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Theory and Methods



by

Hartmut Egger and Udo Kreickemeier

The Authors

Hartmut Egger is a Professor of Economics at the University of Bayreuth and an External Research Fellow of GEP; Udo Kreickemeier is an Associate Professor in the School of Economics, University of Nottingham, and an Internal Research Fellow of GEP.

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Redistributing Gains from Globalisation

by

Hartmut Egger and Udo Kreickemeier

Abstract

This paper analyses the effects of redistribution in a model of international trade with heterogeneous firms in which a fair-wage effort mechanism leads to firm-specific wage payments and involuntary unemployment. The redistribution scheme is financed by profit taxes and gives the same absolute lump-sum transfer to all workers. In this setting a higher tax rate reduces aggregate labour income and makes the income distribution more equal, with unemployment remaining unaffected. International trade increases aggregate income, income inequality and the unemployment rate, *ceteris paribus*. If, however, trade is accompanied by a suitably chosen increase in the profit tax rate, it is possible to achieve higher aggregate income and a more equal income distribution than in autarky, provided that the share of exporters is sufficiently high.

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Non-Technical Summary

This paper investigates the effects of a profit-tax based redistribution scheme in a trade model with heterogeneous firms and imperfect labour markets. There is involuntary unemployment and wages are firm specific, with more productive firms paying higher wages due to a fair wage effort mechanism, as in Egger and Kreickemeier (2006). The redistribution scheme is financed by profit taxes and gives the same absolute lump-sum transfer to all workers. The key features of this stylised tax-transfer system seem plausible: It renders the distribution of disposable labour income indeed more equal according to the Lorenz criterion, and it redistributes income from the group of workers who have a job to those who are unemployed, similar to a wage-tax based unemployment compensation scheme. On the other hand it lowers aggregate labour income. The decrease in aggregate income comes about despite the fact that the pure profit tax distorts neither the incentives nor the competitive position of firms that are already in the market. The tax does, however, make firm entry into the market less attractive, which in a Melitz-type framework implies that firms with lower productivities survive and as a consequence the average productivity of active firms decreases.

In the model there are aggregate gains from international trade, but the personal income distribution becomes more unequal, partly driven by an increase in the number of unemployed, partly by an expansion of high-wage exporting firms. The redistribution scheme considered, while simple, is well-equipped in principle to mitigate the detrimental distribution effects of international trade: by increasing the profit tax one could increase the transfer payments, thereby making the secondary income distribution more equal, *ceteris paribus*. Since any increase in the profit tax entails a welfare cost, the crucial issue is whether trade-cum-redistribution reforms can be found within our system that make the income distribution more equal without destroying the gains from trade completely. We show that these reforms can be found if the share of exporters is sufficiently high, while it may be impossible to reconcile gains from trade with a more equal income distribution if this share is small.

1 Introduction

The recent theoretical literature on trade with heterogeneous firms and labour market imperfections has highlighted a source of worker specific effects of globalisation that was previously ignored: Imperfect labour markets create not only involuntary unemployment, but also firm-specific wage rates, and hence the effect that globalisation has on two ex ante identical workers can be very different depending on whether they are employed by a successful or an unsuccessful firm. This literature points to a new facet concerning the distributional effects of globalisation: an increase in *intra-group* income inequality, as measured by the dispersion of wages between workers who do not differ in their individual characteristics. There is no doubt that in many countries intra-group inequality is an important part of overall inequality, and that it has increased substantially during the recent wave of globalisation (Barth and Lucifora, 2006; Autor, Katz and Kearney, 2008).

The worker-specific effects of globalisation feature prominently in the model of Egger and Kreickemeier (2006), which combines the Melitz (2003) framework with a fair-wage effort model of the Akerlof and Yellen (1990) type. In this setting workers exert full effort only if the wage payment is at least as high as the wage they consider to be fair. With the fair wage of workers being linked to the economic success of the firm they are working in, the implications of this model are well in line with the empirical evidence that larger, more productive firms pay higher wages (see Abowd, Kramarz and Margolis, 1999; Winter-Ebmer and Zweimüller, 1999; Faggio, Salvanes and Van Reenen, 2007). Furthermore, since these are the firms that export in the open economy, the model also offers an explanation for the stylised fact that exporters pay higher wages than non-exporters (see e.g. Bernard and Jensen, 1999; Schank, Schnabel and Wagner, 2007).

In the present paper, we extend the model of Egger and Kreickemeier (2006) by introducing a government sector that redistributes income in the economy towards low income workers. Analysing a framework that incorporates a redistributive government is interesting, since it has been widely argued that increasing inequality is a major cause for the protectionist drift in public policy, and that compensating the losers of globalisation is vital for sustaining current levels of international integration (cf. Scheve and Slaughter,

2007). Our redistribution scheme is very simple: The government taxes profits and uses the proceeds to pay the same *absolute* per capita transfer to all individuals. The key features of this stylised tax-transfer system seem plausible: It renders the distribution of disposable labour income indeed more equal according to the Lorenz criterion, and redistributes income from the group of workers who have a job to those who are unemployed, similar to a wage-tax based unemployment compensation scheme. On the other hand it lowers aggregate labour income. The decrease in aggregate income comes about despite the fact that the pure profit tax distorts neither the incentives nor the competitive position of firms that are already in the market. The tax does, however, make firm entry into the market less attractive, which in a Melitz-type framework implies that firms with lower productivities survive and as a consequence the average productivity of active firms decreases.

Analysing the effect of international trade in our model, we look at two scenarios. First, we consider a situation where the profit tax rate is held constant, and find that there are gains from trade for the economy as a whole, but unemployment increases and the distribution of disposable income becomes more unequal. Notably though, the only individuals who are worse off in *absolute* terms are those workers who lose their job. Second, we explore the possibility of an increase in the tax rate when the economy starts to trade. The idea is to find out whether a tax reform exists that makes the income distribution more equal in the open economy than it was under autarky, without eliminating the gains from trade completely. It is shown that for a sufficiently high share of exporting firms it is indeed possible to make distribution more equal *and* increase aggregate income. This however is not always the case with a low proportion of exporters.

There are other papers besides Egger and Kreickemeier (2006) that feature worker-specific effects of globalisation. While all of the existing studies consider productivity differences as the main source for firm heterogeneity, and most of them build on the Melitz (2003) framework (with Davidson, Matusz and Shevchenko, 2008, being a notable exception), two strands of this literature can be distinguished with respect to the modelling of the labour market imperfection. Helpman and Itskhoki (2007), Helpman, Itskhoki

and Redding (2008), and Felbermayr, Prat and Schmerer (2008) consider a search and matching model with wage bargaining at the individual or the collective level. On the other hand, there are several papers that consider efficiency wages as the main source of labour market imperfection. Egger and Kreickemeier (2008) and Amiti and Davis (2008) use a fair-wage effort approach to efficiency wages, whereas Davis and Harrigan (2007) conduct their analysis in a Shapiro and Stiglitz (1984) framework with a shirking motive of workers. While all of these studies investigate the impact of globalisation on aggregate employment, and a subset of them features firm-specific wage rates, neither study looks at the role of redistribution which is the focus of our analysis.¹

The remainder of the paper is organised as follows. Section 2 introduces the basic model assumptions, characterises the autarky equilibrium and provides insights into the role of redistribution for aggregate income, employment and the income distribution. Section 3 shows how trade between two symmetric countries affects the main variables of interest when the profit tax rate is held constant. In section 4, we shed light on the scope for policy reforms in the open economy that lower income inequality as compared to autarky, without eliminating the gains from trade completely. In section 5, we drop our assumption of complete symmetry between the countries and analyse how country specific tax rates would affect our results. Section 6 summarises the most important results.

2 The Closed Economy

We start in section 2.1 by describing key elements of the heterogeneous firm model with firm-specific wage rates developed in Egger and Kreickemeier (2006). The analysis of firm entry is added in section 2.2, where we also extend the basic model by introducing a simple

¹There is also, of course, a large literature that looks at the issue of compensating the losers from trade in a neoclassical framework. Only few contributions to this literature consider labour market imperfections. The model of Brecher and Choudhri (1994) features involuntary unemployment due to a binding minimum wage. In a more recent contribution, Davidson and Matusz (2006) look at optimal compensation schemes for workers that are displaced by trade shocks in a dynamic model with search frictions in the labour market. The existing literature does not, however, address the issues central to our analysis: the role of firm heterogeneity and intra-group wage inequality.

tax-transfer system that aims at redistributing income towards workers with lower income, and analyse the effect that this system has on aggregate variables. Section 2.3 looks at the effect that the tax-transfer system has on the distribution of labour income.

2.1 A Model of Firm-Specific Wages in General Equilibrium

We consider an economy with a single factor of production, labour L , that is used in the production of differentiated intermediate goods which are sold under monopolistic competition. There is a second sector, which produces homogeneous final output Y under perfect competition, using the differentiated intermediates as the only inputs. The production function for final output is given by

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

with the measure of set V representing the mass of available intermediate goods M .² We take final output as the numeraire, and hence the CES price index P corresponding to the production function in eq. (1) is normalised to one. Profit maximisation of final goods producers results in an isoelastic demand function for each variety of the intermediate good:

$$q(v) = \frac{Y}{M} p(v)^{-\sigma}, \quad (2)$$

where $\sigma \equiv 1/(1 - \rho)$ equals the constant elasticity of substitution between the different varieties.

Intermediate goods producers maximise their profits by charging prices as a constant markup $1/\rho$ over their respective marginal cost, $w_i/(\phi_i \varepsilon_i)$, where ϕ_i denotes the productivity level of firm i , w_i is the wage paid by firm i and ε_i is the effort exerted by workers

²In 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. Using technology (1) instead of the Ethier (1982) technology with external scale economies is attractive for two reasons. First, we avoid a (counterfactual) negative relationship between country size and the unemployment rate. And second, we exclude those trade effects that are purely due to an increase in market size, which are already well understood.

employed in firm i . Wage and effort at the firm level are linked by a fair-wage effort mechanism along the lines of Akerlof and Yellen (1990): $\varepsilon_i = \min[w_i/\hat{w}_i, 1]$, where \hat{w}_i is the wage considered to be fair by workers in firm i .³ It is easily checked that a firm cannot reduce its marginal cost by paying less than the fair wage, as the effort in this case falls proportionally. Hence we can safely assume, following Akerlof and Yellen (1990), that firms pay at least the fair wage, and consequently $\varepsilon_i = 1 \forall i$. Furthermore, it is shown below that firms can hire the profit maximising number of workers if they set $w_i = \hat{w}_i$, so this is what they do in equilibrium.

The wage considered to be fair by a worker depends on two factors: first, the economic success of the firm in which the worker is employed and, second, the income opportunities outside the present job, represented by per capita *wage* income. As in Egger and Kreicemeier (2006), we use the productivity level of a firm as a measure for its economic success and assume

$$\hat{w}(\phi) = \phi^\theta [(1 - U)\bar{w}]^{1-\theta}, \quad (3)$$

where \bar{w} is the average wage rate of those who have a job and $(1 - U)$ is the employment rate. Due to markup pricing, aggregate wage income is a fraction ρ of aggregate revenues R . The wage at the firm level is therefore determined by

$$w(\phi) = \phi^\theta [\rho R/L]^{1-\theta}, \quad (4)$$

and the relative wage paid by two different firms is only a function of their relative productivities: $w_i/w_j = (\phi_i/\phi_j)^\theta$.⁴ Similar ratios can be derived for relative prices, outputs, revenues (denoted by r), and employment levels (denoted by l), where we find

³Howitt (2002) and Bewley (2005) provide a discussion of the empirical evidence that supports the importance of fairness considerations for real world wage payments.

⁴Our model is thus consistent with the empirical observation that more productive firms pay higher wages. Workers would clearly prefer to work for a more productive firm. However, in a situation where effort is – as assumed – non-contractible, firms have no incentive to accept underbidding of their current wage by outside workers. The reason is that immediately after being hired workers would adjust their reference wage according to eq. (3) and thus reduce their effort if the wage falls short of $\hat{w}(\phi)$. Fehr and Falk (1999) confirm in laboratory experiments that the lack of a binding contract on effort plays a crucial role in rendering underbidding by outside workers unsuccessful.

$p_i/p_j = (\phi_i/\phi_j)^{\theta-1}$, $q_i/q_j = (\phi_i/\phi_j)^{\sigma(1-\theta)}$, $r_i/r_j = (\phi_i/\phi_j)^\xi$, and $l_i/l_j = (\phi_i/\phi_j)^{\xi-\theta}$ with $\xi \equiv (\sigma - 1)(1 - \theta)$. These expressions collapse to the respective expressions in the model of Melitz (2003) if we set $\theta = 0$.

Each intermediate goods producer has to operate its own distribution system and thus has to bear a fixed beachhead cost f , in units of final output. With these fixed costs being identical for all producers and firms differing in their productivity levels, we can formulate a zero profit condition $\pi(\phi^*) = r(\phi^*)/\sigma - f = 0$, which separates those firms that produce, i.e. the firms with productivities $\phi \geq \phi^*$, from those firms that remain inactive, i.e. the firms with productivities $\phi < \phi^*$. The explicit determination of cutoff productivity level ϕ^* is deferred to section 2.2, where we discuss firm entry.

As in the Melitz model, it is possible – and very useful – to define an “average” firm with productivity $\tilde{\phi}$. Average productivity $\tilde{\phi}$ is implicitly determined by $q(\tilde{\phi}) = Y/M$, implying that the output of the average firm equals the output per firm in the economy. Substitution in the demand function shows that this definition implies $p(\tilde{\phi}) = 1$, and hence aggregate revenues and aggregate profits are equal to $R = Y = Mr(\tilde{\phi})$ and $\Pi = M\pi(\tilde{\phi})$, respectively. Following the steps in Melitz (2003) we can now write the average productivity as

$$\tilde{\phi} \equiv \left[\frac{1}{1 - G(\phi^*)} \int_{\phi^*}^{\infty} \phi^\xi g(\phi) d\phi \right]^{\frac{1}{\xi}}, \quad (5)$$

where $G(\phi)$ denotes the productivity distribution, and $g(\phi)$ the respective density function.

In order to get explicit solutions, we follow the by now common approach and choose the Pareto distribution – with the lower bound of productivities normalised to one – to parametrise $G(\phi)$: $G(\phi) = 1 - \phi^{-k}$ and $g(\phi) = k\phi^{-(k+1)}$.⁵ In this case, average productivity $\tilde{\phi}$ is proportional to cutoff productivity ϕ^* :

$$\tilde{\phi} = \left(\frac{k}{k - \xi} \right)^{\frac{1}{\xi}} \phi^* \quad (6)$$

Accounting for $\pi(\phi^*) = 0$, it is then immediate that

$$\pi(\tilde{\phi}) = \frac{\xi f}{k - \xi}, \quad (7)$$

⁵The assumption of Pareto-distributed productivities can also be justified from an empirical point of view (cf. Del Gatto, Mion and Ottaviano, 2006). In Egger and Kreickemeier (2006) we discuss implications of a more general productivity distribution.

and hence the profit of the average firm, which is equal to average profits in the economy $\bar{\pi} \equiv \Pi/M$, is independent of $\tilde{\phi}$. That is, independent of the actual productivity of the average firm its profits are fixed by model parameters.

With the average firm being characterised by productivity level $\tilde{\phi}$, we can now also look at the aggregate labour market outcomes. Total wage income can be determined by combining eq. (4) for the average firm with the markup pricing condition $w(\tilde{\phi}) = \tilde{\phi}\rho$. Accounting for eq. (6), this gives

$$\rho \frac{R}{L} = \Delta \phi^* \quad (8)$$

with $\Delta \equiv \rho^{\frac{1}{1-\theta}} [k/(k-\xi)]^{\frac{1}{\xi}}$. Aggregate employment $(1-U)L$ is determined by the adding-up condition

$$(1-U)L = \frac{M}{1-G(\phi^*)} \int_{\phi^*}^{\infty} l(\phi)g(\phi)d\phi,$$

which in analogy to Egger and Kreickemeier (2006) can be reformulated to obtain an explicit solution for the employment rate:

$$1-U = \Delta^{\theta} \frac{k-\xi}{k-\xi+\theta}. \quad (9)$$

We assume $\Delta < 1$, which is sufficient to ensure that unemployment is strictly positive for all $\theta > 0$.⁶ An important feature of the model is jointly illustrated by eqs. (8) and (9): Aggregate output and hence income are an increasing function of the cutoff productivity ϕ^* . As this functional relationship is proportional, aggregate employment in the closed economy is independent of ϕ^* : Any increase in the cutoff productivity – and thus, according to eq. (6), any increase in $\tilde{\phi}$ – translates one-for-one into an increase in total output, leaving no room for aggregate employment effects.

2.2 A Simple Model of Redistribution

We now enrich our basic model structure in section 2.1 and introduce a simple tax-transfer system that aims at reducing labour income inequality, which arises due to firm-specific

⁶This condition is also sufficient for $w(\phi^*) > \rho R/L$, which implies that even those who are employed in the least productive firm have a higher labour income than the one expected outside their current job.

wage payments and the existence of involuntary unemployment. The redistribution system is financed by a tax on profits $\pi(\phi)$, which is imposed by the government at a rate of $s \in (0, 1)$, and tax revenues are redistributed to workers in a lump sum fashion, with identical transfer payments to all individuals. This redistribution scheme has two notable features: First, the profit tax does not influence the pricing behaviour of firms, so that $\pi(\tilde{\phi})$ remains unaffected by adjustments in tax rate s . Second, due to the lump-sum nature of the transfer, the fair wage constraint (4) is unaffected by changes in the redistribution scheme as well.⁷

Taking into account the government budget constraint, the transfer income for each worker equals $sM\bar{\pi}/L$. Hence, secondary, i.e. *post-transfer*, labour income, which is the sum of primary (*pre-transfer*) wage income and transfer payments, is given by $I/L = (\rho R + sM\bar{\pi})/L$. It is clear from our analysis above that there is a link between aggregate gross profits $M\bar{\pi}$ and aggregate revenues R . In particular, we have $M\bar{\pi} = R\rho(1 - \theta)/k$.⁸ Using eq. (8), secondary labour income can then be written as

$$\frac{I}{L} = \Delta\phi^* \left[1 + \frac{s(1 - \theta)}{k} \right]. \quad (10)$$

From eq. (10), it is immediate that for a given cutoff productivity ϕ^* , per capita labour income unambiguously increases in the profit tax parameter s .

The analysis is obviously incomplete, however, without endogenising ϕ^* . To this end, we follow Melitz (2003) and assume that there is an unbounded pool of potential entrants into the intermediates sector. Each firm that decides to enter has to pay a fixed cost f_e (thereafter sunk), measured in units of the final good. After this investment, firms can participate in a lottery and draw their productivity from the Pareto distribution $G(\phi)$. There is an infinite number of time periods. In each of these periods, firms with

⁷The redistribution scheme considered here ignores labour income taxation as a separate source of government revenues. However, this simplification is not crucial. As long as the fair wage constraint in eq. (4) is independent of the tax rate, the results of our analysis would be the same if we considered an extended model variant with a general income tax.

⁸Note that $M\bar{\pi} = M(r(\tilde{\phi})/\sigma - f)$, which, by virtue of $r(\tilde{\phi})/r(\phi^*) = (\tilde{\phi}/\phi^*)^\xi$, $r(\phi^*) = \sigma f$ and $R = Mr(\tilde{\phi})$, can be reformulated to $M\bar{\pi} = R\xi/(\sigma k)$. Using $\xi \equiv (\sigma - 1)(1 - \theta)$ and $\rho \equiv (\sigma - 1)/\sigma$, we obtain the equation in the text.

productivity $\phi \geq \phi^*$ start production because they make non-negative gross profits $\pi(\phi) \geq 0$. Firms face a probability of death δ in each period, and hence – assuming that there is no discounting and focusing on a steady state equilibrium – the present value of gross profits for a firm with $\phi \geq \phi^*$ is $\pi(\phi)/\delta$. With profit taxation, the *free entry condition* for the intermediates sector requires that in equilibrium the sunk costs f_e of entering the productivity draw must equal the present value of average *net* profits of active firms $(1-s)\bar{\pi}/\delta$, multiplied by the probability of a successful draw, $1-G(\phi^*)$. Formally, using our assumption of Pareto distributed productivities, we get

$$\bar{\pi} = \frac{\delta f_e}{1-s} (\phi^*)^k. \quad (11)$$

Together, the zero cutoff profit condition in eq. (7) and the free entry condition in eq. (11) determine the cutoff productivity level:

$$\phi^* = [(1-s)\beta]^{\frac{1}{k}}, \quad (12)$$

with $\beta \equiv f\xi/[(k-\xi)\delta f_e]$. In order to allow for the existence of an equilibrium with positive profit tax rates, we need $\beta > 1$, which is the case if f is sufficiently high and/or δ , f_e are sufficiently small. It is easily checked in eq. (12) that tax rates $s \geq (\beta-1)/\beta$ would lead to $\phi^* \leq 1$, and they are therefore excluded from consideration.

Eq. (12) shows that an increase in the profit tax rate lowers the cutoff productivity ϕ^* . A higher profit tax rate reduces expected net profits, and hence the probability of getting a successful productivity draw has to increase – the cutoff probability has to fall – in order to keep firms outside the market indifferent between entering and not entering. The fall in the cutoff productivity level reduces primary labour income $\rho R/L = \Delta\phi^*$ proportionally. The same holds true for the mass of intermediate input producers $M = R/r(\tilde{\phi})$ since, as shown above, $r(\tilde{\phi})$ is a constant.

Putting together, there are two counteracting effects of a higher profit tax rate on secondary labour income. On the one hand, I/L increases for a given primary income level, while, on the other hand, primary labour income declines. To determine which of these two effects dominates, we can first look at the impact of an increase in s on the level

of per capita transfer payments, which can be written as

$$\eta(s) \equiv \frac{sM\bar{\pi}}{L} = \left(\frac{\beta^{\frac{1}{k}}\Delta(1-\theta)}{k} \right) s(1-s)^{\frac{1}{k}}. \quad (13)$$

The per capita transfer payment $\eta(s)$ reaches a unique maximum at $\hat{s} = k/(k+1)$. Since tax rates $s > \hat{s}$ would reduce both primary labour income as well as transfer payments, only (Laffer-efficient) tax rates $s < \hat{s}$ need to be considered in the subsequent analysis.⁹

Substituting eq. (12) into eq. (10), we can rewrite aggregate labour income as

$$\frac{I}{L} = \beta^{\frac{1}{k}}\Delta A(s), \quad (14)$$

with

$$A(s) \equiv (1-s)^{\frac{1}{k}} \left[1 + \frac{s(1-\theta)}{k} \right]. \quad (15)$$

It is easily checked that $A(0) = 1$ and $A'(s) < 0$. Hence, with a positive profit tax aggregate income unambiguously falls below its benchmark level in the situation without redistribution, which is $\beta^{1/k}\Delta$. This captures the efficiency loss from profit taxation.

Finally, it is straightforward to see that the tax-transfer system considered does not affect the employment rate: We have shown that the profit tax affects firm entry, thereby lowering cutoff productivity, average productivity and aggregate output proportionally. As argued in section 2.1, this proportionality prevents employment effects of changes in ϕ^* . Aggregate employment continues to be determined by eq. (9). The main insights from this section are summarised as follows:

Proposition 1. *A profit-tax based redistribution system with lump-sum transfers that are the same in absolute terms for all individuals, lowers primary as well as secondary labour income and leaves the employment rate unaffected.*

2.3 Distributional Effects

Having determined the effect of the tax-transfer system on aggregate variables, we now turn to the analysis of its impact on the income distribution. It is convenient to proceed in

⁹Notably $s = \hat{s}$ induces $\phi^* < 1$ if $\beta > k + 1$. In this case, the transfer payment is strictly increasing in s over the admissible s -interval $(0, (\beta - 1)/\beta)$.

two steps: First we analyse the effect of the tax-transfer system on the wage distribution across active firms (the *wage profile*). We then look at the effect the system has on the employment allocation across firms. Put together, the two pieces of information allow us to infer the effect on the wage – and eventually income – distribution across *individuals*.

The analysis simplifies drastically if we look at the wage profile not in terms of firms' productivities ϕ but in terms of their *inverse marginal costs* κ , where $\kappa \equiv \phi/w(\phi)$. The simplification results from the fact that κ^* , the inverse marginal cost of the marginal firm is unaffected by s , since from eqs. (4) and (8) we have $\kappa^* = \Delta^{\theta-1}$. Using eqs. (8), (12) and the definition of κ , we can rewrite the wage equation (4) to obtain

$$w(\kappa) = \Delta[(1-s)\beta]^{\frac{1}{k}} \kappa^{\frac{\theta}{1-\theta}}. \quad (16)$$

With κ^* constant, it follows from (16) that $w(\kappa^*)$, the wage paid by the marginal firm, falls as s increases. Noting furthermore $w_i/w_j = (\kappa_i/\kappa_j)^{\theta/(1-\theta)}$, we see that the *relative wage* of any two firms identified by their respective inverse marginal cost (κ -firms for short) is constant.¹⁰

The total income of a worker employed in a firm with inverse marginal cost κ is given by

$$w(\kappa) + \eta(s) = \Delta\beta^{\frac{1}{k}} B(s, \kappa) \quad (17)$$

with

$$B(s, \kappa) \equiv (1-s)^{\frac{1}{k}} \left[\kappa^{\frac{\theta}{1-\theta}} + \frac{s(1-\theta)}{k} \right],$$

and we find $\partial B/\partial s < 0$, $\forall \kappa \geq \kappa^* = \Delta^{\theta-1}$. This shows that an individual employed by a firm with the same marginal cost before and after the increase in s loses in absolute terms from the redistribution scheme. The results are illustrated in figure 1.

In order to link the income distribution across firms just derived to the income distribution across individuals, we need to find the effect that an increase in s has on the labour

¹⁰Note that the identity of κ -firms changes as they are represented by firms with lower productivities after the increase in the profit tax rate.

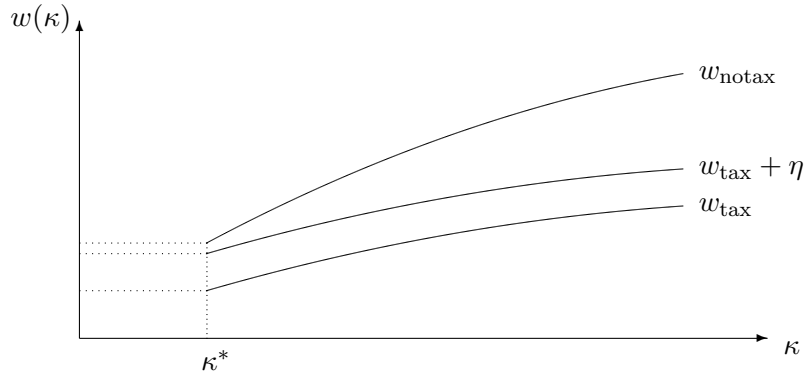


Figure 1: Wage profile across firms

allocation across firms. Using the link between relative productivities and relative employment levels derived above as well as the definition of κ , we find $l_i/l_j = (\kappa_i/\kappa_j)^{(\xi-\theta)/(1-\theta)}$, and hence relative employment levels of any two κ -firms stay constant. Thus, the employment shares across κ -firms is invariant to changes in s , and the results illustrated in figure 1 have a meaningful interpretation for the interpersonal income distribution of employed workers as well: Assuming that the ranking of workers according to their wage stays constant, all employed workers lose in absolute terms from the tax-transfer system. The only winners in absolute terms are the unemployed, as they receive only transfer income. Hence, the redistribution system shifts income from those who are employed to those who are unemployed – similar to a wage-tax based unemployment compensation scheme.

We now finally look at the overall income distribution in the economy, using the standard analytical tool of the Lorenz curve. Due to the labour composition and the wage profile effect, it is immediate that the Lorenz curve for primary labour income is invariant to changes in the tax parameter s and is therefore represented by the same locus $\mathcal{L}_{\text{notransfer}}$ in figure 2, irrespective of whether there is redistribution or not. In the interval $[0, U]$ this curve is flat because primary income of unemployed individuals is zero.¹¹ As the redistri-

¹¹Since the formal derivation of the Lorenz curves is tedious, we defer the derivation details to a supplement, which is available from the authors upon request. There, we also provide a proof for the respective invariance result.

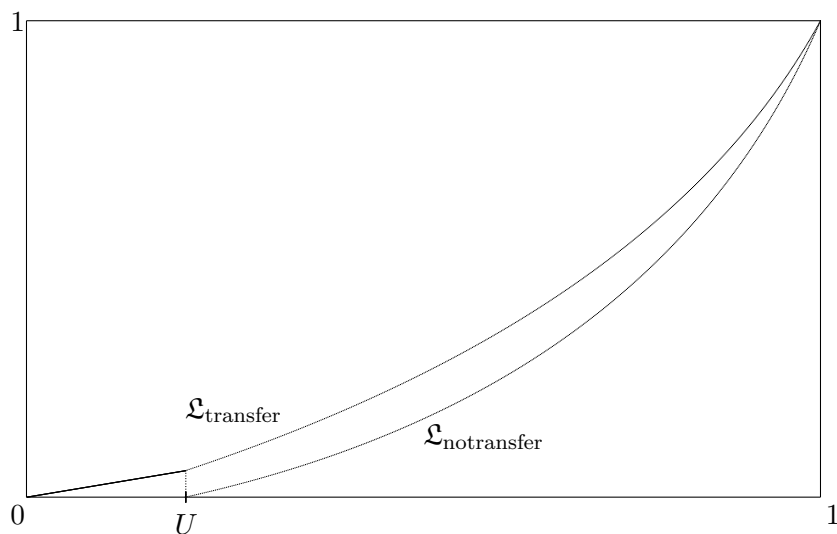


Figure 2: The Lorenz curve for labour income

bution system leaves the primary income distribution unchanged, and the same *absolute* transfer is given to every individual, it must be the case that the secondary income distribution becomes more equal. Hence, in figure 2 the Lorenz curve for secondary labour income, represented by the $\mathfrak{L}_{\text{transfer}}$ -locus, must lie above the respective Lorenz curve for primary labour income. The main insights from this subsection can be summarised as follows:

Proposition 2. *A profit-tax based redistribution system with lump-sum transfers that are the same in absolute terms for all individuals, shifts income from employed workers to those who are unemployed, thereby reducing secondary labour income inequality. The distribution of primary labour income remains unaffected.*

3 The Effects of International Trade

We now consider international trade between two countries that are symmetric in all respects, including their system of redistribution.¹² Section 3.1 introduces the open economy

¹²Asymmetries of countries in their redistribution systems are considered in section 5 below.

framework, section 3.2 analyses the effect of international trade on aggregate income and employment, while section 3.3 looks at the distributional effects of international trade.

3.1 Preliminaries

In the open economy, there is frictionless trade of the final good, while international transactions of intermediates are subject to two types of transport costs. On the one hand, there are fixed *per period* beachhead costs f_x , measured in units of final output, to enter the foreign market and to operate a local distribution system there. For simplicity we focus on the case where domestic fixed costs and export fixed costs are identical, $f = f_x$.¹³ On the other hand, there are iceberg transport costs, implying that $\tau > 1$ units of the intermediates must be shipped in order for one unit to arrive in the foreign economy. Due to these iceberg transport costs, an exporting firm sets higher prices in the foreign economy (denoted by subscript x) than in its home market, resulting in lower demand and lower revenues: $p_x(\phi) = \tau p(\phi)$, $q_x(\phi) = \tau^{-\sigma} q(\phi)$, and $r_x(\phi) = \tau^{1-\sigma} r(\phi)$, where the respective domestic variables are determined as described above. Domestic profits and export profits are given by $\pi(\phi) = r(\phi)/\sigma - f$ and $\pi_x(\phi) = r_x(\phi)/\sigma - f_x$, respectively, and total profits are $\pi_t(\phi) = \pi(\phi) + \max[0, \pi_x(\phi)]$.

It is now easy to see that our transport cost assumptions lead to self-selection of the most productive firms into export status. The domestic cutoff productivity is determined by $r(\phi^*) = \sigma f$, while the export cutoff productivity is determined by $r_x(\phi_x^*) = \sigma f_x$. With $f = f_x$ this implies $r(\phi^*) = r_x(\phi_x^*) = \tau^{1-\sigma} r(\phi_x^*)$, and therefore $r(\phi_x^*)/r(\phi^*) = \tau^{\sigma-1} > 1$. Hence, with $\tau > 1$ the marginal exporting firm makes strictly higher profits in its domestic market than the marginal firm in the market, and it therefore must be a firm with higher productivity. Using the relationships derived above we find specifically $\phi_x^*/\phi^* = \tau^{1/(1-\theta)}$.

The proportion of firms that export χ equals the ex ante probability that a successful productivity draw with $\phi \geq \phi^*$ will exceed the export cutoff ϕ_x^* as well: $\chi = [1 - G(\phi_x^*)]/[1 - G(\phi^*)] = (\phi_x^*/\phi^*)^{-k}$. The proportion of exporters is therefore $\chi = \tau^{-k/(1-\theta)}$, and notably it only depends on the level of iceberg transport costs, but not on the extent of redistribution

¹³The implications of $f \neq f_x$ are discussed in Egger and Kreickemeier (2006).

as measured by the profit tax rate s . Clearly, with $\tau > 1$ we have $\chi \in (0, 1)$ implying that only a subset of the firms actually exports in equilibrium. Only in the borderline case of zero variable transport costs, i.e. $\tau = 1$, even the least productive firms would find it attractive to start exporting, implying $\chi = 1$. The mass of varieties available to domestic consumers is $M_t = M(1 + \chi)$, where M is the mass of domestic firms – and thus the mass of domestically produced varieties.

As in the closed economy, the analysis is greatly simplified by defining the average productivity of all firms in the market – this time including the importing firms. The average productivity $\tilde{\phi}_t$ is implicitly defined by $q(\tilde{\phi}_t) = Y/M_t$: the quantity produced by the average firm for its home market is equal to the average quantity produced by all firms selling in this market. In the case considered here with $f_x = f$, it is readily shown that $\tilde{\phi}_t$ equals $\tilde{\phi}$, the average productivity of domestic firms in the open economy.¹⁴ The analysis of the trade effects on the domestic economy is simplified enormously by this result: From eq. (6) we know that $\tilde{\phi}/\phi^*$ is a constant, and with the additional knowledge of $\tilde{\phi} = \tilde{\phi}_t$ the effect of trade on the average productivity $\tilde{\phi}_t$ can be directly inferred from its effect on the cutoff productivity. Furthermore, applying $r(\phi^*) = \sigma f$ and noting eq. (7), it is immediate that *domestic* revenues and profits of the average firm – with $r(\tilde{\phi}) = r(\tilde{\phi}_t)$ and $\pi(\tilde{\phi}) = \pi(\tilde{\phi}_t)$ due to $\tilde{\phi} = \tilde{\phi}_t$ – remain at their autarky levels.

3.2 Income and Employment

The cutoff productivity in the open economy still has to be compatible with the free entry condition (11), according to which the expected net profits from entering the market have to equal the fixed entry cost f_e . Expected profits of market entry have to be adjusted, however, for overseas profits of exporters. It follows from the definition of $\tilde{\phi}_t$ and the

¹⁴As discussed in Egger and Kreickemeier (2006), this is the result of two effects that influence the relative size of $\tilde{\phi}$ and $\tilde{\phi}_t$ in opposite directions. On the one hand, exporting firms are more productive than non-exporting ones, and this *export selection effect* increases $\tilde{\phi}_t/\tilde{\phi}$, *ceteris paribus*. On the other hand, goods melt away en route due to variable (iceberg) transport costs, and this *lost in transit effect* reduces the measured productivity of exporters in the destination country, thereby reducing $\tilde{\phi}_t/\tilde{\phi}$, *ceteris paribus*. With $f_x = f$ both effects exactly offset each other, so that $\tilde{\phi}_t = \tilde{\phi}$.

assumption that the two trading economies are perfectly symmetric that aggregate pre-tax profits in the economy Π equal $M_t\pi(\tilde{\phi}_t)$. Average pre-tax profits $\bar{\pi}_t$ of domestic firms are therefore equal to $\Pi/M = (1 + \chi)\pi(\tilde{\phi}_t)$, where $\pi(\tilde{\phi}_t)$ is determined in eq. (7). Substitution into free entry condition (11) yields the cutoff productivity for the open economy:

$$\phi^* = [(1 + \chi)(1 - s)\beta]^{\frac{1}{k}} \quad (18)$$

Per capita income I/L is increasing in the cutoff productivity – see eq. (10). With profit taxes remaining constant when a country starts trading, we get

$$\frac{I}{L} = (1 + \chi)^{\frac{1}{k}} \frac{I_a}{L}, \quad (19)$$

where subscript a denotes the respective value of a variable under autarky. Hence, there are gains from trade, and their size is unaffected by the extent to which income is redistributed within the two countries.

Aggregate employment in the open economy obeys the adding up condition

$$(1 - U)L = \frac{M}{1 - G(\phi^*)} \int_{\phi^*}^{\infty} l(\phi)g(\phi)d\phi + \frac{\chi M}{1 - G(\phi_x^*)} \int_{\phi_x}^{\infty} l_x(\phi)g(\phi)d\phi,$$

where $l_x(\phi) = \tau^{1-\sigma}l(\phi)$ is the employment of a firm with productivity ϕ for its export production. We can explicitly solve for the employment rate in direct analogy to eq. (9) to get

$$1 - U = \frac{1 + \chi^{1+\frac{\theta}{k}}}{1 + \chi} (1 - U_a). \quad (20)$$

International trade therefore decreases aggregate employment as long as there is partitioning of firms by their export status, i.e. as long as $\chi < 1$. With $\chi = 1$, employment in the open economy would equal employment under autarky. These results are again independent of the extent of redistribution. Having shown that the employment rate in the closed economy is independent of s , the same must hence be true for the employment rate in the open economy.

The main results from this subsection are summarised in the following proposition.

Proposition 3. *With two symmetric countries and partitioning of firms by their export status, international trade raises aggregate labour income and unemployment.*

3.3 Distribution

In this section we take a closer look at the distributional effects of trade. In doing so, we focus on the case of a constant profit tax rate, and hence look at a situation where the volume of redistribution remains a constant share of aggregate (per period) profits.

Let us start by looking at distribution effects among employed workers. To this end, it is helpful to employ a strategy that we used earlier, and look at the distribution of firms not in terms of their productivity but in terms of their inverse marginal cost. Eqs. (4) and (8) continue to hold in the open economy, and therefore we still have $\kappa^* = \Delta^{\theta-1}$, and hence the wage paid by the marginal firm, $w(\kappa^*)$, increases proportionally with the cutoff productivity level. Furthermore, the demand function for domestic output in the open economy can be written as $q(\phi) = r(\tilde{\phi}_t)p(\phi)^{-\sigma}$ and with $r(\tilde{\phi}_t)$ being constant and firms practicing mark-up pricing, it follows immediately that output $q(\phi^*) = q(\kappa^*)$ of the marginal firm is constant as well. Employment $q(\kappa^*)/\phi^*$ of the marginal firm falls, as it is inversely proportional to ϕ^* .

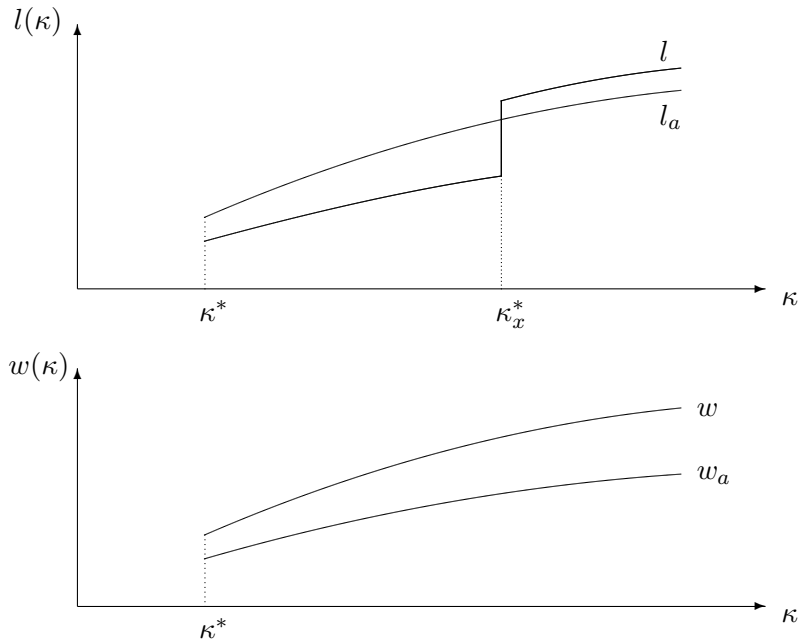


Figure 3: Wage and employment profiles across firms

Relative wages across firms are unaffected by international trade, and the same is true for relative employment levels of firms for their respective *domestic* production. With exporting firms having additional employment, it is clear that there is a reallocation of employment shares towards firms with lower marginal cost (higher κ).¹⁵ The respective wage and employment profiles are illustrated in figure 3. It follows from this figure that wage inequality among employed workers increases due to a pure composition effect.

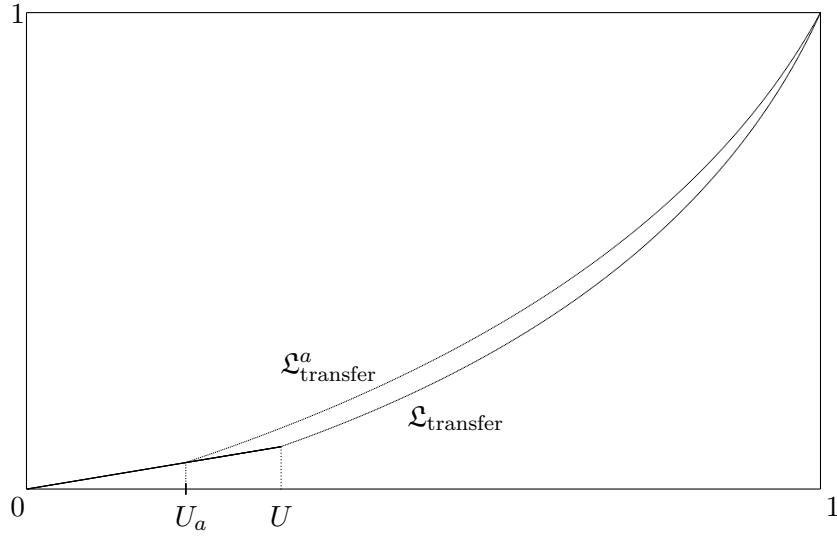


Figure 4: The Lorenz curve for secondary labour income

From (10) and (13), we know that aggregate transfers are proportional to aggregate income, i.e. $\eta(s)L/I = s(1 - \theta)/[k + s(1 - \theta)]$, and therefore the per capita income of unemployed individuals (who only receive transfer income) stays constant as a proportion of average per capita income. The overall income distribution is summarised in figure 4, which shows the Lorenz curves for the secondary income distribution in both the closed and the open economy. It is immediate that the Lorenz curve for the open economy has to lie below the one for the closed economy due to two effects: First, as just described, there is

¹⁵For firms with inverse marginal cost higher than the exporting cutoff level κ_x^* total employment is equal to $l(\kappa) + l_x(\kappa) = (1 + \tau^{1-\sigma})l(\kappa)$. Total employment in an exporting firm is higher than the employment in a firm under autarky that has the same marginal cost. The relative employment level is given by $(1 + \tau^{1-\sigma})/(1 + \tau^{-k/(1-\theta)})^{1/k} > 1$.

more inequality among employed individuals as the employment share of high-wage firms goes up. And second, the unemployment rate increases, thereby increasing the proportion of individuals that exclusively receive transfer income.¹⁶

While it is unambiguous according to the Lorenz criterion that inequality is larger in the open than in the closed economy, it is worth noting that trade brings a gain in absolute terms for those who were unemployed in the autarky equilibrium (due to higher transfers) and to those who had a job in the autarky equilibrium and stay employed (due to increasing wages and reallocation of workers towards high wage firms). The only group of individuals who are worse off in absolute terms in the trade equilibrium are those who lose their job. While their transfer income increases along with everybody else's, this increase cannot make up for their lost wage income.

Proposition 4. *With two symmetric countries and partitioning of firms by their export status, international trade raises both aggregate wage and transfer payments, and it increases primary as well as secondary labour income inequality.*

4 Adjustments in the Redistribution System

We have seen that the proposed redistribution system cannot eliminate the principal conflict between positive income and negative distribution effects of trade, when profit tax rates are held constant. On the other hand, we know that an increase in the profit tax rate, while reducing aggregate income, makes the secondary income distribution more equal. In this section we check whether it is possible to devise a reform of the profit tax rate that renders income distribution more equal than under autarky, without eliminating the gains

¹⁶If there were no variable transport costs ($\tau = 1$), all firms would export, implying that inequality among those who have a job would be unaffected by a movement from autarky to trade. Furthermore, the unemployment rate would be unaffected as well, so that the Lorenz curves of the closed and the open economy would be congruent in this borderline case. This brings to the forefront that it is the selection of the best firms into export status which is responsible for the adverse distributional implications of trade liberalisation. A formal proof of the relative position of the two Lorenz curves is available from the authors upon request.

from trade completely.

The scope for such a policy reform is illustrated in figure 5. The top panel of the figure shows cutoff productivity and aggregate income in the open economy relative to their respective autarky levels as a function of χ . The highest of the three curves represents relative cutoff productivities *and* relative income levels for the case where the profit tax rate is the same under autarky and trade. The remaining two curves correspond to a *trade-cum-redistribution* (TCR) reform, where the movement from autarky to trade is accompanied by an increase in s . The second curve from top represents relative incomes, while the third (dotted) curve represents relative cutoff productivities, illustrating that the increase in s reduces both cutoff productivity and aggregate income, *ceteris paribus*, but income falls by less. This is because, as we have shown above, the increase in s leads to an increase in the share of aggregate income that accrues to labour. Given the particular increase in s for which the figure is drawn, we can see that there are still gains from trade, provided that χ is larger than $\bar{\chi}^1$. Notably, for $\bar{\chi}^2 > \chi > \bar{\chi}^1$ the TCR package increases aggregate income despite reducing the cutoff productivity.

The bottom panel shows the relative Gini coefficients in autarky and trade, where the higher of the two curves represents the constant-tax case, while the other curve depicts the TCR reform just described.¹⁷ In the constant-tax case we have $\mathfrak{G}/\mathfrak{G}_a = 1$ if $\chi = 1$, while $\mathfrak{G}/\mathfrak{G}_a > 1$ for $\chi \in (0, 1)$. The increase in s reduces inequality, and hence the curve for the TCR reform lies strictly below the original curve. Clearly, all TCR reforms for which both $\chi > \bar{\chi}^1$ and $\chi > \bar{\chi}^3$ hold increase aggregate income *and* make the secondary income distribution more equal, as measured by the Gini coefficient.¹⁸ For $\chi = \bar{\chi}^3 > \bar{\chi}^1$

¹⁷Formal details on the derivation of the two Gini coefficients are deferred to a supplement, which is available upon request. There, we also discuss the properties of the $\mathfrak{G}/\mathfrak{G}_a$ locus.

¹⁸It is clear from inspection of figure 5 that the higher the s increase of a TCR reform, the lower the range of values for χ that still lead to gains from trade, and the higher the range of values for χ that are compatible with decreasing inequality according to the Gini criterion. One case not explored in figure 5 is the one where we choose s depending on χ . Allowing for the s adjustment to depend on χ , we have shown in simulations that there are two different scenarios, depending on model parameters k , σ and θ . First, there is the case (e.g., with $k = \sigma = 2$ and $\theta = 0.5$) where a high value of χ is *necessary* to make a TCR reform viable that is both income increasing and inequality reducing. Second there is the case (e.g., with

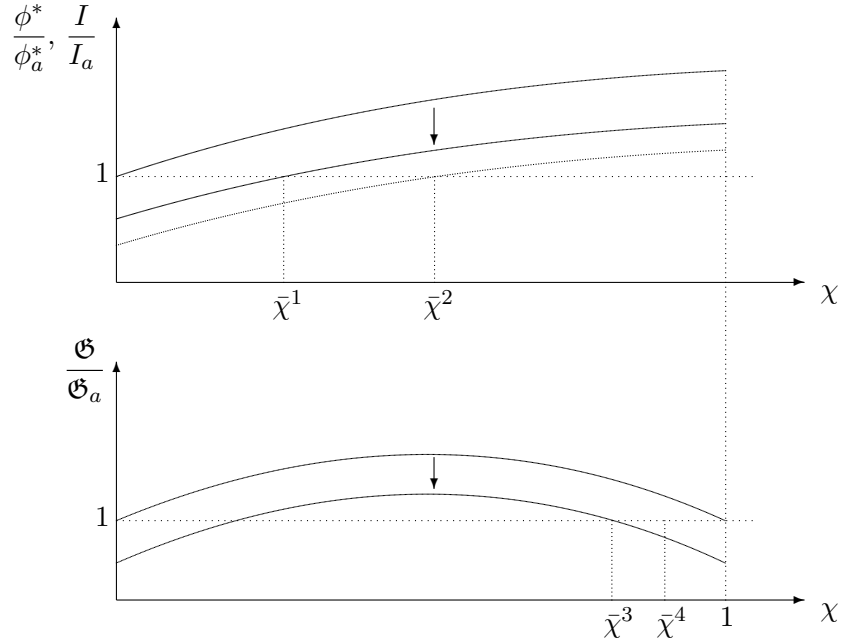


Figure 5: Income level and distribution effects of trade

the Lorenz curves for autarky and the TCR reform intersect, because the unemployed get higher transfers, but the Gini coefficients in both situations are the same. A more equal distribution of labour incomes under the TCR reform according to the Lorenz criterion is assured for $\chi > \bar{\chi}^4$, where $\bar{\chi}^4 \in (\bar{\chi}^3, 1)$.

5 Country-Specific Tax Rates

In this section we account for asymmetries of countries in their redistribution schemes, i.e. we consider differences of countries in the tax parameter s . With asymmetric countries, notation needs to be adjusted and we use subscripts H and F to refer to countries *Home* and *Foreign*. Due to frictionless trade of final goods the CES price index is the same in both countries, and using our previous normalisation we have $P_H = P_F = 1$. In deriving $\overline{k = \sigma = 2}$ and $\overline{\theta = 0.85}$ where by appropriately choosing s as a function of χ we can find such a TCR reform for all values of χ . Further details on these simulation exercises are available from the authors upon request.

the results for the case of symmetric countries we made extensive use of the fact that under complete symmetry the average productivity of domestic firms in the open economy, $\tilde{\phi}$, is equal to the average productivity of all firms selling to the domestic market, $\tilde{\phi}_t$. So what happens when in an otherwise similar situation H and F set different profit tax rates? We have the following important result:

Lemma 1. *In a trade equilibrium with country-specific profit tax rates, the equality of $\tilde{\phi}$ and $\tilde{\phi}_t$ within each country continues to hold.*

Proof. See the appendix. □

The intuition for this result is as follows. Consider for concreteness an increase in s_F , while keeping s_H constant. In analogy to our earlier results κ_F^* is independent of s_F , because wage and productivity of the marginal firm fall proportionally when s_F increases. With relative wages and employment shares across κ firms unaffected, the prices – and therefore the competitive position – of foreign firms remain unchanged. The only channel through which the increase in s_F influences the home country is through the effect on the mass of foreign firms: M_F falls proportionally with ϕ_F^* , and with the share of exporters constant at $\chi = \tau^{-k/(1-\theta)}$, the proportion of domestically produced varieties in the mass of domestically consumed varieties increases:

$$\frac{M_H}{M_{tH}} = \left[1 + \chi \left(\frac{1 - s_F}{1 - s_H} \right)^{\frac{1}{k}} \right]^{-1}$$

The increase in M_H/M_{tH} leaves $\tilde{\phi}_t/\tilde{\phi}$ in each country unchanged, however, with the lost-in-transit effect and the export-selection effect exactly offsetting each other (see fn. 14). Lemma 1 is a powerful result. It implies that as long as we consider domestic and foreign beachhead costs to be the same, the insights from section 3 remain unaffected when we extend our model to one with asymmetric tax rates.

6 Concluding Remarks

This paper investigates the effects of a profit-tax based redistribution scheme in a trade model with heterogeneous firms and imperfect labour markets. In the model there are ag-

gregate gains from international trade, but the personal income distribution becomes more unequal, partly driven by an increase in the number of unemployed, partly by an expansion of high-wage exporting firms. The redistribution scheme considered, while simple, is well-equipped in principle to mitigate the detrimental distribution effects of international trade, since by increasing the profit tax one could increase the transfer payments, thereby making the secondary income distribution more equal, *ceteris paribus*. Since any increase in the profit tax entails a welfare cost, reflected in a reduction of aggregate income, the crucial issue is whether *trade-cum-redistribution* (TCR) reforms can be found within our system that make the income distribution more equal without destroying the gains from trade completely. We show that these reforms can be found if a sufficiently large share of firms export, while it may be impossible to reconcile gains from trade with a more equal income distribution if the share of exporters is small.

Allowing countries to change their profit tax rates unilaterally is a first step towards a more comprehensive analysis of policy setting in an open economy with heterogeneous firms. Our work provides insights into this issue and shows that under our fixed cost assumptions there is no strategic motive for tax authorities in the open economy. However, this result changes if foreign beachhead costs differ from domestic ones. In this case, profit taxes would influence firm entry in the foreign economy with *feedback effects* on the home country. These feedback effects can provide an incentive for strategic policy setting. While extending the formal analysis to the case of asymmetric beachhead costs would be an interesting task for future research, it is beyond the scope of the present paper.

Appendix: Proof of Lemma 1

Using the usual definition of the CES price index, and recalling $P_H = 1$, we can write

$$1 = \frac{1}{M_{tH}} \left[M_H p_H (\tilde{\phi}_H)^{1-\sigma} + \chi_F M_F \tau^{1-\sigma} p_F (\tilde{\phi}_{xF})^{1-\sigma} \right]$$

for country H , where $\tilde{\phi}_{xF} = [k/(k-\xi)]^{1/\xi} \phi_{xF}^*$ denotes the average productivity of exporting firms in country F and $M_{tH} = M_H + \chi_F M_F$ gives the total amount of intermediate goods varieties that are used in the final goods production of country H . With $p_i/p_j =$

$(\phi_i/\phi_j)^{\theta-1}$, and $p_H(\tilde{\phi}_{tH}) = p_F(\tilde{\phi}_{tF}) = 1$, this yields

$$1 = \frac{1}{M_{tH}} \left[M_H \left(\frac{\tilde{\phi}_H}{\tilde{\phi}_{tH}} \right)^\xi + \chi_F M_F \tau^{1-\sigma} \left(\frac{\tilde{\phi}_{xF}}{\tilde{\phi}_{tF}} \right)^\xi \right],$$

and solving for $\tilde{\phi}_{tH}$ gives

$$\tilde{\phi}_{tH} = \tilde{\phi}_H \left\{ \frac{1}{M_{tH}} \left[M_H + \chi_F M_F \tau^{1-\sigma} \left(\frac{\tilde{\phi}_{tH}}{\tilde{\phi}_{tF}} \right)^\xi \left(\frac{\tilde{\phi}_{xF}}{\tilde{\phi}_H} \right)^\xi \right] \right\}^{\frac{1}{\xi}} \quad (21)$$

Due to the fair wage constraint, the relative wage of *any* two firms with the same productivity ϕ that are based in different countries is determined by these countries' average productivities: $w_H(\phi)/w_F(\phi) = (\tilde{\phi}_{tH}/\tilde{\phi}_{tF})^{1-\theta}$. With identical productivities and markup pricing, $p_H(\phi)/p_F(\phi) = w_H(\phi)/w_F(\phi)$ holds. It was shown earlier that relative prices of two firms i and j are related to their relative domestic revenues by $r_i/r_j = (p_i/p_j)^{1-\sigma}$. Combining these results gives $r_H(\phi)/r_F(\phi) = (\tilde{\phi}_{tH}/\tilde{\phi}_{tF})^{-\xi}$. Rewriting this relationship for two firms with productivity ϕ_{xF}^* and noting that export revenues for each exporting firm are a fraction $\tau^{1-\sigma}$ of their domestic revenues, we get $r_H(\phi_{xF}^*)/r_{xF}(\phi_{xF}^*) = \tau^{\sigma-1}(\tilde{\phi}_{tH}/\tilde{\phi}_{tF})^{-\xi}$.

From the zero cutoff profit conditions for foreign exporters as well as domestic firms in combination with $f = f_x$, we obtain $r_{xF}(\phi_{xF}^*) = r_H(\phi_H^*)$, and therefore $r_H(\phi_{xF}^*)/r_H(\phi_H^*) = \tau^{\sigma-1}(\tilde{\phi}_{tH}/\tilde{\phi}_{tF})^{-\xi}$. Replacing relative revenues by relative productivities on the left hand side of this equation, and noting that $\tilde{\phi}_H/\phi_H^* = \tilde{\phi}_{xF}/\phi_{xF}^* = [k/(k-\xi)]^{1/\xi}$, finally leads to

$$\left(\frac{\tilde{\phi}_{xF}}{\tilde{\phi}_H} \right)^\xi = \tau^{\sigma-1} \left(\frac{\tilde{\phi}_{tF}}{\tilde{\phi}_{tH}} \right)^\xi, \quad (22)$$

and substituting back into eq. (21) gives $\tilde{\phi}_{tH} = \tilde{\phi}_H$ and in analogy $\tilde{\phi}_{tF} = \tilde{\phi}_F$.¹⁹ This completes the proof.

¹⁹Notably, using $\tilde{\phi}_t = \tilde{\phi}$ for both economies in eq. (22), gives $\chi_H = \chi_F = \tau^{-k/(1-\theta)} \equiv \chi$.

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Supplement

This supplement consists of four parts. In parts A and B, we provide further derivation details for the closed and the open economy, respectively. In part C, we formally show that a movement from autarky to trade shifts the Lorenz curve downwards and thus increases income inequality if in the open economy there is partitioning of firms by their export status. We also show that the Lorenz curve remains unaffected if all firms export in the open economy, i.e. if $\chi = 1$. In part D, we briefly compare the Gini coefficients for the closed and the open economy and thus provide additional insights for the analysis in section 4.

Supplement A: Derivation Details for the Closed Economy

The Average Productivity in Eq. (5)

The CES price index corresponding to final output in eq. (1) is given by

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

Using $P = 1$ and accounting for the productivity distribution $G(\phi) = 1 - \phi^{-k}$, we further obtain

$$\begin{aligned} 1 &= \frac{1}{1 - G(\phi^*)} \int_{\phi^*}^{\infty} p(\phi)^{1-\sigma} g(\phi) d\phi \\ &= \frac{p(\tilde{\phi})^{1-\sigma}}{1 - G(\phi^*)} \int_{\phi^*}^{\infty} \left(\frac{\phi}{\tilde{\phi}} \right)^{\xi} g(\phi) d\phi \end{aligned}$$

Hence, with $\tilde{\phi}$ being defined by $Y/M = q(\tilde{\phi})$ we have $p(\tilde{\phi}) = 1$ and eq. (5) is immediate.

The Employment Rate in Eq. (9)

Using the adding-up condition for aggregate employment in the text, we obtain

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

Considering $l(\tilde{\phi}) = q(\tilde{\phi})/\tilde{\phi}$, $q(\tilde{\phi}) = r(\tilde{\phi})$ and $r(\tilde{\phi}) = R/M$, we obtain $Ml(\tilde{\phi}) = R/\tilde{\phi}$. Furthermore, it follows from eqs. (6) and (8) that $R = \rho^{\theta/(1-\theta)}\tilde{\phi}L$. Hence, noting $\Delta = \rho^{1/(1-\theta)}[k/(k-\xi)]^{1/\xi}$, eq. (9) is immediate.

The Lorenz Curve in the Closed Economy

The Lorenz curve for secondary labour income consists of two parts. The first part is given by

$$\mathfrak{L}^1(\gamma) = \frac{\eta(s)L\gamma}{I} = \frac{s(1-\theta)\gamma}{k+s(1-\theta)} \quad (23)$$

It measures aggregate income of a share of $\gamma \leq U$ workers without a job relative to overall labour income.

To determine the second segment of the Lorenz curve, we first derive aggregate secondary labour income of workers who are either unemployed or employed in firms with productivities up to $\bar{\phi} \geq \phi^*$ as a proportion of overall labour income. This gives

$$\mathfrak{L}^2 = \frac{s(1-\theta)U}{k+s(1-\theta)} + \frac{M}{(1-G(\phi^*))I} \int_{\phi^*}^{\bar{\phi}} [w(\phi) + \eta(s)]l(\phi)g(\phi)d\phi$$

Substituting $w(\phi)l(\phi) = \rho r(\phi)$, this can be rewritten to give

$$\mathfrak{L}^2 = 1 - \frac{k}{k+s(1-\theta)} \left(\frac{\bar{\phi}}{\phi^*} \right)^{\xi-k} - \frac{(1-U)s(1-\theta)}{k+s(1-\theta)} \left(\frac{\bar{\phi}}{\phi^*} \right)^{\xi-\theta-k}.$$

We can now denote by γ the proportion of workers who earn a primary labour income of less than or equal to $w(\bar{\phi})$. This gives $\gamma = 1 - (1-U) \left(\frac{\bar{\phi}}{\phi^*} \right)^{\xi-\theta-k}$. Solving for $\bar{\phi}/\phi^*$ and substituting the resulting expression in \mathfrak{L}^2 , we arrive at the following expression for the second Lorenz curve segment

$$\mathfrak{L}^2(\gamma) = \frac{s(1-\theta)\gamma}{k+s(1-\theta)} + \frac{k}{k+s(1-\theta)} \left[1 - \left(\frac{1-\gamma}{1-U} \right)^{\frac{k-\xi}{k-\xi+\theta}} \right]. \quad (24)$$

In view of (23) and (24), the Lorenz curve for secondary labour income can thus be written as

$$\mathfrak{L}_{\text{transfer}}(\gamma) = \begin{cases} \frac{s(1-\theta)\gamma}{k+s(1-\theta)} & \text{if } \gamma \in [0, U] \\ \frac{s(1-\theta)\gamma}{k+s(1-\theta)} + \frac{k}{k+s(1-\theta)} \left[1 - \left(\frac{1-\gamma}{1-U} \right)^{\frac{k-\xi}{k-\xi+\theta}} \right] & \text{if } \gamma \in (U, 1]. \end{cases} \quad (25)$$

The Lorenz curve for primary labour income, $\mathfrak{L}_{\text{nottransfer}}(\gamma)$, is obtained by setting $s = 0$ in eq. (25) and it is thus immediate that $\mathfrak{L}_{\text{nottransfer}}(\gamma)$ does not change when s increases.

Furthermore, noting that U is invariant to changes in s , it is also immediate to determine the impact of an s -increase on $\mathfrak{L}_{\text{transfer}}(\gamma)$. First, it follows from eq. (23) that an increase in the tax rate parameter s raises $\mathfrak{L}^1(\gamma)$ for any given $\gamma \in (0, U]$. Second, we can calculate

$$\frac{d\mathfrak{L}^2}{ds} = \frac{k(1-\theta)}{[k+s(1-\theta)]^2} F(\gamma), \quad \text{with} \quad F(\gamma) \equiv \gamma - 1 + \left(\frac{1-\gamma}{1-U} \right)^{\frac{k-\xi}{k-\xi+\theta}}.$$

Noting $F''(\gamma) < 0$, it follows that if $F(\gamma)$ has an extremum in interval $(U, 1)$, the extremum must be a maximum. Hence, $F(U) = U$ and $F(1) = 0$ imply that an increase of the profit tax rate s raises $\mathfrak{L}_{\text{transfer}}(\gamma)$ for any given $\gamma \in (U, 1)$. Together with the result for interval $(0, U]$, we can thus conclude that a higher s lowers income inequality in the closed economy according to the Lorenz criterion.

Supplement B: Derivation Details for the Open Economy

The Average Productivity $\tilde{\phi}_t$

The CES price index in the open economy is given by

$$P = \left\{ M_t^{-1} \left[\frac{M}{1-G(\phi^*)} \int_{\phi^*}^{\infty} p(\phi)^{1-\sigma} g(\phi) d\phi + \frac{\chi M \tau^{1-\sigma}}{1-G(\phi_x^*)} \int_{\phi_x^*}^{\infty} p(\phi)^{1-\sigma} g(\phi) d\phi \right] \right\}^{\frac{1}{1-\sigma}}.$$

Using $P = 1$, we further obtain

$$1 = M_t^{-1} \left[\frac{M p(\tilde{\phi})^{1-\sigma}}{1-G(\phi^*)} \int_{\phi^*}^{\infty} \left(\frac{\phi}{\tilde{\phi}} \right)^{\xi} g(\phi) d\phi + \frac{\chi M \tau^{1-\sigma} p(\tilde{\phi}_x)^{1-\sigma}}{1-G(\phi_x^*)} \int_{\phi_x^*}^{\infty} \left(\frac{\phi}{\tilde{\phi}_x} \right)^{\xi} g(\phi) d\phi \right].$$

Furthermore, defining

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

in total analogy to the autarky case, we arrive at

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

With $\tilde{\phi}_t$ being defined by $q(\tilde{\phi}_t) = Y/M_t$, we obtain $p(\tilde{\phi}_t) = 1$. Furthermore, we can note that $(\tilde{\phi}_x/\tilde{\phi})^\xi = (\phi_x^*/\phi^*)^\xi = \tau^{\sigma-1}$ and thus get

$$1 = M_t^{-1} \left[M \left(\frac{\tilde{\phi}}{\tilde{\phi}_t} \right)^\xi + \chi M \left(\frac{\tilde{\phi}}{\tilde{\phi}_t} \right)^\xi \right].$$

Noting $M_t = (1 + \chi)M$, this finally confirms $\tilde{\phi}_t = \tilde{\phi}$.

The Employment Rate in Eq. (20)

Using the adding-up condition of employment in the open economy, we obtain

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

Substituting $M_t l(\tilde{\phi}_t) = R/\tilde{\phi}_t$ and accounting for $R = \rho^{\theta/(1-\theta)}\tilde{\phi}_t L$ as well as $\Delta = \rho^{1/(1-\theta)}[k/(k - \xi)]^{1/\xi}$, we arrive at

$$1 - U = \Delta^\theta \frac{k - \xi}{k - \xi + \theta} \frac{1 + \chi^{1+\theta/k}}{1 + \chi},$$

which, by virtue of eq. (9) can be reformulated to eq. (20).

The Lorenz Curve in the Open Economy

The Lorenz curve for secondary labour income in the open economy consists of three segments. The first segment is relevant for a population share of $\gamma \leq U$ and is determined in total analogy to the closed economy:

$$\mathfrak{L}^1(\gamma) = \frac{s(1 - \theta)\gamma}{k + s(1 - \theta)} \quad (26)$$

To determine the second segment of the Lorenz curve, we first calculate aggregate secondary labour income of workers who are either unemployed or employed in firms with productivities up to $\bar{\phi} \in (\phi^*, \phi_x^*)$ as a proportion of overall secondary labour income. This

gives

$$\begin{aligned}\mathfrak{L}^2 &= \frac{s(1-\theta)U}{k+s(1-\theta)} + \frac{M}{(1-G(\bar{\phi}^*))I} \int_{\bar{\phi}^*}^{\bar{\phi}} [w(\phi) + \eta(s)]l(\phi)g(\phi)d\phi \\ &= 1 - \frac{k}{k+s(1-\theta)} \frac{1}{1+\chi} \left[\chi + \left(\frac{\bar{\phi}}{\bar{\phi}^*} \right)^{\xi-k} \right] - \frac{s(1-\theta)}{k+s(1-\theta)} \frac{1-U}{1+\chi^{1+\frac{\theta}{k}}} \left[\chi^{1+\frac{\theta}{k}} + \left(\frac{\bar{\phi}}{\bar{\phi}^*} \right)^{\xi-\theta-k} \right]\end{aligned}$$

We can now denote by γ the proportion of workers who earn a primary labour income which is less than or equal to $w(\bar{\phi})$. If $\bar{\phi} \in (\bar{\phi}^*, \phi_x^*)$, this gives

$$\gamma = U + \frac{1-U}{1+\chi^{1+\frac{\theta}{k}}} \left[1 - \left(\frac{\bar{\phi}}{\bar{\phi}^*} \right)^{\xi-\theta-k} \right].$$

Solving for $\bar{\phi}/\bar{\phi}^*$ and substituting the resulting expression in \mathfrak{L}^2 , we finally obtain

$$\mathfrak{L}^2(\gamma) = \frac{s(1-\theta)\gamma}{k+s(1-\theta)} + \frac{k}{k+s(1-\theta)} \frac{1}{1+\chi} \left[1 - \left(1 - \left(1 + \chi^{1+\frac{\theta}{k}} \right) \frac{\gamma-U}{1-U} \right)^{\frac{k-\xi}{k-\xi+\theta}} \right], \quad (27)$$

with the second segment of the Lorenz curve being relevant if $\gamma \in (U, \underline{\gamma})$. Thereby, $\underline{\gamma} \equiv U + (1-U)(1 - \chi^{1-(\xi-\theta)/k})/(1 + \chi^{1+\theta/k})$ and $\gamma = \underline{\gamma}$ is obtained by setting $\bar{\phi} = \phi_x^*$.

To determine the third segment of the Lorenz curve, we first derive aggregate secondary labour income of workers who are either unemployed or employed in firms with productivities up to $\bar{\phi} \geq \phi_x^*$ as a proportion of overall secondary labour income. This gives

$$\begin{aligned}\mathfrak{L}^3 &= \frac{s(1-\theta)U}{k+s(1-\theta)} + \frac{M}{(1-G(\bar{\phi}^*))I} \int_{\bar{\phi}^*}^{\bar{\phi}} [w(\phi) + \eta(s)]l(\phi)g(\phi)d\phi \\ &\quad + \frac{\chi M}{(1-G(\bar{\phi}_x^*))I} \int_{\bar{\phi}_x^*}^{\bar{\phi}} [w(\phi) + \eta(s)]l_x(\phi)g(\phi)d\phi \\ &= 1 - \frac{k}{k+s(1-\theta)} \frac{1+\chi^{\frac{\xi}{k}}}{1+\chi} \left(\frac{\bar{\phi}}{\bar{\phi}^*} \right)^{\xi-k} - \frac{(1-U)s(1-\theta)}{k+s(1-\theta)} \frac{1+\chi^{\frac{\xi}{k}}}{1+\chi^{1+\frac{\theta}{k}}} \left(\frac{\bar{\phi}}{\bar{\phi}^*} \right)^{\xi-\theta-k}.\end{aligned}$$

In analogy to above, we can now denote by γ the proportion of workers who earn a primary labour income which is less than or equal to $w(\bar{\phi})$. If $\bar{\phi} \geq \phi_x^*$, this gives

$$\gamma = U + \frac{1-U}{1+\chi^{1+\frac{\theta}{k}}} \left[\left(1 - \left(\frac{\bar{\phi}}{\bar{\phi}^*} \right)^{\xi-\theta-k} \right) + \chi^{1+\frac{\theta}{k}} \left(1 - \chi^{-\frac{k-\xi+\theta}{k}} \left(\frac{\bar{\phi}}{\bar{\phi}^*} \right)^{\xi-\theta-k} \right) \right].$$

Solving the for $\bar{\phi}/\bar{\phi}^*$ and substituting the resulting expression in \mathfrak{L}^3 , we finally arrive at

$$\mathfrak{L}^3(\gamma) = \frac{s(1-\theta)\gamma}{k+s(1-\theta)} + \frac{k}{k+s(1-\theta)} \left[1 - \frac{1+\chi^{\frac{\xi}{k}}}{1+\chi} \left(\frac{1+\chi^{1+\frac{\theta}{k}}}{1+\chi^{\frac{\xi}{k}}} \frac{1-\gamma}{1-U} \right)^{\frac{k-\xi}{k-\xi+\theta}} \right], \quad (28)$$

where the third segment of the Lorenz curve is relevant for $\gamma \in [\underline{\gamma}, 1]$.

Together, eqs. (26)-(28) determine the Lorenz curve for secondary labour income in the open economy:

$$\mathfrak{L}_{\text{transfer}}(\gamma) = \begin{cases} \mathfrak{L}^1(\gamma) & \text{if } \gamma \in [0, U] \\ \mathfrak{L}^2(\gamma) & \text{if } \gamma \in (U, \underline{\gamma}) \\ \mathfrak{L}^3(\gamma) & \text{if } \gamma \in [\underline{\gamma}, 1] \end{cases} \quad (29)$$

The Lorenz curve for primary labour income, $\mathfrak{L}_{\text{nottransfer}}(\gamma)$, is obtained by setting $s = 0$ in eqs. (26)-(28) and it is thus immediate that $\mathfrak{L}_{\text{nottransfer}}(\gamma)$ does not change when s increases. Furthermore, using the same techniques as in the autarky scenario, we can also show that a higher s lowers secondary labour income inequality in the open economy.

Supplement C: Lorenz Curve Effects of a Movement from Autarky to Trade

To determine the Lorenz curve effects of a movement from autarky to trade, we can first note from our analysis in sections 2.1 and 3.2 that $U > U_a$ (with a indicating an autarky variable) if $\chi < 1$, while $U = U_a$ if $\chi = 1$. Hence, it is immediate from eqs. (23) and (26) that $\mathfrak{L}_{\text{transfer}}^a(\gamma) = \mathfrak{L}_{\text{transfer}}(\gamma)$ holds for any $\gamma \leq U_a$. Furthermore, with $\chi < 1$ it follows from a comparison of eqs. (24) and (26) that $\mathfrak{L}_{\text{transfer}}^a(\gamma) > \mathfrak{L}_{\text{transfer}}(\gamma)$ holds for any $\gamma \in (U_a, U]$.

In a next step, we can look at interval $(U, \underline{\gamma})$, with $\underline{\gamma} = U + (1 - U)(1 - \chi^{1 - (\xi - \theta)/k}) / (1 + \chi^{1 + \theta/k})$. In this case the second segment of the Lorenz curve is relevant in the closed as well as the open economy. One remark is in order here. If all firms export ($\chi = 1$), then $\underline{\gamma} = U$ and interval $(U, \underline{\gamma})$ becomes infinitesimally small. Hence, we can focus on the case with partitioning of firms by their export status ($\chi < 1$) in the subsequent analysis.

By virtue of eqs. (24) and (27) the vertical difference of the two relevant Lorenz curve segments is given by

$$\mathfrak{L}_a^2(\gamma) - \mathfrak{L}^2(\gamma) = \frac{k}{k + s(1 - \theta)} D(\gamma),$$

with

$$D(\gamma) = 1 - \left(\frac{1-\gamma}{1-U_a} \right)^{\frac{k-\xi}{k-\xi+\theta}} - \frac{1}{1+\chi} \left[1 - \left(1 - Z \frac{\gamma-U}{1-U} \right)^{\frac{k-\xi}{k-\xi+\theta}} \right],$$

and $Z \equiv 1 + \chi^{1+\theta/k}$. Hence, the sign of $\mathfrak{L}_a^2(\gamma) - \mathfrak{L}^2(\gamma)$ only depends on the sign of $D(\gamma)$, and it is independent of tax parameter s . It is now immediate that

$$D(U) = 1 - \left(\frac{1-U}{1-U_a} \right)^{\frac{k-\xi}{k-\xi+\theta}} > 0$$

if $\chi < 1$, which confirms $\mathfrak{L}_{\text{transfer}}^a(U) > \mathfrak{L}_{\text{transfer}}(U)$ from above. Furthermore, we can calculate

$$D(\underline{\gamma}) = 1 - \left(\frac{1-\underline{\gamma}}{1-U_a} \right)^{\frac{k-\xi}{k-\xi+\theta}} - \frac{1}{1+\chi} \left[1 - \left(1 - Z \frac{\underline{\gamma}-U}{1-U} \right)^{\frac{k-\xi}{k-\xi+\theta}} \right]$$

Accounting for

$$\begin{aligned} 1 - \underline{\gamma} &= \frac{1-U}{Z} \chi^{\frac{k-\xi+\theta}{k}} \left(1 + \chi^{\xi/k} \right) \\ \underline{\gamma} - U &= \frac{1-U}{Z} \left(1 - \chi^{\frac{k-\xi+\theta}{k}} \right), \end{aligned}$$

we obtain

$$D(\underline{\gamma}) = 1 - \left(\frac{1-U}{1-U_a} \frac{1+\chi^{\xi/k}}{Z} \right)^{\frac{k-\xi}{k-\xi+\theta}} \chi^{\frac{k-\xi}{k}} - \frac{1}{1+\chi} \left(1 - \chi^{\frac{k-\xi}{k}} \right)$$

Noting that $(1-U)/(1-U_a) = Z/(1+\chi)$, according to eq. (20), further implies

$$D(\underline{\gamma}) = \frac{\chi}{1+\chi} - \left(\frac{1+\chi^{\xi/k}}{1+\chi} \right)^{\frac{k-\xi}{k-\xi+\theta}} \chi^{\frac{k-\xi}{k}} + \frac{1}{1+\chi} \chi^{\frac{k-\xi}{k}}.$$

If $\chi \in (0, 1)$, then $1 + \chi^{\xi/k} > 1 + \chi$ and thus

$$D(\underline{\gamma}) > \frac{\chi}{1+\chi} - \left(\frac{1+\chi^{\xi/k}}{1+\chi} \right) \chi^{\frac{k-\xi}{k}} + \frac{1}{1+\chi} \chi^{\frac{k-\xi}{k}} = 0.$$

Hence, $D(\underline{\gamma}) > 0$ and thus $\mathfrak{L}_a^2(\gamma) - \mathfrak{L}^2(\gamma) > 0$.

So far we have shown that $D(U) > 0$ and $D(\underline{\gamma}) > 0$. However, the sign of $D(\gamma)$ for $\gamma \in (U, \underline{\gamma})$ remains to be determined. In order to proceed, we can differentiate $D(\gamma)$. This gives

$$D'(\gamma) = \frac{k-\xi}{k-\xi+\theta} \left[\left(\frac{1-\gamma}{1-U_a} \right)^{-\frac{\theta}{k-\xi+\theta}} \frac{1}{1-U_a} - \left(1 - Z \frac{\gamma-U}{1-U} \right)^{-\frac{\theta}{k-\xi+\theta}} \frac{Z}{1+\chi} \frac{1}{1-U} \right]$$

Accounting for $(1 - U)/(1 - U_a) = Z/(1 + \chi)$ from eq. (20), further implies

$$D'(\gamma) = \frac{k - \xi}{k - \xi + \theta} \frac{Z}{1 + \chi} \frac{1}{1 - U} \left[\left(\frac{1 - \gamma}{1 - U_a} \right)^{-\frac{\theta}{k - \xi + \theta}} - \left(1 - Z \frac{\gamma - U}{1 - U} \right)^{-\frac{\theta}{k - \xi + \theta}} \right],$$

Evaluating $D'(\gamma)$ at $\gamma = U$ and $\gamma = \underline{\gamma}$, gives

$$D'(U) = \frac{k - \xi}{k - \xi + \theta} \frac{Z}{1 + \chi} \frac{1}{1 - U} \left[\left(\frac{1 - U}{1 - U_a} \right)^{-\frac{\theta}{k - \xi + \theta}} - 1 \right] > 0$$

and

$$\begin{aligned} D'(\underline{\gamma}) &= \frac{k - \xi}{k - \xi + \theta} \frac{Z}{1 + \chi} \frac{1}{1 - U} \left[\left(\frac{1 - \underline{\gamma}}{1 - U_a} \right)^{-\frac{\theta}{k - \xi + \theta}} - \left(1 - Z \frac{\underline{\gamma} - U}{1 - U} \right)^{-\frac{\theta}{k - \xi + \theta}} \right] \\ &= \frac{k - \xi}{k - \xi + \theta} \frac{Z}{1 + \chi} \frac{\chi^{-\theta/k}}{1 - U} \left[\left(\frac{1 + \chi}{1 + \chi^{\xi/k}} \right)^{\frac{\theta}{k - \xi + \theta}} - 1 \right] < 0, \end{aligned}$$

respectively.

Hence, function $D(\gamma)$ must have at least one extremum on interval $\gamma \in (u, \underline{\gamma})$. This extremum is characterized by the following condition:

$$D'(\gamma) = 0 \quad \iff \quad 1 - Z \frac{\gamma - U}{1 - U} = \frac{1 - \gamma}{1 - U_a}$$

Substituting this first order condition into the second derivative

$$\begin{aligned} D''(\gamma) &= -\frac{\theta(k - \xi)}{(k - \xi + \theta)^2} \frac{Z}{1 + \chi} \frac{1}{1 - U} \left[-\frac{1}{1 - U_a} \left(\frac{1 - \gamma}{1 - U_a} \right)^{-\frac{k - \xi + 2\theta}{k - \xi + \theta}} + \frac{Z}{1 - U} \left(1 - Z \frac{\gamma - U}{1 - U} \right)^{-\frac{k - \xi + 2\theta}{k - \xi + \theta}} \right] \\ &= -\frac{\theta(k - \xi)}{(k - \xi + \theta)^2} \frac{Z}{1 + \chi} \frac{\chi}{(1 - U)(1 - U_a)} \left(\frac{1 - \gamma}{1 - U_a} \right)^{-\frac{k - \xi + 2\theta}{k - \xi + \theta}} < 0 \end{aligned}$$

Hence, there exists a *unique* interior extremum in the relevant interval, which is a maximum. Together with $D(U) > 0$ and $D(\underline{\gamma}) > 0$, we can thus conclude that with $\chi \in (0, 1)$, $D(\gamma) > 0$ and thus $\mathfrak{L}_{\text{transfer}}^a(\gamma) > \mathfrak{L}_{\text{transfer}}(\gamma)$ holds for any $\gamma \in (U, \underline{\gamma})$.

In a final step, we can now turn to interval $[\underline{\gamma}, 1]$. In this case, the third segment of the Lorenz curve becomes relevant in the open economy and thus we have to look at

$$\mathfrak{L}_a^2(\gamma) - \mathfrak{L}^3(\gamma) = \frac{k}{k + s(1 - \theta)} \left(\frac{1 - \gamma}{1 - U_a} \right)^{\frac{k - \xi}{k - \xi + \theta}} \left[\frac{1 + \chi^{\xi/k}}{1 + \chi} \left(\frac{Z}{1 + \chi^{\xi/k}} \frac{1 - U_a}{1 - U} \right)^{\frac{k - \xi}{k - \xi + \theta}} - 1 \right]$$

Substituting $(1 - U_a)/(1 - U) = (1 + \chi)/Z$, according to (20), we finally obtain

$$\mathfrak{L}_a^2(\gamma) - \mathfrak{L}^3(\gamma) = \frac{k}{k + s(1 - \theta)} \left(\frac{1 - \gamma}{1 - U_a} \right)^{\frac{k - \xi}{k - \xi + \theta}} \left[\left(\frac{1 + \chi^{\xi/k}}{1 + \chi} \right)^{\frac{\theta}{k - \xi + \theta}} - 1 \right].$$

It is now immediate and intuitive that $\mathfrak{L}_a^2(1) - \mathfrak{L}^3(1) = 0$. Furthermore, $\mathfrak{L}_a^2(\gamma) - \mathfrak{L}^3(\gamma) = 0$ extends to any $\gamma \in [\underline{\gamma}, 1)$ if $\chi = 1$. If however $\chi \in (0, 1)$, then $\mathfrak{L}_a^2(\gamma) - \mathfrak{L}^3(\gamma) > 0$ holds for any $\gamma \in [\underline{\gamma}, 1)$.

Summing up, we can therefore conclude that the Lorenz curves in the closed and the open economy are congruent if all firms export ($\chi = 1$). However, if there is selection of the best firms into export status ($\chi < 1$), then secondary labour income inequality is higher in the open than in the closed economy. Finally, setting s equal to zero, it is immediate that these results also extend to the case of primary labour income inequality.

Supplement D: The Gini Coefficient

The Gini coefficient measures two times the area between the diagonal and Lorenz curve in the Lorenz curve diagram. In the closed economy, the area below the Lorenz curve is determined by

$$\int_0^1 \mathfrak{L}_{\text{transfer}}^a(\gamma) d\gamma = \int_0^{U_a} \mathfrak{L}_a^1(\gamma) d\gamma + \int_{U_a}^1 \mathfrak{L}_a^2(\gamma) d\gamma,$$

where

$$\int_0^{U_a} \mathfrak{L}_a^1(\gamma) d\gamma = \frac{s(1 - \theta)}{k + s(1 - \theta)} \frac{U_a^2}{2}$$

and

$$\int_{U_a}^1 \mathfrak{L}_a^2(\gamma) d\gamma = \frac{1 - U_a^2}{2} \frac{s(1 - \theta)}{k + s(1 - \theta)} + \frac{(k - \xi)(1 - U_a)}{2(k - \xi) + \theta} \frac{k}{k + s(1 - \theta)},$$

according to (23) and (24). The Gini coefficient in the open economy is then determined by $\mathfrak{G}_a = 1 - 2 \int_0^1 \mathfrak{L}_{\text{transfer}}^a(\gamma) d\gamma$ and thus given by

$$\mathfrak{G}_a = \frac{k}{k + s(1 - \theta)} \frac{\theta + 2U_a(k - \xi)}{2(k - \xi) + \theta}. \quad (30)$$

The higher the Gini coefficient, the higher is labour income inequality in the closed economy. Due to $d\mathfrak{G}_a/ds < 0$ it is immediate that the considered tax-transfer system lowers inequality.

In the open economy, the area below the Lorenz curve is given by

$$\int_0^1 \mathfrak{L}_{\text{transfer}}(\gamma) d\gamma = \int_0^U \mathfrak{L}^1(\gamma) d\gamma + \int_U^{\underline{\gamma}} \mathfrak{L}^2(\gamma) d\gamma + \int_{\underline{\gamma}}^1 \mathfrak{L}^3(\gamma) d\gamma,$$

where

$$\int_0^U \mathfrak{L}^1(\gamma) d\gamma = \frac{U^2}{2} \frac{s(1-\theta)}{k+s(1-\theta)},$$

$$\begin{aligned} \int_U^{\underline{\gamma}} \mathfrak{L}^2(\gamma) d\gamma &= \frac{\underline{\gamma}^2 - U^2}{2} \frac{s(1-\theta)}{k+s(1-\theta)} + \frac{k}{k+s(1-\theta)} \frac{1-U}{Z(1+\chi)} \\ &\quad \times \left[\frac{k-\xi}{2(k-\xi)+\theta} - \chi^{\frac{k-\xi+\theta}{k}} + \frac{k-\xi+\theta}{2(k-\xi)+\theta} \chi^{\frac{2(k-\xi)+\theta}{k}} \right] \end{aligned}$$

and

$$\begin{aligned} \int_{\underline{\gamma}}^1 \mathfrak{L}^3(\gamma) d\gamma &= \frac{(1-\underline{\gamma}^2)}{2} \frac{s(1-\theta)}{k+s(1-\theta)} + \frac{k}{k+s(1-\theta)} \frac{1-U}{Z} \\ &\quad \times \left[\chi^{\frac{k-\xi+\theta}{k}} \left(1 + \chi^{\xi/k} \right) - \frac{(1+\chi^{\xi/k})^2}{1+\chi} \frac{k-\xi+\theta}{2(k-\xi)+\theta} \chi^{\frac{2(k-\xi)+\theta}{k}} \right] \end{aligned}$$

follow from (26)-(28). Thereby, $Z = 1 + \chi^{1+\theta/k}$ has been considered. The Gini coefficient in the open economy is determined by $\mathfrak{G} = 1 - 2 \int_0^1 \mathfrak{L}_{\text{transfer}}(\gamma) d\gamma$.

Instead of explicitly solving for \mathfrak{G} , we can calculate $\mathfrak{G} - \mathfrak{G}_a$. This gives

$$\begin{aligned} \mathfrak{G} - \mathfrak{G}_a &= -\frac{2(1-U_a)}{(1+\chi f_x/f)^2} \frac{k}{k+s(1-\theta)} \left[\frac{k-\xi}{2(k-\xi)+\theta} [1 - (1+\chi)^2] \right. \\ &\quad \left. + \chi^{k-\xi+\theta} k \left[(1+\chi^{\xi/k})(1+\chi) - 1 \right] - \frac{k-\xi+\theta}{2(k-\xi)+\theta} \left[(1+\chi^{\xi/k})^2 - 1 \right] \chi^{\frac{2(k-\xi)+\theta}{k}} \right] \end{aligned}$$

After tedious but straightforward calculations, we finally arrive at

$$\mathfrak{G} - \mathfrak{G}_a = \frac{2(1-U_a)\chi}{(1+\chi)^2} \frac{k}{k+s(1-\theta)} \left[\frac{k-\xi}{2(k-\xi)+\theta} \chi(1-\chi^{\frac{\theta}{k}}) + J(\chi) \right],$$

with

$$J(\chi) = \frac{2(k-\xi)}{2(k-\xi)+\theta} - \chi^{\frac{\theta}{k}} + \frac{\theta}{2(k-\xi)+\theta} \chi^{\frac{k-\xi+\theta}{k}}.$$

Hence, $J(\chi) \geq 0$ is sufficient for $\mathfrak{G} - \mathfrak{G}_a \geq 0$. It is thus worth to have a closer look at $J(\chi)$. The first derivative of this function is given by

$$J'(\chi) = -\frac{\theta}{k} \chi^{\frac{\theta}{k}-1} \left[1 - \chi^{\frac{k-\xi}{k}} \frac{k-\xi+\theta}{2(k-\xi)+\theta} \right].$$

It is easy to show that $J(\chi)$ has a unique minimum at

$$\chi = \left(\frac{2(k-\xi)+\theta}{k-\xi+\theta} \right)^{\frac{k}{k-\xi}} \equiv \hat{\chi} > 1.$$

Noting further that $J(0) = 2(k-\xi)/[2(k-\xi)+\theta] > 0$, $J(1) = 0$, it is thus straightforward to conclude that $\mathfrak{G} - \mathfrak{G}_a = 0$ if either $\chi = 0$ or $\chi = 1$, while $\mathfrak{G} - \mathfrak{G}_a > 0$ if $\chi \in (0, 1)$. This is in line with the respective insights from the Lorenz curve analysis. Furthermore, this result confirms the shape of the relative Gini curve, $\mathfrak{G}/\mathfrak{G}_a$ in figure 5. Finally, the downward shift of this curve after a *trade-cum-redistribution* reform is immediate when noting that an s -increase shifts the Lorenz curve in the open economy upwards and thus lowers $\mathfrak{G}/\mathfrak{G}_a$ unambiguously for any given χ . This completes the analysis in this supplement.