

Kohl, Miriam

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Redistribution, Selection, and Trade*

Miriam Kohl[†]

TU Dresden

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Abstract

This paper examines the distributional effects of international trade in a general equilibrium model with heterogeneous agents and a welfare state redistributing income. The redistribution scheme is financed by a progressive income tax and gives the same absolute transfer to all individuals. *Ceteris paribus*, international trade leads to an increase in income per capita but also to higher income inequality on two fronts. Inter-group inequality between managers and workers increases, and intra-group inequality within the group of managers goes up as well. We show that for a given tax rate, there is an endogenous increase in the size of the welfare state that works against the increase in inequality, yet cannot offset it. The paper also sheds light on the conditions under which trade can actually lead to a Pareto improvement.

JEL-Classification: F12, F16, F68

Keywords: International trade, Income inequality, Redistribution, Heterogeneous firms

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[†]TU Dresden, Faculty of Business and Economics, Helmholtzstr. 10, 01069 Dresden, Germany; Email: miriam.kohl@tu-dresden.de.

1 Introduction

This paper looks at distributional effects of globalization in the presence of a welfare state redistributing income. Distributional effects of globalization are a topic hotly debated both by the general public and by academia.¹ The recent academic literature suggests that trade leads to overall gains but also to a rise in income inequality.² [Scheve and Slaughter \(2007\)](#) argue that this increase in inequality might lead to a protectionist drift in society and therefore ask for “a New Deal for globalization” that links globalization with redistribution policies. Accordingly it might be vital to accompany trade liberalization by redistribution policies if we want the current level of economic integration to be sustainable. This paper aims to contribute to exactly this discussion.

To this end we construct a trade model of monopolistic competition with heterogeneous firms and occupational choice based on [Egger and Kreickemeier \(2012\)](#). A model with heterogeneity allows us to get a richer picture of distributional effects of globalization that would not be present in a model with homogeneous firms. It is assumed that individuals are heterogeneous with respect to their managerial ability. Individuals observe their own skill and choose whether to become a manager or a worker accordingly. This occupational choice mechanism is as in [Lucas \(1978\)](#). Individuals can only use their managerial ability in the role as managers. We look at a progressive tax-transfer system. The redistribution scheme is financed by a tax solely on profit income and gives the same absolute transfer payment to all individuals. It can be interpreted as a very simple representation of a progressive income tax, since managers represent the high income group whereas workers represent the low income group. It is possible to look at two aspects of income inequality within this framework, namely inter-group inequality between managers and workers and intra-group inequality within the group of managers. Inter-group inequality is calculated as average post tax-transfer managerial income compared to post tax-transfer labour income whereas intra-group inequality is given by the Gini coefficient for post tax-transfer managerial income. We consider trade between two symmetric countries. In particular, this also implies that the tax-transfer system is the same in the two countries. There are two types of costs involved with trade. Firstly, the standard iceberg transport cost and secondly, a fixed exporting cost. This fixed exporting cost leads to selection of only the most productive firms into exporting.

We show that also in the presence of a progressive redistribution scheme gains from trade survive. Self-selection of the most productive firms into exporting increases welfare, measured as output per capita, in the economy. This increase in welfare, however, comes at a cost. For a given tax rate, inequality in the open economy equilibrium is higher than under autarky. We

¹See [Harrison et al. \(2011\)](#) for a non-technical overview on this topic in general and [Goldberg and Pavcnik \(2007\)](#) for a survey on distributional effects of globalization in developing countries.

²See for example [Egger and Kreickemeier \(2009a, 2012\)](#); [Helpman et al. \(2010\)](#); [Yeaple \(2005\)](#).

find that both inter-group inequality and intra-group inequality within the group of managers increase. We show that the redistribution scheme considered affects the occupational choice of individuals. The implication of this finding is that the cutoff ability level, the factor allocation and welfare depend on the tax-transfer system. To be more specific, the tax-transfer system leads to an increase in the cutoff ability and therefore to a decrease in the mass of managers. This means that the redistribution scheme itself leads to an additional selection effect in the economy. It is further shown that the redistribution scheme is distortionary, i.e. it decreases welfare. There exists a trade-off between efficiency and equality both in the closed and in the open economy. With a distortionary redistribution scheme in place it is no longer clear that trade-induced inequality can be decreased without jeopardizing the gains from trade completely.

This paper is related to various strands of the literature. It is linked to the literature that addresses distributional effects of globalization exploiting heterogeneity (see [Egger and Kreickemeier, 2009a, 2012](#); [Helpman et al., 2010](#); [Yeaple, 2005](#)). In particular, this paper contributes to the literature that exploits the link between globalization and top income inequality. [Keller and Olney \(2017\)](#) argue that globalization is an important driving force for the increase in top income inequality. This argument is also made in [Gersbach and Schmutzler \(2007\)](#). Using a matching model they show that globalization increases the heterogeneity of managerial compensation. [Gabaix and Landier \(2008\)](#) and [Gabaix et al. \(2014\)](#) contribute to the empirical literature that tries to explain CEO payments. They link changes in firms size to the increase in top income inequality.

This paper is also related to previous work on redistributing gains from trade. [Dixit and Norman \(1980, 1986\)](#) show the possibility of trade to be a Pareto improvement using redistribution policies that are not lump-sum. [Spector \(2001\)](#) questions the possibility to redistribute gains from trade. He argues that trade can lead to a loss in social welfare. The reason for this is as follows. In an open economy prices are determined on the world market. The government may therefore not be able to equalize equilibrium prices and wages through taxation. [Naito \(2006\)](#) also points to the possibility of social welfare losses.

So far there is surprisingly little research on the link between trade and inequality (exploiting heterogeneity) in the presence of a welfare state redistributing income. There are only few other papers on this topic, with a different focus though. [Egger and Kreickemeier \(2009b\)](#) integrate a distortionary tax-transfer system into a trade model with heterogeneous firms and fair-wages. They show that lower inequality than under autarky without sacrificing the gains from trade completely is possible if trade is accompanied by an increase in the profit tax rate. However, they focus on wage inequality and unemployment. Hence, it can be seen complementary to our analysis. [Itskhoki \(2008\)](#) discusses the optimal policy response to trade-induced inequality focusing on the equity-efficiency trade-off involved. [Antràs et al. \(2017\)](#) look at possibilities to redistribute the

gains from trade when redistribution is costly. Yet, they cannot address inter-group inequality and intra-group inequality among the group of managers. [Kohl \(2017a\)](#) analyzes the distributional effects of international trade in the presence of a redistribution scheme that is financed through a proportional income tax giving the same per capita transfer to all individuals. It is shown that this particular redistribution scheme is non-distortionary. In such a framework it is always possible to decrease trade-induced inequality without jeopardising the gains from trade. This is different as soon as we look at the more realistic case of a progressive income tax which we discuss in this contribution.

The remainder of this paper is organized as follows. In [Section 2](#) we derive the closed economy equilibrium. In [Section 3](#) we look at the open economy equilibrium. In particular, we discuss how trade affects the factor allocation, welfare, the size of the welfare state and the income distribution in the economy. [Section 4](#) concludes by summarizing the most important results.

2 The closed economy

In this section we first describe the economic environment. The basic economic environment is a simplified version of [Egger and Kreickemeier \(2012\)](#) with perfect labour markets. In a second step we introduce a simple redistribution scheme and look at its impact on the equilibrium factor allocation, welfare and the income distribution in the economy.

Individuals

The mass of individuals is an exogenous parameter of the model and denoted by N . We assume that individuals are heterogeneous in their managerial ability. It will be shown that this heterogeneity will drive the decision of individuals whether to become a manager or a worker. The managerial ability can be used if an individual decides to become a manager. It is of no use in the role as workers however. Managers are simultaneously the owner of the firm they are running and earn the firm's profit. Workers are paid an economy wide wage w regardless in which firm they are employed.

Production

There are two sectors in the economy: an intermediate goods sector and a final goods sector. In the final goods sector we assume perfect competition. Final output is a homogeneous good and given by a CES-aggregate of all varieties, i.e.

$$Y = \left[\int_{v \in V} q(v)^{\frac{\sigma-1}{\sigma}} dv \right]^{\frac{\sigma}{\sigma-1}}. \quad (1)$$

The quantity of variety v of the intermediate good is denoted by $q(v)$. The set of all available

varieties is given by V and the elasticity of substitution between the different varieties is indicated by σ with $\sigma > 1$. Following [Ethier \(1982\)](#)³ we see that the production technology exhibits external increasing returns to scale. We choose output as the numéraire implying that the price of the final good is given by $P = 1$. Profit maximization in the final goods sector fixes demand for each variety v of the intermediate good as follows

$$q(v) = Yp(v)^{-\sigma}, \quad (2)$$

with $p(v)$ being the price of variety v . In the intermediate goods sector we assume monopolistic competition along the lines of [Dixit and Stiglitz \(1977\)](#). There is a continuum of firms where the mass of firms will be endogenously determined in the model and is denoted by M . Each firm produces its own variety v . Monopolistic competition implies that firms take aggregate variables as exogenously given but set the price for their own variety like a monopolist. Because the ability of the manager determines the productivity of the firm, $\varphi(v)$, there is firm heterogeneity as in [Melitz \(2003\)](#). Each firm is run by one manager who employs an endogenous number of workers $l(v)$, where the number of workers is proportional to output, i.e. $l(v) = q(v)/\varphi(v)$. The firm specific unit production cost are therefore given as $c(v) = w/\varphi(v)$. Profit maximization in the intermediate goods sector determines the price for each variety v as follows

$$p(v) = \frac{\sigma}{\sigma - 1}c(v). \quad (3)$$

Because of CES the price is a constant mark-up over marginal costs. Combining the firm specific prices (Eq. (3)) with the demand for each variety (Eq. (2)) we can write output and revenue in the intermediate goods sector as follows

$$q(v) = Y \left(\frac{\sigma}{\sigma - 1} \frac{w}{\varphi(v)} \right)^{-\sigma} \quad \text{and} \quad r(v) = p(v)q(v) = Y \left(\frac{\sigma}{\sigma - 1} \frac{w}{\varphi(v)} \right)^{1-\sigma}. \quad (4)$$

Operating profits of firms in the intermediate goods sector are then given by

$$\pi^{op}(v) = r(v) - c(v)q(v) = \frac{1}{\sigma}r(v). \quad (5)$$

We can now compare output, employment, revenues and operating profits of two firms 1 and 2 and find

$$\frac{q(v_1)}{q(v_2)} = \left(\frac{\varphi(v_1)}{\varphi(v_2)} \right)^\sigma \quad \text{and} \quad \frac{l(v_1)}{l(v_2)} = \frac{r(v_1)}{r(v_2)} = \frac{\pi^{op}(v_1)}{\pi^{op}(v_2)} = \left(\frac{\varphi(v_1)}{\varphi(v_2)} \right)^{\sigma-1}. \quad (6)$$

³This modeling approach dates back to [Ethier \(1982\)](#). Many other scholars have used it since (e.g. [Matusz, 1996](#); [Egger et al., 2015](#); [Kohl, 2017a](#)).

We see that the productivity of a firm is decisive for its output, revenue, operating profits and employment. Eq. (6) implies that more productive firms have higher output, higher revenues, higher operating profits and also employ more workers.

Average productivity

We follow the literature and assume that ability and hence also productivity is Pareto distributed. The cumulative distribution function with shape parameter k is given by $G(\varphi) = 1 - \varphi^{-k}$, where the lower bound has been normalized to one. Assuming Pareto allows us to relate average productivity $\tilde{\varphi}$ to the productivity of the marginal firm φ^*

$$\tilde{\varphi} = \left(\frac{k}{k - (\sigma - 1)} \right)^{\frac{1}{\sigma-1}} \varphi^*, \quad (7)$$

where $k > \sigma - 1$ is assumed.⁴ Combining Eq. (6) with Eq. (7) we find that

$$\pi^{op}(\tilde{\varphi}) = \frac{k}{k - (\sigma - 1)} \pi^{op}(\varphi^*). \quad (8)$$

This means that there is a close link between profits of the average and the marginal firm in the economy.

Aggregates

In this part the aggregates in the closed economy shall be determined. Aggregate output is given by⁵

$$Y_a = M^{\frac{\sigma}{\sigma-1}} q(\tilde{\varphi}). \quad (9)$$

Please note that the subscript a indicates the autarky equilibrium. Aggregate revenue is then equal to

$$R_a = Y_a P_a = M^{\frac{\sigma}{\sigma-1}} q(\tilde{\varphi}) = Mr(\tilde{\varphi}), \quad (10)$$

where we used the fact that the final good is chosen as the numéraire and hence its price is normalized to one as well as noting that revenue is defined as price times quantity and the price of the firm with average productivity is given by $p(\tilde{\varphi}) = M^{\frac{1}{\sigma-1}}$.⁶ Aggregate operating profits can be calculated as

$$\Pi_a^{op} = M \pi^{op}(\tilde{\varphi}) = \frac{1}{\sigma} Mr(\tilde{\varphi}) = \frac{1}{\sigma} R_a = \frac{1}{\sigma} Y_a. \quad (11)$$

In general equilibrium aggregate output can also be interpreted as aggregate income. We hence

⁴The derivation of Eq. (7) is deferred to the Appendix; see A.1.

⁵The derivation of Eq. (9) is deferred to the Appendix; see A.2.

⁶Note that the price of the firm with average productivity is got by combining Eqs. (2) and (9).

see that a share of $1/\sigma$ of aggregate output goes to operating profit income whereas the remaining share $(\sigma - 1)/\sigma$ goes to aggregate labour income, i.e.

$$\frac{1}{\sigma}Y_a = \Pi_a^{op} \quad \text{and} \quad \frac{\sigma - 1}{\sigma}Y_a = w_a L_a. \quad (12)$$

The redistribution scheme

The redistribution scheme consists of two parts: a tax part and a transfer part. The tax part looks as follows. There is a proportional tax t on operating profit income⁷, where $t \in (0, 1)$, but no tax on wage income. This tax scheme captures the idea of a progressive income tax, since workers in this model represent the low income group, whereas managers represent the high income group.⁸ The government collects the tax revenue and redistributes it to all individuals in the economy with everyone getting the same absolute transfer payment b . By virtue of the budget constraint of the government the transfer income for each individual is equal to

$$b = \frac{tM\bar{\pi}}{N}. \quad (13)$$

In our analysis we will treat the per capita transfer b as endogenously determined by the budget constraint of the government, whereas the tax rate t is treated as an exogenous parameter. An important property of this tax-transfer system is that it does not change the pricing behavior of firms. The reason for this is that the tax is proportional and the benefit is treated as exogenous from the point of view of a single firm, since the transfer is determined by aggregates. And it is a property of monopolistic competition that aggregates are regarded as exogenously given.

Occupational choice

Following Lucas (1978) and Egger and Kreickemeier (2012) individuals face the choice whether to become a manager or a worker in the economy. They observe their own ability and choose the occupation accordingly by comparing their income in the two different occupations. The labour indifference condition is therefore given by

$$w + b = (1 - t)\pi(\varphi^*) + b, \quad (14)$$

where φ^* is the productivity of the marginal firm. Since the ability of the manager determines the productivity of a firm, φ^* can be interpreted as the ability of the marginal manager that is just

⁷Please note that in the closed economy there is no difference between operating profits and pure profits, since there are no fixed costs involved in the closed economy. This is different in the open economy as will be discussed in Section 3.

⁸This point will become obvious when discussing the occupational choice in the economy.

indifferent between becoming a manager or a worker. This implies that individuals with $\varphi \geq \varphi^*$ choose to become managers, whereas individuals with $\varphi < \varphi^*$ choose to become workers. It is immediate from inspection of Eq. (14) that the transfer b leaves occupational choice unaffected, while the tax t on managerial income distorts occupational choice, making it less attractive, ceteris paribus, to become a manager.⁹

Equilibrium factor allocation

Using the fact that aggregate labour and profit income are constant shares of overall output (cf. Eq. (12)) as well as using Eq. (8) we can write the labour indifference condition as

$$L = \frac{k(\sigma - 1)}{(k - (\sigma - 1))(1 - t)}M. \quad (15)$$

The labour indifference condition is illustrated in Figure 1.¹⁰ We see that it is an upward sloping locus in the $L - M$ space. An increase in the mass of workers decreases the wage ceteris paribus. Likewise an increase in the mass of managers decreases the profit of the marginal manager ceteris paribus. Therefore indifference requires a positive relationship between the mass of workers and the mass of managers. If we compare the labour indifference condition with a strictly positive tax with the case without taxation, we see that with the tax the labour indifference condition becomes flatter. The reason for this is that with the progressive tax each level of profits is associated with lower post-tax profits. Therefore the mass of workers has to increase (thereby lowering the wage) in order to restore indifference. Total resources are constrained. The mass of individuals is exogenously given in this model and denoted by N . Therefore the resource constraint constitutes a second relationship between the mass of workers and the mass of managers, namely

$$L = N - M. \quad (16)$$

In Figure 1 we see that the resource constraint is a downward sloping locus in the $L - M$ space. Combining the labour indifference condition with the resource constraint of the economy, we can solve for the equilibrium factor allocation in the economy and get

$$M_a = \frac{(k - (\sigma - 1))(1 - t)}{k(\sigma - 1) + (k - (\sigma - 1))(1 - t)}N \quad \text{and} \quad L_a = \frac{k(\sigma - 1)}{k(\sigma - 1) + (k - (\sigma - 1))(1 - t)}N. \quad (17)$$

The cutoff ability is implicitly given by $M = [1 - G(\varphi^*)]N$. Using the assumption that abilities are Pareto distributed, i.e. $G(\varphi^*) = 1 - (\varphi^*)^{-k}$ we can solve for the cutoff ability as a function of

⁹This is a crucial difference to Kohl (2017a) where taxation is not progressive. The particular redistribution scheme in Kohl (2017a) does not change the factor allocation in the economy and is therefore non-distortionary.

¹⁰In illustrating the equilibrium we follow Egger and Kreickemeier (2012).

the mass of firms, i.e.

$$\varphi^* = \left(\frac{N}{M} \right)^{\frac{1}{k}}. \quad (18)$$

In the left quadrant of Figure 1 the negative relationship between the mass of managers and the cutoff ability is shown. Calculating the cutoff ability in the economy as a function of solely exogenous parameters we get

$$\varphi_a^* = \left(\frac{k\sigma - (\sigma - 1) - (k - (\sigma - 1))t}{(k - (\sigma - 1))(1 - t)} \right)^{\frac{1}{k}}. \quad (19)$$

The equilibrium factor allocation as well as the equilibrium cutoff ability are illustrated in Figure 1. They all depend on the tax t . Compared to the equilibrium with no tax-transfer system we find that the equilibrium with the redistribution scheme features a greater mass of workers, a smaller mass of managers, and hence a higher cutoff ability.

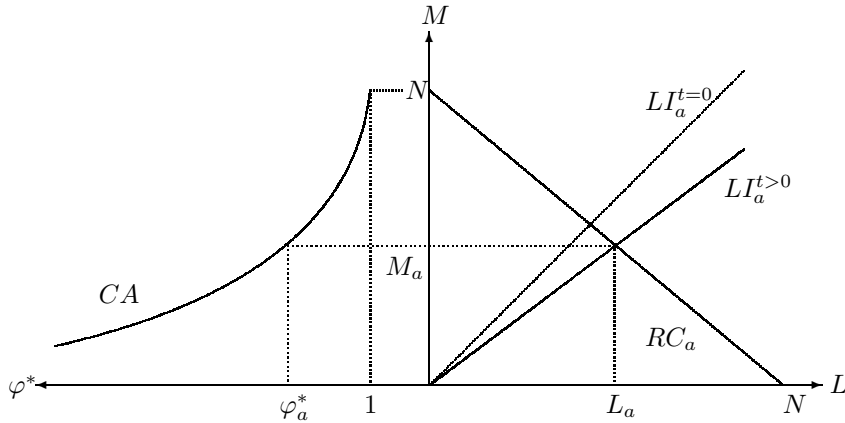


Figure 1: *Closed economy equilibrium with progressive taxation*

Welfare

Following Egger and Kreickemeier (2012) we take a utilitarian approach and define welfare as income per capita. Aggregate income is given by Eq. (11), i.e. $Y_a = \sigma M \pi^{op}(\tilde{\varphi})$. Operating profits of the firm with average productivity $\tilde{\varphi}$ are linked to the profits of the marginal firm with productivity φ^* by Eq. (8). The labour indifference condition requires that profits of the marginal firm are given by $\pi(\varphi^*) = w/(1 - t)$. Therefore we can write the operating profits of the firm with average productivity as follows

$$\pi(\tilde{\varphi}) = \frac{k}{k - (\sigma - 1)} \frac{w}{1 - t}. \quad (20)$$

The price of the intermediate good produced by the firm with average productivity is given by $\tilde{p} = M^{1/(\sigma-1)}$. We further know that all firms pay the same wage and therefore get the economy

wide wage under autarky as

$$w = \tilde{w} = M^{\frac{1}{\sigma-1}} \frac{\sigma-1}{\sigma} \tilde{\varphi}. \quad (21)$$

Combining Eqs. (20) and (21) and using Eq. (7) we get the following expression for aggregate income in the closed economy

$$Y_a = M_a^{\frac{\sigma}{\sigma-1}} \frac{k}{k - (\sigma - 1)} \frac{\frac{\sigma}{\sigma-1} \sigma - 1}{1 - t} \varphi_a^*. \quad (22)$$

Looking at Eq. (22) we see that ceteris paribus aggregate income depends positively on the mass of managers, the tax rate and the ability of the marginal manager. Using the equilibrium values for the mass of managers M_a and the cutoff productivity φ_a^* we can calculate welfare in closed form solution and get

$$\left(\frac{Y}{N}\right)_a = \frac{\sigma - 1}{1 - t} \left[\frac{k(1 - t)}{k(\sigma - 1) + (k - (\sigma - 1))(1 - t)} \right]^{\frac{\sigma}{\sigma-1}} \left[\frac{k(\sigma - 1) + (k - (\sigma - 1))(1 - t)}{(k - (\sigma - 1))(1 - t)} \right]^{\frac{1}{k}} N^{\frac{1}{\sigma-1}}. \quad (23)$$

It is straightforward to show that welfare under the tax-transfer system is smaller than welfare without a tax-transfer system, i.e.¹¹

$$\left(\frac{Y}{N}\right)_a^{t>0} < \left(\frac{Y}{N}\right)_a^{t=0}. \quad (24)$$

The tax-transfer system can therefore be called distortionary. The reason for the distortionary character is that the tax-transfer system changes the equilibrium factor allocation. Again looking at Eq. (22) we can disaggregate the overall effect of the redistribution scheme into three partial effects. First, the change in the mass of managers needs to be taken into account. Relative to a situation without a tax-transfer system the mass of managers decreases, which c.p. is welfare decreasing. Second, the change in the cutoff ability needs to be taken care of. With this redistribution scheme in place the marginal manager has a higher ability, which c.p. is welfare enhancing. Third, the primary effect of the tax driving a wedge between the wage and the profit of the marginal manager needs to be considered. By virtue of Eq. (20) the tax increases the profit of the average firm for a given wage. This c.p. increases welfare. Since the first effect dominates the second and third effect, welfare declines. This result corresponds to the finding by Egger et al. (2015) that show that having a production technology as described by Eq. (1) the factor allocation under autarky without any policy intervention is first-best and hence maximizes welfare.

Size of the welfare state

¹¹The proof is deferred to the Appendix; see A.3.

When introducing the redistribution scheme we argued that the progressive tax scheme is modeled in a way that there is a tax on operating profits. The size of the welfare state is defined as the total amount of tax revenue that is collected by the government and that can be redistributed, i.e.

$$\text{SWS}_a = t\Pi_a^{op} = t\frac{1}{\sigma}Y_a. \quad (25)$$

Looking at Eq. (11) we see that there is a close link between aggregate operating profits and aggregate income, i.e. $\Pi_a^{op} = (1/\sigma)Y$ and therefore also the size of the welfare state is linked to aggregate income and welfare.

Income distribution

There are two possible occupations and therefore two income groups in this model: managers and workers. When characterizing the income distribution in this economy let us first look at the inequality between these two groups. This measure is referred to as *inter-group inequality*. It is calculated as the ratio of average post tax-transfer¹² managerial income and post tax-transfer labour income. With the particular tax-transfer system considered we get

$$\text{InterIneq}_a = \frac{(1-t)\bar{\pi} + b}{w + b}. \quad (26)$$

where the tax and the transfer are linked via the budget constraint of the government and average profits and the wage are endogenous to the redistribution scheme. An increase in the tax rate leads to a decrease in the wage. This can be seen easily. By Eq. (12) we know that total labour income is a constant fraction of total output, i.e. $wL = \frac{\sigma-1}{\sigma}Y$. Since an increase in the tax rate decreases total output and increases the mass of workers, it directly follows that the wage has to fall. This endogenous adjustment counteracts the primary inequality decreasing effect of the redistribution scheme. Using the budget constraint of the government (Eq. (13)), the labour indifference condition (Eq. (14)) and the equilibrium factor allocation (Eq. (17)) together with Eq. (8) we find

$$\text{InterIneq}_a = \frac{\frac{k}{k-(\sigma-1)} + \frac{tk}{k(\sigma-1)+(1-t)(k-(\sigma-1))}}{1 + \frac{tk}{k(\sigma-1)+(1-t)(k-(\sigma-1))}}. \quad (27)$$

This is the expression for inter-group inequality in closed form taking all general equilibrium effects into account. It is straightforward to show that $\frac{\partial \text{InterIneq}_a}{\partial t} < 0$, which means that inter-group inequality decreases in the tax rate.¹³ When talking about the factor allocation and income per capita we found that results were solely driven by the tax part of the redistribution scheme.

¹²An alternative term for post tax-transfer income is secondary income. We will use these two terms interchangeably.

¹³The proof is deferred to the Appendix; see A.4.

This is different here. For the distributional effects the transfer is crucial. This point shall be made clearer with the following thought experiment. Imagine there was a tax on operating profits, but the tax revenue was thrown away. In this case the inter-group inequality can be calculated as follows

$$\text{InterIneq}_a^{t>0,b=0} = \frac{(1-t)\bar{\pi}}{w}. \quad (28)$$

Using $\bar{\pi} = \frac{k}{k-(\sigma-1)}\pi(\varphi^*)$ (Eq. (8)) together with $w = (1-t)\pi(\varphi^*)$ (Eq. (13)) we get

$$\text{InterIneq}_a^{t>0,b=0} = \frac{k}{k-(\sigma-1)}. \quad (29)$$

Interestingly, this result is independent of the tax rate t . It is equal to the result for inter-group inequality with no redistribution scheme at all. This finding is driven by the general equilibrium adjustment of the factor prices as well as the Pareto distribution. Therefore we argue that the transfer plays a crucial role for the distributional effects.

To get a richer picture of inequality we also want to look at the income distribution within the groups. We refer to this as *intra-group inequality*. Within the group of workers there is no heterogeneity. Every worker is paid the economy-wide wage w . Hence there is no income inequality within this group. However, within the group of managers there is heterogeneity. Managers earn the post tax profit of the firm they are running plus the transfer income. Since firm profits depend on the managerial ability of the manager (cf. Eq. (6)) and managers differ in their managerial ability, it follows that managers with a higher ability have a higher income compared to less able managers. In order to characterize the income distribution across managers we calculate the Lorenz curve for post tax-transfer managerial income. The cumulative secondary managerial income of all manager with an ability lower than or equal to $\bar{\varphi} \in [\varphi^*, \infty]$ relative to the aggregate secondary managerial income is given by

$$\frac{I(\bar{\varphi})}{I} = \frac{(1-t)\Pi(\bar{\varphi}) + bM(\bar{\varphi})}{(1-t)\Pi + bM}. \quad (30)$$

We see that secondary managerial income consists of two parts: firstly, post tax profit income and secondly, transfer income. We get the following Lorenz curve for secondary managerial income¹⁴

$$Q_a(\gamma) = \frac{k\sigma - (\sigma - 1) - [k(\sigma - 1) + (k - (\sigma - 1))(1 - t)](1 - \gamma)^{\frac{k-(\sigma-1)}{k}} - t(k - (\sigma - 1))(1 - \gamma)}{k\sigma - (\sigma - 1)}, \quad (31)$$

where γ indicates the share of all firms with a productivity smaller or equal to $\bar{\varphi}$. For each γ the Lorenz curve shows the corresponding income share. The corresponding Gini coefficient can then

¹⁴The derivation of the Lorenz curve is deferred to the Appendix; see A.5.

be calculated as

$$\text{IntraIneq}_a = 1 - 2 \int_0^1 Q_a(\gamma) d\gamma = \frac{\frac{k}{k-(\sigma-1)} - \frac{2k}{2k-(\sigma-1)}}{\frac{k}{k-(\sigma-1)} + \frac{tk}{(\sigma-1)k+(1-t)(k-(\sigma-1))}}. \quad (32)$$

It is straightforward to show that $\frac{\partial \text{IntraIneq}_a}{\partial t} < 0$, which means that intra-group inequality within the group of managers decreases in the tax rate.¹⁵ This result depends crucially on the transfer part of the redistribution scheme. Again imagine there was only a tax on profit income, but no transfer payment. In this case the Gini coefficient would be equal to the Gini coefficient under a scenario without any policy.¹⁶

In this section we characterized the income distribution in the economy using two measures. First, we looked at the difference in average income levels between the two groups. Second, we characterized the income distribution within the group of managers by calculating the Gini coefficient. We showed that both inequality measures decrease in the tax rate. This means that under autarky there clearly exists an efficiency equality trade-off. A positive tax rate decreases inequality, but at the same time decreases welfare.

3 The open economy

In this section the equilibrium in the open economy will be described. We look at intra-industry trade between two identical countries along the lines of [Krugman \(1980\)](#), [Ethier \(1982\)](#) and [Melitz \(2003\)](#). This means that we face two-way trade in horizontally differentiated products. In particular, we discuss how the factor allocation, welfare, the size of the welfare state and the income distribution are affected by trade.

Trade costs

There is free trade in the final goods sector, whereas trade in the intermediate goods sector is subject to trading costs. Following [Egger and Kreickemeier \(2012\)](#) there are two types of trade costs. On the one hand, there is the standard iceberg transport cost, $\tau > 1$. On the other hand, each exporting firm has to hire an export consultant who is paid a fee f .

Redistribution scheme

As in the closed economy the redistribution scheme looks as follows. It is financed by a tax t on

¹⁵The proof is deferred to the Appendix; see [A.6](#).

¹⁶The calculation is deferred to the Appendix; see [A.7](#).

operating profits.¹⁷ This tax revenue is then redistributed to all individuals with everyone getting the same per-capita transfer b . By virtue of the budget constraint of the government, the transfer payment is given by

$$b = \frac{tM\bar{\pi}_o^{op}}{N}, \quad (33)$$

where subscript o denotes the open economy equilibrium.

Occupational choice

Also in the open economy the key mechanism in determining the equilibrium is the occupational choice made by individuals. They have to choose whether to become a manager or a worker or an export consultant. The labour indifference condition states that the post tax-transfer income of the marginal manager should be equal to the post tax-transfer income of a worker and should also be equal to the post tax-transfer income of an export consultant. With the transfer b being the same for everybody, we can write the indifference condition for career choice as

$$(1 - t)\pi(\varphi^*) = w = f. \quad (34)$$

Hence, as under autarky, occupational choice is distorted by the progressive tax.

Decision to export

In the open economy an additional decision needs to be made by managers, namely the decision whether to export or not. Since countries are identical, the operating profits of an exporting firm with domestic operating profits $\pi^{op}(\varphi)$ are equal to $\Omega\pi^{op}(\varphi)$, with $1 < \Omega \equiv 1 + \tau^{1-\sigma} \leq 2$. In equilibrium there will be a marginal exporter with productivity φ_χ^* that is just indifferent between becoming an exporter or a non-exporter. The exporting indifference condition is therefore given by

$$(1 - t)\Omega\pi^{op}(\varphi_\chi^*) - f = (1 - t)\pi^{op}(\varphi_\chi^*). \quad (35)$$

Firms with productivity levels $\varphi \geq \varphi_\chi^*$ become exporters, whereas firms with productivities $\varphi < \varphi_\chi^*$ produce only for the domestic market. Substituting for f from Eq. (34), and using Eq. (6), we can rewrite the exporting indifference condition as follows

$$\Omega = 1 + \left(\frac{\varphi_\chi^*}{\varphi_\chi^*} \right)^{\sigma-1}. \quad (36)$$

We denote the share of exporting firms by χ . It can be calculated as the mass of exporting firms

¹⁷In the open economy there is a difference between operating profits and pure profits since the exporting activity involves to pay fixed costs. For analytical tractability we assume that operating profits and not pure profits are taxed.

relative to the mass of all firms, i.e.

$$\chi = \frac{1 - G(\varphi_\chi^*)}{1 - G(\varphi^*)} = \left(\frac{\varphi^*}{\varphi_\chi^*} \right)^k = (\Omega - 1)^{\frac{k}{\sigma-1}} = \tau^{-k}. \quad (37)$$

Hence, the share of exporting firms is independent of the tax-transfer system, and it is decreasing in the level of transport cost.

Average productivity

Also in the open economy the relationship between average productivity and the productivity of the marginal firm is given by Eq. (7).¹⁸

Aggregates

The aggregates in the open economy are given as follows. Aggregate output is given by

$$Y_o = (M(1 + \chi))^{\frac{\sigma}{\sigma-1}} q(\tilde{\varphi}). \quad (38)$$

Aggregate revenue can be calculated as

$$R_o = Y_o P_o = (M(1 + \chi))^{\frac{\sigma}{\sigma-1}} q(\tilde{\varphi}) = M(1 + \chi) r(\tilde{\varphi}), \quad (39)$$

where we used $p_o(\tilde{\varphi}) = (M(1 + \chi))^{\frac{1}{\sigma-1}}$ and $P_o = 1$. Aggregate operating profits are equal to

$$\Pi_o^{op} = M(1 + \chi) \pi^{op}(\tilde{\varphi}) = \frac{1}{\sigma} M r(\tilde{\varphi}) = \frac{1}{\sigma} R_o = \frac{1}{\sigma} Y_o. \quad (40)$$

We hence find that a share $1/\sigma$ of aggregate output goes to operating profits whereas a share $(\sigma - 1)/\sigma$ goes to aggregate labour income¹⁹, i.e.

$$\frac{1}{\sigma} Y_o = \Pi_o^{op} \quad \text{and} \quad \frac{\sigma - 1}{\sigma} Y_o = w_o L_o. \quad (41)$$

Equilibrium factor allocation

We now want to see how the factor allocation in the economy changes when going from autarky to trade and explain the driving forces. Having shown that the tax-transfer system leaves the export decision unaffected, it is obvious that, for a given t , the results are identical to [Egger and Kreickemeier \(2012\)](#). The first relationship between the mass of workers and the mass of managers that we need to look at is given by the labour indifference condition. As already outlined the

¹⁸The proof is deferred to the Appendix; see [A.8](#).

¹⁹Please note that this property heavily depends on CES.

labour indifference is achieved via the occupational choice mechanism (cf. Eq. (34)). Using Eqs. (5) and (8) together with Eqs. (38) and (41) we can rewrite the labour indifference condition as follows

$$L = \frac{(\sigma - 1)k(1 + \chi)}{(1 - t)(k - (\sigma - 1))}M. \quad (42)$$

The labour indifference condition constitutes an upward sloping relationship between the mass of workers and the mass of managers and is illustrated in Figure 2 indicated as LI_o . Compared to the labour indifference condition under autarky it is less steep. The second relationship that is needed in order to determine the equilibrium in the open economy is the resource constraint. It is given by

$$L = N - (1 + \chi)M. \quad (43)$$

This means that individuals in the open economy are either managers of a firm or production workers or employed as export consultants. It is also different from the resource constraint under autarky, since export consultants are only needed in the open economy, not in the closed economy. Combining Eqs. (42) and (43) we can determine the equilibrium factor allocation in the open economy. We explicitly solve for the mass of manager M_o and the mass of workers L_o

$$\begin{aligned} M_o &= \frac{(1 - t)(k - (\sigma - 1))}{(\sigma - 1)k(1 + \chi) + (1 - t)(k - (\sigma - 1))(1 + \chi)}N, \\ L_o &= \frac{(\sigma - 1)k}{(\sigma - 1)k + (1 - t)(k - (\sigma - 1))}N \end{aligned} \quad (44)$$

with the mass of export consultants following straightforwardly as χM_o . The equilibrium factor allocation in the open economy is illustrated in Figure 2.²⁰ We see that compared to the autarky equilibrium the mass of managers declines in the open economy, whereas the mass of workers stays constant. In fact, the mass of managers in the open economy just declines by the factor $1/(1 + \chi)$, i.e. $M_o = (1/(1 + \chi))M_a$. In the left quadrant of Figure 2 the cutoff ability (i.e. the ability of the marginal manager) is drawn as a downward sloping function of the mass of managers. The cutoff ability is implicitly defined by $M = [1 - G(\varphi^*)]N$. Solving for the cutoff ability in the open economy yields

$$\varphi_o^* = \left(\frac{(\sigma - 1)k(1 + \chi) + (1 - t)(k - (\sigma - 1))(1 + \chi)}{(1 - t)(k - (\sigma - 1))} \right)^{\frac{1}{k}}. \quad (45)$$

Comparing the cutoff ability in the open economy to the cutoff ability in the closed economy we see that it increases with trade. Indeed the following relationship holds: $\varphi_o^* = (1 + \chi)^{\frac{1}{k}}\varphi_a^*$. This means that under trade the marginal manager has a higher ability than under autarky. The reason for this finding is the lower mass of managers under trade.

²⁰In illustrating the equilibrium we follow Egger and Kreickemeier (2012).

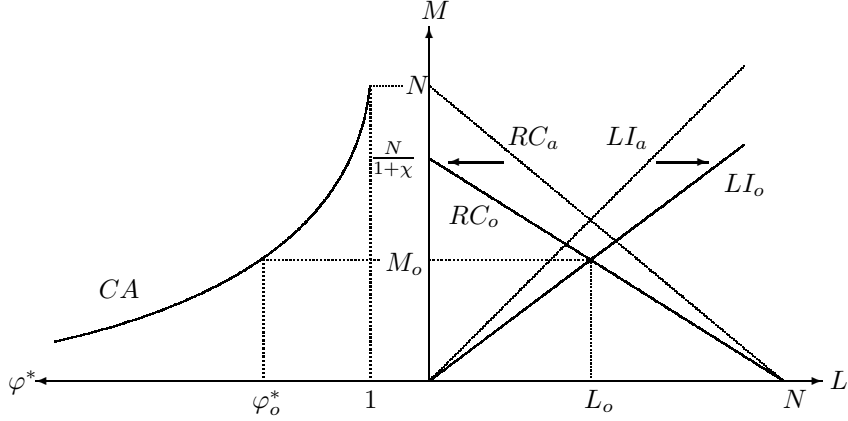


Figure 2: *Open economy equilibrium with progressive taxation*

Welfare

As outlined by Eq. (38) output in the open economy is given by $Y = M(1 + \chi)\sigma\pi^{op}(\tilde{\varphi})$. Following the same steps as done in the autarky equilibrium, we get the following expression for aggregate income

$$Y_o = M_o^{\frac{\sigma}{\sigma-1}} \frac{k}{k - (\sigma - 1)} \frac{\sigma - 1}{1 - t} (1 + \chi)^{\frac{\sigma}{\sigma-1}} \varphi_o^*. \quad (46)$$

If we compare aggregate income in the open economy to aggregate income in the closed economy (Eq. (22)) we find three differences. First, the mass of managers decreases in the open economy relative to autarky. This effect c.p. decreases welfare. Second, there are additional profits and therefore also additional income coming from exporting, which c.p. increases welfare. Third, the ability of the marginal manager is higher in the open economy than in the closed economy. This higher cutoff productivity c.p. increases welfare. It is straightforward to show that the first two effects just offset each other, since the mass of managers and therefore the mass of intermediate goods declines exactly by the factor $1/(1 + \chi)$ when going from autarky to trade. Hence, the only effect that remains is the third effect, namely the increase in the cutoff productivity. We use Eqs. (44) and (45) in order to get a closed form solution for welfare, i.e.

$$\left(\frac{Y}{N}\right)_o = N^{\frac{1}{\sigma-1}} \frac{\sigma - 1}{1 - t} (1 + \chi)^{\frac{1}{k}} \left[\frac{(1 - t)k}{(\sigma - 1)k + (1 - t)(k - (\sigma - 1))} \right]^{\frac{\sigma}{\sigma-1}} \left[\frac{(\sigma - 1)k + (1 - t)(k - (\sigma - 1))}{(1 - t)(k - (\sigma - 1))} \right]^{\frac{1}{k}}. \quad (47)$$

If we compare welfare in the open economy equilibrium with welfare in the autarky equilibrium we find that

$$\left(\frac{Y}{N}\right)_o = (1 + \chi)^{\frac{1}{k}} \left(\frac{Y}{N}\right)_a. \quad (48)$$

We see that welfare in the open economy equilibrium is higher than welfare in the autarky equilibrium by the factor $(1 + \chi)^{\frac{1}{k}}$.²¹ This is exactly the increase in the cutoff productivity. Hence we can conclude that welfare in the open economy is higher than under autarky because trade leads to an increase in efficiency via a higher cutoff productivity. Not only in the closed economy but also in the open economy the distortionary character of the tax-transfer system becomes obvious. It is straightforward to show that welfare with the tax-transfer system is smaller than welfare without the tax-transfer system, i.e.²²

$$\left(\frac{Y}{N}\right)_o^{t>0} < \left(\frac{Y}{N}\right)_o^{t=0}. \quad (49)$$

Size of the welfare state

The size of the welfare state (denoted by SWS) in the open economy equilibrium is equal to the tax rate t multiplied by the amount of operating profits in the open economy Π_o^{op} . By virtue of Eq. (41) there is a close link between operating profits and aggregate income, i.e. $\Pi_o^{op} = \frac{1}{\sigma}Y_o$. When deriving welfare for the open economy we argued that welfare increases when going from autarky to trade. Because the size of the welfare state (for a given tax rate t) is determined by the amount of operating profits and operating profits are linked closely to aggregate income (and hence also to welfare), it directly follows that the size of the welfare state increase in the open economy relative to autarky in the same way as does welfare, i.e.

$$\text{SWS}_o = (1 + \chi)^{\frac{1}{k}} \text{SWS}_a. \quad (50)$$

By virtue of the budget constraint of the government the tax revenue is redistributed to individuals in a lump sum way with everyone getting a per capita transfer b . This means that also the per capita transfer b increases in the open economy relative to autarky.²³ This endogenous adjustment of the size of the welfare state will have important implications for the income distribution and will be discussed in the following.

Income distribution

As done for the closed economy we look at two inequality measures. First, the *inter-group inequality* is determined. Second, the *intra-group inequality* within the group of managers is considered.²⁴

The inter-group inequality is determined by the ratio of secondary profit income and secondary

²¹Note that the gains from trade do not depend on the redistribution scheme. This result would change if we were to fix the transfer b letting the tax rate t adjust endogenously in the open economy.

²²The proof is deferred to the Appendix; see A.9.

²³The model therefore implies that more open economies have bigger governments. This finding is also supported by the data; see Rodrik (1998).

²⁴Derivations and proofs for this whole part are deferred to the Appendix; see A.10 - A.17.

labour income. It can be calculated as

$$\text{InterIneq}_o = \frac{(1-t)\bar{\pi}_o^{op} - \chi f + b}{w + b}. \quad (51)$$

If we compare this expression to the expression under autarky (Eq. (26)) it is at first sight not clear how inter-group inequality changes in the open economy relative to autarky. Let us for a moment ignore the government budget constraint, and assume that the transfer per capita was zero despite a positive t . In this case it is straightforward to show that inter-group inequality increases in the open economy because operating profits increase by more than the wage does. However, with the redistribution scheme in place the transfer per capita is not zero. In fact the transfer per capita in the open economy is higher than in the closed economy. When differentiating Eq. (51) with respect to the per capita transfer b it becomes obvious that inter-group inequality decreases in the size of the per capita transfer. This endogenous adjustment of the transfer payment in the open economy equilibrium counteracts the primary increase in inter-group inequality. In order to establish the overall effect of trade on the inter-group inequality we have to get the closed form solution for inter-group inequality in the open economy. It amounts to

$$\text{InterIneq}_o = \frac{(1+\chi)\frac{k}{k-(\sigma-1)} - \chi + \frac{tk}{(\sigma-1)k+(1-t)(k-(\sigma-1))}}{1 + \frac{tk}{(\sigma-1)k+(1-t)(k-(\sigma-1))}}. \quad (52)$$

We can now compare the closed form solution for inter-group inequality in the open economy with the corresponding expression under autarky. It is straightforward to show that inter-group inequality is higher in the open economy compared to autarky. The trade-induced increase in inter-group inequality, however, is smaller than in the case where the transfer per capita was zero. The reason for inter-group inequality to increase under trade is that the two groups in the society, i.e. managers and workers²⁵, do not benefit equally from trade. For a given tax rate t the post tax-transfer profit income increases by more than the post tax-transfer wage income. In the Appendix it is furthermore shown that inter-group inequality in the open economy is decreasing in the tax rate, i.e. $\frac{\partial \text{InterIneq}_o}{\partial t} < 0$.

When looking at inequality within the group of managers we again start by calculating the Lorenz curve for secondary managerial income. In the open economy the Lorenz curve consists of two parts, because there are two kinds of managers: non-exporters and exporters. The Gini coefficient for secondary managerial income in the open economy is given by

$$\text{IntraIneq}_o = \frac{\frac{\sigma-1}{k-(\sigma-1)}\chi + \frac{k}{k-(\sigma-1)} - \frac{\sigma-1}{2k-(\sigma-1)}\chi^2 - \frac{2k}{2k-(\sigma-1)}}{\frac{\sigma-1}{k-(\sigma-1)}\chi + \frac{k}{k-(\sigma-1)} + \frac{tk}{(\sigma-1)k+(1-t)(k-(\sigma-1))}}. \quad (53)$$

²⁵Note that we do not mention the export consultants explicitly here since they earn the same as workers.

We show in the Appendix that, for a given tax rate t , intra-group inequality in the open economy is higher than intra-group inequality in the closed economy. This is due to the selection of the most productive firms into exporting. Furthermore we derive the effect of an increase in the tax rate on intra-group inequality and prove the negative relationship.

We saw that income per capita depends negatively on the tax rate, whereas the two equality measures we looked at depend positively on the tax rate. We hence can conclude that also in the open economy there exists a trade-off between efficiency and equality.

Can trade lead to a Pareto improvement?

In the last section we argued that on average both groups in the society gain from trade (though unequally). However, this does not imply that trade actually leads to a Pareto improvement. In order to answer the question whether trade can lead to a Pareto improvement we have to compare the post tax-transfer income of all individuals in the closed economy to the post tax-transfer income of all individuals in the open economy.

Let us start by looking at the income of workers. Their income is given by the wage plus the transfer, i.e. $w + b$. Since wage income (wL) is a constant fraction of overall income (Y) and we know that the mass of workers stays constant when going from autarky to trade whereas overall income increases, it follows directly that the wage rate has to be higher in the open economy than in the closed economy equilibrium. Furthermore we know that the transfer per capita endogenously increases when going from autarky to trade. Therefore we can conclude that workers are definitely better off under trade than under autarky.

Let us now turn to the group of managers. We already argued that the managers at the upper end of the income distribution disproportionately gain from trade since there are additional profits through exporting. Hence the remaining question is what happens to the mediocre managers. We therefore compare the income of the marginal manager under trade with the income of the manager (having the same ability) under autarky. The income of the marginal manager under trade is given by $(1 - t)\pi_o(\varphi_o^*) + b_o$. By virtue of the labour indifference condition (Eq. (34)) this is equal to the wage plus the transfer per capita, i.e. $w_o + b_o$. Using Eqs. (41), (48) and (50) this can also be written as $(1 + \chi)^{\frac{1}{\kappa}}w_a + (1 + \chi)^{\frac{1}{\kappa}}b_a$. Let us compare this expression to the income of the manager with ability φ_o^* under autarky. Note that this manager is an inframarginal manager under autarky since the cutoff ability is higher in the open economy than in the closed economy, i.e. $\varphi_o^* > \varphi_a^*$. The income of the respective manager is given by $(1 - t)\pi_a(\varphi_o^*) + b_a$. Using Eqs. (6), (14), (19) and (45) this can be expressed as $(1 + \chi)^{\frac{\sigma-1}{\kappa}}w_a + b_a$. For a moment let us assume that there was no tax-transfer system in place implying that the transfer per capita is zero. In this case the mediocre managers are losing from trade if $\sigma > 2$ and hence trade does not lead to a Pareto

improvement in this case. The tax-transfer system c.p. changes this parameter constraint. With the tax-transfer system the mediocre managers are losing from trade if $\sigma > \Gamma$, where $\Gamma > 2$.²⁶ This means that with the tax-transfer system in place there is more room for trade to lead to a Pareto improvement than without the tax-transfer system. Figures 3 and 4 plot the secondary income of individuals as a function of their ability φ . The continuous line indicates the secondary income schedule under trade, whereas the dotted line shows the secondary income schedule under autarky.²⁷ Figure 3 shows the case for $t = 0$ where trade does not lead to a Pareto improvement. There is a group of low ability managers that are worse off when going from autarky to trade. In contrast to this scenario, Figure 4 illustrates the case for $t = 0.5$ where trade actually leads to a Pareto improvement. We see that also the marginal manager in the open economy gains from trade. Hence, as illustrated graphically, the presence of a welfare state increases the parameter space where trade leads to a Pareto improvement.

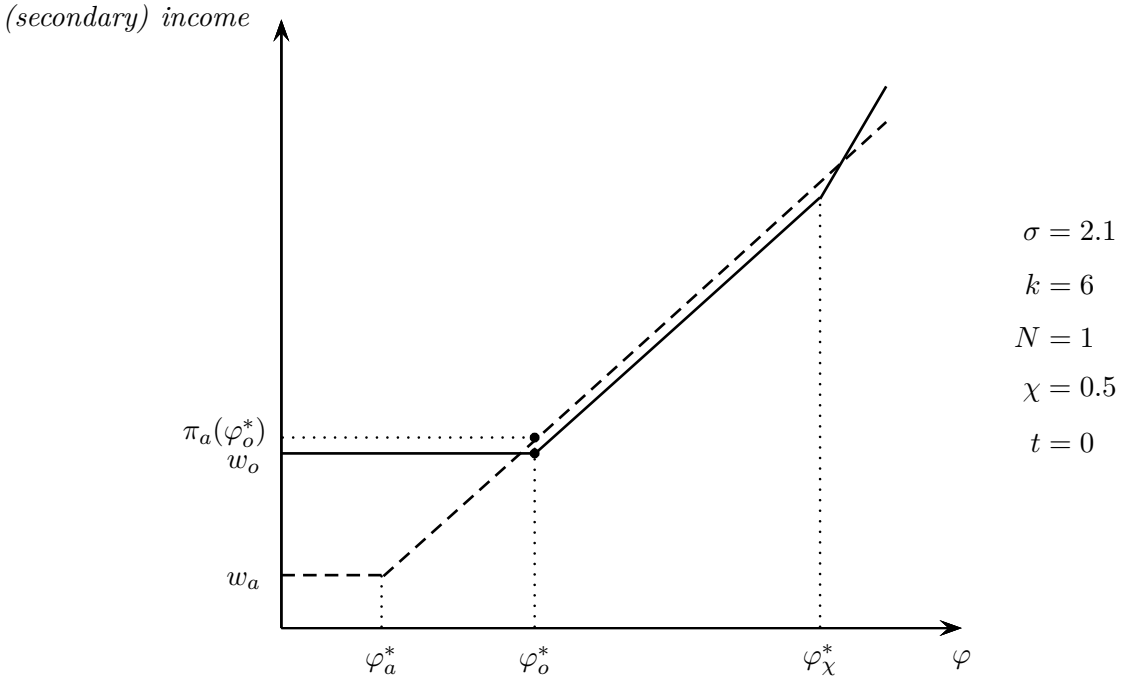


Figure 3: *Secondary income schedules: No Pareto improvement*

4 Conclusion

By incorporating a government sector we have been able to study the distributional effects of globalization in the presence of a welfare state redistributing income. The welfare state is financed

²⁶Note that this result is shown in the Appendix; see A.18.

²⁷The secondary income schedules are derived in the Appendix; see A.19.

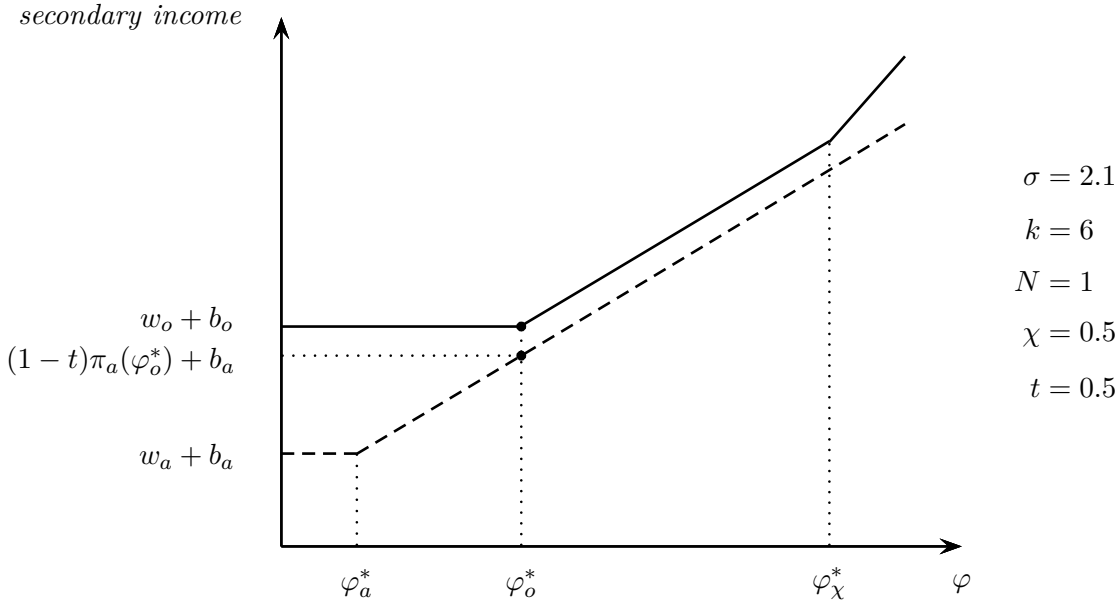


Figure 4: *Secondary income schedules: Pareto improvement*

by a proportional tax on operating profits. This tax can be interpreted as a particularly simple version of a progressive income tax, since managers represent the high income group, whereas workers represent the low income group. The tax revenue is collected by the government and redistributed to individuals in a lump sum fashion with everyone getting the same per capita transfer.

We show that the tax-transfer system affects the occupational choice of individuals and therefore leads to a selection effect changing the factor allocation in the economy. *Ceteris paribus*, an increase in the tax rate decreases welfare, but also lowers income inequality. This means that there exists an efficiency equality trade-off both in the closed and in the open economy. We find that, for a given tax rate, international trade leads to higher aggregate income but also to higher income inequality on two fronts. Both inter-group inequality and intra-group inequality increases. We also find that the size of the welfare state endogenously increases when going from the autarky equilibrium to the open economy equilibrium. This implies that, for a given tax rate, the transfer per capita is higher in the open economy than in the closed economy. This endogenous adjustment is a counteracting force to the primary trade induced increase in inequality, yet cannot outweigh it. Moreover, workers always gain from trade in this model while there exists the possibility that mediocre managers are worse off after trade liberalization. However, we show that the tax-transfer system increases the room for trade to lead to a Pareto improvement.

References

- ANTRÀS, P., A. DE GORTARI, AND O. ITSKHOKI (2017): “Globalization, Inequality, and Welfare,” *Journal of International Economics*, 108, 387–412. 2
- DIXIT, A. AND V. NORMAN (1980): *Theory of International Trade*, Cambridge University Press. 2
- (1986): “Gains from Trade without Lump-sum Compensation,” *Journal of International Economics*, 21, 111 – 122. 2
- DIXIT, A. K. AND J. E. STIGLITZ (1977): “Monopolistic Competition and Optimum Product Diversity,” *The American Economic Review*, 67, 297–308. 4
- EGGER, H. AND U. KREICKEMEIER (2009a): “Firm Heterogeneity and the Labor Market Effects of Trade Liberalization,” *International Economic Review*, 50, 187–216. 1, 2
- (2009b): “Redistributing Gains from Globalisation,” *Scandinavian Journal of Economics*, 111, 765 – 788. 2
- (2012): “Fairness, Trade, and Inequality,” *Journal of International Economics*, 86, 184–196. 1, 2, 3, 6, 7, 8, 12, 14, 15
- EGGER, H., U. KREICKEMEIER, AND J. WRONA (2015): “Offshoring Domestic Jobs,” *Journal of International Economics*, 97, 112–125. 4, 9
- ETHIER, W. J. (1982): “National and International Returns to Scale in the Modern Theory of International Trade,” *American Economic Review*, 72, 389–405. 4, 12
- GABAIX, X. AND A. LANDIER (2008): “Why Has CEO Pay Increased so Much?” *Quarterly Journal of Economics*, 123, 49–100. 2
- GABAIX, X., A. LANDIER, AND J. SAUVAGNAT (2014): “CEO Pay and Firm Size: An Update After the Crisis,” *Economic Journal*, 124, F40–F59. 2
- GERSBACH, H. AND A. SCHMUTZLER (2007): “Does Globalization Create Superstars?” CEPR Discussion Paper 6222. 2
- GOLDBERG, P. K. AND N. PAVCNIK (2007): “Distributional Effects of Globalization in Developing Countries,” *Journal of Economic Literature*, 45, 39 – 82. 1
- HARRISON, A., J. MCLAREN, AND M. MCMILLAN (2011): “Recent Perspectives on Trade and Inequality,” *Annual Review of Economics*, 3, 261–289. 1
- HELPMAN, E., O. ITSKHOKI, AND S. REDDING (2010): “Inequality and Unemployment in a Global Economy,” *Econometrica*, 78, 1239–1283. 1, 2
- ITSKHOKI, O. (2008): “Optimal Redistribution in an Open Economy,” Unpublished Manuscript, Harvard University. 2
- KELLER, W. AND W. OLNEY (2017): “Globalization and Executive Compensation,” CEPR Discussion Paper 12026. 2
- KOHL, M. (2017a): “Trade, Inequality, and the Size of the Welfare State,” CEPIE Working Paper 01/17. 3, 4, 7
- KRUGMAN, P. (1980): “Scale Economies, Product Differentiation, and the Pattern of Trade,” *The American Economic Review*, 70, 950–959. 12

- LUCAS, R. E. J. (1978): “On the Size Distribution of Business Firms,” *Bell Journal of Economics*, 9, 508–523. 1, 6
- MATUSZ, S. J. (1996): “International Trade, the Division of Labor, and Unemployment.” *International Economic Review*, 37, 71 – 84. 4
- MELITZ, M. J. (2003): “The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity,” *Econometrica*, 71, 1695–1725. 4, 12
- NAITO, H. (2006): “Redistribution, Production Inefficiency and Decentralized Efficiency,” *International Tax and Public Finance*, 13, 625–640. 2
- RODRIK, D. (1998): “Why Do More Open Economies Have Bigger Governments?” *Journal of Political Economy*, 106, 997 – 1032. 17
- SCHEVE, K. E. AND M. J. SLAUGHTER (2007): “A New Deal for Globalization,” *Foreign Affairs*, 86, 34 – 47. 1
- SPECTOR, D. (2001): “Is it Possible to Redistribute the Gains from Trade using Income Taxation?” *Journal of International Economics*, 55, 441 – 460. 2
- YEAPLE, S. R. (2005): “A Simple Model of Firm Heterogeneity, International Trade, and Wages,” *Journal of International Economics*, 65, 1–20. 1, 2

A Appendix

A.1 Derivation of Eq. (7)

We want to derive average productivity as a function of marginal productivity. Revenues of the firm with average productivity are given by

$$r(\tilde{\varphi}) = \frac{1}{1 - G(\varphi^*)} \int_{\varphi^*}^{\infty} r(\varphi) dG(\varphi). \quad (\text{A.1})$$

Using Eq. (6) and $G(\varphi) = 1 - \varphi^{-k}$ we get

$$r(\tilde{\varphi}) = \frac{k}{k - (\sigma - 1)} r(\varphi^*). \quad (\text{A.2})$$

Again using Eq. (6) together with Eq. (A.2) we get Eq. (7).

A.2 Derivation of Eq. (9)

Aggregate output is given by

$$Y = \left[\int_0^{\infty} M q(\varphi)^{\frac{\sigma-1}{\sigma}} \mu(\varphi) d\varphi \right]^{\frac{\sigma}{\sigma-1}}. \quad (\text{A.3})$$

Using Eq. (6) as well as noting that $\mu(\varphi)$ is the conditional distribution of $g(\varphi)$ on $[\varphi^*, \infty)$, i.e.

$$\mu(\varphi) = \begin{cases} \frac{g(\varphi)}{1 - G(\varphi^*)} & \text{if } \varphi \geq \varphi^*, \\ 0 & \text{otherwise} \end{cases} \quad (\text{A.4})$$

we get

$$\begin{aligned} Y &= M^{\frac{\sigma}{\sigma-1}} \left[\int_0^{\infty} \left(\left(\frac{\varphi}{\tilde{\varphi}} \right)^{\sigma} q(\tilde{\varphi}) \right)^{\frac{\sigma-1}{\sigma}} \mu(\varphi) d\varphi \right]^{\frac{\sigma}{\sigma-1}} \\ &= M^{\frac{\sigma}{\sigma-1}} \tilde{\varphi}^{-\sigma} q(\tilde{\varphi}) \left[\int_0^{\infty} \varphi^{\sigma-1} \mu(\varphi) d\varphi \right]^{\frac{\sigma}{\sigma-1}}. \end{aligned} \quad (\text{A.5})$$

Noting that $\tilde{\varphi} = \left[\int_0^{\infty} \varphi^{\sigma-1} \mu(\varphi) d\varphi \right]^{\frac{1}{\sigma-1}}$ is a weighted average of the firm productivity levels φ we directly get

$$Y = M^{\frac{\sigma}{\sigma-1}} q(\tilde{\varphi}). \quad (\text{A.6})$$

A.3 Showing that $\left(\frac{Y}{N}\right)_a^{t>0} < \left(\frac{Y}{N}\right)_a^{t=0}$

$\left(\frac{Y}{N}\right)_a^{t>0}$ is given by Eq. (23), i.e.

$$\left(\frac{Y}{N}\right)_a^{t>0} = \frac{\sigma - 1}{1 - t} \left[\frac{k(1 - t)}{k(\sigma - 1) + (k - (\sigma - 1))(1 - t)} \right]^{\frac{\sigma}{\sigma-1}} \left[\frac{k(\sigma - 1) + (k - (\sigma - 1))(1 - t)}{(k - (\sigma - 1))(1 - t)} \right]^{\frac{1}{k}} N^{\frac{1}{\sigma-1}}. \quad (\text{A.7})$$

$\left(\frac{Y}{N}\right)_a^{t=0}$ is given by

$$\left(\frac{Y}{N}\right)_a^{t=0} = (\sigma - 1) \left[\frac{k}{k(\sigma - 1) + (k - (\sigma - 1))} \right]^{\frac{\sigma}{\sigma-1}} \left[\frac{k(\sigma - 1) + (k - (\sigma - 1))}{k - (\sigma - 1)} \right]^{\frac{1}{k}} N^{\frac{1}{\sigma-1}}. \quad (\text{A.8})$$

We have to show that

$$\frac{1}{1-t} \left[\frac{k(\sigma - 1) + (k - (\sigma - 1))(1-t)}{(k\sigma - (\sigma - 1))(1-t)} \right]^{\frac{1}{k}} < \left[\frac{k(\sigma - 1) + (k - (\sigma - 1))(1-t)}{(k\sigma - (\sigma - 1))(1-t)} \right]^{\frac{\sigma}{\sigma-1}}. \quad (\text{A.9})$$

Rewriting this inequality as a function of the tax rate t we get

$$f(t) \equiv \frac{1}{1-t} \left[1 + \frac{k(\sigma - 1)}{k\sigma - (\sigma - 1)} \frac{t}{1-t} \right]^{-\frac{k\sigma - (\sigma - 1)}{k(\sigma - 1)}} \leq 1. \quad (\text{A.10})$$

Noting that $f(0) = 1$ we have to show that $f(t)$ is decreasing in t . We get

$$f'(t) = \frac{1}{(1-t)^2} \left[1 + \frac{k(\sigma - 1)}{k\sigma - (\sigma - 1)} \frac{t}{1-t} \right]^{-\frac{k\sigma - (\sigma - 1)}{k(\sigma - 1)}} \left[1 - \frac{1}{(1-t) + \frac{k(\sigma - 1)}{k\sigma - (\sigma - 1)}t} \right] < 0, \quad (\text{A.11})$$

since $\frac{k(\sigma - 1)}{k\sigma - (\sigma - 1)} < 1$ which completes the proof.

A.4 Showing that $\frac{\partial \text{InterIneq}_a}{\partial t} < 0$

Inter-group inequality in the closed economy is given by Eq. (27). Calculating the partial derivative of InterIneq_a with respect to the tax rate t we get

$$\begin{aligned} \frac{\partial \text{InterIneq}_a}{\partial t} &= \frac{\frac{k[k(\sigma - 1) + (k - (\sigma - 1))(1-t)] - tk(-k + (\sigma - 1))}{[k(\sigma - 1) + (k - (\sigma - 1))(1-t)]^2} \left[1 + \frac{tk}{k(\sigma - 1) + (k - (\sigma - 1))(1-t)} \right]}{\left[1 + \frac{tk}{k(\sigma - 1) + (k - (\sigma - 1))(1-t)} \right]^2} \\ &\quad - \frac{\frac{k[k(\sigma - 1) + (k - (\sigma - 1))(1-t)] - tk(-k + (\sigma - 1))}{[k(\sigma - 1) + (k - (\sigma - 1))(1-t)]^2} \left[\frac{k}{k - (\sigma - 1)} + \frac{tk}{k(\sigma - 1) + (k - (\sigma - 1))(1-t)} \right]}{\left[1 + \frac{tk}{k(\sigma - 1) + (k - (\sigma - 1))(1-t)} \right]^2}. \end{aligned} \quad (\text{A.12})$$

It is straightforward to show that indeed $\frac{\partial \text{InterIneq}_a}{\partial t} < 0$ since $\frac{k}{k - (\sigma - 1)} > 1$.

A.5 Derivation of Eq. (31)

The cumulative secondary managerial income of all managers with a productivity level lower than or equal to $\bar{\varphi} \in [\varphi^*, \infty]$ relative to the aggregate secondary managerial income is given by Eq. (30).

Noting that

$$\begin{aligned}
\Pi(\bar{\varphi}) &= \frac{M}{1 - G(\varphi^*)} \int_{\varphi^*}^{\bar{\varphi}} \pi(\varphi) dG(\varphi) \\
&= \frac{k}{(\sigma - 1) - k} M \pi(\varphi^*) \left[\left(\frac{\varphi^*}{\bar{\varphi}} \right)^{k - (\sigma - 1)} - 1 \right] \\
M(\bar{\varphi}) &= \frac{M}{1 - G(\varphi^*)} \int_{\varphi^*}^{\bar{\varphi}} dG(\varphi) \\
&= M \left[1 - \left(\frac{\varphi^*}{\bar{\varphi}} \right)^k \right]
\end{aligned} \tag{A.13}$$

and using Eqs. (8), (11), (13) and (17) we can rewrite Eq. (30) as follows

$$\frac{I(\bar{\varphi})}{I} = \frac{k\sigma - (\sigma - 1) - (k(\sigma - 1) + (k - (\sigma - 1))(1 - t)) \left(\frac{\varphi^*}{\bar{\varphi}} \right)^{k - (\sigma - 1)} - t(k - (\sigma - 1)) \left(\frac{\varphi^*}{\bar{\varphi}} \right)^k}{k\sigma - (\sigma - 1)}. \tag{A.14}$$

The share of all firms with a productivity smaller or equal to $\bar{\varphi}$ is given by

$$\gamma \equiv \frac{M(\bar{\varphi})}{M} = 1 - \left(\frac{\varphi^*}{\bar{\varphi}} \right)^k. \tag{A.15}$$

Eq. (A.14) together with Eq. (A.15) deliver the Lorenz curve for post tax-transfer managerial income.

A.6 Showing that $\frac{\partial \text{IntraIneq}_a}{\partial t} < 0$

Intra-group inequality in the closed economy is given by Eq. (32). Calculating the partial derivative of IntraIneq_a with respect to the tax rate t we get

$$\begin{aligned}
\frac{\partial \text{IntraIneq}_a}{\partial t} &= - \frac{\frac{k}{k - (\sigma - 1)} - \frac{2k}{2k - (\sigma - 1)}}{\left[\frac{k}{k - (\sigma - 1)} + \frac{tk}{(\sigma - 1)k + (1 - t)(k - (\sigma - 1))} \right]^2} \\
&\quad \times \frac{k [(\sigma - 1)k + (1 - t)(k - (\sigma - 1))] + tk [k - (\sigma - 1)]}{[(\sigma - 1)k + (1 - t)(k - (\sigma - 1))]^2}.
\end{aligned} \tag{A.16}$$

It is straightforward to show that indeed $\frac{\partial \text{IntraIneq}_a}{\partial t} < 0$, since $\frac{k}{k - (\sigma - 1)} > \frac{2k}{2k - (\sigma - 1)}$.

A.7 Derivation of $\text{IntraIneq}_a^{t>0, b=0}$

Imagine there was a positive tax on operating profits, but the tax income was thrown away. For this case we want to derive the Gini coefficient for secondary managerial income. The cumulative secondary managerial income of all managers with a productivity level lower than or equal to $\bar{\varphi} \in [\varphi^*, \infty]$ relative to the aggregate secondary managerial income is given by

$$\frac{I(\bar{\varphi})}{I} = \frac{(1 - t)\Pi(\bar{\varphi})}{(1 - t)\Pi}. \tag{A.17}$$

It becomes immediately obvious that the tax rate cancels. Using Eqs. (6), (8) and (11) we get

$$\frac{I(\bar{\varphi})}{I} = 1 - \left(\frac{\varphi^*}{\bar{\varphi}}\right)^{k-(\sigma-1)}. \quad (\text{A.18})$$

The share of all firms with a productivity smaller or equal to $\bar{\varphi}$ is given by Eq. (A.15). Eq. (A.18) together with Eq. (A.15) deliver the Lorenz curve for secondary managerial income as follows

$$Q_a^{t>0,b=0}(\gamma) = 1 - (1 - \gamma)^{1 - \frac{\sigma-1}{k}}. \quad (\text{A.19})$$

From the Lorenz curve we can then derive the Gini coefficient and get

$$\text{IntraIneq}_a^{t>0,b=0} = 1 - 2 \int_0^1 Q_a^{t>0,b=0}(\gamma) d\gamma = \frac{\sigma - 1}{2k - (\sigma - 1)}. \quad (\text{A.20})$$

Please note that the Gini coefficient is the same as in the case when there is no redistribution scheme at all.

A.8 The relationship between $\tilde{\varphi}$ and φ^* in the open economy

The CES price index in the open economy is given by

$$P^{1-\sigma} = N \int_{\varphi^*}^{\varphi_\chi^*} p(\varphi)^{1-\sigma} dG(\varphi) + N \int_{\varphi_\chi^*}^{\infty} p(\varphi)^{1-\sigma} dG(\varphi) + N \int_{\varphi_\chi^*}^{\infty} \tau^{1-\sigma} p(\varphi)^{1-\sigma} dG(\varphi). \quad (\text{A.21})$$

Using the fact that the final good is chosen as the numéraire and hence its price is normalised to one ($P = 1$) as well as using $\Omega = 1 + \tau^{1-\sigma}$ and $M = [1 - G(\varphi^*)] N = (\varphi^*)^{-k} N$ we can rewrite Eq. (A.21) as

$$1 = M(\varphi^*)^k \left[\int_{\varphi^*}^{\varphi_\chi^*} p(\varphi)^{1-\sigma} dG(\varphi) + \Omega \int_{\varphi_\chi^*}^{\infty} p(\varphi)^{1-\sigma} dG(\varphi) \right]. \quad (\text{A.22})$$

Using $p(\varphi)/p(\varphi^*) = \varphi^*/\varphi$ we get

$$1 = M \frac{k}{k - (\sigma - 1)} p(\varphi^*)^{1-\sigma} \left[1 - \left(\frac{\varphi_\chi^*}{\varphi^*}\right)^{\sigma-1-k} + \Omega \left(\frac{\varphi_\chi^*}{\varphi^*}\right)^{\sigma-1-k} \right]. \quad (\text{A.23})$$

Substituting $(\varphi_\chi^*/\varphi^*)^{-k} = \chi$ and using $p(\varphi^*)/p(\tilde{\varphi}) = \tilde{\varphi}/\varphi^*$ we obtain

$$1 = M \frac{k}{k - (\sigma - 1)} \left(\frac{\varphi^*}{\tilde{\varphi}}\right)^{\sigma-1} p(\tilde{\varphi})^{1-\sigma} \left[1 + \chi(\Omega - 1) \left(\frac{\varphi_\chi^*}{\varphi^*}\right)^{\sigma-1} \right]. \quad (\text{A.24})$$

With the price of the average firm given by $p(\tilde{\varphi}) = (M(1 + \chi))^{\frac{1}{\sigma-1}}$ we find

$$1 = \frac{k}{k - (\sigma - 1)} \left(\frac{\varphi^*}{\tilde{\varphi}}\right)^{\sigma-1} \frac{1}{1 + \chi} \left[1 + \chi(\Omega - 1) \left(\frac{\varphi_\chi^*}{\varphi^*}\right)^{\sigma-1} \right]. \quad (\text{A.25})$$

Solving for the average productivity $\tilde{\varphi}$ gives

$$\tilde{\varphi} = \frac{k}{k - (\sigma - 1)} \frac{1}{\sigma - 1} \varphi^* \left\{ \frac{1}{1 + \chi} \left[1 + \chi(\Omega - 1) \left(\frac{\varphi_\chi^*}{\varphi^*} \right)^{\sigma - 1} \right] \right\}^{\frac{1}{\sigma - 1}}. \quad (\text{A.26})$$

Using $\Omega = 1 + (\varphi^*/\varphi_\chi^*)^{\sigma - 1}$ we arrive at

$$\tilde{\varphi} = \frac{k}{k - (\sigma - 1)} \frac{1}{\sigma - 1} \varphi^* \quad (\text{A.27})$$

which completes the proof.

A.9 Showing that $\left(\frac{Y}{N}\right)_o^{t > 0} < \left(\frac{Y}{N}\right)_o^{t = 0}$

$\left(\frac{Y}{N}\right)_o^{t > 0}$ is given by Eq. (47), i.e.

$$\begin{aligned} \left(\frac{Y}{N}\right)_o^{t > 0} &= N^{\frac{1}{\sigma - 1}} \frac{\sigma - 1}{1 - t} (1 + \chi)^{\frac{1}{k}} \left[\frac{(1 - t)k}{(\sigma - 1)k + (1 - t)(k - (\sigma - 1))} \right]^{\frac{\sigma}{\sigma - 1}} \\ &\quad \left[\frac{(\sigma - 1)k + (1 - t)(k - (\sigma - 1))}{(1 - t)(k - (\sigma - 1))} \right]^{\frac{1}{k}}. \end{aligned} \quad (\text{A.28})$$

$\left(\frac{Y}{N}\right)_o^{t = 0}$ is given by

$$\left(\frac{Y}{N}\right)_o^{t = 0} = N^{\frac{1}{\sigma - 1}} (\sigma - 1) (1 + \chi)^{\frac{1}{k}} \left[\frac{k}{(\sigma - 1)k + (k - (\sigma - 1))} \right]^{\frac{\sigma}{\sigma - 1}} \left[\frac{(\sigma - 1)k + (k - (\sigma - 1))}{(k - (\sigma - 1))} \right]^{\frac{1}{k}}. \quad (\text{A.29})$$

Showing that $\left(\frac{Y}{N}\right)_o^{t > 0} \leq \left(\frac{Y}{N}\right)_o^{t = 0}$ results in showing that

$$\frac{1}{1 - t} \left[\frac{k(\sigma - 1) + (k - (\sigma - 1))(1 - t)}{(k\sigma - (\sigma - 1))(1 - t)} \right]^{\frac{1}{k}} < \left[\frac{k(\sigma - 1) + (k - (\sigma - 1))(1 - t)}{(k\sigma - (\sigma - 1))(1 - t)} \right]^{\frac{\sigma}{\sigma - 1}}. \quad (\text{A.30})$$

This problem is exactly identical to the one in the closed economy (cf. Eq. (A.9)). Therefore the proof is identical to the one in A.3.

A.10 Showing that $\text{InterIneq}_a^{b=0} > \text{InterIneq}_a^{b=0}$

Inter-group inequality under autarky in the case of zero transfer payments is given by

$$\text{InterIneq}_a^{b=0} = \frac{(1 - t)\pi^{op}(\tilde{\varphi})}{w}. \quad (\text{A.31})$$

Using Eqs. (8) and (14) we get

$$\text{InterIneq}_a^{b=0} = \frac{k}{k - (\sigma - 1)}. \quad (\text{A.32})$$

Inter-group inequality in the open economy in the case of zero transfer payments is given by

$$\text{InterIneq}_o^{b=0} = \frac{(1-t)(1+\chi)\pi^{op}(\tilde{\varphi}) - \chi f}{w}. \quad (\text{A.33})$$

Using Eqs. (8) and (34) we get

$$\text{InterIneq}_o^{b=0} = (1+\chi)\frac{k}{k-(\sigma-1)} - \chi. \quad (\text{A.34})$$

Comparing Eqs. (A.34) and (29) it becomes obvious that inter-group inequality in the open economy is higher than under autarky since $\frac{k}{k-(\sigma-1)} > 1$. The trade-induced increase in inter-group inequality amounts to

$$\Delta\text{InterIneq}_{o,a}^{b=0} = \text{InterIneq}_o^{b=0} - \text{InterIneq}_a^{b=0} = \chi\frac{k}{k-(\sigma-1)} - \chi. \quad (\text{A.35})$$

A.11 Derivation of Eq. (52)

Starting point in order to derive inter-group inequality in closed form solution is Eq. (51). Using Eqs. (40) and (33) we get

$$\text{InterIneq}_o = \frac{(1-t)(1+\chi)\pi^{op}(\tilde{\varphi}) - \chi f + \frac{tM(1+\chi)\pi^{op}(\tilde{\varphi})}{N}}{w + \frac{tM(1+\chi)\pi^{op}(\tilde{\varphi})}{N}}. \quad (\text{A.36})$$

Using Eqs. (8) and (34) we can rewrite Eq. (A.36) as follows

$$\text{InterIneq}_o = \frac{N(1-t)(1+\chi)\frac{k}{k-(\sigma-1)}\pi^{op}(\varphi^*) - N\chi(1-t)\pi^{op}(\varphi^*) + tM(1+\chi)\frac{k}{k-(\sigma-1)}\pi^{op}(\varphi^*)}{N(1-t)\pi^{op}(\varphi^*) + tM(1+\chi)\frac{k}{k-(\sigma-1)}\pi^{op}(\varphi^*)}. \quad (\text{A.37})$$

Using the equilibrium factor allocation given by Eq. (44) and simplifying terms we get Eq. (52).

A.12 Showing that $\text{InterIneq}_o > \text{InterIneq}_a$

Inter-group inequality in the open economy is given by Eq. (52). Inter-group inequality in the closed economy is given by Eq. (27). In order to show that inter-group inequality in the open economy is higher than inter-group inequality in the closed economy we just have to show that

$$\begin{aligned} (1+\chi)\frac{k}{k-(\sigma-1)} - \chi &> \frac{k}{k-(\sigma-1)} \\ \chi\frac{k}{k-(\sigma-1)} - \chi &> 0 \\ \chi\left(\frac{k}{k-(\sigma-1)} - 1\right) &> 0. \end{aligned} \quad (\text{A.38})$$

This is the case since $\chi > 0$ and $\frac{k}{k-(\sigma-1)} > 1$. The trade-induced increase in inter-group inequality amounts to

$$\Delta \text{InterIneq}_{o,a} = \text{InterIneq}_o - \text{InterIneq}_a = \frac{\chi \frac{k}{k-(\sigma-1)} - \chi}{1 + \frac{tk}{(\sigma-1)k+(1-t)(k-(\sigma-1))}}. \quad (\text{A.39})$$

This increase is smaller than the increase when $b = 0$ (Eq. (A.35)) since $\frac{tk}{(\sigma-1)k+(1-t)(k-(\sigma-1))} > 0$.

A.13 Showing that $\frac{\partial \text{InterIneq}_o}{\partial t} < 0$

Inter-group inequality in the open economy is given by Eq. (52). Calculating the partial derivative of InterIneq_o with respect to the tax rate t we get

$$\begin{aligned} \frac{\partial \text{InterIneq}_o}{\partial t} = & \frac{\frac{k[(\sigma-1)k+(1-t)(k-(\sigma-1))] + tk(k-(\sigma-1))}{[(\sigma-1)k+(1-t)(k-(\sigma-1))]^2} \left[1 + \frac{tk}{(\sigma-1)k+(1-t)(k-(\sigma-1))} \right]}{\left[1 + \frac{tk}{(\sigma-1)k+(1-t)(k-(\sigma-1))} \right]^2} \\ & - \frac{\frac{k[(\sigma-1)k+(1-t)(k-(\sigma-1))] + tk(k-(\sigma-1))}{[(\sigma-1)k+(1-t)(k-(\sigma-1))]^2} \left[(1 + \chi) \frac{k}{k-(\sigma-1)} - \chi + \frac{tk}{(\sigma-1)k+(1-t)(k-(\sigma-1))} \right]}{\left[1 + \frac{tk}{(\sigma-1)k+(1-t)(k-(\sigma-1))} \right]^2}. \end{aligned} \quad (\text{A.40})$$

It is straightforward to show that indeed $\frac{\partial \text{InterIneq}_o}{\partial t} < 0$ since $(1 + \chi) \frac{k}{k-(\sigma-1)} - \chi > 1$.

A.14 Derivation of Eq. (53)

When deriving the Gini coefficient for secondary managerial income in the open economy we need to distinguish between exporters and non-exporters. The Lorenz curve will therefore have two parts which we will derive step by step in this section. The ratio of cumulative secondary managerial income for all non-exporters with a productivity level lower than or equal to $\bar{\varphi} \in [\varphi^*, \varphi_\chi^*]$ and aggregate secondary managerial income I_o is given by²⁸

$$\frac{I_{ne}(\bar{\varphi})}{I_o} = \frac{(1-t)\Pi_{ne}(\bar{\varphi}) + bM(\bar{\varphi})}{(1-t)M(1+\chi)\pi^{op}(\bar{\varphi}) - M\chi f + bM} \quad (\text{A.41})$$

with

$$\begin{aligned} \Pi_{ne}(\bar{\varphi}) &= \frac{M}{1-G(\varphi^*)} \int_{\varphi^*}^{\bar{\varphi}} \pi(\varphi) dG(\varphi) = \frac{k}{(\sigma-1)-k} M \pi(\varphi^*) \left[\left(\frac{\varphi^*}{\bar{\varphi}} \right)^{k-(\sigma-1)} - 1 \right] \\ M(\bar{\varphi}) &= \frac{M}{1-G(\varphi^*)} \int_{\varphi^*}^{\bar{\varphi}} dG(\varphi) = M \left[1 - \left(\frac{\varphi^*}{\bar{\varphi}} \right)^k \right]. \end{aligned} \quad (\text{A.42})$$

Using Eqs. (8), (33), (34) and (44) we get

$$\frac{I_{ne}(\bar{\varphi})}{I_o} = \frac{\frac{k}{(\sigma-1)-k} \left(\frac{\varphi^*}{\bar{\varphi}} \right)^{k-(\sigma-1)} - \frac{k}{(\sigma-1)-k} + \frac{tk}{(\sigma-1)k+(1-t)(k-(\sigma-1))} - \frac{tk}{(\sigma-1)k+(1-t)(k-(\sigma-1))} \left(\frac{\varphi^*}{\bar{\varphi}} \right)^k}{(1+\chi) \frac{k}{k-(\sigma-1)} - \chi + \frac{tk}{(\sigma-1)k+(1-t)(k-(\sigma-1))}}. \quad (\text{A.43})$$

²⁸It is shown in A.15 that this ratio is increasing in b .

The ratio of firms with productivity levels lower than or equal to $\bar{\varphi}$ is given by

$$\gamma = \frac{M(\bar{\varphi})}{M} = 1 - \left(\frac{\bar{\varphi}}{\varphi^*} \right)^{-k}. \quad (\text{A.44})$$

Combining Eqs. (A.43) and (A.44) we get the first segment of the Lorenz curve

$$Q1_o(\gamma) = \frac{\frac{k}{(\sigma-1)-k}(1-\gamma)^{\frac{k-(\sigma-1)}{k}} - \frac{k}{(\sigma-1)-k} + \frac{tk}{(\sigma-1)k+(1-t)(k-(\sigma-1))} - \frac{tk}{(\sigma-1)k+(1-t)(k-(\sigma-1))}(1-\gamma)}{(1+\chi)\frac{k}{k-(\sigma-1)} - \chi + \frac{tk}{(\sigma-1)k+(1-t)(k-(\sigma-1))}}. \quad (\text{A.45})$$

If we evaluate $Q1_o$ at $\gamma = h_M$ with $h_M \equiv 1 - \left(\frac{\varphi_\chi^*}{\varphi^*} \right)^{-k} = 1 - \chi$ we get

$$Q1_o(h_M) = \frac{\frac{k}{(\sigma-1)-k}\chi^{\frac{k-(\sigma-1)}{k}} - \frac{k}{(\sigma-1)-k} + \frac{tk}{(\sigma-1)k+(1-t)(k-(\sigma-1))} - \frac{tk}{(\sigma-1)k+(1-t)(k-(\sigma-1))}\chi}{(1+\chi)\frac{k}{k-(\sigma-1)} - \chi + \frac{tk}{(\sigma-1)k+(1-t)(k-(\sigma-1))}}. \quad (\text{A.46})$$

The ratio of cumulative secondary managerial income for all firms (exporters and non-exporters) with a productivity level up to $\bar{\varphi} \in [\varphi_\chi^*, \infty)$ and aggregate secondary managerial income I_o is determined as follows

$$\frac{I(\bar{\varphi})}{I_o} = Q1_o(h_M) + \frac{(1-t)\Pi_e^{op}(\bar{\varphi}) - f(M(\bar{\varphi}) - M(\varphi_\chi^*)) + b(M(\bar{\varphi}) - M(\varphi_\chi^*))}{(1-t)\Pi^{op} - f\chi M + bM}. \quad (\text{A.47})$$

Note that

$$M(\bar{\varphi}) - M(\varphi_\chi^*) = M \left[\left(\frac{\varphi^*}{\varphi_\chi^*} \right)^k - \left(\frac{\varphi^*}{\bar{\varphi}} \right)^k \right] \quad (\text{A.48})$$

and

$$\begin{aligned} \Pi_e^{op}(\bar{\varphi}) &= \frac{M}{1-G(\varphi^*)} \int_{\varphi_\chi^*}^{\bar{\varphi}} \pi_e^{op}(\varphi) dG(\varphi) \\ &= \frac{Mk\pi(\varphi^*)\Omega}{\sigma-k-1} \left(\frac{\varphi^*}{\bar{\varphi}} \right)^{k-(\sigma-1)} - \frac{Mk\pi(\varphi^*)\Omega}{\sigma-k-1} \left(\frac{\varphi^*}{\varphi_\chi^*} \right)^{k-(\sigma-1)}. \end{aligned} \quad (\text{A.49})$$

Using Eqs. (A.48) and (A.49) as well as Eqs. (8), (33) and (34) we can write Eq. (A.47) as follows

$$\begin{aligned} \frac{I(\bar{\varphi})}{I_o} &= Q1_o(h_M) + \frac{\frac{k\Omega}{\sigma-k-1} \left(\frac{\varphi^*}{\bar{\varphi}} \right)^{k-(\sigma-1)} - \frac{k\Omega}{\sigma-k-1} \left(\frac{\varphi^*}{\varphi_\chi^*} \right)^{k-(\sigma-1)} - \left(\frac{\varphi^*}{\varphi_\chi^*} \right)^k + \left(\frac{\varphi^*}{\bar{\varphi}} \right)^k}{(1+\chi)\frac{k}{k-(\sigma-1)} - \chi + \frac{tk}{(\sigma-1)k+(1-t)(k-(\sigma-1))}} \\ &\quad + \frac{\frac{tk}{(\sigma-1)k+(1-t)(k-(\sigma-1))} \left(\frac{\varphi^*}{\varphi_\chi^*} \right)^k - \frac{tk}{(\sigma-1)k+(1-t)(k-(\sigma-1))} \left(\frac{\varphi^*}{\bar{\varphi}} \right)^k}{(1+\chi)\frac{k}{k-(\sigma-1)} - \chi + \frac{tk}{(\sigma-1)k+(1-t)(k-(\sigma-1))}}. \end{aligned} \quad (\text{A.50})$$

Using $\gamma = 1 - \left(\frac{\bar{\varphi}}{\varphi^*}\right)^{-k}$ and $h_M \equiv 1 - \left(\frac{\varphi^*}{\chi}\right)^{-k} = 1 - \chi^n$ we can derive the second segment of the Lorenz curve as follows

$$Q2_o(\gamma) \equiv Q1_o(h_M) + \frac{\frac{k\Omega}{\sigma-k-1}(1-\gamma)^{\frac{k-(\sigma-1)}{k}} - \frac{k\Omega}{\sigma-k-1}\chi^{\frac{k-(\sigma-1)}{k}} - \chi + (1-\gamma)}{(1+\chi)\frac{k}{k-(\sigma-1)} - \chi + \frac{tk}{(\sigma-1)k+(1-t)(k-(\sigma-1))}} + \frac{\frac{tk}{(\sigma-1)k+(1-t)(k-(\sigma-1))}\chi - \frac{tk}{(\sigma-1)k+(1-t)(k-(\sigma-1))}(1-\gamma)}{(1+\chi)\frac{k}{k-(\sigma-1)} - \chi + \frac{tk}{(\sigma-1)k+(1-t)(k-(\sigma-1))}}. \quad (\text{A.51})$$

It can be shown that $Q1_o(h_M) = Q2_o(h_M)$. Putting the two segment together, the Lorenz curve for secondary managerial income in the open economy is given by

$$Q_o(\gamma) \equiv \begin{cases} Q1_o(\gamma) & \text{if } \gamma \in [0, h_M] \\ Q2_o(\gamma) & \text{if } \gamma \in [h_M, 1]. \end{cases} \quad (\text{A.52})$$

The Gini coefficient can then be calculated as

$$\text{IntraIneq}_o = 1 - 2 \int_0^1 Q_o(\gamma) d\gamma = 1 - 2 \left[\int_0^{h_M} Q1_o(\gamma) d\gamma + \int_{h_M}^1 Q2_o(\gamma) d\gamma \right]. \quad (\text{A.53})$$

Using Eqs. (A.45), (A.51) and (A.53) tedious calculation leads to Eq. (53)

A.15 Showing that $\frac{I_{ne}(\bar{\varphi})}{I_o}$ is increasing in b

We have to show that

$$\frac{\partial \frac{I_{ne}(\bar{\varphi})}{I_o}}{\partial b} = \frac{M(\bar{\varphi}) [(1-t)M(1+\chi)\pi^{op}(\bar{\varphi}) - M\chi f + bM] - M [(1-t)\Pi_{ne}(\bar{\varphi}) + bM(\bar{\varphi})]}{[(1-t)M(1+\chi)\pi^{op}(\bar{\varphi}) - M\chi f + bM]^2} > 0. \quad (\text{A.54})$$

Using Eq. (A.42) the problem simplifies to show that

$$M \left[1 - \left(\frac{\varphi^*}{\bar{\varphi}}\right)^k \right] [(1-t)M(1+\chi)\pi^{op}(\bar{\varphi}) - M\chi f] > M(1-t) \frac{k}{(\sigma-1)-k} M\pi(\varphi^*) \left[\left(\frac{\varphi^*}{\bar{\varphi}}\right)^{k-(\sigma-1)} - 1 \right]. \quad (\text{A.55})$$

Using Eqs. (8) and (34) we are left with showing that

$$\left[1 - \left(\frac{\varphi^*}{\bar{\varphi}}\right)^k \right] \left[(1+\chi) \frac{k}{k-(\sigma-1)} - \chi \right] > \left[1 - \left(\frac{\varphi^*}{\bar{\varphi}}\right)^{k-(\sigma-1)} \right] \frac{k}{k-(\sigma-1)}. \quad (\text{A.56})$$

This holds since $\frac{k}{k-(\sigma-1)} > 1$ and $\left(\frac{\varphi^*}{\bar{\varphi}}\right)^k < \left(\frac{\varphi^*}{\bar{\varphi}}\right)^{k-(\sigma-1)}$.

A.16 Showing that $\text{IntraIneq}_o > \text{IntraIneq}_a$

Intra-group inequality in the open economy is given by Eq. (53). Intra-group inequality in the closed economy is given by Eq. (32). In order to show that, for a given tax rate t , intra-group

inequality in the open economy is higher than intra-group inequality in the closed economy the problem can be written as follows

$$\frac{A - B + C}{A + D} > \frac{C}{D} \quad (\text{A.57})$$

with

$$\begin{aligned} A &= \frac{\sigma - 1}{k - (\sigma - 1)} \chi \\ B &= \frac{\sigma - 1}{2k - (\sigma - 1)} \chi^2 \\ C &= \frac{k}{k - (\sigma - 1)} - \frac{2k}{2k - (\sigma - 1)} \\ D &= \frac{k}{k - (\sigma - 1)} + \frac{tk}{(\sigma - 1)k + (1 - t)(k - (\sigma - 1))}. \end{aligned}$$

We therefore have to show that $(A - B)D > AC$, i.e.

$$\begin{aligned} &\left(\frac{\sigma - 1}{k - (\sigma - 1)} \chi - \frac{\sigma - 1}{2k - (\sigma - 1)} \chi^2 \right) \left(\frac{k}{k - (\sigma - 1)} + \frac{tk}{(\sigma - 1)k + (1 - t)(k - (\sigma - 1))} \right) > \\ &\frac{\sigma - 1}{k - (\sigma - 1)} \chi \left(\frac{k}{k - (\sigma - 1)} - \frac{2k}{2k - (\sigma - 1)} \right). \end{aligned} \quad (\text{A.58})$$

Rearranging yields

$$\begin{aligned} &\frac{\sigma - 1}{k - (\sigma - 1)} \chi \frac{tk}{(\sigma - 1)k + (1 - t)(k - (\sigma - 1))} - \frac{\sigma - 1}{2k - (\sigma - 1)} \chi^2 \frac{tk}{(\sigma - 1)k + (1 - t)(k - (\sigma - 1))} \\ &+ \frac{\sigma - 1}{2k - (\sigma - 1)} \chi \frac{2k}{k - (\sigma - 1)} - \frac{\sigma - 1}{2k - (\sigma - 1)} \chi^2 \frac{k}{k - (\sigma - 1)} > 0, \end{aligned} \quad (\text{A.59})$$

which is clearly fulfilled since both

$$\frac{\sigma - 1}{k - (\sigma - 1)} \chi \frac{tk}{(\sigma - 1)k + (1 - t)(k - (\sigma - 1))} - \frac{\sigma - 1}{2k - (\sigma - 1)} \chi^2 \frac{tk}{(\sigma - 1)k + (1 - t)(k - (\sigma - 1))} > 0$$

and

$$\frac{\sigma - 1}{2k - (\sigma - 1)} \chi \frac{2k}{k - (\sigma - 1)} - \frac{\sigma - 1}{2k - (\sigma - 1)} \chi^2 \frac{k}{k - (\sigma - 1)} > 0.$$

A.17 Showing that $\frac{\partial \text{IntraIneq}_o}{\partial t} < 0$

Intra-group inequality in the open economy is given by Eq. (53). Calculating the partial derivative of IntraIneq_o with respect to the tax rate t we get

$$\begin{aligned} \frac{\partial \text{IntraIneq}_o}{\partial t} &= - \frac{\frac{\sigma - 1}{k - (\sigma - 1)} \chi + \frac{k}{k - (\sigma - 1)} - \frac{\sigma - 1}{2k - (\sigma - 1)} \chi^2 - \frac{2k}{2k - (\sigma - 1)}}{\left[\frac{\sigma - 1}{k - (\sigma - 1)} \chi + \frac{k}{k - (\sigma - 1)} + \frac{tk}{(\sigma - 1)k + (1 - t)(k - (\sigma - 1))} \right]^2} \\ &\quad \times \frac{k^2(\sigma - 1) + (1 - t)k(k - (\sigma - 1)) + tk(k - (\sigma - 1))}{[(\sigma - 1)k + (1 - t)(k - (\sigma - 1))]^2}. \end{aligned} \quad (\text{A.60})$$

It is obvious that indeed $\frac{\partial \text{IntraIneq}_o}{\partial t} < 0$.

A.18 Condition for trade not to be a Pareto improvement

The marginal manager under trade loses from trade iff

$$(1 + \chi)^{\frac{1}{k}} w_a + (1 + \chi)^{\frac{1}{k}} b_a < (1 + \chi)^{\frac{\sigma-1}{k}} w_a + b_a. \quad (\text{A.61})$$

This is the sufficient condition for trade not to lead to a Pareto improvement. Eq. (A.61) can be rewritten as follows

$$\sigma > 1 + \frac{k \log \left[(1 + \chi)^{\frac{1}{k}} + (1 + \chi)^{\frac{1}{k}} \frac{b_a}{w_a} - \frac{b_a}{w_a} \right]}{\log(1 + \chi)}. \quad (\text{A.62})$$

This means that the marginal manager under trade loses from trade iff

$$\sigma > \Gamma \quad \text{with} \quad \Gamma = 1 + \frac{k \log \left[(1 + \chi)^{\frac{1}{k}} + (1 + \chi)^{\frac{1}{k}} \frac{b_a}{w_a} - \frac{b_a}{w_a} \right]}{\log(1 + \chi)}. \quad (\text{A.63})$$

In order to show that $\Gamma > 2$ we have to show that

$$\frac{k \log \left[(1 + \chi)^{\frac{1}{k}} + (1 + \chi)^{\frac{1}{k}} \frac{b_a}{w_a} - \frac{b_a}{w_a} \right]}{\log(1 + \chi)} > 1. \quad (\text{A.64})$$

This can be rewritten as follows

$$1 + \frac{k \log \left(1 + \frac{b_a}{w_a} - \frac{1}{(1+\chi)^{\frac{1}{k}}} \frac{b_a}{w_a} \right)}{\log(1 + \chi)} > 1. \quad (\text{A.65})$$

Eq. (A.65) clearly holds since $k > \sigma - 1$ with $\sigma > 1$ and $\frac{b_a}{w_a} - \frac{1}{(1+\chi)^{\frac{1}{k}}} \frac{b_a}{w_a} > 0$ as well as $\chi > 0$.

A.19 Deriving the secondary income schedules in Figures 3 and 4

The secondary income for all individuals with abilities $\varphi < \varphi_a^*$ under autarky (these are workers) is given by

$$w_a + b_a = \frac{\frac{\sigma-1}{\sigma} Y_a}{L_a} + \frac{t \frac{1}{\sigma} Y_a}{N}. \quad (\text{A.66})$$

Using Eqs. (17) and (23) this can be written as follows

$$\begin{aligned} w_a + b_a = & \left(\frac{(1-t)k}{(\sigma-1)k + (1-t)(k - (\sigma-1))} N \right)^{\frac{1}{\sigma-1}} \frac{\sigma-1}{\sigma} \left(\frac{(\sigma-1)k + (1-t)(k - (\sigma-1))}{(1-t)(k - (\sigma-1))} \right)^{\frac{1}{k}} \\ & + t \frac{1}{\sigma} \frac{\sigma-1}{1-t} \left(\frac{k(1-t)}{k(\sigma-1) + (k - (\sigma-1))(1-t)} \right)^{\frac{\sigma}{\sigma-1}} \left(\frac{k(\sigma-1) + (k - (\sigma-1))(1-t)}{(k - (\sigma-1))(1-t)} \right)^{\frac{1}{k}} \\ & N^{\frac{1}{\sigma-1}}. \end{aligned} \quad (\text{A.67})$$

The secondary income for all individuals with abilities $\varphi \geq \varphi_a^*$ under autarky (these are managers) is given by $(1-t)\pi_a(\varphi) + b_a$. Using Eqs. (6) and (14) this can be written as follows

$$(1-t)\pi_a(\varphi) + b_a = \left(\frac{\varphi}{\varphi_a^*}\right)^{\sigma-1} w_a + b_a. \quad (\text{A.68})$$

Note that φ_a^* is given by Eq. (19), whereas w_a and b_a are given by Eq. (A.67).

The secondary income for all individuals with abilities $\varphi < \varphi_o^*$ under trade (these are workers and export consultant) is given by

$$w_o + b_o = (1+\chi)^{\frac{1}{k}}(w_a + b_a). \quad (\text{A.69})$$

Note that we used Eqs. (41), (48) and (50).

The secondary income for all individuals with abilities $\varphi_o^* \leq \varphi < \varphi_\chi^*$ under trade (these are non-exporting managers) is given by $(1-t)\pi_o + b_o$. Using Eqs. (6) and (34) this can be written as follows

$$(1-t)\pi_o(\varphi) + b_o = \left(\frac{\varphi}{\varphi_o^*}\right)^{\sigma-1} w_o + b_o. \quad (\text{A.70})$$

Note that φ_o^* is given by Eq. (45), whereas w_o and b_o are given by Eq. (A.69).

The secondary income for all individuals with abilities $\varphi \geq \varphi_\chi^*$ under trade (these are exporting managers) is given by $(1-t)\Omega\pi_o - f + b_o$. Note that Ω is determined by Eq. (36), the fixed exporting cost f is equal to the wage w_o in equilibrium and $\varphi_\chi^* = \frac{1}{\chi} \varphi_o^*$ (where we used Eq. (37)).