Trade, Wages, and Profits

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Abstract

This paper formulates a structural empirical model of heterogeneous firms whose workers exhibit fair-wage preferences, leading to a link between a firm's operating profits and wages of workers employed by this firm. We estimate the parameters of the model in a data-set of five European economies. The model predicts an exporter wage premium, which we find to be sizable in all countries, with nearly 10 percent on average. The estimates enable us to conduct counterfactual exercises. We find that openness to international trade has quantitatively important effects, leading to higher wage inequality and lower aggregate employment.

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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 pointed to the consequences of firm selection for aggregate employment and a new dimension of income inequality resulting from employer-specific wage rates. In Egger and Kreickemeier (2009, 2012) and Amiti and Davis (2012) 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 the labour market outcome from an empirical point of view. To guide the empirical analysis, we set up a theoretical trade model, in which the interaction between the 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, 2012) and Amiti and Davis (2012). 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

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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).

compositional effects of the firm-specific workforce), which in their detailed empirical analysis on Mexican firms, Frías, 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 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 quantify the employment effects of openness and show that the observed exposure to trade has lowered the employment rate in our country sample, with country-specific decreases ranging between 6.4 and 12.3 percent. The negative employment effects of openness do not imply that trade leads to welfare losses. While we are not able to quantify the gains from trade for the countries in our data-set, because we lack information about export destinations, we know from previous theoretical work that aggregate gains from trade are likely to exist in a framework as ours (see Egger and Kreickemeier, 2009, 2012).

Relying on a structural empirical approach distinguishes our work from other existing studies that aim at quantifying the wage and employment effects of trade in a reduced-form analysis at various levels of aggregation – including the country (Dutt, Mitra, and Ranjan, 2009; Egger, Greenaway, and Seidel, 2011; Felbermayr, Prat, and Schmerer, 2011), the industry (Klein, Schuh,

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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.

and Triest, 2003; Goldberg and Pavcnik, 2005), the firm (Trefler, 2004; Amiti and Davis, 2012), and the worker level (Egger, Pfaffermayr, and Weber, 2007; Schank, Schnabel, and Wagner, 2007; Munch and Skaksen, 2008; Klein, Moser, and Urban, 2010).[4] Lacking the structure of a particular model, these studies are not equipped to shed light on the monotonicity (or otherwise) of the estimated trade effects. We tackle this issue by increasing the share of exporters gradually from zero to one in a comparative-static exercise that employs our parameter estimates for calibrating the model proposed in the theory section of this paper. We find that a higher exposure to trade exerts a non-monotonic impact on wage dispersion – increasing it a low levels of integration and reducing it at high ones – while at the other hand it unambiguously lowers the employment rate in all five economies of our data-set, irrespective of the level of economic integration that has already been reached.

There are further advantages of a structural approach over reduced form 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 estimation allows for an assessment of the explanatory power of the underlying model, its mechanisms and transmission channels (e.g., the selection effects which are at the heart of new trade theory models with firm heterogeneity). This makes the approach not only well 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 misrepresentation of the functional form of the very models that are utilized to formulate testable hypotheses.

The remainder of the paper is organised as follows. In Section 2, we outline the theoretical

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[4]To the best of our knowledge, there is only one other study that looks at the link between openness and firm-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 allows them controlling for worker characteristics, which is not possible in our multi-country data-set.

[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.

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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 the estimation, it presents estimates of key model variables, quantifies the exporter wage premium, and assesses for our data-set the empirical validity of the fair wage hypothesis. Section 4 provides insights about the consequences of trade liberalisation on the distribution of wages and operating profits across firms, and it furthermore provides evidence on the employment effects of trade. The last section concludes with a summary of the key findings of our analysis.

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 (2012). As the only modification of their theoretical framework, we account for asymmetric countries and thus make the model 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

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

$$p_i(v) = \frac{\sigma c_i(v)}{\sigma - 1}.$$ (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, it is shown below that firms can hire the profit maximising number of workers if they set $w = \hat{w}$, and hence this is what they do in equilibirium.

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 (see Verhoogen, Burks, and Carpenter, 2007, for empirical support). 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 (2012) 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. 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.

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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).

[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 (2012) 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.

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 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 Egger and Kreickemeier, 2012, for a more detailed discussion).

2.3 The open economy equilibrium

For firm entry into domestic production and into exporting, we adopt the mechanism of Egger and Kreickemeier (2012), which builds upon Lucas (1978) and Rauch (1991), and adds the assumption of fixed export cost as in Melitz (2003). Each country is populated by an exogenous mass of agents that differ in their entrepreneurial abilities. These agents can choose between three different tasks. First, an agent can become an entrepreneur, in which case his/her entrepreneurial ability determines firm productivity. Entrepreneurs are residual claimants and receive the profit of the firm, which equals $\psi_i^t(v)$ if the firm is only active in the domestic market and $\psi_i^t(v) - f_i^x$ if the firm serves the domestic as well as the foreign market and thus has to bear the fixed exporting cost f_i^x, which is the same for all producers. Second, an agent can become self-employed and provide one unit export services at a fee s_i. Firms require $\zeta_i > 0$ units of these services for entering the export market. The fixed export cost is therefore given by $f_i^x = \zeta_i s_i$. Finally, the agent can enter the pool of production workers and supply one unit of labour to the heterogeneous firms in the market. This gives a firm-specific return of $w_i(v)$ as analyzed above.

To characterize the assignment of agents to the different tasks, we need to determine the income that can be realized in the three occupations. The *ex ante* expected income of workers and service providers is given by $(1 - u_i)\bar{w}_i$ and s_i, respectively. Hence, to ensure that both tasks are performed, $(1 - u_i)\bar{w}_i = s_i$ must hold in equilibrium. Profit income on the other hand depends on the entrepreneurial ability of the firm owner and his/her decision to serve only the domestic market or to export part of the production to the foreign economy. To solve the complex decision problem of (potential) entrepreneurs and to determine how ability affects entrepreneurial income, we can make use of the following partial results:

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

(ii) the relative 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

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

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 operating profits and relative wages 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 domestic operating profit and the relative wage of the same firm in the case of exporting (superscript x) and non-exporting (superscript n), respectively, are given by

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

where

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

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. On the other hand, a firm's total operating profit when exporting is $\psi_i^t(v) = (1 + R_i)\psi_i^x(v)$, which, according to (6), is larger than the firm's operating profit in the case of non-exporting.

For the derivation of result (*iii*) we take into account that firms self-select into exporting if and only if this provides a profit gain. Since exporters have to bear the additional fixed cost f_i^x,

we can write the condition for exporting as

$$(1 + R_i)\psi_i^x(\varphi) - f_i^x \geq \psi_i^n(\varphi). \tag{8}$$

Substituting Eqs. (6) as well as the definition of fixed export costs, we can reformulate (8) in the following way: $\left[(1 + R_i)^{\xi_i/(\sigma-1)} - 1\right]\psi_i^n(\varphi) \geq \zeta_i s_i$. This implies that the incentive to export increases in a firm's productivity level and, as formally shown below, only the most productive firms choose exporting if ζ_i is sufficiently high. In this case, Eq. (8) holds with strict equality for the marginal exporting firm, whose productivity we denote by φ_i^x:

$$\left[(1 + R_i)^{\frac{\xi_i}{\sigma-1}} - 1\right]\psi_i^n(\varphi_i^x) = \zeta_i s_i. \tag{9}$$

The productivity cutoff characterized by (9) must be distinguished from the ability/productivity cutoff, φ_i^d that separates entrepreneurs from workers and service providers. This second productivity cutoff is implicitly determined by the condition that the marginal entrepreneur – who is a non-exporter in the equilibrium with export selection considered in the following – earns a profit income which is exactly as high as the income he/she could expect elsewhere in the economy:

$$\psi_i^n(\varphi_i^d) = (1 - u_i)\bar{w}_i = s_i, \tag{10}$$

and all agents with $\varphi \geq \varphi_i^d$ become entrepreneurs, as this maximises their income (see our discussion above). Combining Eqs. (5), (9) and (10), we can calculate

$$\frac{\varphi_i^x}{\varphi_i^d} = \left\{\left[(1 + R_i)^{\frac{\xi_i}{\sigma-1}} - 1\right]\zeta_i^{-1}\right\}^{-\frac{1}{\xi_i}}, \tag{11}$$

where, as claimed above, $\varphi_i^x/\varphi_i^d > 1$ (and therefore self-selection of the most productive firms into exporting) is ensured if the fixed input requirement for exporting ζ_i is 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:

$$\chi_i = \frac{1 - G_i(\varphi_i^x)}{1 - G_i(\varphi_i^d)} = \left(\frac{\varphi_i^d}{\varphi_i^x}\right)^k = \left\{\left[(1 + R_i)^{\frac{\xi_i}{\sigma - 1}} - 1\right]\zeta_i^{-1}\right\}^{\frac{k_i}{\xi_i}}. \tag{12}$$

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):

$$\frac{\psi_i^t(\varphi)}{\psi_i^t(\varphi_i^d)} = \begin{cases} \left(\dfrac{\varphi}{\varphi_i^d}\right)^{\xi_i} & \text{if} \quad \dfrac{\varphi}{\varphi_i^d} < \dfrac{\varphi_i^x}{\varphi_i^d} \\[4mm] (1 + R_i)^{\frac{\xi_i}{\sigma - 1}}\left(\dfrac{\varphi}{\varphi_i^d}\right)^{\xi_i} & \text{if} \quad \dfrac{\varphi}{\varphi_i^d} \geq \dfrac{\varphi_i^x}{\varphi_i^d} \end{cases}. \tag{13}$$

Figure 1 illustrates Eq. (13), 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.[9]

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

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[9]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.
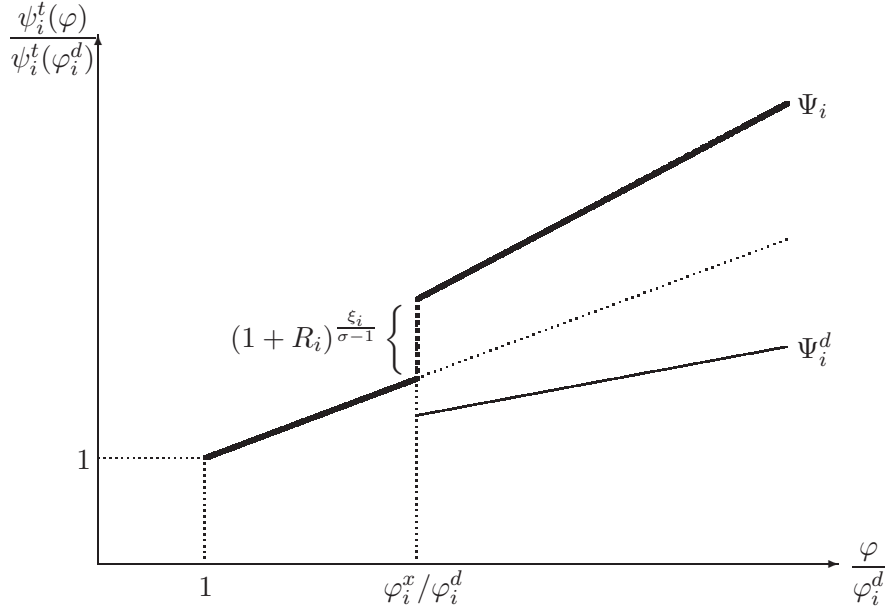
Figure 1: Profile of operating profits

to above we get

$$
\frac{w_i(\varphi)}{w_i(\varphi_i^d)} = \begin{cases} \left(\dfrac{\varphi}{\varphi_i^d}\right)^{\theta_i \xi_i} & \text{if} \quad \dfrac{\varphi}{\varphi_i^d} < \dfrac{\varphi_i^x}{\varphi_i^d} \\[4mm] (1+R_i)^{\frac{\theta_i \xi_i}{\sigma-1}} \left(\dfrac{\varphi}{\varphi_i^d}\right)^{\theta_i \xi_i} & \text{if} \quad \dfrac{\varphi}{\varphi_i^d} \geq \dfrac{\varphi_i^x}{\varphi_i^d} \end{cases} \tag{14}
$$

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.[10] In the context of the model, the exporter wage premium in percent is constant across exporters and amounts to $\Omega_i \equiv 100 \cdot (1 + R_i)^{\frac{\theta_i \xi_i}{\sigma - 1}} - 100$.
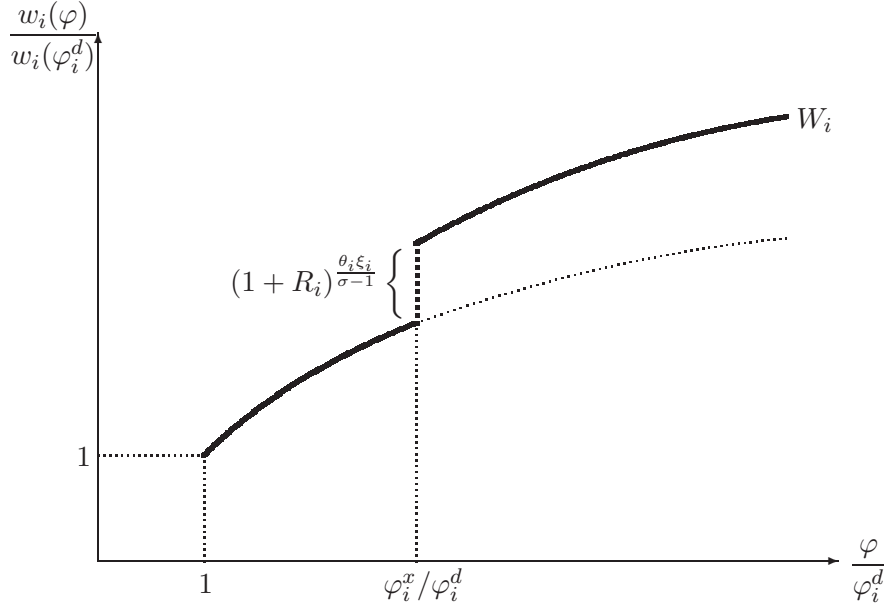

Figure 2: Wage profile

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 finally assess the empirical validity of the fair wage hypothesis 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

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

European countries: Bosnia and Herzegovina; Croatia; France; Serbia; and Slovenia.[11] 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). This implies that in line with our theoretical model we observe only a single type of labour in each firm of our data-set.

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 some of the data has been interpolated, when firm-level informations for specific years was missing, we refrain from exploiting the time-series variation and resort to an analysis of the cross-section variation in the data. Aside from the problem of interpolation, a focus on the cross-section variation seems also better suited for capturing the static nature of our model, outlined in Section 2. 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 −−

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.[12]

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

[12] The share of exporters in our data-set is in general fairly high. For instance, an exporter share of 45 percent

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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. The figures in the table show 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 theoretical model developed in Section 2 suggests that σ can be estimated by the following cross-section model:

$$\frac{r_{vi}^t}{\psi_{vi}^t} = \sigma + error_{vi}, \tag{15}$$

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. (15) 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.[13] Our σ-estimate is similar in magnitude to those reported in other empirical studies (see Broda and

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for France is significantly higher than the 15 percent reported by Eaton, Kortum, and Kramarz (2011). The high exporter shares in the Amadeus data-base reflect the focus on incorporated firms, which means that large producers are over-represented, a feature that this paper shares with other studies that rely on firm-level information for more than a single economy (see, for instance, Mayer and Ottaviano, 2008).

[13]The assumption of pooling σ across industries may appear 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 10.974. 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.

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

$$\ln w_{vi} = \theta_i \ln r_{vi}^t + \mu_i + error_{vi}, \tag{16}$$

where μ_i is a fixed country 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. Eq. (16) shows that fairness parameter θ_i determines the elasticity of the firm-specific wage rates with respect to firm-level revenues (or operating profits) in our framework.

$--$ Table 3 about here $--$

Estimation results for the model in Eq. (16) 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 at one percent the null hypothesis that parameters θ_i and μ_i are poolable across countries.

Calculating parameter ξ_i:

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

$$\hat{\xi}_i = \frac{\hat{\sigma} - 1}{1 + \hat{\theta}_i(\hat{\sigma} - 1)}. \tag{17}$$

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 $\hat{\xi}$. The table suggests that the estimates $\hat{\xi}_i$ vary to some extent around the average $\hat{\xi} = 3.685$, but that the variation is not too

big (all estimates $\hat{\xi}_i$ lie between 3.1 and 4.5).[14] 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. For estimating k_i in a theory-consistent way, 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 $1 - \text{Pr}_{pi} = (\varphi_p/\varphi_i^x)^{-k_i}$, 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 the respective average as $\bar{r}_{pi}^x$ and substituting $\varphi_p/\varphi_i^x = (1 - \text{Pr}_{pi})^{-1/k}$, we obtain[15]

$$\bar{r}_{pi}^x = r_i^x(\varphi_i^x)\frac{k_i}{k_i - \xi_i}\left(1 - \text{Pr}_{pi}\right)^{-\xi_i/k_i}. \tag{18}$$

Substituting $\gamma_i \equiv \xi_i/k_i$, $rank_{pi} \equiv 100 \times (1 - \text{Pr}_{pi})$, and taking logs on both sides of Eq. (18), we can formulate the following estimation equation

$$\ln \bar{r}_{pi}^x = -\gamma_i \ln rank_{pi} + \mu_i + error_{pi}, \tag{19}$$

where μ_i is a fixed country effect, and $rank_{pi} \in \{1, ..., 99\}$. Eq. (19) gives an estimate $\hat{\gamma}_i$ for each country, and in combination with the estimates for ξ_i in Table 3 we can compute $\hat{k}_i = \hat{\xi}_i/\hat{\gamma}_i$.[16]

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[14]Table 3 also reports the weighted average standard error for the weighted average $\hat{\xi}$. However, this variable must be interpreted with care as it is not informative about the dispersion of ξ-values around $\hat{\xi}$ 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.

[15]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. (18).

[16]Two remarks are in order here: First, in principle, we can relate any exporter's revenues to its relative

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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 firm-level revenues 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.

Estimating the 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 the 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

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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.

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

$$\hat{R}_i = \left(\frac{r_i^{tx}}{r_i^{nd}} \chi_i^{\frac{\hat{\xi}_i}{\hat{k}_i}}\right)^{\frac{\hat{\sigma}-1}{\hat{\xi}_i}} - 1. \tag{20}$$

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 the country-specific fixed input requirement for exporting ζ_i:
To compute the fixed labour input requirement for exporting ζ_i, we rewrite (12) in the following way:

$$\hat{\zeta}_i = \left[\left(1 + \hat{R}_i\right)^{\frac{\hat{\xi}_i}{\hat{\sigma}-1}} - 1\right] \chi_i^{-\frac{\hat{\xi}_i}{\hat{k}_i}} \tag{21}$$

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Evaluating (21) at our parameter estimates gives the model-consistent values for ζ_i. As summarized in Column 4 of Table 5, $\hat{\zeta}_i$ varies between 0.883 for Croatia and 3.724 for Bosnia and Herzegovina, with a value of 3.070 for the average country in our data-set.

Estimating the 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

$$\hat{\Omega}_i = 100(1 + \hat{R}_i)^{\frac{\hat{\theta}_i \hat{\xi}_i}{\hat{\sigma} - 1}} - 100, \tag{22}$$

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. Furthermore, Mayer and Ottaviano (2008) find an exporter wage premium of about 9 percent for France, which is fairly close to our estimate.[17,18]

3.3 Assessing the fair wage hypothesis

One key feature of our model is the link between firm-level revenues (or firm-level operating profits) and firm-level average wages resulting from the fair wage hypothesis. As shown in the previous sub-section, the country-specific estimates of elasticity θ_i, measuring the strength of this link, influence the estimated values of all model variables. We now assess how well the fair wage hypothesis is performing in our data-set by comparing for each country the distribution of normalised wages across firms in the data with the distribution predicted by the model, given

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[17]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.

[18]We can also quantify the loss in domestic revenues arising from the exporter wage premium. According to (6) the loss of domestic revenues due to exporting can be computed according to $100 - 100(1 + \hat{R}_i)^{-\hat{\theta}_i \hat{\xi}_i}$. Evaluated at our parameter estimates, this loss is sizable and varies between 28.397 percent for Croatia and 43.689 percent for France.

both the observed revenue distribution and the estimated value for elasticity θ_i.

−− Table 6 about here −−

In a first step, we compare for each country the standard deviations of the two log-transformed distributions of normalised wages. As shown in Table 6, the standard deviation of the predicted distribution is smaller than the standard deviation of the observed distribution for all five countries, and hence our model under-predicts the wage differentiation across firms. This is what one would expect, since the model abstracts from sources of wage differentiation between firms other than rent sharing – in particular does it not account for inter-firm differences in average skill. Interestingly, for four of the five countries (the exception being Bosnia and Herzegovina) the standard deviations of both distributions are still quite similar. In a second step, we look at the correlation coefficient between both distributions. The results for the five countries are also shown in Table 6. We find positive correlation coefficients for all countries, ranging from a moderate 0.512 for Bosnia and Herzegovina, to high and very high values for the other four countries, where the respective coefficients lie in the range from 0.698 to 0.948.

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. Thereby, 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. This counterfactual exercise gives us an estimate for the effects of a large change in the economic environment, which is often at the center of theoretical studies but usually not accounted for in the empirical literature on trade effects. This literature is more concerned about marginal effects of trade liberalisation, and to relate our findings to existing studies, we also shed light on marginal trade effects by computing changes in the distribution of wages and aggregate employment when gradually increasing the share of exporting firms from zero to one.

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

it is possible to derive the effect of openness for each country by comparing the estimated values for normalised wages from Eq. (14) 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 $R_i = 0$.

As an intermediate step, we need to derive for each firm in our data-set a model-consistent measure of normalised productivity φ/φ_i^d, i.e. firm-specific productivity relative to the productivity of the cutoff producer in the same country. We get this variable from Eq. (13), plugging in country-specific estimates for the model parameters, and using observed normalised revenues $r_i^t(\varphi)/r_i^t(\varphi_i^d)$, which are equal to normalised operating profits $\psi_i^t(\varphi)/\psi_i^t(\varphi_i^d)$, on the left hand side.[19] 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).

We now compare for both the original and the 'theory-adjusted' data-set 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

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[19]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.

[20]As outlined in Footnote 19, we have to use model-consistent measures of productivity, when taking the idea of

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,[21] 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.[22] 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. This feature is notable, because with constant markup pricing a firm's total wage bill is a constant fraction of its operating profits, and hence the dispersion of employment-weighted wages – and thus personal wage inequality – responds to trade in the same way as captured by the figures reported in Table 7.[23]

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]Using the 'theory-adjusted' data-set increases the estimate for the wage dispersion effect of trade by 65.6 percent for France and 164.5 percent for Bosnia and Herzegovina, with the values of other countries lying between these bounds.

[22]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. (14), is significantly higher for France than the other countries in our data-set.

[23]Appendix B provides a discussion of other measures of income inequality, including the dispersion of entrepreneurial income as well as the ratio of average profits and wages.

4.2 Aggregate employment

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), and our model allows us to address this concern by providing a closed form solution for the employment effect of trade. As formally shown in the Appendix, the employment effect of trade is determined by[24]

$$\frac{1-u_i}{1-u_i^a} = \frac{\Gamma_i}{1+\chi_i\zeta_i}, \qquad \text{where} \quad \Gamma_i \equiv 1 + \chi_i^{\frac{k-(1-\theta_i)\xi_i}{k_i}} \left[(1+R_i)^{\frac{(1-\theta_i)\xi_i}{\sigma-1}} - 1\right]. \tag{23}$$

From Eq. (12), we have

$$\chi_i\zeta_i = \chi_i^{\frac{k_i-\xi_i}{k_i}} \left[(1+R_i)^{\frac{\xi_i}{\sigma-1}} - 1\right].$$

This implies $\Gamma_i < 1 + \chi_i\zeta_i$ and thus negative employment effects of trade.

Using Eq. (23) together with the parameter estimates from Section 3, we can quantify the negative employment effects of the observed degree of openness. The results from this exercise are summarized in Table 7, where Column 4 reports the employment effects of trade for our country sample in percent. These results indicate that the employment effects of trade are sizable, ranging between -7.5 percent for Bosnia and Herzegovina and -12.3 percent for France, reaching a value of -12.1 percent on average. [25]

4.3 Gradual trade liberalisation

In the previous two subsections, we have studied how a movement from autarky to observed levels of trade affects the dispersion of wages and aggregate employment in our country sample. However, the effects computed for the five countries are not directly comparable, because these countries are exposed to trade at different levels. This can be seen from the third column of Table 1, which reports significant differences in our country sample regarding the exposure to trade as captured by the share of exporting firms. To assess the differential impact that trade exerts on wage dispersion and aggregate employment in the five countries of our data-set, we can

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[24]Thereby, $1-u_i$ measures the *ex ante* probability of finding a job when self-selecting into the pool of production workers. Since the share of population self-selecting into the pool of production workers is given by $k_i(\sigma-1)/(k_i\sigma-\xi_i)$ and hence exogenous, $1-u_i$ is proportional to the employment rate in our model, and we can thus look at (23) when being interested in the employment effect of trade.

[25]Of course, these numbers have to be interpreted in light of the fact that there is some over-representation of large firms in our data-set. Since larger firms are more likely to export, the exporter share in our setting and thus the estimated employment effects of trade are probably upward biased.

make these countries symmetric in their exporter share χ_i. Furthermore, we also estimate the consequences of marginal changes in χ_i in order to see whether changes in the degree of openness exert a monotonic impact on the variables of interest. Thereby, we hold the estimated country-specific values of ζ_i constant and account for theory-consistent adjustments in the export-market potential R_i (see Eq. (12)).
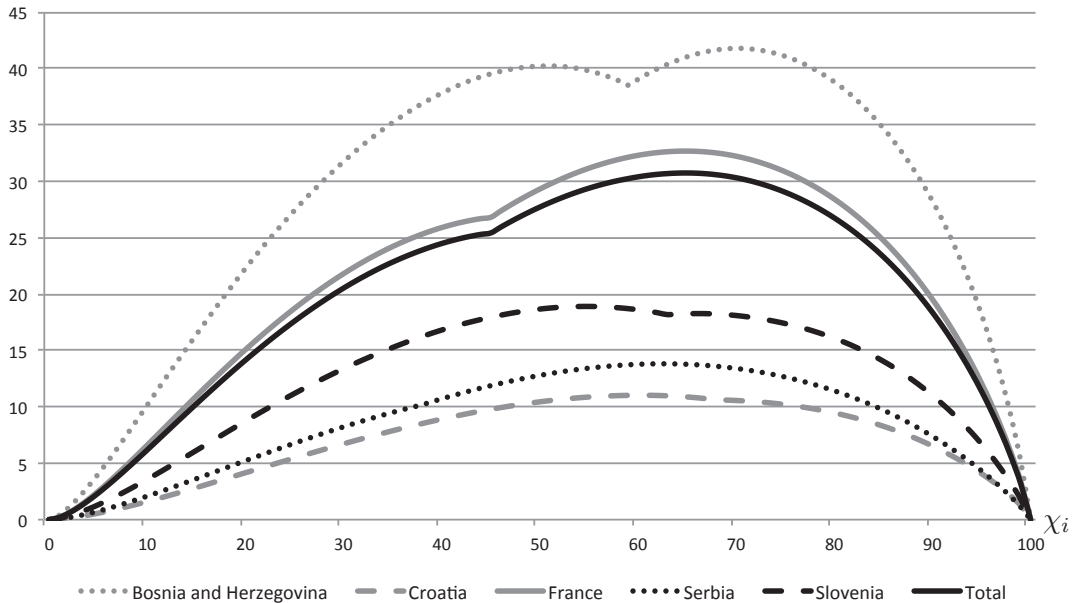

Figure 3: Changes in the share of exporters and the consequences for wage dispersion

Figure 3 shows how changes in the share of exporters affect the wage dispersion in our model. By constructing Figure 3, we followed our previous approach and used the standard deviation of log-transformed wages for measuring wage dispersion. For illustrative purposes, we display changes in a country's wage dispersion relative to its autarky level. From inspection of Figure 3, we see that changes in χ_i exert a non-monotonic effect on wage dispersion, with the quantitative impact of a given increase in χ_i differing significantly between the five economies.[26] It is strongest for Bosnia and Herzegovina and weakest for Croatia. Accounting for the θ_i-estimates reported in Table 5, we see that the country-specific wage-dispersion effects do not simply reflect differences in the estimated degree of labour market imperfections. These estimates are smallest for Bosnia and Herzegovina and of intermediate size for Croatia. For a comprehensive picture upon the

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[26]All loci in Figure 3 – except for the one of Serbia – have a noticeable kink at some intermediate level of χ_i. The respective kink lies at the observed $\hat{\chi}_i$-levels reported in Table 1 and it exists because for constructing Figure 3 we have used the theory-adjusted data-set, which assigns the top χ_i percent of firms in the productivity distribution to the group of exporters and the rest to the group of non-exporters (see above).

link between trade openness and wage dispersion it is not sufficient to look at the rent-sharing process in isolation. Instead, one also requires information about the dispersion of rents between firms for a given $\hat{\theta}_i$, which depends crucially on $\hat{k}_i$ and $\hat{\zeta}_i$ in our model.
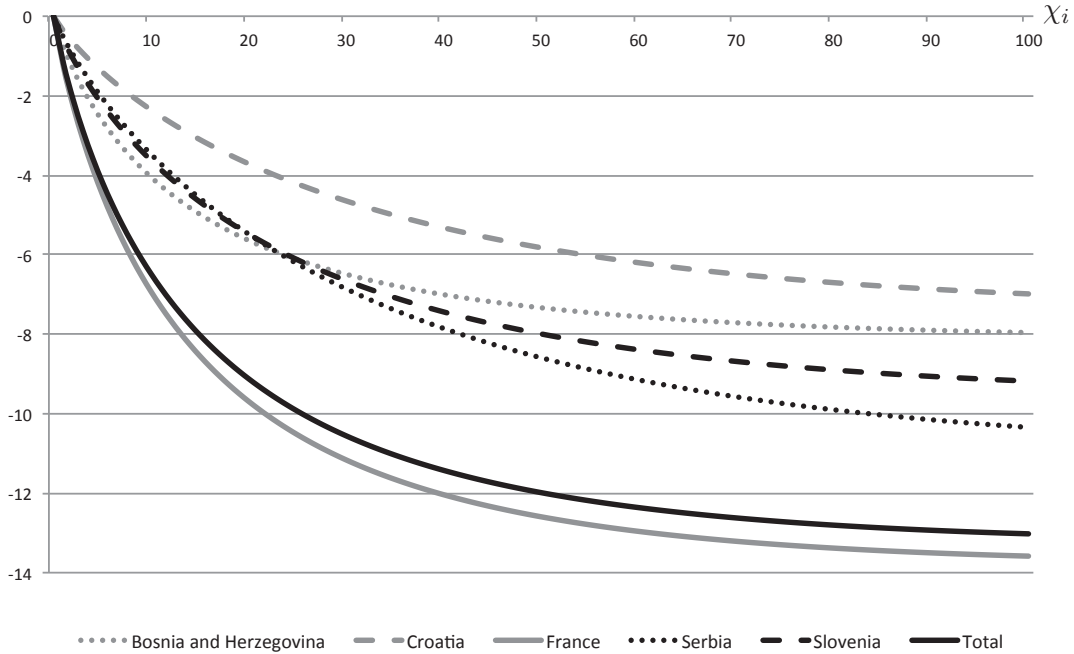

Figure 4: Changes in the share of exporters and the consequences for employment

In Figure 4, we display the impact of changes in χ_i on the economy-wide employment rate, where changes in this figure refer to percentage changes relative to a country' autarky level. An increase in the share of exporting firms exerts a monotonic negative impact on the employment rate in our model, and this is notable, because our model does not presume such a monotonic relationship. The magnitude of the employment effects differ significantly across countries. They are strongest for France and weakest for Croatia. The negative employment effects of trade displayed in Figure 4 are well in line with existing empirical findings for developed as well as developing countries (see, for instance Currie and Harrison, 1997; Revenga, 1997; Menezes-Filho and Muendler, 2011).[27]

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[27]These negative employment effects are in contrast to the findings of Dutt, Mitra, and Ranjan (2009) and Felbermayr, Prat, and Schmerer (2011) who, relying on a reduced form estimation approach, find an employment stimulating effect of trade. The main difference to the other studies cited above is that Dutt, Mitra, and Ranjan (2009) and Felbermayr, Prat, and Schmerer (2011) look at employment effects that include adjustments in the service industry as well as the public sector.

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. At the same time, it has substantially reduced the employment rate of production workers, with negative consequences for the labour market performance of the five countries in our data-set.

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 shown in this paper, the link between trade costs and key variables of labour 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, representing the world by a model in which labour is only employed in a single sector, we exclude a potential moderation of the negative labour market consequences due to absorption of newly unemployed production workers by other industries, such as the service sector. As a consequence, we may over-estimate the negative employment effects of trade in our analysis.

This points to the possible benefits of employing a less parsimonious (multi-industry) theoretical model that allows for cross-sectoral mobility of workers (see, for instance, Artuç, Chaudhuri, and McLaren, 2010). While extending our model in this direction is beyond the scope of the present paper, it is in our view 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. (23). Total employment in the open economy is determined by the following adding up condition:

$$(1 - u_i)L_i = \frac{M_i^d}{1 - G_i(\varphi_i^d)} \int_{\varphi_i^d}^{\varphi_i^x} l_i^n(\varphi) dG_i(\varphi) + \frac{\chi_i M_i^d (1 + R_i)}{1 - G_i(\varphi_i^x)} \int_{\varphi_i^x}^{\infty} l_i^x(\varphi) dG_i(\varphi), \qquad (24)$$

where L_i is the size of the domestic worker pool and 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), (14), and our technology assumptions, we can write

$$(1 - u_i)L_i = \underbrace{\frac{M_i^d l_i^n(\varphi_i^d)}{1 - G_i(\varphi_i^d)} \int_{\varphi_i^d}^{\varphi_i^x} \left(\frac{\varphi}{\varphi_i^d}\right)^{(1-\theta_i)\xi_i} dG_i(\varphi)}_{\equiv A_1} \qquad (25)$$

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

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. (12), we can calculate

$$A_1 = \frac{(\sigma - 1)M_i^d r_i^n(\varphi_i^d)}{\sigma w_i(\varphi_i^d)} \frac{k_i}{k_i - (1 - \theta_i)\xi_i} \left(1 - \chi_i^{\frac{k_i - (1-\theta_i)\xi_i}{k_i}}\right). \qquad (26)$$

Applying the fair-wage constraint in (4) for the marginal firm and accounting for indifference condition (10), it follows that $r_i^n(\varphi_i^d)/\sigma = w_i(\varphi_i^d)$. Hence, (26) reduces to

$$A_1 = \frac{k_i(\sigma - 1)M_i^d}{k_i - (1 - \theta_i)\xi_i} \left(1 - \chi_i^{\frac{k_i - (1-\theta_i)\xi_i}{k_i}}\right). \qquad (27)$$

In a similar vein, we can calculate

$$A_2 = \frac{k_i(\sigma - 1)M_i^d}{k_i - (1 - \theta_i)\xi_i} (1 + R_i)^{\frac{(1-\theta_i)\xi_i}{\sigma - 1}} \chi_i^{\frac{k_i - (1-\theta_i)\xi_i}{k_i}} \qquad (28)$$

and, putting together Eqs. (27) and (28), we thus obtain

$$(1 - u_i)L_i = \frac{k_i(\sigma - 1)M_i^d}{k_i - (1 - \theta_i)\xi_i}\Gamma_i, \qquad (29)$$

with Γ_i defined as in the main text.

We can now make use of the fact that labour income must be proportional to total revenues, and it is given by

$$(1 - u_i)L_i\bar{w}_i = (\sigma - 1)M_i^d\psi_i^n(\varphi_i^d)\frac{k_i(1 + \chi_i\zeta_i)}{k_i - \xi_i}. \qquad (30)$$

Substituting $(1 - u_i)\bar{w}_i = \psi_i^n(\varphi_i^d)$ from indifference condition (10), further gives[28]

$$L_i = (\sigma - 1)M_i^d\frac{k_i(1 + \chi_i\zeta_i)}{k_i - \xi_i}. \qquad (31)$$

Combining the latter with (29), we obtain

$$(1 - u_i) = \frac{k_i - \xi_i}{k_i - (1 - \theta_i)\xi_i}\frac{\Gamma_i}{1 + \chi_i\xi_i}, \qquad (32)$$

and, noting that $(k_i - \xi_i)/[k_i - (1 - \theta_i)\xi_i]$ equals the employment rate under autarky $1 - u_i^a$, we can finally calculate (23). *QED*

B. Other measures of income inequality

In the theoretical model outlined in Section 2, we have assumed that entrepreneurs are residual claimants and therefore receive firm profits. We can apply this assumption to quantify the impact of trade on entrepreneurial (profit) income in our data-set. For this purpose, we first calculate entrepreneurial income in a theory-consistent way. Since non-exporters do not pay a fixed cost, these firms' profits (and thus entrepreneurial incomes) equal their operating profits. Exporters on the other hand pay a common fixed cost $\zeta_i s_i$ to enter the foreign market and this fixed cost has to be subtracted from the firm's operating profit to calculate the corresponding entrepreneurial income. In a second step, we divide the thus calculated entrepreneurial income

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[28]In the main text, we claim that L_i is a constant share of total population $L_i + M_i^d(1 + \chi_i\zeta_i) \equiv N_i$. Noting that $M_i^d(1 + \chi_i\zeta_i) = L_i(k_i - \xi_i)/[k_i(\sigma - 1)]$ must hold, according to (31), we can write $N_i = L_i(k_i\sigma - \xi_i)/[k_i(\sigma - 1)]$. This implies $L_i/N_i = k_i(\sigma - 1)/(k_i\sigma - \xi_i)$, which proves the respective statement in the text.

by the profit of the marginal firm – which is equivalent to s_i, according to indifference condition (10) – and finally calculate the standard deviation of the log-transformed 'normalised' profit income as a measure of entrepreneurial income dispersion.

Since the dispersion of log-transformed normalised operating profits equals the dispersion of log-transformed normalised wages in our model, the existence of a common exporter fixed cost implies that in an open economy the dispersion of entrepreneurial income must be lower than the dispersion of wages in our data-set, and hence the impact of trade on dispersion of entrepreneurial income must be less pronounced than the impact of trade on the dispersion of wages. Relying on the 'theory-adjusted' data-set, the observed exposure to trade has lowered the dispersion of entrepreneurial income by 0.17 percent in Serbia, while it has increased the dispersion of entrepreneurial income in all other countries. The positive effect is strongest in Bosnia and Herzegovina and amounts to 2.69 percent there. Table B.1 provides further details on how trade affects the dispersion of entrepreneurial income in the theory-adjusted' data-set.

−− Table B.1 about here −−

In a final step, we can analyse, how trade changes inter-group inequality in our data-det. Measuring inter-group inequality as in Egger and Kreickemeier (2012) by the ratio of average entrepreneurial income, denoted by $\bar{\pi}_i$, to average labour income, $(1 - u_i)\bar{w}_i$, we can calculate

$$\frac{\bar{\pi}_i}{(1 - u_i)\bar{w}_i} = \frac{k_i + \xi_i \chi_i \zeta_i}{k_i - \xi_i}. \tag{33}$$

It is thus immediate that trade increases inter-group inequality and, applying our parameter estimates, we can quantify its effect. The results from this exercise are summarised in the third column of Table B.1. There, we see that the observed exposure to trade raises log-transformed inter-group inequality in the range of 18.2 percent for Serbia and 70.3 percent for Bosnia and Herzegovina.

C. 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. (19). $\hat{k}_i$ is computed as stated in the text below Eq. (19). $\varphi_i^x/\varphi_i^d = \chi_i^{-1/\hat{k}_i}$ 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.	$\hat{\zeta}_i$	Std. err.	$\hat{\Omega}_i$	Std.err.
Bosnia and Herzegovina	4.187	0.416	3.724	0.268	6.934	1.185
Croatia	1.296	0.060	0.883	0.030	5.860	0.377
France	3.780	0.097	3.379	0.041	10.286	0.170
Serbia	1.152	0.077	1.074	0.030	6.299	0.305
Slovenia	2.424	0.098	1.706	0.048	7.894	0.389
Total	3.533	0.099	3.070	0.043	9.830	0.202

Notes:
$\hat{R}_i$ is estimated as suggested by Eq. (20), while $\hat{\zeta}_i$ and $\hat{\Omega}_i$ are computed, according to Eqs. (21) and (22), respectively. Standard errors are robust to heteroskedasticity and autocorrelation of unknown form.

Table 6: Assessing the empirical validity of the fair wage hypothesis

Country	standard deviation for normalised wages		correlation coefficient
	observed	predicted	
Bosnia and Herzegovina	0.159	0.080	0.512
Croatia	0.213	0.198	0.926
France	0.233	0.163	0.698
Serbia	0.272	0.258	0.948
Slovenia	0.190	0.169	0.888
Total	0.232	0.168	0.721

Notes:
The calculations of standard deviations and correlation coefficients are based on log-transformed variables. Predicted normalised wages are computed from observed revenue ratios, applying Eq. (4) and the parameter estimates in Section 3.

Table 7: Simulating the impact of trade openness on the dispersion of wages and total employment

Country	Δ standard deviation in % (benchmark vs. counterfactual)		$\Delta(1-u)$ in %
	original data-set	'theory-adjusted' data-set	
Bosnia and Herzegovina	14.565	38.519	-7.540
Croatia	5.715	10.619	-6.437
France	16.186	26.808	-12.347
Serbia	4.944	10.184	-7.680
Slovenia	8.921	18.176	-8.490
Total	15.054	25.348	-12.089

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

Table B.1: Simulating the impact of trade openness on the dispersion of entrepreneurial income and inter-group inequality

Country	Δ standard deviation of $\pi_i(\varphi)$ in %	Δ inter-group inequality in %
Bosnia and Herzegovina	2.693	70.287
Croatia	0.078	23.588
France	0.255	41.785
Serbia	-0.174	18.179
Slovenia	0.499	40.741
Total	0.264	40.281

Notes:
All calculations are based on log-transformed variables. Reported figures are percentage changes of observed ($R_i = \hat{R}_i$, $\chi_i = \hat{\chi}_i$) relative to predicted counterfactual autarky ($R_i = 0$, $\chi_i = 0$) outcome. Figures on dispersion of entrepreneurial income, $\pi_i(\varphi)$, are based on 'theory-adjusted' data-set.