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Firm Heterogeneity and the Labour Market Effects
of Trade Liberalisation

by

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Abstract

This paper develops a model that incorporates workers' fair wage preferences into a general equilibrium framework with monopolistic competition between heterogeneous firms à la Melitz (2003). By assuming that the wage considered to be fair by workers depends on the economic success of the firm they are working in, we can study the determinants of profits, involuntary unemployment and within-group wage inequality in a unified framework. We use this model to investigate the effects of globalisation. In a benchmark case with identical costs of entering domestic and foreign markets, there are gains from trade accompanied by distributional conflicts, which have so far not been accounted for in the literature: a simultaneous increase of average profits and involuntary unemployment as well as a surge in within-group wage inequality.

Outline

Non-Technical Summary

This paper develops a model that incorporates workers' fair wage preferences into a general equilibrium framework with monopolistic competition between heterogeneous firms à la Melitz (2003). The equilibrium is characterised by rent sharing at the firm level, with more productive firms having higher profits and paying higher wages. Furthermore, there is involuntary unemployment. These features of the model are in stark contrast to existing models in the recent heterogeneous firm literature, where individual firm performance does not matter for workers, as everyone is paid the same wage, and there is full employment.

We investigate how fairness preferences and firm heterogeneity interact in explaining the consequences of trade liberalisation. Trade liberalisation leads, as in the Melitz model, to the selection of the best firms into export status and exit of the least productive producers, and thereby influences all aggregate variables in the model, including involuntary unemployment and wage inequality. As all workers are ex ante identical, wage inequality in this model is to be understood as being within – rather than between – groups. In a benchmark case with identical costs of entering domestic and foreign markets, there are gains from trade accompanied by distributional conflicts, which have so far not been accounted for in the literature: a simultaneous increase of average profits and involuntary unemployment as well as a surge in within-group wage inequality.

In one extension to our basic setting we allow for differences in the costs of domestic and foreign market entry. In this more general setting, two important results are identified: If foreign market entry costs are sufficiently high, in addition to there being gains from trade economic integration may reduce both within-group wage inequality and the unemployment rate. On the other hand, with sufficiently low entry costs into the foreign market, trade liberalisation may reduce welfare. In this case, both within-group wage inequality and the unemployment rate definitely increase.

1 Introduction

It is by now well established that firms in all sectors are heterogenous with respect to key variables including productivity, size, and export status.[1] Given these empirical regularities, it seems natural to expect that workers would rather work for a successful (i.e. high-productivity) firm than for a competitor in the same industry with low productivity. However, in the established models that account for firm heterogeneity workers are indifferent between employers because the labour market is assumed to be perfectly competitive, and hence workers of a given type are paid the same wage in all firms.[2] In this paper, we develop a framework in which firm performance matters for workers because more successful firms pay higher wages. This is possible because the labour market is imperfectly competitive. By accounting for the interaction between firm heterogeneity and labour market imperfections, our model allows us to shed new light on an issue that is a prime concern to policy makers and the general public alike: the impact of international competition on domestic labour markets.[3]

One tractable framework that allows for firm heterogeneity in general equilibrium is given by Melitz (2003). In the Melitz model, active firms in the market are heterogeneous with respect to their productivity levels. They supply their output under monopolistic competition and active firms make positive profits in equilibrium. We introduce labour market imperfections into this framework by means of a fair wage-effort mechanism similar to the one put forward in Akerlof and Yellen (1990).[4] The original Akerlof and Yellen

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[1]The empirical literature has provided evidence for a selection of the best firms into export status (Clerides, Lach and Tybout, 1998; Bernard and Jensen, 1999).

[2]Two influential contributions to the theoretical literature on heterogenous firms in open economies are Bernard, Eaton, Jensen and Kortum (2003) and Melitz (2003).

[3]See Scheve and Slaughter (2001) for a review of poll data from the U.S. on questions related to globalisation. They show that critical views held by the general public on this topic are due to the expectation of negative labour market effects.

[4]There is considerable support for a mechanism of this type, as illustrated in the review articles by Howitt (2002) and Bewley (2005). Both stress the wide extent and strength of evidence supporting the fair wage model from a range of sources including: surveys of managers and workers, firm-level studies of

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framework is modified by introducing a rent-sharing motive as a determinant of workers' fair wage preferences. Specifically, we assume that the wage considered to be fair depends on the economic success (and thus the productivity level) of the employer (cf. Danthine and Kurmann, 2006), with the workers' outside option playing a role as well.[5]

This framework allows us to analyse how the rent-sharing motive of workers influences the productivity distribution of active firms, welfare and average profits in equilibrium. There are interesting feedback effects on the labour market as well, as the fair wage-effort mechanism induces involuntary unemployment and the rent-sharing motive leads to wage inequality among workers that are employed in different firms. Furthermore, we investigate how fairness preferences and firm heterogeneity interact in explaining the consequences of trade liberalisation. Trade liberalisation leads, as in the Melitz model, to the selection of the best firms into export status and exit of the least productive producers, and thereby influences all aggregate variables in the model, including involuntary unemployment and wage inequality.

While all existing contributions to the heterogeneous firm literature abstract from involuntary unemployment, some look – as we do – at the effect of trade liberalisation on wage inequality. The focus in these papers is on the differential effect that globalisation has on workers that belong to different skill groups.[6] The model in the present paper complements the analysis of inter-group relative wage effects by focussing on the impact that trade has on the wage distribution of ex ante identical workers. There is well doc-

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pay and termination patterns, and experiments.

[5]Fehr and Gächter (2000, p. 172) point out that the idea of *gift exchange*, which underlies the fair wage-effort hypothesis, implies that "more profitable firms pay higher wages". This supports a firm internal reference perspective, with the wage considered to be fair by workers depending on the economic success of the firm they are working in.

[6]Bernard, Redding and Schott (2006) address the impact of trade liberalisation on wage inequality in a two-country, two-sector, two-factor model with a continuum of heterogeneous firms. Yeaple (2005) studies the impact of globalisation on the wage distribution in a model where producers, depending on their production technology, hire workers of different skill levels. Both of these models shed new light on the effect of globalisation on the skill premium.

umented evidence across many countries that within-group wage inequality is important and has increased (see Katz and Autor, 1999; Barth and Lucifora, 2006). Although the observed increase in within-group wage inequality has been parallel to the recent surge in intermediate goods trade (usually referred to by the term international outsourcing), theoretical explanations have so far predominately focussed on two other sources: technological progress and/or organisational change (see Galor and Moav, 2000; Aghion, Howitt and Violante, 2002; and Egger and Grossmann, 2005). In this literature the role of empirically unobservable individual characteristics (like learning abilities, or analytical and social skills) has been in the centre of interest. By modelling the interaction of firm heterogeneity and rent-sharing motives, our analysis identifies a new factor which may explain the intertemporal pattern of within-group wage inequality: changes in the composition of firms due to trade liberalisation.

A further notable feature of our model is the coexistence of involuntary unemployment and positive profits in equilibrium. This allows us to address an issue that has been of some concern recently (and perhaps not so recently as well) to many politicians as well as the popular press: the simultaneous occurrence of increasing profits and increasing unemployment in the face of globalisation.[7] Our results indicate that changes in the composition of firms after trade liberalisation are a candidate for explaining such developments.

The structure of the paper is as follows. In section 2, we introduce a closed economy version of our model and look at the impact that fairness preferences have on the productivity distribution of active firms in equilibrium, welfare and the labour market outcome. We find that the more important the rent sharing motive becomes in workers' fair wage preferences, the higher is the wage that is paid by more productive firms. This renders production of firms with low productivity levels more attractive and therefore leads to a decline in aggregate productivity, with adverse consequences for welfare, average profits and employment. Section 3 looks at the effect of globalisation in a benchmark version of the model where *beachhead* (fixed) costs are the same across all markets. In this case,

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[7]As a case in point, the *International Herald Tribune* remarks on 11 April 2005 that across wealthy nations "job creation stalled at a time when corporate profits are soaring."

changes in the composition of firms in favour of the more productive ones lead to gains from trade and raise average profits of active firms. At the same time, both within-group wage inequality and the unemployment rate increase, thereby indicating distributional conflicts after trade liberalisation. Section 4 addresses the robustness of our results. There, we allow beachhead costs to differ between markets and show that losses from trade cannot be ruled out if variable transport costs are high (cf. Melitz, 2003). In this case, both unemployment and within-group wage inequality definitely increase. In contrast, if the foreign beachhead costs are sufficiently high (and thus the selection mechanism sufficiently strong) gains from trade may be accompanied by positive employment effects and a decline in wage inequality. This underpins the importance of firm composition in explaining the labour market implications of trade liberalisation. A further issue investigated in Section 4 is the role of market size effects due to external economies of scale. Section 5 concludes.

2 Fair Wages and Firm Heterogeneity in a Closed Economy

Consider an economy which is endowed with L units of labour. Two types of goods are produced: differentiated intermediate goods and homogeneous final output.

2.1 The Model: Basics

Final output is a *normalised* CES-aggregate of all available intermediate goods. Following Blanchard and Giavazzi (2003), we assume

$$Y = \left[M^{-(1-\rho)} \int_{v \in V} q(v)^\rho dv \right]^{1/\rho}, \quad 0 < \rho < 1, \tag{1}$$

with the measure of set V representing the mass of available intermediate goods M. In the (hypothetical) case where the final goods sector used an equal quantity q of all intermediate inputs, the production technology in (1) would yield $Y = Mq$, and hence increasing M for a given aggregate level of input would not increase aggregate output. As trade liberalisation in our model increases the mass of avialable input varieties, specification (1) eliminates one potential mechanism through which freer trade could influence aggregate output, namely external scale effects. This mechanism is well understood, of course, from

Ethier (1982). Closing down this channel of influence allows us to focus on the effect that is new and specific to the heterogeneous firm literature à la Melitz (2003): the impact of trade liberalisation on the productivity distribution of active firms.[8]

We take final output as the numéraire and assume perfect competition in the final goods market. The price index corresponding to the CES-aggregated good Y is given by

$$P = \left[M^{-1} \int_{v \in V} p(v)^{1-\sigma} dv \right]^{\frac{1}{1-\sigma}}, \tag{2}$$

with $\sigma \equiv 1/(1-\rho)$ being the elasticity of substitution between the different varieties of intermediate goods. Due to the choice of numéraire, we have $P = 1$. Profit maximisation of competitive final goods producers determines demand for variety v:

$$q(v) = \frac{Y}{M} p(v)^{-\sigma}, \tag{3}$$

where $P = 1$ has been taken into account.

At the intermediate goods level, we assume a continuum of firms, each producing a unique variety. Output q is linear in labour input l and depends on productivity level ϕ: $q(\phi) = \phi l$. There is a fixed input requirement f for each intermediate good, which is assumed to consist of invested final output Y and will be referred to as beachhead cost in the following. Firms share the same $f > 0$ but differ in their productivity levels ϕ. Intermediate goods producers are monopolistically competitive. Facing (3), they choose the profit-maximising price

$$p(\phi) = \frac{w(\phi)}{\rho \phi}, \tag{4}$$

with $w(\phi)/\phi$ being the marginal costs of a firm with productivity level ϕ.

Following Akerlof and Yellen (1988, 1990), we assume that workers have a preference for fairness and condition their effort on the wage paid relative to the wage considered to be fair. If firms pay at least the fair wage, workers provide the normal level of effort, which, for notational simplicity, is set equal to one. The fair wage for workers is a weighted

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[8]We consider a more general production technology that encompasses both the Blanchard-Giavazzi and Ethier specifications as special cases in subsection 4.2.

average between the wage they could expect if they were separated from their current job (taking into account the possibility that they might be unemployed) and the productivity of the firm they are working in. This is a simple way to make the reference wage dependent on a firm-*internal* "market potential" measure.[9] In line with Akerlof (1982) and Danthine and Kurmann (2006), we assume that the reference wage is a geometric average of the above components:

$$\hat{w}(\phi) = \phi^{\theta}[(1 - U)\bar{w}]^{1-\theta}, \tag{5}$$

where $\bar{w}$ is the average wage of employed workers in the economy and $\theta \in [0, 1]$ can be interpreted as a fairness (or rent-sharing) parameter. As in the standard Akerlof-Yellen model, it is optimal for firms to pay not less than the fair wage because effort decreases proportionally if the wage falls short of what workers consider to be fair. Hence, we set $\hat{w}(\phi) = w(\phi)$. Then, the fair wage specification in (5) gives rise to identical wages in all firms if $\theta = 0$ (cf. Melitz, 2003), while wages are firm-specific if $\theta > 0$. In the limiting case of $\theta = 1$, all intermediate goods producers have identical marginal production costs $w(\phi)/\phi = 1$.[10]

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[9]To be more specific, we assume that the wage considered to be fair by workers depends on a firm-specific compenent $v(\phi)$, with $v' > 0$. For the purpose of expositional simplicity, we set $v(\phi) = \phi$, so that the firm-specific component of the fair wage is equivalent to the productivity level of the firm in which a worker is employed. To the best of our knowledge, Danthine and Kurmann (2006) present the first formal analysis of a firm-specific internal fair wage reference. They impose a similar assumption and make the reference wage dependent on output per worker, which equals ϕ in our analysis. Crucially, however, they do not account for productivity differences across firms.

[10]It is an important feature of our analysis that workers in more productive firms have a higher reference wage and, therefore, earn higher wage income than employees of less productive competitors. This allows us to capture the idea of rent sharing in a very simple and stylised way. We would, however, expect the economic mechanisms of our model to be present in rent-sharing models with wage bargaining at the firm level as well.

2.2 Firm Distribution and Average Productivity

Combining (3) and (4), revenues and profits of intermediate goods producers are given by

$$r(\phi) = \frac{Y}{M}\left(\frac{w(\phi)}{\rho\phi}\right)^{1-\sigma}, \qquad \pi(\phi) = \frac{Y}{\sigma M}\left(\frac{w(\phi)}{\rho\phi}\right)^{1-\sigma} - f. \qquad (6)$$

Furthermore, accounting for (5), we see that the ratios of any two firms' wages and prices depend on the ratio of their productivity levels and the fairness parameter θ:

$$\frac{w(\phi_1)}{w(\phi_2)} = \left(\frac{\phi_1}{\phi_2}\right)^{\theta}, \qquad \frac{p(\phi_1)}{p(\phi_2)} = \left(\frac{\phi_1}{\phi_2}\right)^{\theta-1}. \qquad (7)$$

Accordingly, we find

$$\frac{q(\phi_1)}{q(\phi_2)} = \left(\frac{\phi_1}{\phi_2}\right)^{\sigma(1-\theta)}, \qquad \frac{r(\phi_1)}{r(\phi_2)} = \left(\frac{\phi_1}{\phi_2}\right)^{\xi} \qquad (8)$$

and

$$\frac{l(\phi_1)}{l(\phi_2)} = \left(\frac{\phi_1}{\phi_2}\right)^{\xi-\theta}, \qquad (9)$$

with $\xi \equiv (\sigma - 1)(1 - \theta)$. A more productive firm has a higher output level, pays higher wages, demands lower prices, and realises higher revenues and profits than a less productive firm. The higher is θ, the higher is ceteris paribus the wage differential and the lower is the output and revenue differential between firms of differing productivities.

The employment level in more productive firms is higher if and only if $\xi > \theta$ and therefore $\sigma(1-\theta) - 1 > 0$. On the one hand, for any given level of output more productive firms need fewer workers. On the other hand, due to lower marginal costs they charge lower prices and have higher output. For high levels of σ, price differences between varieties translate into large output differences, and therefore firm-level employment increases with firm productivity. In contrast, a higher θ increases relative marginal costs of more productive firms, thereby mitigating output differences between producers. Employment may therefore be lower in more productive firms.

The positive correlation between productivity levels, profits and wage payments, arising under fair wage specification (5), is well in line with the empirical findings on rent sharing in firms. Blanchflower, Oswald and Sanfey (1996) for example document that a rise in

a sector's profitability leads to higher wage payments in that sector. And Hildreth and Oswald (1997) show that changes in profitability induce changes of wages in the same direction. Furthermore, there is empirical evidence for higher wage payments in, with respect to their employment levels, larger firms. Using information from the New Worker Establishment Characteristics Database, Bayard and Troske (1999) conclude that in the U.S. "a significant portion of the firm-size wage premium is the result of employees working in more productive establishments" (p. 102). Winter-Ebmer and Zweimüller (1999) find that "firm-size wage differentials in Switzerland cannot be explained by job-heterogeneity" and that only "half of the differential (the size of which is comparable to the differential in the United States) is accounted for by worker heterogeneity" (p. 93). These empirical findings on firm (or better employment) size related wage payments are consistent with the formal relationships in (7) and (9), if a sufficiently small $\theta > 0$ leads to $\sigma(1-\theta)-1 > 0$.

In a next step, we determine a weighted average of productivity levels $\tilde{\phi}$ which is defined in a way to ensure that the quantity $q(\tilde{\phi})$ is equal to the average output per firm, Y/M. From (3), this implies $p(\tilde{\phi}) = 1$. Now, rewrite (2) as

$$P = \left[\int_0^\infty p(\phi)^{1-\sigma} \mu(\phi) d\phi \right]^{\frac{1}{1-\sigma}}, \tag{2'}$$

where $\mu(\phi)$ is the distribution of productivity parameters of active firms over a subset of $(0, \infty)$. From (7), we have $p(\phi) = p(\tilde{\phi})(\phi/\tilde{\phi})^{\theta-1}$. Substituting into (2') and using $P = p(\tilde{\phi}) = 1$ implies

$$\tilde{\phi} \equiv \left[\int_0^\infty \phi^\xi \mu(\phi) d\phi \right]^{1/\xi}. \tag{10}$$

The average productivity $\tilde{\phi}$ gives the weighted harmonic mean of the ϕs, with relative output levels $q(\phi)/q(\tilde{\phi})$ serving as weights. Denoting by R aggregate revenues in this economy and by Π aggregate profits we find – analogous to Melitz (2003) – that $R = Mr(\tilde{\phi})$ and $\Pi = M\pi(\tilde{\phi})$. Together with the previous results $P = p(\tilde{\phi})$ and (by definition) $Y = Mq(\tilde{\phi})$, this illustrates the usefulness of the particular average defined in (10): The aggregate variables in our model are identical to what they would be if the economy hosted M identical firms with productivity $\tilde{\phi}$. This is in general not true, however, for aggregate

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employment. In particular, we have

$$(1 - U)L = Ml(\tilde{\phi})\tilde{\phi}^{\theta-\xi} \int_0^\infty \phi^{\xi-\theta}\mu(\phi)d\phi, \tag{11}$$

where the RHS equals $Ml(\tilde{\phi})$ only if $\xi = \theta$. This is the case where employment per firm is the same across all firms, according to (9).

2.3 Market Entry and Average Profit

With respect to entry and exit of intermediate goods producers, we follow Melitz (2003) and assume an unbounded pool of prospective entrants into the intermediate goods market. Prior to entry, firms are identical. To enter, firms must make an initial investment in the form of $f_e \geq 0$ units of final output. These fixed costs are hereafter sunk. After the initial investment, firms draw their productivity from a cumulative distribution $G(\phi)$ with density $g(\phi)$. As in Helpman, Melitz and Yeaple (2004) and Baldwin (2005), the Pareto distribution is used to parametrise $G(\phi)$:

$$G(\phi) = 1 - (\bar{\phi}/\phi)^k \qquad\qquad g(\phi) = \frac{k}{\phi}\left(\frac{\bar{\phi}}{\phi}\right)^k, \tag{12}$$

where $\bar{\phi} > 0$ is the lower bound of productivities, i.e. $\phi \geq \bar{\phi}$.[11] A firm drawing productivity ϕ will produce if and only if the expected stream of profits is non-negative. For the sake of clarity, we should emphasise at this stage the importance of distinguishing the two types of fixed costs present in the model: initial investment costs f_e, which must be incurred to participate in the productivity draw and may, therefore, be associated with costs of developing a blueprint; and per-period beachhead costs f, which are associated with entry into the domestic market and investment in the local distribution system.

   If a firm starts production, it faces a probability of death $\delta > 0$ (exogenous and independent of ϕ) in each period. We account for an infinite number of time periods and focus on steady state equilibria in which the aggregate variables remain constant over

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[11]Using firm level data for eleven European countries, Del Gatto, Mion and Ottaviano (2006) show that "Pareto is a fairly good approximation" (p. 17) of the productivity distribution in their data set.

time. Assuming that there is no discounting, each firm's value function can be written as

$$v(\phi) = \max\left\{0, \sum_{t=0}^{\infty}(1-\delta)^t\pi(\phi)\right\} = \max\left\{0, \frac{\pi(\phi)}{\delta}\right\}. \tag{13}$$

The lowest productivity compatible with a non-negative expected profit stream of a firm that chooses to start production is denoted by ϕ^*. Formally, $\phi^* = \inf\{\phi : v(\phi) > 0\}$. From (13), this implies $v(\phi^*) = \pi(\phi^*) = 0$.

The *ex post* distribution of productivities, $\mu(\phi)$, is conditional on a successful draw. Hence,

$$\mu(\phi) = \begin{cases} \dfrac{g(\phi)}{1-G(\phi^*)} = \dfrac{k}{\phi}\left(\dfrac{\phi^*}{\phi}\right)^k & \text{if } \phi \geq \phi^* \\ 0 & \text{otherwise} \end{cases}, \tag{14}$$

where $1 - G(\phi^*)$ is the *ex ante* probability of a successful draw. Together, (10) and (14) determine $\tilde{\phi}$ as a function of cutoff productivity level ϕ^*:

$$\tilde{\phi} = \left(\frac{k}{k-\xi}\right)^{1/\xi}\phi^*, \tag{15}$$

where $k > \xi$ is assumed. The differential between the average productivity of active firms $\tilde{\phi}$ and the cutoff productivity ϕ^* is therefore only a function of the model parameters σ, θ and k.

Let us now turn to the determination of the cutoff productivity ϕ^*. The free entry condition requires that in equilibrium the sunk costs $f_e > 0$ of entering the productivity draw are equal to the present value of the average profits of active firms, $\bar{\pi} \equiv \Pi/M$, multiplied by the probability of a successful draw, i.e. a draw that results in $\phi \geq \phi^*$. Formally, using (12), (13) and $\bar{\pi} = \pi(\tilde{\phi})$, this gives us the free entry condition (FE)

$$\bar{\pi} = \delta f_e \left(\frac{\phi^*}{\tilde{\phi}}\right)^k. \tag{16}$$

Clearly, $\partial\bar{\pi}/\partial\phi^*$ is strictly positive: With a higher cutoff productivity ϕ^* – and therefore a lower probability of getting a favourable draw – a higher average profit is needed to keep a firm indifferent between entering and staying out of the productivity draw.

A second relation between the average profit of active firms and the cutoff productivity can be derived from the condition that the marginal firm in the market makes zero profits,
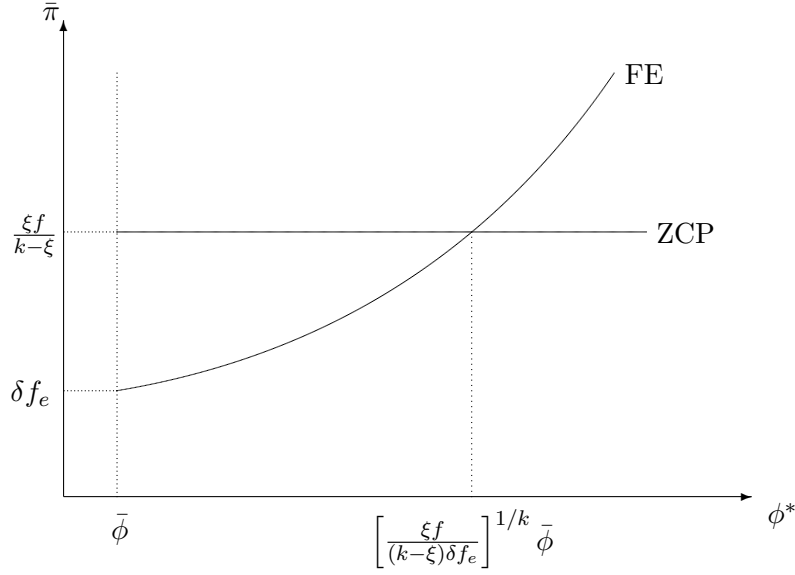
Figure 1: Determination of the cutoff productivity level

i.e. $\pi(\phi^*) = 0$. As shown in (6) this implies $r(\phi^*) = \sigma f$, and using (8) and (15) we get the zero cutoff profit condition (ZCP)

$$\bar{\pi} = \pi(\tilde{\phi}) = \frac{\xi f}{k - \xi}. \tag{17}$$

Figure 1 plots equations (16) and (17). The cutoff productivity level ϕ^* is determined by the intersection of the two curves and formally given by

$$\phi^* = \left[\frac{\xi f}{(k - \xi)\delta f_e} \right]^{1/k} \bar{\phi}. \tag{18}$$

In order to ensure the existence of an equilibrium with a positive mass of producers, we clearly need $\phi^* > \bar{\phi}$, and hence the term in brackets has to be larger than one, which is the case if f is sufficiently high and/or δ, f_e are sufficiently small.

2.4   Welfare, Unemployment and Wage Inequality

We now look at the implication of firm heterogeneity for the aggregate variables welfare, unemployment and wage inequality.

In our model with a single homogeneous final good, per capita income is the natural utilitarian welfare measure. Given the mark-up pricing rule, per capita income is a constant share ρ of per capita output Y/L, and we can therefore use both variables interchangeably to measure welfare. For notational simplicity, we use per capita output Y/L in the following.[12] We have $(1-U)\bar{w}L = \rho Y$, which can be used to substitute for $(1-U)\bar{w}$ in (5). Accounting for $w(\phi) = \hat{w}(\phi)$, this gives us

$$w(\phi) = \phi^\theta \left[\frac{\rho Y}{L} \right]^{1-\theta}. \tag{5'}$$

To determine equilibrium welfare we depict the condition for profit maximisation (4) and the modified fair wage constraint (5') for $\phi = \tilde{\phi}$ in figure 2. The two curves are labelled PMC and FWC, respectively, and their point of intersection gives

$$Y/L = \tilde{\phi}\rho^{\theta/(1-\theta)}. \tag{19}$$

Due to our normalisation of final output in (1), welfare is independent of the mass of producers M and the total labour endowment L, and therefore changes in market size *per se* do not exhibit a direct welfare effect.

The equilibrium mass of producers M is determined by $Mr(\tilde{\phi}) = Y$. Substituting (6) and (19) gives

$$M = \frac{Y}{r(\tilde{\phi})} = \frac{\tilde{\phi}\rho^{\theta/(1-\theta)}L}{\sigma(\pi(\tilde{\phi})+f)} \tag{20}$$

and hence M is proportionally increasing in both labour endowment L and the average productivity level $\tilde{\phi}$.

In order to determine the rate of unemployment U, we make use of the accounting identity that aggregate employment $(1-U)L$ has to equal firm specific employment, summed over all firms M. By virtue of (14), we obtain

$$(1-U)L = M \int_{\phi^*}^\infty l(\phi) \frac{k}{\phi} \left(\frac{\phi^*}{\phi} \right)^k d\phi$$

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[12]Note that while there are firms that make positive profits, expected profit income is zero due to free entry into the productivity lottery.
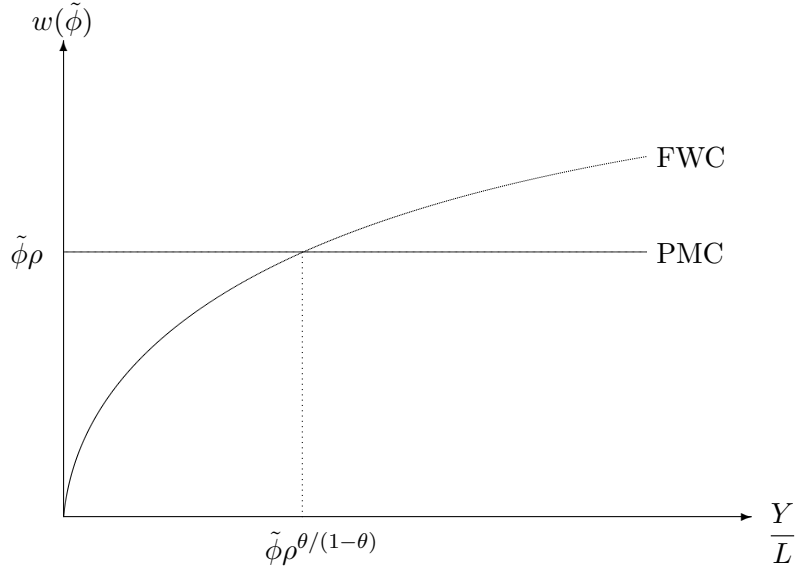
Figure 2: Determination of equilibrium welfare

Using (9), this can be rewritten as

$$1 - U = \frac{Y}{L\tilde{\phi}}\left(\frac{k}{k-\xi}\right)^{\theta/\xi}\frac{k-\xi}{k-\xi+\theta}, \tag{21}$$

and substituting for Y/L from (19) we get

$$1 - U = \rho^{\theta/(1-\theta)}\left(\frac{k}{k-\xi}\right)^{\theta/\xi}\frac{k-\xi}{k-\xi+\theta}. \tag{22}$$

One can immediately see that $\theta = 0$ implies $U = 0$, showing that having the fair wage depend on a firm internal performance measure is necessary in our model to generate unemployment. With $\theta > 0$, we can ensure that $U \in (0,1)$ if k is large enough, implying that there are relatively many firms in the market whose productivity is close to the cutoff level. A sufficient condition that holds for all levels of $\theta \in (0,1)$ is[13]

$$k \geq \frac{\sigma - 1}{1 - \rho^{\sigma-1}}. \tag{23}$$

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[13]For a given θ, $\rho^{\sigma-1}k/(k-\xi) \leq 1$ implies $RHS \leq 1$ in (22). Since $k/(k-\xi)$ declines in θ, we can derive (23) as a sufficient condition for an interior solution, with $RHS \leq 1$ for any possible θ. Condition (23) is also sufficient for $w(\phi^*) \geq (1-U)\bar{w}$, implying that workers earn at least the wage they can expect to get outside their job.

It is also noteworthy that the unemployment rate in (22) is independent of parameter L. This result is a direct consequence of the Blanchard and Giavazzi (2003) type production technology in (1), which rules out pure market size effects on the key economic variables. That changes in labour endowments do not have an impact *per se*, seems to be a plausible outcome as there is no empirical support for a size pattern in the employment rate, and unemployment is a problem for large as well as small economies.

We can use (22) as well to gain insights into the distribution of wages in the model. In the empirical literature, wage rates in different percentiles are often compared (90/10 or 50/10) to gain insights on income/wage dispersion between individuals. For the purpose of analytical tractability, we choose a (slightly) different approach and focus on the ratio of the average to the lowest wage rate, i.e. $\bar{w}/w(\phi^*)$. This inequality measure is derived in two steps. From (4) and (5) we know $(1-U) = \rho^{\theta/(1-\theta)}w(\tilde{\phi})/\bar{w}$. Substituting into (22) gives the differential between the wage paid by the average firm and the average wage as

$$\frac{w(\tilde{\phi})}{\bar{w}} = \left(\frac{k}{k-\xi}\right)^{\theta/\xi} \frac{k-\xi}{k-\xi+\theta}. \tag{24}$$

This differential is equal to one if either $\theta = 0$ or $\theta = \xi$. In the former case, this is due to all firms paying the same wage. In the latter case firms pay different wages, but the two averages $w(\tilde{\phi})$ and $\bar{w}$ coincide because all firms have the same employment level, according to (9). From (7) and (15), we have $w(\tilde{\phi})/w(\phi^*) = [k/(k-\xi)]^{\theta/\xi}$. Together with (24), this gives our desired inequality measure

$$\frac{\bar{w}}{w(\phi^*)} = \frac{k-\xi+\theta}{k-\xi}. \tag{25}$$

Importantly, wage inequality is not triggered by differences in the individual characteristics of workers. But rather it is the interplay of productivity differences between firms and fairness preferences of workers which leads to wage differentiation. Since workers are identical in all respects, $\bar{w}/w(\phi^*)$ can be interpreted as a measure for the dispersion of wage income within a *particular* skill group. A focus on within-group wage inequality seems also to be justified from an empirical point of view, as within-group wage inequality is an important determinant of overall wage inequality (Juhn, Murphy, and Pierce, 1993;

Katz and Autor[14], 1999) and the increase in within-group wage inequality observed in the last three decades was − in contrast to the rise in between-group wage inequality − not confined to the U.S. (Katz and Autor, 1999; Barth and Lucifora, 2006).

2.5 The Role of Fairness Preferences

We have shown above that the borderline case $\theta = 0$ leads to the perfectly competitive labour market outcome in our model: all firms pay the same wage and there is full employment. We now turn to more generally determining the effects that changes in θ have on average profits, per capita output and the key labour market variables. These effects are summarised in the following proposition.

Proposition 1. *Under parameter restriction (23), a higher θ leads to lower average profits of active firms, lower output per capita, higher unemployment and greater wage inequality.*

Proof. See the appendix. □

The intuition behind these results is as follows. Consider an increase in the fairness parameter. This improves the relative position of less productive firms because in relation to their more productive competitors they now pay lower wages, which mitigates the disadvantage they suffer from an unfavourable draw in the productivity lottery. Consequently, less productive firms than before can now survive in the market and the cutoff productivity ϕ^* falls. Both the lower cutoff productivity and the steeper wage profile naturally lead to a widening in the wage differential and a decline in the average profit of active firms.

The productivity of the average firm declines along with the cutoff productivity. Using this, the effects on per capita output and employment can be illustrated with the help of figure 3. The right quadrant is a graphical representation of equation (21), with $F(\cdot)$ giving the economy-wide employment rate as a function of per capita production and the productivity of the average firm. $G(\cdot)$ in the left quadrant determines the wage paid by the firm with average productivity as a function of per capita output, given the fairness

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[14]Katz and Autor (1999, Table 5) show that within-group inequality explains three-fourth of overall wage inequality in the U.S.
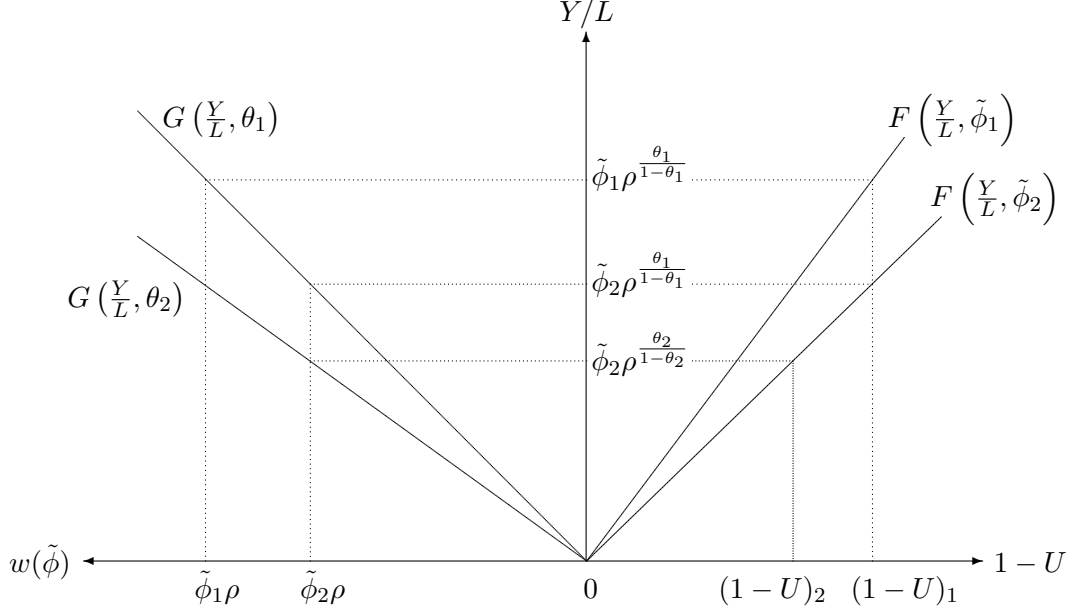
Figure 3: Welfare and employment effects of a change in θ

preferences. From (4) and (5$'$), both evaluated at $\phi = \tilde{\phi}$, we find $G(\cdot) = \rho^{\frac{1-2\theta}{1-\theta}}(Y/L)$. Variables in the old equilibrium are denoted by the subscript 1, those in the new equilibrium by the subscript 2. *Ceteris paribus*, the decrease in average productivity from $\tilde{\phi}_1$ to $\tilde{\phi}_2$ leaves $G(\cdot)$ unchanged but rotates $F(\cdot)$ clockwise, resulting in a first-round decrease in per capita output. However, the increase in θ increases the fair wage demand in the average firm and therefore rotates $G(\cdot)$ counter-clockwise. Given productivity $\tilde{\phi}_2$, the wage is fixed by mark-up pricing, and per capita production has to fall further in order to keep workers – by worsening their outside option – satisfied with the going wage rate. It is this second-round decline in per capita output which leads to a fall in employment, as is illustrated by the movement along $F(Y/L, \tilde{\phi}_2)$ in the right quadrant of figure 3.

There is a further effect on aggregate employment that depends on the size distribution of firms in terms of employment levels (which, as shown above, depends on $\xi - \theta$). In figure 3, this has the effect of rotating $F(Y/L, \tilde{\phi}_2)$ (not shown). While the sign of this effect is ambiguous, we know from proposition 1 that it can never overturn the primary negative employment effect.

16

3 A Benchmark Model of the Open Economy

When economists think about integration effects, they often turn to the theoretically appealing (but empirically not fully convincing) borderline case of full integration of product markets. Full integration of countries which do not differ in their economic fundamentals is formally equivalent in our model to an increase in L and, under technology (1), exhibits no effect on Y/L, U and $\bar{w}/w(\phi^*)$. Only the number of competitors M rises proportionally with market size parameter L. However, if we account for transport costs the key macroeconomic variables no longer remain constant in the process of market integration. This is the case we are focussing on in the following.

Two types of transport costs are distinguished: (i) iceberg transport costs, which are usually considered in trade models with monopolistic competition, and (ii) fixed transport costs, which have been put forward by Melitz (2003) to explain the empirical regularity that larger, more productive firms engage in exporting. We denote by $\tau \geq 1$ the iceberg transport cost parameter and by $f_x \geq 0$ fixed per-period transport costs, which can be interpreted as foreign beachhead (market entry) costs or investment in the foreign distribution system. We investigate integration between $n + 1$ fully symmetric countries. This simplifies our analysis and makes country indices obsolete.

We use index x to refer to variables associated with export sales, while domestic variables are left index free, as in the previous section. Export prices are given by $p_x(\phi) = \tau p(\phi)$, with $p(\phi)$ being determined according to (4). Export sales to any partner country and the respective revenues at the firm level are given by $q_x(\phi) = \tau^{-\sigma} q(\phi)$ and $r_x(\phi) = \tau^{1-\sigma} r(\phi)$, with $q(\phi)$ and $r(\phi)$ being determined according to (3) and (6), respectively. Then, under trade, total revenues of a firm with productivity level ϕ are given by

$$r_t(\phi) = \begin{cases} r(\phi) & \text{if it does not export} \\ r(\phi) + n\tau^{1-\sigma} r(\phi) & \text{if it exports} \end{cases}. \tag{26}$$

Furthermore, profits associated with local sales and exports are given by,

$$\pi(\phi) = \frac{r(\phi)}{\sigma} - f, \qquad \pi_x(\phi) = \frac{r_x(\phi)}{\sigma} - f_x, \tag{27}$$

17

so that $\pi_t(\phi) = \pi(\phi) + \max[0, n\pi_x(\phi)]$ determines the overall (per period) profits of an active producer.

Similar to Melitz (2003), we can distinguish two scenarios. First, if trade costs are sufficiently low, all active firms will engage in exporting, i.e. $\phi^* = \phi_x^*$. Then, free entry of firms determines the cutoff productivity level ϕ^*, according to $\pi_t(\phi^*) = \pi(\phi^*) + n\pi_x(\phi^*) = 0$. In contrast, partitioning of firms by their export status arises under sufficiently high transport costs. In this case ϕ^* is determined by $\pi(\phi^*) = 0$, while $\phi_x^* > \phi^*$ is determined by $\pi_x(\phi_x^*) = 0$. Such a partitioning of firms requires $\pi_x(\phi^*) < 0$. Substituting $r_x(\phi) = \tau^{1-\sigma} r(\phi)$ into (27), we can see that all firms engage in exporting if $\tau^{\sigma-1} f_x \leq f$, whereas $\tau^{\sigma-1} f_x > f$ leads to partitioning of firms by their export status. In analogy to (15), we find

$$\tilde{\phi}_x = \left(\frac{k}{k - \xi} \right)^{1/\xi} \phi_x^*, \tag{28}$$

and hence we have $\tilde{\phi}_x / \tilde{\phi} = \phi_x^* / \phi^*$.

The *ex ante* probability that a successful entrant will engage in exporting is $\chi = [1 - G(\phi_x^*)]/[1 - G(\phi^*)] = (\phi^*/\phi_x^*)^k$. Since firms know their productivity levels before they decide upon their export status, χ also gives the *ex post* fraction of exporters. If all countries are symmetric, the total number of producers selling to one market is given by $M_t = M(1+n\chi)$. The weighted average productivity of all firms active in any one country is determined in analogy to (10) and given by

$$\begin{aligned}
\tilde{\phi}_t &= \left\{ \frac{1}{1 + n\chi} \left(\tilde{\phi}^\xi + n\chi\tau^{1-\sigma}\tilde{\phi}_x^\xi \right) \right\}^{1/\xi} \\
&= \tilde{\phi} \left\{ \frac{1}{1 + n\chi} \left[1 + n\chi\tau^{1-\sigma}(\tilde{\phi}_x/\tilde{\phi})^\xi \right] \right\}^{1/\xi},
\end{aligned} \tag{29}$$

where $\tilde{\phi}$ is the average productivity of all domestic firms and $\tilde{\phi}_x$ is the average productivity of exporting firms. The difference between the two averages $\tilde{\phi}$ and $\tilde{\phi}_t$ is due to two effects: the *lost-in-transit* effect caused by goods melting away en route when variable transport costs are positive and the *export-selection* effect due to the fact that with partitioning it is the most productive firms who export. Inspection of (29) confirms that $\tilde{\phi}_t = \tilde{\phi}$ when there are no variable transport costs and all firms export. Increasing τ decreases $\tilde{\phi}_t/\tilde{\phi}$ directly

18

due to the lost-in-transit effect, but increases $\tilde{\phi}_t/\tilde{\phi}$ due to the export-selection effect if it leads to partitioning of firms by their export status.

The definition of $\tilde{\phi}_t$ in (29) ensures that the quantity produced by the average firm *for its domestic market*, $q(\tilde{\phi}_t)$, is equal to the average output per firm selling to this market, Y/M_t. In analogy to the closed economy case, we furthermore have $P = p(\tilde{\phi}_t) = 1$, $Y = R = M_t r(\tilde{\phi}_t)$, and $\Pi = M_t \pi(\tilde{\phi}_t)$. Hence, for the open economy version of the model $\tilde{\phi}_t$ assumes the role that $\tilde{\phi}$ has for the closed economy version.

In the remainder of this section we look at the case where the per-period domestic beachhead costs f and the per-period foreign beachhead costs f_x are equal. Making the model symmetric in this way allows us to bring to the forefront the role played by firm heterogeneity in the globalisation process. We delegate a discussion of the general case $f \neq f_x$ to section 4. With the assumption $f_x = f$, and using (8) as well as $r(\phi^*) = \sigma f$ and $r_x(\phi_x^*) = \sigma f_x$ (from the respective zero profit cutoff conditions), we get

$$\left(\frac{\phi_x^*}{\phi^*}\right)^\xi = \frac{r(\phi_x^*)}{r(\phi^*)} = \frac{\tau^{\sigma-1} r_x(\phi_x^*)}{r(\phi^*)} = \tau^{\sigma-1}. \tag{30}$$

Substitution in (29) gives $\tilde{\phi}_t = \tilde{\phi}$, where the differential of the two average productivities is independent of τ because with $f_x = f$ the lost-in-transit effect and the export-selection effect exactly offset each other. This simplifies the analysis dramatically because the relative size of ϕ^* and $\tilde{\phi}$ depends only on model parameters σ, θ and k, as shown in (15), and is the same in the closed and open economy. We can therefore focus on deriving the effect that opening up to trade has on the cutoff productivity ϕ^*. We can furthermore see from (17) that $\pi(\tilde{\phi})$, the profit that the average firm makes *in its domestic market*, does only depend on model parameters f, σ, θ, k and therefore remains unaffected after trade liberalisation.

3.1 Comparing Autarky and Trade

From the definition of average productivity $\tilde{\phi}_t$, the average profit of active firms $\bar{\pi}_t \equiv \Pi/M$ in the open economy is given by $\bar{\pi}_t = \pi(\tilde{\phi}_t)(M_t/M) = \pi(\tilde{\phi}_t)(1 + n\chi)$, where $\chi = \tau^{-k/(1-\theta)}$. Comparing this to the average profit in autarky, as given in (17), and using $\tilde{\phi} = \tilde{\phi}_t$, we

find[15]

$$\frac{\bar{\pi}_t}{\bar{\pi}_a} = 1 + n\chi > 1. \tag{31}$$

Hence, average profits of active firms increase as the economy opens up to trade.

As shown above, ϕ^* is jointly determined by the free entry condition and the zero cutoff profit condition. The free entry condition is the same as in the closed economy, with $\bar{\pi}_t$ replacing $\bar{\pi}$ in (16). The modified zero cutoff profit condition (ZCP) becomes

$$\bar{\pi}_t = \frac{\xi f}{k - \xi}\left(1 + n\chi\right), \tag{32}$$

using (17) as well as $\tilde{\phi}_t = \tilde{\phi}$. Together, (16) and (32) determine the cutoff productivity under trade. It is given by

$$\phi^* = \left[\left(\frac{\xi f}{(k-\xi)\delta f_e}\right)(1 + n\chi)\right]^{1/k} \bar{\phi} \tag{33}$$

Comparing ϕ^* to its autarky level ϕ_a^* as determined in (18), we see that trade liberalisation leads to a higher productivity cutoff level: $\phi^* > \phi_a^*$. Graphically, trade liberalisation induces an upward shift of the ZCP locus in figure 1. With the FE curve unchanged, cutoff productivity increases.

As the ratio of average productivity $\tilde{\phi}$ and cutoff productivity ϕ^* is the same under autarky and trade, and we have $\tilde{\phi} = \tilde{\phi}_t$, it follows from (18) and (33) that

$$\frac{\tilde{\phi}_t}{\tilde{\phi}_a} = (1 + n\chi)^{1/k} > 1 \tag{34}$$

Hence, in the completely symmetric case considered here trade liberalisation induces an increase in the average productivity level of active firms in all countries: $\tilde{\phi}_t > \tilde{\phi}_a$. This translates into an increase in per capita production – and therefore welfare – for all trading economies, as shown by (19).[16]

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[15]From now on, we use subscript a to refer to autarky levels.

[16]While under production technology (1) the welfare effect is independent of the change in the mass of intermediates used in each country, it is straightforward to determine this change. In the open economy, we denote by M_t the mass of input varieties used in final goods production, and by M the mass of locally

We now turn to the effects of trade liberalisation on unemployment. Summing up employment at the firm level we get

$$(1 - U)L = M \int_{\phi^*}^{\infty} l(\phi) \frac{k}{\phi} \left(\frac{\phi^*}{\phi} \right)^k d\phi + nM_x \int_{\phi_x^*}^{\infty} l_x(\phi) \frac{k}{\phi} \left(\frac{\phi_x^*}{\phi} \right)^k d\phi \qquad (35)$$

where $l(\phi)$ is the employment in a domestic firm of productivity ϕ for its domestic sales, while $l_x(\phi) = \tau^{1-\sigma} l(\phi)$ is the employment in a domestic exporting firm of productivity ϕ for its export production. This can be rewritten as

$$1 - U = \Gamma \frac{Y}{L\tilde{\phi}_t} \left(\frac{k}{k - \xi} \right)^{\theta/\xi} \frac{k - \xi}{k - \xi + \theta}, \qquad (36)$$

with

$$\Gamma \equiv \frac{1 + n\chi\tau^{-\frac{\theta}{1-\theta}}}{1 + n\chi} < 1. \qquad (37)$$

Substituting for Y/L from (19) we get

$$1 - U = \Gamma \rho^{\theta/(1-\theta)} \left(\frac{k}{k - \xi} \right)^{\theta/\xi} \frac{k - \xi}{k - \xi + \theta}, \qquad (38)$$

Comparing (22) with (38), we see that the move from autarky to trade increases unemployment. The results on average profits, aggregate welfare and unemployment can be summarised as follows:

Proposition 2. *With positive variable transport costs and beachhead costs that are the same across all markets, opening up to international trade increases average profits of active firms, aggregate welfare and the rate of unemployment in the participating countries.*

The intuition for these results is as follows. Opening up for trade raises, all other things equal, the mass of available intermediate good varieties in each market. This reduces demand at the firm level, according to (3), and therefore renders production of marginal firms (with productivity levels close to ϕ_a^*) unattractive. As a consequence, only the more

produced varieties. Noting $r(\tilde{\phi}_t) = r(\tilde{\phi}_a)$ and $Y = M_t r(\tilde{\phi}_t)$, $M_t/M_a = \tilde{\phi}_t/\tilde{\phi}_a > 1$ follows immediately from (20) and (34). Hence, in each country more varieties are used in production after trade liberalisation. The mass of local producers on the other hand declines if and only if $k > 1$: Use (34) and $M_t = (1 + n\chi)M$ to get $M/M_a = (1 + n\chi)^{(1-k)/k}$. Note that $k > 1$ is not implied by (23).

21

productive firms survive under openness, and both average profits and average productivity increase. By virtue of equation (19), this leads to higher per capita output and therefore higher aggregate welfare.

With respect to the unemployment implications of trade liberalisation, let us first consider the limiting case of zero variable transport costs ($\tau = 1$). Each firm in this case sells equal shares of its output in all $n + 1$ markets and we can distinguish two counteracting effects of trade liberalisation. On the one hand, a higher per capita output increases demand for intermediate goods and therefore also for labour input.[17] On the other hand, a higher average productivity means that a lower amount of labour input is required to produce a given level of output. These two effects exactly offset each other if $\tau = 1$, thereby leaving the unemployment rate unaffected by a movement from autarky to trade.

Compared to this benchmark, positive variable transport costs lead to an additional effect on both welfare and employment. On the one hand, they soften the selection process that leads to the increase in average productivity. In each country there is now a mixture of national firms and exporters ($\chi < 1$), and not every firm unable to cover fixed costs $(n+1)f$ has to leave the industry. Average productivity (and therefore welfare) still increases as compared to autarky, but not by as much as it would in the absence of variable transport costs. On the other hand, positive variable transport costs lead to a fall in aggregate employment that is driven by the decreasing employment for export production in all firms. This is trivially true for firms that cease exporting because of higher transport costs, but holds as well for those that continue exporting, as their destination-specific employment in export production falls from $l(\phi)$ to $\tau^{1-\sigma}l(\phi)$.

With welfare and employment effects in hand, we can now investigate how a movement from autarky to trade affects wage payments. Let us first look at the wage of the average

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[17]Of course, part of the increased demand falls on foreign competitors and therefore raises employment abroad. But at the same time there are also more markets, where intermediate goods of a single producer can be sold. In the symmetric country case, there are $(n+1)$ markets served by a mass of $M_t = (n+1)M$ intermediate goods producers. Substituting into (3), we see that overall demand for a single variety can be written as $q(\phi) = (Y/M)p(\phi)^{-\sigma}$ in the open economy scenario with zero variable transport costs.

worker, which is given by $\bar{w} = \rho(Y/L)/(1-U)$. From proposition 2, we know that per capita output rises while the employment rate declines, so that $\bar{w}$ unambiguously increases. This outcome is consistent with empirical evidence showing that export is typically associated with a wage increase in OECD member states and in many developing countries (see Fontagné and Mirza, 2002). However, there are also distributional consequences through changes in the wage dispersion. The wage differential between the worker receiving the average wage and the lowest paid worker can be derived in analogy to the autarky case. It is given by

$$\frac{\bar{w}}{w(\phi^*)} = \Gamma^{-1}\frac{k-\xi+\theta}{k-\xi}. \tag{39}$$

Comparing $\bar{w}/w(\phi^*)$ with its autarky level in (25), we see that wage inequality rises if an economy moves from autarky to trade in the presence of positive variable transport costs (so that $\Gamma < 1$). Intuitively, the increase in cutoff productivity increases both per capita output and the wage paid by the marginal firm proportionally. As unemployment increases, the average wage of those employed increases more than proportionally, and $\bar{w}/w(\phi^*)$ rises. The wage effects of trade liberalisation are summarised in proposition 3.

Proposition 3. *With positive variable transport costs and beachhead costs that are the same across all markets, opening up to trade raises the average wage and widens the wage differential $\bar{w}/w(\phi^*)$ in all participating countries.*

This proposition gives new insights into the distributional consequences of trade liberalisation. While existing theoretical studies on that issue investigate the effects on wages of one skill group relative to another one, our model emphasises the wage dispersion effects within education/skill groups (as all workers have the same individual characteristics). The model points to the role of trade liberalisation as a candidate for explaining the observed increase of within-group wage inequality if productivity differences of firms paired with fairness preferences give rise to firm-specific payments to labour. This effect is triggered by a change in the composition of firms that differ in their productivity levels. To the best of our knowledge, there exists no conclusive empirical evidence on the role of trade liberalisation for within-group wage inequality. However, Bernard and Jensen (1995) find

23

that exporters pay higher wages (for both production and non-production workers), even if controlling for plant size, capital intensity, hours per worker, industry and location. This gives (at least indirect) support for the economic mechanisms in this paper.[18]

3.2 Marginal Trade Liberalisation

Comparing the two scenarios of autarky and (restricted) trade, as we have done in the previous section, is analytically convenient but clearly does not adequately reflect the globalisation experience of the past decades, which has arguably been a gradual process. In the last twenty years more and more countries have opened their borders for international goods transactions and transport costs have fallen dramatically since World War II, leading some observers to proclaim the "death of distance" (Cairncross, 1997) to be imminent.

To gain insights into the development of unemployment and wage inequality during the process of globalisation, we analyze the comparative static effects of changes in transport costs τ and the number of trading partners n. As in the last section, we look at the fully symmetric case where $f_x = f$. This implies $\chi = \tau^{-k/(1-\theta)}$ with $\partial\chi/\partial\tau < 0$, and hence the proportion of firms that export increases with falling variable trading costs, as can be expected. Using this result, we find that a decrease in τ increases average productivity $\tilde{\phi}_t$ (from (34)) and therefore per capita output (from (19)). The same equations can be used to see that average productivity and per capita output increase in the number of partner countries n. This result is not surprising, as trade liberalisation *per se* has a positive effect on welfare. This effect is reinforced if more countries become economically integrated.

The effect of trade liberalisation in the form of either lowering τ or increasing n on

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[18]It is straightforward to show that quantitatively the effect of trade liberalisation on the key model variables described in propositions 2 and 3 depends on fairness preferences: The higher is θ, the smaller is the positive effect of trade liberalisation on welfare and the average profit, and the larger are – subject to only mild conditions – the negative effects on employment and wage inequality. The results on welfare and the average profit follow from (17), (32) and (34), noting that $\partial\chi/\partial\theta < 0$. It has been shown above that both the employment and wage inequality effects of trade liberalisation are solely determined by Γ. We find that $k > 1$ is sufficient for $d\Gamma/d\theta < 0$, and hence the stated result follows. (Derivation details are available from the authors upon request.)

unemployment and the wage differential are determined by their respective effects on Γ, as can be seen from (38) and (39). Partially differentiating (37), we find $\partial \Gamma / \partial n < 0$, and therefore an increase in the number of trading partners raises unemployment as well as the wage differential $\bar{w}/w(\phi^*)$. On the other hand, the effect of changes in variable transport costs on Γ is non-monotonic. This follows from the result established earlier that the employment level in an integrated world with zero variable transport costs ($\tau = 1$) is equal to the autarky situation (which follows if $\tau \to \infty$), while employment falls if one moves from autarky to trade with positive variable transport costs ($\tau > 1$). Differentiating (37) with respect to τ, we have

$$\text{sign}\left(\frac{\partial \Gamma}{\partial \tau}\right) = \text{sign}\left(\frac{k\left[\tau^{\theta/(1-\theta)} - 1\right]}{1 + n\chi} - \theta\right), \tag{40}$$

which allows us to identify a critical $\bar{\tau} > 1$, such that $\partial \Gamma / \partial \tau > 0$ if $\tau > \bar{\tau}$ and $\partial \Gamma / \partial \tau < 0$ if $\tau < \bar{\tau}$. A marginal reduction in variable transport costs increases (decreases) unemployment and wage inequality if τ is larger (smaller) than $\bar{\tau}$.

The results derived so far allow us to address an issue that has featured prominently in both the political debate and the popular press in recent years: the simultaneous occurrence of increasing profits and increasing unemployment in the face of globalisation. Is there a reason to believe that these two phenomena are related? Our framework suggests that the decline in transport costs could be a common cause for both phenomena, and indeed might in addition have contributed to the increase in wage inequality. Notably however, the phenomenon that employment and firm profits move in opposite directions in our model disappears for low levels of transport costs. While further globalisation hence would have the potential for further increasing the profits of active firms, it should eventually, as the "death of distance" becomes a reality, lead to an increase in employment as well.

4 Extensions

The analysis in section 3 has built upon two important assumptions, namely (i) identical beachhead costs for domestic and foreign markets and (ii) no external economies of scale,

due to our normalisation of the CES-aggregator in (1). We now check the robustness of our results by modifying these two model elements. In subsection 4.1, we allow for heterogeneous beachhead costs but keep the normalisation of the CES-aggregator. The role of external economies of scale is analysed in subsection 4.2.

4.1 Heterogeneous Beachhead Costs

In this subsection, we look at the case where beachhead costs for domestic and export markets are different. There is no presumption as to which of these costs one should expect to be higher (which is what makes the benchmark case of $f_x = f$ interesting to begin with), and hence we will consider both $f_x > f$ and $f_x < f$. The analysis in this section is confined to deriving the effects of a movement from autarky to trade, i.e. an adaptation of the analysis in section 3.1 for the case of asymmetric beachhead costs. The analogue to the zero cutoff profit condition (32) is given by

$$\bar{\pi}_t = \frac{\xi f}{k - \xi} \left(1 + n\chi \frac{f_x}{f} \right) \tag{32'}$$

with $\chi = 1$ if $\tau^{\sigma-1} f_x \leq f$. The productivity differential $\tilde{\phi}_t / \tilde{\phi}_a$ determining the welfare effect of globalisation can be written as

$$\frac{\tilde{\phi}_t}{\tilde{\phi}_a} = \begin{cases} \left(\frac{1+n\tau^{1-\sigma}}{1+n} \right)^{1/\xi} \left(1 + n\frac{f_x}{f} \right)^{1/k} & \text{if} \quad \tau^{\sigma-1} f_x \leq f \\ \left(\frac{1+n\chi\frac{f_x}{f}}{1+n\chi} \right)^{1/\xi} \left(1 + n\chi\frac{f_x}{f} \right)^{1/k} & \text{if} \quad \tau^{\sigma-1} f_x > f \end{cases}, \tag{34'}$$

with the first term at the right-hand side of (34') being equal to $\tilde{\phi}_t / \tilde{\phi}$ and the second term equalling ϕ^* / ϕ_a^* (or, equivalently, $\tilde{\phi} / \tilde{\phi}_a$). The effect of globalisation on aggregate employment is still determined solely by the sign of $\Gamma - 1$ (see (36) and (39)), where Γ is now given by

$$\Gamma = \begin{cases} \left(\frac{1+n\tau^{1-\sigma}}{1+n} \right)^{\frac{\theta}{\xi}} & \text{if} \quad \tau^{\sigma-1} f_x \leq f \\ \left(\frac{1+n\chi\frac{f_x}{f}}{1+n\chi} \right)^{\frac{\theta}{\xi}} \frac{1+n\tau^{1-\sigma}\chi^{\frac{k-\xi+\theta}{k}}}{1+n\tau^{1-\sigma}\chi^{\frac{k-\xi}{k}}} & \text{if} \quad \tau^{\sigma-1} f_x > f \end{cases}. \tag{37'}$$

The first term on the right hand side in both lines of $(37')$ equals $(\tilde{\phi}_t/\tilde{\phi})^\theta$, and the second term in line two is smaller than or equal to one (as $\chi \leq 1$).

For simplicity, we start by looking at the effects of globalisation for the borderline case of zero fixed and variable transport costs ($f_x = 0$, $\tau = 1$). As mentioned before and confirmed by inspection of $(34')$ and $(37')$, goods market integration in this case leaves welfare and employment unaffected. Now, increasing τ leaves relative cutoff productivities ϕ^*/ϕ_a^* unchanged, but decreases $\tilde{\phi}_t/\tilde{\phi}$ due to the lost-in-transit effect. Overall, welfare and aggregate employment decrease. On the other hand, with $f_x > 0$ we have $\phi^*/\phi_a^* > 1$ and in addition $\tilde{\phi}_t/\tilde{\phi} > 1$ due to the export-selection effect once the partitioning threshold is reached. Overall, welfare increases. Employment remains unchanged below the partitioning threshold, as it only depends on $\tilde{\phi}_t/\tilde{\phi}$, but not on ϕ^*/ϕ_a^*. In the partitioning regime, the employment effect may be positive or negative, depending on the particular parameter constellation.

With both fixed and variable transport costs strictly positive, the effects just described interact, and the overall welfare and employment effects depend ceteris paribus on the relative size of these costs. Rather than go through an unwieldy catalogue of cases, we focus on some insights that can be gained directly from inspecting $(34')$ and $(37')$. Firstly, higher variable transport costs reduce welfare and employment if there is no partitioning of firms. Hence, there is a tendency of globalisation to exhibit detrimental welfare and employment effects if variable transport costs are high and foreign beachhead costs are moderate. Secondly, $f_x > f$ is sufficient for positive welfare effects and necessary for positive employment effects of globalisation.[19] Thus, there is a tendency for trade liberalisation to be beneficial if foreign beachhead costs are sufficiently high and there is partitioning of firms by their export status.

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[19]It is difficult to show positive employment effects of globalisation analytically. However, numerical simulation exercises indicate that such positive employment effects are possible if there is partitioning of firms by their export status.

4.2 External Economies of Scale

This subsection addresses the impact of external economies of scale on the trade liberalisation effects identified in section 3. For this purpose, we replace technology (1) by the generalised CES-index

$$Y = M^{-\frac{\eta(1-\rho)}{\rho}} \left[\int_{v \in V} q(v)^\rho dv \right]^{1/\rho}, \qquad 0 < \rho < 1, \qquad \eta \in [0, 1]. \qquad (1')$$

This production technology covers our specification without external scale effects ($\eta = 1$) and a model variant in the tradition of the Ethier (1982) framework ($\eta = 0$) as two special cases. The existence of external scale effects (for $\eta < 1$) drives a wedge between the price index P, which is normalised to one, and the price of the firm with average productivity, which is given by $p(\tilde{\phi}) = M^{\frac{1-\eta}{\sigma-1}}$. By virtue of (5'), this has consequences for per capita output, and hence welfare:

$$Y/L = \tilde{\phi} \rho^{\theta/(1-\theta)} M^{(1-\eta)/\xi}, \qquad (19')$$

which depends positively on the mass of available input varieties M if $\eta < 1$. Hence, to the extent that the mass of available input varieties increases with country size (measured by aggregate labour supply), larger countries have higher welfare. In order to ensure stability of the autarky equilibrium we assume $\xi > 1 - \eta$.[20]

Using (19'), the equilibrium mass of available intermediate goods can be determined in analogy to (20) and is given by:

$$M = \left[\frac{\tilde{\phi} \rho^{\theta/(1-\theta)} L}{\sigma \left(\pi(\tilde{\phi}) + f \right)} \right]^{\frac{\xi}{\xi-(1-\eta)}} \qquad (20')$$

In contrast to our benchmark model, a higher labour endowment L now leads to a more than proportional increase in the mass of available input varieties.

With respect to the unemployment rate, we obtain

$$1 - U = \rho^{\theta/(1-\theta)} \left(\frac{k}{k-\xi} \right)^{\theta/\xi} \frac{k-\xi}{k-\xi+\theta} M^{\frac{\theta(1-\eta)}{\xi}}, \qquad (22')$$

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[20]In the opposite case of $\xi < 1 - \eta$, a marginal increase of M (above M_a) would raise per capita output more than proportionally, thereby leading to further entry (due to $M = Y/r(\tilde{\phi})$) and ultimately driving both welfare and the mass of intermediate competitors up to infinity.

which simplifies to (22) if $\eta = 1$. In contrast, with $\eta < 1$ the unemployment rate exhibits a size pattern: The higher the labour endowment L, the greater an economy's mass of available input varieties and the lower is its unemployment rate (under autarky). For an interior solution with $U < 1$, the endowment of labour must be sufficiently low. This is assumed in the following.

The final variable of interest is within-group wage inequality $\bar{w}/w(\phi^*)$. Noting that $w(\tilde{\phi})/w(\phi^*)$ is a constant if productivity levels are Pareto-distributed, we can investigate the role of market size by looking at $w(\tilde{\phi})/\bar{w}$. By virtue of fair wage condition (5), we have $w(\tilde{\phi})/\bar{w} = (1 - U)[w(\tilde{\phi})/\tilde{\phi}]^{-\theta/(1-\theta)}$ which, using $w(\tilde{\phi})/\tilde{\phi} = \rho p(\tilde{\phi}) = \rho M^{\frac{1-\eta}{\sigma-1}}$ together with (22′), turns out to be identical to (24). As a consequence, within-group wage inequality in (25) remains unaffected by the generalisation considered in this subsection.

We can now compare the autarky to the trade equilibrium, focussing, as in section 3, on the symmetric case of identical beachhead costs in all markets: $f = f_x$. There are two channels through which trade liberalisation affects welfare. First, there are productivity gains, as the least productive firms leave the market: $\tilde{\phi}_t > \tilde{\phi}_a$ (see section 3). Second, the number of available input varieties goes up after trade liberalisation[21] ($M_t > M_a$), which with $\eta < 1$ increases welfare further. Concerning wage inequality, we know from the autarky scenario that the generalisation of production technology (1) has no implication for the relative wage $\bar{w}/w(\phi^*)$. Hence, the finding that a movement from autarky to trade amplifies wage inequality survives for all possible η-values.

Finally, following the analysis in section 3, the employment rate in the trade scenario can be reformulated in the following way:

$$1 - U = (1 - U_a)\Gamma \left(M_t/M_a\right)^{\theta(1-\eta)/\xi}. \tag{38′}$$

There are two counteracting effects of trade liberalisation on unemployment rate U. On the one hand, unemployment increases due to partitioning of firms by their export status (see section 3). On the other hand, there are additional positive labour demand effects

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[21]Substitute $\tilde{\phi}_t$ for $\tilde{\phi}$ and M_t for M in (20′) and consider $\xi > 1 - \eta$. Then, $M_t > M_a$ follows immediately from $\tilde{\phi}_t > \tilde{\phi}_a$.

if $\eta < 1$ leads to external scale effects. Which of the two effects dominates critically depends on the size of transport costs τ and parameter η. In the borderline case of zero variable transport costs $\tau = 1$, we have $\Gamma = 1$ and the partitioning effect vanishes. Thus, employment unambiguously increases after trade liberalisation through the second channel of influence. In contrast, if $\tau > 1$ and the external scale effect is sufficiently weak, i.e. if η is not too low, it is the first effect that dominates and the unemployment rate is higher under trade than under autarky.[22]

Summing up, we find that the results in section 3 for the impact of trade liberalisation on welfare and wage inequality are robust with respect to different degrees of external scale effects. However, our conclusions from the previous analysis on the unemployment effects of trade liberalisation have to be modified. A negative employment effect is triggered if variable transport costs are not too low and the external scale effects are moderate, while a positive employment effect can be expected if variable transport costs are negligible and the external scale effect is particularly strong.

5   Concluding remarks

The role of globalisation for labour market performance has featured prominently in the economics debate for a long time. While the effect of trade liberalisation on the skill premium has been at the forefront of this debate, its effect on wage inequality between workers of the same skill group has been ignored. To address this issue, we develop a model that incorporates a fair wage mechanism into a general equilibrium framework with heterogeneous firms that differ in their productivity levels. Furthermore, we assume that rent-sharing motives are a determinant of workers' fair wage preferences, so that wage payments contain a firm-specific component. This gives a theoretical framework in which within-group wage inequality and unemployment are determined simultaneously, with the productivity distribution of active firms being a key factor of the labour market outcome. We then use this model to study the effects of international integration of goods markets

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[22]It is noteworthy that $U > U_a$ is possible even if $\eta = 0$.

on national labour markets.

Noting from previous theoretical work that economic integration affects the productivity distribution of active producers, we have been particularly interested in how these changes translate into per capita output, unemployment and within-group wage inequality effects. In our fully symmetric benchmark model where domestic and foreign beachhead (market entry) costs are the same, there are gains from trade accompanied by higher average profits, higher unemployment and a larger wage dispersion. This highlights two distributional conflicts national governments face in the process of globalisation: One is due to the simultaneous occurrence of higher average profits and higher unemployment. The second distributional conflict arises between workers employed by different firms: Those who stay employed benefit to different extents from the gains from trade, while those who become newly unemployed lose.

In one extension to our basic setting we allow for differences in the costs of domestic and foreign market entry. In this more general setting, two important results have been identified: If foreign beachhead costs are sufficiently high, in addition to there being gains from trade economic integration may reduce both within-group wage inequality and the unemployment rate. However, if foreign beachhead costs are low, trade liberalisation may reduce per capita output and welfare. In this case, both within-group wage inequality and the unemployment rate definitely increase.

In future work our framework can be extended in a number of directions. For one, it would be potentially fruitful to introduce trade policy instruments into the model and to look at their effect on welfare and the labour market. Another promising area for future research is the addition of a second factor of production that would allow the simultaneous discussion of within-group and between-group wage inequality.

Appendix

Proof of proposition 1

First, $d\bar{\pi}/d\theta < 0$ is a direct consequence of (17). Second, it follows from (19), that

$$\frac{d(Y/L)}{d\theta} = \frac{1}{Y/L}\left[\frac{1}{(1-\theta)^2}\ln\rho + \frac{1}{\tilde{\phi}}\frac{d\tilde{\phi}}{d\theta}\right]$$

which given that $\rho \in (0,1)$ is negative if $d\tilde{\phi}/d\theta < 0$. Substituting (18) into (15) and differentiating the respective expression with respect to θ we obtain

$$\frac{d\tilde{\phi}}{d\theta} = \left[\frac{\tilde{\phi}}{\xi}\Omega(k,\xi) + \frac{\tilde{\phi}}{\phi^*}\frac{d\phi^*}{d\xi}\right]\frac{d\xi}{d\theta},$$

with

$$\Omega(k,\xi) \equiv -\frac{1}{\xi}\ln\left(\frac{k}{k-\xi}\right) + \frac{1}{k-\xi}$$

To determine the sign of $\Omega(\cdot)$ we use

$$\frac{\partial\Omega(k,\xi)}{\partial k} = -\frac{\xi}{k(k-\xi)^2} < 0.$$

Together with $\lim_{k\to\infty}\Omega(k,\xi) = 0$, this implies that $\Omega(k,\xi) > 0$ for any $k \in (\xi,\infty)$. Noting further that $d\phi^*/d\xi > 0$ (from (18)) and $d\xi/d\theta = -(\sigma - 1) < 0$, we have $d\tilde{\phi}/d\theta < 0$ and thus $d(Y/L)/d\theta < 0$.

Third, differentiating (22) with respect to θ gives

$$\frac{d(1-U)}{d\theta} = (1-U)\left\{\frac{1}{(1-\theta)^2}\left[\ln\rho + \frac{1}{\sigma-1}\ln\left(\frac{k}{k-(\sigma-1)(1-\theta)}\right)\right]\right.$$
$$\left.-\frac{1}{k-(\sigma-1)(1-\theta)}\left[\frac{\theta}{1-\theta} + \frac{k-(\sigma-1)}{k+1-\sigma(1-\theta)}\right]\right\},$$

which is negative if inequality (23) holds. Fourth, differentiating (25) with respect to θ gives

$$\frac{d(\bar{w}/w(\phi^*))}{d\theta} = \frac{k-(\sigma-1)}{(k-\xi)^2},$$

which is positive, due to inequality (23).

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Firm Heterogeneity and the Labour Market Effects

of Trade Liberalisation – Supplement

Derivation of eqs. (15), (21), (29), (36), (32′) and (37′)

The following six subsections provide derivation details for eqs. (15), (21), (29), (36), (32′) and (37′).

Derivation of eq. (15)

$$
\begin{aligned}
\tilde{\phi} &= \left[\frac{1}{1 - G(\phi^*)} \int_{\phi^*}^{\infty} \phi^\xi g(\phi) d\phi \right]^{1/\xi} \\
&= \left[\frac{1}{1 - G(\phi^*)} \int_{\phi^*}^{\infty} \phi^\xi \frac{k}{\phi} \left(\frac{\bar{\phi}}{\phi} \right)^k d\phi \right]^{1/\xi} \\
&= \left[\frac{k \bar{\phi}^k}{1 - G(\phi^*)} \int_{\phi^*}^{\infty} \phi^{\xi - k - 1} d\phi \right]^{1/\xi} \\
&= \left[\frac{k \bar{\phi}^k}{1 - G(\phi^*)} \left(\frac{1}{\xi - k} \phi^{\xi - k} \Big|_{\phi^*}^{\infty} \right) \right]^{1/\xi} \\
&= \left[\frac{k \bar{\phi}^k}{1 - G(\phi^*)} \frac{1}{k - \xi} (\phi^*)^{\xi - k} \right]^{1/\xi} \\
&= \left[\frac{1}{1 - G(\phi^*)} \left(\frac{\bar{\phi}}{\phi^*} \right)^k \frac{k}{k - \xi} \right]^{1/\xi} \phi^* \\
&= \left[\frac{k}{k - \xi} \right]^{1/\xi} \phi^*
\end{aligned}
$$

Derivation of eq. (21)

$$
\begin{aligned}
(1 - U)L = M \int_{\phi^*}^{\infty} l(\phi) \frac{k}{\phi} \left(\frac{\phi^*}{\phi} \right)^k d\phi \\
= M \int_{\phi^*}^{\infty} l(\tilde{\phi}) \left(\frac{\phi}{\tilde{\phi}} \right)^{\xi - \theta} \frac{k}{\phi} \left(\frac{\phi^*}{\phi} \right)^k d\phi \\
= M l(\tilde{\phi}) \tilde{\phi}^{\theta - \xi} (\phi^*)^k k \int_{\phi^*}^{\infty} \phi^{\xi - \theta - k - 1} d\phi
\end{aligned}
$$

36

$$= Ml(\tilde{\phi})\tilde{\phi}^{\theta-\xi}(\phi^*)^k k\left(\frac{1}{\xi-\theta-k}\phi^{\xi-\theta-k}\Big|_{\phi^*}^{\infty}\right)$$

$$= Ml(\tilde{\phi})\tilde{\phi}^{\theta-\xi}(\phi^*)^k k\frac{(\phi^*)^{\xi-\theta-k}}{k-\xi+\theta}$$

$$= Ml(\tilde{\phi})\left(\frac{\tilde{\phi}}{\phi^*}\right)^{\theta-\xi}\frac{k}{k-\xi+\theta}$$

$$= Ml(\tilde{\phi})\left(\frac{k}{k-\xi}\right)^{\frac{\theta-\xi}{\xi}}\frac{k}{k-\xi+\theta}$$

$$= Ml(\tilde{\phi})\left(\frac{k}{k-\xi}\right)^{\frac{\theta}{\xi}}\frac{k-\xi}{k-\xi+\theta}$$

$$= \frac{Y}{\tilde{\phi}}\left(\frac{k}{k-\xi}\right)^{\frac{\theta}{\xi}}\frac{k-\xi}{k-\xi+\theta}$$

Dividing both sides by L gives eq. (21).

Derivation of eq. (29)

The price index under openness is given by

$$P_t = \left\{\frac{1}{M_t}\left[M\int_0^{\infty}p(\phi)^{1-\sigma}\mu(\phi)d\phi + M_x n\tau^{1-\sigma}\int_0^{\infty}p(\phi)^{1-\sigma}\mu(\phi)d\phi\right]\right\}^{1/(1-\sigma)},$$

where P_t is determined in a similar way as $(2')$, with the mere difference that it also accounts for prices of imported goods. Note that $\lim_{\tau\to\infty}P_t = P$. Substituting eqs. (7), (14) and noting that $P_t = 1$ follows from our choice of numéraire, we can rewrite the price index in the following way:

$$1 = \left\{\frac{p(\tilde{\phi}_t)}{M_t}\left[M\int_{\phi^*}^{\infty}\left(\frac{\phi}{\tilde{\phi}_t}\right)^{\xi}\frac{g(\phi)d\phi}{1-G(\phi^*)} + M_x n\tau^{1-\sigma}\int_{\phi_x^*}^{\infty}\left(\frac{\phi}{\tilde{\phi}_t}\right)^{\xi}\frac{g(\phi)d\phi}{1-G(\phi_x^*)}\right]\right\}^{1/(1-\sigma)},$$

Noting further $M_x = \chi M$, $M_t = (1+n\chi)M$ and

$$\tilde{\phi} = \left[\int_{\phi^*}^{\infty}\phi^{\xi}\frac{g(\phi)d\phi}{1-G(\phi^*)}\right], \quad \tilde{\phi}_x = \left[\int_{\phi_x^*}^{\infty}\phi^{\xi}\frac{g(\phi)d\phi}{1-G(\phi_x^*)}\right],$$

according to (10), we obtain

$$1 = \frac{p(\tilde{\phi}_t)}{1+n\chi}\left[\left(\frac{\tilde{\phi}}{\tilde{\phi}_t}\right)^{\xi} + n\chi\tau^{1-\sigma}\left(\frac{\tilde{\phi}_x}{\tilde{\phi}_t}\right)^{\xi}\right].$$

Solving for $\tilde{\phi}_t$ gives

$$\tilde{\phi}_t \equiv \left\{ \frac{p(\tilde{\phi}_t)}{1+n\chi} \left(\tilde{\phi}^\xi + n\chi\tau^{1-\sigma}\tilde{\phi}_x^\xi \right) \right\}^{1/\xi},$$

and defining $\tilde{\phi}_t$ such that $p(\tilde{\phi}_t) = 1$ gives the first line in (29).

Derivation of eq. (36)

$$
\begin{aligned}
(1-U)L &= M \int_{\phi^*}^{\infty} l(\phi) \frac{k}{\phi} \left(\frac{\phi^*}{\phi} \right)^k d\phi + nM_x \int_{\phi_x^*}^{\infty} l_x(\phi) \frac{k}{\phi} \left(\frac{\phi_x^*}{\phi} \right)^k d\phi \\
&= M_t l(\tilde{\phi}_t) \tilde{\phi}_t^{\theta-\xi} k \left(\frac{(\phi^*)^k}{1+n\chi} \int_{\phi^*}^{\infty} \phi^{\xi-\theta-k-1} d\phi + \frac{\tau^{1-\sigma} n\chi (\phi_x^*)^k}{1+n\chi} \int_{\phi_x^*}^{\infty} \phi^{\xi-\theta-k-1} d\phi \right) \\
&= M_t l(\tilde{\phi}_t) \tilde{\phi}_t^{\theta-\xi} \frac{k}{k-\xi+\theta} \left(\frac{(\phi^*)^{\xi-\theta} + \tau^{1-\sigma} n\chi(\phi_x^*)^{\xi-\theta}}{1+n\chi} \right) \\
&= M_t l(\tilde{\phi}_t) \left(\frac{\tilde{\phi}_t}{\tilde{\phi}} \right)^{\theta-\xi} \left(\frac{\tilde{\phi}}{\phi^*} \right)^{\theta-\xi} \frac{k}{k-\xi+\theta} \left(\frac{1 + \tau^{1-\sigma} n\chi \left(\frac{\phi^*}{\phi_x^*} \right)^{\theta-\xi}}{1+n\chi} \right) \\
&= M_t l(\tilde{\phi}_t) \left(\frac{k}{k-\xi} \right)^{\frac{\theta-\xi}{\xi}} \frac{k}{k-\xi+\theta} \left(\frac{\tilde{\phi}_t}{\tilde{\phi}} \right)^{\theta-\xi} \left(\frac{1 + \tau^{1-\sigma} n\chi \left(\frac{\phi^*}{\phi_x^*} \right)^{\theta-\xi}}{1+n\chi} \right) \\
&= M_t l(\tilde{\phi}_t) \left(\frac{k}{k-\xi} \right)^{\frac{\theta}{\xi}} \frac{k-\xi}{k-\xi+\theta} \left(\frac{\tilde{\phi}_t}{\tilde{\phi}} \right)^{\theta-\xi} \left(\frac{1 + \tau^{1-\sigma} n\chi \left(\frac{\phi^*}{\phi_x^*} \right)^{\theta-\xi}}{1+n\chi} \right) \\
&= \frac{Y}{\tilde{\phi}} \left(\frac{k}{k-\xi} \right)^{\frac{\theta}{\xi}} \frac{k-\xi}{k-\xi+\theta} \left(\frac{\tilde{\phi}_t}{\tilde{\phi}} \right)^{\theta-\xi} \left(\frac{1 + \tau^{1-\sigma} n\chi \left(\frac{\phi^*}{\phi_x^*} \right)^{\theta-\xi}}{1+n\chi} \right)
\end{aligned}
$$

Dividing both sides by L and using $\tilde{\phi}_t = \tilde{\phi}$ as well as $\phi_x^*/\phi^* = \tau^{1/(1-\theta)}$ (due to $f = f_x$) gives eq. (36).

Derivation of eq. (32′)

From (6), (8) and (15), we know that $\pi(\phi^*) = 0$ is equivalent to $\bar{\pi} = \pi(\tilde{\phi}) = \xi f/(k-\xi)$ (see (17)). In analogy, we can use eqs. (6), (8) and (15) together with (27) to find that $\pi(\phi_x^*) = 0$ is equivalent to $\bar{\pi}_x = \pi(\tilde{\phi}_x) = \xi f_x/(k-\xi)$. Then, average profits in the open

economy are given by

$$\bar{\pi}_t = \bar{\pi} + n\chi\bar{\pi}_x = \bar{\pi}\left(1 + n\chi\frac{f_x}{f}\right),$$

which can be reformulated to the expression in $(32')$.

Derivation od eq. $(37')$

From the derivation of eqs. (21) and (36) it follows that the employment rate after trade liberalisation is given by

$$1 - U = (1 - U_a)\frac{Y\tilde{\phi}_a}{Y_a\tilde{\phi}_t}\Gamma,$$

where subscript a refers to an autarky variable, Y denotes output in the trade regime and

$$\Gamma \equiv \left(\frac{\tilde{\phi}_t}{\tilde{\phi}}\right)^{\theta-\xi}\left(\frac{1 + \tau^{1-\sigma}n\chi\left(\frac{\phi^*}{\phi_x^*}\right)^{\theta-\xi}}{1 + n\chi}\right).$$

Noting that $Y/Y_a = \tilde{\phi}_t/\tilde{\phi}_a$, according to (19), the employment rate under openness can be reformulated in the following way: $1 - U = (1 - U_a)\Gamma$. If $\tau^{\sigma-1}f_x \leq f$, all firms export and $\phi^* = \phi_x^*$. In this case, we have $\Gamma = \tilde{\phi}_t/\tilde{\phi}_a$, which, according to $(34')$, is equivalent to the first line of $(32')$. However, if $\tau^{\sigma-1}f_x > f$, there is partitioning of firms by their export status and $\phi^*/\phi_x^* = \chi^{1/k}$, $\tilde{\phi}_t/\tilde{\phi} = [(1 + n\chi f_x/f)/(1 + n\chi)]^{1/\xi}$. In this case, we have

$$\Gamma = \left(\frac{1 + n\chi\frac{f_x}{f}}{1 + n\chi}\right)^{\frac{\theta}{\xi}}\frac{1 + n\tau^{1-\sigma}\chi^{\frac{k-\xi+\theta}{k}}}{1 + n\chi\frac{f_x}{f}}.$$

This can be reformulated to the second line of $((32'))$, when noting that $\chi = (\phi^*/\phi_x^*)^{1/k} = (\tau^{\sigma-1}f_x/f)^{-k/\xi}$ and thus $f_x/f = \chi^{-\xi/k}\tau^{1-\sigma}$.

Derivation details: external scale effects

The next two subsections provide derivation details for the results in subsection 4.2.

The Closed Economy

Let the production technology in the final goods sector be given by $(1')$. Differentiating $(1')$ with respect to $q(v)$ and setting the resulting expression equal to $p(v)$ gives demand for a single input variety:

$$q(v) = (Y/M^\eta)p(v)^{-\sigma}, \qquad \sigma = 1/(1-\rho), \tag{3'}$$

using $P = 1$. If the CES-index in (1) is replaced by $(1')$ the price index in $(2')$ has to be reformulated in the following way:

$$P = \left[M^{1-\eta} \int_0^\infty p(\phi)^{1-\sigma} \mu(\phi)d\phi \right]^{\frac{1}{1-\sigma}}, \tag{2''}$$

Using $P = 1$ together with $p(\phi) = p(\tilde{\phi})(\phi/\tilde{\phi})^{\theta-1}$, we obtain

$$1 = M^{1-\eta} p(\tilde{\phi})^{1-\sigma} \int_0^\infty \left(\frac{\phi}{\tilde{\phi}} \right)^\xi \mu(\phi)d\phi, \qquad \xi = (\sigma-1)(1-\theta).$$

Substituting for $\tilde{\phi}$, it follows immediately that $1 = M^{1-\eta}p(\tilde{\phi})^{1-\sigma}$ and thus $p(\tilde{\phi}) = M^{\frac{1-\eta}{\sigma-1}}$.

In a next step we determine per capita output and the mass of input producers in the autarky equilibrium. Using $p(\tilde{\phi}) = M^{\frac{1-\eta}{\sigma-1}}$ and the price-markup condition, we get $w(\tilde{\phi}) = \rho\tilde{\phi}M^{\frac{1-\eta}{\sigma-1}}$. Together with the fair wage constraint in $(5')$, we then obtain $\rho\tilde{\phi}M^{\frac{1-\eta}{\sigma-1}} = \tilde{\phi}^\theta[\rho Y/L]^{1-\theta}$, which can be reformulated to give $(19')$. Noting further $Mr(\tilde{\phi}) = Y$ and $r(\tilde{\phi}) = \sigma(\pi(\tilde{\phi}) + f)$, it follows from $(19')$ that the equilibrium mass of competitors is given by $(20')$.

With the mass of producers and per capita output at hand, we can now determine the unemployment rate. For this purpose, we use

$$(1-U)L = Ml(\tilde{\phi}) \left(\frac{k}{k-\xi} \right)^{\theta/\xi} \frac{k-\xi}{k-\xi+\theta},$$

from the derivation of equation (21). Noting that $Ml(\tilde{\phi}) = Mq(\tilde{\phi})/\tilde{\phi}$ and $M^{\frac{\sigma-\eta}{\sigma-1}}q(\tilde{\phi}) = Y$ together imply $Ml(\tilde{\phi}) = M^{-\frac{1-\eta}{\sigma-1}}Y/\tilde{\phi}$, we can rewrite the latter expression to obtain

$$1 - U = \frac{Y}{L\tilde{\phi}} M^{-\frac{1-\eta}{\sigma-1}} \left(\frac{k}{k-\xi} \right)^{\theta/\xi} \frac{k-\xi}{k-\xi+\theta}.$$

Substituting $(19')$, yields $(22')$. Finally, rewriting fair wage condition (5), we obtain

$$w(\tilde{\phi})/\bar{w} = (1 - U)\left(w(\tilde{\phi})\tilde{\phi}^{-1}\right)^{-\theta/(1-\theta)}$$

Substitution of $w(\tilde{\phi}) = p(\tilde{\phi})\rho\tilde{\phi} = M^{\frac{1-\eta}{\sigma-1}}\rho\tilde{\phi}$ yields

$$w(\tilde{\phi})/\bar{w} = (1 - U)\left(\rho p(\tilde{\phi})\right)^{-\theta/(1-\theta)},$$

which, by virtue of $(22')$, is identical to (24). Together with $w(\tilde{\phi})/w(\phi^*) = [k/(k-\xi)]^{\theta/\xi}$, this implies that wage inequality (25) remains unaffected by changes in the market size parameter, even if $\eta \neq 1$. This completes our discussion of the autarky scenario.

The Open Economy

Assuming $f_x = f$, we have $\tilde{\phi}_t = \tilde{\phi}$ (see section 3). In analogy to the autarky case, we can now derive per capita output as a function of the mass of competitors M_t and the average productivity level $\tilde{\phi}_t$. The respective expression is given by[23] $Y/L = \tilde{\phi}_t\rho^{\theta/(1-\theta)}M_t^{(1-\eta)/\xi}$. Together with $Y = M_t r(\tilde{\phi}_t)$, we thus obtain

$$M_t = \left[\frac{\tilde{\phi}_t\rho^{\theta/(1-\theta)}L}{\sigma(\pi(\tilde{\phi}_t) + f)}\right]^{\frac{\xi}{\xi-(1-\eta)}}. \tag{20''}$$

Hence, the mass of available varieties increases $(M_t > M_a)$ after trade liberalisation, as there is an increase in the average productivity level $\tilde{\phi}_t > \tilde{\phi}_a$ and $\xi > 1 - \eta$ has been assumed.[24] This induces an increase in per capita output, according to $(19')$, so that gains from trade are also realised if $\eta \neq 1$.

In a next step, we can use

$$(1 - U)L = M_t l(\tilde{\phi}_t)\left(\frac{k}{k-\xi}\right)^{\theta/\xi}\frac{k-\xi}{k-\xi+\theta}\Gamma$$

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[23]For a derivation, substitute $p(\tilde{\phi}_t) = M_t^{\frac{1-\eta}{\sigma-1}}$ into $w(\tilde{\phi}_t) = \rho\tilde{\phi}_t p(\tilde{\phi}_t)$. Then, using the resulting expression in fair wage constraint $(5')$, gives Y/L.

[24]Note that the profit the average firm makes in its domestic market remains unaffected by trade liberalisation: $\pi(\tilde{\phi}_t) = \pi(\tilde{\phi}_a)$.

from the derivation of equation (36) to determine the unemployment effects of trade liberalisation. (Note that Γ is defined in (37).) Due to $M_t l(\tilde{\phi}_t) = M_t^{-\frac{1-\eta}{\sigma-1}} Y/\tilde{\phi}_t$, we can rewrite the employment rate in the following way:

$$(1 - U) = \frac{Y}{L\tilde{\phi}_t} M_t^{-\frac{1-\eta}{\sigma-1}} \left(\frac{k}{k-\xi}\right)^{\theta/\xi} \frac{k-\xi}{k-\xi+\theta}\Gamma.$$

Substituting for Y/L, we end up with

$$1 - U = \rho^{\theta/(1-\theta)} \left(\frac{k}{k-\xi}\right)^{\theta/\xi} \frac{k-\xi}{k-\xi+\theta} M_t^{\theta(1-\eta)/\xi}\Gamma,$$

which can easily be transformed into $(38')$. Finally, with respect to our wage inequality measure, we find that market size does not matter and that (39) remains unaffected by changes in η.