor markets. We therefore follow this approach in order to obtain an estimate for the elasticity of substitution σ .

First, note that we can rewrite trade flows as given in Equation (2) by replacing the variety price using the wage curve and observing that $w_i = y_i / [(1 - u_i)L_i]$ as follows: $x_{ij} = ((\beta_i(1 + \gamma_i\xi_i - \gamma_i)y_it_{ij}) / (\xi_i(1 - u_i)L_iP_j))^{1-\sigma} \tilde{y}_j$. Estimation of Equation (14) using observable determinants of bilateral trade costs generates estimates $\widehat{t_{ij}^{1-\sigma}}$.¹² We next substitute $\widehat{t_{ij}^{1-\sigma}}$ in Equation (7) to generate \hat{x}_{ij} and $\widehat{t_{mj}^{1-\sigma}}$ in its analogue to generate \hat{x}_{mj} . Using observed

¹¹See Appendix C for the solution of the system of multilateral resistance terms with asymmetric trade costs.

¹²For instance, in the model by Anderson and van Wincoop (2003), $\widehat{t_{ij}^{1-\sigma}}$ would be determined by the exponentiated value of $[(1 - \sigma)\rho] \ln d_{ij} + [(1 - \sigma) \ln b_{US,CA}] \text{Border}_{ij}$.

unemployment and replacement rates we end up with:

$$\frac{\hat{x}_{ij}}{\hat{x}_{mj}} = \frac{\widehat{t_{ij}^{1-\sigma}}}{\widehat{t_{mj}^{1-\sigma}}} \left(\frac{\beta_i(1 + \gamma_i\xi_i - \gamma_i)y_i\xi_m(1 - u_m)L_m}{\beta_m(1 + \gamma_m\xi_m - \gamma_m)y_m\xi_i(1 - u_i)L_i} \right)^{1-\sigma}. \quad (15)$$

We can solve Equation (15) for σ , where y_i , y_m , L_i , L_m , γ_i , γ_m , u_i , and u_m are observables. Following the literature, we assume that $\xi_i = \xi_m = 0.5$. In addition, we assume that $\beta_i = \beta_m$. Then, we can calculate $n^2(n - 1)$ values of σ by using all combinations i , j , and m ($m \neq i$). As a measure of central tendency, we use the average value of all estimates of $\sigma > 1$ as our summary estimate in order to insure that trade costs do not counterfactually increase with rising distance. We use bootstrapped standard errors for σ .

2.3 Estimating the elasticity of the matching function

The other crucial parameter for our counterfactual analysis is the elasticity of the matching function, μ . As with the elasticity of substitution, there are a great many of plausible estimates of the matching elasticity available in the literature. Still, we demonstrate that it is also possible to obtain an estimate of μ within our structural gravity framework relying on the cross-country-pair variation in bilateral trade flows.

Using again Equation (3) and (4) and the definition of Ξ_j , we can write $1 - u_j = \Xi_j \left(p_j / \tilde{P}_j \right)^{(1-\mu)/\mu}$. As we observe u_j in the baseline, we may take ratios for two countries and the log of this ratio to obtain:

$$\ln \left(\frac{1 - u_j}{1 - u_m} \right) = \frac{1 - \mu}{\mu} \left[\ln \left(\frac{p_j \tilde{P}_m}{p_m \tilde{P}_j} \right) - \ln \left(\frac{c_j \Omega_j}{c_m \Omega_m} \right) \right]. \quad (16)$$

We can solve Equation (16) for μ , where u_j , c_j and Ω_j are in principle observable. The unobservable variety prices p_j and the price indices P_j can be replaced by $(\beta_j p_j)^{1-\sigma} = (y^W / \tilde{y}^W) \theta_j \tilde{\Pi}_j^{\sigma-1} = (y^W / \tilde{y}^W) \mathfrak{k}_j$ and $\tilde{P}_j^{1-\sigma} = \sum_{i=1}^n t_{ij}^{1-\sigma} \mathfrak{k}_i$, respectively. In our application, we assume again that $\beta_j = \beta_m$. In addition, we assume identical recruiting costs, c_j , across countries as empirical measures

of recruiting costs which are comparable across countries are hard to come by. We can then calculate $n(n-1)$ such values of μ by using all combinations j and m ($m \neq j$). As a summary estimate, we average over all estimated values of μ within the unit interval. We use bootstrapped standard errors for μ .¹³

3 Preferential trade agreements and labor market frictions

We now evaluate the trade effects of preferential trade agreements and labor market reforms in a sample of 28 OECD countries for the years 1950 to 2006. The trade data are from Head, Mayer and Ries (2010). We use internationally comparable harmonized unemployment rates as well as employment and civil labor force data from OECD (2012). Internationally comparable gross average replacement rates are from OECD (2007).¹⁴

To obtain an estimable gravity equation as given in Equation (14), we need to parameterize trade costs. We follow the literature and proxy t_{ij} by a vector of trade barrier variables as follows:

$$t_{ij\tau}^{1-\sigma} = \exp(\delta_1 PTA_{ij\tau} + \delta_2 \ln DIST_{ij} + \delta_3 CONTIG_{ij} + \delta_4 COMLANG_{ij}), \quad (17)$$

where $PTA_{ij\tau}$ is an indicator variable of preferential trade agreement membership between country pair ij in year τ , $DIST_{ij}$ is bilateral distance, $CONTIG_{ij}$ is a dummy variable indicating whether countries i and j are contiguous, and $COMLANG_{ij}$ indicates whether the two countries share a common official language.¹⁵ The data for the PTA 's are constructed from the notifications

¹³We use analytical standard errors for the trade cost parameters.

¹⁴As Mexico does not have any unemployment insurance scheme but is characterized by a large informal employment share, its labor market institutions are markedly different to the other OECD countries in our sample. Consequently, no replacement rate data are available for Mexico. We therefore exclude it from our analysis. For all other countries, we use the simple average of replacement rates between 2005 and 2007 as data for 2006 are not available.

¹⁵We do not use common colonizer indicators or similar variables regularly used in the literature as these have very little variation in our OECD sample.

Table 1: Summary statistics

	Mean	Std. Dev.	Min.	Max.	N
x_{ij} (cur. mn U.S.\$)	2,048.991	8,950.166	0	348,420.6	38,313
GDP (cur. mn U.S.\$)	386,072.995	1,143,571.923	126.99	13,201,819	43,372
PTA	0.237	0.425	0	1	44,688
$\ln DIST$	7.863	1.213	4.201	9.880	44,688
$CONTIG$	0.077	0.266	0	1	44,688
$COMLANG$	0.074	0.262	0	1	44,688

Notes: Summary statistics for the OECD sample from 1950 to 2006. The 28 countries included are Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States. Data are taken from Head, Mayer and Ries (2010).

to the World Trade Organization (WTO) and augmented and corrected by using information from PTA secretariat webpages. Table 1 contains summary statistics of the data.

Obviously, countries do not randomly sign PTAs. This has long been recognized in the international trade literature, see for example Treffer (1993), Magee (2003), Baier and Bergstrand (2007), and references therein. Empirical evidence shows that the exogeneity assumption of PTAs is inappropriate when attempting to quantify the effects of regional trade agreements. To avoid potential endogeneity, we follow Baier and Bergstrand (2007) and Anderson and Yotov (2011) and use a two-step estimation approach to obtain consistent estimates of trade cost coefficients. In a first step, we estimate Equation (14) including (directional) bilateral fixed effects, i.e., we estimate

$$z_{ij\tau} = \exp(k + \delta_1 PTA_{ij\tau} + \varphi_{i\tau} + \phi_{j\tau} + \nu_{ij} + \varepsilon_{ij}), \quad (18)$$

where $\varphi_{i\tau}$ and $\phi_{j\tau}$ are exporter and importer time-varying fixed effects and ν_{ij} is a time-constant (directional) bilateral fixed effect.¹⁶ Note that $\varphi_{i\tau}$ and $\phi_{j\tau}$ control for the multilateral resistance terms $\tilde{\Pi}_i$ and \tilde{P}_j , and the bilateral fixed effect also captures the time-invariant geography variables. In a second step,

¹⁶We report results for regressions including bilateral fixed effects, i.e. $\nu_{ij} = \nu_{ji}$, and directional bilateral fixed effects, i.e. $\nu_{ij} \neq \nu_{ji}$.

we re-estimate Equation (14) to obtain estimates for the coefficients of the time-invariant geography variables, δ_2 to δ_4 . We therefore use only exporter- and importer-time-varying fixed effects and constrain the coefficient of *PTA*, δ_1 , to the estimate of the first step, $\hat{\delta}_1$.

Finally, we use data from the last year in our sample, 2006, to estimate the elasticity of substitution and the elasticity of the matching function.

3.1 Estimation results

We present results estimating log-linearized trade flows by OLS as well as the Poisson pseudo-maximum-likelihood (PPML) estimator for the trade flows in levels following the recommendation by Santos Silva and Tenreyro (2006) in Table 11.

Columns (1)-(4) of Table 11 present results using bilateral fixed effects, i.e., assuming symmetric trade costs $t_{ij} = t_{ji}$ which is the same assumption made by Anderson and van Wincoop (2003). Columns (5)-(8) allow for asymmetric unobserved trade costs, i.e. $t_{ij} \neq t_{ji}$, by employing directional bilateral fixed effects. Each of these two blocks contains four specifications. Columns (1) and (5) report OLS estimates for scaled trade flows $z_{ij\tau}$ in logs. Column (2) and (6) present PPML estimates for the scaled trade flows in levels to control for heteroskedasticity and zero trade flows. Columns (3) and (7) reproduce Columns (1) and (5) for unscaled trade flows $x_{ij\tau}$. Finally, Columns (4) and (8) present PPML estimates for unscaled trade flows. The slightly larger number of observations for unscaled trade flows stems from the fact that GDP data are not available for all countries in all years where we have trade data and control variables.

Our estimates are in accordance with well-known results from the empirical trade literature. Distance is a large obstacle to trade, whereas contiguity, a common language and PTAs enhance trade. Comparing the results from Columns (1)-(4) with those of Columns (5)-(8) reveals that allowing for asymmetric trade costs does not substantially change our parameter estimates. Comparing with PPML estimates shows a clear pattern: distance coefficients

Table 2: Estimation results for the OECD sample, 1950-2006

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	PPML	OLS	PPML	OLS	PPML	OLS	PPML
	$\ln z_{ijt}$	z_{ijt}	$\ln x_{ijt}$	x_{ijt}	$\ln z_{ijt}$	z_{ijt}	$\ln x_{ijt}$	x_{ijt}
Second stage								
$\ln DIST_{ij}$	-1.050*** (0.009)	-0.669*** (0.027)	-1.041*** (0.010)	-0.816*** (0.010)	-1.050*** (0.009)	-0.669*** (0.027)	-1.040*** (0.010)	-0.813*** (0.010)
$CONTIG_{ij}$	0.097*** (0.019)	0.276*** (0.030)	0.116*** (0.019)	0.414*** (0.018)	0.097*** (0.019)	0.275*** (0.030)	0.115*** (0.019)	0.414*** (0.018)
$COMLANG_{ij}$	0.386*** (0.019)	0.769*** (0.049)	0.387*** (0.019)	0.150*** (0.017)	0.386*** (0.019)	0.769*** (0.049)	0.387*** (0.019)	0.151*** (0.017)
First stage								
PTA_{ijt}	0.274*** (0.016)	0.308*** (0.019)	0.267*** (0.017)	0.332*** (0.019)	0.274*** (0.014)	0.311*** (0.016)	0.276*** (0.015)	0.341*** (0.013)
Estimated elasticities								
σ	2.349*** (0.303)	2.535*** (0.051)	2.349*** (0.024)	2.395*** (0.728)	2.349*** (0.352)	2.535*** (0.195)	2.350*** (0.255)	2.395*** (0.476)
μ	0.946*** (0.003)	0.928*** (0.007)	0.947*** (0.001)	0.938*** (0.009)	0.946*** (0.005)	0.928*** (0.007)	0.947*** (0.003)	0.938*** (0.008)
zero trade		X		X		X		X
symmetric t_{ijt}	X	X	X	X				
asymmetric t_{ijt}					X	X	X	X
N	36,945	37,741	37,493	38,313	36,945	37,741	37,493	38,313

Notes: Results for trade flows between 28 OECD countries between 1950 and 2006 estimated by ordinary least squares (OLS) and Poisson pseudo-maximum-likelihood (PPML). z_{ij} are trade flows standardized by importer and exporter GDPs. $\ln DIST$ is distance between exporting and importing country, $CONTIG$ is an indicator variable equal to 1 if the exporting and importing countries i and j share a common border, $COMLANG$ is an indicator variable equal to 1 if the exporting and importing country share a common official language, and PTA is an indicator variable equal to 1 if the exporting and importing country have signed a preferential trade agreement. All regressions control for multilateral resistance terms (MRTs) via exporter and importer fixed effects. (Robust) standard errors in parentheses, *** $p < 0.01$. Standard errors for σ and μ are bootstrapped using 200 replications.

are smaller in absolute values, but all other coefficients are larger (except for the coefficients of *COMLANG* in specifications (4) and (8)). The differences are larger for estimates using scaled trade rather than unscaled trade flows. Note that in the case of specifications using unscaled trade flows, GDP effects are captured by the time-varying importer- and exporter-fixed effects. Hence, those specifications implicitly allow for non-unitary GDP coefficients.

PTAs increase trade by 30.60 percent (Column (3)) to 40.64 percent (Column (8)) when neglecting general equilibrium effects.¹⁷ The general equilibrium effects are accounted for in the counterfactual analysis, to which we turn in Section 3.2.

Turning to the elasticity of substitution, our significant estimates lie between 2.349 in Columns (1), (3), and (5) and 2.535 in Columns (2) and (6). These results are very much in line with recent evidence from Feenstra, Obstfeld and Russ (2012) who report estimates for the Armington elasticity between domestic and foreign goods of around 1 and between different foreign sources of 3.1. As our model forces these two elasticities to be equal, we would expect an estimate that lies in between these two estimates.¹⁸

Finally, our estimates of the matching elasticity vary between 0.928 and 0.947 and are significant at any standard level of significance. With our method, we find that the elasticity of labor markets in OECD countries indicates a very low level of labor market frictions and a very high matching elasticity compared to previous estimates. For example, Yashiv (2000) estimates μ between 0.2 and 0.6 for Israel for the years between 1975 and 1989. A literature review by Petrongolo and Pissarides (2001) reports estimates between 0.12 and 0.81 across studies focussing on several countries and time periods. Hall (2005) finds $\mu = 0.24$ for the United States for the years 2000 to 2002. Rogerson and Shimer (2010) estimate $\mu = 0.58$ for the same data for the years 2000 to 2009.¹⁹ Even though our estimates are on the high side,

¹⁷Effects are calculated as $(\exp(\hat{\delta}_{PTA}) - 1) \times 100$ percent.

¹⁸See Feenstra (2010) for a detailed discussion of estimates of the elasticity of substitution in international trade.

¹⁹Note that the literature reports both estimates of the matching elasticity with respect to the unemployed, as we do, or with respect to vacancies. In our discussion, we transformed

note that our method infers the matching elasticity from (ratios) of bilateral trade flows using their cross-country-pair variation at one point in time. All other estimates of the matching elasticity in the literature use time series data on the number of matches, vacancies, and the unemployed from a single labor market. Hence, it is not too surprising that our estimates are somewhat different from the literature. In the counterfactual analysis, to which we turn next, we therefore provide results for alternative values of the matching elasticity.

3.2 Counterfactual analysis

We conduct two counterfactual experiments in our OECD sample. First, we evaluate the effects of PTAs. To this end, we compare a situation with PTAs as observed in 2006 with a counterfactual situation without any PTAs. Second, we evaluate improvements of labor market institutions in the United States and Germany.

3.2.1 Evaluating the effects of PTAs

Our first counterfactual experiment evaluates the effects of introducing PTAs as observed in 2006 compared to a counterfactual situation in which there are no PTAs. We base our counterfactual analysis on parameter estimates from Column (6) of Table 11 as they control for heteroskedasticity and impose unitary income elasticities for trade flows consistent with our framework.

The results are shown in Table 3.²⁰ It is organized as follows. Column (1), “PLM %GDP”, gives the percentage change in nominal GDP in terms of the price index of Australia for the case of perfect labor markets. Column (2), “SMF %GDP”, gives the same change within our search and matching framework. Columns (3) and (4) use Equation (12) and decompose the change in nominal GDP of Column (2) into price and employment changes. Column (5) reports the percentage change in the employment share for the case of imperfect labor markets, whereas Column (6) reports unemployment changes in

the estimates when necessary assuming constant returns to scale in the matching process.

²⁰In the Appendix, we additionally provide results concerning the changes in trade flows across countries.

percentage points. Finally, Columns (7) and (8) report the equivalent variation (EV) for the case of perfect and imperfect labor markets, respectively.

Table 3 reveals that all countries gain in terms of GDP when introducing PTAs as observed in 2006. This translates into an average gain in terms of GDP of 12.73 percent when assuming perfect labor markets. The average GDP gain increases by 4 percent to 13.28 percent when accounting for employment effects. Hidden behind these average effects is substantial heterogeneity. Some countries gain substantially more than the average, for example Canada with a gain of 20.70 percent, whereas other countries such as the United States experience a smaller increase of 9.92 percent. The decomposition of (log) GDP change into (log) price and (log) employment changes highlights that for many of our sample countries, roughly 7 percent of the increase in GDP is driven by the increase in employment. Countries with only slight increases in GDP may even see negative employment effects, as can be seen in Column (5) of Table 3. Typically, welfare effects are magnified when taking into account employment effects. For example, the standard welfare estimate for Canada is about 5 percent larger when taking into account labor markets imperfections.

To assess the fit of our model, we first compare the implied changes in both openness (measured as imports plus exports over nominal GDP) and in unemployment rates predicted by our model with actually observed data for our sample. While it is straightforward to calculate these changes for our model, we cannot, of course, observe “real-world” counterfactual openness and unemployment rates. Thus, to compare model predictions with observed data, we take a simple and admittedly very crude approach: we calculate the observed change in openness and the unemployment rate as the change between the first year for which unemployment rate data are available and 2006.²¹

²¹The first year is 1955 for the United States and Japan, 1956 for New Zealand, Ireland, France, and Canada, 1958 for Finland, 1959 for Italy, 1960 for Denmark and Turkey, 1961 for Greece, 1962 for Germany, 1964 for Australia and Austria, 1970 for Sweden, 1972 for Norway, Spain, and the United Kingdom, 1975 for Switzerland, 1983 for Belgium and the Netherlands, 1984 for Portugal, 1989 for Korea, 1990 for Poland, 1991 for Iceland, 1992 for Hungary, 1993 for the Czech Republic, and 1994 for the Slovak Republic. Note that all countries either had no or only a few PTAs in place for the first year in which we observe the unemployment rate, but all of them had experienced a tremendous increase in PTAs by

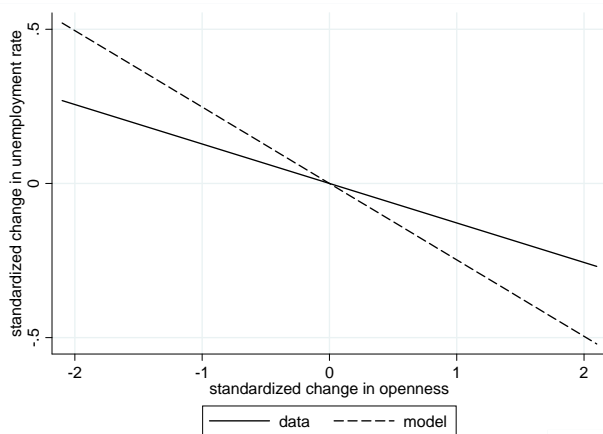


Figure 1: Implied regression lines of changes in openness and unemployment rates for both model and data.

Note that we standardized changes for comparison reasons. As can be seen from Figure 1, our model replicates the average negative correlation between openness and unemployment. The correlation between the fitted values of the two regression lines is 0.57.

As an additional validation of our results we compare observed unemployment rates in the first year available for our sample countries with the implied counterfactual unemployment rates without PTAs predicted by our model (see Figure 2). The correlation between the observed and predicted counterfactual unemployment rate is 0.54 which is tantamount to explaining 29 percent of the variation in the observed unemployment rate. Thus, although there is room for improving the model fit, we are the first to explain any of the observed variation in unemployment rates by changes in international trade policy changes.

As in every trade model, the resulting magnitudes of policy changes crucially depend on the exact values of the elasticities. We therefore test the sensitivity of our results to variations in the elasticity of substitution σ as well as in the elasticity of the matching function μ . In the interest of brevity, we present only average effects in Table 4. The GDP, employment, and EV effects

2006.

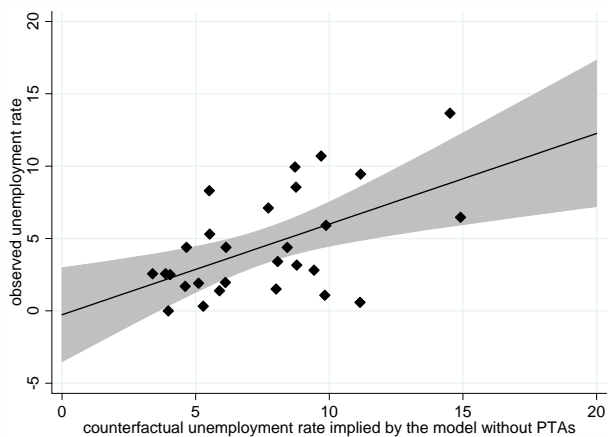


Figure 2: Regression of observed unemployment rate on the counterfactual unemployment rate implied by the model without *PTAs*.

crucially depend on the values of σ and μ . When the elasticity of substitution increases, GDP, employment, and EV changes become smaller. This is because varieties are better substitutes, making trade less important. Hence, incepting *PTAs* leads to smaller predicted gains in terms of GDP, employment, and welfare. Changes in the elasticity of the matching function μ also show a clear pattern. Lower values of μ indicate higher GDP, employment, and welfare changes. A lower μ corresponds to larger labor market imperfections. When μ approaches 1 we end up in the case of perfect labor markets. The reason for this is that larger frictions on the labor market imply that firms have to post more vacancies in order to find a worker, effectively increasing recruiting costs. As trade liberalization decreases the overall price level, it also lessens a firm's recruiting costs. This reduction of recruiting costs is more important in labor markets with higher frictions, making trade liberalization more attractive. Overall, Table 4 highlights that the extent of labor market frictions plays a crucial role in assessing the quantitative impact of free trade agreements.

Table 3: Comparative static effects of PTA inception controlling for trade imbalances in 2006

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	PLM	SMF	share %GDP	SMF	SMF	SMF	PLM	SMF
	%GDP	%GDP	$\% \ln(\hat{p})$	$\% \ln(\hat{e})$	$\% \hat{e}$	Δu	%EV	%EV
Australia	16.45	17.40	92.75	7.25	1.17	-1.10	16.49	17.43
Austria	17.73	19.01	91.69	8.31	1.46	-1.37	20.59	22.12
Belgium	18.25	19.61	91.45	8.55	1.55	-1.40	21.92	23.57
Canada	20.70	22.16	90.60	9.40	1.90	-1.75	28.24	29.72
Czech Republic	17.29	18.50	91.95	8.05	1.38	-1.26	19.36	20.80
Denmark	16.71	17.84	92.28	7.72	1.28	-1.21	17.84	19.16
Finland	15.90	16.91	92.77	7.23	1.14	-1.04	15.72	16.90
France	15.70	16.71	92.88	7.12	1.11	-1.00	15.22	16.43
Germany	15.27	16.22	93.31	6.69	1.01	-0.90	13.77	14.91
Greece	15.62	16.60	92.92	7.08	1.10	-0.99	15.10	16.24
Hungary	16.79	17.92	92.24	7.76	1.29	-1.18	18.01	19.35
Iceland	15.36	16.26	93.17	6.83	1.04	-1.00	14.28	15.29
Ireland	16.19	17.20	92.66	7.34	1.17	-1.11	16.35	17.49
Italy	15.22	16.15	93.27	6.73	1.01	-0.94	13.83	14.94
Japan	9.25	9.28	101.03	-1.03	-0.09	0.09	-1.24	-1.26
Korea	9.39	9.44	100.71	-0.71	-0.06	0.06	-0.90	-0.89
Netherlands	16.86	18.01	92.32	7.68	1.28	-1.21	17.86	19.23
New Zealand	10.49	10.72	98.70	1.30	0.13	-0.13	1.61	1.85
Norway	16.38	17.45	92.55	7.45	1.21	-1.15	16.78	18.02
Poland	16.58	17.69	92.34	7.66	1.26	-1.07	17.53	18.83
Portugal	16.02	17.04	92.70	7.30	1.16	-1.06	16.03	17.21
Slovak Republic	17.05	18.22	92.08	7.92	1.34	-1.14	18.72	20.11
Spain	15.15	16.07	93.25	6.75	1.01	-0.92	13.86	14.93
Sweden	16.17	17.22	92.61	7.39	1.18	-1.09	16.39	17.62
Switzerland	18.50	19.89	91.31	8.69	1.59	-1.51	22.66	24.34
Turkey	15.58	16.54	93.00	7.00	1.08	-0.96	14.87	15.97
United Kingdom	13.61	14.31	94.49	5.51	0.74	-0.70	9.92	10.72
United States	9.92	10.08	99.63	0.37	0.04	-0.03	0.30	0.49
Average	12.73	13.28	96.59	3.41	0.55	-0.50	7.53	8.16

Notes: Counterfactual analysis is based on parameter estimates from column (6) of Table 11. PLM gives results assuming perfect labor markets. SMF gives results using a search and matching framework for the labor market. Averages are weighted averages using country GDP as weight.

Table 4: Average comparative static effects of PTA inception controlling for trade imbalances for various parameter values

μ	σ	PLM %GDP	SMF %GDP	SMF % \hat{e}	SMF % Δu	PLM %EV	SMF %EV
0.2	5	4.81	16.68	11.91	-9.24	2.75	15.25
	10	2.13	7.11	5.00	-4.22	1.20	6.33
	15	1.37	4.51	3.16	-2.74	0.77	3.98
0.5	5	4.81	7.54	2.75	-2.41	2.75	5.67
	10	2.13	3.32	1.20	-1.08	1.20	2.44
	15	1.37	2.13	0.77	-0.70	0.77	1.55
0.75	5	4.81	5.69	0.90	-0.81	2.75	3.71
	10	2.13	2.52	0.40	-0.36	1.20	1.61
	15	1.37	1.62	0.25	-0.23	0.77	1.03
0.9	5	4.81	5.10	0.30	-0.27	2.75	3.07
	10	2.13	2.26	0.13	-0.12	1.20	1.34
	15	1.37	1.45	0.08	-0.08	0.77	0.85
0.99	5	4.81	4.83	0.03	-0.03	2.75	2.78
	10	2.13	2.14	0.01	-0.01	1.20	1.21
	15	1.37	1.37	0.01	-0.01	0.77	0.78

Notes: Table reports average changes in nominal GDP, employment, and the equivalent variation in percent assuming either a perfect labor market (PLM) or using a search and matching framework (SMF) for the labor market controlling for trade imbalances with varying elasticity of substitution σ and elasticity of the matching function μ . The remaining parameters are set to values from column (6) of Table 11.

3.2.2 Evaluating the effects of labor market reforms

In our second counterfactual experiment, we evaluate the effects of a hypothetical labor market reform which improves U.S. labor market institutions. We implement this by a 3 percent increase in $\hat{\kappa}_j$ for the United States, i.e., we set $\hat{\kappa}_{U.S.}$ to 1.03. Given our estimate of the matching elasticity of $\mu = 0.928$, this change in $\hat{\kappa}_{U.S.}$ corresponds to either an increase of 2.8 percent in the overall matching efficiency m_j or a 32 percent reduction of recruiting costs in the United States. Note that within our framework we do not necessarily have to specify the explicit source of changes in labor market institutions. The results

of this experiment are set out in Table 5.²²

Table 5: Comparative static effects of $\hat{\kappa}_{U.S.} = 1.03$ controlling for trade imbalances in 2006

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	PLM	SMF	share	%GDP	SMF	SMF	PLM	SMF
	%GDP	%GDP	% $\ln(\hat{p})$	% $\ln(\hat{e})$	% \hat{e}	Δu	%EV	%EV
Australia	0.00	0.79	92.75	7.25	0.06	-0.05	0.00	0.77
Austria	0.00	0.50	98.72	1.28	0.01	-0.01	0.00	0.09
Belgium	0.00	0.48	99.41	0.59	0.00	-0.00	0.00	0.04
Canada	0.00	0.96	90.76	9.24	0.09	-0.08	0.00	1.21
Czech Republic	0.00	0.52	98.14	1.86	0.01	-0.01	0.00	0.13
Denmark	0.00	0.53	97.89	2.11	0.01	-0.01	0.00	0.15
Finland	0.00	0.56	97.15	2.85	0.02	-0.01	0.00	0.21
France	0.00	0.52	98.23	1.77	0.01	-0.01	0.00	0.12
Germany	0.00	0.52	98.28	1.72	0.01	-0.01	0.00	0.12
Greece	0.00	0.55	97.34	2.66	0.01	-0.01	0.00	0.20
Hungary	0.00	0.53	97.73	2.27	0.01	-0.01	0.00	0.16
Iceland	0.00	0.62	95.59	4.41	0.03	-0.03	0.00	0.37
Ireland	0.00	0.59	96.30	3.70	0.02	-0.02	0.00	0.29
Italy	0.00	0.53	97.81	2.19	0.01	-0.01	0.00	0.16
Japan	0.00	0.55	97.53	2.47	0.01	-0.01	0.00	0.18
Korea	0.00	0.55	97.34	2.66	0.01	-0.01	0.00	0.20
Netherlands	0.00	0.51	98.48	1.52	0.01	-0.01	0.00	0.10
New Zealand	0.00	0.73	93.58	6.42	0.05	-0.04	0.00	0.64
Norway	0.00	0.56	97.17	2.83	0.02	-0.01	0.00	0.21
Poland	0.00	0.53	97.78	2.22	0.01	-0.01	0.00	0.16
Portugal	0.00	0.56	96.88	3.12	0.02	-0.02	0.00	0.24
Slovak Republic	0.00	0.53	97.83	2.17	0.01	-0.01	0.00	0.16
Spain	0.00	0.55	97.23	2.77	0.01	-0.01	0.00	0.21
Sweden	0.00	0.55	97.44	2.56	0.01	-0.01	0.00	0.19
Switzerland	0.00	0.48	99.47	0.53	0.00	-0.00	0.00	0.03
Turkey	0.00	0.56	96.99	3.01	0.02	-0.01	0.00	0.23
United Kingdom	0.00	0.62	95.71	4.29	0.03	-0.02	0.00	0.36
United States	0.00	2.55	-16.54	116.54	2.97	-2.83	0.00	2.54
Average	0.00	1.30	55.11	44.89	1.11	-1.06	0.00	1.10

Notes: Counterfactual analysis is based on parameter estimates from column (6) of Table 11. PLM gives results assuming perfect labor markets. SMF gives results using a search and matching framework for the labor market. Averages are weighted averages using country GDP as weight.

²²Again, detailed results on the heterogeneous trade effects can be found in the Appendix.

All countries gain in terms of GDP when U.S. labor market institutions improve. This highlights the positive spillover effects, recently theorized by Egger, Egger and Markusen (2012) and Felbermayr, Larch and Lechthaler (2009), and documented empirically in a reduced-form setting in Felbermayr, Larch and Lechthaler (2009). Of course, when perfect labor markets are assumed, it is not possible to evaluate any change in them. Therefore, Columns (1) and (7) are uninformative. The decomposition of (log) GDP into (log) price and (log) employment changes highlights that in the United States prices fall and all increases in GDP are due to increases in employment. For the trading partners of the United States, the positive GDP effects are composed of roughly 97 percent of price changes and 3 percent changes in employment. This can also be seen when comparing the relative magnitudes of the employment changes reported in Column (5) of Table 5. Concerning welfare, obviously the United States profits the most from its improvements in labor market institutions, with an increase in welfare of 2.54 percent. However and importantly, all other countries also gain, with the highest gains for Canada at 1.21 percent.

We also analyzed the recent German labor market reforms implemented between 2003 and 2005.²³ These reforms reduced unemployment benefits to increase search incentives for unemployed workers and are thought to have increased the overall matching efficiency of German labor markets.²⁴ For our counterfactual scenario, we reduce the matching efficiency by 5 percent and increase the replacement rate to the level prevailing in 2003. We find that unemployment in Germany would be about 4 percentage points higher and GDP more than 4 percent lower were it to undo its recent labor market reforms.

4 Conclusion

State of the art frameworks for quantitative analyses of international trade policies to evaluate the trade and welfare implications of trade liberalization all assume perfect labor markets. However, net employment effects are at

²³Results can be found in the Appendix.

²⁴Fahr and Sunde (2009) estimate this increase to be about 5 percent.

the heart of the political debate on trade integration. Accordingly, recent developments in international trade theory have highlighted the link between trade liberalization and labor market outcomes.

We build on these theoretical contributions to develop a quantitative framework of bilateral trade flows which takes into account labor market frictions within a search and matching framework. Our model allows counterfactual analysis of changes in trade costs and labor market reforms on trade flows, prices, employment, and welfare.

We apply our structural model to a sample of 28 OECD countries from 1950 to 2006 to evaluate the effects of preferential trade agreements (PTAs) and labor market reforms in the United States and Germany. We find that introducing PTAs as observed in 2006 leads to greater GDP increases when accounting for aggregate employment effects. Countries with only slight increases in GDP see negative employment effects. Our second counterfactual analysis assumes an improvement of labor market institutions in the United States. Average welfare effects are substantially magnified when taking into account employment effects. U.S. GDP increases roughly five times more than GDP of the other countries. While the United States profits the most from improvements of its labor market institutions with an equivalent variation of 2.54 percent, all of its trading partners also experience an increase in welfare due to positive spillover effects.

As our approach does not require any information about the labor market except for the elasticity of the matching function, it can be easily applied to any other field in which the gravity equation is employed.

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Appendix

A Introduction to the Appendix

In this Appendix, we present further results and robustness checks.

In Section B, we derive sufficient statistics for welfare with imperfect labor markets and show that in the case of imperfect labor markets, the welfare statistics presented in Arkolakis, Costinot and Rodríguez-Clare (2012) are augmented by the net employment change.

In Section C, we derive the solution of the system of asymmetric multilateral resistance equations.

In Section D, we present a variant of our model where wages are determined by a binding minimum wage instead of bargaining once the match between a worker and firm is established. We derive counterfactual changes in employment and show that for constant labor market institutions, calculated employment changes are identical to the ones assuming wage bargaining as in the main text.

In Section E, we assume that the wage setting process is determined within an efficiency wage framework. Again, when labor market institutions remain unchanged, calculated changes in employment and GDP are identical to the model presented in the main text.

In Section F, we present an alternative model setup in the vein of the Ricardian model of international trade by Eaton and Kortum (2002) and show that our results from the main text hold when reinterpreting the elasticity of substitution as the technology dispersion parameter used in Eaton and Kortum (2002).

Section G presents further results on trade flow and employment changes for the evaluation of PTAs and labor market reforms in the United States as well as detailed results for labor market reforms in Germany as presented in Section 3 from the main text.

Finally, Section H presents results for the counterfactual analyses in Section 3 from the main text under the assumption of balanced trade.

B Sufficient statistics for welfare with imperfect labor markets

Defining real income as $W_j \equiv \tilde{y}_j/P_j$ and taking the log-derivative leads to $d \ln W_j = d \ln \tilde{y}_j - d \ln P_j$. As $y_j = w_j(1-u_j)L_j$, we can write the log-derivative of y_j as $d \ln y_j = d \ln w_j - u_j/(1-u_j)d \ln u_j = -u_j/(1-u_j)d \ln u_j$, where the second expression on the right-hand side follows by choice of numéraire. Noting that $\tilde{y}_j = y_j(1+d_j)$ and taking d_j as constant, it holds that $d \ln \tilde{y}_j = d \ln y_j$.

The log-derivative of $P_j = [\sum_{i=1}^n (\beta_i p_i t_{ij})^{1-\sigma}]^{\frac{1}{1-\sigma}}$ is given by

$$d \ln P_j = \sum_{i=1}^n \left(\left(\frac{\beta_i p_i t_{ij}}{P_j} \right)^{1-\sigma} d \ln p_i + \left(\frac{\beta_i p_i t_{ij}}{P_j} \right)^{1-\sigma} d \ln t_{ij} \right).$$

Using $x_{ij} = ((\beta_i p_i t_{ij})/P_j)^{1-\sigma} \tilde{y}_j$ and defining $\lambda_{ij} = x_{ij}/\tilde{y}_j = ((\beta_i p_i t_{ij})/P_j)^{1-\sigma}$, yields

$$d \ln P_j = \sum_{i=1}^n \lambda_{ij} (d \ln p_i + d \ln t_{ij}). \quad (19)$$

Noting that $p_i = (1 - \gamma_i + \gamma_i \xi_i)/\xi_i w_i$, it also holds that $d \ln p_i = d \ln w_i$. Hence, we can also write: $d \ln P_j = \sum_{i=1}^n \lambda_{ij} (d \ln w_i + d \ln t_{ij})$. Combining terms leads to $d \ln W_j = d \ln y_j - d \ln P_j = -\frac{u_j}{1-u_j} d \ln u_j - \sum_{i=1}^n \lambda_{ij} (d \ln w_i + d \ln t_{ij})$. Taking the ratio of λ_{ij} and λ_{jj} we can write $\lambda_{ij}/\lambda_{jj} = [(\beta_i p_i t_{ij})/(\beta_j p_j t_{jj})]^{1-\sigma}$. Noting that $dt_{jj} = 0$ by assumption and that w_j is the numéraire, so that $dw_j = dp_j = 0$, the log-change of this ratio is given by $d \ln \lambda_{ij} - d \ln \lambda_{jj} = (1 - \sigma)(d \ln t_{ij} + d \ln p_i)$. Combining this with Equation (19) leads to:

$$d \ln P_j = \frac{1}{1-\sigma} \left(\sum_{i=1}^n \lambda_{ij} d \ln \lambda_{ij} - d \ln \lambda_{jj} \sum_{i=1}^n \lambda_{ij} \right).$$

Noting that $\tilde{y}_j = \sum_{i=1}^n x_{ij}$, it follows that $\sum_{i=1}^n \lambda_{ij} = 1$ and $d \sum_{i=1}^n \lambda_{ij} = \sum_{i=1}^n d \lambda_{ij} = 0$. Hence, $\sum_{i=1}^n \lambda_{ij} d \ln \lambda_{ij} = \sum_{i=1}^n d \lambda_{ij} = 0$. Using these facts, the above expression simplifies to $d \ln P_j = -\frac{1}{1-\sigma} d \ln \lambda_{jj}$. The welfare change can then be expressed as follows $d \ln W_j = -\frac{u_j}{1-u_j} d \ln u_j + \frac{1}{1-\sigma} d \ln \lambda_{jj}$. Integrating between the initial and the counterfactual situation we get $\ln \hat{W}_j =$

$\ln \hat{e}_j + \frac{1}{1-\sigma} \ln \hat{\lambda}_{jj}$, where $e_j = 1 - u_j$ is the share of employed workers. Taking exponents leads to $\hat{W}_j = \hat{e}_j \hat{\lambda}_{jj}^{\frac{1}{1-\sigma}}$. Moving from any observed level of trade to autarky, i.e., $\lambda_{jj}^c = 1$, yields $\hat{W}_j = \hat{e}_j (\lambda_{jj})^{-\frac{1}{1-\sigma}}$. Note, however, that in contrast to the case with perfect labor markets considered in Arkolakis, Costinot and Rodríguez-Clare (2012), even this expression needs information about employment changes.

C Solution of asymmetric multilateral resistance equations

Using Equation (8), we can write $\tilde{\Pi}_i^{1-\sigma} = \sum_{j=1}^n t_{ij}^{1-\sigma} \tilde{P}_j^{\sigma-1} \tilde{\theta}_j$. Defining $\mathfrak{P}_j = \tilde{\theta}_j \tilde{P}_j^{\sigma-1}$ leads to $\tilde{\Pi}_i^{1-\sigma} = \sum_{j=1}^n t_{ij}^{1-\sigma} \mathfrak{P}_j$. Similarly, P_j can be written as $\tilde{P}_j^{1-\sigma} = \sum_{i=1}^n t_{ij}^{1-\sigma} \tilde{\Pi}_i^{\sigma-1} \theta_i$. Defining $\mathfrak{t}_i = \theta_i \tilde{\Pi}_i^{\sigma-1}$ leads to $\tilde{P}_j^{1-\sigma} = \sum_{i=1}^n t_{ij}^{1-\sigma} \mathfrak{t}_i$. Now dividing $\tilde{\Pi}_i^{1-\sigma} = \sum_{j=1}^n t_{ij}^{1-\sigma} \mathfrak{P}_j$ by $\tilde{\Pi}_i^{1-\sigma}$ and using again $\mathfrak{t}_i = \theta_i \tilde{\Pi}_i^{\sigma-1}$ leads to $\theta_i = \mathfrak{t}_i \sum_{j=1}^n t_{ij}^{1-\sigma} \mathfrak{P}_j$ which can be rearranged to $\theta_i = \mathfrak{t}_i \sum_{j=1}^n t_{ij}^{1-\sigma} \mathfrak{P}_j$. Similarly, dividing $\tilde{P}_j^{1-\sigma} = \sum_{i=1}^n t_{ij}^{1-\sigma} \mathfrak{t}_i$ by $\tilde{P}_j^{1-\sigma}$ and using again $\mathfrak{P}_j = \tilde{\theta}_j \tilde{P}_j^{\sigma-1}$ leads to $\tilde{\theta}_j = \mathfrak{P}_j \sum_{i=1}^n t_{ij}^{1-\sigma} \mathfrak{t}_i$ which can be rearranged to $\tilde{\theta}_j = \mathfrak{P}_j \sum_{i=1}^n t_{ij}^{1-\sigma} \mathfrak{t}_i$. $\theta_i = \mathfrak{t}_i \sum_{j=1}^n t_{ij}^{1-\sigma} \mathfrak{P}_j$ and $\tilde{\theta}_j = \mathfrak{P}_j \sum_{i=1}^n t_{ij}^{1-\sigma} \mathfrak{t}_i$ define a system of $2n$ equations that can be solved for the $2n$ unknowns \mathfrak{t}_i and \mathfrak{P}_j .

D Minimum wages within the search and matching framework

In this Section, we introduce minimum wages in our search and matching framework. The binding minimum wage replaces the bargaining of workers and firms that are matched. We then show that this leads to expressions for counterfactual changes in GDP, employment, trade flows, and welfare which are isomorphic to those in the main text.

We assume balanced trade for the following derivations. Let us first consider the bounds for a binding minimum wage. If the minimum wage is above

the wage that a firm and a worker agree upon, it is not binding and hence not relevant. The lower bound for a binding minimum wage, denoted by \underline{w}_j , is therefore given by the **wage curve** from the main text

$$\underline{w}_j = w_j = \frac{\xi_j}{1 + \gamma_j \xi_j - \gamma_j} p_j. \quad (20)$$

The upper bound for a minimum wage, denoted by \bar{w}_j , is given by the job's output, as firms would not be able to recover recruiting costs. Hence, $\bar{w}_j = p_j$.

A well defined equilibrium with a binding minimum wage \tilde{w} exists if $\underline{w}_j < \tilde{w}_j < \bar{w}_j$. With a given binding minimum wage, the wage curve is no longer relevant. ϑ_j can be solved by using the **job creation curve** given in the main text

$$\begin{aligned} \tilde{w}_j &= p_j - \frac{P_j c_j}{m_j \vartheta_j^{-\mu}} \Rightarrow \\ \vartheta_j &= \left(\frac{p_j - \tilde{w}_j}{P_j} \right)^{1/\mu} \left(\frac{c_j}{m_j} \right)^{-1/\mu}, \end{aligned} \quad (21)$$

which corresponds to Equation (4) in the main text. GDP in country j can be derived by replacing u_j using Equation (3) from the main text and (21):

$$y_j = \tilde{w}_j m_j \left(\frac{p_j - \tilde{w}_j}{P_j} \right)^{\frac{1-\mu}{\mu}} \left(\frac{c_j}{m_j} \right)^{\frac{\mu-1}{\mu}} L_j, \quad (22)$$

which corresponds to Equation (5).

Counterfactual employment can be calculated using the definition of u_j given in Equation (3) in the main text. Then, replacing ϑ by the expression given in Equation (21) and defining $\tilde{\Xi}_j = m_j \left(\frac{c_j}{m_j} \right)^{\frac{\mu-1}{\mu}}$ and $\hat{\kappa}_j = \tilde{\Xi}_j^c / \tilde{\Xi}_j$, we get

$$\frac{1 - u_j^c}{1 - u_j} = \hat{\kappa}_j \left(\frac{p_j^c - \tilde{w}_j}{p_j - \tilde{w}_j} \right)^{\frac{1-\mu}{\mu}} \left(\frac{P_j}{P_j^c} \right)^{\frac{1-\mu}{\mu}}. \quad (23)$$

Assuming that the nominal minimum wage is indexed to prices, we can express

it as share of prices, i.e. $\tilde{w}_j = \xi_j p_j$. Then the last expression simplifies to

$$\frac{1 - u_j^c}{1 - u_j} = \hat{\kappa}_j^* \left(\frac{p_j^c}{p_j} \right)^{\frac{1-\mu}{\mu}} \left(\frac{P_j}{P_j^c} \right)^{\frac{1-\mu}{\mu}}, \quad (24)$$

where $\hat{\kappa}_j^* = \hat{\kappa}_j ((1 - \xi_j^c)/(1 - \xi_j))^{(1-\mu)/\mu}$. Equation (24) exactly corresponds to Equation (10) in the main text except for the replacement of $\hat{\kappa}_j$ by $\hat{\kappa}_j^*$. Hence, when assuming that labor market institutions (here: minimum wage levels) do not change, we can proceed as with bargained wages to calculate employment effects.

Note that in the case of binding minimum wages, all GDP changes are due to employment changes. Hence, counterfactual GDP changes correspond to employment changes.

Counterfactual trade flows and welfare can be calculated as in the case of bargained wages.

E Efficiency wages within the search and matching framework

In this Section, we show how efficiency wages in the spirit of Stiglitz and Shapiro (1984) can be introduced into our search and matching framework by replacing the bargaining of workers and firms with the no-shirking condition. Note that we assume balanced trade in the following.

We first derive the asset value for a shirker, s , and a non-shirker, ns . The non-shirker ns earns wage w_j while exerting effort e_j . Hence, the asset value in our one-shot framework is given by

$$E_j^{ns} = w_j - e_j. \quad (25)$$

A shirker s also earns wage w_j but does not exert any effort e_j . However, a share α_j of shirkers is detected by firms and gets fired, which leads to unemployment. Given that in unemployment the worker earns $\gamma_j w_j$, the asset value

for a shirker can be written as

$$E_j^s = w_j + \alpha_j(U_j - E_j^s) \Rightarrow E_j^s = \frac{w_j + \alpha_j \gamma_j w_j}{1 + \alpha_j}. \quad (26)$$

The no-shirking condition $E^{ns} \geq E^s$ leads to $E^{ns} = E^s$ in equilibrium. Hence, using Equations (25) and (26), the wage can be written as:

$$w_j = \frac{1 + \alpha_j}{\alpha_j(1 - \gamma_j)} e_j. \quad (27)$$

As in the case of bargaining, wages can be solved without knowledge of ϑ_j . ϑ_j can be solved by using the **job creation curve** given in the main text:

$$\begin{aligned} \frac{1 + \alpha_j}{\alpha_j(1 - \gamma_j)} e_j &= p_j - \frac{P_j c_j}{m_j \vartheta_j^\mu} \Rightarrow \\ \vartheta_j^\mu &= \left(\frac{m_j}{P_j c_j} \right) \left(p_j - \frac{1 + \alpha_j}{\alpha_j(1 - \gamma_j)} e_j \right). \end{aligned} \quad (28)$$

Now assume that effort e_j can be expressed in terms of prices p_j as $e_j = \xi_j p_j$. Then we can simplify Equation (28) to:

$$\vartheta_j = \left(\frac{p_j}{P_j} \right)^{1/\mu} \left(\frac{c_j}{m_j} \tilde{\Omega}_j \right)^{-1/\mu}, \quad (29)$$

with $\tilde{\Omega}_j = \frac{\alpha_j(1-\gamma_j)}{\alpha_j(1-\gamma_j)-(1+\alpha_j)\xi_j}$, which corresponds to Equation (4).

GDP in country j can be derived by replacing u_j in $y_j = w_j(1 - u_j)L_j$ using Equation (3) from the main text and Equation (29), and w_j by using Equation (27):

$$y_j = \frac{1 + \alpha_j}{\alpha_j(1 - \gamma_j)} e_j m_j \left(\frac{p_j}{P_j} \right)^{\frac{1-\mu}{\mu}} \left(\frac{c_j}{m_j} \tilde{\Omega}_j \right)^{\frac{\mu-1}{\mu}} L_j, \quad (30)$$

which corresponds to Equation (5).

Counterfactual employment can be calculated using the definition of u_j given in Equation (3) in the main text, replacing ϑ_j by the expression given

in Equation (29) and defining $\tilde{\Xi}_j = m_j \left(\frac{c_j}{m_j} \tilde{\Omega}_j \right)^{\frac{\mu-1}{\mu}}$ and $\hat{\kappa}_j = \Xi_j^c / \Xi_j$

$$\frac{1 - u_i^c}{1 - u_i} = \hat{\kappa}_j \left(\frac{p_i^c}{p_i} \right)^{\frac{1-\mu}{\mu}} \left(\frac{P_i}{P_i^c} \right)^{\frac{1-\mu}{\mu}}. \quad (31)$$

which exactly corresponds to Equation (10) in the main text except for the replacement of $\hat{\kappa}_j$ by $\tilde{\kappa}_j$. Hence, when assuming that labor market institutions do not change, we can proceed as with bargained wages to calculate employment effects.

Counterfactual GDPs can be calculated by using again $e_j = \xi_j p_j$, which leads to:

$$y_j = \frac{1 + \alpha_j}{\alpha_j(1 - \gamma_j)} \xi_j p_j m_j \left(\frac{p_j}{P_j} \right)^{\frac{1-\mu}{\mu}} \left(\frac{c_j}{m_j} \tilde{\Omega}_j \right)^{\frac{\mu-1}{\mu}} L_j. \quad (32)$$

Defining $\check{\Xi}_j = m_j \left(\frac{c_j}{m_j} \tilde{\Omega}_j \right)^{\frac{\mu-1}{\mu}}$, we can write:

$$y_j = \frac{1 + \alpha_j}{\alpha_j(1 - \gamma_j)} \xi_j p_j \left(\frac{p_j}{P_j} \right)^{\frac{1-\mu}{\mu}} \check{\Xi}_j L_j. \quad (33)$$

Now take the ratio of counterfactual GDP, y_j^c , and observed GDP, y_j , and note that the labor force, L_j , stays constant:

$$y_j^c = \check{v}_j \frac{p_j^c \left(\frac{p_j^c}{P_j^c} \right)^{\frac{1-\mu}{\mu}}}{p_j \left(\frac{p_j}{P_j} \right)^{\frac{1-\mu}{\mu}}} = \check{v}_j \left(\frac{p_j^c}{p_j} \right)^{\frac{1}{\mu}} \left(\frac{P_j}{P_j^c} \right)^{\frac{1-\mu}{\mu}} y_j, \quad (34)$$

where $\check{v}_j = \tilde{v}_j^c / \tilde{v}_j = (1 + \alpha_j^c) / (1 + \alpha_j) \alpha_j (1 - \gamma_j) / [\alpha_j^c (1 - \gamma_j^c)] \xi_j^c / \xi_j \tilde{\Xi}_j^c / \tilde{\Xi}_j$. Then, using Equation (9) from the main text and the fact that $\tilde{P}_j^{1-\sigma} = \sum_i (y^W / \tilde{y}^W) t_{ij}^{1-\sigma} \mathbf{t}_i$, we end up with exactly the same expression as given in the result in Implication 3 in the main text except for the replacement of \tilde{v}_j by \check{v}_j . Hence, we can calculate counterfactual GDP as in the case of bargained wages. Similarly, counterfactual trade flows and welfare can be calculated as in the case with bargained wages.

F A Ricardian trade model with imperfect labor markets following Eaton and Kortum (2002)

In the following, we introduce search and matching frictions in the Ricardian model of international trade by Eaton and Kortum (2002) and show that this leads to expressions for counterfactual changes in GDP, employment, trade flows, and welfare which are isomorphic to those in the main text. Note that in the following we assume balanced trade.

The representative consumer in country j is again characterized by the utility function U_j . As in Eaton and Kortum (2002), we assume a continuum of goods $k \in [0, 1]$. Consumption of individual goods is denoted by $q(k)$, leading to the following utility function

$$U_j = \left[\int_0^1 q(k)^{\frac{\sigma-1}{\sigma}} dk \right]^{\frac{\sigma}{\sigma-1}}, \quad (35)$$

where σ is the elasticity of substitution in consumption. Again, international trade of goods from i to j imposes iceberg trade costs $t_{ij} > 1$.

Countries differ in the efficiency with which they can produce goods. We denote country i 's efficiency in producing good $k \in [0, 1]$ as $\mathfrak{z}_i(k)$. Denoting input costs in country i as \mathfrak{c}_i , the cost of producing a unit of good k in country i is then $\mathfrak{c}_i/\mathfrak{z}_i(k)$.

Taking trade barriers into account, delivering a unit of good k produced in country i to country j costs

$$p_{ij}(k) = \left(\frac{\mathfrak{c}_i}{\mathfrak{z}_i(k)} \right) t_{ij}. \quad (36)$$

Assuming perfect competition, $p_{ij}(k)$ is the price which consumers in country j would pay if they bought good k from country i . With international trade, consumers can choose from which country to buy a good. Hence, the price they actually pay for good k is $p_j(k)$, the lowest price across all sources i :

$$\underline{p}_j(k) = \min \{ p_{ij}(k); i = 1, \dots, n \}, \quad (37)$$

where n denotes the number of countries.

Let country i 's efficiency in producing good k be the realization of an independently drawn Fréchet random variable with distribution $F_i(\mathbf{z}) = e^{-T_i \mathbf{z}^{-\theta}}$, where T_i is the location parameter (also called “state of technology” by Eaton and Kortum 2002) and θ governs the variation within the distribution and thereby also the comparative advantage within the continuum of goods.

Plugging in Equation (36) in $F_i(\mathbf{z})$ leads to $G_{ij}(p) = Pr[P_{ij} \leq p] = 1 - e^{-[T_i(\mathbf{c}_i t_{ij})^{-\theta}]p^\theta}$. Noting that the distribution of prices for which a country j buys is given by $G_j(p) = Pr[P_j \leq p] = 1 - \prod_{i=1}^n [1 - G_{ij}(p)]$ leads to:

$$G_j(p) = 1 - e^{-\Phi_j p^\theta}, \quad (38)$$

where $\Phi_j = \sum_{i=1}^n T_i (\mathbf{c}_i t_{ij})^{-\theta}$.

The probability that country i provides good k at the lowest price to country j is given by (see Eaton and Kortum 2002, page 1748):

$$\pi_{ij} = \frac{T_i (\mathbf{c}_i t_{ij})^{-\theta}}{\Phi_j}. \quad (39)$$

With a continuum of goods between zero and one this is also the fraction of goods that country j buys from country i . Eaton and Kortum (2002) show that the price of a good that country j actually buys from any country i is also distributed $G_j(p)$, and that the exact price index is given by $P_j = \tilde{\Gamma} \Phi_j^{-1/\theta}$ with $\tilde{\Gamma} = [\Gamma(\frac{\theta+1-\sigma}{\theta})]^{1/(1-\sigma)}$ where Γ is the Gamma function.

The fraction of goods that country j buys from country i , π_{ij} , is also the fraction of its expenditures on goods from country i , x_{ij} , due to the fact that the average expenditures per good do not vary by source. Hence,

$$x_{ij} = \frac{T_i (\mathbf{c}_i t_{ij})^{-\theta}}{\Phi_j} y_j = \frac{T_i (\mathbf{c}_i t_{ij})^{-\theta}}{\sum_{k=1}^n T_k (\mathbf{c}_k t_{kj})^{-\theta}} y_j, \quad (40)$$

where y_j is country j 's total spending.

Assuming balanced trade, exporters' total sales (including home sales) are

equal to total expenditure and are simply given by:

$$y_i = \sum_{j=1}^n x_{ij} = T_i \mathbf{c}_i^{-\theta} \sum_{j=1}^n \frac{t_{ij}^{-\theta}}{\Phi_j} y_j. \quad (41)$$

Solving for $T_i \mathbf{c}_i^{-\theta}$ leads to:

$$T_i \mathbf{c}_i^{-\theta} = \frac{y_i}{\sum_{j=1}^n \frac{t_{ij}^{-\theta}}{\Phi_j} y_j}. \quad (42)$$

Replacing $T_i \mathbf{c}_i^{-\theta}$ in Equation (40) with this expression leads to:

$$x_{ij} = \frac{t_{ij}^{-\theta}}{\Phi_j \left(\sum_{j=1}^n \frac{t_{ij}^{-\theta}}{\Phi_j} y_j \right)} y_i y_j.$$

Using $P_j = \tilde{\Gamma} \Phi_j^{-\frac{1}{\theta}}$ to replace Φ_j in both terms of the denominator leads to:

$$x_{ij} = \frac{t_{ij}^{-\theta}}{\tilde{\Gamma}^\theta P_j^{-\theta} \left(\sum_{j=1}^n \frac{t_{ij}^{-\theta}}{\tilde{\Gamma}^\theta P_j^{-\theta}} y_j \right)} y_i y_j.$$

Define

$$\Pi_i = \left(\sum_{j=1}^n \left(\frac{t_{ij}}{P_j} \right)^{-\theta} \theta_j \right)^{-\frac{1}{\theta}},$$

and note that we can express P_j also as follows:

$$\begin{aligned} P_j &= \left(\tilde{\Gamma}^{-\theta} \Phi_j \right)^{-\frac{1}{\theta}} = \left(\tilde{\Gamma}^{-\theta} \sum_{i=1}^n T_i (\mathbf{c}_i t_{ij})^{-\theta} \right)^{-\frac{1}{\theta}} = \left(\tilde{\Gamma}^{-\theta} \sum_{i=1}^n \frac{t_{ij}^{-\theta} y_i}{\sum_{l=1}^n \frac{t_{il}^{-\theta}}{\Phi_l} y_l} \right)^{-\frac{1}{\theta}}, \\ &= \left(\sum_{i=1}^n \left(\frac{t_{ij}}{\Pi_i} \right)^{-\theta} \theta_i \right)^{-\frac{1}{\theta}}, \end{aligned}$$

where $\theta_j = y_j/y^W$ with $y^W = \sum_j y_j$. Then we can write:

$$x_{ij} = \frac{y_i y_j}{y^W} \left(\frac{t_{ij}}{\Pi_i P_j} \right)^{-\theta}.$$

Replacing $-\theta$ by $1 - \sigma$ we end up with exactly the same system as in the model by Anderson and van Wincoop (2003).

Hence, our approach can be applied to both worlds with the only difference that the interpretation differs and the roles of θ and σ have to be exchanged.

F.1 Counterfactual GDP in the Eaton and Kortum (2002) framework with perfect labor markets

We assume that there are no intermediates and one unit of the final good is produced with one unit of labor, hence $\mathbf{c}_i = w_i$. Equation (42) can be written as

$$T_i w_i^{-\theta} = \frac{y_i}{\sum_{j=1}^n \frac{t_{ij}^{-\theta}}{\Phi_j} y_j} = \frac{\theta_i}{\sum_{j=1}^n \tilde{\Gamma}^{-\theta} \left(\frac{t_{ij}}{P_j} \right)^{-\theta} \theta_j} = \tilde{\Gamma}^\theta \theta_i \Pi_i^\theta.$$

Solving for w_i leads to:

$$w_i = \tilde{\Gamma}^{-1} T_i^{\frac{1}{\theta}} \theta_i^{-\frac{1}{\theta}} \Pi_i^{-1}.$$

As $y_i = w_i L_i$, the change in GDP is given by $y_i^c/y_i = w_i^c/w_i$. Hence,

$$\frac{y_i^c}{y_i} = \frac{\tilde{\Gamma} T_i^{\frac{1}{\theta}} (\theta_i^c)^{-\frac{1}{\theta}} (\Pi_i^c)^{-1}}{\tilde{\Gamma} T_i^{\frac{1}{\theta}} \theta_i^{-\frac{1}{\theta}} \Pi_i^{-1}} = \frac{(\theta_i^c)^{-\frac{1}{\theta}} (\Pi_i^c)^{-1}}{\theta_i^{-\frac{1}{\theta}} \Pi_i^{-1}} = \left(\frac{\mathbf{t}_i^c}{\mathbf{t}_i} \right)^{-\frac{1}{\theta}},$$

where $\mathbf{t}_i = \theta_i \Pi_i^\theta$.

F.2 Counterfactuals in the Eaton and Kortum (2002) framework with imperfect labor markets

We assume that there are no intermediates and \mathfrak{z}_i units of the final good k are produced using one unit of labor. For simplicity, we omit the product index k

in the following. Denoting the net price earned by the producer by $p_i = p_{ij}/t_{ij}$, the total surplus of a successful match is given by $\mathfrak{z}_i p_i - b_i$, while the firm's rent is given by $\mathfrak{z}_i p_i - w_i$ and the worker's by $w_i - b_i$. Nash bargaining leads to $w_i - b_i = \xi_i/(1 - \xi_i)(\mathfrak{z}_i p_i - w_i)$. Using $b_i = \gamma_i w_i$ and combining leads to

$$w_i = \frac{\xi_i}{1 - \gamma_i + \xi_i \gamma_i} \mathfrak{z}_i p_i = \frac{\xi_i}{1 - \gamma_i + \xi_i \gamma_i} \mathbf{c}_i. \quad (43)$$

Firms create vacancies until all rents are dissipated. The free entry (zero profit) condition is given by $M_i/V_i(\mathfrak{z}_i p_i - w_i) = P_i c_i$. Rewriting leads to the job creation curve

$$w_i = \mathfrak{z}_i p_i - \frac{P_i c_i}{m_i \vartheta_i^{-\mu}} = \mathbf{c}_i - \frac{P_i c_i}{m_i \vartheta_i^{-\mu}}. \quad (44)$$

We can combine Equations (43) and (44) to write the wage paid by a firm as

$$w_i = \frac{\xi_i}{1 - \gamma_i + \gamma_i \xi_i - \xi_i} \frac{P_i c_i}{m_i \vartheta_i^{-\mu}}. \quad (45)$$

The wage paid by a firm producing variety k is solely determined by parameters and aggregate variables and does neither depend on its variety-specific price nor on productivity. Hence, as wages are equalized across firms, Equation (44) then implies that also \mathbf{c}_i is the same across firms, irrespective of the variety they produce. Hence the job creation and wage curve are the same for all firms and we can thus determine aggregate labor market tightness ϑ_i as the locus of intersection of both curves:

$$\vartheta_i = \left(\frac{\mathbf{c}_i}{P_i} \right)^{1/\mu} \left(\frac{c_i}{m_i} \Omega_i \right)^{-1/\mu}. \quad (46)$$

Equation (42) can be written as

$$T_i \mathbf{c}_i^{-\theta} = \frac{y_i}{\sum_{j=1}^n \frac{t_{ij}^{-\theta}}{\Phi_j} y_j} = \frac{\theta_i}{\sum_{j=1}^n \tilde{\Gamma}^{-\theta} \left(\frac{t_{ij}}{P_j} \right)^{-\theta} \theta_j} = \tilde{\Gamma}^\theta \theta_i \Pi_i^\theta.$$

Solving for \mathbf{c}_i leads to:

$$\mathbf{c}_i = \tilde{\Gamma}^{-1} T_i^{\frac{1}{\theta}} \theta_i^{-\frac{1}{\theta}} \Pi_i^{-1}. \quad (47)$$

As $y_i = w_i(1 - u_i)L_i$, the change in GDP is given by $y_i^c/y_i = (1 - u_i^c)w_i^c/[(1 - u_i)w_i]$ and replacing w_i by $\xi_i/(1 - \gamma_i + \gamma_i\xi_i)\mathbf{c}_i$ leads to

$$\begin{aligned} \frac{y_i^c}{y_i} &= \frac{(1 - u_i^c)\tilde{\Gamma}T_i^{\frac{1}{\theta}}(\theta_i^c)^{-\frac{1}{\theta}}(\Pi_i^c)^{-1}\xi_i^c(1 - \gamma_i + \gamma_i\xi_i)}{(1 - u_i)\tilde{\Gamma}T_i^{\frac{1}{\theta}}\theta_i^{-\frac{1}{\theta}}\Pi_i^{-1}\xi_i(1 - \gamma_i^c + \gamma_i^c\xi_i^c)} \\ &= \frac{(1 - u_i^c)(\theta_i^c)^{-\frac{1}{\theta}}(\Pi_i^c)^{-1}\xi_i^c(1 - \gamma_i + \gamma_i\xi_i)}{(1 - u_i)\theta_i^{-\frac{1}{\theta}}\Pi_i^{-1}\xi_i(1 - \gamma_i^c + \gamma_i^c\xi_i^c)} \\ &= \frac{(1 - u_i^c)}{(1 - u_i)} \frac{\xi_i^c(1 - \gamma_i + \gamma_i\xi_i)}{\xi_i(1 - \gamma_i^c + \gamma_i^c\xi_i^c)} \left(\frac{\mathbf{t}_i^c}{\mathbf{t}_i}\right)^{-\frac{1}{\theta}}, \end{aligned} \quad (48)$$

where $\mathbf{t}_i = \theta_i\Pi_i^\theta$.

For the change in employment (the first fraction on the right-hand side of Equation (48)) the same relationship holds as is given in the main text in Equation (10) when we remember once more that $-\theta = 1 - \sigma$. Hence, we end up with

$$\frac{y_i^c}{y_i} = \hat{v}_i \hat{\kappa}_i \left(\frac{\mathbf{t}_i^c}{\mathbf{t}_i}\right)^{-\frac{1}{\mu\theta}} \left(\frac{\sum_i t_{ij}^{-\theta} \mathbf{t}_i}{\sum_i (t_{ij}^c)^{-\theta} \mathbf{t}_i^c}\right)^{-\frac{1-\mu}{\mu\theta}}, \quad (49)$$

which is the same relationship as given in Implication 3 in the main text when we remember that we assumed balanced trade and again replace $1 - \sigma$ by $-\theta$.

Besides counterfactual employment, also counterfactual trade flows and welfare can be calculated as in the main text.

G Further results for counterfactual analyses

G.1 Further results for introducing PTAs as observed in 2006

This section reports additional results for the counterfactual analysis presented in Section 3.2.1 in the main text.

Tables 6 and 7 report goods trade changes for perfect and imperfect labor markets, respectively. Trade changes are heterogeneous across importers and exporters. To summarize this heterogeneity, we present quantiles of calculated trade flow changes across all destination countries for all exporters. Both tables report the minimum and maximum changes, along with the 0.025, 0.25, 0.5, 0.75, and 0.975 quantiles. Comparing numbers across columns for each row reveals the heterogeneity across importers, while comparing numbers across rows for each column highlights the heterogeneity across exporters.

In general, every country experiences both positive and negative bilateral trade flow changes. For example, the introduction of PTAs as observed in 2006 implies that the change in trade flows for the United Kingdom is larger than 11.94% for 25% of all countries importing goods from the United Kingdom. Turning to the trade flow results of our model with imperfect labor markets (Table 7), we find a similar pattern for trade flow changes. Again, changes are heterogeneous across importers and exporters and, again, small and remote countries experience larger changes. The implied trade flow changes differ from the case with perfect labor markets but are of similar magnitude.

The employment effects of incepting PTAs from column (5) of Table 3 in the main text are illustrated graphically in Figure 3.

G.2 Further results for a labor market reform in the U.S.

Table 8 summarizes the trade effects of the hypothetical labor market reform in the U.S. presented in Section 3.2.2 in the main text. A labor market reform in the United States spurs trade changes across the whole sample. The effects of exports by the United States range between -0.98% and 0.08%. Effects across other exporters range from -0.98% for Australia to 0.77% for Belgium and Switzerland. On average, 50% of trade flow changes are larger than 0.41%. The size pattern of the spillover effects of labor market reforms in the United States clearly depend on the distance from and trade volume of the corresponding country and the United States.

The employment effects of the counterfactual U.S. labor market reform

Table 6: Heterogeneity of comparative static trade effects of PTA inception with perfect labor markets and controlling for trade imbalances in 2006

Exporting country	Changes in exports in percent by importer quantiles						
	Min.	0.025	0.25	0.5	0.75	0.975	Max.
Australia	-30.19	-29.69	-24.57	-23.39	-21.97	20.12	20.37
Austria	-32.09	-30.93	-3.37	0.47	2.42	6.46	7.02
Belgium	-32.84	-31.70	-4.21	-0.65	1.29	5.27	5.83
Canada	-33.64	-33.57	-31.02	-30.04	-28.74	4.98	9.92
Czech Republic	-31.44	-30.27	-2.45	1.44	3.41	7.48	8.05
Denmark	-30.58	-29.40	-1.23	2.70	4.70	8.82	9.40
Finland	-29.34	-28.14	0.53	4.46	6.57	10.76	11.35
France	-29.03	-27.82	0.98	4.93	6.93	11.25	11.84
Germany	-28.36	-27.14	1.94	5.92	7.89	12.27	12.90
Greece	-28.91	-27.70	1.15	5.11	7.06	11.44	12.03
Hungary	-30.69	-29.51	-1.38	2.54	4.54	8.65	9.23
Iceland	-28.49	-27.28	2.46	5.79	7.85	22.56	24.66
Ireland	-29.78	-28.58	-0.08	3.82	5.91	10.08	10.66
Italy	-28.27	-27.05	2.06	6.05	8.02	12.44	13.04
Japan	-17.92	-17.34	-11.32	-9.96	-8.41	4.63	4.83
Korea	-18.20	-17.52	-11.49	-10.00	0.20	24.21	24.32
Netherlands	-30.80	-29.63	-1.54	2.37	4.36	8.47	9.05
New Zealand	-20.24	-19.67	-13.83	-12.48	-10.85	16.41	19.42
Norway	-30.08	-28.89	0.18	3.44	5.67	19.84	21.89
Poland	-30.37	-29.19	-0.93	2.94	5.01	9.14	9.72
Portugal	-29.53	-28.33	0.27	4.19	6.29	10.47	11.06
Slovak Republic	-31.08	-29.91	-1.94	1.97	3.95	8.04	8.61
Spain	-28.17	-26.95	2.21	6.20	8.18	12.60	13.20
Sweden	-29.75	-28.56	-0.05	3.86	5.95	10.12	10.70
Switzerland	-33.20	-32.07	-3.32	-0.46	0.95	14.50	16.45
Turkey	-28.84	-27.63	1.97	5.28	7.33	21.98	24.06
United Kingdom	-25.67	-24.41	5.76	9.90	11.94	13.58	13.61
United States	-15.89	-15.80	-12.57	-11.10	-9.54	19.13	21.00
Average	-28.33	-27.31	-3.78	-0.52	1.68	12.35	13.36

Notes: Counterfactual analysis based on parameter estimates from column (6) of Table 11 in the main text.

Table 7: Heterogeneity of comparative static trade effects of PTA inception with imperfect labor markets and controlling for trade imbalances in 2006

Exporting country	Changes in exports in percent by importer quantiles						
	Min.	0.025	0.25	0.5	0.75	0.975	Max.
Australia	-29.96	-29.51	-24.58	-23.37	-21.98	20.31	20.56
Austria	-32.05	-30.91	-3.69	0.19	2.15	6.21	6.79
Belgium	-32.82	-31.69	-4.54	-0.95	0.99	5.00	5.58
Canada	-33.61	-33.54	-30.97	-29.83	-28.67	5.28	10.21
Czech Republic	-31.39	-30.23	-2.75	1.17	3.15	7.25	7.84
Denmark	-30.52	-29.35	-1.52	2.45	4.45	8.61	9.20
Finland	-29.26	-28.08	0.26	4.20	6.34	10.57	11.17
France	-28.98	-27.79	0.66	4.61	6.67	11.00	11.61
Germany	-28.32	-27.12	1.59	5.59	7.57	12.02	12.65
Greece	-28.83	-27.64	0.87	4.84	6.81	11.24	11.85
Hungary	-30.63	-29.47	-1.68	2.29	4.29	8.43	9.02
Iceland	-28.37	-27.16	2.25	5.63	7.69	22.69	24.83
Ireland	-29.66	-28.47	-0.30	3.62	5.75	9.95	10.56
Italy	-28.21	-27.01	1.75	5.75	7.73	12.21	12.82
Japan	-17.61	-17.08	-11.28	-9.86	-8.33	4.96	5.19
Korea	-17.90	-17.28	-11.47	-9.96	0.38	24.35	24.47
Netherlands	-30.76	-29.60	-1.86	2.10	4.09	8.23	8.82
New Zealand	-20.03	-19.51	-13.88	-12.50	-10.91	16.62	19.63
Norway	-30.00	-28.82	-0.09	3.22	5.48	19.89	21.98
Poland	-30.31	-29.14	-1.23	2.65	4.76	8.93	9.52
Portugal	-29.44	-28.26	0.01	3.94	6.08	10.29	10.89
Slovak Republic	-31.03	-29.87	-2.24	1.71	3.69	7.81	8.40
Spain	-28.09	-26.88	1.92	5.93	7.92	12.40	13.02
Sweden	-29.68	-28.50	-0.33	3.58	5.71	9.92	10.52
Switzerland	-33.18	-32.06	-3.64	-0.73	0.69	14.45	16.44
Turkey	-28.74	-27.55	1.71	5.07	7.12	22.04	24.17
United Kingdom	-25.55	-24.30	5.52	9.67	11.73	13.34	13.37
United States	-15.99	-15.90	-12.64	-11.14	-9.63	19.34	21.20
Average	-28.25	-27.24	-4.01	-0.72	1.49	12.26	13.30

Notes: Counterfactual analysis based on parameter estimates from column (6) of Table 11 in the main text.

Table 8: Heterogeneity of comparative static trade effects of $\hat{\kappa}_{U.S.} = 1.03$ controlling for trade imbalances with imperfect labor markets in 2006

Exporting country	Changes in exports in percent by importer quantiles						
	Min.	0.025	0.25	0.5	0.75	0.975	Max.
Australia	-0.98	-0.91	-0.10	-0.06	-0.01	0.08	0.08
Austria	-0.34	-0.27	0.50	0.58	0.62	0.72	0.72
Belgium	-0.30	-0.23	0.55	0.63	0.66	0.76	0.77
Canada	-0.97	-0.97	-0.49	-0.45	-0.40	-0.31	-0.31
Czech Republic	-0.39	-0.32	0.46	0.54	0.58	0.68	0.68
Denmark	-0.41	-0.34	0.44	0.52	0.57	0.66	0.66
Finland	-0.47	-0.40	0.38	0.46	0.51	0.60	0.60
France	-0.38	-0.31	0.47	0.55	0.58	0.69	0.69
Germany	-0.37	-0.30	0.47	0.55	0.59	0.69	0.69
Greece	-0.44	-0.37	0.40	0.48	0.53	0.62	0.62
Hungary	-0.42	-0.35	0.43	0.51	0.56	0.65	0.65
Iceland	-0.61	-0.54	0.27	0.32	0.36	0.45	0.45
Ireland	-0.54	-0.47	0.34	0.39	0.44	0.52	0.52
Italy	-0.41	-0.34	0.44	0.52	0.57	0.66	0.66
Japan	-0.44	-0.38	0.40	0.48	0.53	0.62	0.62
Korea	-0.46	-0.39	0.39	0.47	0.52	0.61	0.61
Netherlands	-0.36	-0.29	0.48	0.56	0.60	0.70	0.70
New Zealand	-0.85	-0.78	0.03	0.07	0.12	0.20	0.21
Norway	-0.46	-0.39	0.38	0.46	0.51	0.60	0.60
Poland	-0.41	-0.34	0.43	0.51	0.56	0.65	0.65
Portugal	-0.48	-0.41	0.36	0.44	0.49	0.58	0.58
Slovak Republic	-0.41	-0.34	0.44	0.52	0.57	0.65	0.66
Spain	-0.45	-0.38	0.39	0.47	0.52	0.61	0.61
Sweden	-0.44	-0.37	0.40	0.48	0.53	0.62	0.62
Switzerland	-0.29	-0.22	0.55	0.63	0.67	0.76	0.77
Turkey	-0.47	-0.41	0.37	0.45	0.50	0.59	0.59
United Kingdom	-0.60	-0.53	0.28	0.33	0.37	0.46	0.46
United States	-0.98	-0.91	-0.10	-0.06	-0.01	0.07	0.08
Average	-0.50	-0.44	0.33	0.41	0.45	0.54	0.54

Notes: Counterfactual analysis based on parameter estimates from column (6) of Table 11 in the main text.

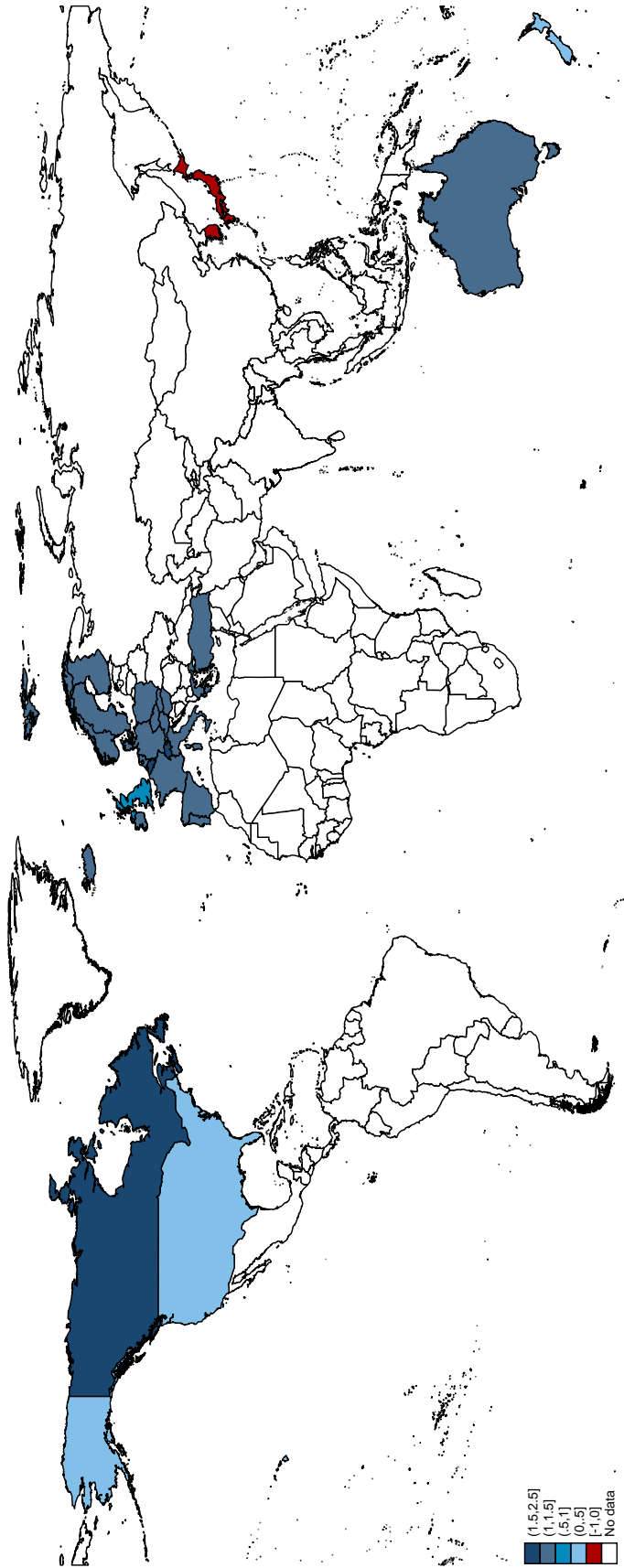


Figure 3: Employment effects of incepting PTAs as observed in 2006.

from column (5) of Table 5 are graphically illustrated in Figure 4.

G.3 Evaluating the effects of counterfactually undoing the recent German labor market reforms

In the following, we present the results of counterfactually undoing the recent labor market reforms in Germany as alluded to in the last paragraph of Section 3.2.2 in the main text.

Table 9 presents the main results, and Table 10 the corresponding trade effects. As can be seen, undoing the German labor market reforms would increase unemployment in Germany by about 4 percentage points, and welfare would be more than 3 percent lower. Most importantly, we see that abolishing German labor market reforms would have negative spillover effects in all trading partners of Germany. Whereas the net effect on unemployment rates in the trading partners is negligible given our parameter estimates, welfare effects are not: Austria's welfare would be about 0.9 percent lower without German labor market reforms. This is also reflected in the trade effects reported in Table 10. Austria's exports would change between 0.5 and 1.2 percent across its importing partners. Again, trade effects are heterogeneous across countries.

H Results with balanced trade

The following Tables present the results for the same counterfactual experiments as presented in Section 3.2 in the main text but we assume balanced trade throughout, i.e. $\tilde{y}_j = y_j$ and $\tilde{\theta}_j = \theta_j$. Results basically remain the same, both qualitatively and quantitatively. Note that imposing balanced trade also affects the estimates for σ and μ , whereas the estimated trade cost coefficients do not change by construction (see Table 11).

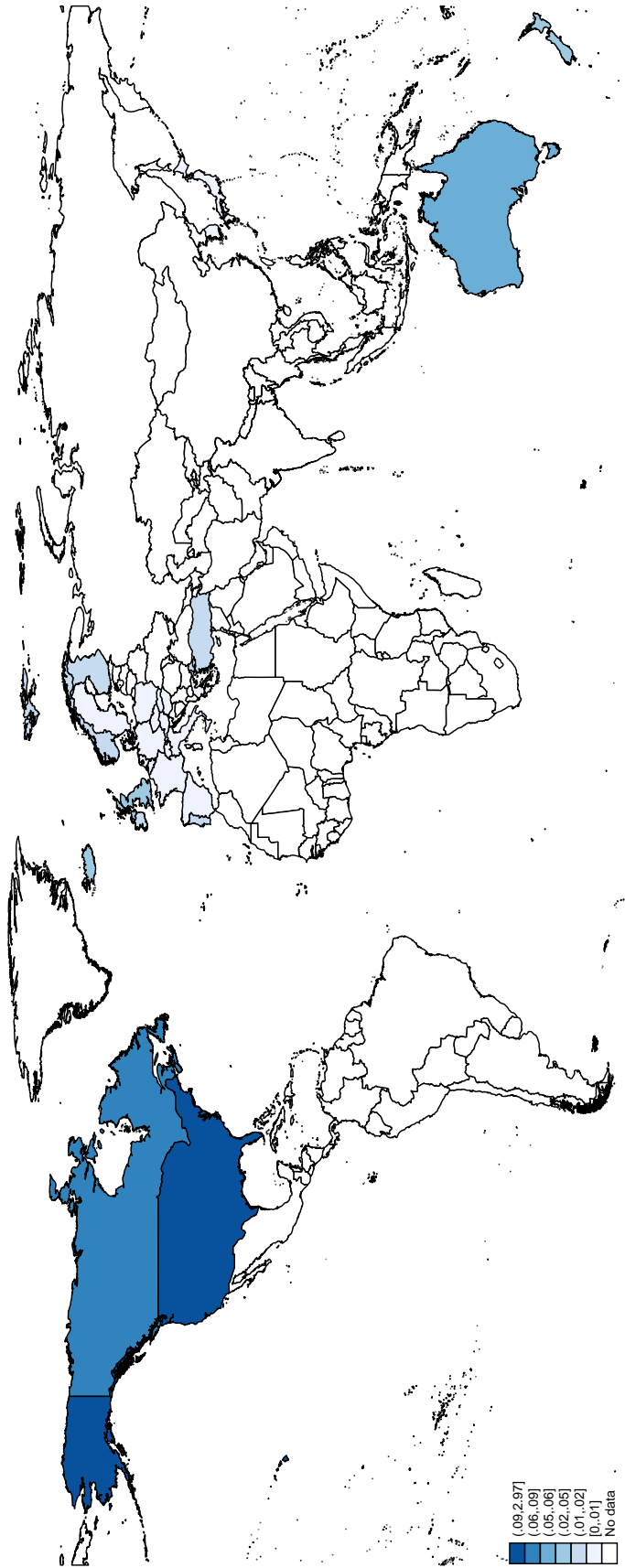


Figure 4: Employment effects of a hypothetical labor market reform in the United States ($\hat{\kappa}_{US} = 1.03$).

H.1 Introducing PTAs as observed in 2006

Table 12 presents the results from incepting PTAs as observed in 2006 starting from a counterfactual situation without any PTAs assuming balanced trade. Tables 13 and 14 present the changes in trade flows for both perfect and imperfect labor markets, similar to Tables 6 and 7.

H.2 Different parameter values for elasticities

Table 15 presents the robustness checks for different parameter values for the elasticity of substitution and the matching elasticity assuming balanced trade.

H.3 Evaluating the effects of a labor market reform in the U.S.

Tables 16 and 17 present the results from the counterfactual labor market reform in the U.S. assuming balanced trade.

H.4 Evaluating the effects of counterfactually undoing the recent German labor market reforms

Tables 18 and 19 present the results of counterfactually undoing the recent labor market reforms in Germany assuming balanced trade.

Table 9: Comparative static effects of undoing recent German labor market reforms controlling for trade imbalances in 2006

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	PLM	SMF	share %GDP	SMF	SMF	SMF	PLM	SMF
	%GDP	%GDP	$\% \ln(\hat{p})$	$\% \ln(\hat{e})$	$\% \hat{e}$	Δu	%EV	%EV
Australia	0.00	-0.02	92.75	7.25	-0.00	0.00	0.00	-0.03
Austria	0.00	-0.35	82.14	17.86	-0.06	0.06	0.00	-0.89
Belgium	0.00	-0.29	82.44	17.56	-0.05	0.05	0.00	-0.72
Canada	0.00	-0.01	98.28	1.72	-0.00	0.00	0.00	-0.01
Czech Republic	0.00	-0.22	82.44	17.56	-0.04	0.04	0.00	-0.56
Denmark	0.00	-0.22	82.59	17.41	-0.04	0.04	0.00	-0.55
Finland	0.00	-0.09	84.05	15.95	-0.02	0.02	0.00	-0.23
France	0.00	-0.13	83.00	17.00	-0.02	0.02	0.00	-0.34
Germany	0.00	-4.58	-37.14	100.89	-4.63	4.16	0.00	-3.13
Greece	0.00	-0.08	83.99	16.01	-0.01	0.01	0.00	-0.21
Hungary	0.00	-0.12	83.20	16.80	-0.02	0.02	0.00	-0.30
Iceland	0.00	-0.08	84.47	15.53	-0.01	0.01	0.00	-0.20
Ireland	0.00	-0.05	85.86	14.14	-0.01	0.01	0.00	-0.12
Italy	0.00	-0.09	83.56	16.44	-0.02	0.02	0.00	-0.24
Japan	0.00	-0.03	92.24	7.76	-0.00	0.00	0.00	-0.04
Korea	0.00	-0.03	91.42	8.58	-0.00	0.00	0.00	-0.05
Netherlands	0.00	-0.21	82.72	17.28	-0.04	0.04	0.00	-0.53
New Zealand	0.00	-0.02	92.76	7.24	-0.00	0.00	0.00	-0.03
Norway	0.00	-0.12	83.57	16.43	-0.02	0.02	0.00	-0.29
Poland	0.00	-0.20	82.61	17.39	-0.04	0.03	0.00	-0.49
Portugal	0.00	-0.07	84.47	15.53	-0.01	0.01	0.00	-0.17
Slovak Republic	0.00	-0.12	83.13	16.87	-0.02	0.02	0.00	-0.31
Spain	0.00	-0.08	84.19	15.81	-0.01	0.01	0.00	-0.19
Sweden	0.00	-0.12	83.49	16.51	-0.02	0.02	0.00	-0.30
Switzerland	0.00	-0.24	82.24	17.76	-0.04	0.04	0.00	-0.60
Turkey	0.00	-0.09	84.07	15.93	-0.02	0.01	0.00	-0.21
United Kingdom	0.00	-0.09	84.21	15.79	-0.02	0.01	0.00	-0.22
United States	0.00	-0.03	91.18	8.82	-0.00	0.00	0.00	-0.05
Average	0.00	-0.43	78.53	18.52	-0.39	0.35	0.00	-0.39

Notes: Counterfactual analysis based on parameter estimates from column (6) of Table 11. PLM gives results assuming perfect labor markets. SMF gives results using a search and matching framework for the labor market. Averages are weighted averages using country GDP as weight.

Table 10: Heterogeneity of comparative static trade effects of undoing recent German labor market reforms controlling for trade imbalances with imperfect labor markets in 2006

Exporting country	Changes in exports in percent by importer quantiles						
	Min.	0.025	0.25	0.5	0.75	0.975	Max.
Australia	-0.25	-0.25	-0.08	-0.02	0.18	0.56	0.59
Austria	0.49	0.49	0.62	0.71	0.81	1.15	1.17
Belgium	0.34	0.34	0.47	0.56	0.66	1.14	1.19
Canada	-0.25	-0.25	-0.10	-0.05	0.16	0.54	0.57
Czech Republic	0.18	0.19	0.32	0.41	0.51	1.01	1.04
Denmark	0.18	0.19	0.31	0.40	0.50	1.00	1.03
Finland	-0.10	-0.09	0.03	0.13	0.34	0.72	0.75
France	-0.01	-0.00	0.12	0.21	0.42	0.81	0.84
Germany	-0.02	-0.02	0.11	0.20	0.41	0.80	0.83
Greece	-0.12	-0.12	0.01	0.11	0.31	0.70	0.72
Hungary	-0.04	-0.04	0.09	0.18	0.40	0.78	0.81
Iceland	-0.12	-0.12	0.01	0.11	0.31	0.70	0.73
Ireland	-0.20	-0.19	-0.02	0.03	0.24	0.62	0.65
Italy	-0.10	-0.10	0.03	0.12	0.34	0.72	0.75
Japan	-0.24	-0.24	-0.07	-0.01	0.19	0.58	0.61
Korea	-0.24	-0.23	-0.07	-0.01	0.20	0.58	0.61
Netherlands	0.17	0.17	0.30	0.39	0.49	0.99	1.02
New Zealand	-0.25	-0.25	-0.08	-0.02	0.18	0.56	0.59
Norway	-0.05	-0.04	0.08	0.17	0.39	0.77	0.80
Poland	0.13	0.14	0.26	0.35	0.45	0.95	0.98
Portugal	-0.15	-0.15	-0.02	0.08	0.28	0.67	0.70
Slovak Republic	-0.03	-0.03	0.10	0.19	0.40	0.79	0.82
Spain	-0.14	-0.14	-0.01	0.09	0.30	0.68	0.71
Sweden	-0.04	-0.03	0.09	0.18	0.40	0.78	0.81
Switzerland	0.22	0.23	0.35	0.44	0.55	1.04	1.07
Turkey	-0.12	-0.11	0.01	0.11	0.32	0.70	0.73
United Kingdom	-0.11	-0.10	0.02	0.12	0.33	0.71	0.74
United States	-0.24	-0.24	-0.07	-0.01	0.19	0.57	0.60
Average	-0.04	-0.04	0.10	0.18	0.37	0.77	0.80

Notes: Counterfactual analysis based on parameter estimates from column (6) of Table 11 in the main text.

Table 11: Estimation results for OECD sample, 1950-2006, assuming balanced trade

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	PPML	OLS	PPML	OLS	PPML	OLS	PPML
	$\ln z_{ijt}$	z_{ijt}	$\ln x_{ijt}$	x_{ijt}	$\ln z_{ijt}$	z_{ijt}	$\ln x_{ijt}$	x_{ijt}
Second stage								
$\ln DIST_{ij}$	-1.050*** (0.009)	-0.669*** (0.027)	-1.041*** (0.010)	-0.816*** (0.010)	-1.050*** (0.009)	-0.669*** (0.027)	-1.040*** (0.010)	-0.813*** (0.010)
$CONTIG_{ij}$	0.097*** (0.019)	0.276*** (0.030)	0.116*** (0.019)	0.414*** (0.018)	0.097*** (0.019)	0.275*** (0.030)	0.115*** (0.019)	0.414*** (0.018)
$COMLANG_{ij}$	0.386*** (0.019)	0.769*** (0.049)	0.387*** (0.019)	0.150*** (0.017)	0.386*** (0.019)	0.769*** (0.049)	0.387*** (0.019)	0.151*** (0.017)
First stage								
PTA_{ijt}	0.274*** (0.016)	0.308*** (0.019)	0.267*** (0.017)	0.332*** (0.019)	0.274*** (0.014)	0.311*** (0.016)	0.276*** (0.015)	0.341*** (0.013)
Estimated elasticities								
σ	2.361*** (0.174)	2.506*** (0.045)	2.371*** (0.606)	2.383*** (0.560)	2.362*** (0.019)	2.507*** (0.048)	2.373*** (0.491)	2.383*** (0.449)
μ	0.947*** (0.003)	0.928*** (0.007)	0.946*** (0.009)	0.939*** (0.006)	0.947*** (0.001)	0.928*** (0.007)	0.945*** (0.006)	0.939*** (0.005)
zero trade		X		X		X		X
symmetric t_{ijt}	X	X	X	X				
asymmetric t_{ijt}					X	X	X	X
N	36,945	37,741	37,493	38,313	36,945	37,741	37,493	38,313

Notes: Results for trade flows between 28 OECD countries between 1950 and 2006 estimated by ordinary least squares (OLS) and Poisson pseudo-maximum-likelihood (PPML). z_{ij} are trade flows standardized by importer and exporter GDPs. $\ln DIST$ is distance between exporting and importing country, $CONTIG$ is an indicator variable equal to 1 if the exporting and importing countries i and j share a common border, $COMLANG$ is an indicator variable equal to 1 if the exporting and importing country share a common official language, and PTA is an indicator variable equal to 1 if the exporting and importing country have signed a preferential trade agreement. All regressions control for multilateral resistance terms (MRTs) via exporter and importer fixed effects. (Robust) standard errors in parentheses, *** $p < 0.01$. Standard errors for σ and μ are bootstrapped using 200 replications.

Table 12: Comparative static effects of PTA inception assuming balanced trade in 2006

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	PLM	SMF	share %GDP	SMF	SMF	SMF	PLM	SMF
	%GDP	%GDP	$\% \ln(\hat{p})$	$\% \ln(\hat{e})$	$\% \hat{e}$	Δu	%EV	%EV
Australia	16.69	17.64	92.78	7.22	1.18	-1.11	16.69	17.64
Austria	18.31	19.61	91.78	8.22	1.48	-1.39	21.05	22.60
Belgium	18.79	20.17	91.53	8.47	1.57	-1.42	22.37	24.04
Canada	21.05	22.53	90.63	9.37	1.92	-1.77	28.68	30.16
Czech Republic	17.82	19.06	92.04	7.96	1.40	-1.28	19.74	21.19
Denmark	17.25	18.40	92.37	7.63	1.30	-1.23	18.19	19.54
Finland	16.44	17.48	92.87	7.13	1.16	-1.05	16.04	17.24
France	16.26	17.30	92.97	7.03	1.13	-1.02	15.56	16.79
Germany	15.65	16.61	93.39	6.61	1.02	-0.91	13.94	15.10
Greece	16.22	17.23	93.01	6.99	1.12	-1.01	15.45	16.62
Hungary	17.30	18.46	92.33	7.67	1.31	-1.19	18.34	19.70
Iceland	15.88	16.80	93.27	6.73	1.05	-1.01	14.54	15.56
Ireland	16.63	17.65	92.77	7.23	1.18	-1.12	16.52	17.67
Italy	15.69	16.64	93.37	6.63	1.03	-0.95	14.05	15.17
Japan	9.59	9.62	101.02	-1.02	-0.09	0.09	-1.27	-1.29
Korea	9.74	9.79	100.70	-0.70	-0.07	0.06	-0.92	-0.91
Netherlands	17.20	18.36	92.39	7.61	1.29	-1.22	18.06	19.44
New Zealand	10.79	11.02	98.71	1.29	0.13	-0.13	1.63	1.88
Norway	16.80	17.88	92.64	7.36	1.22	-1.16	16.99	18.23
Poland	17.14	18.28	92.43	7.57	1.28	-1.09	17.90	19.23
Portugal	16.55	17.59	92.80	7.20	1.17	-1.07	16.33	17.52
Slovak Republic	17.57	18.77	92.18	7.82	1.35	-1.16	19.06	20.47
Spain	15.73	16.67	93.35	6.65	1.03	-0.93	14.15	15.24
Sweden	16.70	17.77	92.70	7.30	1.20	-1.10	16.71	17.96
Switzerland	19.06	20.48	91.40	8.60	1.61	-1.53	23.11	24.81
Turkey	16.11	17.09	93.10	6.90	1.10	-0.97	15.15	16.27
United Kingdom	14.21	14.93	94.57	5.43	0.76	-0.71	10.20	11.02
United States	10.26	10.43	99.60	0.40	0.04	-0.04	0.35	0.54
Average	13.14	13.70	96.61	3.39	0.56	-0.51	7.68	8.32

Notes: Counterfactual analysis based on parameter estimates from column (6) of Table 11. PLM gives results assuming perfect labor markets. SMF gives results using a search and matching framework for the labor market. Averages are weighted averages using country GDP as weight.

Table 13: Heterogeneity of comparative static trade effects of PTA inception with perfect labor markets assuming balanced trade in 2006

Exporting country	Changes in exports in percent by importer quantiles						
	Min.	0.025	0.25	0.5	0.75	0.975	Max.
Australia	-29.91	-29.39	-24.14	-22.93	-21.50	20.63	20.88
Austria	-32.29	-31.15	-3.53	0.33	2.32	6.34	6.92
Belgium	-32.98	-31.85	-4.26	-0.68	1.28	5.27	5.84
Canada	-33.36	-33.29	-30.74	-29.71	-28.40	5.31	10.25
Czech Republic	-31.59	-30.44	-2.53	1.37	3.37	7.44	8.03
Denmark	-30.75	-29.59	-1.33	2.61	4.64	8.76	9.35
Finland	-29.55	-28.36	0.39	4.27	6.47	10.66	11.26
France	-29.27	-28.08	0.78	4.68	6.78	11.10	11.70
Germany	-28.33	-27.12	2.13	6.08	8.13	12.56	13.19
Greece	-29.21	-28.01	0.87	4.77	6.80	11.19	11.80
Hungary	-30.83	-29.67	-1.45	2.50	4.52	8.64	9.23
Iceland	-28.68	-27.47	2.32	5.69	7.78	22.41	24.49
Ireland	-29.82	-28.64	-0.00	3.87	6.05	10.23	10.83
Italy	-28.39	-27.18	2.04	5.99	8.04	12.48	13.09
Japan	-17.98	-17.37	-11.23	-9.95	-8.27	4.67	4.89
Korea	-18.25	-17.56	-11.42	-9.90	0.20	24.38	24.49
Netherlands	-30.68	-29.51	-1.23	2.72	4.75	8.88	9.47
New Zealand	-20.18	-19.59	-13.61	-12.24	-10.61	16.46	19.44
Norway	-30.08	-28.90	0.31	3.61	5.87	20.00	22.03
Poland	-30.59	-29.42	-1.11	2.72	4.88	9.01	9.61
Portugal	-29.71	-28.52	0.16	4.03	6.22	10.40	11.01
Slovak Republic	-31.23	-30.07	-2.01	1.91	3.92	8.02	8.61
Spain	-28.45	-27.24	1.95	5.89	7.95	12.38	12.99
Sweden	-29.93	-28.75	-0.16	3.71	5.89	10.06	10.66
Switzerland	-33.36	-32.24	-3.42	-0.52	0.91	14.38	16.31
Turkey	-29.03	-27.84	1.81	5.16	7.24	21.80	23.87
United Kingdom	-26.03	-24.79	5.39	9.47	11.59	13.17	13.19
United States	-15.79	-15.71	-12.48	-10.97	-9.45	19.02	20.88
Average	-28.44	-27.42	-3.80	-0.55	1.69	12.35	13.37

Notes: Counterfactual analysis based on parameter estimates from column (6) of Table 11.

Table 14: Heterogeneity of comparative static effects of PTA inception with imperfect labor markets and assuming balanced trade in 2006

Exporting country	Changes in exports in percent by importer quantiles						
	Min.	0.025	0.25	0.5	0.75	0.975	Max.
Australia	-29.68	-29.21	-24.15	-22.91	-21.51	20.83	21.08
Austria	-32.25	-31.12	-3.84	0.06	2.04	6.10	6.70
Belgium	-32.96	-31.84	-4.59	-0.98	0.98	5.00	5.59
Canada	-33.33	-33.27	-30.68	-29.62	-28.34	5.61	10.54
Czech Republic	-31.54	-30.40	-2.84	1.11	3.11	7.22	7.82
Denmark	-30.69	-29.54	-1.63	2.36	4.39	8.55	9.16
Finland	-29.47	-28.29	0.11	4.01	6.24	10.47	11.09
France	-29.22	-28.04	0.46	4.37	6.52	10.85	11.47
Germany	-28.29	-27.09	1.78	5.74	7.81	12.30	12.94
Greece	-29.13	-27.95	0.59	4.51	6.55	11.00	11.62
Hungary	-30.77	-29.62	-1.74	2.25	4.27	8.42	9.03
Iceland	-28.55	-27.36	2.11	5.53	7.62	22.53	24.65
Ireland	-29.70	-28.53	-0.22	3.66	5.89	10.10	10.72
Italy	-28.33	-27.13	1.73	5.69	7.75	12.25	12.88
Japan	-17.65	-17.10	-11.17	-9.80	-8.18	5.02	5.26
Korea	-17.94	-17.31	-11.39	-9.84	0.40	24.53	24.65
Netherlands	-30.64	-29.49	-1.56	2.44	4.47	8.63	9.24
New Zealand	-19.97	-19.43	-13.67	-12.26	-10.66	16.68	19.65
Norway	-30.00	-28.83	0.03	3.38	5.68	20.04	22.12
Poland	-30.53	-29.37	-1.40	2.44	4.64	8.80	9.41
Portugal	-29.62	-28.45	-0.11	3.78	6.01	10.23	10.85
Slovak Republic	-31.17	-30.03	-2.31	1.65	3.67	7.79	8.40
Spain	-28.37	-27.18	1.67	5.62	7.69	12.18	12.82
Sweden	-29.86	-28.69	-0.44	3.43	5.65	9.86	10.48
Switzerland	-33.33	-32.22	-3.73	-0.79	0.65	14.33	16.30
Turkey	-28.94	-27.75	1.55	4.95	7.03	21.86	23.97
United Kingdom	-25.92	-24.68	5.15	9.24	11.38	12.93	12.94
United States	-15.89	-15.81	-12.55	-11.02	-9.54	19.23	21.08
Average	-28.35	-27.35	-4.03	-0.75	1.51	12.26	13.30

Notes: Counterfactual analysis based on parameter estimates from column (6) of Table 11.

Table 15: Average comparative static effects of PTA inception assuming balanced trade for various parameter values

μ	σ	PLM %GDP	SMF %GDP	SMF % \hat{e}	SMF % Δu	PLM %EV	SMF %EV
0.2	5	4.86	16.76	11.90	-9.23	2.75	15.23
	10	2.15	7.13	5.00	-4.22	1.20	6.33
	15	1.38	4.53	3.16	-2.74	0.77	3.98
0.5	5	4.86	7.60	2.75	-2.41	2.75	5.66
	10	2.15	3.35	1.20	-1.08	1.20	2.44
	15	1.38	2.15	0.77	-0.70	0.77	1.55
0.75	5	4.86	5.75	0.90	-0.81	2.75	3.71
	10	2.15	2.55	0.40	-0.36	1.20	1.61
	15	1.38	1.64	0.25	-0.23	0.77	1.03
0.9	5	4.86	5.15	0.30	-0.27	2.75	3.07
	10	2.15	2.28	0.13	-0.12	1.20	1.34
	15	1.38	1.47	0.08	-0.08	0.77	0.85
0.99	5	4.86	4.89	0.03	-0.03	2.75	2.78
	10	2.15	2.16	0.01	-0.01	1.20	1.21
	15	1.38	1.39	0.01	-0.01	0.77	0.78

Notes: Table reports average changes in nominal GDP, employment, and the equivalent variation in percent assuming either a perfect labor market (PLM) or using a search and matching framework (SMF) for the labor market with varying elasticity of substitution σ and elasticity of the matching function μ .

Table 16: Comparative static effects of $\hat{\kappa}_{U.S.} = 1.03$ assuming balanced trade in 2006

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	PLM	SMF	share	%GDP	SMF	SMF	PLM	SMF
	%GDP	%GDP	$\% \ln(\hat{p})$	$\% \ln(\hat{e})$	$\% \hat{e}$	Δu	%EV	%EV
Australia	0.00	0.79	92.78	7.22	0.06	-0.05	0.00	0.79
Austria	0.00	0.51	98.69	1.31	0.01	-0.01	0.00	0.09
Belgium	0.00	0.49	99.36	0.64	0.00	-0.00	0.00	0.04
Canada	0.00	0.96	90.80	9.20	0.09	-0.08	0.00	1.23
Czech Republic	0.00	0.52	98.12	1.88	0.01	-0.01	0.00	0.14
Denmark	0.00	0.53	97.88	2.12	0.01	-0.01	0.00	0.16
Finland	0.00	0.56	97.15	2.85	0.02	-0.01	0.00	0.22
France	0.00	0.52	98.20	1.80	0.01	-0.01	0.00	0.13
Germany	0.00	0.52	98.25	1.75	0.01	-0.01	0.00	0.13
Greece	0.00	0.55	97.32	2.68	0.01	-0.01	0.00	0.20
Hungary	0.00	0.54	97.71	2.29	0.01	-0.01	0.00	0.17
Iceland	0.00	0.62	95.60	4.40	0.03	-0.03	0.00	0.38
Ireland	0.00	0.59	96.29	3.71	0.02	-0.02	0.00	0.30
Italy	0.00	0.53	97.79	2.21	0.01	-0.01	0.00	0.16
Japan	0.00	0.54	97.50	2.50	0.01	-0.01	0.00	0.19
Korea	0.00	0.55	97.32	2.68	0.01	-0.01	0.00	0.20
Netherlands	0.00	0.51	98.45	1.55	0.01	-0.01	0.00	0.11
New Zealand	0.00	0.73	93.60	6.40	0.05	-0.04	0.00	0.65
Norway	0.00	0.56	97.17	2.83	0.02	-0.02	0.00	0.22
Poland	0.00	0.54	97.76	2.24	0.01	-0.01	0.00	0.17
Portugal	0.00	0.57	96.87	3.13	0.02	-0.02	0.00	0.25
Slovak Republic	0.00	0.53	97.81	2.19	0.01	-0.01	0.00	0.16
Spain	0.00	0.55	97.22	2.78	0.02	-0.01	0.00	0.21
Sweden	0.00	0.55	97.43	2.57	0.01	-0.01	0.00	0.19
Switzerland	0.00	0.48	99.41	0.59	0.00	-0.00	0.00	0.04
Turkey	0.00	0.56	96.98	3.02	0.02	-0.02	0.00	0.24
United Kingdom	0.00	0.62	95.73	4.27	0.03	-0.02	0.00	0.36
United States	0.00	2.54	-16.66	116.66	2.97	-2.83	0.00	2.54
Average	0.00	1.30	55.06	44.94	1.11	-1.06	0.00	1.10

Notes: Counterfactual analysis based on parameter estimates from column (6) of Table 11. PLM gives results assuming perfect labor markets. SMF gives results using a search and matching framework for the labor market. Averages are weighted averages using country GDP as weight.

Table 17: Heterogeneity of comparative static trade effects of $\hat{\kappa}_{U.S.} = 1.03$ with imperfect labor markets and assuming balanced trade in 2006

Exporting country	Changes in exports in percent by importer quantiles						
	Min.	0.025	0.25	0.5	0.75	0.975	Max.
Australia	-0.98	-0.91	-0.10	-0.05	-0.01	0.08	0.08
Austria	-0.36	-0.29	0.48	0.56	0.60	0.71	0.71
Belgium	-0.31	-0.24	0.53	0.60	0.65	0.74	0.75
Canada	-0.98	-0.98	-0.49	-0.45	-0.40	-0.31	-0.31
Czech Republic	-0.40	-0.33	0.44	0.52	0.56	0.67	0.67
Denmark	-0.41	-0.35	0.43	0.50	0.56	0.65	0.65
Finland	-0.47	-0.40	0.37	0.45	0.50	0.59	0.59
France	-0.39	-0.32	0.45	0.53	0.57	0.67	0.67
Germany	-0.39	-0.32	0.45	0.53	0.57	0.68	0.68
Greece	-0.46	-0.39	0.38	0.47	0.52	0.61	0.61
Hungary	-0.43	-0.36	0.41	0.49	0.55	0.64	0.64
Iceland	-0.61	-0.54	0.27	0.31	0.36	0.45	0.45
Ireland	-0.55	-0.48	0.33	0.38	0.43	0.52	0.52
Italy	-0.42	-0.35	0.42	0.50	0.55	0.64	0.64
Japan	-0.44	-0.37	0.40	0.47	0.53	0.62	0.62
Korea	-0.46	-0.39	0.38	0.47	0.51	0.61	0.61
Netherlands	-0.37	-0.30	0.47	0.54	0.59	0.69	0.69
New Zealand	-0.85	-0.78	0.03	0.07	0.12	0.21	0.21
Norway	-0.47	-0.40	0.37	0.45	0.50	0.59	0.59
Poland	-0.42	-0.35	0.42	0.49	0.55	0.64	0.64
Portugal	-0.50	-0.43	0.35	0.43	0.48	0.57	0.57
Slovak Republic	-0.42	-0.35	0.42	0.50	0.55	0.64	0.65
Spain	-0.47	-0.40	0.37	0.46	0.51	0.60	0.60
Sweden	-0.45	-0.38	0.39	0.47	0.52	0.62	0.62
Switzerland	-0.31	-0.24	0.53	0.61	0.65	0.75	0.75
Turkey	-0.49	-0.42	0.35	0.44	0.49	0.58	0.58
United Kingdom	-0.60	-0.53	0.28	0.32	0.37	0.46	0.46
United States	-0.98	-0.91	-0.10	-0.06	-0.01	0.08	0.08
Average	-0.51	-0.45	0.32	0.39	0.44	0.54	0.54

Notes: Counterfactual analysis based on parameter estimates from column (6) of Table 11.

Table 18: Comparative static effects of undoing recent German labor market reforms assuming balanced trade in 2006

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	PLM	SMF	share %GDP	SMF	SMF	SMF	PLM	SMF
	%GDP	%GDP	$\% \ln(\hat{p})$	$\% \ln(\hat{e})$	$\% \hat{e}$	Δu	%EV	%EV
Australia	0.00	-0.03	92.78	7.22	-0.00	0.00	0.00	-0.03
Austria	0.00	-0.39	82.93	17.07	-0.07	0.06	0.00	-0.91
Belgium	0.00	-0.31	83.13	16.87	-0.05	0.05	0.00	-0.73
Canada	0.00	-0.02	99.31	0.69	-0.00	0.00	0.00	-0.00
Czech Republic	0.00	-0.25	83.41	16.59	-0.04	0.04	0.00	-0.57
Denmark	0.00	-0.24	83.44	16.56	-0.04	0.04	0.00	-0.56
Finland	0.00	-0.11	85.05	14.95	-0.02	0.02	0.00	-0.23
France	0.00	-0.16	84.19	15.81	-0.02	0.02	0.00	-0.34
Germany	0.00	-4.58	-37.40	101.08	-4.63	4.15	0.00	-3.11
Greece	0.00	-0.10	85.33	14.67	-0.02	0.01	0.00	-0.21
Hungary	0.00	-0.14	84.42	15.58	-0.02	0.02	0.00	-0.31
Iceland	0.00	-0.10	85.40	14.60	-0.01	0.01	0.00	-0.20
Ireland	0.00	-0.07	87.07	12.93	-0.01	0.01	0.00	-0.12
Italy	0.00	-0.12	84.98	15.02	-0.02	0.02	0.00	-0.24
Japan	0.00	-0.03	91.78	8.22	-0.00	0.00	0.00	-0.04
Korea	0.00	-0.04	91.06	8.94	-0.00	0.00	0.00	-0.05
Netherlands	0.00	-0.23	83.49	16.51	-0.04	0.04	0.00	-0.54
New Zealand	0.00	-0.03	92.76	7.24	-0.00	0.00	0.00	-0.03
Norway	0.00	-0.14	84.54	15.46	-0.02	0.02	0.00	-0.29
Poland	0.00	-0.22	83.58	16.42	-0.04	0.03	0.00	-0.50
Portugal	0.00	-0.09	85.83	14.17	-0.01	0.01	0.00	-0.18
Slovak Republic	0.00	-0.15	84.35	15.65	-0.02	0.02	0.00	-0.32
Spain	0.00	-0.10	85.59	14.41	-0.01	0.01	0.00	-0.19
Sweden	0.00	-0.14	84.46	15.54	-0.02	0.02	0.00	-0.30
Switzerland	0.00	-0.27	83.31	16.69	-0.04	0.04	0.00	-0.62
Turkey	0.00	-0.11	85.25	14.75	-0.02	0.01	0.00	-0.22
United Kingdom	0.00	-0.11	85.21	14.79	-0.02	0.01	0.00	-0.22
United States	0.00	-0.04	91.25	8.75	-0.00	0.00	0.00	-0.04
Average	0.00	-0.44	78.90	18.15	-0.39	0.35	0.00	-0.39

Notes: Counterfactual analysis based on parameter estimates from column (6) of Table 11. PLM gives results assuming perfect labor markets. SMF gives results using a search and matching framework for the labor market. Averages are weighted averages using country GDP as weight.

Table 19: Heterogeneity of comparative static trade effects of undoing recent German labor market reforms assuming balanced trade with imperfect labor markets in 2006

Exporting country	Changes in exports in percent by importer quantiles						
	Min.	0.025	0.25	0.5	0.75	0.975	Max.
Australia	-0.26	-0.26	-0.10	-0.05	0.15	0.53	0.56
Austria	0.53	0.54	0.65	0.74	0.84	1.18	1.20
Belgium	0.37	0.37	0.49	0.58	0.68	1.15	1.20
Canada	-0.26	-0.26	-0.13	-0.08	0.13	0.50	0.53
Czech Republic	0.22	0.23	0.34	0.43	0.53	1.02	1.05
Denmark	0.21	0.22	0.33	0.42	0.52	1.01	1.04
Finland	-0.08	-0.08	0.04	0.13	0.33	0.71	0.74
France	0.02	0.02	0.14	0.23	0.43	0.81	0.84
Germany	0.01	0.01	0.12	0.21	0.42	0.80	0.83
Greece	-0.10	-0.10	0.02	0.11	0.31	0.69	0.72
Hungary	-0.01	-0.01	0.10	0.19	0.40	0.78	0.81
Iceland	-0.11	-0.10	0.01	0.11	0.31	0.69	0.71
Ireland	-0.18	-0.18	-0.02	0.03	0.23	0.61	0.64
Italy	-0.08	-0.07	0.04	0.13	0.34	0.72	0.75
Japan	-0.26	-0.25	-0.10	-0.04	0.16	0.54	0.57
Korea	-0.25	-0.24	-0.09	-0.04	0.17	0.54	0.57
Netherlands	0.19	0.20	0.31	0.40	0.50	0.99	1.02
New Zealand	-0.26	-0.26	-0.10	-0.05	0.15	0.53	0.56
Norway	-0.03	-0.02	0.09	0.18	0.39	0.77	0.79
Poland	0.16	0.17	0.28	0.37	0.47	0.96	0.99
Portugal	-0.13	-0.13	-0.01	0.08	0.28	0.66	0.69
Slovak Republic	-0.00	0.00	0.11	0.20	0.41	0.79	0.82
Spain	-0.12	-0.12	-0.00	0.09	0.30	0.67	0.70
Sweden	-0.02	-0.02	0.10	0.19	0.40	0.77	0.80
Switzerland	0.27	0.27	0.39	0.47	0.57	1.06	1.09
Turkey	-0.10	-0.09	0.02	0.12	0.32	0.70	0.73
United Kingdom	-0.09	-0.09	0.02	0.12	0.32	0.70	0.73
United States	-0.25	-0.25	-0.09	-0.04	0.17	0.54	0.57
Average	-0.02	-0.02	0.11	0.19	0.37	0.77	0.79

Notes: Counterfactual analysis based on parameter estimates from column (6) of Table 11 in the main text.