Trade, Wages, and Profits

by

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Abstract

This paper formulates a structural empirical model of heterogeneous firms whose workers exhibit fair-wage preferences. In the underlying theoretical framework, such preferences lead to a link between a firm's operating profits on the one hand and wages of workers employed by this firm on the other hand. The latter establishes an exporter wage premium, since exporters have higher profits, given their productivity, than non-exporting firms. We estimate the parameters of the model in a data-set of five European economies and find that, when evaluated at these parameter values, the model has a high level of explanatory power. The estimates also enable us to quantify the exporter wage premium and the consequences of trade for the main variables of interest. According to our results, openness to international trade contributes to greater inequality across firms in terms of both operating profits and average wages. We also find evidence for gains from trade for all five countries, which go along with negative, but quantitatively moderate, aggregate employment effects.

JEL codes: C31, F12, F16, J31

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1   Introduction

An important strand of research in international economics is concerned with distributional effects of openness in the presence of labour market imperfections. Theoretical contributions on the matter go back to the seminal work of Brecher (1974) who analysed the consequences of minimum wages in interaction with openness to trade for relative factor prices and the unemployment of workers. Brecher's pioneering work was followed by papers that added micro-foundations of the labour market imperfections.[1] The most recent theoretical contributions, which combine labour market imperfections with new trade models that allow for firm heterogeneity within sectors, have highlighted a new dimension of income inequality resulting from firm-specific wage rates. In Egger and Kreickemeier (2009, 2011) and Amiti and Davis (2011) there is rent-sharing at the firm level resulting from workers' fair wage concerns, Davis and Harrigan (2011) generate wage differences across heterogeneous firms by assuming firm-specific monitoring technology in an efficiency wage framework à la Shapiro and Stiglitz (1984), and in Helpman, Itskhoki, and Redding (2010) more productive firms pay higher wages since they have an incentive to screen their workforce more thoroughly, which leaves them with workers of higher average ability.

Relying on insights from this most recent theoretical literature, it is the aim of this paper to shed new light on the interplay between trade openness and inequality from an empirical point of view. To guide the empirical analysis, we set up a theoretical trade model, in which the interaction of heterogeneity of producers in their productivity and labour market imperfection leads to self-selection of firms into export status and firm-specific wage payments. The combination of these two features is instrumental for an exporter wage premium and gives rise to aggregate inequality and unemployment. Labour market imperfection is captured by means of a fair-wage mechanism, assuming that workers provide effort in accordance with a fair-wage constraint, as in Egger and Kreickemeier (2009, 2011) and Amiti and Davis (2011). A key advantage of this model is that one estimable parameter, referred to as the *fair-wage parameter* is a compact measure of labour market imperfection. Furthermore, firm-specific wage rates in the fair wage model are explained by rent sharing at the firm level (rather than by compositional effects of the firm-specific workforce), which in their detailed empirical analysis on Mexican firms, Frías,

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[1]Different approaches to model labour market imperfections include trade unions (Brander and Spencer, 1988; Brecher and Van Long, 1989), search and matching frictions (Davidson, Martin, and Matusz, 1988, 1999; Hosios, 1990), efficiency wages (Matusz, 1994, 1996), and fair wage concerns of workers (Agell and Lundborg, 1995; Kreickemeier and Nelson, 2006).

Kaplan, and Verhoogen (2009) have shown to be an important contributor to wage differences across firms.[2]

We structurally estimate the key parameters of this model for a cross-sectional data-set of 113,326 firms from five European countries.[3] Using these estimates, the exporter wage premium is found to average nearly 10 percent in our data-set. Comparing the wage distribution across firms predicted by our model with the actual distribution in our data set, we find that the model has a high predictive power and can explain more than 70 percent of the variation in wages across firms. Our estimates and the data at hand support counterfactual experiments. In particular, we analyse for the five countries in our data-set the role of openness to trade for the distribution of wages and operating profits across firms, where changes in these two measures are linked by the fair-wage based rent-sharing mechanism. The model generates heterogeneous responses across firms to a country's movement from autarky to trade, which can be summarised by adjustments in the standard deviations of operating profits and wages. We show that the observed extent of trade has significantly increased inequality for both variables across firms relative to autarky, with the standard deviation increasing between 15 and 25 percent on average, depending on the method of measurement.

Aside from looking at the distributional consequences of trade, we also use our model to look at the link between aggregate gains from trade and aggregate employment. We show that the welfare gains needed to achieve positive employment effects for the five countries in our data-set would be high: depending on the country, the number lies between 70 and 334 percent. We then use a simplified version of our model to derive suggestive evidence that the true gains from trade are smaller than these values, and that hence we would expect trade to have had a negative effect on aggregate employment.

While our paper is among the first ones to study empirically the interplay between openness and firm-specific wages using a structural model, it is related to a large literature that uses reduced-form analysis for exploring the wage and employment effects of globalisation – of course without providing insights on the consequences of trade for the whole distribution of wages paid by firms of different productivity.[4] Such work has been conducted at various levels of

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[2]See also Klein, Moser, and Urban (2010) and Eaton, Kortum, Kramarz, and Sampognaro (2011) for evidence on a within skill-group exporter wage premium in Germany and France, respectively.

[3]Those countries are ones for which we have firm-level data on both domestic sales and exports: Bosnia and Herzegovina; Croatia; France; Serbia; and Slovenia.

[4]To the best of our knowledge, there is only one other study that looks at the link between openness and firm-

aggregation, the country (Egger, Greenaway, and Seidel, 2011), the industry (Klein, Schuh, and Triest, 2003; Goldberg and Pavcnik, 2005), the firm (Trefler, 2004; Amiti and Davis, 2011), and the worker (Egger, Pfaffermayr, and Weber, 2007; Schank, Schnabel, and Wagner, 2007; Munch and Skaksen, 2008; Klein, Moser, and Urban, 2010; Eaton, Kortum, Kramarz, and Sampognaro, 2011). The evidence suggests that (final and intermediate goods) imports tend to replace domestic jobs while exports create jobs so that reciprocal trade liberalisation tends to have only little effects on wages and employment (Klein, Schuh, and Triest, 2003). While some work considers differences in the effects across industries and types of workers, it appears to be the case that consequences of exports versus imports are found to materialize both within types of workers and within industries (Klein, Moser, and Urban, 2010; Eaton, Kortum, Kramarz, and Sampognaro, 2011).

By estimating aggregate employment effects of trade, our model is also related to a recent study by Felbermayr, Prat, and Schmerer (2011), who find for a sample of 20 OECD countries that higher trade openness systematically lowers unemployment. Similar to the other studies mentioned above and in contrast to our approach, Felbermayr, Prat, and Schmerer (2011) provide a reduced-form analysis. In a similar vein, Dutt, Mitra, and Ranjan (2009) estimate the impact of trade on unemployment using information from an even larger country set – including 92 developed and developing economies. Their study documents a significant difference between short-run and long-run employment effects, with trade exerting a negative impact on unemployment in the long run. Taking stock, it seems fair to say that existing studies do not find strong support for our observation of a negative employment effect of trade. However, previous findings are also not at odds with ours, as a direct comparison of the respective employment effects is not possible. On the one hand, in our counterfactual analysis we focus on the selection effects of trade and ignore other possibly important channels through which employment effects of trade can materialize (see above). On the other hand, we rely on a structural empirical approach and thus can allow in principle for a non-monotonic relationship between the key variables of interest when conducting the counterfactual analysis. As pointed out in Egger and Kreickemeier (2009, 2011) the non-monotonicity of labour market effects may indeed be an issue

specific wages in a structural empirical model, namely Helpman, Itskhoki, Muendler, and Redding (2011). Their empirical study employs detailed Brazilian data for manufacturing industries form a large matched employer-employee data-set. This data-set has the advantage that it allows controlling for worker characteristics, which is not possible in our data-set. However, it restricts the analysis to a single country and hence does not allow for inference upon whether and to what extent the effects of trade on firm-specific wages vary across countries.

in a Melitz (2003)-type model with labour market imperfections, so that inferring the impact of large changes in key model parameters – as, for instance, a movement from autarky to trade or a significant change in trade openness – from point estimates of a reduced-form analysis may be problematic.

There are several advantages of a structural approach over reduced from studies, with a particular one being that a structural approach allows to account for potentially complex nonlinear (e.g., demand or pricing) relationships underlying the data-generating process.[5] Furthermore, a structural model allows for a systematic estimation of a specifitc model's parameters and an assessment of the explanatory power of that model, its mechanisms and transmission channels (e.g., the selection effects which are at the heart of new new trade theory). This makes it not only better suited for the counterfactual analysis considered here but renders our estimation results also amenable to *ex-ante* analysis since one could take the estimated parameters to other data-sets in order to conduct a wide range of possible counterfactual experiments as is custom in other fields of international economics (e.g., in trade policy analysis based on computable general equilibrium models). Also, exploiting the structure of a theoretical model linking labour market imperfections and firm activity in the (partially) open economy helps avoiding problems of endogeneity of regressors in empirical work in so far as such endogeneity may root in the mis-representation of the functional form of the very models that are utilized to formulate testable hypotheses.

The remainder of the paper is structured as follows. In Section 2, we outline the theoretical model underlying the structural empirical work at the heart of the paper and illustrate the key mechanisms at work. Section 3 describes the data-set utilized in estimation, it presents estimates of key model variables, quantifies the exporter wage premium, and assesses the model fit. Section 4 provides insights about the consequences of trade liberalisation on the distribution of wages and operating profits across firms, and it furthermore provides tentative evidence on the employment effects of trade. The last section concludes with a summary of the key findings and an outline of future work.

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[5]We tend to assume complex nonlinear relationships with great empirical success in many different applications in international economics. See, for instance, Eaton and Kortum (2002) or Arkolakis and Muendler (2010) for the estimation of structural empirical models of trade based on isoelastic demand functions of consumers.

2 Theoretical background

In this section, we describe key elements of a trade model with heterogeneous firms and labour market imperfections, which in many respects is similar to Egger and Kreickemeier (2009) (EK2009, henceforth). They introduce labour market frictions by means of a fair-wage effort mechanism into a Melitz (2003)-type trade model, and we extend this framework in two important dimensions: first, we modify the fair-wage constraint in order to allow for an exporter wage premium; second, we account for asymmetric countries and thus make the model more suitable for the empirical application in Section 3.

2.1 Profit-maximisation in the final and intermediate goods sector

Let us consider two economies ($i = 1, 2$) that are open to trade and produce two types of goods: differentiated intermediates, q, and a homogeneous final output, Y. Either economy has a representative consumer who uses all of his/her income for the consumption of Y, which is supplied by atomistic firms in a perfectly competitive market and can be costlessly traded internationally. Its price is therefore equalised between countries. We choose Y as the numéraire, and hence its price is set equal to one. The production function for Y in country i is given by:

$$Y_i = \left[(M_i^t)^{-\frac{1}{\sigma}} \int_{v \in V_i} q_i(v)^{\frac{\sigma-1}{\sigma}} dv \right]^{\frac{\sigma}{\sigma-1}}, \tag{1}$$

where $q_i(v)$ denotes demand for intermediate good variety v in country i, V_i is the set of intermediate goods that are available for final goods production in i, M_i^t is the Lebesgue measure of set V_i, representing the mass of intermediate goods that are used in the production of Y_i, and $\sigma > 1$ is the elasticity of substitution between the different varieties of q in the production process. With the price of Y normalised to one, Eq. (1) represents also aggregate revenues, and hence profit maximsation in the final goods sector is identical to maximising Eq. (1) minus total expenditures $\int_{v \in V_i} p_i(v) q_i(v) dv$. This leads to an isoelastic demand function for each variety of the intermediate good of

$$q_i(v) = \frac{Y_i}{M_i^t} p_i(v)^{-\sigma}, \tag{2}$$

where $p_i(v)$ denotes the price of variety v in country i.

In the intermediate goods market, there is a continuum of firms, each producing one unique variety. The mass of domestic producers in country i is given by M_i^d and together with exporters M_j^x from country j $(j \neq i)$ these firms add up to the mass of producers that serve the domestic market: $M_i^t = M_i^d + M_j^x$. The intermediate goods market in either country is characterised by monopolistic competition, implying that firms take aggregate variables as given, while they set prices as a monopolist in the market for their own variety. Denoting unit costs of selling variety v in market i by $c_i(v)$, the solution to a firm's price-setting problem is given by the constant mark-up rule:

$$p_i(v) = \frac{\sigma c_i(v)}{\sigma - 1}. \tag{3}$$

Unit costs of selling in market i are equal to unit production costs $\tilde{c}_i(v)$ for domestic varieties. Imported varieties are subject to standard iceberg trade costs, represented by parameter $\tau > 1$, and therefore $c_i(v) \equiv \tau_j \tilde{c}_j(v)$ for imported varieties. Unit production costs $\tilde{c}_i(v)$ are constant, and depend on technology and wages, both of which are firm-specific. Technology for each firm is exogenous, as in Melitz (2003), while wage determination at the firm level is explained in the next subsection.

2.2 Firm-specific wages in an imperfectly competitive labour market

The labour market model starts from the premise that workers have fairness preferences relating their effort to the wage they are paid relative to some reference wage, which they consider to be fair (see Akerlof, 1982 and Akerlof and Yellen, 1988, 1990). To put it formally, we assume $\varepsilon = \min[w/\hat{w}, 1]$, where ε is effort, w is the wage per worker and $\hat{w}$ is the fair-wage reference. Under this specification, a firm cannot reduce its effective labour costs by setting a wage that is lower than $\hat{w}$ and, hence, has no incentive to do so. Therefore, we can safely assume that firms pay at least the fair wage and workers provide full effort $\varepsilon = 1$.[6] Furthermore, provided that each firm finds a sufficient number of workers when offering $w = \hat{w}$, this is what they do in equilibrium. Throughout our analysis, we focus on a parameter domain that gives rise to involuntary unemployment, so that demand is indeed the short side of the labour market and

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[6]Actually, effective labour costs are the same for any $w \leq \hat{w}$ and, similar to Akerlof and Yellen (1990), we therefore impose the additional assumption that firms have a slight preference for paying fair wages and, hence, "when profits are unaffected by payment of fair wages, they prefer to do so" (p. 272).

firms do not have to pay a wage that is higher than $\hat{w}$.

From the discussion above, it is immediate that in the fair wage-effort model the labour costs of firms depend crucially on the worker's reference wage, $\hat{w}$. Akerlof (1982) and the literature following him point out that the wage considered to be fair by a worker has a firm-internal and a firm-external component. The firm-external component is commonly associated with the worker's income opportunities outside his/her present job, which are the same for all *ex ante* identical agents and equal the average income of employed and unemployed workers. We set unemployment benefits to zero, which leads to an expression of $(1 - u_i)\bar{w}_i$ for the firm-external component of the fair wage in country i, where u_i is the unemployment rate and $\bar{w}_i$ the average wage of employed workers.[7] As outlined by Danthine and Kurmann (2007, p. 858), the firm-internal component should account for the observation that "the better (worse) the firm is doing, the more (less) the worker expects to be paid in exchange for a given level of effort". Egger and Kreickemeier (2011) point to total operating profits as a suitable measure of firm performance in this respect.[8] These operating profits depend on a firm's location as well as on its exporter status and are denoted by $\psi_i^t(v)$ – where superscript t is used for referring to total operating profits from domestic and foreign activity. Hence, the firm-internal component gives rise to a rent-sharing mechanism that induces firm-specific wage payments in our setting.[9] Imposing the additional assumption that the fair wage can be expressed as a weighted geometric mean of its two components and using $w = \hat{w}$ from above, we get

$$w_i(v) = \left[\psi_i^t(v)\right]^{\theta_i} \left[(1 - u_i)\bar{w}_i\right]^{1-\theta_i} , \tag{4}$$

with $\theta_i \in (0, 1)$ denoting a rent-sharing (or *fair-wage*) parameter that can be country-specific. Of course, with *ex ante* identical workers, firm-specific wage payments are consistent with an equilibrium only if workers in firms with low profitability cannot successfully underbid wage

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[7]It is straightforward within this framework to allow for strictly positive unemployment benefits, financed by lump-sum taxes. This extension would leave the basic mechanisms unaffected, and we therefore use the more parsimonious specification in the following.

[8]Amiti and Davis (2011) suggest using pure profits instead of operating ones. While this modification would not affect the main insights from our analysis qualitatively, it is less attractive from the purpose of analytical tractability and, hence, we rely on operating profits as the firm-internal component of fair wages in the subsequent analysis.

[9]Rent sharing does also materialize in the EK2009 framework, where labour productivity serves as the firm-internal component of the fair wage. However, since labour productivity is constant and does not depend on a firm's exporter status, the EK2009 model excludes important aspects of wage payments in an international context. In particular, it does not allow for an exporter wage premium, which has been shown to be important empirically (see Frías, Kaplan, and Verhoogen, 2009).

payments in firms with high profitability. In the fair wage theory, it is a combination of information asymmetry and incomplete contracting which prevents such underbidding (see EK2009 for a more detailed discussion).

2.3   The open economy equilibrium

Firm entry into domestic production and into exporting is modeled as is standard in Melitz-type frameworks: there is an unbounded pool of entrants deciding on paying a fixed market entry cost, which is immediately sunk, that allows them to draw labour productivity φ from the common distribution $G_i(\varphi)$. Knowing their productivity, they then decide whether to start producing, and which markets (only domestic, or domestic and foreign) to serve. Fixed export costs ensure that only a subset of the producing firms find it profitable to export. Two differences between our setup and the standard Melitz model stand out. First, following EK2009 all three types of fixed costs in the model (entry costs f_i^e, fixed production costs f_i^d, and fixed export costs f_i^x) are measured in units of final output, rather than labour. This is to allow for identical fixed costs across firms in our setup that in equilibrium features firm-specific wage rates, thereby focusing on marginal cost heterogeneity, as in Melitz (2003). Second, due to the fair wage constraint the entry decision into the foreign market has feedback effects on a firm's competitive position in the home market, since higher total profits due to exporting lead to higher firm-specific wages via the rent sharing mechanism, and therefore to higher marginal cost at home.

In order to describe the sorting of firms into the respective categories, we need to derive the following partial results:

(i) the relative wage and operating profit of two firms of *differing* productivities but with the *same* export status;

(ii) the relative wage and domestic operating profit of an exporting and a non-exporting firm of the *same* productivity;

(iii) the relative productivity of the least productive firm and the least productive *exporting* firm.

To derive result (i), note that due to constant mark-up pricing operating profits at the firm level ψ_i are a constant fraction $1/\sigma$ of firm revenues r_i. Combining the demand function, Eq.

(2), with the fair wage constraint, Eq. (4), and using the definition $r_i = p_i q_i$, we get

$$\frac{w_i(v_1)}{w_i(v_2)} = \left[\frac{\varphi(v_1)}{\varphi(v_2)}\right]^{\theta_i \xi_i} \qquad \text{and} \qquad \frac{r_i^t(v_1)}{r_i^t(v_2)} = \frac{\psi_i^t(v_1)}{\psi_i^t(v_2)} = \left[\frac{\varphi(v_1)}{\varphi(v_2)}\right]^{\xi_i}, \qquad (5)$$

where $\xi_i \equiv (\sigma - 1)/[1 + \theta_i(\sigma - 1)]$, and firms 1 and 2 are constrained to be either two exporting firms or two non-exporting firms. Hence, for two firms in country i with the same export status, relative wages and operating profits are determined solely by relative productivities.

For result (ii), we make use of the standard feature of monopolistic competition models with CES demand that export revenues of an exporting firm are a fraction $\tau^{1-\sigma}$ of its domestic revenues, when controlling for economy-wide variables in the two markets. Using this result, as well as Eqs. (2) and (4), the relative wage and domestic operating profit of the same firm in the case of exporting (superscript x) and non-exporting (superscript n), respectively, is given by

$$\frac{w_i^x(v)}{w_i^n(v)} = (1 + R_i)^{\frac{\theta_i \xi_i}{\sigma - 1}}, \qquad \frac{r_i^x(v)}{r_i^n(v)} = \frac{\psi_i^x(v)}{\psi_i^n(v)} = (1 + R_i)^{-\theta_i \xi_i}, \qquad (6)$$

where

$$R_i \equiv \tau_i^{1-\sigma} \left(\frac{Y_j/M_{tj}}{Y_i/M_{ti}}\right). \qquad (7)$$

The term R_i is to be interpreted as the *export market potential* for country i: R_i is larger the smaller the iceberg transport cost, and the larger the average revenue per firm selling in the export market relative to the domestic market. Eq. (6) shows that entering the export market raises wage costs and thus lowers a firm's revenues and profits in the *domestic* market via the feedback effect described above.

For the derivation of result (iii) we use the condition that the marginal exporting firm with productivity φ_i^x must make the same total profits when exporting and not exporting, respectively, taking into account the fixed export cost f_i^x and the feedback effect of exporting on domestic marginal cost:

$$\frac{(1 + R_i) r_i^x(\varphi_i^x)}{\sigma} - f_i^x = \frac{r_i^n(\varphi_i^x)}{\sigma}.$$

We can now substitute for r_i^x from Eq. (6) to get

$$\left[(1 + R_i)^{\frac{\xi_i}{\sigma - 1}} - 1\right] r_i^n(\varphi_i^x) = \sigma f_i^x = \sigma f_i^d \frac{f_i^x}{f_i^d} = r_i^n(\varphi_i^d) \frac{f_i^x}{f_i^d},$$

where φ_i^d is the domestic cutoff productivity, and the last equality sign is due to the condition that the marginal firm in the market makes zero profits, implying that its operating profits $r_i^n(\varphi_i^d)/\sigma$ are equal to domestic fixed costs f_i^d. Using Eq. (6) we can substitute for the relative revenues of the least productive firm in the market and the marginal exporting firm by the ratio of their productivities:

$$\frac{\varphi_i^x}{\varphi_i^d} = \left\{ \left[(1 + R_i)^{\frac{\xi_i}{\sigma - 1}} - 1 \right] \frac{f_i^d}{f_i^x} \right\}^{-\frac{1}{\xi_i}}, \tag{8}$$

where $\varphi_i^x / \varphi_i^d > 1$ (and therefore self-selection of the most productive firms into exporting) is ensured by assuming that fixed export costs f_i^x are sufficiently large.

For the empirical implementation of our model in the next section we make the common assumption that the cumulative distribution function of productivities is Pareto: $G_i(\varphi) = 1 - (\varphi/\bar{\varphi}_i)^{-k_i}$, with k_i being the shape parameter and $\bar{\varphi}_i$ being the lower floor of the support region of the respective distribution in country i. In this case, the share of exporting firms in country i, χ_i is only a function of the ratio between the domestic and foreign cutoff productivities:

$$\chi_i = \frac{1 - G_i(\varphi_i^x)}{1 - G_i(\varphi_i^d)} = \left(\frac{\varphi_i^d}{\varphi_i^x} \right)^k = \left\{ \left[(1 + R_i)^{\frac{\xi_i}{\sigma - 1}} - 1 \right] \frac{f_i^d}{f_i^x} \right\}^{\frac{k_i}{\xi_i}}. \tag{9}$$

By simply putting together the results derived so far, we can now summarise our theoretical model in two equations, both of which have a straightforward graphical representation. First, we can express the operating profits of an i-borne firm of any given productivity relative to the operating profits of the least productive firm in this country (these are labelled "normalised" operating profits in the following):

$$\frac{\psi_i^t(\varphi)}{\psi_i^t(\varphi_i^d)} = \begin{cases} \left(\dfrac{\varphi}{\varphi_i^d} \right)^{\xi_i} & \text{if} \quad \dfrac{\varphi}{\varphi_i^d} < \dfrac{\varphi_i^x}{\varphi_i^d} \\ \\ (1 + R_i)^{\frac{\xi_i}{\sigma - 1}} \left(\dfrac{\varphi}{\varphi_i^d} \right)^{\xi_i} & \text{if} \quad \dfrac{\varphi}{\varphi_i^d} \geq \dfrac{\varphi_i^x}{\varphi_i^d} \end{cases} . \tag{10}$$

Figure 1 illustrates Eq. (10), using $\Psi_i \equiv \psi_i^t(\varphi)/\psi_i^t(\varphi_i^d)$ to denote the profile of normalised operating profits as a function of normalised firm productivity. This profile is increasing in firm-specific productivity φ and it has a discontinuity at the normalised exporter productivity

cutoff φ_i^x/φ_i^d. At this cutoff, the profile of normalised total operating profits shifts upwards and becomes steeper as exporters earn operating profits from domestic and foreign activity. In contrast, the profile for normalised domestic operating profits (Ψ_i^d) shifts downwards and becomes flatter, since access to the foreign market is associated with higher wage payments and thus lower domestic profits, according to Eq. (6). The size of the shift as well as the change in the slope of profile Ψ_i depend on R_i, the export market potential for country i.[10]
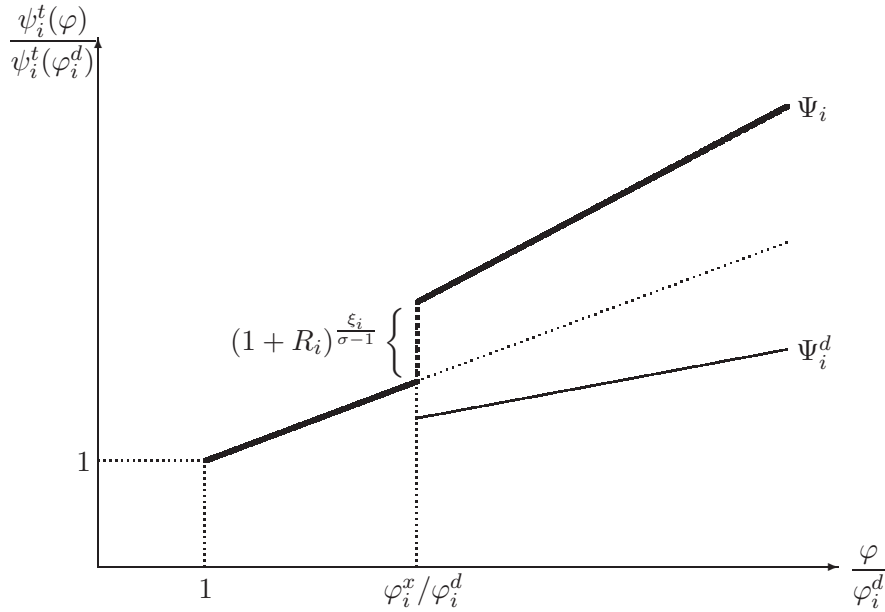

Figure 1: Profile of operating profits

Second, we can express the wage paid by a firm of any given productivity based in country i relative to the wage paid by the least productive firm based in this country. In direct analogy to above we get

$$\frac{w_i(\varphi)}{w_i(\varphi_i^d)} = \begin{cases} \left(\dfrac{\varphi}{\varphi_i^d}\right)^{\theta_i\xi_i} & \text{if} \quad \dfrac{\varphi}{\varphi_i^d} < \dfrac{\varphi_i^x}{\varphi_i^d} \\[4mm] (1+R_i)^{\frac{\theta_i\xi_i}{\sigma-1}}\left(\dfrac{\varphi}{\varphi_i^d}\right)^{\theta_i\xi_i} & \text{if} \quad \dfrac{\varphi}{\varphi_i^d} \geq \dfrac{\varphi_i^x}{\varphi_i^d} \end{cases} \tag{11}$$

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[10]Our model does not give a clear prediction regarding the curvature of the two Ψ_i segments in Figure 1. The respective profiles are concave (convex) if $1 > (< \xi_i)$, i.e. if $1 > (<)(\sigma-1)(1-\theta_i)$. For a graphical representation we consider a linear shape, while in the empirical analysis we will estimate the values of σ and θ_i and, thus, provide insights upon the true size of ξ_i in our data-set.

Figure 2 illustrates the wage profile, using $W_i \equiv w_i(\varphi)/w_i(\varphi_i^d)$ to denote the profile of normalised wages as a function of normalised firm productivity. As shown in this figure, wages are increasing and concave in productivity φ. The profile shifts upwards at the normalised exporter cutoff φ_i^x/φ_i^d and the gradient of the profile is steeper for exporters than non-exporters. The reason for the latter is that exporters are active at home and abroad and thus realize additional profits from serving foreign consumers. Workers participate in these profit gains due to the rent-sharing mechanism that is introduced by the fair wage-effort model in Subsection 2.2. Comparing profiles W_i and Ψ_i, one can see that normalised wages are less sensitive to a change in normalised productivity than normalised operating profits. This is because the fair wage reference of workers in Eq. (4) contains a firm-external component that generates wage compression between firms, ceteris paribus.[11] In the context of the model, the exporter wage premium in percent is constant across exporters and amounts to $\Omega_i \equiv 100 \cdot (1 + R_i)^{\frac{\theta_i \xi_i}{\sigma - 1}} - 100$.
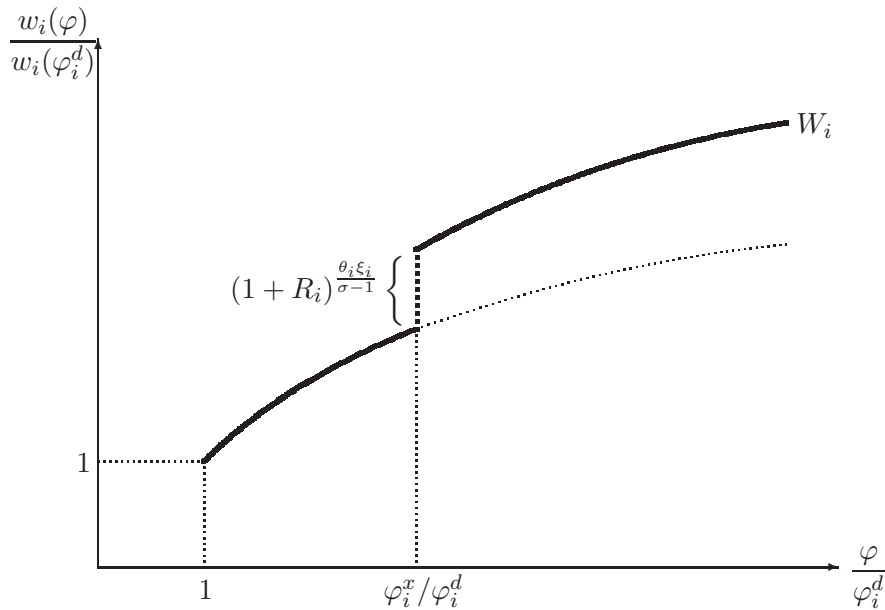

Figure 2: Wage profile

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[11]In contrast to Ψ_i, we can be sure that both segments of W_i are strictly concave since $\theta_i \xi_i < 1$.

3   Empirical analysis

Our goal in this section is an empirical implementation of the theoretical model developed in Section 2 which allows us to estimate its key parameters. These parameter estimates are then used to formulate a numerical model on the basis of which we can quantify the country-specific exporter wage premium. We furthermore assess the goodness of fit of the model by comparing estimated and observed wage profiles across firms in the data.

3.1   Data

A data base that provides information across firms, countries, and time about many of the key variables of interest is Bureau van Dijk's *Amadeus Database*. Apart from balance sheet data, this source contains data on exports (levels and status) across time and firms in five European countries: Bosnia and Herzegovina; Croatia; France; Serbia; and Slovenia.[12] Data for all countries covered are available for the period 2000 to 2008. An advantage of this data-base is that all information on profits, revenues, exports, employees, or wages per employee can be gathered from the same source for several countries. A disadvantage is that data on skills of workers are not available (see Budd, Konings, and Slaughter, 2005).

Table 1 summarizes the number of firms active in the average year and the percentage of exporters among those. Since inspection of the firm-level panel data reveals that imputation was used by the data provider, we refrain from exploiting the time-series variation and resort to an analysis of the cross-section variation in the data. Furthermore, we do not associate firms with industries (sectors), nor do we make use of the industry-dimension in our data-set (see Eaton, Kortum, and Sotelo, 2011, for a similar strategy). The reason is that a significant share of firms is active in more than one NACE (revision 1) industry, even when using as highly aggregated data as 2-digit industries. Lacking detailed information on the composition of a firm's output, we would have to classify firms as belonging to the main sector they operate in (according to their sales and own reporting). Hence, industry-level effects are prone to aggregation bias, and may be misleading.

−− Table 1 about here −−

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[12] Amadeus contains many more countries. However, the quality of export data restricts our sample to the five mentioned economies.

Table 1 illustrates that there is one big country in the sample with almost $100,000$ firms in the average year: France. The other countries are smaller: about $6,000$ firms are covered for Serbia in the average year, and the smallest country in the sample is Bosnia and Herzegovina with less than $1,500$ firms in the average year. There is not only large variation in country size, but also considerable variation in export market participation. According to Table 1, only about 38 percent of the active firms export in Serbia (possibly a consequence of the political and economic isolation of Serbia at the end of the 20th and the beginning of the 21st century), while about 45 percent of the French firms and around 60 percent of firms in Bosnia and Herzegovina, Croatia, and Slovenia export in the average year between 2000 and 2008.

$$-- \text{ Table 2 about here } --$$

Table 2 summarizes average values and standard deviations for log of revenues (sales; r_{vi}^t), log of operating profits (ψ_{vi}^t), log of exports, log of number of employees, and log of wages per employee (w_{vi}) across all firms per country. Thereby, we use the convention of referring to firms by subscript v and to countries by subscript i. All figures, except for the number of employees, are based on values in thousands of nominal Euros. For instance, the figures in the table suggest that average sales for firms are largest in Slovenia and smallest in Bosnia and Herzegovina. One obtains a similar regional pattern for firm-level variables when using operating profits, exports, number of employees, or average wages. In the following subsection we will outline estimation procedures for and estimates of the fundamental parameters and variables of interest. In general, we will report point estimates and standard errors which are based on bloc-bootstrapping with 1,000 replications.

3.2 Estimation in steps

Estimating the elasticity of substitution between product varieties σ:
The above theoretical model suggests that σ can be estimated by the following cross-section model:

$$\frac{r_{vi}^t}{\psi_{vi}^t} = \sigma + error_{vi}, \tag{12}$$

where r_{vi}^t and ψ_{vi}^t denote total revenues (sales) and operating profits of a firm v in country i, σ is the elasticity of substitution between varieties v and $error_{vi}$ is a disturbance term.

For the sake of efficiency in parameter estimation, one may allow for clustering of $error_{vi}$ at the level of i, but this does not affect the point estimate of σ. Estimation of Eq. (12) with the sample as in Tables 1 and 2 leads to a point estimate of $\hat{\sigma} \simeq 6.698$ and a standard error of 0.030. It might be that the assumption of pooling σ across industries appears rather strong. Allowing σ to vary across (NACE revision 1) 2-digit industries indexed as $h = 1, ..., H$, leads to an average estimate of $H^{-1} \sum_{h=1}^{H} \hat{\sigma}_h \simeq 7.297$ with a standard deviation across industries of 10.886. Hence, there is sizable variation in σ across industries, but the industry-level estimates are well centered in the neighbourhood of the average value of 6.698 so that we may draw inference about aggregate relationships from pooled estimates. Furthermore, taking into account the aforementioned problems associated with the assignment of firms to specific sectors, disregarding industry-level estimates seems advisable in a context as ours which is focused on aggregate measures. The σ-estimate from the pooled regression is of similar magnitude as those reported in other empirical studies (see Broda and Weinstein, 2006) and well in line with parameter values typically employed for the calibration of trade models (see Arkolakis, 2010; Arkolakis and Muendler, 2010).

Estimating the country-specific rent-sharing parameter θ_i:

A parameter which is at the heart of our analysis is θ_i, the rent-sharing parameter which is a compact measure of labour market imperfections in our setting. To estimate it, we can make use of the fair-wage constraint in Eq. (4). Taking logs on both sides of this equation, we can postulate a regression of the following form

$$\ln w_{vi} = \theta_i \ln r_{vi}^t + \mu_i + error_{vi}, \tag{13}$$

where μ_i is a fixed country-year effect, controlling for the firm-external component of the workers' reference wage, $(1 - u_i)\bar{w}_i$, which is weighted by the country-specific factor $(1-\theta_i)$ in our model.

−− Table 3 about here −−

Estimation results for the model in Eq. (13) are summarised in Table 3. As the table indicates, the weighted average of θ across all firms and countries amounts to 0.102 with a robust standard error of 0.001. The country-specific estimates $\hat{\theta}_i$ vary between 0.053 for Bosnia and Herzegovina and 0.150 for Serbia. All of the estimates $\hat{\theta}_i$ are significantly different from

zero at one percent. Moreover, F-tests (not reported in the table) reject the null hypothesis that parameters θ_i and μ_i are poolable across countries at one percent.

Calculating parameter ξ_i:

With the parameter estimates $\hat{\sigma}$ and $\hat{\theta}_i$ at hand, we can simply compute

$$\hat{\xi}_i = \frac{\hat{\sigma} - 1}{1 + \hat{\theta}_i(\hat{\sigma} - 1)}. \tag{14}$$

The respective results are summarised in the last pair of columns of Table 3. That table reports estimates for individual countries as well as the weighted average $\hat{\bar{\xi}}$. The table suggests that the estimates $\hat{\xi}_i$ vary to some extent around the average $\hat{\bar{\xi}} = 3.685$, but that the variation is not too big (all estimates $\hat{\xi}_i$ lie between 3.1 and 4.5).[13] However, we should recognize that $\hat{\xi}_i$ will enter in the exponent of variables so that some small variation in it can account for nontrivial differences in the magnitude of comparative static effects. For that reason, we rely on country-specific estimates $\hat{\xi}_i$ in the subsequent analysis.

Estimating the country-specific Pareto shape parameter k_i:

A third fundamental parameter in our analysis is the shape parameter of the Pareto distribution, k_i. Like the fair wage parameter θ_i, we allow k_i to vary across countries. In estimating k_i, we follow the strategy of Arkolakis (2010) and Arkolakis and Muendler (2010) and make use of the fact that, when randomly drawing an exporter from the total population of a country's exporters, the probability that this firm has higher revenues than an exporter with a productivity level φ_p is equal to $1 - \Pr_{pi} = (\varphi_p/\varphi_i^x)^{-k_i}$, where $\Pr_{pi}$ is the relative percentile of exporter v in the respective revenue distribution (of domestic exporters). Equipped with this insight, we can calculate average revenues of exporters with a productivity equal to or higher than φ_p. Denoting

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[13]Table 3 also reports the weighted average standard error for the weighted average $\hat{\bar{\xi}}$. However, this variable must be interpreted with care as it is not informative about the dispersion of ξ-values around $\hat{\bar{\xi}}$ in the pooled sample, but rather captures the accuracy of the country-level estimates. For that reason, we do not further discuss average standard errors of computed variables in the main text.

the respective average as $\bar{r}_{pi}^x$ and substituting $\varphi_p / \varphi_i^x = (1 - \mathrm{Pr}_{pi})^{-1/k}$, we obtain[14]

$$\bar{r}_{pi}^x = r_i^x(\varphi_i^x) \frac{k_i}{k_i - \xi_i} (1 - \mathrm{Pr}_{pi})^{-\xi_i/k_i} . \tag{15}$$

Substituting $\gamma_i \equiv \xi_i / k_i$, $rank_{pi} \equiv 100 \times (1 - \mathrm{Pr}_{pi})$, and taking logs on both sides of Eq. (15), we can formulate the following estimation equation

$$\ln \bar{r}_{pi}^x = -\gamma_i \ln rank_{pi} + \mu_i + error_{pi}, \tag{16}$$

where μ_i is a fixed country effect, and $rank_{pi} \in \{1, ..., 99\}$. Eq. (16) gives an estimate $\hat{\gamma}_i$ for each country, and in combination with the estimates for ξ_i in Table 3 we can compute $\hat{k}_i = \hat{\xi}_i / \hat{\gamma}_i$.[15]

−− Table 4 about here −−

The second column in Table 4 summarizes the findings for the estimates $\hat{\gamma}_i$. For the pooled sample, we obtain an estimate of $\hat{\gamma} = 0.861$, with a robust standard error of 0.004. Poolability of γ_i across countries is rejected at one percent. Hence, assuming one parameter, $\gamma_i = \gamma$ for all i, is not justifiable with the data at hand. The estimates for $\hat{\gamma}_i$ are fairly close to those reported in Arkolakis (2010) and Arkolakis and Muendler (2010): 0.67 and 0.83, respectively. Note that in our model existence of a finite positive mean of the Pareto distribution of productivity levels requires $\gamma_i < 1$, which is supported by the estimates in our data-set. Column 3 displays computed $\hat{k}_i$ for the five individual countries as well as the weighted average for the whole sample, which amounts to $\hat{k} = 4.306$. The estimates for the individual countries take values in between 3.994 for Serbia and 5.965 for Bosnia and Herzegovina and are significantly higher than those found by Del Gatto, Mion, and Ottaviano (2006), who rely on a different estimation approach and report k_i-values close to 2.

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[14]Noting that

$$\bar{r}_{pi}^x = \int_{\varphi_p}^{\infty} r_i^x(\varphi) \frac{dG_i(\varphi)}{1 - G_i(\varphi_p)},$$

it is straightforward to calculate Eq. (15).

[15]Two remarks are in order here: First, in principle, we can relate any exporter's revenues to its relative position in the productivity distribution: $r_i^x(\varphi_p) = (1 - \mathrm{Pr}_{pi})^{-\xi_i/k_i} r_i^x(\varphi_i^x)$. However, working with averages has the advantage that our results make use of all information and do not rely on just a few observations, namely those for the $p \in \{1, ..., 99\}$ firms. Second, in principle we could also use information on non-exporters for estimating k_i. However, since from our model we should not expect non-exporters in the upper tail of the productivity distribution, we cannot directly apply the technique used here for inferring insights on k_i from non-exporters.

Estimating country-specific productivity cutoff ratio φ_i^x/φ_i^d:

With Pareto distributed productivities, the estimated productivity cutoff ratio for exporting and non-exporting firms is simply given by $\chi_i^{-1/\hat{k}_i}$, where exporter share χ_i is directly observable in the data-set. The respective values of $\chi_i^{-1/\hat{k}_i}$ are summarised in the penultimate column of Table 4. The productivity cutoff ratio is fairly small and amounts to only 1.204 on average. The country-level values vary between 1.093 for Bosnia and Herzegovina and 1.272 for Serbia. This suggests that Serbian exporters must be more productive relative to national firms to be able to survive at the export market than, say, firms in France and even more so than firms in other comparably small countries in the sample. However, the differences in the estimates for the productivity cutoff ratios are not very large for our country sample.

Estimating country-specific export market potential R_i:

We now estimate for each country the export market potential R_i as defined in Eq. (7). As a first step, we can re-write Eq. (6) to get

$$R_i = \left(\frac{r_i^{tx}}{r_i^{nx}}\right)^{\frac{\sigma-1}{\xi_i}} - 1,$$

where r_i^{tx} denotes total revenues of the marginal exporter and r_i^{nx} denotes the *hypothetical* (counterfactual) revenues that this firm could realize if it did not export. While our data-set provides information about r_i^{tx} for each country, no direct information is available, of course, about r_i^{nx}. However, our formal analysis in Section 2 shows that $r_i^{nx} = \chi_i^{-\xi_i/k_i} r_i^{nd}$, where r_i^{nd} denotes domestic revenues of the marginal producer in country i. Information on the latter is available in our data-set and, hence, using the estimates $\hat{k}_i$, $\hat{\xi}_i$, and $\hat{\sigma}$ from above, we can compute

$$\hat{R}_i = \left(\frac{r_i^{tx}}{r_i^{nd}}\chi_i^{\frac{\hat{\xi}_i}{\hat{k}_i}}\right)^{\frac{\hat{\sigma}-1}{\hat{\xi}_i}} - 1. \tag{17}$$

The second column of Table 5 depicts the computed export market potential $\hat{R}_i$ for each country i.

−− Table 5 about here −−

As shown in Table 5 the export market potential amounts to 3.533 on average with a standard

error of 0.099. This points to a fairly high degree of openness of the average country in our sample. Country-level values lie between 1.152 for Serbia and 4.187 for Bosnia and Herzegovina. The variation in the estimates $\hat{R}_i$ is quite sizable, and since higher values of $\hat{R}_i$ indicate that a country is ceteris paribus better integrated in (or more open to) the world economy, the respective figures in Table 5 seem to be well in line with insights from other studies that smaller and less peripheral countries are more open than larger and more peripheral ones.

Estimating country-specific exporter wage premium Ω_i:
As explained in Section 2, our model gives rise to a pure exporter wage premium, which is the same for all exporting firms and can be computed according to

$$\hat{\Omega}_i = 100(1 + \hat{R}_i)^{\frac{\hat{\theta}_i \hat{\xi}_i}{\hat{\sigma}-1}} - 100, \tag{18}$$

when employing estimates $\hat{\theta}_i$, $\hat{\xi}_i$, $\hat{\sigma}$, and $\hat{R}_i$ from above. As shown in the last two columns of Table 5, the premium amounts to about 10 percent on average. The exporter wage premium is highest for Slovenia and France and lowest for Croatia and Serbia. In particular, the estimates for France and Slovenia seem to be well in line with findings for other OECD countries. For instance, relying on US Census data for 1984-1992, Bernard and Jensen (1999) report an exporter premium in a firm's average (production and non-production) wage of about 8.5 to 17.9 percent.[16]

3.3 Assessing the model fit

In the previous subsection we have estimated the fundamental parameters of the model outlined in Section 2 using data for five European countries. The structural parameter estimates are in line with estimates from other studies (where available). However, this does not provide insights into the capability of the model to explain real world linkages between key economic variables. To shed light on this issue, we now assess to what extent the calibrated model can reproduce real-world observations from our data-set. In particular, one endogenous variable is central to our analysis of firm heterogeneity: firm-level average wages. Hence, we focus on this variable in assessing the model fit.

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[16]The existence of an exporter wage premium is also well in line with recent empirical findings for Germany (Schank, Schnabel, and Wagner, 2007) and Mexico (Frías, Kaplan, and Verhoogen, 2009). Existing studies to this literature also find support for the key insight from our theoretical study that this premium can be mainly explained by self-selection of the most-productive firms into export status and is not just a result of the heterogeneity of firms in their workforce.

We proceed in two steps. First, we use the observed pattern of revenues (sales) to learn about firms' productivity levels relative to the cutoff producer in the same country. For this purpose, we consider $r^t(\varphi)/r^t(\varphi_i^d) = \psi^t(\varphi)/\psi^t(\varphi_i^d)$, according to Eq. (6), and apply Eq. (10) to obtain a model-consistent productivity profile from our data-set, i.e. we calculate φ/φ_i^d for each firm in country i.[17] In a second step, we use the productivity patterns together with the estimated variables $\hat{\theta}_i$, $\hat{\sigma}$ (which together imply $\hat{\xi}_i$), $\hat{k}_i$, and $\hat{R}_i$ to calibrate the profiles of firm-level wages according to Eq. (11). We can then compare the thus calculated profile of normalised wages to the normalised wage profile in our data-set, and compute the correlation coefficient between model-generated and observed values in order to obtain insights into the predictive power of the model.

Since there is an overlap of exporters and non-exporters in productivity space in the data, i.e. selection is not as sharp as in the Melitz (2003) model, we conduct this exercise for the true and a theory-adjusted data-set, where 'theory-adjusted' means that we manipulate the data to make it consistent with the following two conditions: (i) *no overlap* of non-exporters and exporters in productivity space and (ii) an exporter share as observed in the raw data. To achieve this goal without eliminating a huge amount of producers, we define for each country a 'revenue cut-off', such that the share of firms above this cutoff equals the share of exporting firms of the respective country in our data-set, and then reclassify all firms below the cutoff as non-exporters and all firms above the cutoff as exporters. This provides a newly constructed data-set in which all firms' export decisions are consistent with sharp selection into export status as in Melitz (2003). Considering both the original and the 'theory-adjusted' data-set, we obtain two correlation coefficients for each of the five economies. The corresponding results are summarised in Table 6.

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[17]This structural approach differs significantly from other strategies for estimating firm-level productivity. For instance, sales per employee is a widely used proxy for labour productivity. However, according to our theoretical model, sales per employee are just proportional to wages and therefore do not contain independent information about productivity parameter φ. Hence, employing this measure would be at odds with our theory. Furthermore, in recent years economists have used information on investment (see Olley and Pakes, 1996) or other inputs (see Levinsohn and Petrin, 2003) to estimate firm-level productivity in a structural dynamic approach. While we could employ this method in principle, we do not do so, because the reasoning underlying this estimation method is inconsistent with our assumptions (i) that labour is the only factor of production and (ii) that productivity levels are constant over time. To assess the predictive power of the model, we must take *all* of its assumptions seriously, and relying on a sophisticated method of estimating firm-productivity according to some other model is in contradiction to the general purpose of following a structural estimation approach that builds upon the theoretical model in Section 2. Saying this, we should also mention that we have employed other measures of productivity – in particular also one that relies on Olley and Pakes (1996) – to see how robust our results are in this respect. Notably, the model fit turns out to be good in all considered specifications.

The correlation coefficients in Table 6 suggest the following conclusions. First, the parameter estimates are quite successful in general when it comes to generating distributions of normalised wages for our country sample. The correlation coefficient for log-transformed normalised wages lies between 0.507 and 0.948 when relying on the original data-set and between 0.512 and 0.948 when considering the 'theory-adjusted' one.[18] In comparison to other calibration studies in international economics, the estimated correlation coefficients are quite high, so that we may conclude that the model works fairly well in reproducing observed patterns of firm-level wage payments.[19] Furthermore, there is almost no difference in the estimated correlation coefficients for the original and the 'theory-adjusted' data-set. This suggests that the observed overlap of exporters and non-exporters in the productivity (and revenue) distribution does not lower the predictive power of our model, even though it relies on the assumption of sharp self-selection of firms into export status according to their productivity levels and thus cannot account for the observed overlap, by construction.

4 Comparative static analysis

In this section, we use our model to compute the effect that the actual level of trade has on the five countries in our sample, compared to a hypothetical situation of autarky. We first look at the effect on the distribution of wages across firms in each of the five countries, and subsequently address the consequences for aggregate employment.

4.1 The distribution of wages and operating profits across firms

In this subsection, we consider the effect of openness on compact measures of inequality across firms in normalised wages for each of the countries in our sample. In the context of our model we can easily assess the effect of openness by comparing the estimated values for normalised wages

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[18]Using the same approach for assessing the ability of our model to reproduce observed patterns in operating profits, we get correlation coefficients above 0.99 for each country in our sample. However, this result should be interpreted with care. Since operating profits themselves are not directly observable in the data, they are constructed by combining information on revenues and insights from our model. For that reason, the correlation coefficients must be high by construction, when inferring model-consistent normalised productivity patterns from observed revenue figures.

[19]For instance, see Alvarez and Lucas (2005) for the calibration of a multi-country Ricardian trade model along the lines of Eaton and Kortum (2002).

from Eqs. (10) and (11) for the actual degree of openness, measured by the estimated value for the export market potential $\hat{R}_i$, with the values for the same variables in a counterfactual situation with $R_i = 0$. In doing so, we employ the normalised productivity levels estimated in Subsection 3.3 for both the original and the 'theory-adjusted' data-set. Then, we can compare the distributions for the counterfactual (autarky) and benchmark normalized equilibrium values by means of the standard deviation for log-transformed variables.[20] The corresponding results for each country from this experiment are summarised in Table 7.

−− Table 7 about here −−

Table 7 shows that trade brings about a greater inequality in firm-level wages everywhere. The corresponding impact is sizable and amounts to 15.1 percent on average when relying on productivity estimates from the original data-set and to 25.3 percent on average when relying on ones from the 'theory-adjusted' data-set. This difference can be explained by the observed overlap of exporters and non-exporters in the same productivity percentile, which is excluded by construction in the 'theory-adjusted' data-set. While there is a quantitative difference in the distributional effects of trade between the two data-sets, both share similar qualitative features. In particular, the impact of trade on firm-level wage inequality is smallest for Croatia and Serbia, and largest for Bosnia and Herzegovina and France. The latter is somewhat surprising, as we would expect in general that trade effects are less pronounced in larger economies. However, one should keep in mind that the comparative-static experiment conducted here is of different magnitude for each economy and, with France being the only country that has been member of the European Union over the whole time span for which data are available (2000-2008), it is plausible that a movement from autarky to the observed degree of openness is associated with a larger parameter change for France than for other countries in our sample.[21] Finally, with log-transformation, normalised wages are proportional to normalised operating profits, and hence the figures in Table 7 also capture the impact of trade on inequality across firms in normalised operating profits.

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[20] As outlined in Footnote 17, we have to use model-consistent measures of productivity, when taking the idea of a structural empirical approach seriously. For that reason, we can only infer information on normalised variables from our data-set. This restricts the scope for comparative-static exercises. For instance, we cannot estimate the impact of trade on other measures of inequality such as the Gini coefficient or the Theil index, as our approach does not allow for determining *absolute* levels of the cutoff productivity in autarky or trade, which, however, is needed for estimating changes in these inequality measures.

[21] This can be confirmed, when noting that the relevant term $[\hat{\theta}_i \hat{\xi}_i / (\hat{\sigma} - 1)] \ln(1 + \hat{R}_i)$, cf. Eq. (11), is significantly higher for France than the other countries in our data-set.

4.2 Welfare and employment

In this subsection, we apply the model to get insights about general equilibrium effects of trade. An issue that in the context of globalisation is of primary concern for workers is the increasing risk of job loss (see Scheve and Slaughter, 2001). While our theory does not allow a direct quantification of the employment effects of trade, we can derive a link between the effects of trade on aggregate welfare, measured by per capita income $(1-u_i)\bar{w}_i$, and aggregate employment, respectively.[22] As formally shown in the Appendix, our model relates welfare and employment effects of trade in the following way:

$$\frac{1-u_i}{1-u_i^a} = \left(\frac{(1-u_i)\,\bar{w}_i}{(1-u_i^a)\,\bar{w}_i^a}\right)^{\theta_i} \frac{\Gamma_i}{\Phi_i},\tag{19}$$

where

$$\Gamma_i \equiv 1 + \chi_i^{\frac{k-(1-\theta_i)\xi_i}{k_i}}\left[(1+R_i)^{\frac{(1-\theta_i)\xi_i}{\sigma-1}}-1\right] \quad \text{and} \quad \Phi_i \equiv 1 + \chi_i^{\frac{k-\xi_i}{k_i}}\left[(1+R_i)^{\frac{\xi_i}{\sigma-1}}-1\right],$$

respectively. Eq. (19) shows that the effect of trade on aggregate employment can take either sign: higher per capita income (or, equivalently, higher aggregate output) increases employment, ceteris paribus, as shown by the first term on the right hand side. The second term reflects the fact that exporting induces higher wage payments and hence a cost-penalty, which, all other things equal, makes the labour market imperfection more severe.[23] We can use Eq. (19) together with the parameter estimates from Section 3 to quantify how large the gains from trade must be in order to generate positive employment effects relative to autarky at the observed degree of openness. The results from this exercise are summarized in Table 8.

−− Table 8 about here −−

Columns 2-6 of Table 8 report employment changes for small, medium, and large welfare effects of trade. These figures indicate that employment effects of trade are negative if gains from trade are comparatively small despite the large change in the degree of openness underlying

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[22]Estimating the employment effects or the welfare effects of trade independently, rather than just their relationship to each other, would require information about the *absolute* level of cutoff productivity φ_i^d, which is not available in our data-set – and cannot be estimated in a theory-consistent way (see Footnote 17).

[23]It is easily confirmed that $(1+R_i)^{\xi_i/k_i}-1 > \chi_i^{\theta_i\xi_i/k_i}\left[(1+R_i)^{(1-\theta_i)\xi_i/k_i}-1\right]$, which proves $\Gamma_i < \Phi_i$ and thus a negative employment effect from the cost-penalty associated with exporting. Of course, when aggregate gains from trade are accompanied by lower aggregate employment, this points to a more than proportional increase in the average wage of employed workers.

our policy experiment. For instance, even welfare gains of 10 or 50 percent of (counterfactual) autarky level income per capita are not sufficient for any country to generate positive employment effects. The largest relative decline in employment in our experiment is found for France and Slovenia. However, noting that the OECD reports harmonized unemployment rates of 7.8 percent for France and 4.4 percent for Slovenia in 2008. Hence, the negative employment effects in columns 2 and 3 of Table 8 amount to an increase in the rate of unemployment of less than one percentage point for these two economies. On the other hand, the results in columns 5 and 6 suggest that for countries such as Bosnia and Herzegovina and France, gains from trade must be more than 200 percent to be associated with positive employment effects at observed degrees of openness relative to autarky. To shed further light on this issue, we report 'break-even' welfare effects in column 7, which refer to the minimum level of gains from trade that is necessary to avoid negative employment effects at observed degrees of openness relative to autarky.

Whether the calculated welfare changes that are necessary for avoiding negative employment effects are unrealistically high or not is difficult to say, as the comparative-static exercise in this subsection does not involve just small parameter changes, such as changes in trade costs of 10 or 15 percent, but instead refers to a policy experiment of huge magnitude in which countries cease trade entirely in the counterfactual analysis. While studying such exercises is common practice in trade theory, it is usually not at the agenda of empirical research as data on such large policy experiments are typically not available.[24] Due to the lack of empirical evidence, we follow a different approach for getting an idea about the magnitude of gains that might be involved if the countries in our sample move from autarky to the observed degree of openness and compute the respective gains our model would predict for the benchmark scenario of two fully symmetric countries.[25] As shown in the Appendix, gains from trade between two identical countries are given by

$$\frac{(1-u_i)\bar{w}_i}{(1-u_i^a)\bar{w}_i^a} = \left[\left(\frac{\Phi_i}{1+\chi_i}\right)^{\frac{1}{\sigma-1}}\Phi_i^{\frac{1}{k_i}}\right]^{\frac{1}{1-\theta_i}}. \tag{20}$$

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[24] A notable exception is Bernhofen and Brown (2005) who provide estimates on the upper bounds of comparative advantage gains from trade that Japan experienced after its opening up for trade in the 19th century.

[25] Lacking information upon the level of cutoff productivity φ_i^d, we cannot compute welfare effects for asymmetric economies and thus have to rely on a benchmark scenario of symmetric countries, when quantifying the magnitude of the welfare stimulus from trade in our setting.

Substituting the parameter estimates from Section 3, then allows us to quantify the gains from trade between symmetric countries, in order to get a rough idea about the magnitude of welfare gains involved in a country's opening up from autarky to the observed degree of openness. The computed welfare gains lie between 11.05 percent for Serbia and 41.05 percent for France, and for all countries in the sample the welfare gains are significantly lower than those required for a positive employment stimulus, according to Table 8.[26] In view of these insights, we may be tempted to conclude that the observed patterns of trade are associated with negative employment effects in the five European countries considered in our analysis. However, one should be cautious when deriving general conclusions from a specific model that ignores potentially important features of the real world (such as external scale effects). On the other hand, by relying on a specific model, we do not need to impose the restrictive assumption that the estimated relationship between observed changes in trade costs and unemployment is monotonic, when shedding light on large policy experiments, as, for instance, a country's movement from autarky to trade.

5   Concluding remarks

This paper introduces a fair-wage effort mechanism into an otherwise standard trade model with heterogeneous firms to motivate a structural empirical approach for estimating patterns of operating profits and wages across firms in large open economies. Employing firm-level data from five European economies with altogether more than 100,000 firms, we can estimate all parameters of the model using information from just a single data-base. Equipped with these parameters, we identify an exporter wage premium of about 10 percent on average in our country sample. Furthermore, our parsimonious theoretical model has a high predictive power and can explain more than 70 percent of the variation in wages across firms in our data-set. In a counterfactual analysis, we show that the observed extent of trade has significantly increased inequality of wages and operating profits across firms relative to autarky. We also produce evidence suggesting that trade is likely to have led to a modest reduction in total employment in all five economies despite

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[26]The computed gains from observed trade are significantly higher than those reported by Eaton and Kortum (2002) who conduct a similar counterfactual analysis in a multi-country Ricardian model for 19 OECD economies. According to Eaton and Kortum (2002), welfare losses from moving towards autarky are modest. They lie in between 0.2 percent for Japan and 10.3 percent for Belgium and they amount to 2.5 percent for France, which is the only country that is considered in their as well as our study.

the existence of aggregate gains from trade.

While following a structural empirical approach has many advantages over conventional reduced-form empirical applications, it is particularly recommended if one is interested in large policy experiments, as, for instance, a country's movement from autarky to observed patterns of trade, because one does not have to impose the restrictive assumption of a monotonic relationship between trade costs and outcome variables of interest, which often does not exist in models of international trade. For instance, as explained in Egger and Kreickemeier (2009, 2011), the link between trade costs and key variables of labor market performance need not be monotonic, and hence conclusions from reduced-form estimations upon the general impact of trade on employment and wages may be misguided from a theoretical point of view. On the other hand, taking the structure of a theoretical model seriously, confines the set of possible policy experiments. For instance, we cannot easily compute the welfare effects of trade between asymmetric countries, as our data-set does not provide information on absolute productivity levels, and proxies usually considered in the empirical literature are at odds with our theoretical model.

However, this is not an argument against the use of a structural empirical approach, but instead indicates that we need to consider more sophisticated mechanisms for determining firm-level productivity than a simple lottery as suggested by the Melitz (2003) model. Going in this direction is a natural next step, if one is interested in employing models of heterogenous firms for estimating the consequences of trade for welfare and labor market outcome, which in our view is a worthwhile task for future research.

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A. Derivation details

Employment effects of trade

In the following, we provide derivation details for Eq. (19). Total employment in the open economy is determined by the following adding up condition:

$$(1 - u_i)L_i = \frac{M_i^d}{1 - G_i(\varphi_i^d)} \int_{\varphi_i^d}^{\varphi_i^x} l_i^n(\varphi)dG_i(\varphi) + \frac{\chi_i M_i^d(1 + R_i)}{1 - G_i(\varphi_i^x)} \int_{\varphi_i^x}^{\infty} l_i^x(\varphi)dG_i(\varphi), \qquad (21)$$

where superscripts n and x are used for distinguishing between *domestic* employment of non-exporters and exporters, respectively. Noting that $l_i^x(\varphi) = (1 + R_i)^{-\frac{\theta_i \xi_i \sigma}{\sigma - 1}} l_i^n(\varphi)$ and $l_i^n(\varphi) = (\varphi/\varphi_i^d)^{(1-\theta_i)\xi_i} l_i^n(\varphi_i^d)$ follow from Eqs. (2), (3), (5), (11), and our technology assumptions, we can write

$$(1 - u_i)L_i = \underbrace{\frac{M_i^d l_i^n(\varphi_i^d)}{1 - G_i(\varphi_i^d)} \int_{\varphi_i^d}^{\varphi_i^x} \left(\frac{\varphi}{\varphi_i^d}\right)^{(1-\theta_i)\xi_i} dG_i(\varphi)}_{\equiv A_1} \qquad (22)$$

$$+ \underbrace{\frac{\chi_i M_i^d l_i^n(\varphi_i^d)}{1 - G_i(\varphi_i^x)} (1 + R_i)^{\frac{(1-\theta_i)\xi_i}{\sigma - 1}} \int_{\varphi_i^x}^{\infty} \left(\frac{\varphi}{\varphi_i^d}\right)^{(1-\theta_i)\xi_i} dG_i(\varphi)}_{\equiv A_2}.$$

Accounting for $w_i(\varphi_i^d)l_i^n(\varphi_i^d) = (\sigma - 1)r_i^n(\varphi_i^d)/\sigma$ and $\varphi_i^x/\varphi_i^d = \chi_i^{-1/k}$, according to Eq. (9), we can calculate

$$A_1 = \frac{(\sigma - 1)M_i^d r_i^n(\varphi_i^d)}{\sigma w_i(\varphi_i^d)} \frac{k_i}{k_i - (1 - \theta_i)\xi_i} \left(1 - \chi_i^{\frac{k_i - (1-\theta_i)\xi_i}{k_i}}\right) \qquad (23)$$

and, noting that total labour income is proportional to total revenues and given by

$$(1 - u_i)L_i \bar{w}_i = \frac{(\sigma - 1)M_i^d r_i^n(\varphi_i^d)}{\sigma} \frac{k_i}{k_i - \xi_i} \left(1 + \frac{\chi_i f_i^x}{f_i^d}\right), \qquad (24)$$

we finally get

$$A_1 = \frac{(1 - u_i)L_i \bar{w}_i}{w_i(\varphi_i^d)} \frac{k_i - \xi_i}{k_i - (1 - \theta_i)\xi_i} \frac{1 - \chi_i^{\frac{k_i - (1-\theta_i)\xi_i}{k_i}}}{1 + \chi_i f_i^x/f_i^d}. \qquad (25)$$

In a similar vein, we can now calculate

$$A_2 = \frac{(1-u_i)L_i\bar{w}_i}{w_i(\varphi_i^d)} \frac{k_i - \xi_i}{k_i - (1-\theta_i)\xi_i} \frac{(1+R_i)^{\frac{(1-\theta_i)\xi_i}{\sigma-1}} \chi_i^{\frac{k_i-(1-\theta_i)\xi_i}{k_i}}}{1 + \chi_i f_i^x / f_i^d} \tag{26}$$

Putting together Eqs. (25) and (26), and using Eq. (9), we obtain

$$(1-u_i)L_i = \frac{(1-u_i)L_i\bar{w}}{w_i(\varphi_i^d)} \frac{k_i - \xi_i}{k_i - (1-\theta_i)\xi_i} \frac{\Gamma_i}{\Phi_i}, \tag{27}$$

with Γ_i and Φ_i defined as in the main text. Dividing both sides of Eq. (27) by $(1-u_i)L_i$ and solving for $\bar{w}_i/w_i(\varphi_i^d)$, gives

$$\frac{\bar{w}_i}{w_i(\varphi_i^d)} = \frac{k_i - (1-\theta_i)\xi_i}{k_i - \xi_i} \frac{\Phi_i}{\Gamma_i}. \tag{28}$$

Substituting $\bar{w}_i/w_i(\varphi_i^d)$ into the fair-wage constraint (4) for the marginal domestic producer and noting that $\psi_i^t(\varphi_i^d) = f_i^d$, furthermore implies

$$\left(w_i(\varphi_i^d)\right)^{\theta_i} = \left(f_i^d\right)^{\theta_i} \left[(1-u_i)\frac{k_i - (1-\theta_i)\xi_i}{k_i - \xi_i} \frac{\Phi_i}{\Gamma_i}\right]^{1-\theta_i} \tag{29}$$

In a final step, we can now solve the latter for the employment rate in the open economy and obtain

$$1 - u_i = \left(\frac{w_i(\varphi_i^d)}{f_i^d}\right)^{\frac{\theta_i}{1-\theta_i}} \frac{k_i - \xi_i}{k_i - (1-\theta_i)\xi_i} \frac{\Gamma_i}{\Phi_i}. \tag{30}$$

Following a similar logic for determining the employment rate in the closed economy, we get

$$\frac{1-u_i}{1-u_i^a} = \left(\frac{w_i(\varphi_i^d)}{w_i(\varphi_i^a)}\right)^{\frac{\theta_i}{1-\theta_i}} \frac{\Gamma_i}{\Phi_i} \tag{31}$$

Finally, applying the fair wage constraint to the marginal producer in the open and the closed economy, gives

$$\frac{w_i(\varphi_i^d)}{w_i(\varphi_i^a)} = \left(\frac{(1-u_i)\bar{w}_i}{(1-u_i^a)\bar{w}_i^a}\right)^{1-\theta_i}. \tag{32}$$

Combining Eqs. (31) and (32) establishes Eq. (19). *QED*

Gains from trade between two fully symmetric countries

With trade between two fully symmetric countries, we get $R_i = \tau_i^{1-\sigma}$, according to Eq. (7), and $M_i^t = (1 + \chi_i)M_i^d$. The CES price index in the open economy is then given by[27]

$$
P_i = \left\{ \frac{1}{1+\chi_i} \left[\int_{\varphi_i^d}^{\varphi_i^x} p_i^n(\varphi_i)^{1-\sigma} \frac{dG_i(\varphi)}{1-G_i(\varphi_i^d)} + \chi_i (1+R_i) \int_{\varphi_i^x}^{\infty} p_i^x(\varphi)^{1-\sigma} \frac{dG_i(\varphi)}{1-G_i(\phi_i^x)} \right] \right\}^{\frac{1}{1-\sigma}} \tag{33}
$$

Accounting for Eqs. (3), (5), and (6), and setting $P_i = 1$ due to our choice of numéraire, we can further calculate

$$
1 = \frac{p_i^n(\varphi_i^d)^{1-\sigma}}{1+\chi_i} \frac{k_i}{k_i - \xi_i} \left[1 - \left(\frac{\varphi_i^x}{\varphi_i^d} \right)^{\xi_i - k_i} + \chi_i (1+R_i)^{\frac{\xi_i}{\sigma-1}} \left(\frac{\varphi_i^x}{\varphi_i^d} \right)^{\xi_i} \right]. \tag{34}
$$

Substituting $\chi_i = \left(\varphi_i^x / \varphi_i^d \right)^{-k_i}$, $\Phi_i = 1 + \chi_i f_i^x / f_i^d$, and Eq. (8), we finally obtain

$$
p_i^n(\varphi_i^d) = \left(\frac{k_i}{k_i - \xi_i} \frac{\Phi_i}{1+\chi_i} \right)^{\frac{1}{\sigma-1}}. \tag{35}
$$

We can now use Eq. (35) together with Eq. (3) to solve for the wage rate of the marginal producer as a function of this firm's productivity:

$$
w_i(\varphi_i^d) = \left(\frac{k_i}{k_i - \xi_i} \frac{\Phi_i}{1+\chi_i} \right)^{\frac{1}{\sigma-1}} \frac{\sigma - 1}{\sigma} \varphi_i^d. \tag{36}
$$

Combining Eq. (36) with the fair-wage constraint of the marginal producer in Eq. (4), and noting that $\psi_i^t(\varphi_i^d) = f_i^d$, we can solve for per-capita income $(1-u_i)\bar{w}_i$ as a function of φ_i^d. This gives

$$
(1-u_i)\bar{w}_i = \left(f_i^d \right)^{-\frac{\theta_i}{1-\theta_i}} \left[\left(\frac{k_i}{k_i - \xi_i} \frac{\Phi_i}{1+\chi_i} \right)^{\frac{1}{\sigma-1}} \frac{\sigma - 1}{\sigma} \varphi_i^d \right]^{\frac{1}{1-\theta_i}}. \tag{37}
$$

Hence, to get an explicit solution for $(1-u_i)\bar{w}_i$, we need to determine φ_i^d. To do this, we first calculate average profits of domestic firms. Noting that aggregate operating profits are

$$
\bar{\Psi}_i^t = \frac{M_i^d}{\sigma} \left[\int_{\varphi_i^d}^{\varphi_i^x} r_i^n(\varphi_i) \frac{dG_i(\varphi)}{1-G_i(\varphi_i^d)} + \chi_i (1+R_i) \int_{\varphi_i^x}^{\infty} r_i^x(\varphi) \frac{dG_i(\varphi)}{1-G_i(\varphi_i^x)} \right]. \tag{38}
$$

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[27]We keep country indices, in order to make clear, where country-specific estimates have to be employed in the calibration exercise of Subsection 4.2

Accounting for Eqs. (5), (6) and substituting $\chi_i = \left(\varphi_i^x/\varphi_i^d\right)^{-k_i}$, $r_i^n(\varphi_i^d)/\sigma = f_i^d$ as well as Eq. (8), we can further calculate

$$\bar{\Psi}_i^t = \frac{M_i^d f_i^d k_i}{k_i - \xi_i}\left(1 + \frac{\chi_i f_i^x}{f_i^d}\right).$$

(39)

Subtracting total fixed cost expenditures $M_i^d f_i^d \left(1 + \chi_i f_i^x/f_i^d\right)$, substituting $\Phi_i = 1 + \chi_i f_i^x/f_i^d$ as defined in the main text, and dividing the resulting expression by M_i^d gives average (per-period) profits of domestic firms

$$\bar{\pi}_i^t = \frac{f_i^d \xi_i}{k_i - \xi_i}\Phi_i.$$

(40)

In Melitz (2003)-type models, the latter is usually referred to as the (modified) zero-cutoff profit condition, since the outcome in Eq. (40) is directly linked to the condition that the marginal producer in the market makes zero per-period profits in a (steady-state) equilibrium, i.e. $\psi_i^t(\varphi_i^d) = f_i^d$. To solve for φ_i^d, we can now combine the zero-cutoff profit condition with the free entry condition, where the latter captures the result that new firms enter the productivity lottery until the expected discounted profit of new entrants equals the cost of participating in the productivity lottery, f_i^e. Assuming that firms have an infinite horizon, abstracting from time discounting and assuming that all producers face an exogenous probability of exit, $\delta_i > 0$, in each period, in which they are active, the free entry condition in the steady-state equilibrium can be written in the following way:

$$\bar{\pi}_i^t = \left(\varphi_i^d\right)^{k_i}\delta f_i^e.$$

(41)

Combining Eqs. (40) and (41), then gives an explicit solution for the cutoff productivity level:

$$\varphi_i^d = \left[\frac{f_i^d \xi_i}{(k_i - \xi_i)\delta f_i^e}\Phi_i\right]^{\frac{1}{k_i}}$$

(42)

Substituting Eq. (42) into Eq. (37), we get

$$(1 - u_i)\bar{w}_i = \left(f_i^d\right)^{-\frac{\theta_i}{1-\theta_i}}\left[\left(\frac{k_i}{k_i - \xi_i}\frac{\Phi_i}{1 + \chi_i}\right)^{\frac{1}{\sigma-1}}\frac{\sigma - 1}{\sigma}\left(\frac{f_i^d \xi_i}{(k_i - \xi_i)\delta_i f_i^e}\Phi_i\right)^{\frac{1}{k_i}}\right]^{\frac{1}{1-\theta_i}}.$$

(43)

Following the analysis from above step-by-step for the closed economy, we can calculate

$$(1 - u_i^a)\bar{w}_i^a = \left(f_i^d\right)^{-\frac{\theta_i}{1-\theta_i}} \left\{ \left(\frac{k_i}{k_i - \xi_i}\right)^{\frac{1}{\sigma-1}} \frac{\sigma - 1}{\sigma} \left(\frac{f_i^d \xi_i}{(k_i - \xi_i)\delta_i f_i^e}\right)^{\frac{1}{k_i}} \right\}^{\frac{1}{1-\theta_i}}. \tag{44}$$

Dividing Eq. (43) by Eq. (44), finally gives Eq. (20). *QED*

B. Tables

Table 1: Number of firms and percentage of exporters active
(Data pertain to the average year of 2000 to 2008)

Country	Number of firms	Share of exporters (χ_i)
Bosnia and Herzegovina	1,494	0.59
Croatia	3,573	0.68
France	99,456	0.45
Serbia	6,152	0.38
Slovenia	2,651	0.63
Total	113,326	0.46

Table 2: Summary statistics for variables in logs. Data pertain to the average year of 2000 to 2008. Figures are means (top) and standard deviations (bottom).

Country	sales $(\ln r_{vi}^t)$	oper. profits $(\ln \psi_{vi}^t)$	exports $(\ln)$	employees $(\ln)$	wages/empl. $(\ln w_{vi})$
Bosnia and Herzegovina	5.18	2.78	3.55	2.31	0.72
	1.52	1.70	2.30	1.51	0.42
Croatia	6.59	3.53	4.16	2.55	2.03
	1.60	1.91	2.84	1.53	0.44
France	6.72	3.60	3.93	1.99	3.51
	1.57	1.81	3.04	1.38	0.50
Serbia	6.04	3.02	3.35	2.43	1.01
	1.67	2.09	2.38	1.58	0.53
Slovenia	7.02	4.18	5.56	2.73	2.56
	1.73	1.73	2.93	1.68	0.36
Total	6.67	3.57	3.98	2.05	3.27
	1.60	1.83	3.01	1.42	0.84

Note:
The log of exports is based upon a subsample of the observations due to truncation at zero exports. All monetary variables are measured in 1,000 Euros.

Table 3: Estimating the fair wage parameter θ_i and ξ_i

Country	$\hat{\theta}_i$	Std.err.	$\hat{\xi}_i$	Std.err.
Bosnia and Herzegovina	0.053	0.008	4.472	0.159
Croatia	0.114	0.005	3.511	0.061
France	0.099	0.001	3.713	0.022
Serbia	0.150	0.004	3.123	0.040
Slovenia	0.097	0.004	3.743	0.054
Total	0.102	0.001	3.685	0.027

Notes:
$\hat{\theta}_i$ is obtained from a model for each country which reads $\ln w_{vi} = \theta_i \ln r^t vi + \mu_i + error_{vi}$, where μ_i is a country fixed effect. Standard errors are robust to heteroskedasticity and autocorrelation of unknown form.

Table 4: Estimating the Pareto shape parameter k_i and the productivity cutoff ratio φ_i^x/φ_i^d

Country	$\hat{\gamma}_i$	Std.err.	$\hat{k}_i$	Std.err.	$\chi_i^{-1/\hat{k}_i}$	Std.err.
Bosnia and Herzegovina	0.750	0.005	5.965	0.216	1.093	0.004
Croatia	0.815	0.004	4.306	0.078	1.135	0.002
France	0.866	0.004	4.287	0.032	1.207	0.002
Serbia	0.782	0.007	3.994	0.062	1.272	0.005
Slovenia	0.774	0.007	4.838	0.083	1.100	0.002
Total	0.861	0.004	4.306	0.039	1.204	0.002

Notes:
$\hat{\gamma}_i$ is estimated as in Eq. (16). $\hat{k}_i$ is computed as stated in the text below Eq. (16). $\varphi_i^x/\varphi_i^d = \chi_i^{-1/\hat{k}_i}$ is calculated using values for χ_i as observed in the data and summarised in Table 1, and for $\hat{k}_i$ as reported in the fourth column of this table. Standard errors are robust to heteroskedasticity and autocorrelation of unknown form.

Table 5: Estimating averages of export market potential R_i and the exporter wage premium Ω_i

Country	$\hat{R}_i$	Std.err.	$\hat{\Omega}_i$	Std.err.
Bosnia and Herzegovina	4.187	0.416	6.934	1.185
Croatia	1.296	0.060	5.860	0.377
France	3.780	0.097	10.286	0.170
Serbia	1.152	0.077	6.299	0.305
Slovenia	2.424	0.098	7.894	0.389
Total	3.533	0.099	9.830	0.202

Notes:
$\hat{R}_i$ is estimated as suggested by Eq. (17), while $\hat{\Omega}_i$ is computed according to Eq. (18). Standard errors are robust to heteroskedasticity and autocorrelation of unknown form.

Table 6: Assessing the model fit in terms of correlation coefficients for observed and predicted normalised wages

Country	original data-set	'theory-adjusted' data-set
Bosnia and Herzegovina	0.507	0.512
Croatia	0.926	0.926
France	0.698	0.698
Serbia	0.948	0.948
Slovenia	0.888	0.888
Total	0.721	0.721

Notes:
The calculations of correlation coefficients are based on log-transformed variables. Normalised productivity levels $\ln \varphi_i - \ln \varphi_i^d$ are estimated from observed revenue ratios, applying Eqs. (6) and (10), while calculations of $\ln w_{vi} - \ln w_{vi}^d$ are based on Eq. (11) and the parameter estimates in Section 3.

Table 7: Simulating the impact of trade openness on the dispersion of wages and operating profits

	Δ standard deviation in % (benchmark vs. counterfactual)	
Country	original data-set	'theory-adjusted' data-set
Bosnia and Herzegovina	14.565	38.519
Croatia	5.715	10.619
France	16.186	26.808
Serbia	4.944	10.184
Slovenia	8.921	18.176
Total	15.054	25.348

Notes:
Calculations are based on log-transformed variables. Reported figures are percentage changes of observed ($R_i = \hat{R}_i$) relative to predicted counterfactual autarky ($R_i = 0$) outcome.

Table 8: Calculating the link between welfare and employment effects of trade

	Employment effects of given Δ Welfare					Δ Welfare for
Country	10%	50%	100%	200%	500%	const. empl.
Bosnia and Herzegovina	-7.07	-5.52	-4.05	-1.95	1.75	333.82
Croatia	-5.41	-1.99	1.29	6.10	14.86	78.84
France	-11.52	-8.76	-6.13	-2.29	4.64	279.22
Serbia	-6.35	-1.90	2.42	8.83	20.73	70.53
Slovenia	-7.64	-4.83	-2.14	1.77	8.83	150.25
Total	-10.89	-8.04	-5.31	-1.32	5.90	259.28

Notes:
Δ Welfare refers to welfare changes in percent. The link between welfare and employment effects of trade is calculated according to Eq. (19).