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International Trade and Wage Inequality in the United States: Some New Results

Jeffrey D. Sachs and Howard J. Shatz

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and President and Fellows of Harvard College

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**INTERNATIONAL TRADE AND WAGE INEQUALITY IN THE UNITED STATES:
SOME NEW RESULTS**

Jeffrey D. Sachs and Howard J. Shatz*

ABSTRACT

This paper shows that theory and evidence are more supportive of the link between increasing trade with developing countries and increasing U.S. wage inequality than recent criticisms have led many to believe. Much of the current debate focuses on the idea that relative goods prices must change for relative wages to change. The paper first demonstrates several additional channels through which an expansion of North-South trade causes a fall in the relative wage of unskilled workers in the North, even when *there are no changes in relative output prices*. It then explores the wage implications of a counterfactual in which U.S. trade with developing countries in 1990 remains the same as that in 1978. Changes in trade with developing countries are shown to have widened wages between low-skilled and high-skilled workers by 3.4 to 5.4 percent. Finally, it investigates changing relative prices and finds strong evidence that, in fact, from 1978 to 1995, value added and output prices in unskilled-intensive manufacturing sectors fell considerably relative to prices in skill-intensive manufacturing sectors.

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Jeffrey Sachs is the Director of the Harvard Institute for International Development and the Galen L. Stone Professor of International Trade at Harvard University. Sachs serves as an economic advisor to several governments in Latin America, Eastern Europe, the former Soviet Union and Asia. He has also been a consultant to the IMF, the World Bank, the OECD, and the UNDP.

Howard Shatz is a Ph.D. candidate in Public Policy at Harvard, focusing on international economics. He has worked with Jeffrey Sachs on the influence of international trade on U.S. labor markets and is now researching world foreign direct investment flows.

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J. Sachs
H. Shatz
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International Trade and Wage Inequality in the United States:
Some New Results

The effects of U.S. trade with developing countries on U.S. wage inequality and employment patterns continue to be a subject of enormous contention. The charge that U.S.-developing country trade lowers the wages of unskilled U.S. workers, or perhaps all U.S. workers, has entered the U.S. political debate with considerable force, and the debate among economists has heated up as well. The range of opinion is enormous, sometimes even within the writings of the same author. Paul Krugman (1995a), for example, dismissed fears of low-wage trade competition as nothing more than the confusion of the 19th century "pauper labour argument" re-visited. A few months later, Krugman (1995b) acknowledged that growing North-South trade could account for some, but not most, of the widening inequality. More recently, Krugman and co-author Anthony Venables (1995) have presented a theoretical model in which the falling cost of international transport, and therefore rising international trade between the "North" (developed countries) and the "South" (developing

countries), can eventually lead to an **absolute** decline in the wage levels of the North, as a result of deindustrialization and convergence of income with the South. This model suggests that the "pauper labour argument" is not simply confusion, but rather an unresolved empirical question.

In fact, a wide range of theories suggests that increased trade with developing countries, whether the result of falling transport costs, or falling protectionist barriers, or increased capacity of developing countries to produce goods for world markets, can lead to downward pressures on low-skilled wages. Theory also suggests circumstances in which increased trade will not produce such downward pressures. Most importantly, if the developing countries are producing and exporting goods to the U.S. that are not produced in the U.S. economy, then low-wage workers will not in general feel the brunt of increased trade flows.

The Heckscher-Ohlin-Samuelson (HOS) model, with its Stolper-Samuelson corollary, is the benchmark theoretical treatment of North-South trade, i.e., trade between high-wage and low-wage economies (see, for example, Lawrence and Slaughter, 1993; Wood, 1994; Sachs and Shatz, 1994; and Leamer, 1995, for discussions revolving around the HOS model). The baseline model in recent

debates rests on the following assumptions. There are two kinds of factor inputs, skilled labor, L_s , and unskilled labor, L_u . There are two output sectors as well. To economize on subscripts and superscripts, we denote the skill-intensive sector as S , and the unskilled-intensive sector as U . Let L_{ij} be the input of L_i in sector j . Then, we assume $L_{uu}/L_{su} > L_{us}/L_{ss}$ at all factor prices. There are constant returns to scale in production, perfect competition, full employment, and identical technologies in both countries. The skill-intensive good is numeraire ($P_s = 1$), and P_u denotes the relative price of U . The wage (in units of the numeraire, of course) is W_u for L_u , and W_s for L_s .

Now, assume a rise in trade between the the skill-intensive economy (the North) and the unskilled-intensive economy (the South) due to the elimination of protectionist barriers. Comparing the free trade equilibrium with autarky, the HOS theory predicts: (1) a rise in the production, and export, of S in the North, and in the production, and export, of U in the South; (2) a fall in P_u , the relative price of U , in the North; (3) a fall in the relative wage of unskilled workers in the North, W_u/W_s (and in the relative wage of skilled workers in the South); and (4) a rise in the ratio of unskilled to skilled workers in each sector in the North, as firms economize on skilled workers after

the rise in their relative wage. Thus, (L_{ui}/L_{si}) rises in each sector i ($i=U,S$).

If we consider the period of the 1980s as one of falling trade barriers in the developing countries (see Sachs and Warner, 1995, for a demonstration of this point), how do the various predictions of the HOS model fare in empirical terms? Predictions (1) and (3) seem to be consistent with the data. U.S. production and net exports of unskilled-intensive goods have declined in the past two decades, while net imports of these goods from developing countries have risen. At the same time, the relative wage of low-skilled workers has fallen significantly in the U.S. This basic correlation of increased U.S. trade with developing countries and U.S. relative wage trends is, of course, the starting point of the controversy. Prediction (4) seems to be contrary to the facts, since virtually all manufacturing sectors in the U.S. have experienced a reduction in L_u/L_s , rather than an increase, despite the fall in W_u/W_s . This pattern suggests that technological shifts ("unskilled-saving technical change") are at work, perhaps in addition to the effects of trade.

A significant controversy has arisen around Prediction (2). There is no conclusive agreement among researchers on the trends

of relative prices of low-skilled goods (e.g. apparel, footwear, assembly operations). The absence of clear evidence on relative price trends has led some observers, especially Bhagwati and Dehejia (1994) and Bhagwati (1995), to conclude that trade must have played a small or insignificant role in the widening of U.S. wage inequality. Bhagwati argues that increased trade with developing countries can be the culprit in rising wage inequality only if the relative prices of U-goods have declined; since they have not, trade must not be the cause of widening wage inequalities. (Krugman and Lawrence, 1994, also point to the price data, and to the circumstantial evidence in favor of Lu-saving technical change, to suggest that it is technology rather than trade which accounts for the observed wage trends).

In our view, the conclusion that trade has played a small or even insignificant role in widening U.S. wage inequality is premature, and perhaps simply incorrect, for two reasons. First, the HOS model is not the only theoretical basis for a link between trade and relative wages. There are, in fact, many channels by which increased trade with low-wage countries could lead to a fall in the relative or absolute wages of unskilled workers. For example, the Krugman and Venables (1995) study is based on agglomeration economies arising from transport costs and

increasing returns to scale, rather than from HOS assumptions, yet it still delivers the prediction of factor-price equalization between North and South as transport costs fall to low levels. The first part of the present paper demonstrates several additional channels through which an expansion of North-South trade causes a fall in the relative wage of unskilled workers in the North, *even when there are no changes in relative output prices.*

Second, the evidence on relative prices is much more supportive of HOS predictions than Bhagwati or some others have suggested. Because of the so-called "magnification effect," according to which relative price changes lead to more-than-proportionate changes in relative wages, even very small changes in relative prices -- hard to detect in the data -- would be consistent with large relative wage movements. Krugman (1995b) makes an illustrative calculation in which the magnification effect is roughly 3: a 1 percent reduction in the relative price of unskilled-intensive goods leads to a 3 percent reduction in the relative wage of unskilled workers. In fact, there are reasons to believe that the relative price of unskilled-intensive goods has in fact declined during the past fifteen years, by an economically meaningful margin.

It is the purpose of this paper to show that theory and evidence are more supportive of the trade-wage link than recent criticisms have led many to believe. The first part of this paper emphasizes the theoretical robustness of the trade-wage linkage, even beyond the assumptions of the HOS model. The second part of the paper revisits the empirical evidence, especially the price data, and shows that in fact the weight of the evidence points to economically significant relative price movements of the sort predicted by the HOS model.

II. Theoretical Issues

Increased trade with between the U.S. and low-wage developing countries could put downward pressure on U.S. unskilled wages for many reasons. The HOS model emphasizes one: the fall in the relative price of U goods, which is then passed through to the wages of unskilled workers. There are, in fact, a variety of ways that the same outcome may apply even when P_u does not change.

A. Capital Mobility

The first, and potentially very important, channel in addition to HOS is capital mobility. If the capital stock of Lu-

intensive sectors can move from the U.S. to developing countries, then W_u/W_s can decline even if there is no change in P_u .

Consider the following simple model to illustrate this point. We assume that there are two tradeable sectors, S and U, as well as a nontradeable sector N. The S sector is a final good, while U is an intermediate good used in the production of S. The price of S is taken as numeraire, and P_u is the relative price of the U, and P_n is the relative price of N. The unskilled good U is produced either domestically, with output D_u , or in the partner country, with output F_u . K_u is the capital stock used in U production, and is divided between U.S.-based enterprises (K_d) and foreign-based enterprises (K_f), with $K_u = K_d + K_f$. Capital is sector specific, so that K_u cannot be used in N production and K_n cannot be used in U production.

The full model is as follows:

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|-----|---------------------------|---------------------------------|
| (1) | $S = S(L_s, U)$ | production function of S |
| (2) | $D_u = \min(L_{uu}, K_d)$ | production function of D_u |
| (3) | $F_u = K_f$ | production of F_u |
| (4) | $L^*_{uu} = K_f$ | foreign labor employed in F_u |
| (5) | $U = D_u + F_u$ | total production of U |
| (6) | $K_d = K_u - K_f$ | domestic capital stock in U |

- (7) $N = N(L_{un}, K_n)$ production function of N
- (8) $L_u = L_{uu} + L_{un}$ total unskilled labor
- (9) $W_s = \partial S / \partial L_s$ labor demand for L_s in S
- (10) $W_u = P_n (\partial N / \partial L_{un})$ labor demand for L_u in N
- (11) $P_u = \partial S / \partial U$ demand for U in S
- (12) $\Pi_f = P_u F_u - W^* u (L^* u u)$ quasi-rents (profits) on K_f
- (13) $Y = S - P_u F_u + P_n N + \Pi_f$ definition of national income
- (14) $N = f(Y, P_n)$ final demand for nontradeables

The production functions for S and N are standard neoclassical, constant-returns-to-scale production functions. The skilled labor force is fixed at L_s , and is fully employed in the S sector. The unskilled labor force is fixed at L_u , and is divided between the domestic U sector (L_{uu}) and the nontradeable sector (L_{un}). The amount of K_u allocated to the foreign country, K_f , is taken to be exogenous, and is presumed to be determined by the regulations governing foreign direct investment in the South (as well as by country risk, relative factor prices, tax policies, and other considerations). Foreign output and labor input in the production of F_u are determined by the amount of K_f , according to (3) and (4). The home country takes the foreign wage in the U sector as given. Presumably, $W^* u \ll W_u$. Therefore, the quasi-

rents earned by K_u are higher when employed abroad than at home. Full capital mobility would lead to $K_f = K_u$, $K_d = 0$.

Notice that the supply of U is fixed, since $U = D_u + F_u = K_d + K_f = K$. Thus, U may be produced at home or abroad, but the total amount of U is unchanging. Since both L_s and U are fixed, the supply of S is also fixed. Moreover, the marginal product of L_s is also fixed, so that W_s is fixed, according to (9). The marginal product of U in the production of S is also fixed. Therefore, P_u is fixed, according to (11), since $\partial S/\partial U$ is a function of U/L_s , which is fixed.

Now, suppose that the developing country liberalizes its foreign investment regime, so that it becomes possible to shift more of K_u to the foreign country. Since W_u^* is less than W_u , entrepreneurs will want to shift capital to K_f , in order to earn higher quasi-rents. We assume that the permitted shift in K_f is exogenous, and look at the comparative static effects of $\partial K_f > 0$. As K_d falls, L_{uu} declines by an equal amount, and L_{un} rises by the same amount. Low-skilled workers lose their jobs in tradeables and are forced to find jobs in non-tradeables. The production of nontradeables goods increases. The wage of low-skilled workers will be determined by (10), with W_u equal to the marginal value product of labor in N . Since the employment in N

is rising, with an unchanged capital stock, the physical marginal product $\partial N/\partial L_{un}$ will decrease.

P_n may rise or fall. P_n will tend to fall because of the increased production of N ; it may rise, however, because of a positive income effect, i.e. a rise in Y in (13). This is due to the increased quasi-rents enjoyed by the owners of K_f . As long as the income effect is relatively small (either $\partial f/\partial Y$ is small, or W^*u is close to W_u), then P_n will fall. In this case, W_u surely declines, since $W_u = P_n(\partial N/\partial L_{un})$. Note, therefore, that W_u can fall even though P_u remains completely unchanged.

This mechanism, whether or not it is empirically important, is certainly in the minds of those who argue that increased trade with developing countries is "eliminating jobs" in the U-sectors within manufacturing. As capital moves to the low-wage foreign country, overall manufacturing employment is reduced, and unskilled workers are pushed into the nontradeables sector. Note that the shift of capital abroad does not have to show up in the data as foreign direct investment or outsourcing, since the physical capital could actually be sold outright to a foreign producer. For example, the machinery in a U.S. footwear firm could be sold on the secondary market to a Chinese producer, so that the imports of Chinese footwear would not show up as

outsourcing by a U.S. firm, nor as foreign direct investment.¹

In case that K_f is the result of foreign direct investment, it is worthwhile noting the balance-of-payments accounting of a rise in K_f . From the production side, $Y = (S - P_u F_u) + P_n N + \Pi_f$, and from the final-demand side $Y = C_s + P_n N$, where C_s is the final domestic demand for S . The trade deficit is equal to the net imports of S plus the net imports of U , or $TD = (C_s - S) + P_u F_u$, so that $TD = \Pi_f$. Thus, the trade deficit is equal to the earnings on foreign direct investment. The U.S. becomes a rentier country, running a trade deficit financed by profits on overseas investment. This clears up the confusion raised by Krugman (1994), in which he erroneously argued that "large-scale deindustrialization can take place only if low-wage nations are major exporters of capital to high-wage nations." The low-wage countries run export surplus, which pay for the repatriation of profits on foreign direct investment from the North.

With a small amendment to the technological assumptions, we

¹Feenstra and Hanson (1995) also consider the effects of capital mobility on relative wages. They develop a theoretical model in which an increase in the capital stock of developing countries relative to that of advanced countries decreases the relative wage of unskilled workers in both regions and increases the prices of the more skilled activities. They also examine empirical evidence and find these patterns in U.S.-Mexican economic relations.

can get a simple and interesting expression for the change in wage inequality. Suppose now that production of S requires sector-specific capital, K_s , as well as L_s and U , according to

$$(1') S = S(\min(L_{ss}, K_s), U)$$

Suppose also that the production of D_u and N use skilled labor as well as unskilled labor, so that

$$(2') D_u = \min[L_{uu}, L_{us}/\alpha, K_d]$$

$$(7') N = N(L_{un}, L_{sn}, K_n)$$

In the short term, K_s and K_n are fixed and sector specific. L_{ss} is therefore also fixed, according to the fixed coefficients technology in (1'). As before, P_u will be unchanged when K_u is shifted abroad, since $P_u = \partial S / \partial U$, which will be unaffected by the rise in K_f .

The fall in K_d , by contrast, releases both L_u and L_s from the D_u sector, forcing their re-employment in the nontradeables sector. Specifically, $\partial L_{un} = -\partial K_d > 0$ and $\partial L_{us} = -\alpha(\partial K_d) > 0$. According to (7'), the relative wage of skilled and unskilled workers is governed by the relative supplies of L_{un} and L_{sn} .

Letting σ_{su} be the Hick's elasticity of substitution between L_{un} and L_{sn} in the production of N , we can write:

$$(15) \quad w_u - w_s = -(l_u - l_s)/\sigma_{su}$$

where the lower-case variable signifies the proportionate change of the upper-case variable (i.e. $w_u = \partial W_u/W_u$). According to (15), the proportionate widening of the gap between low-skilled and high-skilled workers is determined in the nontradeables market, according to the changing ratio of unskilled to skilled workers in the N sector. As long as the ratio of unskilled to skilled labor released from D_u is greater than the pre-existing ratio of unskilled to skilled labor in nontradeables, the nontradeables sector must become more intensive in unskilled labor than it was previously. To absorb this higher proportion of unskilled labor, the relative wage of unskilled labor must decline.

B. Import Competition with Monopolistic Import-Competing Sector

Consider now a slightly different mechanism, depending on imperfect competition, that leads to the same shift of unskilled labor from tradeables to nontradeables. Return to the original

model, (1) - (14). Suppose, however, that K_d is fixed, with no mobility of capital abroad ($K_f = 0$), or profits from foreign investment. Foreign production is now limited by the size of the *foreign-owned* capital stock, so that (3) becomes:

$$(3') \quad F_u = K \cdot f$$

Suppose also that the domestic U industry is monopolised, while the foreign industry is made up of competitive firms with a total output F_u . Thus, the foreign imports represent a *competitive fringe* of the domestic monopolist. We introduce one more key assumption. Suppose now that the production technology $D_u = \min(L_u, K_d)$ represents the low-marginal-cost method of production of U, but there exists another method potentially available at world price P^* (this could represent an alternative imported input, for which the U.S. is a price taker). Assuming that $W_u < P^*$, it pays to use the technology in (2), since marginal costs are lower. Even in this case, however, the domestic monopolist will be unable to charge a price higher than P^* , since a price of P^* would elicit an infinitely elastic supply of the high-cost alternative to U.

The demand curve for the domestic monopolist is easily

found. The derived demand for U is determined in (1) such that $\partial S/\partial U = P_u$, for the price range $0 \leq P_u \leq P^*$. This implicitly determines a market-demand equation $U = U(L_s, P_u)$. Since $U = D_u + F_u$, the derived demand for the domestic producer is $D_u = U(L_s, P_u) - F_u$. For the monopolist, L_s and F_u are given, and P_u is the choice variable. For an inelastic derived demand for U , the domestic monopolist should set the domestic price at the limit price P^* , i.e. at the maximum level such that the input at price P^* will not be used. Then, domestic production is equal to $U(L_s, P^*) - F_u$. Note that the foreign competitive firms also sell into the U.S. market at the price P^* , earning pure quasi-rents on K^*f . These quasi-rents are earned because of the fixed short-run supply of foreign capacity in the production of U .

Notice, then, what happens when the foreign firms increase their production and export capacity as the result of an increase in K^*f . The U.S. monopolist keeps the U.S. market price unchanged at P^* , and absorbs the increased foreign competition by a one-for-one reduction of domestic production. Therefore, as F_u increases by one unit, D_u falls by one unit. This prompts an equivalent reduction in employment of L_{uu} , and the laid-off unskilled worker must find work in the nontradeables sector. The increased nontradeable sector employment results in a fall in the

marginal physical product of labor in the nontradeable sector, i.e. $\partial N/\partial L_{un}$ falls. Also, P_n falls as the result of a rising supply of N combined with a negative income effect on the demand for N (monopoly profits are diminished by the increased competition from abroad). Thus, the wage of unskilled workers will fall, since $W_u = P_n(\partial N/\partial L_{un})$, and both P_n and $\partial N/\partial L_{un}$ decline.

Note that in this model, the trade balance must be zero, so that the imports of F_u are paid for by the exports of S . Higher F_u (caused by a rise in K^*f) prompts a negative income effect, which causes a decline in domestic consumption of the tradeable final good S . This leads to a larger trade surplus of S , which pays for the imports of F_u .

We can easily extend the model to include employment of skilled labor in D_u and N , as we did before. Once again, the rise in K^*f will elicit a shift of *both* unskilled and skilled labor to the nontradeables sector. As long as the ratio of unskilled to skilled workers rises in the nontradeables sector as a result of this influx of labor, the relative wage of unskilled workers will decline.

C. Increasing Division of Labor and the Scope of the Market

A third possibility for a fall in W_u/W_s emerges from the classical idea that the division of labor in the economy is limited by the scope of the market. Robert Frank and Philip Cook (1995) have recently argued that the rising inequality in U.S. labor markets results partly from the fact that global markets extend the ability of the top-quality producers to reach an international marketplace. We use the framework of Murphy, Shliefer, and Vishny, (hereafter MSV, 1989) to construct a simple example of how internationalization can widen wage inequalities, and once again, to highlight the differences with the HOS model, we study a case in which relative output market prices are unchanging.

Suppose that there are a number of goods that may all be produced by a standardized technology:

$$(16) Q_i = L_i$$

$$(17) L_i = L_{ui} + L_{si}$$

Output of sector i is equal to total labor input, and labor input is to the simple sum of unskilled and skilled labor. According to this technology, there is no market advantage to have labor skills. Now, suppose that for each sector, there is an

alternative advanced technology which requires a fixed cost F of skilled labor and then allows production at a lower marginal cost, i.e.

$$(18) \quad Q_i = \theta (L_{iu} + L_{is}), \quad \text{with} \quad \theta > 1 \quad \text{and fixed cost } L_{si} = F$$

Suppose that there are N sectors in total, but that $NF \gg L_s$. There is a shortage of skilled workers, so that only a fraction of sectors will be able to engage in high-technology production. For simplicity, we will assume that $F = L_s$, that is, *there is just enough skilled labor in the economy to support high-tech production in a single sector.* (This assumption could easily be relaxed; we take the simplest case for purposes of illustration). The scarcity of skilled labor will allow it to earn a premium once high-technology production is introduced.

We also assume that the high technology is proprietary, monopolized by a single firm in each sector: high-tech production, if carried out at all, will be carried out by a monopolist. Finally, we assume that market demand is governed by a standard CES utility function over the N goods, of the form:

$$(19) \quad U(C_1, C_2, C_3, \dots, C_N) = [(1/N) \sum C_i^{-\rho}]^{-1/\rho}$$

Of course, this leads to a market-demand for output of sector i given by:

$$(20) C_i = (1/N) (P_i/P)^{-\sigma} Y \quad \text{with } \sigma = 1/(1+\rho)$$

where P is the true price index corresponding to (19). We assume that $\rho > 0$, so that $\sigma < 1$, i.e. market demand for each output is price inelastic.

Consider first a closed-economy variant of the model. We start by analysing the equilibrium in which all sectors use low-technology production. Labor is divided equally among the N sectors. Setting the wage of unskilled workers as numeraire, it is clear that $W_s = P_i = W_u = 1$ for all goods i . Production is simply $Q_i = (L_u + L_s)/N$.

Now we ask whether any single monopolist will choose to engage in high-tech production, assuming that the other $N-1$ sectors are engaged in low-tech production. Notice that the monopolist's pricing strategy is straightforward. Since the elasticity of demand for sector i is $\sigma < 1$, and is therefore always inelastic, the monopolist will raise the price as high as possible without provoking entry by the low-technology competitive fringe. In other words, the monopolist will set the

price of sector i at 1 (or just infinitesimally below 1). Market demand will therefore be Y/N . Total marginal production costs are $(Y/N)/\theta$; fixed costs are $W_s F$, and profits Π_i will be:

$$(21) \quad \Pi_i = (Y/N) - (Y/N)/\theta - W_s F$$

Notice that W_s must be greater than or equal to 1, since skilled workers can always earn a wage equal to 1 by working in low-tech production. Initially, with no high-tech production in the economy, $W_s = 1$. Since $Y = L_u + L_s$, the conditions for positive profits in the introduction of high-tech production is:

$$(22) \quad \Pi_i \geq 0 \quad \text{iff} \quad F \leq [(\theta-1)/\theta] (L_u + L_s)/N$$

Clearly, if θ is close to 1 and $(L_u + L_s)/N$ is small, then profits would be negative, and the high-technology will not be adopted. Market demand, measured as average employment per sector, is too small to cover the fixed cost F .²

²As MSV point out, it may be possible that high-tech production is feasible if a *group* of high-tech monopolists simultaneously choose the high-tech production strategy, since the increased output of each one could spill over to raise the market demand of the others. We have ruled out this particular possibility for simplicity, by assuming that there is only enough

When the economy is opened to trade, all sectors are subject to the aggregate demand given by:

$$(23) \quad C_i = (1/N) (P_i/P)^{-\sigma} (Y + Y^*)$$

Notice that world demand has now replaced domestic demand in each sector's demand function. A potential high-tech monopolist would now be able to export to world markets. Once again, the monopolist would set a market price of 1, so the opening of world trade would not change the relative prices of goods, but it would expand the market, thereby allowing a change in production technology. It is easy to check the new zero profit condition, under the initial condition that $W_s = 1$. We find:

$$(22') \quad \pi_i \geq 0 \quad \text{iff} \quad F \leq [(\theta-1)/\theta] (L_u + L_s + Y^*)/N$$

Clearly, for a large enough value of Y^* , it is possible for high-technology production to be profitable in the open economy, when it is not in the closed economy.

Assuming that high-technology production is profitable, all

skilled labor to supply one high-tech sector.

potential monopolists will bid for the skilled labor. The skilled wage will rise until the point where the pure profits of high-tech production are exhausted, i.e., the profits are converted entirely into quasi-rents earned by the scarce factor, skilled labor. From (22'), and the zero profit condition $\Pi_i = 0$, we find that

$$(24) \quad W_s = [(\theta-1)/\theta] (L_u + L_s + D^*) / (F^*N) > 1$$

The conclusion is the following. Trade liberalization raises the real wage of high-skilled workers, even though it does not affect relative output prices or the real wage of low-skilled workers. The larger world market allows for a change in technology to the benefit of high-skilled workers. Note that low-skilled workers do not suffer, since they face the same wages and output prices as in the closed economy. The skilled workers, by contrast, enjoy an absolute gain in utility.

D. Multiple channels of influence

We have identified several channels through which increased U.S. trade with developing countries can lower the relative wages of unskilled labor: the HOS effect, operating through a fall in

Pu; capital flows from the U.S. to developing countries, reducing the capital stock, and thereby the employment of unskilled workers in manufacturing; increased import-competition facing a domestic monopolist, thereby prompting a loss of manufacturing-sector jobs of unskilled labor; and an increased division of labor (proxied by a technology with higher fixed costs, but lower variable costs), made possible by an expansion of the market.

No theoretical, simulation, or econometric model yet exists which integrates these various forces, but there is no reason why they cannot all simultaneously operate. Labor markets tend to be segmented in the short term, so that workers in different sectors might be subjected to different kinds of influences. In some sectors, the physical capital is easily transported to low-wage countries; in other sectors, increased import competition causes job losses of domestic monopolists; in still other sectors, a fall in the relative price of unskilled-intensive goods delivers HOS-type effects, even though they apply to just a subset of the labor market.

For this reason alone, the search for trade effects should not be limited to a specific phenomenon, such as the fall in Pu. It is not correct to conclude that trade has had little effect on Wu/Ws since Pu has not declined, even putting aside the question

of the empirical evidence on the trend in Pu. Economists will have to look over the range of evidence: trade flows, employment changes, shifts in technology, and price changes, in order to reach an appropriate assessment of the effects of trade on wage inequality.

III. Empirical Implications

Earlier studies have uncovered several important facts concerning trends in U.S. trade, wages, and employment. These include the following: (1) U.S. trade with low-wage countries tends to conform broadly to the expected HOS pattern. On average, the U.S. exports skill-intensive goods, and imports labor-intensive goods from the developing countries; (2) U.S. trade with low-wage countries increased significantly during the 1980s, with trade measured as a percentage of manufacturing value added and economy-wide GDP; and (3) the timing of the widening of wage inequality is similar to the timing of increased U.S. trade with low-wage countries (increasing throughout the 1980s), though the timing of both shifts is imprecise, with the dating of turning points depending on the particular measures that are examined.

The linkages of changing trade patterns to changing

employment patterns has been studied in many works, such as Borjas, Freeman, and Katz (1992), Sachs and Shatz (1994), and Saeger (1995). The first two of these studies examine the employment content of changing net trade vectors. As predicted by HOS, the rise of net imports from developing countries is unskilled-intensive relative to the rest of the manufacturing sector.

This can be seen in Table 1, reproduced from Sachs and Shatz (1994, Table 13, p. 29), which shows the factor content of the changing net trade with developing and developed countries. 131 manufacturing sectors are ranked by decile, in order of decreasing skill intensity (in this study, skilled labor is equated with non-production workers, and unskilled labor is equated with production workers). For each decile and for all manufacturing, we measure the implicit decline in employment of skilled (nonproduction), unskilled (production), and all workers due to the rise of net imports from developing, developed, and all countries between 1978 and 1990, compared with a counterfactual in which net trade relative to final demand in each sector is assumed to remain at its 1978 level. By this definition of the counterfactual, increased trade with low-wage countries reduced the employment of low-skilled workers by 6.2

percent, and that of high-skilled workers by 3.3 percent between 1978 and 1990. Trade with all countries reduced low-skilled employment by 7.2 percent, and high-skilled employment by 2.1 percent. In the lowest-skilled decile, more than one quarter of all jobs in 1978, 27.1 percent, were eliminated by trade. Trade with low-wage countries caused 23.5 percentage points of the change, while trade with advanced countries caused only 3.6 percentage points.

Perhaps equally important, the net import vector is unskilled-intensive relative to the *rest of the economy* as well, suggesting that labor shed from the manufacturing sector would require a rise in the ratio L_u/L_s in the nontradeable sector. We make this argument in two steps. First, Saeger (1995) shows that increased net imports from developing countries are indeed associated with overall "deindustrialization," defined in this case as a declining share of the labor force in manufacturing. *Controlling for per capita income and other structural characteristics of the economy (e.g. changes in natural resource production as a percent of GDP), increased net imports of manufactures from developing countries are associated with decreases in overall employment in manufacturing, measured as a percent of total employment.* On average, within the OECD

economies, the rising net imports from developing countries in the 1970s and 1980s can be associated with a decline in the share of manufacturing employment in overall employment of around 2-3 percentage points. For the U.S., Saeger estimates the effect to be a decline of around 2.7 percentage points, about one-third of the total decrease in the manufacturing share of employment.

The labor released from U.S. manufacturing as a result of increased net imports from developing countries must be absorbed by the nontradeables sector, mainly services, or by unemployment, as is more typically the case in the European context of downwardly rigid wages. It is necessary, therefore, to compare the skill intensity of the labor released from import-competing sectors and the skill intensity of the nontradeables sectors. For this purpose, we equate unskilled workers with high-school or lower education, and skilled workers with above-high-school education. (We measure L_u and L_s in this way, rather than as production versus non-production workers, since the education-based measure is a more appropriate yardstick than the production-based measure for the non-manufacturing sector).

One categorization is shown in Table 2, where we compare the (education-based) ratio L_u/L_s for various manufacturing sectors. We first rank the sectors into deciles, from highest L_s/L_u to

lowest, grouping the industries so that each decile has approximately the same level of 1979 employment. We also take two weighted sums of Lu/Ls over 131 manufacturing sectors. First, we weight by each sector's share in U.S. manufacturing exports to developing countries, w_i^x , and then by each sector's share in manufacturing imports from developing countries, w_i^m .^{3 4} We see that U.S. exports to developing countries are more skill-intensive than U.S. imports from developing countries, and that the relationship holds throughout the 1980s.

In Table 3, we show the same ratios, Lu/Ls, for

³The weights w_i^x is defined as $X_i/\sum X_j$, where X_i is U.S. exports to low-wage countries from sector i , and $\sum X_j$ is total U.S. manufacturing exports to low-wage countries (the sum over all sectors). The weights w_i^m is defined as $M_i/\sum M_j$, where M_i is U.S. imports from low-wage countries in sector i , and $\sum M_j$ is total U.S. manufacturing imports from low-wage countries.

⁴Rather than using trade with all developing countries, we use trade with only the top nine developing-country trade partners, Brazil, China, Hong Kong, Korea, Mexico, Malaysia, Singapore, Taiwan, and Thailand. These nine countries accounted for 79 percent of the growth in trade from LDCs between 1978 and 1990. In 1978 they accounted for 16.2 percent of all imports to the U.S., and 13.6 percent of all exports from the U.S. By 1990, they accounted for 26.8 percent of all U.S. imports, and 21.9 percent of all U.S. exports. In addition, in 1978 they accounted for 55.6 percent of all developing country imports to the U.S. and 37.2 percent of all developing country exports from the U.S. By 1990, these figures were 73.7 percent and 62.1 percent, respectively.

manufacturing as a whole, the nontraded sector including government, and the private nontraded sector. It is clear that manufacturing is far less skilled than the nontraded sector, whether the latter includes government or not. Comparing Table 2 and Table 3, it is also clear that both the import-competing and export-competing sectors of manufacturing are less skill-intensive than the nontraded sector, though the import-competing industries are far less so. A cutback in manufacturing employment (and especially import-competing manufacturing employment) will therefore release **relatively unskilled** workers into the service sector, leading to a fall in the relative wage of unskilled workers, with the effect being larger should those employees come from the import-competing sector of manufacturing.

The precise magnitude of this effect is of course much harder to determine. As a crude estimate, we examine the following counterfactual. How much lower would L_{sn} and L_{un} have been if the net trade vector with developing countries had remained unchanged after 1978, so that labor would not have been "released" from the manufacturing sector? (As before, we define "unchanged" in the counterfactual as an unchanging ratio of net trade to final demand in each manufacturing sector). Panel A of Table 4 shows the results of the counterfactual when workers are

categorized as low skill if they have a high school education or less, and high skill if they have some college. We estimate that due to changes in net trade, manufacturing lost 5.5 percent of its 1979 low-skilled workers, and 4.9 percent of its high-skilled workers.

Since the ratio L_u/L_s is much higher in manufacturing than nontradeables, this translates into a far higher ratio of L_u/L_s "released" into the nontraded sector than is initially present in nontradeables, as shown in Panel B of Table 4. That panel also shows that these extra employees would have increased L_u/L_s to 1.20 (from 1.18) for the whole nontraded sector, and to 1.23 (from 1.21) for the private nontraded sector, assuming that the private sector rather than the government absorbed them.

Table 5 then shows the effect on wages. For the whole nontraded sector, with the counterfactual as a baseline, we see that L_{un}/L_{sn} is estimated to have risen by 1.68 percent as a result of the shifts in net trade. We can therefore calculate the decline in W_u/W_s associated with the rise in L_{un}/L_{sn} . Assuming an elasticity of substitution of $1/3$ between L_u and L_s , the relative wage W_u/W_s would have declined by 5.04 percent. For an elasticity of substitution of $1/2$, W_u/W_s would have declined by 3.36 percent. For the private nontraded sector, had

government not absorbed any workers, L_{un}/L_{sn} is estimated to have risen by 1.80 percent as a result of the shifts in net trade. With an elasticity of substitution of $1/3$ between L_u and L_s , the relative wage W_u/W_s would have declined by 5.39 percent. For an elasticity of substitution of $1/2$, W_u/W_s would have declined by 3.40 percent. Unfortunately, we lack appropriate econometric estimates of the short-run and long-run elasticities of substitution between L_{un} and L_{sn} to judge which of these estimates is more appropriate.

In addition to "deindustrialization" due to increased trade with developing countries, W_u/W_s can fall simply as the result of a decline in P_u , even without a decline in manufacturing employment, as we know from the HOS model. Much of the empirical debate over the past two years has revolved around the question of whether P_u has in fact declined, with Bhagwati in particular asserting that there is no evidence of a decline in P_u , and therefore no evidence for an effect of trade on wages. Even though the "therefore" is theoretically unjustified, the evidence on P_u is empirically important, if not definitive.

In fact, the quality of data on international trade prices leaves much to be desired. First, recall the basis of the HOS theory. (In the discussion that follows, we drop the convention

that $P_s = 1$, and therefore carry a term equal to the nominal change in P_s). In a model of two goods and two factors, and with no specialization, there is a one-to-one relationship between the percentage change in P_u/P_s and the percentage change in W_u/W_s . Specifically, with technology given by $S = S(L_{ss}, L_{us})$ and $U = U(L_{us}, L_{uu})$, where each function is constant returns to scale, we know:

$$(25) \quad \begin{aligned} p_s &= \beta_{ss} * w_s + (1-\beta_{ss}) * w_u \\ p_u &= \beta_{su} * w_s + (1-\beta_{su}) * w_u \end{aligned}$$

where β_{ss} is the share of skilled labor in total output of sector S, and β_{su} is the share of skilled labor in total output of sector U. By assumption, $\beta_{ss} > \beta_{su}$. The lower-case variables p_s , p_u , w_s , and w_u , represent the log changes of the respective upper-case variables. It is immediate that $(w_s - w_u) = \gamma (p_s - p_u)$, where $\gamma = [1/(\beta_{ss} - \beta_{su})] > 1$. This is an implication of the famous "magnification effect": the proportionate change in relative wages is greater than the proportionate change in relative prices.

The simple relationship between (w_s-w_u) and (p_s-p_u) becomes more complicated if we take into account the distinction between

value added and gross output, and the role of technical change. In particular, suppose that the gross output functions can be written as:

$$(26) \quad Q_s = Q_s(S(L_{ss}, L_{us}), M_s) * T_s \text{ and}$$

$$Q_u = Q_u(U(L_{us}, L_{uu}), M_u) * T_u$$

Here Q represents gross output. T_s and T_u are the pure levels of technical progress in gross output in the S and the U sectors respectively. S and U are now defined as the *value-added* functions of the two sectors. M_s and M_u are the intermediate inputs which are combined with value added to produce gross output.

Now, P_s and P_u are generally measured as gross output prices. Note, however, that there is no simple relationship between these gross output changes and relative wage changes, because of the intervening effects of intermediate input prices and technological change. The relationship between output prices and input prices is given as follows:

$$(27) \quad p_s = \{ \beta_{vs} * [\beta_{ss} * w_s + (1 - \beta_{ss}) * w_u] + (1 - \beta_{vs}) * p_m \} - \tau_s$$

$$p_u = \{ \beta_{vu} * [\beta_{su} * w_s + (1 - \beta_{su}) * w_u] + (1 - \beta_{vu}) * p_m \} - \tau_u$$

In this expression, β_{vs} is the share of value added in gross output in sector S. Now, β_{ss} is defined as the share of skilled labor in value added in S (rather than as the share of skilled labor in gross output). τ_s is the proportionate change in total factor productivity, and p_m is the proportionate change in materials prices. Other variables are defined analogously. We see that before relating relative price changes to relative wage changes, we must adjust the relative price changes to account for technology and intermediate inputs. In particular, the revised expression is:

$$(28) \quad (w_s - w_u) = \gamma (p_s' - p_u')$$

$$p_s' = [(p_s + \tau_s) - (1 - \beta_{vs}) * p_m] / \beta_{vs}$$

$$p_u' = [(p_u + \tau_u) - (1 - \beta_{vu}) * p_m] / \beta_{vu}$$

Price changes should be adjusted for changes in total factor productivity, and for movements of intermediate goods prices. In some contexts, p_s' and p_u' are referred to as changes in "effective" prices.

Consider one relevant example. If the price of skill-intensive goods declines, but the reason is a *rise* in total factor productivity in the S sector, there is no reason to expect

a decline in W_s/W_u . For example, the sharp decline in computer prices in the past decade is **not** a cause for the decline of the relative wage of skilled engineers that are employed intensively in computer production, since (quality-adjusted) computer prices are falling as a result of technological progress.

With the backdrop of equation (28), consider just how flimsy is Bhagwati's rejection of the trade-wage linkage based on the ostensible evidence of relative price movements. The data on trade prices to which Bhagwati refers, from the study of Lawrence and Slaughter (1993), are subject to at least five serious problems. First, out of 143 3-digit manufacturing sectors, the import price data cover only 51 sectors, and only 30 start in 1980 and run through the whole decade. Likewise, the export price data cover only 46 sectors, and only 19 start in 1980. Second, the trade data do not adjust for intermediate input prices. Third, the trade data do not adjust for productivity changes. Fourth, the trade data (like many kinds of price data) do not adequately control for quality changes, so that the price increases are overstated for commodities with important quality improvements, such as computers. Fifth, trade data often do not reflect actual transactions costs, since an important proportion of manufacturing trade is actually within affiliates of the same

firm. Enterprises use internal transfer prices for tax and other purposes that may be very different from prices that apply in arms-length transactions. We should then add the important theoretical point that *even small movements in relative prices could be associated with rather large movements in relative wages.*

If we compare domestic U.S. prices with the prices of U.S. imports and exports, we discover that the office machinery sector (i.e. computers) presents a special problem. There is a vast discrepancy between computer prices measured using the domestic prices, constructed by the U.S. Bureau of Economic Analysis, and the international trade prices, constructed by the U.S. Bureau of Labor Statistics. In particular, the domestic prices fall sharply, while the trade prices do not, probably because the trade prices do not adequately reflect the improving quality of the computers in international trade (so that the measured prices vastly understate the decline of quality-adjusted prices). When we formally test the discrepancy between trade prices and domestic output prices for 30 overlapping sectors, we can reject the hypothesis that the discrepancy in computer prices is due

merely to sampling error.⁵ For this reason, we always add a dummy variable for the computer sector in cross-sectoral price equations.

The empirical question is whether the relative price of unskilled-intensive goods actually fell in the 1980s, as would be a necessary condition for HOS effects to operate. To answer this question, we rely on two data sets. For 1978-89, we use domestic output prices for 450 4-digit manufacturing sectors based on the 1972 SIC classification (rather than the 50 or so sectors used by Lawrence and Slaughter (1993) for which trade price data are available for at least some time during the period 1980-90). For 1989-95, we use domestic output prices for 410 4-digit

⁵Let P_{ti} be the trade price index for sector i , and P_{di} be the domestic price index for sector i , both measured in 1990 with a base $P_{ti} = P_{di} = 1$ in 1978. We assume that discrepancies in the two prices are due to random errors, plus a fixed effect for the computer sector, so that:

$$\ln(P_{ti}/P_{di}) = \beta_0 + \beta_1 \theta_i + \epsilon_i$$

where $\theta_i = 1$ for i =computers, and $\theta_i = 0$ otherwise. We test the null hypothesis that $\beta_1 = 0$, which we reject at $p=.0001$. Only one other industry dummy variable is found to be significant, that for sugar and confectionary products, which reflects the discrepancy between the U.S. domestic and international trade prices caused by the highly protectionist U.S. trade regime for sugar.

manufacturing sectors based on the 1987 SIC classification. These data were recently developed, and kindly provided, by Alan Krueger, whose 1995 study reaches similar conclusions to those reported here. Using a concordance between the 1972 and 1987 SIC classifications, kindly provided by Wayne Gray, we also merge the two data sets to construct a single time series over the entire interval 1978-95. For both data sets, we can construct value added prices as well as gross output prices. For the earlier data set, we can also try to adjust for productivity, using an estimate of sectoral total factor productivity developed by Wayne Gray (1989, 1992). While these TFP estimates are carefully made given the data, they are no doubt subject to enormous error themselves, so that we can not rely heavily on the TFP-adjusted estimates.

Letting p_i be the proportionate change in output prices of sector i , we ask whether p_i rises less (or falls more) for unskilled-intensive sectors. Of course, the theoretically correct measure is not output prices per se, but rather output prices adjusted for intermediate input prices and technical change. As a basic regression model, we use the following:

$$(29) \quad dp_i = \beta_0 + \beta_1 [Lu/(Lu+Ls)]_i + \beta_2 Z_i + \epsilon_i$$

The change in prices over a particular time period is regressed on the sectoral share of unskilled labor in total employment, and in principle, on industry characteristics, Z_i . In fact, the only variable that we include for Z_i is a dummy variable for the four-digit-SIC computer sectors, which we include for reasons just explained. The HOS hypothesis is that $\beta_1 < 0$, that is, unskilled-intensive sectors experienced smaller increases in prices than skill-intensive sectors. We use several variants for the time period, and for measuring prices, including: gross output prices, value-added prices, and value-added prices adjusted for total factor productivity. As in Krueger (1995), we run the regression with weighted least squares, with weights equal to the value of shipments of the sector at the start of the sample period. Our proxy for L_u is the number of production workers, and for L_s the number of non-production workers. Thus, $L_u/(L_u+L_s)$ is the share of production workers in total employment.

The main result, shown in Table 6, is that *there is consistent evidence that the price increases in L_u -intensive sectors were considerably below those of L_s -intensive sectors during the period 1978-1995.* According to the estimate in column 3, based on value-added prices and the entire time period, an

industry with unskilled workers 30 percent of its total workforce (i.e. $L_u/(L_u+L_s) = 0.3$) would have experienced a 40 percent rise in its value added price from 1978 to 1995 relative to an industry with a skill ratio of 90 percent. The ratios of 30 percent and 90 percent are approximately the bounds of the highest-skilled and lowest-skilled industries in manufacturing.

Table 7 shows some examples of price changes from industries within the top two and bottom two skill deciles.⁶ The table also shows weighted averages of price changes for the deciles indicated. The weights are each industry's share of its decile's 1978 value of shipments. The computer industries, SIC 357, were not included in the weighted averages because of the data problems mentioned earlier. Weighted average prices rose in all deciles for all time periods, but the increases for the top deciles are well above those for the bottom deciles.

To provide an additional summary of the changes in relative prices, we calculate the percentage change in U.S. valued-added prices and effective prices weighted by the share of each

⁶The deciles, please note, were formed from 131 3-digit industries grouped from highest skilled (Decile 1) to lowest skilled (Decile 10). We then labelled each 4-digit industry with the decile of its 3-digit group. For example, 2086, soft drinks, is within 208, beverages, which is in Decile 1.

sector's trade with developing countries.⁷ An import price index is constructed by weighting value-added prices by weights w_i^m , the share of sector i in total U.S. manufacturing imports from developing countries. Similarly, an export price index is constructed using the weights w_i^x , the share of sector i in total U.S. manufacturing exports to developing countries. We see in Figure 1 that the import-weighted price index falls steadily relative to the export price index, by 21.9 percentage points between 1978 and 1989, and by an additional 8.3 percentage points between 1989 and 1995.

Conclusions

This paper has reviewed and extended the theoretical and empirical debate on the linkages of U.S.-developing country trade and U.S. wage inequality between skilled and unskilled workers. On a theoretical level, there is a wide range of models that deliver the prediction that increased trade with low-wage countries will increase the wage inequality between high-skilled and low-skilled workers. It is misleading to pin all of our attention on the baseline Heckscher-Ohlin-Samuelson model, though

⁷Again, only the top nine developing-country trade partners are used.

that baseline model is indeed enormously important and the appropriate starting point of analysis. On the empirical front, a considerable range of evidence also points in the direction of at least some relative wage effects from trade, including: (1) observed shifts in employment, and their relationship to observed shifts in trade; (2) the relative skill intensity of the manufacturing versus service sectors; and (3) the trends of relative prices. Another look at the trade data, including measures of value-added prices rather than gross output prices, and an extension of the data to 1995, point in the direction of falling relative prices of commodities intensive in low-skilled labor, the kind of price effect that we expect from increased U.S.-developing country trade, and the kind that can contribute to a widening of wage inequalities between skilled and unskilled workers. Further work is now required to refine both the theoretical framework (for example, by integrating the range of HOS and non-HOS models into a more comprehensive model), and the empirical work (for example, by improving the estimates of effective prices, and by placing the data into a large-scale econometric or simulation framework, to study general equilibrium implications of the observed trade, employment, and price changes).

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Table 1. Accounting for Trade Effects on U.S. Employment
Percent

Skill decile	Change in total employment by country group		
	Developing country trade	Developed country trade	All trade
1	0.2	12.2	12.3
2	-0.9	0.9	0.0
3	-2.8	-1.7	-4.4
4	-2.3	2.9	0.5
5	-2.0	-1.6	-3.6
6	-5.5	-2.4	-7.9
7	-5.2	-1.4	-6.6
8	-2.6	-2.1	-4.7
9	-3.4	-6.7	-10.1
10	-23.5	-3.6	-27.1

Addendum

All manufacturing	-5.7	-0.2	-5.9
Production workers	-6.2	-1.0	-7.2
Nonproduction workers	-3.3	2.2	-2.1

Notes: Import figures, originally reported on a customs value basis, have been increased by factors for c.i.f., tariffs, and tariff equivalents of quotas. Denominator in addendum is total manufacturing employment for the specific employment group in 1978.

Sources: Authors' counterfactual calculations described in the text and in Sachs and Shatz (1994) based on NBER Productivity Dataset.

Table 2. Skill Level of Manufacturing, 1979 and 1990

A. High School to College Employment Ratio by Decile

Education Decile	1979	1990
1	0.89	0.47
2	1.28	0.81
3	1.72	1.05
4	2.08	1.33
5	2.47	1.79
6	2.63	1.78
7	3.09	2.21
8	3.54	2.46
9	4.59	3.84
10	6.98	4.42

B. Trade-weighted Averages of High School to College Employment Ratio, All Manufacturing

Year	1979		1990	
Weights	Import	Export	Import	Export
Ratio	4.05	2.22	2.87	1.61

Notes:

High School workers are those with a high school education or less. College workers are those with at least some college. In both cases, only full-time workers who had a job the week before the Current Population Survey was taken were included.

In panel A, industries were ranked from high skill to low skill, according to the ratio of college workers to high school workers, and then grouped so that each decile would have approximately equal levels of 1979 employment.

In panel B, a weighted average of the high school to college ratio for all manufacturing was taken. Weights were sector shares of exports or imports to or from the top nine LDC trade partners (as explained in the text).

Sources: National Bureau of Economic Research Current Population Survey merged data files, and U.S. Department of Commerce trade statistics.

Table 3. High School and College Employment in Manufacturing and the Nontraded Sector, 1979, in thousands

	High School	College	Lu/Ls
Manufacturing	14,378.4	5,991.0	2.40
Nontraded	26,198.0	22,278.2	1.18
Private Nontraded	23,925.7	19,825.1	1.21

Notes:

High School workers are those with a high school education or less. College workers are those with at least some college. In both cases, only those workers with a full-time job during the week before the Current Population Survey was taken were included.

The nontraded sector includes construction; transport, communication, and public utilities; wholesale and retail trade; finance, insurance, and real estate; services; and public administration. The private nontraded sector includes all of the above except for public administration. The mining, and agriculture, forestry, and fishing sectors, are omitted completely.

Source: National Bureau of Economic Research Current Population Survey merged data files.

Table 4. Effects of Trade on Manufacturing Employment
1979 to 1990

A. Change in Employment by Country Group and Education Group
(Percent)

	LDC Trade	Developed Country Trade	All Trade
All employees	-3.7	-1.6	-5.3
High School Employees	-4.0	-1.5	-5.5
College Employees	-3.0	-2.0	-4.9

B. Employees Released from Manufacturing due to Trade
Thousands

	New Nontraded Lu/Ls		
High School	College	All Nontraded	Private Nontraded
790.8	293.6	1.20	1.23

Notes:

High School workers are those with a high school education or less. College workers are those with at least some college. Only full-time workers who held a job during the week before the Current Population Survey was taken were included.

For the counterfactual calculations, the counterfactual change in net imports for the computer sector has been constrained to equal zero. In addition, eight industries were treated as pure intermediate goods industries, so that they were considered as producing no output for final demand. Therefore, changes in imports or exports would not have had the multiplier effects seen in other industries. The eight and their U.S. Bureau of Economic Analysis codes were:

- 16 Broad, narrow fabrics, mills,
- 25 Paperboard containers,
- 28 Plastics and synthetics,
- 33 Leather tanning and finishing,
- 37 Primary iron and steel,
- 38 Primary nonferrous metals,
- 39 Metal containers, and
- 57 Electronic components.

BEA codes were used, rather than SIC, because the Input-Output tables used in the counterfactual are in BEA codes. In addition, the counterfactual uses 1979 employment data and 1978 trade data.

continued

Table 4 continued

In addition, LDC trade for the counterfactual calculations includes all developing countries, not just the top nine, as used elsewhere in the paper.

In Panel B, the nontraded sector includes construction; transport, communication, and public utilities; wholesale and retail trade; finance, insurance, and real estate; services; and public administration. The private nontraded sector includes all of the above except public administration. The mining, and agriculture, forestry, and fishing sectors, were omitted.

Source: Authors' counterfactual calculations using the NBER Productivity Dataset, 1994 version, BEA 1987 annual input-output tables, NBER CPS merged data files, and U.S. Department of Commerce trade statistics.

Table 5. Change in Nontraded Skill Levels and Wages Due to Trade Rise in Lu/Ls, and Change in Wu/Ws, in the Nontraded Sector

Public and Private Nontraded

Percent Change in Lu/Ls 1.68

Percent Change in Wu/Ws

Elasticity of Substitution = 1/3 5.04

Elasticity of Substitution = 1/2 3.36

Private Nontraded

Percent Change in Lu/Ls 1.80

Percent Change in Wu/Ws

Elasticity of Substitution = 1/3 5.39

Elasticity of Substitution = 1/2 3.40

Notes and Sources:

High School workers are those with a high school education or less. College workers are those with at least some college. In both cases, only full-time workers who held a job in the week before the Current Population Survey was taken are included.

The nontraded sector includes construction; transport, communication, and public utilities; wholesale and retail trade; finance, insurance, and real estate; services; and public administration. The private nontraded sector includes all of the above except public administration. The mining, and agriculture, forestry, and fishing sectors, were omitted.

Source: Authors' counterfactual calculations using the NBER Productivity Dataset, 1994 version, BEA 1987 annual input-output tables, NBER CPS merged data files, and U.S. Department of Commerce trade statistics.

Table 6. Regressions of Change in Price on Skill Level

Dependent Price Variable	Value Added			Effective V.A.		Output		Effective Output
	78-89	89-95	78-95	78-89	78-89	89-95	78-95	78-89
Independent Variables								
Skill ratio	-0.34* (1.99)	-0.36* (2.44)	-0.81** (3.32)	-0.12 (1.29)	-0.26** (3.95)	-0.15** (4.23)	-0.45** (5.32)	-0.18** (2.42)
Computer dummy	-2.78** (14.83)	-0.14 (0.38)	-0.62 (1.18)	-0.23* (2.21)	-1.66** (22.84)	-0.13 (1.40)	-0.53** (2.92)	-1.61** (19.70)
Constant	0.63** (4.95)	0.41** (3.79)	1.12** (6.12)	0.65** (8.97)	0.66** (13.31)	0.23** (8.80)	0.92** (14.49)	0.59** (10.65)
Adj. R-squared	.33	.01	.02	.01	.54	.04	.07	.47
N	450	410	410	450	450	410	410	449
Year of Shipments Value Weight	1978	1989	1978	1978	1978	1989	1978	1978

t-statistics are in parentheses

* significant at .05 level

** significant at .01 level

Notes and Sources: The dependent variable is the log change of price during the indicated time period. We use four price variables: value added price; effective value added price, which takes account of total factor productivity; output price; and effective output price, which is annual change in output price plus annual change in TFP. Of the independent variables, the skill ratio is the 1978 ratio of production workers to total workers for each sector, so that a low skill ratio number indicates a high-skill sector. The computer dummy equals one for all four-digit industries within 3-digit sector 357 under the 1972 SIC classification. Data sources include the NBER Productivity Dataset and Alan Krueger.

Table 7. Price Changes for Representative Industries
Percent Change

Industry	Value Added Price			Output Price		
	78-89	89-95	78-95	78-89	89-95	78-95
Decile 1						
2711 Newspapers	86.5	37.3	123.8	79.0	31.1	110.1
2086 Soft drinks	69.8	20.3	90.1	57.6	12.8	70.4
Decile average	53.3	14.0	67.3	57.3	17.9	75.2
Decile 2						
3724 Aircraft engines	56.2	30.8	87.0	54.6	21.3	75.9
Decile average	50.1	19.7	69.8	53.1	15.0	68.1
Decile 9						
3221 Glass containers	46.0	9.9	55.9	51.2	13.5	64.7
Decile average	44.5	13.7	58.2	43.4	14.3	57.7
Decile 10						
2211 Cotton weaving mills	17.2	7.9	25.1	30.5	7.5	38.0
2281 Yarn mills	5.1	-12.1	-7.0	28.2	1.8	30.0
Decile average	21.0	22.0	43.0	32.9	20.3	53.2

Notes:

Deciles are formed by ranking 131 3-digit industries by proportion of unskilled to total employees and then grouping the industries into 10 equal groups, such that Decile 1 is the most skilled and Decile 10 is the least skilled. Production workers are used as a proxy for unskilled workers. Each 4-digit industry is then deemed to be in the decile indicated by its 3-digit group.

Price changes are discussed in the text, and show proportional changes in the period indicated.

Decile averages are weighted averages, with the weights formed by 1978 industry shipments divided by 1978 decile shipments within each decile.

Sources: Price data from 1978 to 1989 are from the NBER Productivity Dataset. Price data for 1989 and 1995 are courtesy of Alan Krueger.

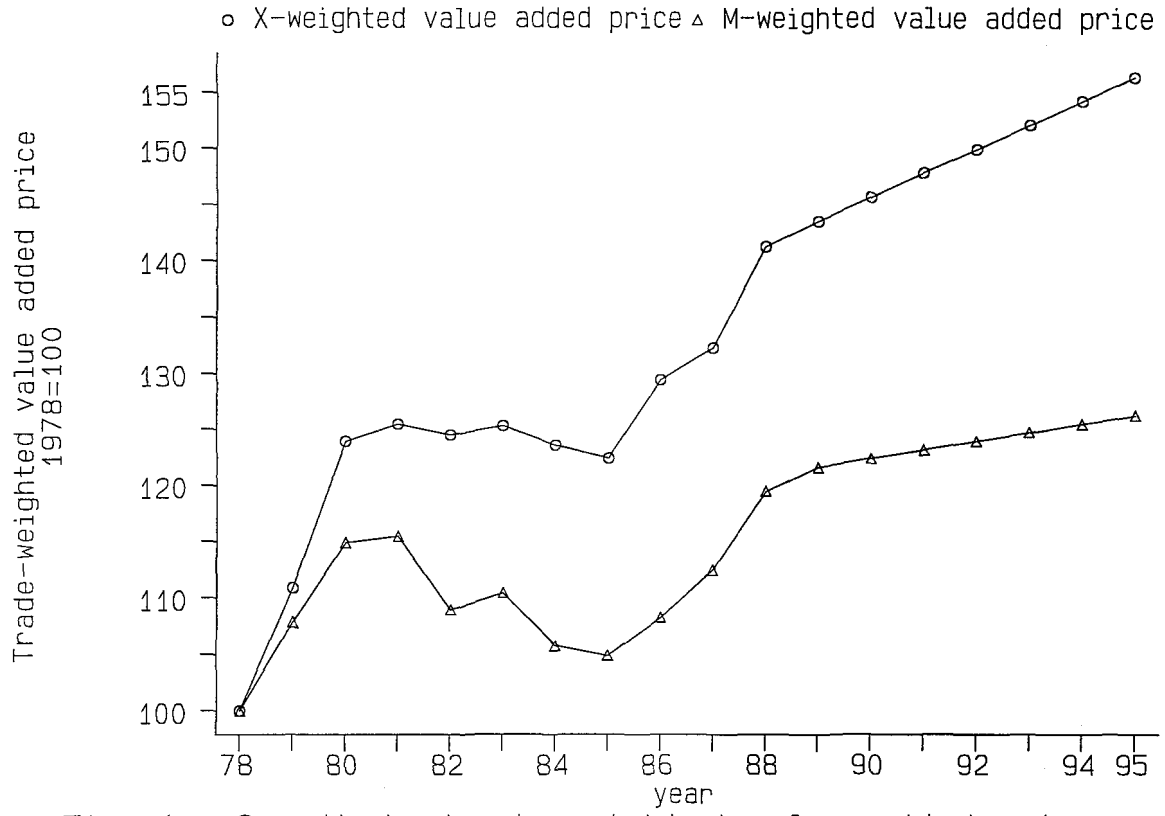


Fig. 1. Growth in trade-weighted value added prices

Notes to Figure 1

This figure shows the graph of trade-weighted value added prices for manufacturing, 1978 to 1995. Each observation is the weighted average of the value added price for 105 3-digit manufacturing sectors, with the weights each sector's share of exports or imports to or from the United States' top nine LDC trade partners. These are Brazil, China, Hong Kong, Korea, Malaysia, Mexico, Singapore, Taiwan, and Thailand.

In other words, each observation is:

$\sum W_i P_i$, where W_i is the weight for sector i , and P_i is the value added price for sector i .

Weights are computed as:

$T_i / \sum T_i$, where T_i is the trade flow, either exports or imports, for sector i to or from the nine LDCs.

Value added price for each sector is computed based on the annual log change from the following equation:

$$p_o = \beta_v p_v + \beta_m p_m + \beta_e p_e,$$

where p is the log change in price from year t to $t+1$, β is the share in total output, o is output, v is value added, m is materials, and e is energy.

Note that figures for 1990 to 1994 are a linear extrapolation of the 1989 to 1995 price change, as there was no data available for 1990 through 1994. For the change from 1989 to 1995, there were no separate figures for materials and energy costs and prices. Rather, there were cost and price figures only for intermediates.

Sources: Output, materials, and energy total values and prices for 1978 to 1989 are from the NBER Productivity Dataset. Output prices, intermediates prices, and share of intermediates for 1989 and 1995 are courtesy of Alan Krueger. There is no data for 1990 to 1994. For both periods, share of value added is computed as one minus share of intermediates.