Trade and the (dis)incentive to reform labor markets: The case of reform in the European Union ☆

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ARTICLE INFO

ABSTRACT

We study the relation between international trade and the gains to reform labor markets by removing firing restrictions. We find that trade linkages imply substantially smaller benefits to reform than those calculated in the closed economy general equilibrium model of Hopenhayn and Rogerson [Hopenhayn, Hugo, Rogerson, Richard, 1993. Job Turnover and policy evaluations: a general equilibrium analysis. Journal of Political Economy 101 (5), 915–938 October]. When economies trade, labor market policies in one country spill over to other countries through their effect on the terms of trade. A key finding in the open economy is that the share of the welfare gains from domestic labor market reform exported substantially exceeds the share of goods exported. Thus, with international trade, a country retains little to no benefit from unilaterally reforming its labor market. A coordinated elimination of firing taxes yields considerable benefits. We also find that the U.K. benefits from labor market reform by its continental trading partners. These insights provide some explanation for recent efforts toward labor market reform in the European Union.

1. Introduction

Continental European labor markets are characterized by a number of regulations which limit the willingness of firms to create and destroy jobs. These policies appear to contribute to the generally higher levels of unemployment in Europe relative to the U.S. Among these regulations, Hopenhayn and Rogerson (1993) and Veracierto (2001) find that firing restrictions also generate significant welfare costs. Despite these costs individual European economies maintain these policies. Some recent discussions of reform have occurred within the multilateral framework of the European Union. In these discussion, the U.K., the country with the fewest regulations of job turnover, is the strongest proponent of reforming firing restrictions.

This article has three goals. First, we seek to understand the reluctance of individual European countries to eliminate unilaterally firing restrictions. Second, we would like to explain why labor market reform is being initiated through multilateral

channels. And third, we would like to understand why the U.K. is pushing for labor market reform by its trading partners. For this purpose, we develop a two-country general equilibrium model of establishment dynamics and international trade. The model is calibrated to European data and the effect of firing taxes is analyzed.

This article is closely related to the analysis of firing taxes by Hopenhayn and Rogerson (1993) and Veracierto (2001).[2] It extends their analysis by introducing international trade and permits us to analyze the international transmission of domestic firing restrictions.[3] Given that European economies are tightly integrated through trade, this provides a more accurate measure of the welfare costs of removing firing restrictions for European economies. It also allows us to consider the role of trade in maintaining these firing tax policies.

The economy considered is a two-country, two-good model of Ricardian trade with heterogeneous production establishments. Each country specializes in the production of a single good. Within each country, this good is produced by a large number of heterogeneous firms facing persistent idiosyncratic technology shocks. Firms respond to these shocks by entering and exiting, expanding and contracting over time. Firing taxes distort employment decisions as firms are less prone to hire and fire workers. Thus, firing taxes create both a productive inefficiency and competitive inefficiency. The productive inefficiency occurs as the firing costs imply that the marginal product of labor is not equal across firms. The competitive inefficiency occurs because all firms will eventually exit so that firing taxes are a tax on the lifecycle of a firm. Combined, these two effects lead to a reduction in aggregate employment and output. Previous work quantifies the magnitude of these effects and determines the implication for welfare in the closed economy. In this paper, we show that with international trade the reduction in output improves the terms of trade of the country with the firing costs and provides a possible benefit to domestic agents.[4] It implies that some of the welfare costs of this policy are borne by foreign agents.

We find that firing taxes equal to eleven months of wages reduce steady state output by 4.13%, consumption by 3.22%, and employment by 4.50% in the country with the firing taxes. These effects are similar to Hopenhayn and Rogerson (1993) and Veracierto (2001).[5] However, in contrast to their work however, we find smaller welfare costs to these policies. There are two reasons we find smaller welfare costs. First, in contrast to previous work, we evaluate the impact of exempting small firms from firing restrictions. Since most firms are small this reduces the distortions at the firm level. Second, and more central to this paper, we consider the impact of international trade linkages. We find that these firing taxes have a sizable effect on a country's trading partners, reducing foreign consumption by 0.92% through a 3.06% worsening of its terms of trade. Because of this trade linkage, we find that unilaterally eliminating firing taxes lowers welfare by 0.04% of steady state consumption in the country undertaking reform and raises the trading partner's welfare by 0.92% of steady state consumption. This large spillover occurs even with moderate amounts of international trade of 30% of GDP. Consequently, by welfare measures, countries have very little incentive to eliminate these firing costs. Moreover, countries without firing taxes, like the UK, have the most to gain from reform by their trading partners.

A key finding in the open economy is that the share of the welfare gains from domestic labor market reform exported substantially exceeds the share of goods exported. In our baseline case, 105% of the gains are exported even though the domestic economy only exports 30% of its goods. That the share of welfare gains is about 3 and half times the share of trade is perhaps surprising. Firing costs reduce the incentive to work and thus artificially reduce the supply of a country's goods, improving its terms of trade. Eliminating these firing taxes leads workers to supply more labor. The country's welfare gain is the difference between the utility gain from increased consumption and the utility loss from reduced leisure. However, the increased supply of the domestic good also worsens the country's terms of trade, which lowers the domestic economy's real income and reduces the consumption gain.[6] In our baseline case, the terms of trade effect lowers the consumption gain in proportion to the trade share without affecting the utility loss from reduced leisure. Thus the share of the welfare gains exported substantially exceeds the share of goods exported and trade linkages weaken the incentive to reform. This is true for a wide range of values for the elasticity of substitution between domestic and foreign goods. We find that the proportion of the welfare gains from domestic reform that are exported increases with the reformer's total trade share, while the benefits to its trading partners increase with the bilateral trade share.

For France, Germany and Italy, we find that the gains to unilaterally reforming labor markets tend to be negative or small so that there is little incentive to change from the status quo. On the other hand, the gains to a coordinated elimination of firing taxes by European economies are relatively large, providing a welfare gain of approximately 0.88% of lifetime consumption. In contrast, Mendoza and Tesar (2005) find that the welfare gains to international coordination of more conventional capital and labor taxes

[2] Bentolila and Bertola (1990) and Millard and Mortensen (1997) find that firing taxes reduce both job creation and job destruction and thus have an ambiguous effect on employment. Delacroix (2003) and Ljungqvist (2002) determine how the net effect on employment depends on the nature and timing of firing costs.

[3] Fogli (2000) and Saint-Paul (2002a) have attributed the emergence and persistence of these labor market policies to political economy considerations. Saint-Paul (2000) suggests that under certain conditions a two-tier reform system may be successful in implementing reform. We abstract from this channel to focus on the international transmission of these policies and the interaction between countries. These interactions imply that a multilateral approach is necessary for successful reform.

[4] All of the benefits in this model are due to the change in the terms of trade. Alvarez and Veracierto (2001) consider the potential benefits of firing restrictions when there are financial and relocation frictions. To the extent that firing costs contribute to lower employment and output, the mechanism outlined here will have the same effect.

[5] This negative effect of firing restrictions on the rate of employment finds empirical support in Boeri e al. (2000), Heckman and Pagés (2000) and Nickell (1997) who find a negative relationship between the two in OECD and Latin American countries, after controlling for other labor market policies. Bassanini and Duval (2006) find that the effect is stronger for demographic groups with less attachment to the labor market (such as prime-aged females and young workers).

[6] The results are similar to those in the optimal tariff literature summarized by Corden (1984). Much like a tariff, the labor market restrictions considered reduce the supply of a country's goods thereby improving its terms of trade. Unlike tariffs though, these labor market distortions can distort productivity.

are approximately 0.28% of lifetime consumption. Moreover, we find that continental labor market reform would raise welfare in the U.K., a large trading partner of these continental economies, by 0.21% of lifetime consumption.

This paper is related to two strands of research. First, there is a literature that investigates the economic effects of domestic labor market distortions and international trade.[7] Most work in this area focuses on minimum wage policies and the pattern of comparative advantage and employment.[8],[9] Closely related to our work is Saint-Paul (2002b), who studies the effect of firing costs on the pattern of trade.[10] In a model with a product lifecycle, Saint-Paul finds that firing taxes shift countries toward industries with stable demand — mature goods late in the product lifecycle. In this environment firing taxes will lower world welfare but may improve domestic welfare when specializing in the secondary innovation yields efficiency gains. Second, recent work by Albuquerque and Rebelo (2000), Melitz (2003), and Ruhl (2005) use models of establishment dynamics to study trade policy. Unlike these papers, our emphasis is on understanding how domestic labor market policies distort establishment-level decisions and affect international trade and welfare.

The paper is organized as follows. Section 2 summarizes some recent developments in Europe to reform labor markets. Section 3 describes the baseline model. In Section 4, we discuss the competitive equilibrium, and in Section 5 the model is calibrated to a composite of the three largest European economies for which firing costs are considered to be high — France, Germany, and Italy. In Section 6, the quantitative effects of a change in policy are analyzed. Section 7 explores the sensitivity of the results to the amount of trade and the strength of the terms of trade effect. The results do not change qualitatively. Section 8 concludes and considers possible extensions.

2. The European context

Beginning with the 1997 Luxembourg Extraordinary European Council Meeting on Employment, and continuing in subsequent Council meetings, the member states of the European Union have met to discuss the unemployment situation in Europe.[11] The result is the *European Employment Strategy* (EES), which seeks to improve employability, develops entrepreneurship, encourages adaptability in businesses and their employees, and strengthens the policies for equal opportunities.[12] The EES emphasizes the use of funded active labor market policies such as training, employment subsidies and job search assistance, with little reference to employment protection legislation (EPL). The EES is carried out through an "open method of coordination" between Member States. The European Council in Lisbon in 2000 built upon the foundations of the Luxembourg Summit and set a new strategic goal for the next decade, defined as the *Lisbon Strategy*, to "become the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion," with policies aiming at "modernizing the European social model by investing in people and building an active welfare state." It also refined the coordination method by agreeing that, every year, the European council should agree on employment guidelines for each Member State.

The EES provided for an impact evaluation five years after the Luxembourg summit.[13] Not surprisingly, given the initial focus of the EES, almost all changes reported involve active labor market policies. In fact, the few modifications to the employment protection legislation in various European countries since 1998 have shown no clear trend, some reforms or proposals corresponding to liberalization of EPL, others to its tightening (Young, 2003).[14] It is to be noticed, however, that starting in 2001, the Council recommendations for the individual countries did mention the need to adapt employment regulations "to ensure a balance between flexibility and security for the labour force."

The *Lisbon Strategy* can be contrasted with the U.K.'s approach toward labor market reform. For that, one can look at speeches made by the Chancellor of the Exchequer at the U.K. Treasury. Going back to 1997 — and prior to the Luxembourg summit, a special summit of the G8 was organized in the U.K. Chancellor Brown commented that "employability is the key to a cohesive society which offers opportunity to all its citizens… This is a new economic agenda. It enables us to benefit from flexible labor markets… We intend to make this a key to both our Presidency of the G8 and the European Union."[15] Following the G8 summit, Chancellor Brown commented on the *London Principles* resulting from the conference, which include "the need for structural reforms in our labor markets."[16] Finally, in February 2002, the UK Treasury and Department of Trade and Industry jointly published a White paper

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[7] Bhagwati (1971) provides a concise summary of the theory of international trade under domestic distortions.

[8] Brecher (1974) finds that minimum wage policies may reverse the pattern of comparative advantage. Davis (1998a,b) shows that when there is international trade minimum wage policies generate considerably more unemployment than in a closed economy.

[9] Calmfors (2001) and Sibert and Sutherland (2000) study the incentive to reform labor markets in a monetary union. These papers focus on the use of monetary policy to reduce structural unemployment and respond to asymmetric shocks through a temporary change in the terms of trade.

[10] Samaniego (2006) relates cross-country differences in firing taxes to the international pattern of production and adoption of information technology.

[11] The European Council brings together the heads of state or government of the fifteen member states of the European Union and the president of the European Commission. The decisions taken at the European Council meetings are a major impetus in defining the general political guidelines of the European Union.

[12] See the Presidency Conclusions to the various Council Meetings.

[13] Impact Evaluation of the European Employment Strategy — Technical Analysis, supporting COM(2002) 416 final of 17.7.2002.

[14] Although EPL tightened across Europe in the 1960s and 1970s, changes since the 1980s have also shown no clear trend. The introduction of fixed-term contracts has been the only significant change (in some countries,) but its use has also been regulated in some countries (Bertola et al., 1999).

[15] "Employability to top the agenda in the U.K. G8 conference," UK Treasury press release, May 29, 1997. Another press release prior to the Luxembourg summit, dated July 18, 1997, is entitled "Chancellor takes job crusade to Europe."

[16] "G8 employability action plans published," UK Treasury press release, May 9, 1998.

"Realizing Europe's Potential," emphasizing the challenging reforms ahead, in particular "a commitment to better regulation across Europe… slashing red tape… and to more intelligent regulation stimulating enterprises amongst our business community."[17]

In fairness, there is harmony between the *Lisbon Strategy* and the *London Principles* on active labor market policies. However, the *London Principles* also emphasize reform aimed at labor market flexibility. Our model allows us to address two related questions. First, why is the U.K., which has already reformed its EPL, pushing for such reforms in the rest of Europe? Second, which is the better way to achieve reform for the European countries, unilateral reform or concerted action at the pan-European level?

3. Model

The following framework generalizes the environment developed by Hopenhayn and Rogerson (1993) to an international context.[18] There are two dominant approaches to modelling international trade. First, there are models in which trade is based on differences between countries. These are commonly referred to as models of national product differentiation and include models where countries differ by technology, preferences, or endowment. The second approach is built on increasing returns to scale. While both models provide plausible explanations for trade, the evidence favors the national product differentiation and leads us to adopt this approach.[19]

Assume there are two countries, $i = 1, 2$, each producing an imperfectly substitutable good,[20] denoted by χ and γ. Country 1 specializes in the production of good χ and country 2 specializes in good γ. At time t, the price of a unit of good χ is p_t and the price of a unit of good γ is q_t.

In each country a large number of firms produce the domestic good. Each firm uses labor as its only input and begins the period with a stock of workers from the previous period, n_{t-1}. At the beginning of the period, firms are subjected to an idiosyncratic productivity shock, s_t, and respond by adjusting their employment levels. A firm in country 1 facing a price of p_t for its output makes period profits of

$$p_t f(s_t, n_t) - w_{it} n_t - g_i(n_t, n_{t-1}),$$

where $g_i(n_t, n_{t-1})$ is a cost the firm incurs to adjust its employment level from n_{t-1} to n_t. This adjustment cost may differ across countries due to different labor market policies. We focus on the role of firing costs and assume that firms must make a fixed payment of $\tau_i w_i$ for each job they destroy so that

$$g_i(n_t, n_{t-1}) = \begin{cases} \tau_i \cdot w_i \cdot \max\{0, n_{t-1} - n_t\} & \text{if } n_{t-1} \geq \text{threshold}, \\ 0 & \text{otherwise}, \end{cases}$$

where w_i is the wage prevailing in the current period. This structure for firing costs reflects the practice in European economies to exempt small firms from such regulations.

The firm specific shocks are independent across firms, but the stochastic process for shocks is common to all firms. The shock s_t follows a first order Markov process and takes discrete values in a set S. The transition function $Q(s, s')$ defines the probability $s_{t+1} = s' \in S$ given $s_t = s$. A special element of that set is $s = 0$. Firms that receive the zero productivity shock will never receive a positive productivity shock again ($Q(0, 0) = 1$) and are viewed as exiting the market.[21] To exit the market a firm must fire all of its current workers and pay any dismissal costs. As exiting firms have no revenue, its dismissal payment is covered by the owners of the firm.

Next, consider the decision of potential entrants. There are a large number of ex-ante identical potential entrants in each period. Entrants must incur a one-time up-front cost of c_e denominated in units of the locally produced good.[22] Entrants incur this cost at the end of period t and then can enter the market in period $t+1$: In period $t+1$; each entrant draws an idiosyncratic shock from the probability distribution $v(s)$ and then hires workers and begins production. An entrant in period t becomes an incumbent with no stock of past employees in period $t+1$. The distribution of v is the same each period and does not depend on the number of new entrants or existing firms.

The preferences of agents in each country are characterized by the expected utility function

$$u_i = E_0 \sum_{t=0}^{\infty} \beta^t [u(c_{it}) - v(n_{it})],$$

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where c_{it} and n_{it} are consumption and hours worked in country i. Consumption is a composite of the foreign and domestic goods with

$$c_{1t} = c(x_{1t}, y_{1t}),$$

$$c_{2t} = c(y_{2t}, x_{2t}).$$

We follow Hansen (1985) and Rogerson (1988) and assume that labor is indivisible and allows agents to trade lotteries on the probability of working. Indivisibility of labor is now a common assumption in computable models. In this context, this assumption is necessary for the number of employees at a firm to be well defined. The economy behaves as if there was a representative agent with preferences defined by

$$V_i = \sum_{t=0}^{\infty} \beta^t [u(c_{it}) - AN_{it}],$$

where N_{it} is the fraction of agents in country i employed at time t. Every period, households purchase consumption using income received from supplying labor, profits of Π_{it} from owning firms, and lump-sum transfers of R_{it} from the government.[23] These transfers are rebates to consumers of the firing costs collected from the firms. Firms are owned exclusively by domestic consumers and there is no intertemporal asset trade. The period budget constraint of a country i consumer in period t is

$$p_t x_{it} + q_t y_{it} = w_{it} N_{it} + \Pi_{it} + R_{it}.$$

We abstract from international asset trade for two reasons. First, empirically there is substantial evidence of home bias in asset ownership (Lewis, 1999) and very little evidence of risk sharing across countries (Backus and Smith, 1993). Our second reason is more practical. With international asset trade, a country will by definition share the welfare gains to its domestic labor market policies. With no trade in assets, the budget constraints imply the following trade balance equation

$$p_t x_{2t} = q_t y_{1t}.$$

4. Competitive equilibrium

This section describes a stationary competitive equilibrium. With firing taxes, the firm's problem is dynamic as firms maximize the expected value of discounted profits net of firing costs. The individual state of a firm is its stock of workers from the last period, e, and its current productivity level, s. The problem of firms in country 1 is described by the following Bellman equation

$$V_1(s, e) = \max_{n \geq 0} \left\{ pf(s, n) - w_1 n - g_1(n, e) + \frac{1}{1 + \rho} \sum_{s'} V_1(s', n) Q(s, s') \right\}.$$

A similar problem exists for firms from country 2. This problem leads to a well-defined policy rule, $N_1(s, e)$ which can be used to determine period profits (π) and firing cost payments (r):

$$\pi_1(s, e) = pf(s, N_1(s, e)) - w_1 N_1(s, e) - g_1(N_1(s, e), e),$$

$$r_1(s, e) = g_1(N_1(s, e), e).$$

For new entrants, the value of entering is equal to the discounted expected value of beginning tomorrow with technology s and no workers, where the shock s is drawn from the distribution v. The free entry condition then implies that

$$pc_e = \frac{1}{1 + \rho} \sum_s V_1(s, 0) v(s),$$

$$qc_e = \frac{1}{1 + \rho} \sum_s V_2(s, 0) v(s),$$

in countries 1 and 2 respectively.

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[23] Firing costs are treated as transfers since they include severance payments. An alternate approach would assume that these costs involve a deadweight loss. This would substantially increase the costs of these policies. This is considered in Alessandria and Delacroix (2004).

The state of the economy is characterized by the distribution of individual firm state variables in each country. Let μ_i denote the measure over employment and productivity levels (e, s) of incumbent firms in country i. In period t, this measure does not include the entrants that incurred the fixed cost in period $t-1$, but have yet to produce. These entrants are included as incumbents in the $t+1$ distribution μ'_i. Let M_i represent the mass of entrants. The transition from μ_i to μ'_i is denoted by $\mu'_i = T(\mu_i, M_i)$. In a stationary economy, $\mu_i = T(\mu_i, M_1)$.

Having defined the measure of incumbents and entrants, some aggregates can be computed. Let $X(\mu_1, M_1)$ represent the amount of good χ produced in country 1. Let $\Pi_1(\mu_1, M_1)$ represent aggregate profits of country 1 firms. Let $R_1(\mu_1, M_1)$ represent aggregate adjustment costs and let $N_1^d(\mu_1, M_1)$ denote the aggregate demand for labor by country 1 firms. Similar variables can be defined in country 2.

$$X(\mu_1, M_1) = \sum_{s \times e} f[N_1(s, e), s]\mu_1(s, e) + M_1 \sum_s f[N_1(s, 0), s]v(s),$$

$$\Pi_1(\mu_1 M_1) = \sum_{s \times e} \pi_1(s, e)\mu_1(s, e) + M_1 \sum_s \pi_1(s, 0)v(s) - M_1 pc_e,$$

$$R_1(\mu_1, M_1) = \sum_{s \times e} r_1(s, e)\mu_1(s, e),$$

$$N_1^d(\mu_1, M_1) = \sum_{s \times e} N_1(s, e)\mu_1(s, e) + M_1 \sum_s N_1(s, 0)v(s).$$

In a stationary equilibrium, the consumer's problem reduces to the following static optimization problem,

$$U_i = \max_{x_i, y_i, N_i} u_i(x_i, y_i) - AN_i,$$

s.t. $px_i + qy_i = w_iN_i + \Pi_i + R_i$.

The solution to this problem is characterized by the following first order conditions

$$\frac{\partial u_i}{\partial x_i} = A\frac{p}{w_i},$$

$$\frac{\partial u_i}{\partial y_i} = A\frac{q}{w_i}.$$

The labor supply can be solved from the budget constraint as

$$N_i^s = \frac{px_i + qy_i - \Pi_i - R_i}{w_i}.$$

Finally, the market clearing conditions are

$$x_1 + x_2 = X - M_1c_e,$$

$$y_1 + y_2 = Y - M_2c_e.$$

As in Hopenhayn and Rogerson (1993), for accounting purposes, we define GDP$_\chi = x_1 + x_2$ and GDP$_\gamma = y_1 + y_2$. The fixed start-up costs are treated similarly to intermediate inputs in the national accounts.

5. Calibration

The parameter values are chosen so that the steady state in the model matches certain features of a composite of the German, French, and Italian economies. These countries are our baseline as their firing costs are similar and large (Bentolila and Bertola, 1990) and they are fairly well integrated economically. Following these authors, firing restrictions are set as 90% of annual wages.[24] To reflect actual European regulations, we assume that firms with less than 15 employees are exempt from paying firing costs.

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[24] They calculate firing costs to be (as a fraction of annual wages) 0.73 in Germany, 0.93 in France, and 1.05 in Italy. Lazear (1990) finds severance payments of close to a year as well. In a study of the Italian economy, Garibaldi and Violante (2005) find that firms incur considerably higher firing costs.

Table 1

Estimates of γ

		GER	FRA	UK	ITA
OLS	Coeff.	1.79	1.31	1.27	1.03
	T-statistic	6.53	9.89	16.90	6.45
	Adj. *R*-sq.	0.61	0.80	0.91	0.65
TSLS [a]	Coeff.	0.26	0.22	0.07	0.18
	T-statistic	2.13	1.96	0.50	1.96
	Adj. *R*-sq.	0.98	0.98	0.99	0.97

Correlation of terms of trade with Y [b]

	GER	FRA	UK	ITA
P/Pm	−0.38	−0.35	−0.16	−0.13

P: gdp deflator, Pm: import price deflator.
[a] Using lagged relative prices as instrument and regressing on lagged relative quantity.
[b] Data are for 1981:1 to 2002:4 and are hp filtered using a smoothing parameter of 1600.

Throughout the calibration, values for the composite European country are obtained by using weights for the three countries that reflect their employment shares.[25]

Parameters linked to aggregate data are straightforward to choose. A period is one year so that the discount factor is set to 0.964, which corresponds to a 4% annual interest rate. The production function is chosen to be

$$f(s, n) = s n^{\theta},$$

where the parameter θ is set to 0.64 to match labor's share of income. The entry cost is chosen so that the price level equals the domestic wage.[26]

The utility function and consumption aggregator have the following functional forms,

$$u(c) = \ln c(x, y),$$

$$c(x, y) = \left[\omega x^{\frac{\gamma-1}{\gamma}} + (1 - \omega) y^{\frac{\gamma-1}{\gamma}} \right]^{\frac{\gamma}{\gamma-1}}.$$

As in Hopenhayn and Rogerson (1993) and Veracierto (2001), the utility is logarithmic in the consumption aggregator.

The form of consumption aggregation is common in the international trade literature (Armington, 1969). The impact of domestic labor market policies is determined in part by international trade linkages. Given the consumption aggregator, these linkages depend entirely on the elasticity of substitution γ and the home-bias parameter $\omega > 1/2$ (countries put a higher weight on their domestically produced good). Estimates of γ vary widely in the literature depending on whether time series or cross sectional techniques are used on aggregate or disaggregate data. Time series[27] studies estimate the Armington elasticity by regressing changes in trade flows on changes in relative prices. While some studies find that some individual goods[28] are highly substitutable across countries, at the aggregate level elasticities are much lower, in the range of 0:5 to 1:5. These values are consistent with those used in the international business cycle research (Backus et al., 1992; Heathcoate and Perri, 2002; Corsetti et al., 2003) to reconcile the movements in the terms of trade with trade flows.

We estimate the elasticity of substitution between imports and domestic goods for the U.K., Germany, Italy, and France using the following first order condition,

$$\ln \frac{x_{1,t}}{y_{1,t}} = \gamma \ln \frac{\omega}{1 - \omega} - \gamma \ln \frac{p_{x,t}}{p_{y,t}} + \varepsilon_t, \tag{1}$$

where $\frac{p_{x,t}}{p_{y,t}}$ measures country 1's terms of trade. As our focus is on the long run relationship between relative prices and relative quantities, we estimate this equation in levels. The data are discussed in the Appendix A and results are reported in Table 1. Estimates of the Armington elasticity range between 1:03 for Italy and 1:79 for Germany, consistent with the evidence from previous studies.[29] Given the distribution of estimates, we focus on the case where $\gamma = 1:25$ and discuss the sensitivity of our results to this value in Section 7.

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[25] The employment shares are from the IMF's International Financial Statistics database.
[26] This normalization is done since one cannot disentangle whether a high firm value is due to a high price or to a high expected value of idiosyncratic productivity.
[27] See Stern et al. (1976), Shiells et al. (1986), and Shiells and Reinert (1993).
[28] Cross sectional studies estimate the Armington elasticity by regressing imports on a distance related measure of trade costs. An example of this is Hummels (2001) which estimates an elasticity of substitution of between 2 and 5 at the one digit SIC level.
[29] The OLS estimates are 1.79 for Germany, 1.31 for France, 1.27 for the U.K. and 1.03 for Italy (see Table 1) Given concerns over endogeneity — specifically that demand shocks from cuts in tariffs and trade cost — might bias these estimates upwards, we also estimated the elasticity using two-stage least square. These results, although not as significant, actually suggest substantially lower elasticity estimates. We retained the estimate leading to the most conservative terms of trade effect. It is also very close to the equivalent estimate in Acemoglu and Ventura (2002).
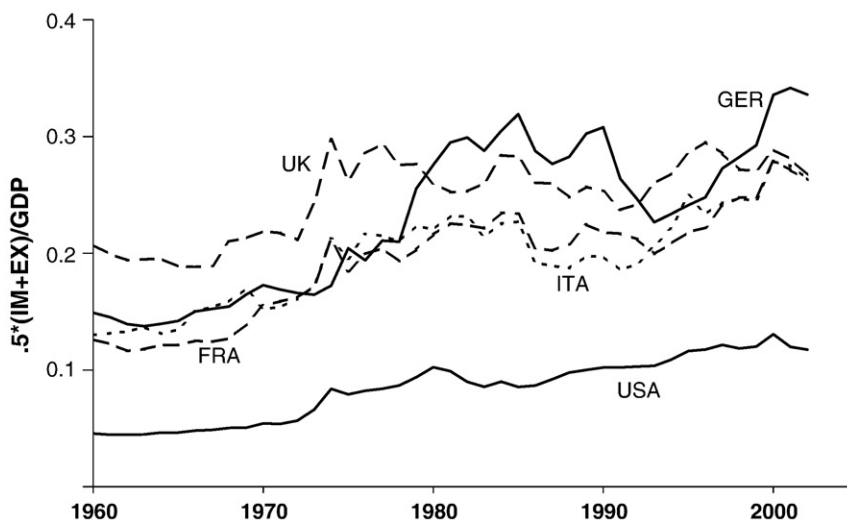
Fig. 1. Trade shares over time.

To determine the amount of trade integration, we compute the trade share of GDP as

$$\text{Trade Share} = \frac{\text{EXPORTS} + \text{IMPORTS}}{2*\text{GDP}},$$

where exports and imports measure trade in goods and services. With trade shares of about 30%, these European countries are fairly open compared to the US, which trades only about 12% of GDP. These trade shares have grown substantially in the past forty years for both the US and Europe (see Fig. 1). A substantial share of trade growth in Europe has come as a result of increased intra-European integration. Similarly, a substantial share of the growth in trade in the US has come from increased integration with Canada and Mexico, so that Europe and the US have become relatively less important trading partners (see Table 2). The home-bias parameter is chosen to generate a trade share of 30%, which matches the current average trade share in these European countries. In Section 7, we discuss how results vary with trade share and country size.

The idiosyncratic productivity shocks, the transition matrix Q and the initial distribution of shocks (and the disutility of labor) are chosen to reproduce certain features of labor market data. In particular, we focus on matching three types of statistics: (i) employment, such as the proportion the labor force employed, (ii) firm distributional characteristics, such as average firm size, the distribution of firm size, and the contribution to employment by firm size,[30] and finally (iii) statistics characterizing establishment dynamics, such as job creation (destruction) rates and exit rate by class size. We focus on the manufacturing sector as these goods are most often traded.

Table 3 summarizes the characteristics of employment and firm demographics that we seek to match. These statistics are calculated from an OECD dataset (see Bartelsman et al., 2003) collected to allow for international comparisons of firm demographics. Despite the difficulty in making international comparisons of this type, we are encouraged by the similarity of our three European countries. Relative to the US, European employment is concentrated in smaller firms. A final aspect of the data that we seek to match is the job creation rate between consecutive periods from Davis et al., (1998). For our synthetic European economy, job creation rates are 9.5% at the annual level.

We allow for ten positive technology shocks. Five of these shocks are chosen to match the mean employment level in each bin {5,30,70,200,1500} from the data and five are chosen as the endpoints of the employment intervals {20,50,100,500,5000}. The size of the employment grid is 500 employment levels spaced between one and a maximum of 5000 employees.

To determine the transition matrix, we make a few assumptions.[31] First, we allow the failure rate to decline with the size of the technology shock. We choose the failure rate to drop from 10% for the lowest technology to 1.5% for the best technology. Second, we constrain the probability of remaining in the same state to be the same for firms with technology s_i and $i \in [1,9]$. We allow the persistence for the first and last shocks to be higher but constrain these to be the same. Finally, we assume that shocks only change a firm's technology by one technology level per period, with the probability of becoming less productive exceeding that of becoming more productive.

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[30] It is important to match these two distributions, since even though very large firms are quite rare, they contribute a lot to total employment. As we will see later, changing the level of firing taxes affects the relative supply of goods in each country. We thus needed to make sure that all class sizes were given their actual contribution to output in the quantitative work.

[31] An alternative is to discretize a stochastic process for the shocks as in Veracierto (2001). We found that our approach led to a better fit with the characteristics of the employment and firm distributions.

Table 2
Trade shares

		USA	Germany	France	UK	Italy
	Trade/Income (2002)	11.7%	33.6%	26.3%	26.7%	26.4%
Bilateral trade share (2001)	USA		8.4%	8.3%	13.2%	6.8%
	Germany	4.8%		15.5%	11.9%	16.1%
	France	2.7%	10.0%		8.7%	11.6%
	UK	4.4%	7.5%	8.7%		5.9%
	Italy	1.8%	6.9%	8.9%	4.2%	
	Trade w/Europe	13.7%	24.4%	33.1%	24.8%	33.6%

This says that 4.8% of US trade is between the US and Germany.

Table 3
Model and data

		Model	European aggregate [a]	Italy	France [b]	Germany	US
Average firm size		25.5	23.2	14.1	27.0	25.5	66.6
Job creation		9.4%	9.5%				
Employment to population ratio		0.66	0.66				
Share employment	<20	0.281	0.211	0.314	0.199	0.166	0.068
	20 to 50	0.128	0.135	0.159	0.162	0.107	0.069
	50 to 100	0.095	0.102	0.102	0.112	0.095	0.063
	100 to 500	0.201	0.248	0.194	0.241	0.280	0.147
	500+	0.295	0.304	0.230	0.285	0.352	0.653
Share firms	<20	0.838	0.831	0.887	0.779	0.835	0.729
	20 to 50	0.101	0.101	0.076	0.140	0.089	0.150
	50 to 100	0.037	0.034	0.021	0.043	0.035	0.061
	100 to 500	0.019	0.030	0.014	0.033	0.035	0.049
	500+	0.005	0.005	0.002	0.005	0.006	0.012
Exit rate by bin	<20	0.095	0.101	0.093	0.127	0.090	0.094
	20 to 50	0.035	0.042	0.041	0.077	0.021	0.048
	50 to 100	0.028	0.031	0.032	0.063	0.011	0.040
	100 to 500	0.020	0.023	0.031	0.045	0.005	0.035
	500+	0.017	0.017	0.029	0.033	0.000	0.010

[a] Countries are weighted by aggregate employment.
[b] French data do not fully reflect the importance of small manufacturing firms as there is a floor on the sales revenue.

Table 4 reports the parameters of the model. Table 3 demonstrates that the model economy matches up well with establishment dynamics in our European aggregate.

6. Results

In this section, we report how the steady state of the world economy[32] changes when labor market frictions are removed.[33] Since labor market regulations are more prevalent in Europe, in our baseline both countries impose firing costs. We consider two policies: either remove all firing costs (i.e. $\tau = 0$, hence a *flexible* economy) or maintain the current level of taxes (i.e. $\tau = .9$, the average level for France, Germany and Italy, and hence a *rigid* economy). The analysis proceeds in two steps. First, we examine the steady state when both countries have flexible labor markets (FF). This coordinated change in policies allows us to determine how firing taxes distort labor markets and the welfare gains to removing these distortions. Next, we examine the world equilibrium when the domestic economy unilaterally lowers its firing taxes to zero (we call this the flexible-rigid case — hereafter FR). This unilateral move induces a terms of trade effect, which distorts the division of welfare gains across the two countries. To quantify the benefit of policy changes, we calculate the percentage decrease in steady state consumption a consumer would be willing to give up to adopt a particular policy. The focus here is primarily on welfare[34] rather than the firm and employment demographics as these have been studied elsewhere.[35] Table 5 summarizes the results of these experiments.

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[32] The numerical solution takes advantage of the model structure and is based on Hopenhayn and Rogerson (1993), adapted to the two-country setup. The methodology is detailed in Appendix B.

[33] We focus on steady states as Veracierto (2001) finds that transitional dynamics have a small quantitative impact on welfare calculations.

[34] The focus here is on the gains to remove firing taxes when terms of trade considerations matter, and is not on the optimal fiscal policy given terms of trade considerations.

[35] For the impact of firing costs on firm dynamics, see Hopenhayn and Rogerson (1993) or Veracierto (2001).

Table 4
Calibration

Preferences				Technology		Regulations				
$\beta=1/1.04$	$A=2.14$	$\gamma=1.25$	$\omega=.663$	$\theta=.64$	$ce=48.4$	$\tau=.9$	Cutoff 15 employees			
Productivity shocks										
$s0=0$	$s1=2.4$	$s2=4.1$	$s3=5.0$	$s4=5.6$	$s5=6.6$	$s6=7.0$	$s7=8.0$	$s8=12.5$	$s9=15.0$	$s10=27.5$
Distribution over initial productivity shocks										
$v0=.314$	$v1=.514$	$v2=.140$	$v3=.030$	$v4=0$	$v5=0$	$v6=0$	$v7=.0042$	$v8=.0018$	$v9=0$	$v10=0$
Transition probability (Q)										
1	0.1	0.1	0.05	0.03	0.03	0.03	0.02	0.02	0.02	0.015
0	0.8	0.09	0	0	0	0	0	0	0	0
0	0.1	0.75	0.115	0	0	0	0	0	0	0
0	0	0.06	0.75	0.125	0	0	0	0	0	0
0	0	0	0.085	0.75	0.125	0	0	0	0	0
0	0	0	0	0.095	0.75	0.125	0	0	0	0
0	0	0	0	0	0.095	0.75	0.13	0	0	0
0	0	0	0	0	0	0.095	0.75	0.13	0	0
0	0	0	0	0	0	0	0.1	0.75	0.13	0
0	0	0	0	0	0	0	0	0.1	0.75	0.185
0	0	0	0	0	0	0	0	0	0.1	0.8

6.1. Flexible-flexible case

Firing restrictions substantially reduce employment, output, consumption, and wages. If both countries eliminate these restrictions, then steady state output will increase by 4.13%, consumption by 4.13%, employment by 4.50% and real wages by 4.13% in each country. As both countries pursue the same policy there is no change in the terms of trade so that the model's results are identical to the closed economy case. By our welfare measure, agents in each country gain 0.88% of steady state consumption.

Table 5
Results

	Baseline	Flexible
Average firm size	100	+5.47%
Average productivity	100	−0.37%
JCR	9.4%	12.1%
Output	100	+4.13%
Hours	100	+4.50%
Real wage	100	+4.13%
Redistributions	100	−11.82%
Entrants	100	−0.97%

Terms of trade, consumption and welfare

Baseline case	RR	FR, in F	FR, in R
Terms of trade	0%	−3.06%	+3.06%
Consumption	100	+3.22%	+0.92%
Welfare gains (%)	0%	−0.04%	+0.92%
Asymmetric case	Small country		
Terms of trade	+2.70%		
Consumption	+0.21%		
Welfare gains (%)	+0.21%		

Firm and employment distributions

	Baseline	Flexible
Share firms		
Less than 20	83.8%	75.1%
20 to 50	10.1%	19.7%
50 to 100	3.7%	3.3%
100 to 500	1.9%	1.6%
Above 500	0.5%	0.3%
Share employment		
Less than 20	28.1%	19.2%
20 to 50	12.8%	20.9%
50 to 100	9.5%	8.4%
100 to 500	20.1%	21.5%
Above 500	29.5%	30.0%

Baseline case: $\gamma=1.25$, trade share=30%, small firms exempted and symmetric countries. All results are relative to the baseline.

Firing restrictions distort the ability of firms to adjust to technology shocks. They also are a tax on the lifecycle of firms given that existing firms expect to shrink and eventually go out of business. Both of these effects imply that removing firing restrictions raises the real wage in each country. With CRRA preferences, the income and substitution effects of an increase in the real wage cancel out. However in this model, lower taxes imply a decrease in the redistributions — profits and lump-sum taxes — to domestic consumers which is not proportional to labor income and a resulting negative income effect. Consequently removing firing taxes cause both labor supply and consumption to increase. Because of the change in labor, the increase in welfare is considerably smaller than the increase in consumption.

For the United States, Hopenhayn and Rogerson (1993) and Veracierto (2001) find that firing costs have larger costs in terms of quantities and welfare. Our findings differ because we consider firing taxes that exempt small firms. Since most firms are small, many firms do not pay firing costs. This permits small firms to adjust fully to some technology shocks. It also leads some small firms to delay expansion. With decreasing returns to scale, this tends to raise the productivity of small firms relative to large firms. Consequently, exempting small firms from firing taxes substantially reduces the productive inefficiency. As this is the main channel through which welfare is lowered in Hopenhayn and Rogerson (1993) and Veracierto (2001), we find smaller welfare costs. In practice, firing restrictions exempt small firms so that the previous estimates of their welfare costs are overstated.

In the baseline case, the welfare gains to a coordinated policy on firing taxes are 0.88% of lifetime consumption. These gains are significant compared to the gain of 0.28% of lifetime consumption that Mendoza and Tesar (2005) find from international coordination of labor and capital taxes in a two country, neoclassical growth model. The sizable difference in these findings suggest there are benefits to consider a broader range of policy tools in models with firm level heterogeneity. We now explore how trade linkages affect the division of welfare gains, rather than their magnitude.

6.2. Flexible-rigid case

Eliminating firing restrictions in just one country leads to an increase in steady state output by 4.13%, consumption by 3.22%, employment by 4.50% and real wages (w/p) by 4.13 in the flexible economy. The country that remains rigid experiences a 0.92% increase in consumption as its imports become 3.06% less expensive. The rigid economy does not experience any change in employment or output. This occurs because the change in the terms of trade changes the real wage of the rigid worker, but the income and substitution effects of this change in real wage cancel.

In total, welfare in the rigid economy increases by 0.92%, but the flexible economy actually experiences a welfare loss of −0.04%. This loss occurs because the large change in output worsens the terms of trade so that the gains in consumption do not offset the foregone leisure. This result is similar to the immiserizing growth result of Bhagwati (1958), where growth in output deteriorates the terms of trade so that real income is reduced. This is not the case here. The flexible country can afford more, but this extra consumption does not compensate workers for giving up leisure.

In our baseline case, neither country has an incentive to eliminate its firing restrictions. Regardless of the level of taxes in the other country, each country is better off maintaining firing taxes on its labor market. Of course, in equilibrium, this is suboptimal. This suggests an additional rationale for why countries have been slow to eliminate these firing restrictions.

7. Sensitivity analysis

Here we examine the sensitivity of our findings by varying assumptions about two features of the model.[36] First, we consider the size of trade flows. We show that the gains to the reforming country are decreasing in the share of goods exported, so that relatively closed economies have the most to gain from labor market reform. Next, we show that the gains to the non-reforming country are increasing with the size of its imports from the reforming country relative to its own GDP. Thus, for the same initial quantity of bilateral trade flows, small countries have more to gain from their trading partner's labor market reform than large countries. Second, we consider how the elasticity of substitution between goods affects the amount that domestic labor market policies spill over to trading partners. As expected, we find that when goods are more substitutable, the reforming country captures more of the gains from reform as its terms of trade worsens by less.

7.1. Trade flows

Here we explore the influence of trade flows on the welfare gains to unilateral labor market reform. First, we show that the welfare gain is decreasing in a country's export share. Next, show that a trading partner's welfare gain is increasing in its import share with the reforming country. Finally, we consider the case where countries are of different sizes. This permits us to quantify the gains to the U.K. from convincing its continental trading partners to jointly reform their labor markets.

7.1.1. Export and import shares
Fig. 2a plots the share of the benefits from reform that the reforming country keeps against its export share, ranging from 1% to 50%, holding the policy of all its trading partners fixed. It is clear that the more a country trades, the less it benefits from removing firing

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[36] Alessandria and Delacroix (2004) consider three additional extensions. First, they allow countries to produce both goods but with some comparative advantage. Despite an adverse terms of trade effect, countries still prefer to continue specializing after unilateral reform for the range of productivity differences reported in the literature. Second, they allow for firing taxes which are not rebated and find that the benefits from reform are still shared with the trading partner. Third, they examine the impact of removing the small-firm exemption.

a

Export Share
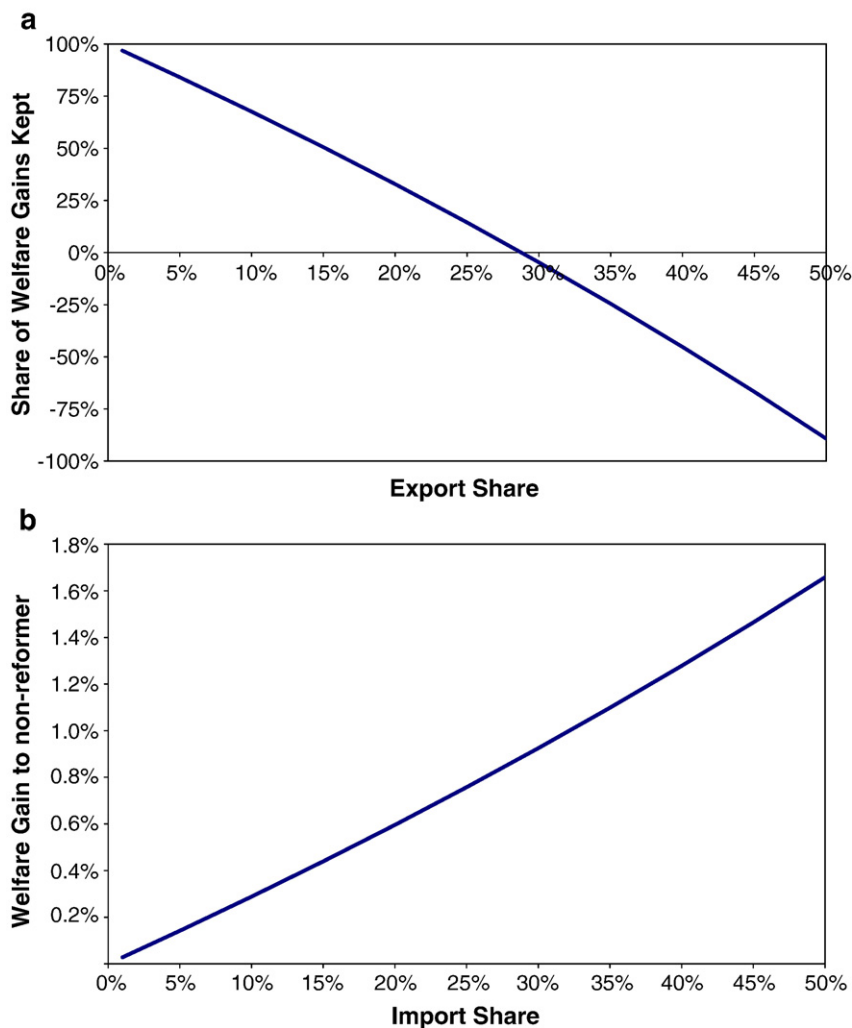
b

Import Share

Fig. 2. Welfare gains and trade flows.

taxes. For trade shares above 28%, countries are made worse off by reform. For the range of trade shares of France, Italy and Germany, we see the gains to reform are small or negative. Thus a single country's negative or limited gain to reform is coming from the fact that, were this country to reform, it would suffer from a negative terms of trade effect with all its trading partners. In other words, what is relevant to account for the reluctance to reform is the total trade share and not country-to-country shares. Another way of saying this is that countries that trade a lot benefit the most from firing taxes. Consequently, a relatively closed economy like the U.S. has little to gain from adopting these policies.

Fig. 2b plots a non-reforming trading partner's absolute welfare gain against its bilateral import share. As expected, increasing the import share increases the size of the welfare gain. Thus, countries that are more integrated, measured by trade shares, have the most gain from getting their trading partner to reform their labor markets. In this respect, the U.S. has less to gain from European labor market reform than the U.K.

7.1.2. Asymmetric countries

To get a better measure of the gains to the U.K. of reform of continental labor markets, we modify the model to include two countries of different sizes. For simplicity, we assume that for each agent in country 1 there are N agents in country 2. Consumers have the following preferences over these goods,

$$C_1 = \left(\omega x_1^{\frac{\gamma-1}{\gamma}} + (1-\omega) y_1^{\frac{\gamma}{\gamma-1}} \right)^{\frac{\gamma}{\gamma-1}},$$

$$C_2 = \left(\omega^* y_2^{\frac{\gamma-1}{\gamma}} + (1-\omega^*) x_2^{\frac{\gamma-1}{\gamma}} \right),$$
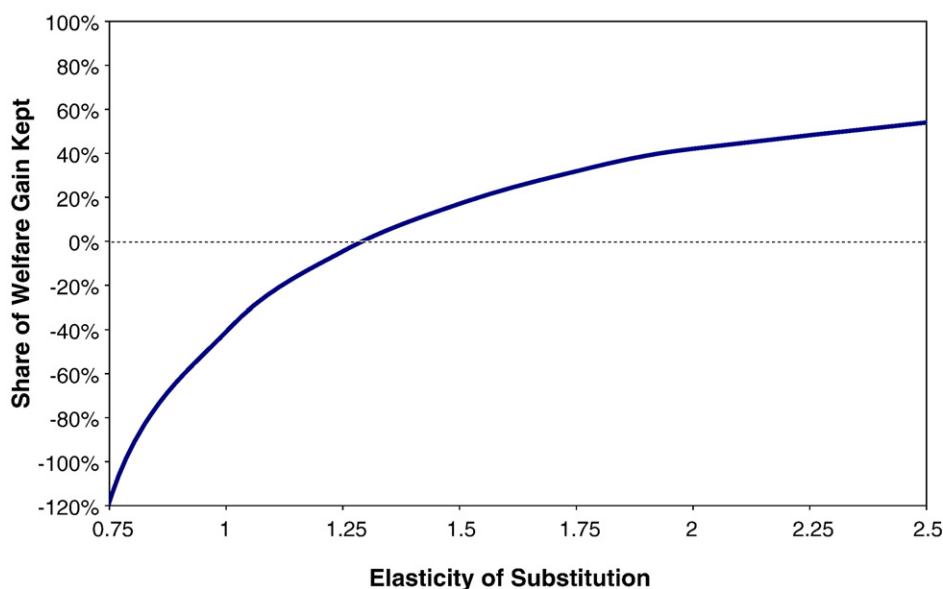
Fig. 3. Welfare gains and elasticity of substitution.

where now the home-bias parameter differs across countries. Given the different country sizes the trade balance and resource constraints are modified as follows

$$pNx_2 = qy_1,$$

$$Nx_2 + x = \mathrm{GDP}_X,$$

$$Ny_2 + y_1 = \mathrm{GDP}_Y.$$

This case quantifies the gains to the U.K. of coordinated reform by its continental trading partners. As such, we calibrate the model to match the bilateral trade between the U.K. and this block of countries of approximately 7.5% of GDP as reported in Table 2. Next, we choose $N = 3.3$ to match the ratio of GDP in the continental block to that of the U.K. and finally, we assume that initially the terms of trade is equal to 1. In this case, the labor market reform leads to a 2.7% change in the terms of trade and a 0.21% increase in steady state consumption in the U.K. (see Table 5).

7.2. Elasticity of substitution

A key parameter influencing our results is the elasticity of substitution. Combined with the trade share, this parameter determines how the change in output from reform influences the terms of trade. In our model, this is the only channel through which labor market reform affects its trading partners. There is some evidence that when a country's output grows relatively fast, its terms of trade tends to worsen. First, at business cycle frequencies, for G7 countries, the terms of trade is negatively correlated with output so that when countries are growing relatively fast the price of their domestically produced goods relative to imports is declining (see Table 1). Second, for a broad cross-section of both industrialized and developed countries over the period 1965 to 1985, Acemoglu and Ventura (2002) estimate an elasticity of the terms of trade with respect to output of −0.60, or slightly above our baseline calibration value of −0.74.

Taking a linear approximation of our model, it is possible to derive the elasticity of the terms of trade with respect to output as

$$\varepsilon = \frac{\Delta q - \Delta p}{\Delta X - \Delta Y} = \frac{1}{1 + 2\,\widehat{\omega}(\gamma - 1)},$$

where $\widehat{\omega}$ measures the expenditure share on home produced goods at home. A higher value of ε implies a more adverse terms of trade effect for the reforming country. One can see that as the international goods become more substitutable, the terms of trade effect is weakened. The elasticity of substitution also determines how the terms of trade is affected by trade flows: the elasticity of the terms of trade increases with trade shares if and only if $\gamma < 1$. When $\gamma = 1$, the income and substitution effects in the consumption aggregator cancel out and the size of foreign demand does not matter in determining the terms of trade. When the

income effect dominates ($\gamma < 1$,) reform in country 1 makes country 2 relatively richer. If trade shares increase, the demand for good X relative to good Y increases, decreasing the terms of trade. The opposite mechanism takes place when the substitution effect dominates ($\gamma > 1$).

Fig. 3 plots the share of the welfare gain the unilaterally reforming country keeps against the elasticity of substitution over a range from $\gamma \cup [0.75, 2.5]$. At the low end, when $\gamma = 0.75$ we see that the reforming country is made much worse off, with welfare declining by 1.04% of steady state consumption. At the high end, when $\gamma = 2.5$; which is much larger elasticity than used in the international macro literature and what we find for the continental economies, the terms of trade effect is weaker so that the reforming country keeps about 50% of the benefit from its change in policy. In the immediate range around our benchmark calibration of $\gamma = 1.25$, we see that slightly larger elasticities imply small but positive gains to trade reform. However, over this entire range of elasticities, we see that the share of the benefit exported always substantially exceeds the export share. Thus, for a wide range of elasticities, trade linkages weaken the incentive to reform.

8. Conclusion

This paper studies the impact of domestic labor market reform of firing restrictions on welfare in an international context. We find that international trade considerably weakens a country's incentive to undertake reform as much, if not all, of the gains are exported to its trading partners through a worsened terms of trade. In a model calibrated to match European data, we find that very little of the gains to lifting firing taxes accrue to the reforming country and may even lead to lower welfare. These results arise because firing taxes substantially reduce output and employment and thus have strong terms of trade effects. We have shown that unilateral reform may be more difficult to implement when a country's total trade share is higher, as it suffers from an adverse terms of trade effect on a higher share of its consumption.

We find that continental European economies have very little to gain from removing firing taxes and so trade linkages provide a plausible explanation for the persistence of these policies. We also find that the U.K. has the most to gain from reform in continental Europe, and may explain why the U.K. has been strongly pushing for these reforms. Our analysis suggests that there are substantial benefits to international coordination to eliminate distortions in domestic labor markets. These benefits are consistent with the European Council's efforts to initiate reform of continental labor markets at the multilateral level.

Our focus on the interaction of firing restrictions and the terms of trade is motivated by recent discussions of removing these restrictions within the multilateral framework of the European Community as detailed in Section 2. The model was thus set up to address both the positions of continental European countries and of the U.K., and quantify the gains to all parties from changing this policy. To evaluate these policy changes we focused on a model in which firing taxes have no benefit in the closed economy. We find that the gains differ considerably from traditional closed economy analyses. Clearly, other policies could be used to create favorable terms of trade movements, possibly without some of the inefficiencies associated with restricting optimal adjustment to productivity shocks. However, to the extent that firing taxes generate some benefits, such as those discussed by Alvarez and Veracierto (2001), then the gains to removing these policies will be even lower than what we have found.

These results are developed within a model of international trade driven by specialization. We have largely abstracted from the influence of firing costs on the pattern of trade or the export decision of firms. Much recent research has found that exporting firms have very different characteristics than non-exporters[37] and that the identity of exporters changes over time. Firing restrictions are sure to reduce the benefits to exporting and affect the export participation decision. Our model can be extended along these lines.

Appendix A: Estimating the elasticity of substitution

To map Eq. (1) to the data, it is useful to rewrite it as

$$\ln \frac{m_{i,t}}{\text{gdp}_{i,t} - ex_{i,t}} = \gamma \ln \frac{1 - \omega}{\omega} + \gamma \ln \frac{p_{i,t}^{\text{gdp}}}{p_{i,t}^m} + \varepsilon_{it},$$

where for country i in period t, $p_{i,t}^{\text{gdp}}(p_{i,t}^m)$ is the gdp (import) price deflator, $m_{i,t}(ex_{i,t})$ measures real imports (exports) and $\text{gdp}_{i,t}$ measures real gdp. The term on the lefthand side measures the relative demand of imports to domestic absorption. We use annual data for Germany (1975 to 2002), the United Kingdom (1975 to 2002), France (1978 to 2002) and Italy (1980 to 2002). The data are from the OECD's main economic indicators and annual national accounts. Row 1 reports estimates using OLS for the four countries of interest. Row 2 reports estimates of the elasticity of substitution using TSLS. In this regression, to deal with the slow response of trade flows to relative prices, we include lagged relative absorption and instrument using lagged values of the terms of trade.

Appendix B: Algorithm for solving the model

The numerical resolution is comprised of three main steps: (i) solving the firm problem in each country to obtain the relative price of labor to output in each country (w_1/p and w_2/q), (ii) using the derived policy functions to generate the measure of

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[37] See Bernard et al. (2003).

firms over the productivity and employment states (s, e) — up to a scale factor equal to the number of entrants in each country, and (iii) solving for the consumer problem in each country to get the scale factor.

Step 1: *Solve the firm problem in each country (this is done conditional on τ_1 and τ_2).*

We summarize the procedure for country 1 only, as it is similar for country 2. Also, notice that the two problems can be solved separately.

(1a) Choose an initial value for w_1/p,

(1b) Iterate on the value function for firms in country 1 to compute $V_1(s, e)$ for all realizations of the state space,

(1c) Integrate $V_1(s, 0)$ over initial productivity draws to compute the value of entry in the economy,

(1d) Check the free entry condition (*the value of entry is decreasing in w_1/p*),

(1e) Update w_1/p using the Newton–Raphson method and loop on w_1/p until the free entry condition is satisfied.

Step 2: *Compute the policy functions $N_1(s, e)$ and $N_2(s, e)$ to generate the distribution of incumbents over states.*

We summarize the procedure only for country 1. Again, step 2 can be carried out separately for country 1 and for country 2.

(2a) Use the policy function $N_1(s, e)$ generated in step 1 to compute the invariant distribution $\hat{\mu}_1 = (s, e)$ of incumbents, *assuming a unitary mass of entrants. That is, solve for the fixed-point $\hat{\mu}_1 = T(\hat{\mu}_1, 1)$. Because the operator T is linearly homogeneous in μ and M jointly, we solve for the mass of entrants M_1 in step 3 to obtain the equilibrium measure of incumbents $\mu_1 = T(\mu_1, M_1)$.*

(2b) Use the policy function and the invariant distribution to compute aggregate labor demand, aggregate supply and aggregate profits and transfers, up to the scale factor.

Step 3: *Solve the consumer problem in each country to obtain the scale factor.*

(3a) The consumer problems in countries 1 and 2 can be solved simultaneously. The first order conditions, combined with the trade balance, can be solved analytically to obtain the relative price of labor w_1/w_2. After normalization of one of the two wages, all other prices can be computed, as well as all the domestic and foreign demands for goods X and Y.

(3b) Knowing aggregate demands for the two goods, their market clearing conditions are used to compute the scale factors M_1 and M_2.

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