Globalization and Inequality

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Abstract. The theory of comparative advantage predicts that, with expanding global markets, income inequality in poorer countries should decrease. To date, however, the international record on inequality is at best mixed in the face of recent globalization. In this paper, we outline an alternative theory that seems more consistent with what has actually happened.

Глобализация и неравенство

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Из теории сравнительных преимуществ следует, что с расширением глобальных рынков должно снижаться неравенство доходов в более бедных странах. Однако международные данные о наблюдаемом неравенстве не позволяют сделать однозначных выводов такого рода. В настоящей статье мы предлагаем теорию, которая представляется более согласованной с имеющимися наблюдениями.

1. *Introduction*

Supporters of the anti-globalization movement argue that "globalization has dramatically increased inequality between and within nations" (Mazur [2000]), and in particular that it has marginalized the poor in developing countries and left behind the poorest countries. Meanwhile, more moderate mainstream politicians argue that the poor must invest in education to take advantage of globalization (Clinton (2000)).

Such views are difficult to reconcile with a standard Heckscher-Ohlin trade model with two countries, two goods, and two factors (skilled and unskilled labor, or alternatively capital and labor). Under a simple model, globalization should benefit the poor in poor countries and reduce inequality in poor countries, and within the developing world the poorest countries and least educated workers should have the greatest opportunity to benefit from globalization. The argument goes as follows. Suppose there are two countries, the North, with a high ratio of skilled to unskilled workers, and the South, with a low ratio. Under autarky the wage of skilled workers will be relatively low in the skill-abundant North and relatively high in the skill-scarce South. Opening trade will equalize factor prices in the two countries. Hence, the wage of skilled workers will rise in the North and fall in the South, while the wage of unskilled workers will fall in the North and rise in the South. Thus inequality will rise in the rich country and fall in the poor country. The extent of, and gains from, trade will typically be greater the scarcer are skills in the South. Similar results obtain in a Heckscher-Ohlin model with capital and labor as the two inputs, assuming labor is equally distributed within each country while capital is not.

2. *Evidence on Trade and Inequality in Poor Countries*

There are, however, at least two empirical problems with the Heckscher-Ohlin story. First, it predicts that bilateral trade will be greatest when factor endowments are most different, *ceteris paribus* (Vanek 1968). There is little trade between advanced countries such as the U.S. and very poor countries such as Chad. A second problem with the Heckscher-Ohlin model is that evidence from examination of specific developing countries following trade liberalization and from cross-country studies does not suggest that trade liberalization generally reduces inequality in poor countries and in fact frequently suggests that trade liberalization can increase inequality.

Mexico is the most intensively studied liberalization experience. Mexico joined the General Agreement on Tariffs and Trade (GATT) in 1985 and embarked on a broad liberalization of trade and foreign investment. Between mid 1985 and the end of 1987, import license coverage fell from 92% to 25% and average tariff rates fell from 23.5% to 11.8%, while the share of foreign direct investment in total investment rose from 1.4% to 9.8% (Hanson and Harrison, 1999, Feenstra and Hanson, 1997). While the pre-1985, the trend in wage inequality had been downward, in the period 1984-1990, white-collar real hourly wages increased 13.4% while blue-collar wages decreased 14.0%. As further evidence of a rising wage differential, Feliciano (1993) and Cragg and Epelbaum (1996) use household-level data to find that the return to schooling increased in Mexico during the late 1980s. The biggest rise in inequality was observed in firms engaged in export industries. Accordingly, Feenstra and Hanson (1996b) argue that rising wage inequality

in Mexico is linked to capital inflows from abroad. An increase in outsourcing by Northern multinationals shifted production in Mexico towards skill-intensive goods thereby increasing the relative demand for skilled labor. That globalization has favored skill-intensive production in Mexico is further suggested by the fact that employees of multinational firms and international joint ventures receive higher wages, with or without adjustment for observable correlates of skill (Aitken, Harrison and Lipsey, 1996; Pavcnik, 2000).

Time series studies finding that wage inequality increases after globalization in developing countries include work on Argentina (Robbins, Gonzales, and Menendez, 1995), Chile (Robbins, 1995a), Colombia (Robbins, 1996a), Costa Rica (Robbins and Gindling, 1997) and Uruguay (Robbins, 1995b, 1996b).[1] Wood (1997) surveys the literature and concludes that increased openness is associated with reduced wage inequality in the Asian Tiger economies in the 1970s and 1980s but with increased inequality in Latin America in the 1990s.

Lindert and Williamson (2001) argue that the limited evidence available for other countries indicates that liberalization tends to be followed by increases in inequality, but causality is doubtful (particularly since in several large countries (India, China, Russia, Indonesia) liberalization had been only partial. In the case of China global integration has proceeded further in coastal than in hinterland regions, and coincides with increased coastal-hinterland wage inequality. However Wei and Wu (2001) find that Chinese cities (which include adjacent rural areas) that experience a greater degree of openness in trade

[1] Behrman, Birdsall and Székely (2001) show that the skilled-unskilled wage gap in Latin America is large and grew rapidly after 1977, but argue that is associated with financial sector liberalization and capital account opening and not trade liberalization per se. They speculate that the growth in the gap is due to

(as instrumented for by distance from Shanghai or Hong Kong) also tend to have greater declines in rural-urban income inequality.

Most of the recent panel data literature either finds that trade liberalization is positively associated with inequality in poor countries or finds no strong association. Barro (2000)'s survey of inequality and growth in a panel of countries finds that the relationship between openness and inequality is positive for low-income countries and negative for high income countries, with the turning point occurring at a GDP per capita level of $13, 000. Kapstein and Milanovic (2002) find a similar result, with a turning point around $6, 000.[2] Lundberg and Squire (1999) find in panel data (including both developed and developing countries) that the income share of the lowest two quintiles is negatively affected by openness, while that of middle and upper quintiles is positively affected. Rama (2001) observes that these results may be sensitive to the set of controls included in the regressions. Dollar and Kraay's (2001a, 2001b) cross-sectional studies of the relationship between growth and openness argue that changes in measures of international integration are not significantly associated with changes in the share of income that goes to the poorest quintile. Li, Squire and Zou (1997), White and Anderson (2001) and Garrett (2001) all find the sign and the significance of the effect on globalization on inequality depend on the measure of globalization used (generally negative and insignificant for trade/GDP, generally positive and insignificant for FDI/GDP).

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complementarity between human capital and physical capital, abetted by deepening of the financial sector and opening of the capital market.

[2] When regional dummies are included in regressions, openness reduces inequality in rich and transition economies, increases it in Latin America and has no significant effect elsewhere. However, since there is a correlation between income levels and region membership (Latin American countries are more similar to other Latin American countries than to African countries in income level) it is not clear that including regional dummies does not throw the baby out with the bath water.

Using a dataset derived from countries' wage reports to the ILO, Rama (2001) finds that trade/GDP and an indicator variable for openness do not significantly affect returns to education; however FDI/GDP has an enormous positive effect on returns to education.

In summary, the empirical evidence does not suggest that globalization consistently has the expected Heckscher-Ohlin effects of reducing inequality in poor countries. In fact there is some evidence that trade can sometimes increase inequality in developing countries.

3. *Review of Theoretical Models*

We observed above that the simple Heckscher-Ohlin model makes two strong predictions that are not apparent empirically: there should be large amounts of trade between very rich and very poor countries, and trade should increase inequality in rich countries and decrease it in poor countries. More complicated versions of the Heckscher-Ohlin model (allowing for multiple countries and goods, as well as non-traded goods and sector-specific capital) can have more nuanced predictions. However, the basic predictions of the direction of changes in inequality usually remain in except in perverse cases: see Wood [1997] for a survey.

Wood (1997) also observes that a possible explanation for the differing effects on inequality of globalization in East Asia in the 1960s and 1970s and Latin America in the 1990s are two large exogenous changes in the world economy in the intervening period. He points to the development of skill-complementary technologies and the entry into the global economy in the 1980s of economies such as China and Indonesia with large

endowments of unskilled labor. He argues that where East Asian countries liberalizing in the 1960s and 1970s were relatively *low* skill with respect to countries then integrated into the global economy, Latin American countries in the 1990s in fact had relatively *high* rather than relatively *low* skill levels with respect to the 1990s global economy as a whole. However, note that Latin American merchandise exports to high income countries comprised 78% of all Latin American merchandise exports in 2000; exports within Latin America accounted for another 14%. East Asian and Pacific low and middle income countries' merchandise exports were directed mainly to high income countries (76%) and to other East Asian and Pacific countries (14%). Trade between Latin America and Asia in either direction represented less than 2% of either region's merchandise exports (World Bank 2002). This suggests that the presence of East Asia in the global economy is unlikely to be the reason for the increases in inequality in Latin America after liberalization. Although sufficiently strong assumptions on elasticities of substitution allow small volumes of trade to have large effects of factor prices, conventional elasticities suggest that this is not the case.

Wood[1994] provides a Heckscher-Ohlin model with three types of workers (skilled, with basic education, and uneducated, who have comparative advantages in skill-intensive manufacturing, labor-intensive manufacturing, and agriculture). Suppose wages increase with skill (so that skilled workers earn the most and uneducated workers earn the least). Consider a country with a comparative advantage in agriculture. Trade liberalization will reduce wage inequality in this country by the standard Heckscher-Ohlin argument – the country will export agricultural products and import manufactures and services, so wages for unskilled workers rise while other workers experience wage

decreases. This unambiguously reduces inequality. In rich countries (with many skilled workers) the effect on inequality of trade liberalization is again in accordance with standard Heckscher-Ohlin theory: skilled workers gain and those with less skill lose. This increases inequality. In a country with a high proportion of medium-skill workers, and hence a comparative advantage in manufacturing, however, the opening of trade can either increase or decrease wage inequality as workers in the middle of the wage distribution gain while those at the top and bottom lose. However, the limited evidence available for Latin American countries also indicates that rises in inequality are due to gains at the top of the distribution, rather than in the middle. Behrman, Birdsall and Székely (2001) show that returns to higher education increased greatly (relative to returns to secondary or primary education) throughout Latin America in the 1990s.

Similarly, Davis (1996) gives a three-good, two-type Heckscher-Ohlin model which can also explain increasing inequality in some developing countries after trade liberalization. The three goods differ in capital intensiveness (X > Y > Z). Assume that imperfect markets do not allow complete factor price equalization and that Northern countries are more capital abundant and have higher wage to capital rental rate ratio. In equilibrium Northern countries produce X and Y and Southern countries produce Y and Z (thus North and South form distinct 'cones of diversification'). Reducing their tariff barriers will affect Southern countries differently according to the relative importance of Y and Z production in each. The least developed countries, which export Z and import Y, will experience a decrease in inequality as in the conventional Heckscher-Ohlin model: wages fall as the world price of Z falls. More developed Southern countries, which export

Y and import Z will experience a rise in inequality: the world price of Y also falls, but since Y is capital intensive relative to Z, this leads to higher rental rates and lower wages.

Aside from the Heckscher-Ohlin model, trade can potentially increase inequality in both rich and poor countries in other models. In the basic version of the specific factors or Ricardo-Viner model there are two goods and two factors, capital and labor (with fixed endowments). Capital is specific to a particular industry and cannot be moved between industries, while labor is costlessly mobile between industries. If the price of the export goods rises due to trade liberalization, the export sector expands by increasing the wage; this reduces employment in the other sector. The real effects of trade liberalization on workers in both rich and poor countries are ambiguous: wages are higher but since the export good has increased in price, real welfare effects depend on a consumer's relative tastes for the poor country's export good and the rich country's export good (Jones, 1971). If the poor country exports agricultural products and these form a large fraction of poor country workers' consumption then poor country workers will be worse off. However, this model does not explain the empirical finding of increased inequality of wages.

Feenstra and Hanson (1996a) provide a Heckscher-Ohlin-type model with a continuum of intermediate goods which predicts that globalization, interpreted as FDI flows from North to South, leads to higher relative wages for skilled workers in both rich and poor countries. Index the continuum of intermediate goods by $z \in [0,1]$, so that higher z reflects higher skill intensity of production. Capital is complementary with skilled labor; the North has more capital and more skilled labor than the South. It can be shown that in equilibrium there is a cutoff z^* such that the South produces intermediate

goods in $[0, z^*]$ while the North produces intermediate goods in $[z^*,1]$. FDI from the North to the South increases z^*. This increases the average skill intensiveness of production in both countries, which raises the relative wages of skilled workers in both countries.

Note that both the specific factors and Feenstra and Hanson models share with the other standard trade models the prediction that *ceteris paribus* trade should be greatest between countries with the most different factor endowments; this is not observed.[3]

Murphy and Shleifer (1997) provide a model of product quality where the lack of trade between rich and poor countries arises from demand considerations: consumers in rich countries are wealthy enough to wish to consume high quality goods which are not produced by low-skilled workers in poor countries. This is because high-skilled workers in rich countries have a comparative advantage in producing high quality goods, while poor countries' workers have a comparative advantage in producing low quality goods. Their model does not directly have implications for inequality, but it offers an explanation for the lack of trade between rich and poor countries that is related to ours. It

[3] Xu (2002) shows that in a model with endogenously determined non-traded goods, trade liberalization in the South can have a U-shaped relationship with inequality, reducing inequality when trade barriers start at a high level and increasing it when they are initially lower. His model combines features of the Heckscher-Ohlin and Feenstra-Hanson approach. There are two countries and three goods sectors: a skill-intensive good that is produced only in the North, a labor-intensive good that is produced only in the South, and a continuum of goods of intermediate skill intensities indexed by [0,1]. Modeling non-zero trade barriers in Southern countries as iceberg costs, Xu observes that in equilibrium there will be cutoff indices $0 < x_N < x_S < 1$ such that goods in $[0, x_N]$ are produced in the South only, goods in $[x_S, 1]$ are produced in the North only, and goods in $[x_N, x_S]$ are produced in each country and not traded. Southern trade liberalization in this model has two effects: it decreases the range of non-traded goods (that is, the difference $x_S - x_N$) and this affects both x_N and x_S in a global trading equilibrium. There is an increase in x_N (the mechanism is through expansion of Northern exports and global trade balance). As in the Feenstra-Hanson model, this favors skilled workers in the South. However, the decrease in the range of non-traded goods has the opposite effect, favoring unskilled workers. Xu shows that the 'traded goods' effect dominates for low initial trade barrier levels while the 'non-traded goods' effect dominates for high initial trade barriers. Thus liberalization produces a U-shaped effect on inequality in South (a similar argument shows the same is true in the North).

also provides a possible justification for the claim that poor countries may not be able to benefit from globalization.

4. *Model*

In the Heckscher-Ohlin model, two countries trade produced goods with one another. However, recently globalization has, to a large extent also been globalization of the *production process* (rather than of trade in produced goods). A single product can be manufactured out of components made and assembled in different countries, or designed in one country and manufactured in another. Thus, in effect, the people working on the product are working together. Workers in poor countries not only produce labor-intensive products as toys, but also jointly produce with workers in rich countries – for example by working in call centers. We are interested in modeling this type of globalization, which occurs via cross-border production, where a product is designed in one country, manufactured in a second and customer service is provided by a call center in a third country.

We propose a model of production by workers of different skill-levels (Kremer and Maskin (1997)) that is consistent with 1) the small scale of trade between countries with very different factor endowments and 2) the possibility that globalization may increase inequality in both rich and poor countries.

Specifically, consider a model in which there are two countries and just one consumption good. The *rich* country has workers of two skill levels, *A* and *B*, where $A \geq B$. The *poor* country has workers of skill levels *C* and *D*, where $C \geq D$. For now, assume $A \geq B \geq C \geq D$. In a stylized two-type model this may be a reasonable assumption (the lowest quartile of the U.S. skill distribution may well be higher than the

highest quartile of the Indian distribution; the presence of small numbers of very high skill workers in India or very low skill workers in the U.S. makes no difference to our results (on this see further below).

There are many competitive firms in each country, but each firm is characterized by the same production process, in which there are two tasks—a managerial (or skill-sensitive) task, and an assistant's (or relatively skill-insensitive) task. A firm's output depends on the skill levels of the workers who undertake the two tasks. Thus if a worker of skill *H* is assigned the manager's task and a worker of skill *L* is assigned the assistant's task output is given by

$$H^2 L. \qquad (1)$$

The production function (1) implies that it is more efficient for a firm to assign a higher-skill worker to the managerial task and a lower-skill worker to the assistant's role than the other way around; i.e., if $H > L,$ then $H^2 L > HL^2.$ It also implies that it may be more efficient for there to be *cross-matching* (workers with *different* skill levels working in the same firm) than *self-matching* (workers with the *same* skill level working together). Indeed, suppose that there are two workers each of skill levels *H* and *L* $(H > L)$. If these four workers are self-matched, then total output is

$$H^3 + L^3, \qquad (2)$$

whereas if they are cross-matched output is

$$2H^2 L. \qquad (3)$$

Notice that as long as

$$H < \left(\frac{1+\sqrt{5}}{2} \right) L,$$

then (3) exceeds (2), i.e., cross-matching is superior.

We are interested in the matching patterns and workers' wages in competitive equilibrium. Because there are constant returns to scale, total wage payments must equal firm revenues. Hence, if we normalize the output price to 1 and *H*-workers are self-matched in equilibrium, we have

$$H^3 - 2w_H = 0$$

i.e.,

$$w_H = \frac{H^3}{2},$$

where w_H is an *H*-worker's wage. If *H*- and *L*-workers are cross-matched in equilibrium, then

$$H^2 L - w_H - w_L = 0.$$

Note that even if *H*-workers are cross matched as well as self-matched in equilibrium then we still have $w_H = \frac{H^3}{2},$ since if cross-matching firms were to offer more then there would be no *H*-self-matching in equilibrium, while if they were to offer less then there would be no cross-matching.

5. *Inequality*

Returning to our two-country framework, we will assume that globalization means that workers from different countries can work together in the same firm. Thus, before globalization, *A*- and *B*-workers could be cross-matched (although not necessarily), and the same for *C*- and *D*-workers. But international matches are not

possible: for example, *B*- and *C*-workers *cannot* be cross-matched. By contrast, after globalization, all cross-matches are in principle possible. (Later we consider the case where cross-border matching must involve *A*-workers.)

We shall suppose, however, that low skill workers in poor countries are of low enough skill that

$$B > \left(\frac{1+\sqrt{5}}{2} \right) D, \tag{4}$$

so that it is not efficient for the least-skilled workers in the poor country to be cross-matched with any worker in the rich country. That low-skilled workers in poor countries have difficulty participating in cross-border matching is consistent with the evidence from some forms of cross-border production. For example, call centers in India tend to employ middle-class Indians who can speak with an American accent with which U.S. customers are familiar. Multinationals and exporters in developing countries typically pay manufacturing wages substantially above the norm for the country (Lipsey (1994); Aitken, Harrison, and Lipsey (1996); Hanson and Harrison (1999)). Although this may in part constitute rents, it suggests that multinationals are likely to hire workers who are more skilled than the typical worker in the country. Even factories that hire workers who have few observable skills are likely to attract workers who are skilled along unobservable dimensions, given that they pay high wages.

As there is only one consumption good, there are obviously no gains from trade in output between the rich and poor country. Globalization potentially allows efficiency gains through cross-border production.

If skill levels in the rich and poor countries are sufficiently disparate (that is, if $B > \left(\frac{1+\sqrt{5}}{2}\right)C$) then it is inefficient for any rich country workers to match with any poor country workers. Therefore the model offers a clear explanation of why very little trade is observed between the U.S. and Chad, for example.

Furthermore, in this model globalization causes inequality in the poor country (the gap between the wages of *C*- and D-workers) either to increase or to remain the same:

***Proposition*:** Given (4), globalization (weakly) increases inequality in the poor country, in the sense that w_C (weakly) rises and w_D (weakly) falls. Furthermore, there is a broad range of parameters for which the increase in inequality is strict.

Proof: Let X_D and X_C be the numbers of *D*- and C-workers, respectively. Denote the pre-globalization wages by w_D and w_C and the post-globalization wages by w'_D and w'_C .

Case I: $X_D > X_C$

In this case, at least some *D*-workers must be self-matched both before and after globalization. Hence,

$$w_D = w'_D = \frac{D^3}{2} \ . \tag{5}$$

Now, before globalization, *C*-workers are either self-matched or paired with *D*-workers. Hence,

$$w_C = \max\left\{\frac{C^3}{2}, DC^2 - \frac{D^3}{2}\right\}. \tag{6}$$

But after globalization, *C*-workers still have the options of self-matching or matching with *D*-workers. (Note that the second part of this statement is true because *D*-workers' skill level is so low that rich country workers do not want to match with them: hence they

are still 'available' to *C*-workers as potential matches after globalization.) Furthermore, because $w_D = w'_D$, those options still yield the same wages. Hence,

$$w'_C \geq \max\left\{\frac{C^3}{2}, DC^2 - \frac{D^3}{2}\right\}. \tag{7}$$

Case II: $X_D < X_C$

In this case, before globalization, at least some *C*-workers are self-matched, and *D*-workers are either self-matched or paired with *C*-workers:

$$w_C = \frac{C^3}{2} \qquad w_D = \max\left\{\frac{D^3}{2}, DC^2 - w_C{}^3\right\}. \tag{8}$$

After globalization, *C*-workers can, at worst, be self-matched. Hence,

$$w'_C \geq \frac{C^3}{2} = w_C. \tag{9}$$

After globalization, a *D*-worker will either be self-matched or matched with a *C*-worker. Hence,

$$w'_D = \max\left\{\frac{D^3}{2}, DC^2 - w'_C\right\}. \tag{10}$$

From (8)-(10)

$$w'_D \leq w_D.$$

Q.E.D.

As is evident from the proof, the basic reason behind the increase in inequality in poor countries is the additional potential matches that globalization brings to each type of worker. For *C*-workers, globalization opens more possible matches; for *D*-workers it does not. In this sense *D*-workers can be *marginalized* by globalization in this model if before globalization they matched with *C*-workers but are afterwards forced to self-match. This

leaves *C*-workers weakly better off; because w_D depends (weakly) negatively on w_C this leaves *D*-workers weakly worse off. Hence inequality increases. It is clear that the relative sizes (and ordering) of *A*, *B* and *C* do not matter to this argument.

Note that the assumption that *D*-workers are so low skilled that it is inefficient for them to be involved in international matching is important. For example, if before globalization *C*- and *D*-workers match, while afterwards *A*- and *C*-workers match and *B*- and *D*-workers match, then globalization has added new matching possibilities for both *C*- and *D*-workers and so no conclusion can be drawn about the changes w_C and w_D without considering the exact values of *A*, *B*, *C* and *D* and the numbers of workers of each type.

Similarly, without making stronger assumptions, we cannot pin down what effect globalization has on inequality in the rich country other than to say that the wages of the *A*- and *B*-workers cannot both go down; all other combinations are possible. In particular, we can have

$$w'_A > w_A \quad \text{and} \quad w'_B > w_B\,, \tag{11}$$

if, after globalization, both *A*- and *B*-workers are matched with *C*-workers (in sharing profits with *C*-workers the *A*- and *B*-workers benefit from the fact w_C is relatively low). We can have

$$w'_B > w_B \quad \text{and} \quad w'_A < w_A\,, \tag{12}$$

if, after globalization, *B*-workers are matched with both *C*- and *A*-workers (*B*-workers' wages are pushed up by the possibility of matching with *C*-workers, and this reduces *A*-workers' wages). Finally, we can have

$$w'_B < w_B \quad \text{and} \quad w'_A > w_A \tag{13}$$

if, after globalization, *A*-workers are matched with both *B*- and *C*-workers (the mirror image of the previous case).

6. Extensions

In presenting the basic model above, we made several assumptions for the sake of clarity. We assumed that each country has only two types of workers (*A*- and *B*-workers in the rich country and *C*- and *D*-workers in the poor country), that $A > B > C > D$ and that *D*-workers are so low skill that it is inefficient for them to be involved in international matching. In this section we consider the results obtained from altering some of these hypotheses.

6.1 Some workers of each type in each country

The first extension that we consider is to the case where each country contains workers of all four types. The rich country is distinguished by having many *A*- and *B*-workers and few *C*- and *D*-workers, while the poor country has many *C*- and *D*-workers and few *A*- and *B*-workers relative to the difference between the numbers of the main two types of workers in the country. This alteration to the model generally has no effect on wages either before or after globalization and therefore no effect on the predictions about changes in inequality. This is because the addition of small numbers of workers of different types do not change the matching possibilities for most workers.[4]

***Proposition*:** Given fixed (and not equal) numbers X_A and X_B of *A*- and *B*-workers in the rich country and X_C and X_D of *C*- and *D*-workers in the poor country, the addition of

[4] However, the fact that globalization may affect the wages of the minority types of workers in a country means that we can no longer think of inequality in the sense of first-order stochastic dominance as we have implicitly done above: instead to be rigorous we must consider more general measures of inequality such as the Gini coefficient. However since the main two types of workers form the vast majority of workers in a country, qualitative conclusions such as 'if w_C is increased by globalization and w_D is weakly decreased then inequality in the poor country has increased' clearly remain valid.

small numbers X'_A and X'_B of *A*- and *B*-workers in the poor country does not change w_C and w_D. There is an analogous result for the rich country.

Proof: To be precise, consider again the first case considered in the discussion of poor country inequality above (with *D* so low that it is inefficient for *D*-workers to match internationally and $X_D > X_C$). Suppose that the numbers of *A*- and *B*- workers in the poor country are small enough that $X_D > X'_A + X'_B + X_C$. Then it follows as before that some *D*-workers must be self-matched in equilibrium both before and after globalization, so $w_D = w'_D = \frac{D^3}{2}$. as before. Moreover, since X'_A and X'_B are small some *C*-workers must be self-matched or paired with *D*-workers as before. Even if other *C*-workers match with *A*- or *B*-workers, this does not affect wage determination in competitive equilibrium. Thus $w_C = \max\left\{\frac{C^3}{2}, DC^2 - \frac{D^3}{2}\right\}$ as before; if X'_A and X'_B are sufficiently small numbers not to affect the types of matchings that occur after globalization, then $w'_C \geq \max\left\{\frac{C^3}{2}, DC^2 - \frac{D^3}{2}\right\}$ is also unchanged. This completes the proof in this case. The other cases are similar.

Addition of *A*- and *B*- workers to the poor country will change wages for *C*- and *D*-workers in the poor country before globalization only if sufficiently many are added that $X_D < X_A + X_B + X_C$ and after globalization only if an analogous condition holds for the world as a whole. Thus the addition of small numbers of *A*- and *B*-workers to the poor country can have an effect on wages only if X_C and X_D are very close (however, the effect on wages is discrete at the point where *D*-workers switch from being in the majority to the minority). If the numbers of *A*- and *B*-workers in the poor country are small enough, it

is still true that if $w'_C > w_C$ while $w'_D = w_D$ then inequality (in the sense of the Gini coefficient or other frequently-used continuous measures of inequality, but not of stochastic dominance) has increased in the poor country. Thus the conclusion is unchanged from before. Other cases for rich and poor countries are similar.

6.2 A-workers are needed for globalization

Next, returning to the basic model, consider the arguably realistic case where *B*-workers cannot take advantage of globalization. This is consistent with stylized facts on employment and globalization. Nike's designers and marketers can live in the U.S. and work with Vietnamese workers, but Nike cannot hire U.S. factory supervisors to oversee workers in Vietnam. Since *D*-workers are of such low skill that it is inefficient for them to match internationally, the only potential new match allowed by globalization is between *A*- and *C*-workers. In this case it follows that

$$w'_A \geq w_A \quad \text{and} \quad w'_B \leq w_B . \tag{14}$$

A-workers benefit from matching with low-wage *C*-workers, and this means *B*-workers (who are either self-matched or matched with *A*-workers both before and after globalization) are worse off. In fact, the argument is exactly the same as for showing w_C weakly increases and w_D weakly decreases after globalization: the only potential new match for rich country workers involves *A*-workers: hence *A*-workers are weakly better off and *B*-workers are weakly worse off.[5] Thus inequality in the rich country unambiguously increases in this case. The conclusion about increased inequality in the poor country remains the same as before.

6.3 C > B and friction in international matching

We have been considering globalization in a very strong sense – international matching after globalization occurs costlessly and, conditional on skill levels, is as efficient as domestic matching. Since globalization is not a zero-one variable (tariff rates and the costs of international communications, for example, vary continuously), we now consider the case where international matching is less efficient than domestic matching. More specifically, suppose that if workers of skill levels *H* and *L* live in the same country and work together, then production is H^2L, but if they match internationally then production is only $\mu H^2 L$, where $0 \le \mu \le 1$. The parameter μ represents the efficiency of international matching; previously we modeled globalization as an increase from $\mu = 0$ to $\mu = 1$. Now we consider the case where after globalization, $0 < \mu < 1$.

Consider as before the case where each country has two types of workers, $A > B$, $C > D$, and *D* is sufficiently low that it is not efficient for *A*-workers to match with *D*-workers. (Note we are no longer assuming that $B > C$ or that it is inefficient for *B*- and *D*-workers to match if $\mu = 1$.) If $\mu = 1$ then it is possible in this case for inequality in the poor country to decrease after globalization if *B*- and *D*-workers match after globalization. For example, suppose X_C is very large, so that some *C*-workers must self-match both before and after globalization (so $w_C = w'_C = \frac{C^3}{2}$). If *B*- and *D*-workers match after globalization, then $w'_D > w_D$, so inequality decreases. This case, however, does not seem the most empirically relevant, since we do not observe much matching of low-skill workers in rich and poor countries.

[5] Again, this does not depend on the relative sizes or ordering of *A*, *B* and *C* provided that the only new

However, decreasing μ below 1 makes international matching less efficient. This means that *B*- and *D*-workers are less likely to match even after globalization. Thus it is more likely that w_D will not increase after globalization, and therefore more likely that inequality will increase after globalization. In general the effect of reducing μ on globalization's effect on inequality is ambiguous since for μ low, not only *D*- but also *C*-workers are less likely to be involved in international matching.

An interesting case to consider is where *D* is large enough that $A > \frac{1+\sqrt{5}}{2} D > C$, so the potential matches made possible by globalization are *AC* and *BD*. (Note we are not assuming here that *B* > *C*). Then it is possible for *D*-workers to be 'marginalized' by globalization, in the sense that before globalization they match with type *C*-workers whereas after globalization they are forced to be self-matched while the other three types of workers match among themselves. Since $C < \frac{1+\sqrt{5}}{2} D$, cross matching is efficient (so $C^2 D > \frac{C^3}{2} + \frac{D^3}{2}$) so before globalization, *D*-workers will be cross-matched with *C*-workers whether if $X_C > X_D$ (in which case $w_D = C^2 D - \frac{C^3}{2} \geq \frac{D^3}{2}$) or if $X_D > X_C$ (in which case $w_D = \frac{D^3}{2}$). However, in the second case, even if more *D*-workers are forced to self-match after globalization, still $w_D' = w_D = \frac{D^3}{2}$. Hence we consider the case where $X_C > X_D$ (and so $w_C = \frac{C^3}{2}$ and $w_D = C^2 D - \frac{C^3}{2} \geq \frac{D^3}{2}$). Suppose that after globalization

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potential match allowed by globalization is between *A*- and *C*-workers.

B- and *C*-workers strictly prefer to match with *A*-workers or with each other than with *D*-workers. There are various possible conditions on the relative skill levels and numbers of workers of each skill level that can ensure this. Two examples are:

1. if $X_B > X_A + X_C$ and $\frac{B^3}{2} > \mu B^2 D - \frac{D^3}{2}$ (so some *B*-workers must either self-match or match with *D*-workers after globalization, and so they prefer to self-match; in this case $w'_B = \frac{B^3}{2}$), and $\mu \max\{B^2C, C^2B\} - \frac{B^3}{2} > C^2D - \frac{D^3}{2}$ (so *C*-workers prefer to match with *B*-workers than with *D*-workers). Sample parameters for which these inequalities hold are $A > \frac{1+\sqrt{5}}{2} \approx 1.62$, $B = 1.2$, $C = 1.55$, $D = 1$ and $\mu = 0.9$.
2. if $X_A > X_B + X_C$ (so some *A*-workers must be self-matched after globalization, so $w'_A = \frac{A^3}{2}$), and $\mu A^2 C - \frac{A^3}{2} > C^2 D - \frac{D^3}{2}$ and $A^2 B - \frac{A^3}{2} > \mu B^2 D - \frac{D^3}{2}$ (so *B*- and *C*-workers prefer the *A*-match to the *D*-match, even if w_D is as low as possible; note they might still prefer the *BC* match to the *AB* or *AC* match but this is unimportant for the argument). Sample parameters for which all the above inequalities hold are $A = 1.3$, $D = 0.7$, B and C both between 0.84 and 1.13 and $\mu = 1.$[6]

Both sets of conditions ensure that no group of workers will want to cross-match with *D*-workers after globalization, the *A*-workers because it is inefficient and the *B*- and *C*-workers as guaranteed by the above inequalities. Thus after globalization *D*-workers must

self-match, so $w'_D = \frac{D^3}{2} < w_D$. The *D*-workers have been 'marginalized' by globalization – *C*-workers, who formerly matched with them, now prefer to match with *A*-workers or *B*-workers. Note that inequality unambiguously increases in the poor country in this case: $w'_D < w_D$ and $w'_C > w_C$.

7. *Conclusion*

Finally, observe that our model makes no clear prediction on trends in *global* inequality, even in the cases where inequality increases within both rich and poor countries.[7] Precise results depend on the relative numbers of *A*-, *B*-, *C*-, and *D*-workers as well as on the relative skill levels. However, if people measure their status relative to others in their own society, then they will perceive inequality increasing. This analysis corresponds to the view of many anti-globalization protestors that globalization benefits elites in both rich and poor countries.

Of course, while joint production may be a good model of some types of trade, the Heckscher-Ohlin model may be appropriate in other cases. Low-end shoe factories in poor countries may hire relatively low-skill workers. Still, the presence of some industries in which foreign investors typically hire medium-skill workers who are high-skill relative to others in their country may help explain why there is not a clear equalizing effect of trade in poor countries.

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[6] Note this second example works with $\mu = 1$ and so doesn't precisely fit the discussion here. If there are enough *A*-workers and *B*- and *C*-workers prefer to match with *A*-workers than with *D*-workers, that can marginalize *D*-workers.

[7] See Milanovic (2002) for a survey of trends in global inequality. While Milanovic concludes that global inequality has been increasing in the past few decades, others including Sala-i-Martin (2002) come to the opposite conclusion.

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