

# Trade shares, the rise of emerging markets and inequality\*

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## **Abstract**

In this paper we document a negative relationship between changes in the world trade share of a country and changes in the country's income and wage inequality. We propose a multi-country trade model with differentiated goods that helps to explain such a pattern. We assume that factor intensity of production for the export and domestic markets differs as in Matsuyama (2007). We show that differential rate of factor supply growth and technological change across countries are consistent with the observed relationship between trade shares and inequality.

Keywords: income inequality, skill wage premium, trade shares

JEL codes: F15, F16, J31, O33

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# 1 Introduction

In this paper we revisit the trade and inequality debate. We first present a new set of evidence regarding changes in a country's inequality and changes to its share of world trade. We then develop a multi-country model of trade based upon national product differentiation and examine how the entry of new countries into world trade, differential and symmetric changes in tariffs, factor supplies and technology across countries could affect relative factor prices and trade shares. We show that differential rate of capital accumulation and technological change across countries can produce the observed pattern of inequality and trade shares in the data. Thus in contrast to the existing literature which emphasize the role of trade liberalization/integration or skill-biased technological change, we argue that increased *global* trade due to faster rate of capital accumulation and technological catching up in the rest of the world are also important explanations for the increased inequality observed in the developed countries.

In figures (1) - (4) we can observe an interesting pattern in the evolution of the available cross-country measures of wage and income inequality and countries' shares in world trade in the last three decades.<sup>1</sup> Trade share of a country is measured by the value of its exports over total world exports. The available data suggests a negative relationship between changes in the inequality measures and changes in world trade share. That is, on average countries that experienced an increase in the world trade shares faced a decline in wage or income inequality while countries that experienced a fall in world trade share faced an increase in inequality. In particular, as in Figure (1) we can observe on data for OECD countries that the wage premium of university graduates was negatively correlated with the change in the trade share in the same period. This pattern is repeated in the few datasets that can be constructed from the World Bank, OECD or Luxembourg Income Study data where one can find cross-country measures of income or wage inequality reaching back into 1980s or 1990s.<sup>2, 3</sup>

Since the 1990s a substantial amount of research has been devoted to studying the effect of trade on inequality. This research has been driven mainly by the experience of the United States which has seen rising inequality since the 1980s. This period coincides also with the increasing trade integration of the emerging countries into the world trading system. A natural first explanation for the rising inequality in the US is therefore the Heckscher-Ohlin model whereby trade with the unskilled labor abundant South raises the skill premium in the skilled labor abundant North. Early empirical studies show that North-South trade has a modest impact on Northern inequality.<sup>4</sup> Other studies indicate rising inequality also in developing countries contrary to the predictions of the Heckscher-Ohlin model. This led to two contending explanations for the observed increased in inequality, skill-biased

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<sup>1</sup>All these are unconditional correlations.

<sup>2</sup>For example the changes in the earnings of 9th decile in comparison with the median and first decile of wage earnings in OECD follow the same pattern. The relationships between changes in the trade share measures and income/wage inequality measures are negative, although not necessarily always statistically significant from zero.

<sup>3</sup>We excluded communist or post-communist countries from the samples, as for obvious reasons the income inequality there was kept artificially low.

<sup>4</sup>See however, Wood (1994) who finds a significant impact of North-South trade on Northern inequality and Krugman (2008) for a recent reassessment of the impact taking into account international fragmentation of production.

technological change and increased global, as opposed to just North-South, trade. Examples of this literature include Leamer (1998), Davis (1998), Krugman (2000) and Xu (2001) who study the effect of technical change on relative factor prices. Acemoglu (2003), Dinopoulos and Segerstrom (1999) and Thoenig and Verdier (2003) show how trade liberalization can induce skill-biased technological progress in models with endogenous innovation. Neary (2002) shows how competition induced by trade integration causes oligopolistic firms to increase strategic investment which is skilled labor intensive. Finally, Epifani and Gancia (2008) argue that trade integration lowers the relative price of increasing returns goods and increase the relative demand of skilled workers used intensively in these industries. All of these papers concentrate on explaining how inequality can increase in all countries and so cannot explain the negative relationship between inequality and trade shares. In particular, they cannot be used to explain why some countries may experience rising trade share and falling inequality as observed in figures (1) - (4).

In this paper we suggest a novel explanation for these interesting patterns in the data in a multi-country trade model following the lead proposed by Matsuyama (2007). Matsuyama (2007) drops the assumptions of Samuelson's (1954) iceberg formulation to model trade costs and assumes instead that supplying export markets require more skilled labor/capital than supplying the domestic market. For example, financing (in terms of the period granted for the credit), insurance, freight of goods destined for foreign markets may require more capital and skilled labor than production of varieties for domestic purpose. Globalization (in his model, the lowering of trade costs between two trading countries) then increases the amount of goods traded internationally thus raising the relative demand for skilled workers and the wage premia in all countries. Like other papers in the literature, Matsuyama concentrates on factors that can lead to increased inequality in every country. We adopt the same key assumption that exports require a different factor intensity from domestic consumption and extend his analysis to consider factors that could lead to differential changes in inequality as observed in the data.

We consider a world where there are two factors of production, capital and labor and where countries produce a (different) set of goods differentiated by the country of origin. Assume that consumers' preferences are Cobb-Douglas and they divide their income equally among domestic and imported varieties. The set of goods each country is capable of producing depends on the country's technological/knowledge level. To enter into exporting, firms need to incur a fixed cost (in terms of units of exports). This helps to endogenize the range of goods that will be exported which will be a subset of the set of goods produced. Suppose that preparing goods for international trade is a sector of the economy like any other that requires resources. If this sector has a different factor intensity than other sectors, then any changes in trade volumes will have an impact on domestic factor prices. We show that trade liberalization by some/all countries increases inequality everywhere as in Matsuyama (2007). We show also that a differential rate of capital accumulation and technological progress can produce the observed relationship between inequality and trade shares.

The intuition is as follows. Suppose some countries accumulate capital at a faster rate than others, then the relative return to capital will fall in these countries as marginal product

of labor increases. These countries are able to export more varieties as the fixed cost of entering into export activity decreases as capital becomes more abundant. Since their income increases as capital becomes more abundant, they increase their demand for foreign varieties. This leads to more firms entering into exports in the rest of the world. At the same time consumers in the rest of the world devote a larger fraction of their income to consuming these countries' products. Resources therefore move from domestic to export sector in the rest of the world. If capital is used more intensively in the export sector, the relative return to capital will rise in the rest of the world. Since countries that accumulate capital faster supply a greater share of world traded varieties their trade share increases and the reverse takes place for other countries. Thus differential rate of capital accumulation can produce the observed negative relationship between inequality and trade shares.

Another factor that can produce such a relationship is differential rate of technological progress that increases both the range of goods produced and the productivity of supplying goods to foreign markets. As a country is able to produce a larger set of goods it devotes a larger fraction of its income to consuming domestically produced goods and less to foreign goods. At the same time lower fixed cost of exports make exporting more profitable and more firms enter to export. Depending on parameter values, resources can either move from domestic to export sector or vice versa and hence the relative return to capital can increase or decrease. In the rest of the world, the reverse happens. Since there is lower demand for their exports, less firms enter into exporting. However, since they are importing a greater range of goods from the country experiencing technological progress, they devote a smaller fraction of their income to their domestic varieties. Thus resources can move either from domestic to export sector or vice versa. We derive sufficient conditions for the relative return to capital to fall and trade share to increase for the country experiencing technological progress and the reverse in the rest of the world. Together these results explain the negative relationship we observe in the data between trade shares and inequality.

Our model thus suggests that in addition to trade integration, capital accumulation and technological catching up by the emerging economies may play a role in contributing to falling trade share and increasing inequality in the developed countries. Only developed countries that are themselves experiencing rapid technological progress (for example Ireland) are spared this inequality trend. As will be seen more clearly later in the model, even though the volume of trade between developed and emerging countries may not be very large, the net effect on the trade volume of developed countries can be large. This is because increased trade with the emerging countries triggers increased trade also among developed countries. Our model also suggests that for emerging countries, their inequality could go up or down depending on whether trade liberalization or capital accumulation/technological progress is dominating. Thus our model can provide an explanation of why East Asia countries experience less increase in inequality than Latin American countries in recent years. East Asian (except China) countries liberalized trade earlier and hence it is human capital accumulation and technological progress that are the dominating factors in affecting inequality. In Latin American countries trade liberalization comes much later and hence is much more important in affecting inequality in the 1990s.

The rest of the paper is organized as follows. In section (2) we lay out the model. Section

3 discusses the case of symmetric countries and section 4 analyzes the case of differential rate of change of tariffs, factor supplies and technology on relative factor prices. A simple calibration exercise is performed in section 5 and section (6) concludes.

## 2 The Model

Consider a world of  $N + 1$  countries. There are two factors of production capital  $K$  and labor  $L$ . Countries differ in their technology and their level of technology determines the variety of goods they are able to produce. So country  $i$  is able to produce the set of goods  $[0, x_i]$  with higher  $x_i$  representing a more advanced level of technology. Each good variety for domestic consumption is produced by perfectly competitive firms using only labor as input.<sup>5</sup> We choose units so that one unit of labor produced one unit of the good for domestic consumption. We follow the Armington assumption that goods are differentiated by country of origin so each good variety can potentially be exported. However, preparing a good variety for exports requires additional resources. A firm has to incur a fixed cost (in units of exports) to set up an export facility/global trading company and combine additional capital and labor with a unit of the good to produce a unit of export. We assume that the technology for supplying exports is Cobb-Douglas of the form:

$$Y = AK^\phi L^{1-\phi} \tag{1}$$

where  $0 \leq \phi \leq 1$ . Note that  $A$  is a productivity parameter and it is set adequately so that the marginal cost of production of the differentiated good for domestic consumption is less than the marginal cost of producing the same good for exports. We have assumed that producing exports is more capital intensive than producing for domestic consumption.

Consumers' preferences are assumed to be Cobb-Douglas as follows:

$$\int_0^M \ln c_k dk \tag{2}$$

where  $M$  represents the total number of domestically produced and imported varieties and  $c_k$  is the quantity consumed of variety  $k$ . Consumers thus spend an equal fraction of their income on each variety.

The unit cost of producing for domestic consumption is just  $w_i$  where  $w_i$  is the return to labor. Since varieties for domestic consumption are produced by competitive firms, prices are equal to unit costs. The unit cost of producing for exports is given by  $\psi_i = \Phi_i r_i^\phi w_i^{1-\phi}$  where  $\Phi_i = \frac{1}{A_i \phi^\phi (1-\phi)^{1-\phi}}$ . There is free entry into setting up export facilities and the fixed cost is given by  $F_i = f_i \Phi_i r_i^\phi w_i^{1-\phi}$ . The fixed cost is assumed to be large enough that only a subset of the varieties produced will be exported. So some goods remain untraded. The fixed costs thus endogenize the number of varieties exported  $\eta_i$ . Given that not all good varieties are exported, firms will prefer to export different varieties so that they can enjoy a larger demand. Each exporting firm is then a monopoly for the variety it exports. Given

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<sup>5</sup>Having capital also in the production function for domestic consumption does not change our results but does not allow analytical solution. See however, simulation results in the calibration exercise in section 5.

Cobb-Douglas preferences, firms will then want to charge infinite price for the product in foreign markets. We assume therefore that each variety can be exported by another constant returns technology which is more costly per unit. The firm that incurs the fixed cost can then charge a price that limits price potential competitors out of the market. We assume that this price is given by  $\frac{1}{\sigma}\psi_i$  where  $0 < \sigma < 1$ . The zero profit condition for entry into supplying foreign markets for firms from country  $i$  is then given by:

$$(1 - \sigma) \sum_{s \neq i}^{N+1} \frac{I_s}{x_s + \sum_{j \neq s}^{N+1} \eta_j} = f_i \Phi_i r_i^\phi w_i^{1-\phi} \quad (3)$$

where  $I$  represents income.

The trade balance from the point of view of this country  $i$  is then

$$\sum_{s \neq i}^{N+1} \frac{\eta_i}{x_s + \sum_{j \neq s}^{N+1} \eta_j} \frac{I_s}{T_s} = \frac{\sum_{s \neq i}^{N+1} \eta_s}{x_i + \sum_{s \neq i}^{N+1} \eta_s} \frac{I_i}{T_i} \quad (4)$$

where  $T_s$  is the import tariff imposed in country  $s$ .

### 3 A World of Symmetric Countries

In this section we analyze our model for the case where all countries are symmetric. This will serve as a benchmark for our analysis of asymmetric changes later. We examine the effect of the entry of new countries into the world trading economy on factor prices in currently trading countries. We also analyze changes in factor supplies and in technology on relative factor prices. We obtain many results similar to that of Matsuyama (2007). All proofs are in the appendix.

**Proposition 1** *The entry of new countries into the world trading system increases the relative return to capital in currently trading economies.*

The intuition for the above result is as follows. Since goods are differentiated according to country of origin, consumers in currently trading countries will want to divert a fraction of their income to new varieties coming from new exporting countries. At the same time there are new markets for the existing exporters though they suffer a fall in demand from existing trading partners. Also falling wages (due to lower demand for domestic varieties) lowers the fixed cost of entering into exporting and increase the number of varieties exported. Overall there is a reallocation of resources from producing for domestic consumption to supplying foreign markets. Therefore, the relative demand for the factor used more intensively in the export sector increases and so does its relative price. Note that in this case all currently trading economies suffer a fall in their trade share since it is just proportional to the number of trading countries. Our result suggests for example that India and China joining the world trading system will tend to raise inequality in the rest of the world, developed or developing countries alike. This occurs not so much because China and India export unskilled intensive goods but because other countries want to import new varieties from China and India and they also export more varieties both to the new markets and to the existing ones.

**Proposition 2** *The relative return to capital increases (falls) if there is a world wide:*

- a) fall (increase) in tariffs*
- b) increase (fall) in the productivity of export activity*
- c) fall (increase) in capital supply and/or increase (fall) in labor supply*
- d) fall (increase) in the range of goods produced*

World wide fall in tariffs increases the profitability of entering into exports and hence the number of traded varieties increases. This reduces the demand for domestic variety and results in a reallocation of resources from domestic to export sector raising the relative demand and return to capital. Thus though our model is based upon product differentiation, it generates the same result as in Matsuyama (2007). Propositions 2b and 2c are also the same as in Matsuyama (2007). The key driving force is the basic assumption about the export sector being more capital intensive. When there is an increase in export productivity, more firms enter into export activity as fixed costs fall. The increase in traded varieties reduce demand for domestic varieties and resources are reallocated from domestic to export sector raising the relative return to capital. An increase in the supply of capital (labor) decreases marginal product of capital (labor) and decreases its relative return. What is new in our model is proposition 2 d. Technological progress which increases the range of goods produced in each country reduces the fraction of income each country spends on imported varieties. Exporting then becomes less profitable and less firms enter into exports. Resources are reallocated from exports to domestic sectors thus lowering the relative return to capital.

## 4 Asymmetric Countries

In this section we analyze differential changes in tariffs, factor supplies and technological progress on relative factor returns and trade shares in different countries. Since analytical solution is not possible for the general case of  $N + 1$  asymmetric countries, we analyze the case where there are  $N$  symmetric countries  $j$  and 1 country  $i$  which is different and study the impact of trade liberalization, capital accumulation and technological change in country  $i$  on itself and on the rest of the world.

**Proposition 3** *Lowering tariffs in a country increases its trade share and increases the relative return to capital in all countries.*

A reduction in tariffs in country  $i$  leads to lower income through the terms of trade effect. This reduces the demand for domestic and foreign varieties alike. However, since tariffs are lower, the overall effect is to increase the profitability of foreign varieties and more firms enter into exporting in the rest of the world. The lower demand for domestic varieties (both through the terms of trade effect and larger number of foreign varieties available) in country  $i$  lowers wages and lowers the fixed cost of entering into exports. More firms enter into exporting. The net effect is a reallocation of resources from domestic to export sector. Similarly, in the rest of the world, faced with larger traded varieties, there is lower demand for domestic varieties. Resources move from domestic to export sector as well. Thus in

both set of countries, exported varieties increase and relative return to capital increases. However, the increase in variety is more important for the country liberalizing trade and hence its trade share increases.

**Proposition 4** *An increase in a country's rate of capital accumulation reduces its relative return to capital, increases its trade share and raises the relative return to capital in the rest of the world.*

Note that Proposition 4 runs contrary to the predictions in a Heckscher-Ohlin model whereby capital accumulation in any part of the world lowers relative return to capital everywhere. The intuition for the result is as follows. An increase in the supply of capital raises marginal productivity of labor in export production and hence its relative return. It also reduces the fixed cost of entering export activity and hence more firms enter to export. In the rest of the world two things happen. First, as capital supply increases in country  $i$  its income increases and the quantity demanded of each foreign variety increases. This raises the profitability of exporting and more firms enter to export in the rest of the world as well. In addition, as world traded varieties increase, each country in the rest of the world devotes a smaller fraction of its income on domestic variety. Both effects lead to a reallocation of resources from domestic to export sector thus raising the relative return to capital. Even though all countries increase their export varieties, the net effect is an increase in the trade share of country  $i$ . Thus countries which experience faster capital accumulation enjoy rising trade shares and falling inequality while the reverse takes place in other countries. Faster capital accumulation in some set of countries is thus capable of generating the negative relationship between inequality and trade shares observed in the data.

**Proposition 5** : *Technological progress that raises the range of goods produced by a country lowers its trade share and lowers the relative return of capital in all countries.*

As a country is able to produce a larger set of goods it devotes a larger fraction of its income to consuming domestic varieties and less expenditure to foreign varieties. This raises the demand for labor and hence wages. As wages increase the fixed cost of exporting increases and hence some firms exit the export sector. In the rest of the world, less firms engage in exports as they faced lower demand for their products from country  $i$ . At the same time their consumers devote a larger fraction of their income to consuming domestic variety as world traded varieties fall. Thus in both set of countries the export sector shrinks and the relative return to capital falls. Exported varieties decrease in both sets of countries but the net effect is a fall in the trade share of country  $i$ .

**Proposition 6** *Technological progress that increases the productivity of supplying foreign markets in a country raises its trade share and increases the relative return to capital in all countries.*

An improvement in the export technology can come from better organization or functioning for global companies stemming from better communication technology or improvement in the provision of services as emphasized in the outsourcing literature. It can also stem from better international transportation technology. In our model, lower marginal costs of

export do not raise profits but lower fixed costs of export encourage more firms to enter into exporting. Faced with more varieties coming from country  $i$ , the rest of the world consumers devote a smaller fraction of their income to consuming domestic varieties. This lowers wages in the rest of the world and encourages more firms to enter into exporting. As resources move from domestic to export sector, relative demand and hence relative return to capital increases. Since the rest of the world exports more varieties, country  $i$ 's consumers devote a smaller fraction of their income to domestic variety and resources move from the domestic to the export sector raising the relative return to capital. Though all countries increase the number of exported varieties, it is the country experiencing technology progress that enjoys the increase in trade share.

We have seen from Propositions 5 and 6 that the two different types of technological change produce exactly opposing effects on inequality. Furthermore, all countries experience the same directional change in inequality though trade shares must necessarily change in different directions. However, do we believe that the two types of technological change are mutually exclusive? If we think of countries as being able to produce more and more varieties of specialized goods and services, this must have an impact on the productivity of producing goods in general and exports in particular. This could be coming from learning by doing effects, aggregate increasing returns as more specialized inputs become available as emphasized in the endogenous growth literature or improvement in service links as highlighted in the outsourcing literature. If we allow the productivity in the export sector to depend on the number of varieties a country is capable of producing, we can derive a sufficient condition for the country experiencing technological progress to experience falling relative return to capital and rising trade share while the opposite occurs in the rest of the world.

**Proposition 7** *If the productivity parameter  $A$  in the production function of export takes the form  $x_i^\varepsilon$ , then a sufficient condition for technological progress of country  $i$  to lead to rising trade share and falling relative return to capital in country  $i$  and the reverse happening in the rest of the world is  $1 - \phi \leq \varepsilon \leq 1$ .*

The bounds on the parameters are fairly intuitive. The larger is  $\varepsilon$ , the larger the spillovers effect of increasing the range of good varieties produced on the export productivity. Since increasing  $x_i$  and increasing export productivity have opposing effects on relative return to capital, as  $\varepsilon$  becomes larger the effect of higher export productivity will dominate. Therefore an intermediate range for  $\varepsilon$  is required so that the trade share of country  $i$  increases and that the relative return to capital moves in opposite directions in the two sets of countries.

## 4.1 Discussion of Results

To summarize our results so far, we have shown that trade liberalization, faster capital accumulation and technological progress in the export sector in some countries can increase inequality in other countries of the world. Our model thus suggests that the integration of the emerging countries into world trade and their rapid human capital accumulation and technological catching up are important factors in explaining the rise in inequality of some developed countries, in particular the US. Notice that all of the above mentioned factors

lead to increased trade not just between developed and emerging countries but also between developed countries themselves as every country in fact, exports more varieties to each other. This is a result that comes only in a multi-country setting and cannot be observed in a two country model. It suggests that empirical studies that look only at North South trade to estimate the impact of emerging countries' trade on developed countries' labor markets may underestimate the true impact once the indirect effect is taken into account. Finally, given that the data tells us that there is an inverse relationship between changes in inequality and changes in trade share and that trade liberalization itself cannot explain this relationship, we must conclude that other factors, namely, human capital accumulation and technological catching up are equally if not more important in explaining the rise in inequality in the US and other developed countries.

As far as the emerging countries themselves are concerned, our results suggest that there can be a variation of experience regarding inequality. Countries that liberalized trade earlier and experience rapid human capital accumulation and technological progress will find their inequality decreasing as the latter factors dominate the former. Countries that liberalized their trade in later periods are likely to find their inequality increasing as trade liberalization becomes the dominating factor in determining inequality.

## 5 A Simple Calibration Exercise

How much can the simple model laid out in section 2 account for changes in the skill premium for example in the US? In this section we perform a simple calibration exercise to answer this question. For the purpose of this exercise it is useful to assume that capital is also used in the production for domestic consumption. We assume that the production technology is Cobb-Douglas with the capital share being  $\alpha$  and that  $\alpha < \phi$ . We obtain the following factor accounting equation :

$$y_i = (k_i)^{-1} \frac{\alpha \frac{x_i}{\eta_i} + \frac{\phi}{T_i} N \frac{1-2v_i}{(N-1)v_i}}{(1-\alpha) \frac{x_i}{\eta_i} + \frac{(1-\phi)}{T_i} N \frac{1-2v_i}{(N-1)v_i}} \quad (5)$$

For calibration purposes, we have to account for all parameters. We assume no changes in factor supply for the country whose inequality we are interested in. We can observe the trade shares  $v_i$ . We estimated the ratio of all vs. exported varieties  $\frac{x_i}{\eta_i}$  and  $T$  from data on OECD countries for trade in goods and services for 1981 and 2005 assuming that for each year  $\frac{x_s}{\eta_s} = \frac{x}{\eta}$  and  $T_s = T, \forall s$ .<sup>6</sup> The share in the value of world trade of the USA in 1981 was  $v = 0.1355$  whereas in 2005 it was  $v = 0.0928$ .<sup>7</sup> Assuming the skilled labor intensity in the domestic sector  $\alpha = 0.1$  and  $\phi = 0.2$  in the foreign-bound sector, with a number of countries  $N = 100$  the model predicts an 11.3% change in the skilled wage premium

<sup>6</sup>In order to fit these parameters, we regressed the export/GDP in PPP terms ratio over the countries' value shares in world's trade of goods and services taken from OECD and WTO data with the assumed number of countries  $N = 100$ . The expression for exports/GDP as a function of value shares is then  $\zeta_i = \frac{N(1-2v_i)}{T_i((N-1)\frac{x_i}{\eta_i}v_i + N(1-2v_i))}$  where  $\zeta$  is export/GDP. We took 3 year averages centered around 1981 and 2005 of the export/GDP and value shares to eliminate short term valuation changes due to exchange rate movements.

<sup>7</sup>Data to calculate these shares were taken from OECD.

without any changes in factor supply. The change in the bachelor degree / high school graduate median wage premium for males in the US data for years 1981-2005 was 30%.<sup>8</sup> Our model with plausible parameters can thus account for 37.6% of the change in the skill premium for the US. With the same assumptions and taking into account their changes in the world trade shares, for the United Kingdom and Canada for the same years the model predicts respectively a 18.2% and a 12.1% increase in the skilled wage premium. The model can therefore reproduce important changes in the wage premia; hence, the mechanism we discuss may be a relevant driver of factor price divergence observed in recent years.

The model implied changes in the wage premium depending on changes in value of country shares in world trade  $v$ , share of tradable varieties  $\eta/x$  (estimated from 1981 and 2005 OECD data with a restriction  $T = 1.2$ ) and intensities of the domestic and export-bound sectors are shown in Table 1. For the estimated and assumed parameter values countries with smaller initial trade shares are in fact more sensitive to changes in their world share of trade and the level of goods tradability.

Table 1: Percentage changes of the wage premium as a function of changes in trade shares and the share of traded goods,  $N=200$ ,  $\alpha=0.1$ ,  $\beta=0.2$ ,  $T_1=1$ ,  $T_2=1$

$v_{1981}$	$v_{2005}$	$\left(\frac{\eta_i}{x_i}\right)_{1981}$	$\left(\frac{\eta_i}{x_i}\right)_{2005}$	implied % change in $\frac{w_1}{w_2}$
.1	.1	0.0022	0.0131	7.3
.1	.05	0.0022	0.0022	2
.1	.05	0.0022	0.0131	16.8
.05	.05	0.0022	0.0131	14.5
.05	.025	0.0022	0.0022	3.7
.05	.025	0.0022	0.0131	29.2
.02	.02	0.0022	0.0131	28
.02	.01	0.0022	0.0022	7.6
.02	.01	0.0022	0.0131	47.4

## 6 Conclusions

In this paper we have presented a set of new evidence showing that there is a negative relationship between changes in a country's inequality and changes in its trade share. We developed a multi country model using a key assumption of Matsuyama (2007) that export activity requires more skilled labor/capital than producing for domestic consumption and showed that differential rate of capital accumulation and technological progress across countries can produce such a relationship. We also showed that trade liberalization/integration alone is not able to generate such a relationship. We thus argued that existing literature which focuses mainly on trade liberalization/integration as the driving force for increased inequality in the US may have missed some other important contributing factors, in particular, human capital accumulation and technological progress in the rest of the world. We also argue that empirical estimates that focus exclusively on North-South trade may have underestimated the true impact of Southern trade on the North's labor market since the

<sup>8</sup>Data from the Current Population Survey of the U.S. Census Bureau.

increased trade with the South triggers increased trade among the Northern countries as well. Our simple calibration exercise showed that our model is capable of explaining around one third of the change in skilled wage premium in the US.

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## A Proofs

Before showing analytically the results from the main section, it is useful to transform the model equations in order to be able to obtain easily the desired results. We consider the case where country  $i$  is trading with  $N$  other symmetric countries  $j$  first.

The zero profit conditions for firms from a country  $i$  and  $j$  are respectively

$$(1 - \sigma) \frac{I_j N}{x_j + \eta_i + (N - 1) \eta_j} = f_i \psi_i \quad (6)$$

$$(1 - \sigma) \frac{I_j (N - 1)}{x_j + \eta_i + (N - 1) \eta_j} + (1 - \sigma) \frac{I_i}{T_i (x_i + N \eta_j)} = f_j \psi_j \quad (7)$$

The demand for capital in country  $j$  for export sales to other countries of similar type is given by:

$$\begin{aligned} K_j^{e_j}(Q) &= \Phi \left( \frac{r_j}{w_j} \right)^{\phi-1} \frac{I_j}{p_{jj}} \frac{(N - 1) \eta_j}{(x_j + \eta_i + (N - 1) \eta_j)} \\ &= \frac{\phi}{r_j} \sigma I_j \frac{(N - 1) \eta_j}{(x_j + \eta_i + (N - 1) \eta_j)} \end{aligned} \quad (8)$$

whereas for export sales to country of  $i$  is given by:

$$K_j^{e_i}(Q) = \frac{\phi}{r_j} \sigma \frac{I_i}{T_i (x_i + N \eta_j)} \eta_j \quad (9)$$

So total demand for capital stemming from variable costs is then

$$K_j^{e_j}(Q) + K_j^{e_i}(Q) = \frac{\phi}{r_j} \sigma \left( I_j \frac{(N - 1) \eta_j}{(x_j + \eta_i + (N - 1) \eta_j)} + \frac{I_i}{T_i (x_i + N \eta_j)} \eta_j \right) \quad (10)$$

whereas for the fixed cost

$$K_j^f(Q) = \Phi \left( \frac{r_j}{w_j} \right)^{\phi-1} \eta_j f_j \quad (11)$$

The total capital demand stemming from the export sector is then, expressed in terms of the fixed cost from (7)

$$K_j(Q) = \frac{1}{1 - \sigma} \frac{\phi}{r_j} \eta_j f_j \psi_j \quad (12)$$

We can rewrite as:

$$(1 - \sigma) \frac{K_j (y_j)^{1-\phi}}{\Phi_j f_j \phi} = \eta_j \quad (13)$$

where  $y_j = \frac{r_j}{w_j}$

In country  $i$  the total demand for capital can also be expressed similarly as

$$K_i^e(Q) = \frac{1}{1-\sigma} \frac{\phi}{r_i} \eta_i f_i \psi_i \quad (14)$$

or:

$$(1-\sigma) \frac{K_i(y_i)^{1-\phi}}{\Phi_i f_i \phi} = \eta_i \quad (15)$$

Therefore the factor market clearing equations for country  $i$  and  $j$  are, after substitutions for factor demands and from the trade balance, respectively

$$y_i k_i = \frac{\phi}{\frac{x_i T_i}{N \eta_j} + (1-\phi)} \quad (16)$$

where  $k_i = \frac{K_i}{L_i}$

$$y_j k_j = \frac{\phi}{\frac{x_j}{(N-1)\eta_j + \eta_i} + (1-\phi)} \quad (17)$$

Substituting (15) and (13) into the conditions (16) and (17) we get respectively

$$(1-\phi) + \frac{x_i T_i}{N} \frac{\Phi_j f_j \phi}{K_j (1-\sigma) y_j^{1-\phi}} = \frac{\phi}{y_i k_i} \quad (18)$$

$$\left[ \frac{\phi}{y_j k_j} - (1-\phi) \right] \left( (N-1) \frac{K_j y_j^{1-\phi} (1-\sigma)}{\phi \Phi_j f_j} + \frac{K_i (y_i)^{1-\phi} (1-\sigma)}{\phi \Phi_i f_i} \right) = x_j \quad (19)$$

Substituting for  $y_i$  from (18) into (19) we get:

$$\left[ \frac{\phi}{y_j k_j} - (1-\phi) \right] \left( \frac{(N-1) \frac{K_j y_j^{1-\phi} (1-\sigma)}{\phi \Phi_j f_j} + K_i (1-\sigma)}{\phi \Phi_i f_i \left[ (1-\phi) + \frac{x_i T_i}{N} \frac{\Phi_j f_j \phi}{K_j (1-\sigma) y_j^{1-\phi}} \right]^{1-\phi} \left( \frac{k_i}{\phi} \right)^{1-\phi}} \right) = x_j \quad (20)$$

The trade share is

$$v_i = \frac{\eta_i}{2\eta_i + N\eta_j} = \frac{1}{2 + N \frac{\eta_j}{\eta_i}} \quad (21)$$

We can also express the ratio of traded varieties  $\frac{\eta_i}{\eta_j}$  from (17) and (13) as

$$\left( (N-1) + \frac{\eta_i}{\eta_j} \right) = \frac{x_j}{(1-\sigma) \frac{K_j (y_j)^{1-\phi}}{\Phi_j f_j \phi} \left( \frac{\phi}{y_j k_j} - (1-\phi) \right)} \quad (22)$$

From (16) and (15) we can also derive the following equation:

$$\frac{\eta_i}{\eta_j} = \frac{(1-\sigma) N \left[ \frac{\phi}{y_i k_i} - (1-\phi) \right] K_i y_i^{1-\phi}}{x_i \Phi_i f_i \phi} \quad (23)$$

**Proof of Proposition 1:**

If all countries are the same, the zero profit condition for entry into exporting is then:

$$(1 - \sigma) \frac{IN}{T(x + N\eta)} = \Phi f(r)^\phi (w)^{1-\phi} \quad (24)$$

The factor market clearing condition is:

$$yk = \frac{\phi}{(1 - \phi) + \frac{xT}{N} \frac{f\Phi\phi}{(1-\sigma)Ky^{1-\phi}}} \quad (25)$$

From equation (25) we find  $\frac{\partial y}{\partial N} > 0$ .

**Proof of Proposition 2:** Implicitly differentiating equation (25), we can derive  $\frac{\partial y}{\partial T} > 0$ ,  $\frac{\partial y}{\partial A} > 0$ ,  $\frac{\partial y}{\partial K} < 0$ ,  $\frac{\partial y}{\partial L} > 0$  and  $\frac{\partial y}{\partial x} < 0$ . ■

**Proof of Proposition 4:** Implicitly differentiating equation (20) we obtain  $\frac{\partial y_j}{\partial T_i} > 0$  and from (19) we obtain  $\frac{\partial y_i}{\partial T_i} > 0$ . Then from (22) we can find  $\frac{\partial v_i}{\partial T_i} < 0$ . ■

**Proof of Proposition 4:** Implicitly differentiating equation (20) we have  $\frac{\partial y_j}{\partial K_i} > 0$ . Then from (22) we can find  $\frac{\partial v_i}{\partial K_i} > 0$  and from (23) we find  $\frac{\partial y_i}{\partial K_i} < 0$ . ■

**Proof of Proposition 6:** From equations (20), (22) and (18)  $\frac{\partial y_i}{\partial A_i} > 0$ ,  $\frac{\partial v_i}{\partial A_i} > 0$  and  $\frac{\partial y_j}{\partial A_i} > 0$ . ■

**Proof of Proposition 5:** From equations (20), (22) and (19)  $\frac{\partial y_i}{\partial x_i} < 0$ ,  $\frac{\partial v_i}{\partial x_i} < 0$  and  $\frac{\partial y_j}{\partial x_i} < 0$ . ■

**Proof of Proposition 7:** Substituting  $\Phi_i = \frac{1}{x_i^\varepsilon \phi^\phi (1-\phi)^{1-\phi}}$  into (20) and taking implicit differentiation we find that a sufficient condition for  $\frac{\partial y_j}{\partial x_i} > 0$  is  $\varepsilon \geq 1 - \phi$ . From (22) we obtain  $\frac{\partial v_i}{\partial x_i} > 0$ .

Substituting  $\Phi_i = \frac{1}{x_i^\varepsilon \phi^\phi (1-\phi)^{1-\phi}}$  into (23) we can derive the following :

$$\frac{\eta_i}{\eta_j} = \frac{(1 - \sigma)N \left[ \frac{\phi}{y_i k_i} - (1 - \phi) \right]}{x_i} \frac{K_i x_i^\varepsilon y_i^{1-\phi} \phi^\phi (1 - \phi)^{1-\phi}}{f\phi} \quad (26)$$

From the above equation and noting that  $\frac{\partial v_i}{\partial x_i} > 0$ , we can see that a sufficient condition for  $\frac{\partial y_i}{\partial x_i} < 0$  is  $\varepsilon \leq 1$ . ■

## B Figures

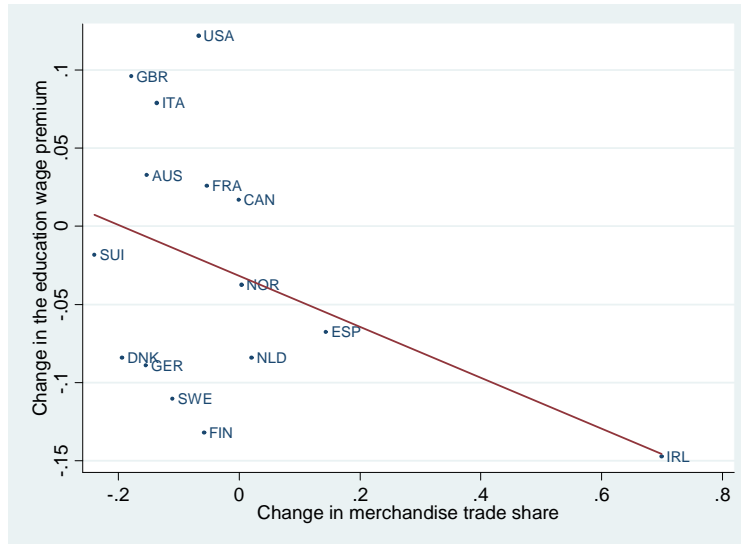


Figure 1: Change in the wage premium of university graduates vs. the share in the world merchandise trade, Mid 1980s – beginning 2000s. Coefficient of correlation  $\beta = -0.162$ , t-statistic =  $-3.95$ . R-squared =  $0.18$ ,  $N = 15$ , robust standard errors. Wage measure source: Luxembourg Income Study. Trade statistics source to calculate shares: WTO.

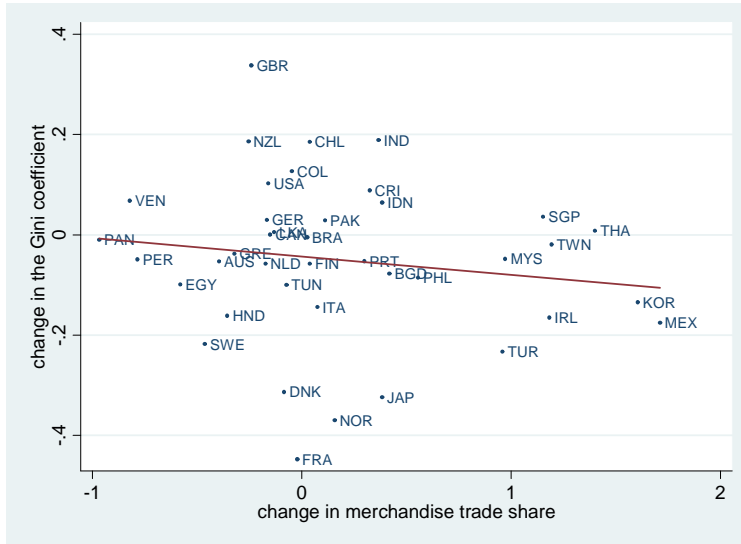


Figure 2: Change in the Gini index of income distribution vs. the change in the share in the world merchandise trade, beginning 1970s – beginning 2000s. Coefficient of correlation  $\beta = -.055$ , t-statistic =  $-2.33$ , R-squared =  $0.10$ ,  $N = 40$ , robust standard errors. Gini index source: World Bank, Luxembourg Income Study. Trade statistics source to calculate shares: WTO.

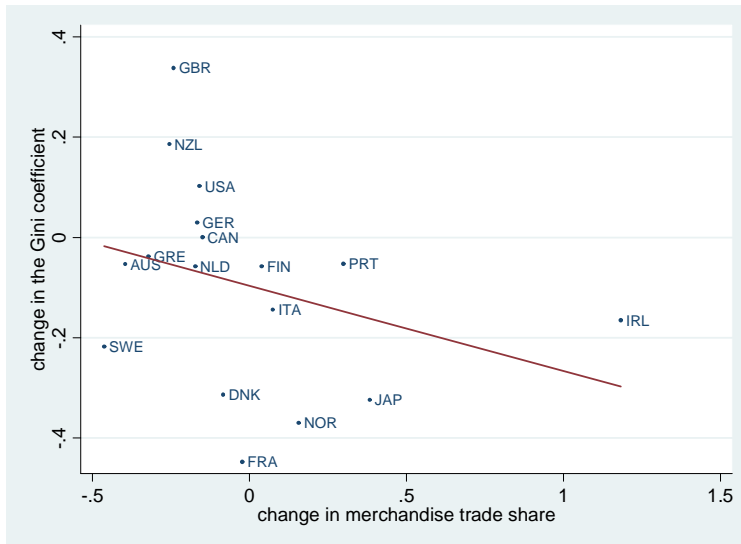


Figure 3: Change in the Gini index of income distribution vs. the change in the share in the world merchandise trade among OECD countries, beginning 1970s – beginning 2000s. Coefficient of correlation  $\beta = -.17$ , t-statistic =  $-1.66$ , R-squared =  $0.10$ ,  $N = 17$ , robust standard errors. Gini index source: World Bank, Luxembourg Income Study. Trade statistics source to calculate shares: WTO.

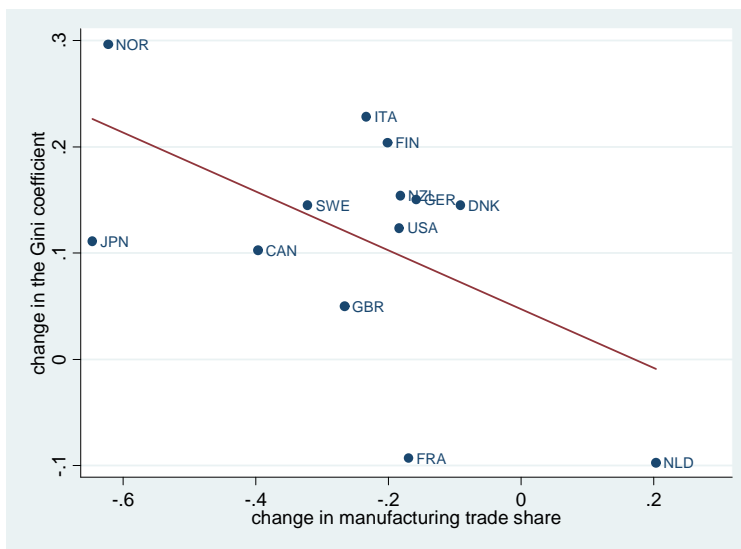


Figure 4: Change in the Gini index of income for working age population, 18-65 vs. the share in the world manufactures trade. Mid80s – Mid00s. Correlation coefficient  $\beta = -0.277$ , t-statistic =  $-2.09$ ,  $N = 13$ , R-squared =  $0.29$ , robust standard errors. Gini coefficient source: OECD. Trade statistics source to calculate shares: WTO.