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IN SEARCH OF STOLPER-SAMUELSON EFFECTS ON U.S. WAGES

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ABSTRACT

Economic growth in Europe and Asia and Latin America could have contributed in many different ways to the lower wages and increased income inequality that the United States has been experiencing. One plausible model that links external product markets to internal labor markets is the Heckscher-Ohlin-Samuelson general equilibrium model. This model operates over a time period that is long enough to allow complete detachment of workers and capital from their original sectors. According to this model the news of Asian growth is carried to the US labor markets by declines in prices of labor intensive tradables. These price reductions twist the labor demand curve, dictating lower real wages for unskilled workers who reside in communities with abundant unskilled labor but raising the wages for unskilled workers who are fortunate to live in communities inhabited mostly by skilled workers.

US relative producer prices of labor-intensive tradables did decline in the 1970s by about 30%. These product price declines are compatible in the long run with real wage reductions totalling almost 40% for unskilled workers. In the 1980s however, changes in US producer prices worked in favor of these low-wage workers, raising their equilibrium wages by about 20%.

The sectoral bias of TFP growth did not much favor low- or high-wage workers, but TFP changes did work strongly in favor of nonproduction workers and against production workers in the 1970s. If these TFP improvements had not generated any product price response, the TFP improvements in the 1970s call for a 100% increase in earnings of nonproduction workers and a 60% reduction in earnings of production workers.

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In Search of Stolper-Samuelson Linkages Between International Trade and Lower Wages[1]

by

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With the widening of the gap between wages of the unskilled and wages of the skilled has come an intense effort by economists on both sides of the Atlantic to identify the cause. The top three suspects are education, technology and international trade. Most casual observers hold the opinion that all three of these suspects are guilty. The public schools in the United States seem to be doing a poorer job preparing their graduates for the job market, and have been adding to the supply of unskilled, ill-prepared workers. On the demand side, technological change is altering the nature of work. Many functions are being technologically transferred from unskilled to skilled workers (e.g. typing this manuscript), while others are being downgraded to require the most minimal level of education.(e.g. clerking in McDonalds). Last of the three suspects is international trade. Unlike the eyewitness accounts of the "damage" being done by a deteriorating educational system and the information revolution, the evidence against international trade is mostly circumstantial and largely captured in **Figures 1 and 2**. Figure 1 compares over the last several decades the levels of real wages in manufacturing(using both the CPI deflator and the PPI deflator) and the US trade dependence ratio, the ratio of exports plus imports divided by GDP. Figure 2 illustrates the vast differences between wages earned by US manufacturing workers and wages earned in much of the rest of the world.

Figure 1 reveals that the abrupt halt in the early 1970's to the previously very steady rise in real wages came suspiciously at a time when the United States was experiencing a rapid increase in trade dependence. The reason why increasing trade dependence might hold down US wages is suggested by Figure 2 in which each country is represented by a line segment with height equal to 1989 wages and width equal to population and countries are sorted by wage levels. If this is the global labor pool, it is a very strange pool indeed, with the liquid piled high at one end and hardly present at the other. What could possibly be holding up the high end? Barriers is one answer: The arbitrage opportunities suggested by Figure 2 have not genuinely been present because of the real and threatened interventions by governments which isolate workers in the high-wage countries from competition with workers in the low-wage third world. Now, according to this line of thinking, with the liberalizations that are sweeping the globe, US workers are suddenly finding themselves in direct competition with a huge mass of workers around the

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globe who are receiving wages that are a tiny fraction of US wages. If the workforces in China and India and Mexico and South America are integrated through the exchange of products with the US workforce, how could the US resist at least some downward movement of wages of unskilled workers??

While public opinion holds all three suspects guilty of wage suppression, the jury of academics seems to be rendering a very different verdict. Education and globalization have been found innocent and technological change guilty. Labor economists have not found evidence of much change in the relative supply of unskilled workers as a result of educational failures They also do not find evidence of much change in the demand for labor coming from international trade. Like Sherlock Holmes who counsels "Eliminate the impossible, and all that is left is the truth," once these economists found education and globalization innocent, they have chosen to convict technology, never mind that there is little organized evidence presented against this culprit.

My view is very different. First of all, I object, Your Honor, the evidence that has been presented in support of the innocence of globalization is "incompetent, irrelevant, and immaterial." I move for a mistrial. ("Overruled; sit down Mr. Scheck"). Second, this is a crime that most likely could not have been committed by any one of the culprits but requires all three to be working together. If, for example, the educational system had created a workforce in the United States that had very few unskilled workers, then economic integration of the goods markets with Mexico could benefit all US workers, even the lowest skilled. Our fear of NAFTA speaks volumes regarding our confidence in our educational system. Third, I would argue, the question is not: Which is the guilty force? The real question is: What are we going to do about it? If we find education and globalization innocent, and technology guilty, we seem to me to be edging toward a very passive response: There is nothing that we can do. The continuing and persistent belief that globalization is guilty, nevermind the academic argument to the contrary, probably comes from the fact that globalization has an apparent remedy: economic isolation. A guilty verdict against education also points to a remedy, but educational investments have a very long gestation period, and we cannot expect to have much impact on the income inequality trends very quickly by pulling the education lever.

Though free trade remains a target of political rhetoric, with both NAFTA and the WTO now passed, the option of economic isolation may be pretty much gone. This leaves us with a question: What private educational investments and what public investments in immobile knowledge or infrastructure assets are most appropriate for the 21st Century when products can be shipped around the globe with little risk of government interventions, when liquid pools of physical and knowledge capital can freely seek out workers with the lowest wages relative to productivity, and when computers are prepared to do many mundane tasks with great accuracy and efficiency?

This paper will not move us much closer to an answer to this important question. It has the more modest goal of establishing the role that *one form* of globalization plays in the income inequality drama, namely relative price reductions for labor-intensive tradables. The view offered here is that at the end of the World War II countries sorted themselves into two different groups. Europe and Japan and the Asian NICs chose economic integration with the United States. But most of the rest of the world opted for inward looking isolationist policies. Those that chose integration experienced a period of technological backwardness, but the technological lead that the US enjoyed in the 1960's vis-à-vis the integrated economies dissipated rapidly in the 70:s even as the gap increased vis-à-vis the isolated countries. Economic isolationism eventually collapsed as this technological gap became more and more intolerable. Now the global economy faces the wrenching task of integrating the enormous number of low-skilled workers who reside in countries that formerly chose isolation. This integration may or may not mean lower wages for unskilled workers in the advanced high-wage countries. One possibility is that high rates of investment in immobile assets particularly human capital and infrastructure will assure that these advanced countries will continue to attract more than their share of mobile physical and knowledge assets and will continue to have workforces that command comfortably high wages. Another possibility is that a combination of trade and capital flows will eliminate entirely the economic separation of workers at different points on the globe and that wage levels will be determined only by skills and effort, and not at all by geography. This would surely mean greatly reduced levels of wages of unskilled workers in the advanced high-wage countries since the liberalizations of the last couple of decades have added enormously to the supply of unskilled workers with no commensurate increase in human or physical capital.

Before proceeding it should be emphasized that the forces that might be affecting income inequality in the United States are diverse and interactive. A list of possibilities is provided in the display below. Included are US investment rates, US labor supply changes, technological change, increased international factor mobility and increased trade in goods and services . On this list are many forms of "globalization" including the increased international mobility of intangible knowledge assets, reduced market power for unions, delocalization of assembly operations, and so on. In this paper only one globalization effect is considered: lower prices for labor-intensive tradables. The economic liberalizations that have increased the supply of labor-intensive tradables in the longer run will doubtless divert physical capital from the high-wage developed countries to the low-wage developing countries, which of course can work against labor in the high-wage countries. This and other forms of "globalization" are not considered here, not because they are unimportant or less important, but only because it is hard enough to try to get one piece of the puzzle to fit, let alone two or more!! (Think about that metaphor.)

Forces Lowering Wages of Unskilled US Workers

- Inadequate investment
  - Education failures
  - Low savings rate
- Labor Force changes
  - Female Labor Force Participation
  - Aging
- Technological change
  - Factor-biased productivity improvements in manufacturing
  - Sectoral-biased productivity improvements in manufacturing
  - Productivity gains in services
- International Factor mobility
  - Immigration
  - Capital Flows
  - Technology transfers
- Globalization of the markets for goods and services
  - Lower prices for labor-intensive tradables (e.g. apparel)
  - Foreign demand for local services from an external deficit
  - Reduced market power (e.g. autos and steel)
  - Delocalization (e.g. assembly in Mexico)
  - Internationalization of the Service Sector (e.g. computer programming in India)

The first step in the argument is to get clear the circumstances in which price reductions for labor-intensive tradables will drive down wages in high-wage markets. The Heckscher-Ohlin model is a particularly rich conceptual setting for thinking about this issue. This is a model that ought to remind us that **prices are set on the margin.** It doesn't matter that trade in manufactures is a small proportion of GDP. It doesn't matter that employment in apparel is only one percent of the workforce. What matters is whether or not the marginal unskilled worker is employed in the apparel sector, sewing the same garments as a Chinese worker whose wages are 1/20th of the US level. Then lower prices for apparel as a consequence of increased Chinese apparel supply causes lower wages for all unskilled workers in the same regional labor pool as the US garment worker.

Wage determination in an HO model is described by the Stolper-Samuelson Theorem which links product prices with wages. This theorem reminds us that what matters is not the level of imports of apparel but rather their price. The quantity-oriented tradition of computing the labor embodied in trade and comparing it with the size of the US labor force suffers from several defects that are more fully discussed in Leamer(1995). First and foremost is the fact that the factor contents are the *net* external factor supplies. The net external labor supply can change if the external price of labor changes, but it can also change if there are changes in either the internal labor demand or the internal labor supply. For example, technological change that lowers the internal demand for unskilled labor may offset the increase in imports of the services of unskilled workers that might otherwise have come from a fall in their the external price. This can keep the imports of labor services low, even as the external marketplace is selecting a lower price for labor.

Section 1 is designed to present the HO model in as transparent a way as possible. An intellectual bridge between trade theory and labor economics is formed in this section by concentrating completely on the labor demand curve. What does the HO model imply about the labor demand curve? There are many surprising results. Indeed the most important message of the HO model is that trade in commodities transforms a local labor demand curve into a global labor demand, even though there is not direct arbitrage through labor migration. Another important idea that comes from a Heckscher-Ohlin framework is that the effects on wages of both globalization and technological change should be studied by cross-industry not within-industry comparisons. In this general equilibrium framework, with product prices held fixed and to a first order of approximation, it does not matter that the technological change reduces the inputs of unskilled workers in every sector; what matters is whether the technological improvement is concentrated in sectors that are intensive in unskilled workers, intensive in skilled workers or intensive in capital. **Factor bias doesn't matter; sector bias does.**[3]

Section 2 is a discussion of various data displays suggested by the HO framework.. From this section arises one important conclusion. The three decades under examination had very different outcomes. The 1960's had relative price stability, growth in all sectors of the economy and wage gains at every level of skill. The 1970's was the Stolper-Samuelson decade with price, trade, and employment data consistent with the presence of Stolper-Samuelson effects on wage inequality. The 1980's on the other hand have no evidence of Stolper-Samuelson effects, but globalization nonetheless may be operative through, for example, declines in market power in metals and autos or through the external deficit that makes the marginal demand for workers come from the local nontraded sector.

When the HO framework is only a loose guide for the examination of the data it is impossible to infer how much effect relative price variability is having on wage rates. Therefore, in the final section, a formal data analysis is presented which uses a specific HO model and which attempts to separate the technology effects and the Stolper-Samuelson effects on wage levels and wage inequality. Data on price changes, factor shares and technological change are used to estimate the "mandated" wage changes that are required to maintain zero profits across sectors. In this exercise the separation of technology from globalization effects depends on how the observed product price variability is split between technological change and globalization. Ideally, one would have a global supply and demand model that could help to determine what impact technological change is having on product prices. Here a common "pass-through"

[3] Factor bias can matter if the change is large enough to allow second order effects, or if the factor-biased technological change precipitates sectoral-biased price adjustments, for example, reduction of prices of labor-intensive tradables as a consequence of labor-saving technological changes. However, if the demand for nontradables is very elastic, the released factors can be absorbed in nontradables with little or no change in tradables prices.

rate is assumed for all sectors meaning that a given percent of the technological improvement is passed on to consumers in the form of lower prices. The remaining variability in product prices is attributed to "globalization," thus acting as if product prices were completely determined by the external marketplace.

The analysis is done with the labor force sliced by wage levels and by the usual production/nonproduction distinction. Two conclusions emerge. (1) The residual "globalization" effects on income inequality generally dominate the technological effects. (2) The 1970's was the Stolper-Samuelson decade with product price changes causing increases in inequality. Product price variability in the 1980's actually worked in the opposite direction. The numbers that emerge from this analysis are very large: 4% mandated reduction per year in wages of low-wage workers in the 1970's offset by 2% per year gains in the 1980's. Accumulated over the two decades, these numbers are big enough to account for most of the increase in income inequality in the United States.

The major shortcomings of the estimates of the relative impact of globalization and technological change reported in Section 3 are: (1) The estimates are based on one special HO model which presumes first that the demand for labor is infinitely elastic and second that the globalization "shock"" is a product price change which stimulates a factor price response. In this framework, education cannot matter at all since changes in the supply of unskilled or skilled workers have no effect on wages. (2) The separation of the observed changes of product prices into globalization and technological components is questionable. In particular, a constant pass-through rate is a doubtful assumption. (3) The data on prices, factor shares and total factor productivity are all measured with error. (4) There are no consideration whatsoever to the adjustment process by which the labor markets might absorb the news of product price changes. The mandated wage changes apply only over a time frame long enough to allow complete separation of worker and capital from the sectors in which they were originally deployed.

In other words, much is left to be done. We need to compute the "globalization" effects allowing for product mix changes and/or allowing for the possibility that the marginal demand for labor comes internally from the nontraded goods sector. We need to be more careful about the demand side to determine how technological change alters product prices. We need to link product price changes more clearly to globalization. We need to explore other ways of measuring the factor shares and TFP. We need to adjust econometrically for measurement errors including outlier problems. We need to consider empirically other forms of globalization including the effect of the external deficit on the demand for nontradables, the increased mobility of knowledge and physical assets, and reduced market power especially in metals and transportation equipment. Finally we need to explore the implications of other conceptual frameworks, namely the Ricardo-Viner framework that has sector-specific labor-related assets and also the Chamberlainian framework with increasing returns to scale and imperfect competition.

Nonetheless, I believe that this paper supports the view that increased competition from low-wage developing countries during the 1970's had an important impact on the US labor market either in that decade or subsequently. This was the Heckscher-Ohlin Stolper-Samuelson decade during which there were substantial relative price declines for labor-intensive products made in the US. The 1980's experienced no continuing price declines for labor-intensive goods, presumably because the US economy had isolated itself from low-wage competition by product upgrading or by trade restrictions particularly the Multi-Fibre Arrangement. If it is the MFA, then we can expect another round of price reductions of labor-intensive products made in the US as the MFA is phased out according to plan or as Mexico is able to access the US marketplace relatively free of MFA restrictions. If it is product upgrading, then the US may have positioned itself so that most categories of labor will benefit from cheaper imports coming from low-wage developing countries. Research is underway to separate these two possibilities.

1.0 A Heckscher-Ohlin Theory of Labor Demand

Two important mistakes that we make when we analyze data are: (1) taking the theory too seriously, and (2) not taking the theory seriously enough. In practice we always make some of both kinds of errors. It is a matter of judgment as to which is the more severe. Probably because of my extensive training in general equilibrium international trade economics, I am disturbed that there is so little of international trade theory evident in the measurement methods that are now commonplace in the empirical literature connecting globalization to local labor markets. Indeed there seem to be some major misconceptions about this theory about which I have complained in Leamer(1994). (See also the review by Deardorff and Hakura(1994).)

The goal of this section is to add a dash of trade theory to the debate by laying out the essential aspects of the traditional Heckscher-Ohlin general equilibrium model as clearly as possible. Toward that end, I will focus exclusively on the demand for labor and ask the simple question: How might "globalization" and "technological change" alter the US demand for labor? It should be repeated again for emphasis that "globalization" and "technological change" have many potential routes by which they can affect the local labor markets. The globalization "shock" that is emphasized in this paper is an increase in the foreign supply of unskilled workers associated with the economic liberalizations that are sweeping the globe. The technology shock is exogenous sectoral-biased productivity improvements. Two basic questions are posed: (1) **What might keep the wages of unskilled workers in the United States high as the global labor market absorbs huge increases in the supply of unskilled workers from formerly isolated regions?** (2) **What kind of technological change tends to lower wages of unskilled workers and increase income inequality?** These questions are answered indirectly by a series of labor demand curves depicted in Figures 3 to 9 Details of the derivations of these labor demand curves can be found in appendix 2.

Two standard results in a Heckscher-Ohlin framework describe the demand for labor. The Factor Price Equalization Theorem identifies conditions under which the demand for labor is **infinitely elastic.** [1] The Stolper-Samuelson Theorem explains how changes in product prices shift the demand for labor "**up and down**". These results have two important implications for a study of the impact of "globalization" on the US labor market. First, with the reduction of the US share of world GDP should come an increase in the elasticity of the labor demand. Second, unless the US marketplace is so large that it completely controls product prices, the news of the foreign liberalizations is communicated to the US labor market through changes in product prices which shift the labor demand up or down. In other words, price shocks cause price reactions. This conflicts with many studies by labor economists who measure the global shock with quantity measures (levels of imports or the factor content of trade) and who sometimes measure the reaction with quantity measures (employment levels).

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[1] Incidentally, in my Graham Lecture, Leamer(1995), I have argued that it would be better to call this the "Factor Price Insensitivity Theorem" meaning that wages do not change with labor supplies.

The content of these two theorems is communicated in Figures 3 and 4 which are built on the following assumptions:

a) Two goods (machinery and apparel) and two factors of production (capital and labor).

b) Constant returns to scale production functions

c) Factors costlessly mobile between sectors but completely immobile internationally.

d) A country that is too small to affect world prices.

Figure 3 contrasts the relatively inelastic labor demand of a closed economy with the infinitely elastic labor demand of a small open economy that faces fixed world product prices. The shifting up or down of the labor demand in response to a reduction in the price of the labor intensive good is illustrated in Figure 4. The horizontal axis in both these figures is the ratio of labor to capital; the vertical axis is the real wage in buying power over apparel, the labor intensive good. The labels M and A on the horizontal axes refer to the labor-intensities of the two products, Machinery and Apparel, which are assumed technologically fixed without materially affecting the discussion. The horizontal scale in Figure 3 is separated into a region in which the country exports apparel and a region in which the country exports machinery. The no-trade point occurs when the pre-trade and post-trade product prices are identical, thus where the labor demand functions for the closed and open economies cross.

The extreme elasticity of a labor demand curve for a small open economy comes from an ultrasensitive response of product mix to changes in labor or capital supply.[2] More generally, both wages and output mix will respond to labor supply increases. In a Ricardo-Viner unit of time, the output mix is relatively unresponsive to labor supply changes, and it is wages that do the adjusting.[3] In a Heckscher-Ohlin unit of time with product prices given and factors mobile between sectors, outputs are ultra-sensitive to labor supply changes and wages can stay fixed even as labor supply changes. Ultrasensitive output responses can occur only in a time period that is long enough to allow substantial reshuffling of capital between sectors. The Heckscher-Ohlin clock surely doesn't click year by year. Decade by decade is a better estimate of the speed. It may well be that the Heckscher-Ohlin forces work so slowly that by the time they might become operative other changes in the economy have made them irrelevant.

Notice in Figure 3 that the labor demand function of the open economy is infinitely elastic only for labor-to-capital ratios between M and A. The input intensities in the two sectors are assumed to be fixed, and if the labor-to-capital factor supply ratio is outside the interval between M and A, the open economy specializes completely in one product and has one factor that is redundant and that commands a zero return. The closed economy has zero returns for one factor over a broader set of labor-to-capital ratios because demand has to be satisfied internally and complete specialization of a closed economy is inconsistent with utility functions that place value on product diversity.

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[2] The Jones magnification result is $\hat{M} < 0 < \hat{L} < \hat{A}$, meaning that the percentage change in outputs magnifies the percentage change in labor (here assumed to be positive).

[3] A Ricardo-Viner model has sector-specific assets.

An important feature of these labor demand curves is that relatively high wages are provided by the open economy in comparison with the closed economy when labor is very abundant, but also when labor is very scarce. Trade theory has tended to concentrate attention on the segment of the labor demand curve between M and A, within which openness raises wages for labor abundant countries but lowers wages for labor scarce countries. But in the labor-scarce segment between zero and M, openness also raises real wages. This extremely important and often overlooked feature of a Heckscher-Ohlin model is worth repeating in a somewhat different way. If two regions are economically integrated and if they are sufficiently similar in factor abundance, then economic integration will lower the return to capital and raise the wage rate in the labor abundant country, and will have the opposite effect on earnings in the capital abundant country. In other words, there are winners and losers. But **if the countries are sufficiently dissimilar in their factor supply ratios, and if the integrated equilibrium has one or both countries fully specialized, then both factors in both regions can be made better off from economic integration of the product markets.** Keep in mind here the huge differences in labor abundance of the United States compared with low-wage Asia. Absent capital mobility, this raises the possibility that labor on both sides of the Pacific can gain from increased cross-Pacific trade.

The impact of a fall in the price of apparel on the labor demand schedule, as described by the Stolper-Samuelson Theorem, is illustrated in **Figure 4**. A reduction in the price of the labor-intensive good lowers the real wage of labor regardless of the numeraire. Thus in the segment between M and A, the labor demand curve is shifted downward. For the economy that is fully specialized in machinery (labor-to-capital abundance ratios less than M), the fall in the relative price of apparel means that labor commands a higher wage in terms of apparel (though the same in terms of machinery). Thus for very capital abundant countries, increased supply of apparel from Asia increases the earnings of both capital and labor. More on this possibility in the next figure.

The labor demand schedule in Figure 3 can be easily amended to allow more sectors simply by adding more horizontal segments as in **Figure 5,** each segment selecting a different pair of products. This figure reminds us that the increased competition from labor abundant countries shifts downward only the right tail of the labor demand curve applicable to labor abundant countries but shifts upward the demand for labor at lower levels of labor supply. Higher real wages accrue to capital abundant countries from cheaper imports of noncompeting goods. Thus "globalization" of this form is a problem only for those countries/regions that are forced because of inadequate supplies of capital to compete with low-wage Asia. For more capital abundant countries, the rising tide of Asian trade lifts all boats. This establishes one method of escape from the forces of global wage equalization: capital investments that support product upgrading. A question can summarize this discussion: "What is the source of the marginal demand for unskilled workers in your community?" If it is apparel or footwear manufacturing because your community doesn't have the skills and capital to support an upgraded product mix, then the 21st century promises to be a difficult time.

If the model allows another factor of production, say human capital, then there are more complex choices of product mix and a variety of demand functions for unskilled labor depending on the supply of human capital. Figure 6 illustrates the demand for unskilled labor of two hypothetical countries with different ratios of skilled to unskilled workers. The horizontal axis for this demand curve is, as before, the ratio of unskilled labor to physical capital. Figure 6 offers a more complicated version of the message of **Figure 5**: "Protection" from competition with low-wage countries can come from high rates of investment. Thus: **The problem isn't trade by itself; it's a combination of trade and the deplorably low US rates of investment in all kinds of capital.** [4]

The next topic is the trade deficit and the "overvaluation" of the dollar. In order to think about the possible effects of a trade deficit this simple model needs nontraded goods whose prices can be influenced by local demand. The labor demand function for a country with two tradables and one labor-intensive nontradable is illustrated in **Figure 7**. This demand curve has an interval of infinite elasticity which occurs when the country produces both tradables. In this interval the two zero profit conditions for tradables can be used to solve for the two internal factor prices as a function of the two external product prices. These internal factor prices determine the price of nontraded goods from the nontraded goods zero-profit condition. In this interval the marginal demand for labor is external since the international exchange of

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[4] Parenthetically, this model suggests two methods for fighting income inequality caused by globalization: broadening the ownership of human capital or raising the wage of unskilled workers by increasing the total amount of human capital. Broadened ownership of human capital could be achieved, for example, by dispersing public funds for general education. But increased total human capital stock could be achieved most efficiently with educational tax incentives that would encourage especially the most able to invest in more education. The solution that broadens the ownership of human capital is economically inefficient since investments are undertaken that offer relatively low rates of return. This lowers the total human capital stock created by a given investment level. The apparently elitist policy that concentrates educational investments on the most able is the preferred method of fighting income inequality for a country that has a product mix that is almost the same as the high-wage countries, that is one with relatively low output levels of labor-intensive manufactures. For this kind of country, a small stimulus for the most able to increase educational attainment can reduce inequality by raising the wage level of unskilled workers. Among OECD countries, the United States has an unusually large apparel sector and may be the country that is least able to fight income inequality with elitist educational policy.

We can also use a three factor model to make some remarks about **increased capital mobility.** Suppose that globalization means not just integration of the goods markets and equalization of goods prices, but also freedom for capital to find locations on the globe with the highest rates of return. Then capital will flow out of the high-wage countries.. The flow will stop when the return is equalized. If the supply of skilled workers in the high-wage country is relatively small compared with unskilled workers, equalization of the return to capital can only occur with equalization of the other two factor costs including low wages for unskilled workers. But if the supply of skilled workers is great enough, the capital outflow can be terminated by a decline in the rental price of human capital, not wages of unskilled workers. Thus, at least in this model, **the assault on income equality represented by capital mobility toward the low-wage developing regions can be completely met by educational investments which attract capital by lowering the cost of complementary skilled inputs.** Of course, this lower private return to skills reduces the attractiveness of investments in skills. In the longer run, human capital in a skill-abundant country can be turned into more productive investments in physical assets in the emerging regions, thus creating new pressure for low-wages. Public subsidies to education are then the natural means of maintaining reasonably low levels of income inequality.

products is creating implicitly an infinitely elastic external demand for labor services. But if labor is very scarce or very abundant, the economy will fully specialize on one traded good and will produce also the nontraded good. In that event the marginal demand for labor can be said to be internal in the nontrables sector.

An external deficit raises the demand for nontradables and may or may not affect wages. If the marginal demand for labor is internal then the increase in demand for nontradables must be contained by higher prices for nontradables and therefore higher wages. But if the marginal demand for labor is external, the increased demand for nontradables can be met simply by shifting resources from the tradables sector. Since the opportunity cost of these productive resources in tradables is fixed, there is no change in the price of nontradables and no change in wages. These possibilities are depicted in Figure 8 which shows how an external deficit affects the demand for labor if the non-tradable is labor-intensive.[5]

Figures 7 and 8 can also allow us to contrast "globalization" of the product market from "globalization" of the factor market. Into each figure I have inserted two labor/capital ratios that are provocatively labeled "Seattle" and "LA". Seattle is rich in capital and opts for a mix of tradables that is concentrated on capital intensive goods like aerospace and software design. The city of Los Angeles has a higher ratio of workers to capital because of an earlier migrant inflow. In LA, wages are lower and the mix of manufactures is more diverse, including an active garment district. Each of these communities is exposed to one form of globalization and isolated from the other. Immigrants into Seattle would have to be absorbed into the nontraded goods sectors and would drive down wages, but further immigration into LA can be absorbed in the tradables sector with no effect on wages. On the other hand, workers in LA are exposed to competition with Chinese apparel manufacturers, whereas no sector in Seattle competes with

[5] Although this figure can be used to think about the impact of the US trade deficit in the middle of the 1980's on US wages, it needs to be applied with care. Any question regarding the effects of a deficit suffers terrible vagueness since there are many different ways that government policy might affect the external deficit and these different policies are unlikely to have the same impact on the economy. For example, the external deficit might be reduced by increased personal income taxes or by reduced defense expenditure. The deficit might be reduced by increased private savings encouraged by favorable tax treatment for IRAs. The external deficit might be reduced by a NAFTA agreement that creates new external investment opportunities. And so on and so on. It is completely inconceivable that all these policies and all the other possibilities would have the same impact on the demand for labor. In the models presented here, with the capital stock given, an external deficit could have an effect on labor demand in one of two ways. A deficit can cause or be accompanied by changes in relative prices of tradables or a deficit can cause or be accompanied by changes in the demand for nontradables.

China. Thus Seattle is exposed to migrant shocks but isolated from product price shocks. LA is isolated from further migrant shocks but exposed to product price shocks. [6]

Another important isolating force that can support high wages in the face of increased competition from low-wage countries is technological superiority. The United States enjoyed a substantial technological/organizational advantage in the 1960's and part of the globalization story surely has to do with the increased fluidity of technology and the mostly uncompensated transfer of US knowledge assets to other countries. This transfer may or may not drive down wages of US unskilled workers depending on its impact on international relative prices of products. In any case, it seems unlikely that technological superiority can be used anymore to support high wages in the United States since international commerce by itself carries stowaway knowledge assets, and other knowledge assets are sold or deployed abroad by multinational firms.

The effect of technological superiority on the demand for labor depends on whether the superiority is concentrated in labor-intensive or capital-intensive sectors. The simplest case of neutral technological differences refers to a country using a superior technology that affects labor and capital productivities proportionately in both sectors. Then the demand curve in Figure 3 is just shifted proportionately upward. If this hypothetical second country uses the same technology in apparel but a superior one in machinery, the labor demand curve shifts in a more interesting way depicted in **Figure 9**.[7]

Figure 9 can also be interpreted as a depiction of the effect of proprietary and local technological improvement in the capital intensive sector, a kind of change which improves productivity but does not force down world product prices. Although one cannot see it in Figure 9, the shift down or up in the labor demand schedule depends on whether the technological change is concentrated in the capital-intensive of the labor-intensive sector, not on whether the change is labor-saving or capital-saving. It is the sector-bias that matters, not the factor bias. This is made completely transparent in the algebra presented in Section 3. Figure 9 is a first step toward understanding the impact of the computer revolution, although this

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[6] Borjas and Ramey(1993) report the following data which does show much lower skill premia in Seattle than in Los Angeles, but also an increase over time in both locations. The former finding conforms with the theory just presented. The latter tends to contradict it.

Returns to Skills in Metropolitan Areas
Log Wage Ratio of College Graduates to:

	Year	High School Dropouts	High School Graduates
Los Angeles	1976	.578	.311
	1990	.841	.471
Seattle	1976	.220	.196
	1990	.532	.293

[7] This labor demand curve is derived on the assumption that the superior technology in machinery is more capital-intensive than the inferior technology, and thus the region of incomplete specialization is broadened.

technological change is neither proprietary nor local and needs to be studied with a model that allows relative price variability. One possibility is that the technological improvement is fully passed on to consumers in lower prices. In that event the nominal wage level stays the same and real wages rise depending on the numeraire good.[8]

[8] Another possibility is that labor-saving technological change shifts the comparative advantage of all countries toward the labor-intensive goods. The consequent increased supply induces offsetting price reductions and then Stolper-Samuelson amplifications More on this below.

2 Evidence

A data analysis based on a specialized HO *model*, such as the one-cone "even" model, allows a very close link between theory and data, but does so only by an uncomfortable commitment to a highly specialized version of the general theory. The general HO framework can drive the data analysis, but only if we are willing to tolerate an uncomfortably fuzzy link between theory and data. The best treatment to these two kinds of discomfort is: Some of each. In this section, the empirical facts are presented with only a "light" touch of the HO framework. In the next section, a formal data analysis is presented which is based explicitly on the one-cone HO model.

The key plot elements of the HO fable are relative product prices and product mix. According to the theory, a decline in the relative price of labor intensive manufactures is met in some communities by product upgrading. Other communities that are too abundant in unskilled workers to allow product upgrading experience declines in wages of unskilled workers and increases in returns to skills and/or capital.

From this section arises one important conclusion. The three decades under examination had very different outcomes. The 1960's had relative price stability, growth in all sectors of the economy and wage gains at every level of skill. The 1970's was the Stolper-Samuelson decade with price, trade, and employment data consistent with the presence of Stolper-Samuelson effects on wage inequality. The 1980's on the other hand have no evidence of Stolper-Samuelson effects, but globalization may nonetheless be operating either through declines in market power in metals and autos or through the external deficit that makes the marginal demand for workers come from the local nontraded sector, or through delocalization, or through ....

Figure 10, which depicts prices, trade and employment in apparel, tells the story. The price of apparel relative to the overall PPI was quite constant from 1960 to 1970, then fell by 30% over the next decade, at which point apparel prices stabilized. Employment in apparel increased during the 1960's from 1.2 million to 1.4, but began a decline in 1973 that has seen employment drop to under 1.0 million with no end in sight. Meanwhile, the employment loss is matched almost exactly by increases in imports as a share of domestic output, beginning at about 0% and reaching 35% by 1985.[1] But, you may object, this is too small a share of total US employment to matter. Does the tail wag the dog? Yes, indeed, the tail does wag the dog, if you believe in economics. Prices are set on the margin. Then what about the timing? Hasn't most of the increase in inequality come in the 1980's, not the 1970's? This is a difficult question. First of all, I am not yet willing to accept this timing of the increase in income inequality as a fact. On the contrary, I will show below that the *sectoral* wage inequality increased most in the 1970's and was relatively constant in the 1980's. But even if the increase in *worker* wage inequality is concentrated in the 1980's, this may be due to delayed Stolper-Samuelson effects. These effects are operative only over periods that are long enough to allow complete mobility of factors of production among sectors. The

[1] Sorry, but that is where my data on production levels terminates.

initial redistribution induced by price changes accrue mostly to sector specific factors, say skilled workers in apparel, and only over time will this spill over to unskilled workers throughout the economy.

There is one more question that needs addressing: Why didn't the price declines for apparel continue into the 1980's? This question needs answering if we are to form a clear vision of the future. One possibility is that the Multi-Fiber Arrangement which controls trade in apparel and textiles had more bite in the 1980's than the 1970's. With the scheduled phase-out of the MFA (again!) and with Mexican apparel exports to the US soon to be free of the MFA, this portends another burst of inequality caused by cheaper imports of apparel and textiles. Another possibility is that through product upgrading, US apparel producers by 1980 no longer were in competition with low-wage Asian sources of supply. T-shirts and jeans are imported; women's high-fashion clothing was made locally. This upgrading allows import prices of apparel to fall even as prices paid to US producers do not. This upgrading interpretation is much more optimistic since it suggests that the US economy is positioned to allow gains from increased trade with low-wage countries to accrue to all factors of production.

Other figures discussed in this section depict additional supportive evidence. It is shown that the US has become increasingly dependent on imports of most manufactures but especially of labor-intensive manufactures, apparel and footwear. There are many more countries that were exporters of labor intensive products in 1990 than there were in 1960. The United States which once had a distinctive pattern of factor supplies, with abundance of land, human capital and physical capital, is now surrounded by other competitors with equal or superior capital/worker and skill ratios. Product prices of apparel and also textiles fell substantially during the 1970:s. Employment levels in these labor intensive sectors have declined substantially from their peak levels in 1970. Wage levels in these unskilled sectors have declined and the gap between wages paid in the most labor-intensive sectors and other sectors has increased.

What Happened in 1972/1973 ?

One of the most surprising features of many of the graphs now to be discussed is the abrupt change in the series in the early 1970's.. Take a look again at the real wage data in Figure 1. Before 1972, real hourly earnings of production workers in manufacturing climbed virtually along a straight line at about 2.5% per year. The dip in real wages in 1973 that came from a burst in inflation in producer prices was offset by relatively rapid wage increases until 1978, when again the series on real wages dips. Thereafter real wages never got close to the trend line of the 1960's. This sharp break in the behavior of this series in 1972/73 is a highly unusual feature which cries out for explanation. This same kind of break occurs in many of the series now to be discussed, and no explanation of the changes in wages is going to be very satisfying if it cannot offer some interpretation of this remarkable transition.

Real Wages of Production Workers by Two-digit Sectors: Three Subperiods

The transition year 1972 is also very evident in the disaggregated wage data depicted in Figure 11. Until that year wages in every two-digit sector grew at a very similar rate. The burst of product price inflation of 1973 reduced wages in all sectors uniformly. In the subsequent decade, real wages fluctuated substantially, but by 1985 had regained or slightly exceeded their 1972 levels in all sectors except apparel. Thereafter, slow growth in real wages in many sectors resumed.

This figure has two vertical lines that separate what seem to be three distinct subperiods: first the pleasant 1960's with substantial and general wage increases, next the turbulent 1970's with real wages regaining their initial levels only at the end of the decade, and finally in the 1980's a mixture of the first two subperiods with some real wage growth and some turbulence. The Stolper-Samuelson effects seem very clearly present in the middle decade of the 1970's but the 1980's will remain a mystery as far as this paper is concerned.[2] It is quite possible that product upgrading during the 1970's isolated the US labor market from low-wage Asian competition. Another form of globalization may be operative in the 1980's, perhaps the diminished market power hypothesis explored by Borjas and Ramey(1993), or perhaps related to the external deficit. The sharp rise in wages in chemicals and the decline in metals wages in the 1980's may be important parts of the puzzle.

Skill Premia: Sectoral Wages Divided by Wages in Apparel

As Bell and Freeman (1991) observe, wages can differ across sectors for a variety of reasons including economic rents to immobile workers and compensation for undesirable features of the work such as effort levels (efficiency wages), safety and high local costs of living. But within the framework of the HO model, the only reason that wages differ across manufacturing sectors is differences in the skill mixes. To keep the story brief enough for a single sitting, we adopt the HO framework and interpret the wage differences evident in Figure 11 as indicators of skills. With this as a given, the changes over time of the sectoral distribution of wages can come either from changes in the compensation for skills or from changes of the sectoral skill intensities. In the next section, both are explicitly allowed. For the moment, we abstract from changes in the skill intensities and take changes in wage differences across sector to be indicators only of changes in the compensation for skills.

Figure 12 depicts the average wages in a sector relative to apparel wages and is (boldly) labeled a skill premium. Here again we see the three subperiods. In the first, except for a dip in the late 1960's there was little change in these skill premia. In the second subperiod, there was a substantial increase in the skill premia. Then in the third period, the skill premia stayed relatively constant. Although this figure suggests that most of the increase in income inequality came between 1970 and 1982, but the consensus view is that the 1980's actually experienced the greatest increase in inequality. For example, Borjas and Ramey's(1993) estimate based on annual demographic files from the Current Population Survey of the premium for a college education relative to high school dropouts is relatively constant until 1981 after which it increases dramatically. This conflict between individual data and industry aggregates will not be resolved here, but here is one conjecture. High school dropouts may have become increasingly

[2] The divergence of apparel and textile wages in the 1970's may be evidence of product upgrading in the textile sector aimed at escaping foreign low-wage low-skill competition.

unemployable in manufacturing and the skill premia in Figure 12 implicitly compare college graduates with high-school graduates.

Cumulative 4-digit Sectoral Wages

The cumulative distribution of wages depicted in Figure 13 is perhaps the most dramatic way of summarizing the three-decades story. The horizontal axis in this figure is the level of sectoral real hourly earnings of production workers using the producer price index as the deflator. On the vertical axis is the percent of production workers who are employed in sectors that pay on average no more than the indicated real wage. In this figure the growth in real wages in all sectors of the economy from 1961 to 1971 is indicated by the shift rightward of this cumulative distribution. There is some slight tendency for the higher paid sectors to award relatively large wage increases. This can be seen in the numerical details of this cumulative that are reported in Table 1. Indeed it is the case that the 10th percentile and the median wage grew at the rate of 2.5% from 1961 to 1971, while the 90th percentile grew at the rate of 3.0%.

In the next decade, from 1971 to 1981, real wages generally fell, more at the lower levels of initial wages than at the higher ones. The exception is that wages continued to rise for those above the 95% percentile. Then from 1981 to 1991, the experience of the previous decade was largely reversed, bringing the cumulative for 1991 back to its 1971 position for wages lower than the 70%. Above the 70th percentile, wages in 1991 exceeded their 1971 levels.

Relative Prices: 2-digit data

The relevance of the Heckscher-Ohlin model for studying the impact of globalization on wages and the skill premium depends fundamentally on reductions in prices of labor-intensive tradables, a change that can be associated with increased foreign competition and that can be mapped into the kind of wage changes that have occurred over the last several decades. Lawrence and Slaughter(1993) argue that there is no association between price changes and labor-intensities, which would seem to be a decisive finding against the HO model. This finding is echoed by Bhagwati(1994) and by Krugman and Lawrence (1993). Even Sachs and Shatz(1994) who are overall sympathetic to the idea that increased competition with low-wage developing countries is lowering wages of the unskilled nevertheless have a hard time finding supporting evidence in the price data. The conclusions of these authors seem based primarily on the subperiods over which they have measured relative prices. In fact, the two-digit relative price data in Figure 14 evidence three distinct subperiods. Most of the relative price reductions of labor-intensive products occurred in the turbulent middle period stretching from 1972 to 1983. In the first period from 1960 to 1972 the price of the labor-intensive products (apparel and textiles) relative to the overall PPI fell modestly by about 4% and 8% respectively. In the second period from 1972 to 1983, prices of these labor-intensive products fell by another 30%. Then in the third period, there was little change in the relative price of apparel and textiles. [3]

[3] The middle decade experienced a very large increase in the price of petroleum which, however, cannot account for the relative price decline of apparel and textiles since energy inputs are a small share of costs in manufacturing.

World Factor Supplies

The price variability that is displayed in Figure 14 could be due strictly to internal factors such as shifts in demand, technological change, or US factor supply changes. In order to argue that globalization is a driving force behind the price reductions for labor intensive products in the 1970's, we need to show first the increase in world supply and second the increase in US imports that would be associated with lower global prices. The increase in world supply in an HO framework comes from relatively rapid capital accumulation in labor-abundant countries. This did indeed occur. Figures 15 and 16 illustrate the differences in factor supplies of capital, professional workers and nonprofessional workers for a large number of countries in 1965 and 1988. Straight lines coming from one of the vertices in these triangles vary one factor and hold the other two fixed. Thus the three factor ratios can be read from the scales on the edges of these triangles.

Roughly speaking, countries that are clustered around the US point are the ones that are most likely to be US competitors. Interpreted in that way, these figures suggest why the US might be getting itself into difficulties internationally. The 1965 figure has the United States on the edge of the advanced countries with abundance of both professional workers and also capital. From this uniqueness presumably came relatively great gains from trade and also insulation from competition with the most labor-abundant countries. But by 1988 the United States is only one of many. The US is exceeded in both physical capital and human capital per worker by a collection of OECD countries. More alarming, on the other side are a group of low-wage countries with ratios of human and physical capital that are high enough to turn these countries into US competitors, especially as the "high-end" marketplaces are taken over by the advanced OECD countries with higher investment rates than the US.

World Trade in labor-intensive Manufactures

The increase in global supply of labor-intensive tradables is suggested by Figures 17 and 18 which report the net export data, comparing 1965 with 1988. These data apply to Leamer's(1984) labor intensive aggregate composed of non-metallic mineral manufactures, furniture, travel goods, apparel, footwear. A full view and a zoomed view are provided. If there were no change in comparative advantage from 1965 to 1988 these data would all lie on a straight line. For most of Leamer's other aggregates, the patterns of trade are very stable. But comparative advantage in labor-intensive manufactures displayed in these figures is very much in turmoil, with a large number of countries shifting from being net importers to being net exporters, a feature which is particularly apparent in the zoomed view. In response, France, the United Kingdom, Austria and even Hong Kong switch in the opposite direction. Japan and Belgium, although still having positive net exports of this category, are substantially reducing their export dependence on this product, falling from the list of top ten net exporters to well back in the pack. Moving in the same direction, net imports per worker by the United States increased by a factor of twenty-five over this period.

Net exports

Next in the story we need to link these increases in world output levels to US trade. Figures 19 and 20 depict the US sectoral net export dependence ratios, first the surplus sectors and then the deficit sectors. This OECD data base extends only to 1985 and the three-decades story is necessarily incomplete. The first two decades are apparent in these figures. Figure 19 shows that the United States has enjoyed a long-standing comparative *ad*vantage in **industrial machinery, chemicals, tobacco products, instruments and fabricated metals**. These trade balances generally floated downward until 1972 when the trade dependence of the US began to increase. But these net export ratios took a nose-dive in 1981-1985, with the exception of tobacco. Figure 20 shows that the United States has had a long-standing comparative *dis*advantage in **leather products, misc. manufactures, apparel, primary metals, and textiles**. Electronics was once a source of foreign exchange but switched to being a net import item in the 1970's. These trade deficits generally increase gradually until the 1972 when imports of leather, miscellaneous manufactures, apparel and primary metals began to increase dramatically.

Employment

Employment levels in manufacturing sectors are depicted in Figures 21 and 22, first for the sectors that had early peak employment levels and then for the late-peaking sectors. These figures also tell the three decades story. Employment in most sectors of the economy was growing in the first period up to the early 1970's. The 1970's brought substantial declines in employment in apparel, textiles and metals. Apparel employment levels continued to decline in the 1980's. The 1980's brought also declines in employment in machinery, electronics and instruments. Peak employment in transportation was also in 1970, but high variability disguises any clear trend.

The employment reductions in apparel and textiles are a natural feature of the Heckscher-Ohlin framework and these data support the idea that the Stolper-Samuelson effects were probably present during the 1970's. Metals prices did not decline in the face of increased international competition, and the reduction in employment in metals does not seem to be an HO outcome but is more likely connected to market power considerations. Likewise, the decline in employment in machinery and electronics in the 1980's is not associated with any dramatic relative price movements in manufacturing, and these events may more likely be connected to the external deficit to which we now turn.

The Exchange Rate and the External Deficit

The decade of the 1970's appears to be a period in which the Stolper-Samuelson effects were present, but the 1980's were very different with no substantial further reduction of the prices of labor-intensive products. An appealing interpretation of these facts is that the US economy isolated itself in the late 1970's from low-wage Asian competition by product upgrading. Jeans and T-shirts were sown in Asia. Women's high-fashion clothing was sown in the US. This segmentation of the market allowed import prices to continue to fall with no further reduction in US producer prices.

Although Stolper-Samuelson price reductions were not evident in the 1980's, most data sets indicate that the income inequality trends were especially evident . Within the HO framework adopted in this paper, there is another route by which "globalization" can affect US wages: demand for nontradables associated with the external deficit. Mostly as a teaser, I now display the data on the exchange rate and the external deficit. From Figure 23 can be seen the increased volatility of the exchange rate that came from the breaking down of the Bretton Woods fixed exchange rate system. The dollar devalued by about 30% from 1970 to 1981, at which point it more than recovered, reaching a dramatic peak in 1985, only to come crashing down to its 1980 level by 1988. The period of increased volatility of the dollar conforms suspiciously well with the period of stagnant and volatile real wages depicted in Figure 1. The US trade surplus, illustrated in Figure 24, has a negative trend beginning in the 1960's and reaching a low point of -3% of GDP in 1986.

3.0 Formal Decomposition of Technological and Stolper-Samuelson Effects

This section reports a formal statistical analysis of an NBER data base on four-digit SIC products compiled by Bartelsman and Gray(1994). The goal is to estimate the impacts of both technological change and globalization on US wages. This analysis uses the one-cone HO model as a straightjacket. It is assumed that within each decade the mix of tradables produced is constant and sufficient to determine factor prices uniquely. The mix is allowed to vary from decade to decade. This data analysis is thus built on the (unlikely) assumption that the only way that globalization can affect the US labor market is via relative price changes that induce Stolper-Samuelson wage responses. The external deficit is not a consideration, except as it may affect relative prices of tradables. Market power in autos and steel is also not considered.

A crucial step in this attempt to separate the effects of "globalization" from "technological change" is the division of the observed product price changes into components separately associated with these two forces. This calls for an elaborate consideration of both supply and demand sides of a general equilibrium model Here we use a simple "pass-through" assumption that a selected proportion of the productivity increase is passed on to consumers in the form of lower prices. The residual price variability is attributed to "globalization" on the assumption that tradables goods prices are determined in the international marketplace. Of course, in markets in which the US is a major supplier or demander, these product price changes can come from events strictly internal to the US. Thus we may putting the "globalization" label onto something strictly internal to the US. I would defend the analysis against this criticism in two ways. First, this is the methodological mirror image of the usual procedure which extracts first the globalization effect and attributes everything else to technology.[1] It seem interesting, at least, to go in the opposite direction, first extracting the technological effect and then attributing everything else to globalization. Second and more importantly, even if the US has market power, internal prices of tradables can be affected by tariffs and/or nontariff barriers. Thus we are getting an answer to the policy question, whether or not the shock is internal or external. For example, when we conclude that relative price declines for apparel and textiles have led to increased income inequality, we are elliptically saying that things would have been different if the US had used barriers aggressively to maintain relative prices. It doesn't matter whether the relative price decline came from internal or external events. To remind the reader of this point, the g- for general replaces globalization in the narrative below.

3.1 Methodology for Estimating the Separate Effects of Globalization and Technological Change on Factor Prices

The foundation of the Stolper-Samuelson theorem is the set of zero profit conditions $\mathbf{p} = \mathbf{A}'\mathbf{w}$ where $\mathbf{p}$ is the vector of product prices, $\mathbf{w}$ is the vector of factor costs and $\mathbf{A}$ is the matrix of input intensities, inputs per unit of output. Differentiating one of these zero-profit conditions produces

[1] See Mishel and Bernstein(1994) for criticism of this procedure.

$$dp_i = \sum_k (A_{ik} dw_k + dA_{ik} w_k) \ .$$

Using the usual notation $\hat{x} = dx / x$ this can be written as

$$\hat{p}_i = dp_i / p_1 = \sum_k [(A_{ik} w_k / p_i)(dw_k / w_k) + dA_{ik} w_k / p_i] = \sum_k \theta_{ik} \hat{w}_k + \sum_k \theta_{ik} \hat{A}_{ik} \ .$$

Then the input intensity $A_{ik} = v_{ik} / Q_i$, can be differentiated to obtain

$$\hat{A}_{ik} = \hat{v}_{ik} - \hat{Q}_i \cdot$$

Using this and the standard measurement in the growth of total factor productivity implies

$$T\hat{F}P_i = \hat{Q}_i - \sum_k \theta_{ik} \hat{v}_{ik} = -\sum_k \theta_{ik} \hat{A}_{ik} \ ,$$

from which we obtain the fundamental condition linking product price changes, factor costs changes and technology changes:

$$\hat{p}_i = \sum_k \theta_{ik} \hat{w}_k - T\hat{F}P_i = \theta_i' \hat{w} - T\hat{F}P_i \qquad (1)$$

This is the equation that will serve as a foundation for separating the impacts of globalization and technology on factor prices. From data on a cross-section of 450 4-digit SIC industries describing price changes $\hat{p}$, TFP growth $T\hat{F}P$ and beginning-period factor shares θ, we may estimate this equation and interpret the coefficients on the factor shares as the "**mandated**" changes in factor costs, $\hat{w}$. These are the changes in factor costs that are needed to keep the zero profits condition operative in the face of changes in technology and product prices. These mandated wage changes can then be compared with actual wage changes. If the two conform adequately, we will argue that we have provided an accurate explanation of the trends in wages. Incidentally, the mandated changes in factor costs may induce actual factor costs in a later decade. The model and the data analysis is entirely silent on issues of timing.

An important apparent implication of Equation (1) is that the factor bias of technological change is entirely irrelevant. What matters is only the sectoral distribution of TFP growth since only TFP growth by sector enters the equation. This conclusion applies only to small changes and only if the technological change does not induce sector-biased price changes.[2] For discrete changes, we need to include the second order effects

$$dp_i = \sum_k (A_{ik} dw_k + dA_{ik} w_k + dw_k dA_{ik}) \ .$$

Dividing this by the initial price level produces the equation

[2] The startling conclusion that only sector bias matters was stated unequivocally in the original version of this paper. A graph produced by Ronald Findlay and some words from Paul Krugman suggested otherwise. What follows is a mapping of the graph and the words into the algebra. In particular, Ronald Findlay's graph forced me to realize the potential importance of second order effects; and Paul Krugman's words made me realize the possibility that factor-biased technological change could induce sectoral-biased price changes.

$$\hat{p}_i = dp_i / p_1 = \sum_k \theta_{ik} \hat{w}_k + \sum_k \theta_{ik} \hat{A}_{ik} + \sum_k [(A_{ik} w_k / p_i)(dA_{ik} / A_{ik})(dw_k / w_k)] \ .$$

Thus, including the second order effects, we have

$$\hat{p}_i = \theta_i' \hat{w} - T\hat{F}P_i + \hat{A}_i' diag(\theta_i) \hat{w}$$

This does allow factor bias to matter in the general equilibrium through second order effects involving the product of percentage changes in inputs and percentage changes in wages. This makes life even more complicated since a data analysis that properly deals with these second order effects must allow for the endogeneity of the factor intensities A.

A second problem with equation (1) is that it is an equilibrium condition that is entirely silent on the relationship between price changes and TFP growth. Without knowledge of the price changes induced by TFP growth, it is impossible to disentangle the effects of technological change from the effects of globalization and other sources of product price variability. In order to make the underidentification problem clear, we can separate this equation into two, one part that is due to technology (t) and another that is due to other factors (g). {g standing for globalization but also encompassing demand shifts}

$$\hat{p}_i(t) + \hat{p}_i(g) = \theta_i' \hat{w}(t) + \theta_i' \hat{w}(g) - T\hat{F}P_i$$

where

$$\hat{p}_i(t) = \theta_i' \hat{w}(t) - T\hat{F}P_i$$

$$\hat{p}_i(g) = \theta_i' \hat{w}(g)$$

$$\hat{p}_i = \hat{p}_i(t) + \hat{p}_i(g)$$

Obviously there are many values of the g-effect on wages that are compatible with this set of equations given data on TFP growth and product price changes. In order to make any headway in disentangling the globalization effects from the technological effects we will need to get a handle on that portion of the product price change that is due to technological change. To do this in a completely convincing manner we need to model world-wide demand and supply conditions. This would require a very large modeling effort. An *expedient* alternative is to assume that all sectors have the same "rate of technological pass-through" to product prices, namely $\hat{p}_i(t) = -\lambda \ \ T\hat{F}P_i$ where λ is the pass-through rate that is common across sectors.

A zero pass-through rate applies if technological change is specific to a small open economy which takes product prices as given from the rest-of-the-world. It may be that there are other conditions in which sectors would experience a common pass-through rate, but this would require a very special kind of model. Generally, the effect of technological change on product prices is not even confined to the sector experiencing the change. For example, labor-saving technological change regardless of the sectors in which it occurs may induce product price reductions in labor-intensive tradables, thereby shifting demand to labor-intensive products and thus absorbing the workers released by the technological change. In other words, factor-biased technological change may induce sectoral biased price changes. Then the factor bias of the technological change would matter. But the need for compensating sectoral-biased price changes is less, or possibly not present at all, if the demand for nontradables is very elastic and if the nontradables sector can absorb the released factors without necessitating changes in the price of tradables.

Intermediate inputs raise yet another difficulty with the pass-through assumption. Including intermediate inputs into equation (2) is no great problem. We simply need to include in the equation the inner product of the materials inputs shares γ and the product prices

Zero profit identity:	$\hat{p}_i = \theta_i' \hat{w} + \gamma_i' \hat{p} - T\hat{F}P_i$	(2)

The product prices on the right-hand side of this equation can be moved to the left to create a Stolper-Samuelson system of equations implicitly defining a mapping of "value-added prices" into factor prices:

$$\hat{p}_i - \gamma_i' \hat{p} = \theta_i' \hat{w} - T\hat{F}P_i$$

This is looking quite nice since it is exactly as before with value added prices in place of final goods prices, but the next step is where the danger lurks, namely appropriately treating TFP effects on prices. The assumption that will be used in the calculations below is that TFP improvements affect only value-added prices

Pass-Through Assumption:	$\hat{p}_i(t) - \gamma_i' \hat{p}(t) = -\lambda \quad T\hat{F}P_i$	(3)

In fact, productivity improvements in one sector are likely to have both forward and backward linkages to other sectors, affecting the demand for inputs in the sector experiencing the improvement and also altering the prices of materials in sectors that use the product as an input. An alternative would be to apply the pass-through to final goods prices and to allow for the indirect effect of technological improvements on materials prices. If only the first-round effect on input prices is considered this produces the equation

$$\hat{p}_i(t) - \gamma_i' \left\{ -\lambda \quad T\hat{F}P_i \right\} = -\lambda \quad T\hat{F}P_i,$$

which basically says that technologically-induced price reductions are especially great in sectors that use as inputs the products experiencing technological improvements. Unfortunately, the data set we will be analyzing has materials inputs and materials input prices by sector but not the full set of input-output linkages. Anyway, if one went that route, allowing only for first-round effects would be uncomfortable.

Thus to do the job right, we really need a complete world-wide general-equilibrium input-output model. We need this to deal with second-order effects, to select pass-through rates, and also to determine sectoral-biased price changes induced by factor-biased technological change. For now we can plow ahead, remembering that we are implicitly assuming that the second-order effects are small, that pass-through rates are similar and apply to value-added prices, and that the factor biases in technological change have not been enough to cause sectoral-biased price changes for tradable goods, possibly because of the absorptive capacity of the nontraded sectors.

Given the pass-through assumption (3), we can find the mandated changes in factor prices that accompanies the technological change, namely factor prices satisfying

$$-\lambda \quad T\hat{F}P_i = \theta_i^{'}\hat{w}(t) - T\hat{F}P_i, \quad \text{or equivalently}$$

Technological Effect on Wages	$(1-\lambda)T\hat{F}P_i = \theta_i^{'}\hat{w}(t)$.	(4)

After allowing for some effect of technological change on product prices that which is left over is the globalization effect

$$\hat{p}_i(g) - \gamma_i{}'\hat{p}(g) = (\hat{p}_i - \gamma_i^{'}\hat{p}) - (\hat{p}_i(t) - \gamma_i{}'\hat{p}(t)) = \hat{p}_i - \gamma_i{}'\hat{p} + \lambda \quad T\hat{F}P_i.$$

Inserting this into (2) produces the equation linking g-price changes to mandated earnings.

Globalization Effect on Wages	$\hat{p}_i + \lambda \quad T\hat{F}P_i = \theta_i^{'}\hat{w}(g) + \gamma_i{}'\hat{p}$	(5)

The data analysis next to be discussed thus involves two kinds of equations, both with factor shares as explanatory variables. In one set of equations, suggested by (4), the dependent variable is the sectoral growth in TFP. The estimated coefficients from this regression are multiplied by (1-λ) to find the technological effect on mandated earnings. In the other set of equations, suggested by (5), the dependent variable is the sectoral-inflation rate adjusted for TFP-induced changes. On the right hand side of (5) is the inner product of materials shares and product price changes. The data set does not contain detailed information on the material input shares, but it does contain the overall materials share and the corresponding price level, sector by sector. This is all that we need since we can replace the inner product of materials shares and price inflation rates with the overall materials share times the price inflation rate of materials inputs, sector by sector.

3.2 Descriptive statistics

Descriptive statistics of the Bartelsman and Gray NBER data on the hourly earnings of production workers and the average annual earnings of production and nonproduction workers are reported in Table 2.[3] The Heckscher-Ohlin theory that will be used to explore quantitatively the impact of technological change and globalization on wages assumes that workers and other factors are mobile across sectors. At any point in time, the average wage in an industrial sector would then be determined exclusively by the skill mix in the sector and not by historical sector-specific investments by workers in human or locational

[3] Defined as PRODW / PRODH, PRODW / PRODE, (PAY-PRODW) / (EMP - PRODE).

capital. With the additional assumption that skill proportions in each sector are (roughly) constant over time , changes in the distribution of wages across sectors would be driven by changes in wages at different levels of skills. Then the intersectoral dispersion of wages would be an indicator of income inequality. The first purpose of the displays in Table 2 and the cumulative distributions in Figure 13 is to support mildly this interpretation of the intersectoral distribution of earnings.

A way to measure wage inequality that does not rely on an assumption of fixed factor ratios would be to find subcategories of workers with skill levels which are fairly uniform within groups and substantially different across groups, say scientists in one group and deliverymen in another. Then differences in the average wage levels of these categories could be used to measure income inequality. Unfortunately, data on employment and earnings for subcategories of workers are difficult to find. Data categorized into production and nonproduction workers are readily available and have been used by Lawrence and Slaughter(1994) to study the relationship between wages and globalization. But Leamer(1994) and Mishel and Bernstein(1994) have argued that these categories are actually rather broad and suspiciously heterogeneous. The second function of the displays in Table 2 is to cast a bit more doubt on the usefulness of the production/nonproduction categorization for studying wage inequality across skill groups.

Table 2 has a variety of statistics concerning earnings and has several measures of income inequality highlighted in boldface. (These statistics are not weighted by sector-size, and can be influenced by relatively unimportant sectors.) Uncorrected for inflation, average hourly earnings of production workers rose from $2.27 to $11.11 per hour from 1961 to 1991. Over the same period, average annual earnings of production workers rose from $4,530 to $22,530 and nonproduction workers from $7,330 ($7,170) to $35,9800. If one thought that the categories of production and nonproduction sorted workers by skill, then the ratio of nonproduction to production earnings would be measure of income inequality. These ratios for the median earnings in the four periods were 1.58, 1.56, 1.57, 1.63, thus suggesting that most the increase in income inequality came after 1980, which is fairly similar with other measures of wage inequality(e.g. Borjas and Ramey(1993)). However, there is a very substantial amount of wage inequality across sectors within the production and nonproduction categories. In 1971, for example, there was a sector that had average production workers of $3,660 and another with $11,860. In the same period, average earnings of nonproduction workers varied across sectors from a low of $4,930 to a high of $15,250. The substantial overlap of the ranges of these earnings numbers casts doubt on the usefulness of the production/nonproduction categories.

Other measures of wage inequality of the economy are the coefficient of variation, the range relative to the median and the range relative to the minimum **(across sectors)**, all of which are reported in Table 2. Most of these suggest an increase in inequality in the 1971-81 decade and some further increase in the 1981-91 decade. The coefficient of variation of hourly wages of production workers remained almost unchanged from 1961 to 1971, but then grew by about a third by 1981, with little change thereafter.

The coefficient of variation of the average annual earnings of production workers is similar, as is the coefficient of variation of annual earnings of nonproduction workers, after vetting some extreme sectors in 1961.

Descriptive statistics for TFP growth are reported in Table 3. Note that the middle period, 1971-1981, was a period of little TFP growth on average but a great deal of dispersion across sectors. The first decade, 1971-1981, had TFP growth of about 8% per year. The third decade, 1981-1991, had TFP growth of about 4% per year. Both had standard errors of about 1.7%. Incidentally, the increased dispersion of the TFP growth figures during the turbulent 1970s is worrisome reminder that measurement errors may be important.

3.6 Discussion of Estimates

Finally, we turn to estimates of equations (4) and (5) for pass-through rates equal to one and zero. Because the calculation of factor shares is somewhat suspect, it makes sense first just to look at the correlations between price inflation rates and various beginning-of-period sectoral indicators in Table 4. Notice in this table that the price changes are hardly correlated with any of the sectoral indicators in the first decade, 1961-1971. In the second decade, 1971-1981, price increases were especially high in capital intensive, high production-wage sectors. In the third decade, 1981-1991, price changes were negatively correlated with capital-intensity and with material costs. Thus at a first glance, the three-decade story seems to apply. Relative price changes mattered little for determining relative wages in the 1960's; product price changes worked to lower wages in the 1970's, particularly for low-wage production workers; then in the 1980's it was capital that suffered with, possibly, all forms of labor gaining.

Although the simple correlations in Table 4 are very suggestive, an implication of equations (4) and (5) is that simple correlations of price changes with arbitrarily scaled industry indicators cannot tell the story. Multiple regressions on factor shares are needed. The final set of tables report attempts to find regressions of this type that make sense. Table 5 reports data on earnings shares and the corresponding definitions of earnings in terms of the Bartlesman and Gray data series. These earnings shares have two important features that need to be mentioned. First, in the absence of direct data on capital rental costs, the capital earnings are simply set to 10% of book values of plant, equipment and inventories. The best approach would be to multiply the sum of the real rate of interest plus deprecation times the capital current market value. The 10% real rate of interest is arbitrary but probably not very important since it affects mostly the capital coefficients in the subsequent regressions and not much the labor coefficients. More important is the implicit assumption that depreciation rates do not vary across sectors. A second observation about the calculations reported in Table 5 is that the earnings of each factor are divided by total earnings, not the value of shipments. Included in the value of shipments are rents to sector-specific assets that come from unexpected price variability. These are explicitly excluded from consideration by the Heckscher-Ohlin conceptual framework that we are using.

To determine earnings of "high-wage" and "low-wage" workers, the wage differences across sectors are interpreted as coming entirely from differences in the mixes of skilled and unskilled workers with the lowest wage sector having entirely low-wage workers and the highest wage sector having entirely high-wage workers. The proportion of high-wage and low-wage workers in other sectors is linearly extrapolated from the level of the wage. In the middle panel of Table 5 are the wage levels that are used to separate workers into high-wage and low-wage categories. At the bottom are sectors that have been excluded because of extreme values of the nonproduction wage. Note, by the way, that the high-wage production workers are paid considerably more than the low-wage nonproduction workers, thus the apparent overlapping of skills of the two groups.

According to the numbers reported in Table 5, materials constitute the largest share of total earnings, beginning at 61% and rising to 65%. This increase occurred exclusively in the 1971-1981 decade. The capital share also grew, but only slightly, from 7% to 9%. The gain to materials and capital is almost exactly matched by a reduction in the share of production workers which fell from 22% to 16%. This shift away from production workers is the focus of much of Lawrence and Slaughter's(1993) discussion. The separation of workers into high-wage and low-wage subcategories has left a larger share of high-wage than low-wage workers. This means that in every case the mean wage level across sectors is lower than the median ; the distributions are skewed to the right.

Table 6 contains estimates of Equations (4) and (5) for three different decades, 1961-71, 1971-81 and 1981-91, using only labor, capital and materials as inputs. The dependent variables are the compound annualized rate of increase in product prices over the decade and also the annualized growth of TFP. Explanatory variables are beginning-of-period factor shares θ for labor, capital and materials. The top part of the table contains regressions of price inflation rates and TFP growth rates over three decades on the beginning-of-the-decade capital and labor shares. These regressions are used to form estimates of "mandated" earnings growth which are reported in the bottom part of the table. The set of regressions in the middle panel at the top of this table use the sum of inflation plus TFP growth as the dependent variable, implicitly assuming that technological change is passed on 100% to consumers through lower prices. [4] Notice that these numbers are just the sum of counterparts on the left and right. All these are weighted regression estimates with employment levels averaged over the three initial periods as weights.[5]

The coefficients for the 1961-1971 price inflation equation reported in the first column of Table 6 suggest that a 3.27% rate of increase in wage rates, a -5.32%. rate of increase in capital rental rates would have been consistent with the least change in profits in the economy. With overall inflation equal to 1.91%, this means a net annualized real increase in earnings of these factors equal to 1.35% and -7.24% which are numbers reported under the heading "Mandated Annualized Earnings Growth Due to Price

[4] Of course, the estimates in the center panel are the sum of the right and left panels.

[5] Weights are kept constant to avoid changes in the results coming from changing weights. Weights in econometric terms are the inverses of the variances (not standard errors). Employment weights and value-added weights give similar results. Unweighted regressions are entirely different.

Changes Unrelated to Technology." Below those numbers are the effects of sectoral bias in technological change that is not accompanied by any price changes. These are just the regressions of TFP growth on factor shares. In this 1961-1971 period, technological change worked slightly against labor, and very much in favor of capital. . The sum of these two sets of numbers are reported next in the same column. Thus the total mandated change in labor earnings is 1.28% per year, mostly due to the positive g-effect. Capital had a much higher mandated earnings growth of 6.02% per year, with a very large technological effect offsetting a large g-effect. If, on the other hand, the pass-through rate is 100% and any technological improvement also lowers prices by 100% of the TFP growth, then the TFP effect on earnings is neutral across factors and equal to the average TFP improvement in that decade of .83%. After adjusting for the TFP effect on prices, the mandated growth in wages due to the g-effect is reduced to 1.28%.. Thus, although the choice of pass-through rate does not much affect the total mandated earnings in 1961-1971, it does affect the separation into t-effects and g-effects.

The three-decades story is very evident in this table.

1960's: Capital intensive sectors experienced rapid technological improvement, but also relative price reductions. These offsetting effects left both labor and capital with improving conditions.

1970's: Wage levels were under downward pressure in 1970's, entirely because of product price changes that strongly worked against labor.

1980's: Technological change worked strongly against labor. Whether the pass-through rate is low or high, the total mandated wage increases were modest , positive if high and negative if low.

Table 7 has the same analysis with labor categories divided into high-wage and low-wage subcategories. The mandated wage changes from this table are depicted in Figure 25. Here again the three-decades story emerges clearly. The decade of the 1970's is when the g-effect (non-TFP) worked strongly against low-wage workers. This was offset by favorable conditions in the 1980's. This conclusion is not at all affected by the pass-through rate. High-wage workers had smaller mandated wage changes with gains in the 1960's offset by losses in the 1980's. The division of the total losses in the 1980's depends critically on the pass-through rate, with the g-effect dominating for high pass-through rates and the t-effect dominating for low pass-through rates.

Finally, Table 8 and Figure 26 report the same analysis for production/nonproduction subcategories of labor. The conclusions suggested by this table are somewhat different. The pattern of the total effects for production workers is similar to the pattern for low-wage workers but the nonproduction workers have positive mandated wage increases in all three decades unlike high-wage workers who had negative values for the 1980's. For the zero pass-through rate, much more of the action is on the technology side; in particular the loss suffered by production workers in the 1970's is attributable to technology not globalization. The reverse conclusion applies if the pass-through is 100% where the action is all due to globalization. With zero pass-through, technological change is working against production workers and in favor of nonproduction workers, except in the 1980's when both kinds of labor suffered from sectoral bias the technological change. (Is that corporate downsizing?)

Thus the conclusions that g-effects dominate t-effects and that the 1970's was the Stolper-Samuelson decade with product price changes causing increases in inequality are found in three of the four cases, the exception being the estimates applicable to production/nonproduction workers using a 0% pass-through. In that case it is the t-effects that dominate. In that case the globalization effect worked to the advantage of production workers in the 1970's.

Appendix: **Documentation of data base used in Section 3.**

Aug 24, 1994
Productivity Database
Eric J. Bartelsman and Wayne B. Gray

***PRELIMINARY AND INCOMPLETE DOCUMENTATION. NBER Technical WP will follow.

This database contains annual information on 450 manufacturing industries from 1958 to 1991. The industries are those defined in the 1972 Standard Industrial Classification, and cover the entire manufacturing sector. Much of the data is taken from the Annual Surveys of Manufactures and Censuses of Manufactures, with the remainder created based on information from various government agencies. The initial version of the data was developed as a joint project by the University of Pennsylvania, the Bureau of the Census, and SRI, Inc., covering the 1958-1976 period (and is referred to herein as the PCS dataset). The data has been extended to 1991 with new versions of some of the variables, although the basic information contained has not been changed.

If you have further questions about these data, or find problems with them, please contact Wayne Gray at (617)868-3900 (the National Bureau of Economic Research) or (508)793-7693 (Clark University), or Eric Bartelsman at 1mejb00@fed.frb.gov.

Variable Descriptions and Comments

SIC, YEAR - identify each observation in the dataset (SIC ranges from 2011 to 3999 and YEAR ranges from 58 to 91)

EMP - number of employees (in 1,000s) - does not include employees in auxiliary (administrative) units

PAY - total payroll (millions of dollars) - does not include social security or other legally mandated payments, or employer payments for some fringe benefits.

PRODE - number of production workers (in 1,000s)

PRODH - number of production worker hours (in millions of hours)

PRODW - production worker wages (millions of dollars)

VADD - value added by manufacture (millions of dollars; equals shipments - materials + inventory change)

MATCOST - cost of materials (millions of dollars) - includes energy spending, so to calculate spending on non-energy materials one must use (MATCOST-ENERGY)

ENERGY - expenditures on purchased fuels and electrical energy (millions of dollars)

VSHIP - value of industry shipments (millions of dollars; not adjusted for inventory changes)

INVENT - end-of-year inventories (millions of dollars; pre-1982 based on any generally accepted accounting method; 1982+ based either at cost or at market, with LIFO users asked to report pre-adjustment values)

INVEST - new capital spending (millions of dollars; combines spending on structures and equipment)

CAP - real capital stock (millions of 1987 dollars, equals (EQUIP + PLANT))

EQUIP - real equipment capital stock (millions of 1987 dollars)

PLANT - real structures capital stock (millions of 1987 dollars)

PISHIP - price deflator for value of shipments (equals 1 in 1987)

PIMAT - price deflator for materials (1 in 1987; all materials, not just non-energy materials)

PIEN - price deflator for energy (1 in 1987)

PIINV - price deflator for new investment (1 in 1987; combines deflators for structures and equipment)

TFP - five-factor total factor productivity growth (calculated from other variables; expressed as annual growth rate)

APPENDIX 2 Derivation of the Labor Demand Curves

The key building block of the Heckscher-Ohlin model is the Lerner-Pearce diagram, **Figure A1**, which illustrates the relationship between goods prices and factor prices. In this diagram there are unit value isoquants for two hypothetical products, a labor-intensive good labelled apparel and a capital-intensive good labelled machinery. These unit value isoquants indicate combinations of capital and labor that are required to produce a unit value of the good. "Tangent" to these two unit-value isoquants is a straight line which is the only unit isocost line satisfying a zero-profit condition in both goods. The equation for this unit isocost is $1 = wL + rK$ where L and K are labor and capital inputs and w and r are the corresponding factor prices. From this equation one can solve for the intersections with the axes of this unit isoquant. On the horizontal axis is the inverse of the wage rate ($1/w$) and on the vertical axis is the inverse of the rental rate on capital ($1/r$). Perhaps without the reader's full awareness, this has established the Factor Price Equalization Theorem, which I prefer to call the Factor Price Insensitivity Theorem: Factor prices depend on product prices but not on factor supplies. In other words, the long-run demand for labor in a small open economy is infinitely elastic.

Also in this diagram is the parallelogram indicating the allocation of capital and labor between the two industries, with input ratios conforming to the technologically fixed input ratios in each industries. (Nothing of substance hinges on substitutability of inputs at the level of the industry.) From straightforward manipulation of this parallelogram, one can derive the Rybczynski theorem: An increase in labor supply increases output of the labor-intensive good and decreases output of the capital-intensive good. Thus even as the economy is growing, one output is declining. It is this extreme shift in output mix that allows the labor demand of the economy to be infinitely elastic.

It is also easy to see from Figure A1 that a reduction of the price of apparel causes a decline in the wage rate. A reduction of the apparel price makes the apparel unit-value isoquant shift outward - it takes more capital and labor to produce a unit value of apparel. This shifting outward of the apparel unit-value isoquant shifts the intersection of the unit cost line to the right, and thus selects a lower wage rate. This is the familiar Stolper-Samuelson Theorem.

Figure A2 allows a third factor and more goods into the model. Triangular displays of this kind have been used in Leamer(1987) to discuss alternative paths of development. Here each vertex represents one of the three factors (unskilled workers, skilled workers, and physical capital). A movement in the triangle directly toward one of the vertices corresponds to an increase in that factor, holding fixed the other two. In the diagram are three products that use no skilled workers and that use an increasing amount of physical capital: apparel, textiles and steel. One product uses all three inputs (chemicals/aircraft) and one uses only physical capital and skilled workers (software). The message of the model is not hurt by the fact that these characterizations are suggestive but far from accurate.

Figure A2 is completed by connecting the product points with straight lines to form "cones of diversification."[1]. These cones select countries with sufficiently similar factor supply ratios that they have the same factor prices and output mix. In this diagram, movement toward a vertex corresponds to an increase in the supply of the factor, which cannot raise the return to that factor. In other words, the demand for a factor is not upward sloping. This implies that the triangle of diversification formed by the apparel, textiles and aircraft points has the lowest wages. The product mix with steel, textiles and aircraft has higher wages for the unskilled and the product mix of software, steel and aircraft has the highest wages. Thus the labelling of three cones of diversification as "low", "medium" and "high", refering to the level of wages of unskilled workers.

With this as the model, Figure 6 illustrates the demand for unskilled labor of two hypothetical countries with different ratios of skilled to unskilled workers. The horizontal axis for this demand curve is, as before, the ratio of unskilled labor to physical capital. These two demand curves correspond with the two arrows pointing toward the physical capital vertex in Figure A2. The skill abundant country with the arrow closer to the skilled worker vertex in Figure A2 exits the low-wage cone at a relatively low ratio of unskilled workers to physical capital. It also enters the highest wage cone at a relatively low ratio of unskilled to skilled.

We can also use Figure A2 to make some remarks about increased capital mobility. The cone that has the highest wages for unskilled workers also has the lowest return to physical capital. Suppose that globalization means not just integration of the goods markets and equalization of goods prices, but also freedom for capital to find locations on the globe with the highest rates of return. Then capital will flow out of the high-wage countries located in the software:steel:chemicals/aircraft cone and into countries located in the cones with higher returns to physical capital. As capital leaves the high-wage cones, the factor supply is dragged away from the physical capital vertex in Figure A2. Now there are two possibilities. If the supply of skilled workers is relatively small compared with unskilled workers, this loss of capital drags the factor endowment point through the moderate wage steel:textiles:chemicals/aircraft cone and into the very low-wage textiles:apparel:chemicals/aircraft cone. But if the supply of skilled workers is great enough, loss of capital can drag the country away from the physical capital vertex along the path depicted in Figure A2. This country <u>doesn't</u> get dragged into cones with lower wages. Instead, it loses the steel sector, specializes in the skill intensive sectors, software and chemicals/aircraft. This country competes in chemicals/aircraft against the low-wage countries but does so by offsetting its cost disadvantage at low skills with cost advantages at high skills. In other words, it opts for high wages for low-skilled workers and a low premium for skills. Thus, at least in this model, the assault on income equality represented by capital mobility toward the low-wage developing regions can be completely met by

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[1] The way that the diagram is divided depends on product prices. Implicitly it has been assumed that aircraft has a high enough price that it advantageous to produce it everywhere in the world, and therefore all the other product points are connected with lines to the aircraft point.

educational investments which attract capital by lowering the cost of complementary skilled inputs. This lower private return to skills reduces the attractiveness of investments in skills. In the longer run, human capital in a skill-abundant country can be turned into more productive investments in physical assets in the emerging regions, thus dragging the country "round the bend" into the low-wage cone.

The next topic is the trade deficit and the "overvaluation" of the dollar. In order to think about the possible effects of a trade deficit and also issues of product choice this simple model needs **nontraded goods** whose prices can be influenced by local demand. **Figures A3 and A4** are Lerner-Pearce diagrams with a labor-intensive nontradable. In Figure **A3** wages and the return to capital are determined externally, and these factor prices select the price of nontradables from the nontradables zero profit condition. In Figure **A4**, the demand for nontradables is too great at that externally determined price to leave enough labor for the tradables sector to allow the production of both apparel and machinery. The economy accordingly fully specializes in machinery production, and chokes off demand for the nontradable with relatively high nontradable prices. This selects a high-wage equilibrium with a concentrated mix of tradables. There is also a low-wage equilibrium in which the economy produces only apparel and the nontradable.

These ideas are summarized in the labor demand function with nontraded goods illustrated in **Figure 8**. This demand curve has an interval of infinite elasticity selected when the country produces both goods. In this interval the two zero profit conditions can be used to solve for the two internal factor prices as a function of the two external product prices. These internal factor prices determine the price of nontraded goods from the nontraded goods zero-profit condition.. But if labor is very scarce or very abundant, the economy will fully specialize on one traded good and produce also the nontraded good.

Finally, **Figure A5** shows the effect of labor-saving technological change in the capital-intensive sector, which at constant product prices causes a reduction in wages from w to w'. If the supply of factors to the tradables sector is held fixed, relatively more capital and labor must be allocated to the apparel sector since the input mix in the machinery sector has become less like the factor supply vector. (Use Figure A1 to check this assertion.) The economy thus produces more machinery because of the technological improvement and more apparel because of the reallocation of the factors. Depending on which force dominates and also on the elasticities of demand, relative prices can go either way. If relative prices do vary, there will be technologically-induced Stolper-Samuelson effects.

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List of Figures

Appendix Figures

Gross Hourly Earnings of Manufacturing Production and Non-supervisory Workers and Trade Dependence (1960 $)

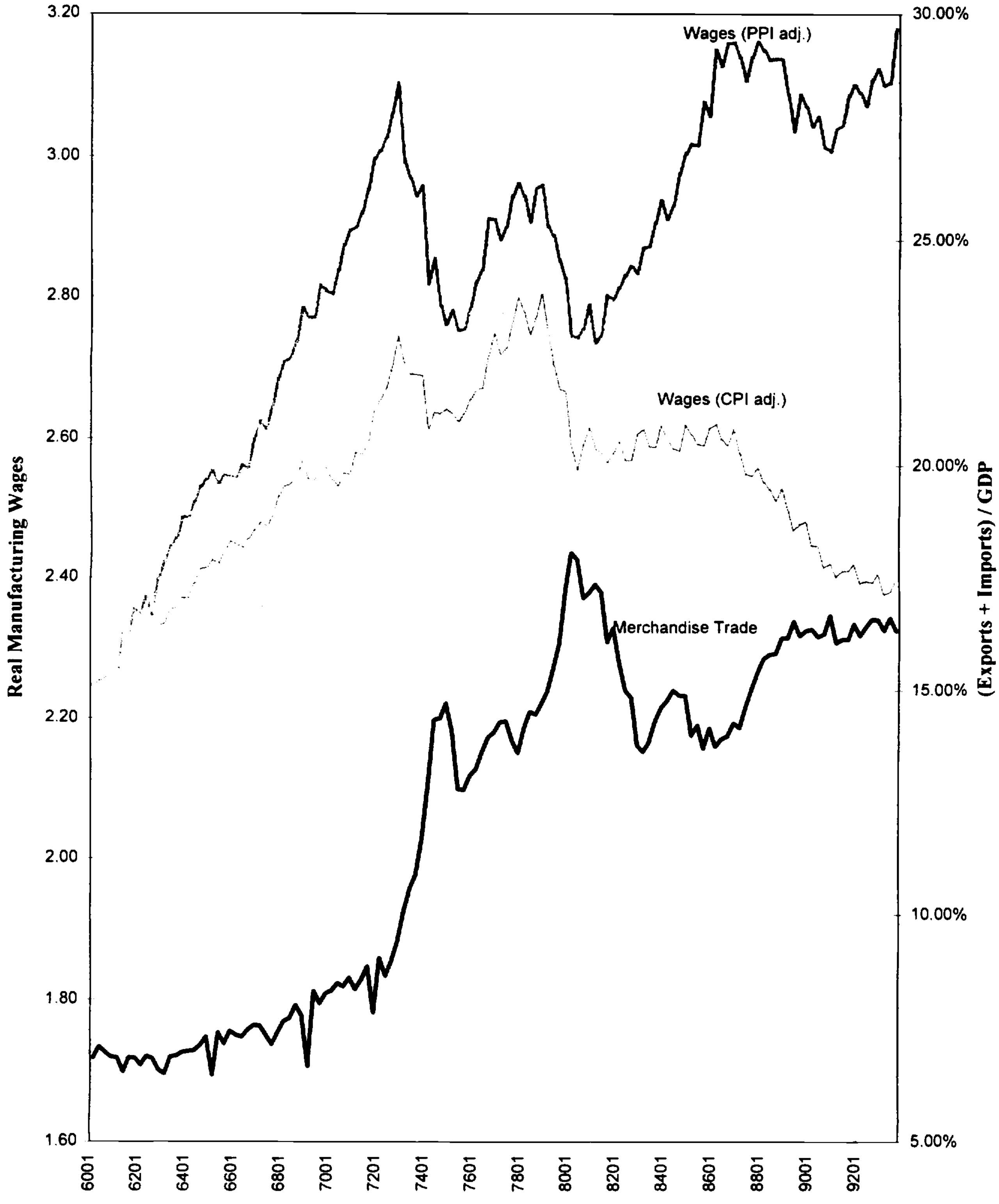


FIGURE 1

Industrial Wages and Population, 1989

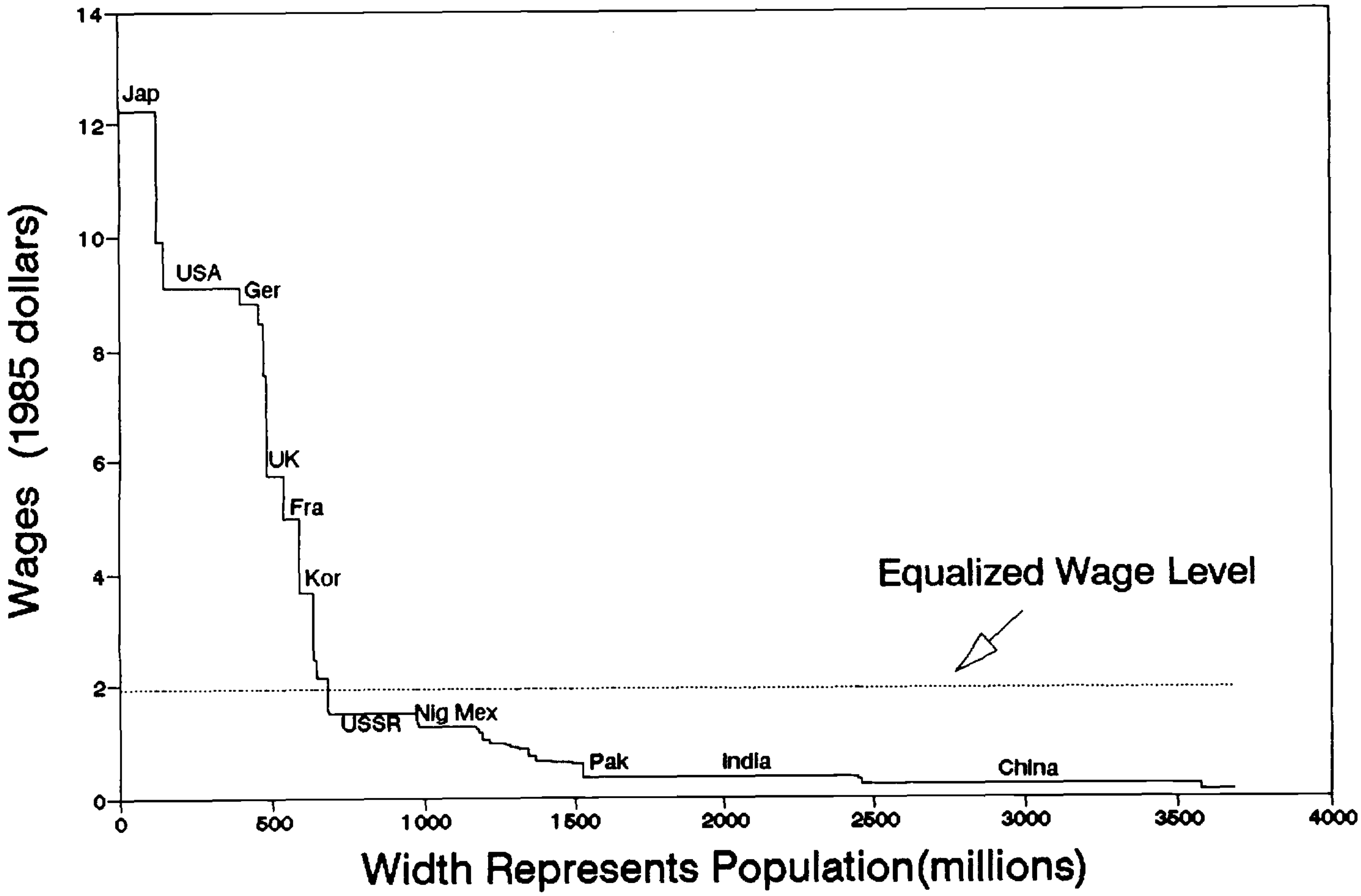


FIGURE 2

Labor Demand

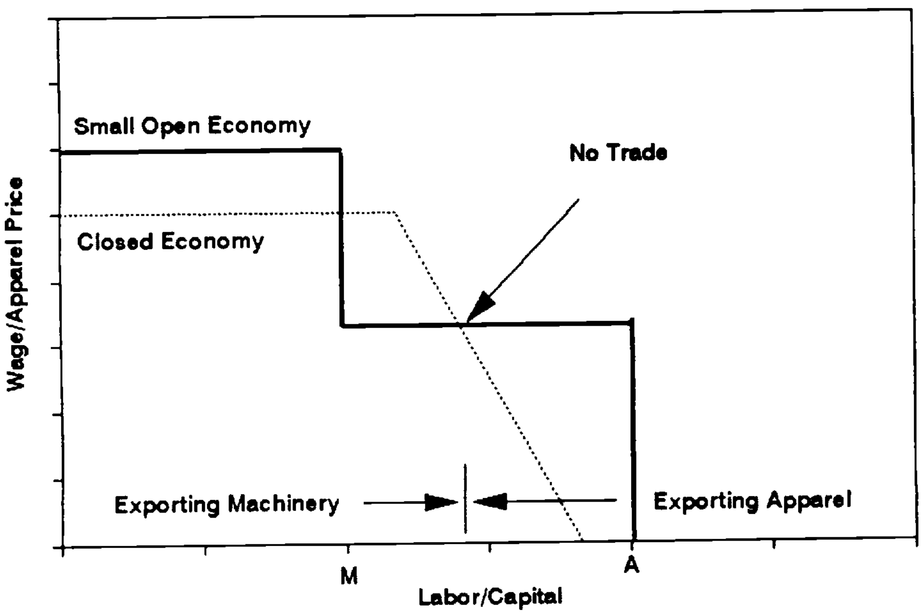


FIGURE 3

Globalization Effect

Reduced Relative Price of Apparel

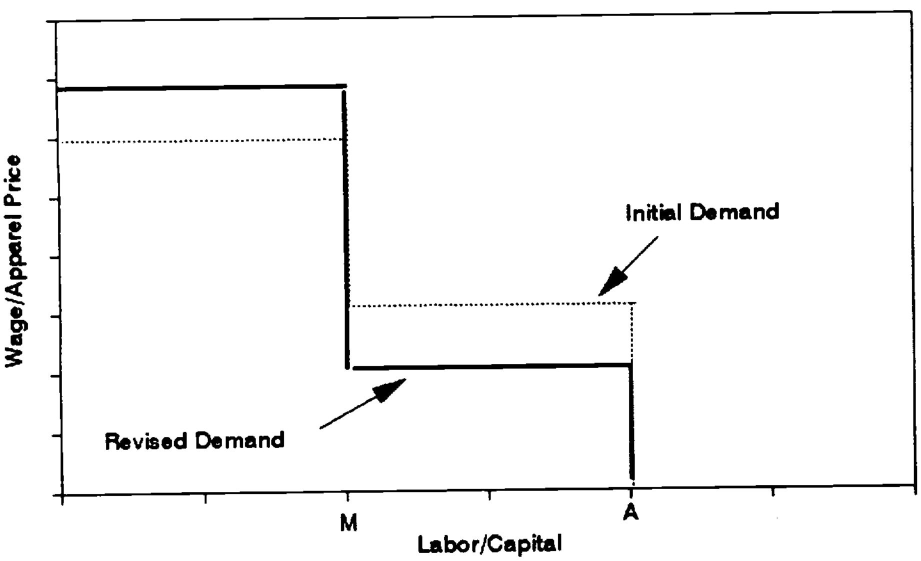


FIGURE 4

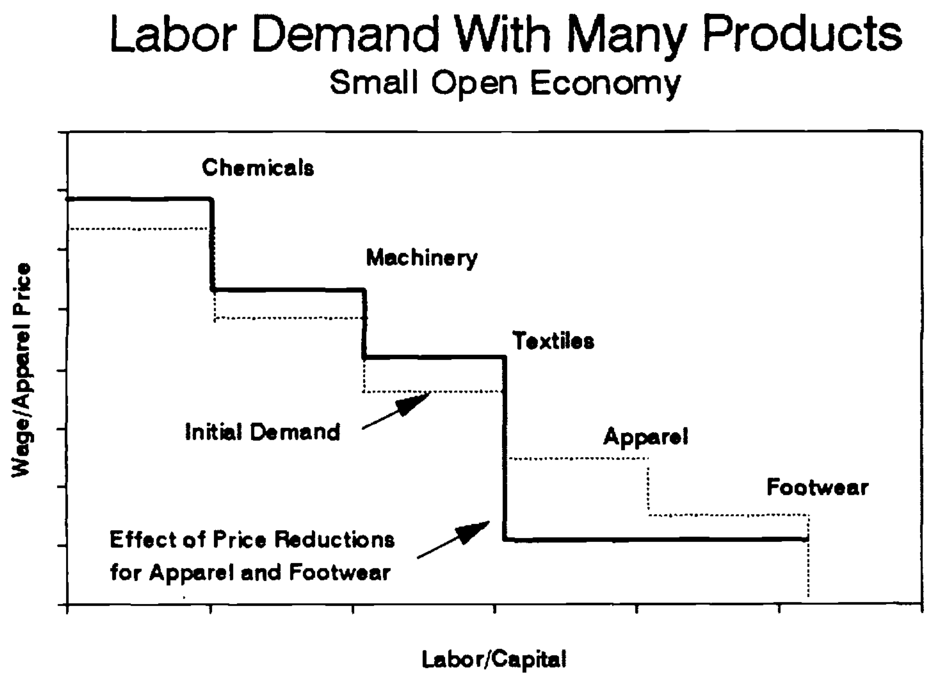


FIGURE 5

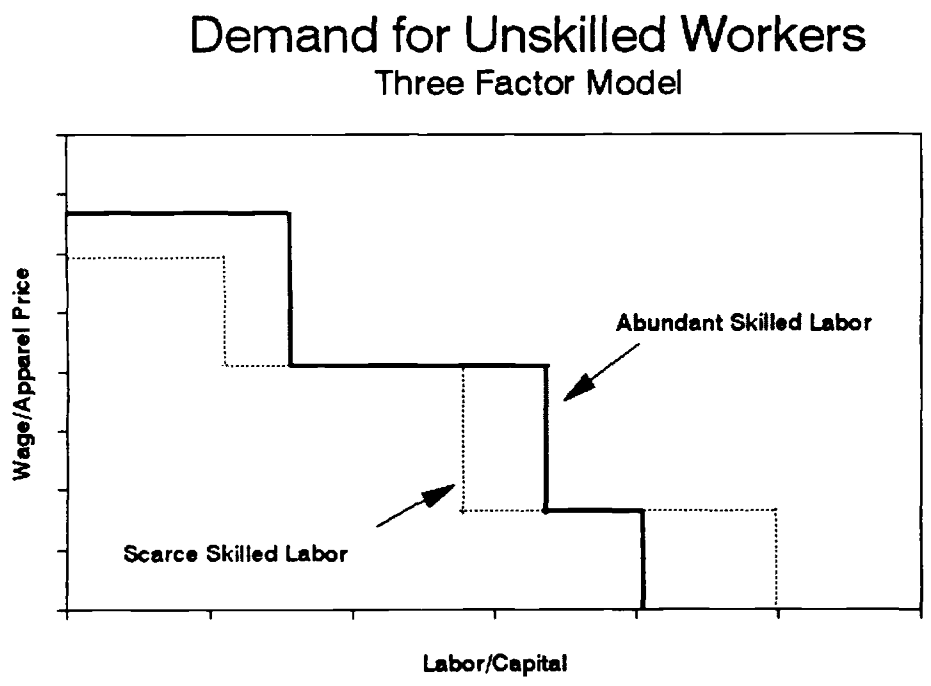


FIGURE 6

Demand for Labor
Labor-Intensive Nontradeables

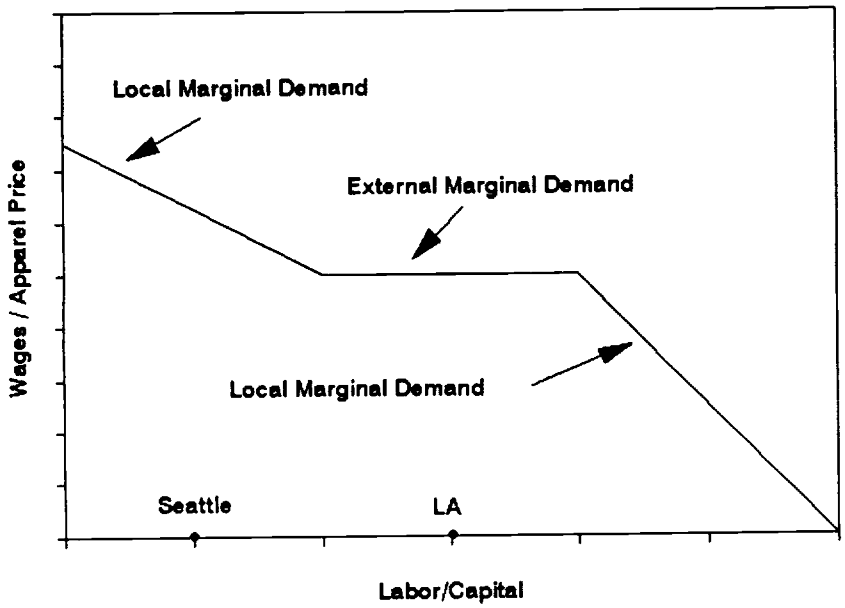


FIGURE 7

Demand for Labor
Effect of a Trade Deficit

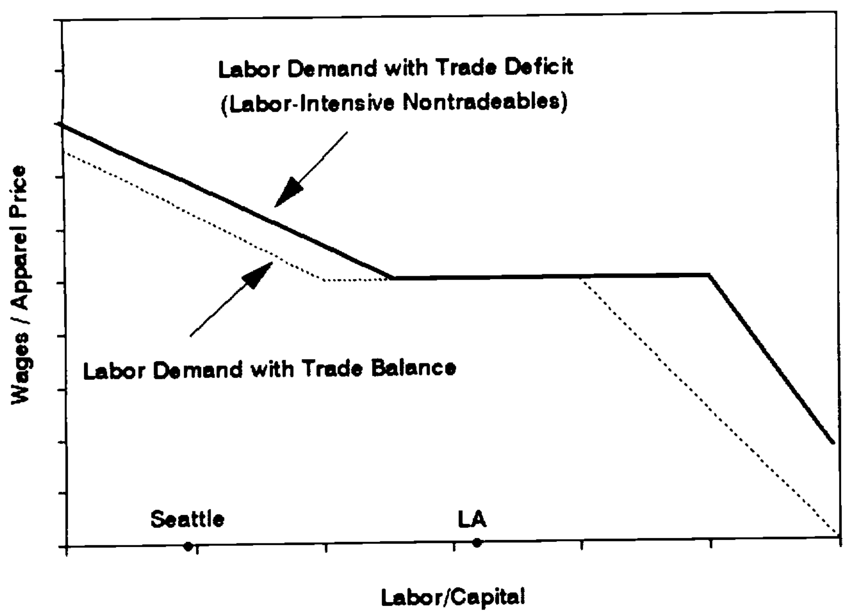


FIGURE 8

Demand for Labor

Effect of Technical Change

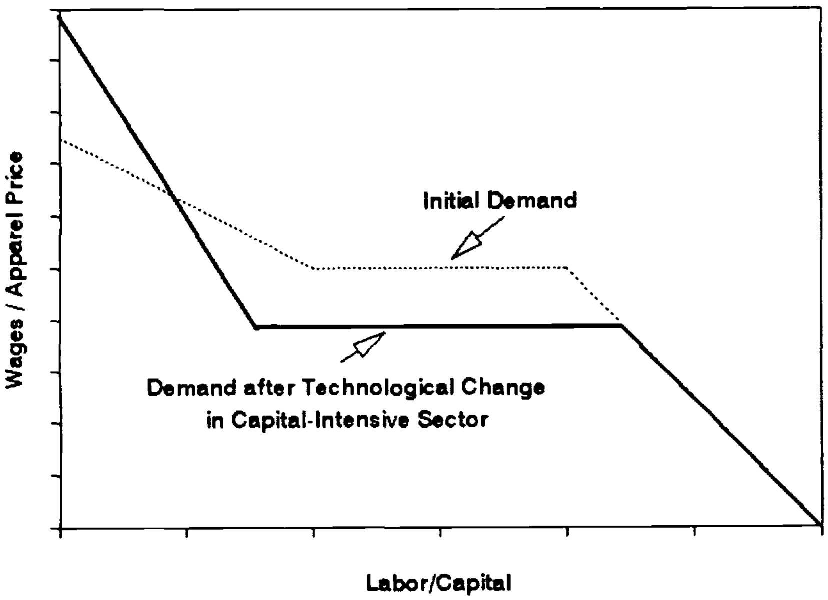
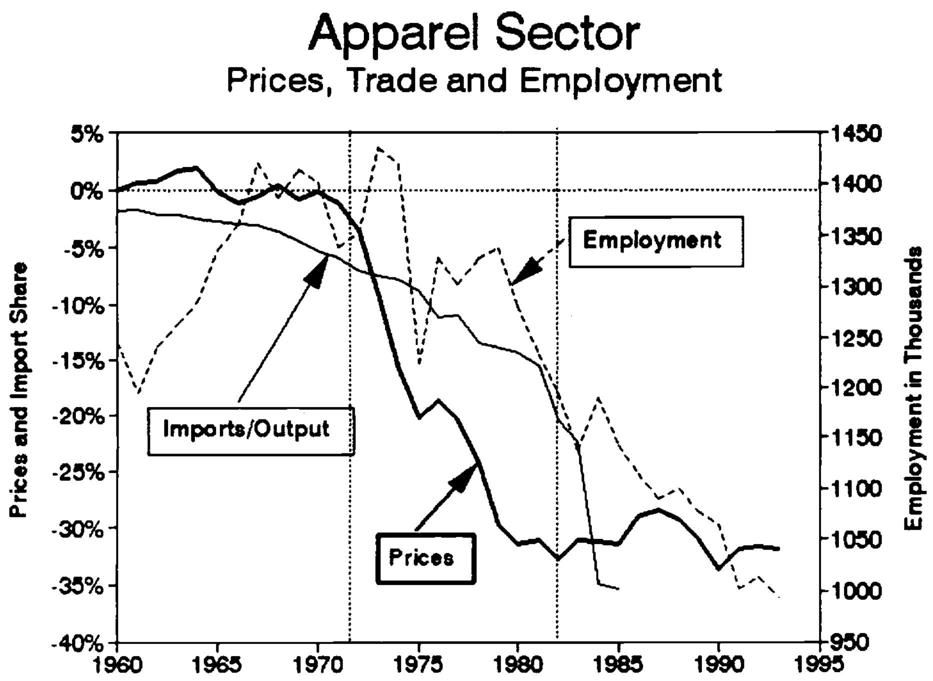


FIGURE
9



Apparel Sector
Prices, Trade and Employment
Prices and Import Share
Employment in Thousands
Employment
Imports/Output
Prices
5%
0%
-5%
-10%
-15%
-20%
-25%
-30%
-35%
-40%
1450
1400
1350
1300
1250
1200
1150
1100
1050
1000
950
1960
1965
1970
1975
1980
1985
1990
1995

FIGURE 10

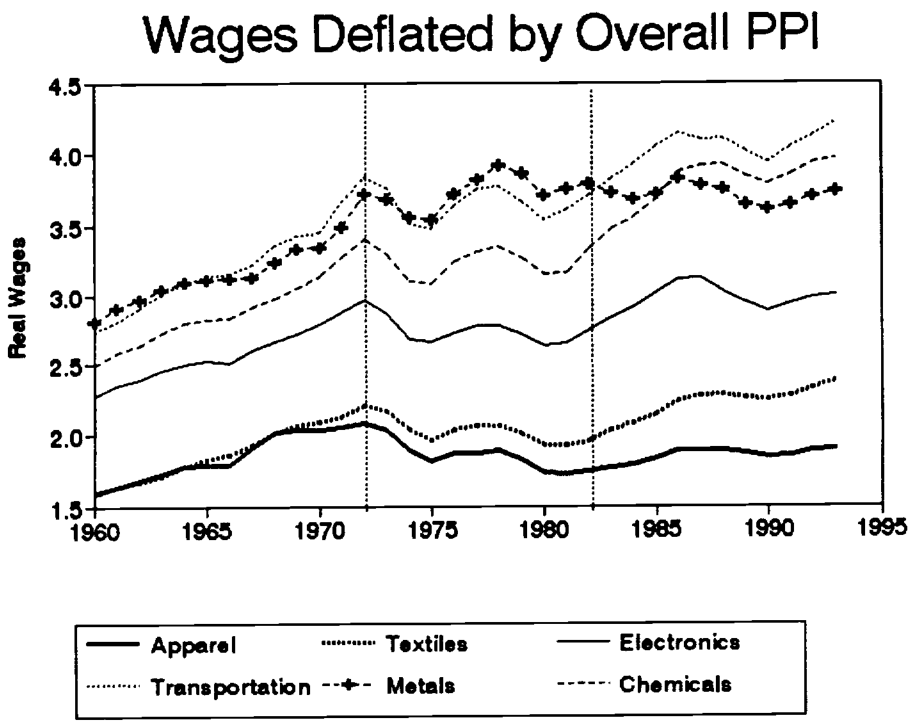


Figure 11

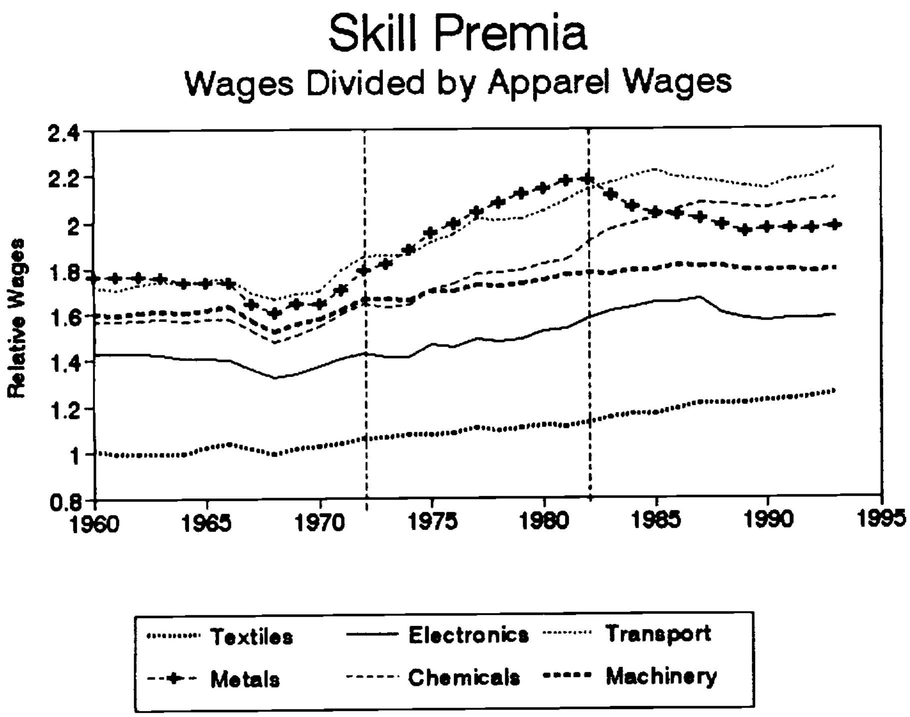
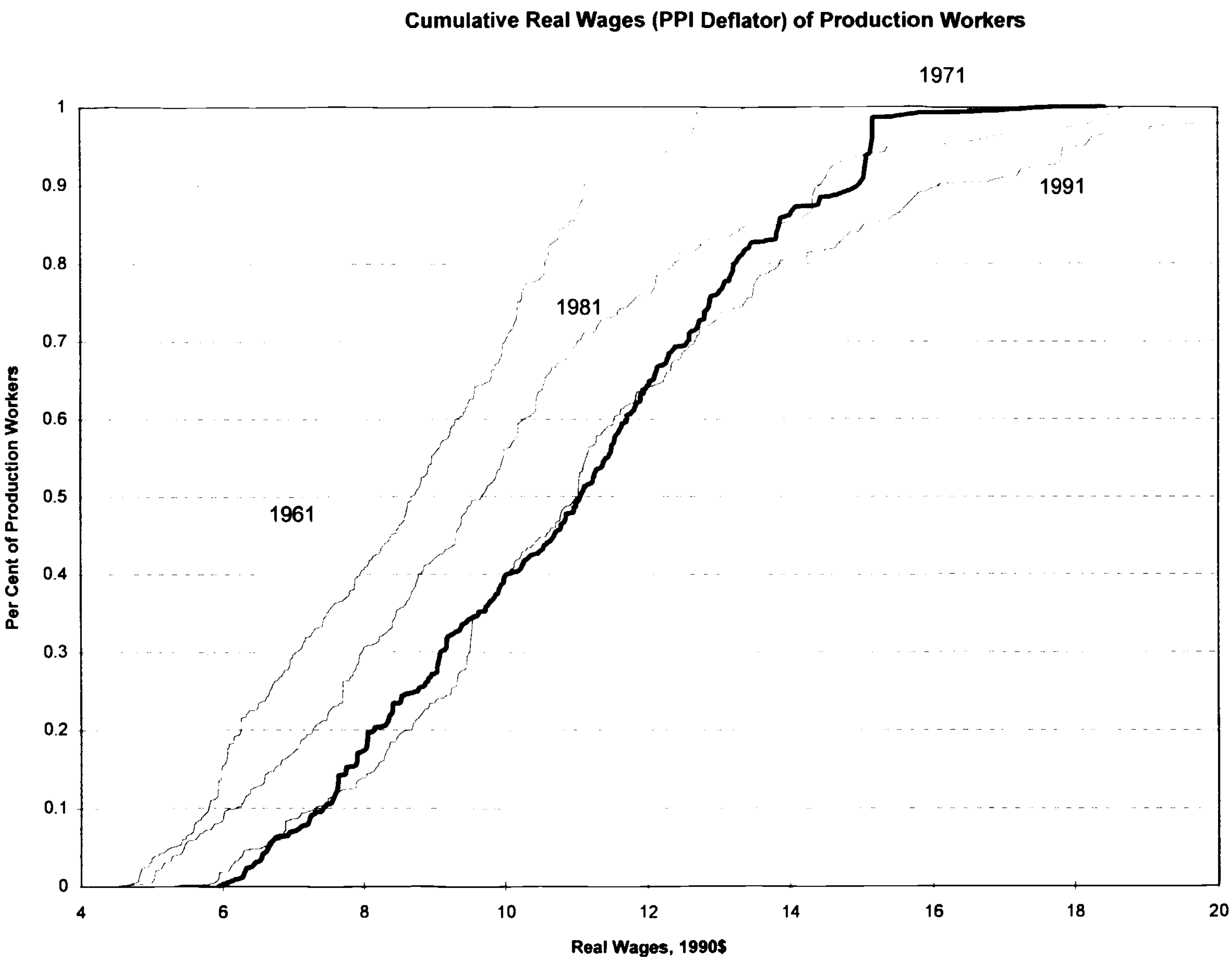
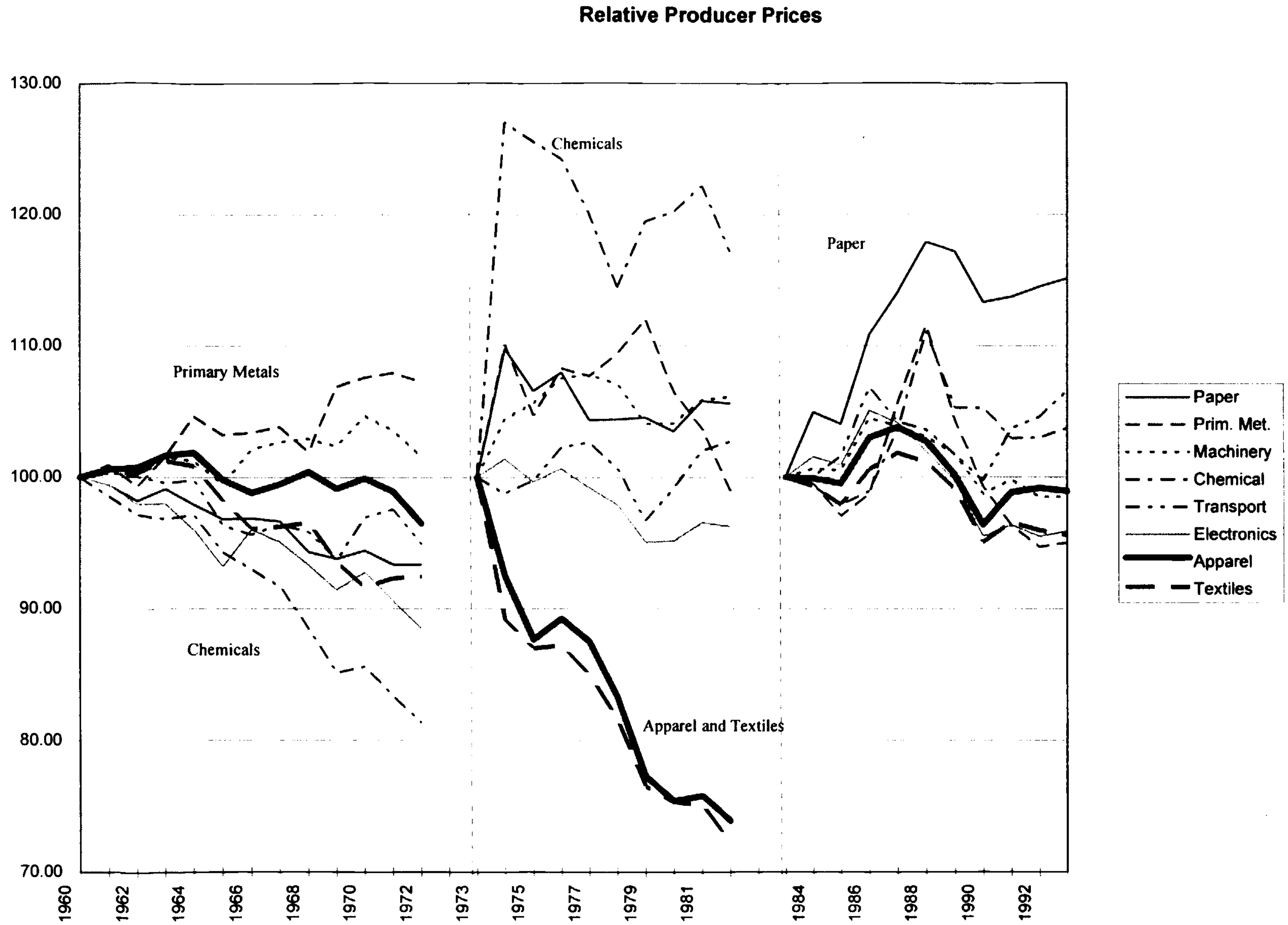


Figure 12

Figure 13



Cumulative Real Wages (PPI Deflator) of Production Workers
1971
1981
1961
1991
Per Cent of Production Workers
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
4
6
8
10
12
14
16
18
20
Real Wages, 1990$



Relative Producer Prices
130.00
120.00
110.00
100.00
90.00
80.00
70.00
1960
1962
1964
1966
1968
1970
1972
1973
1975
1977
1979
1981
1984
1986
1988
1990
1992
Chemicals
Paper
Primary Metals
Chemicals
Apparel and Textiles
Paper
Prim. Met.
Machinery
Chemical
Transport
Electronics
Apparel
Textiles

1965 Factor Supplies

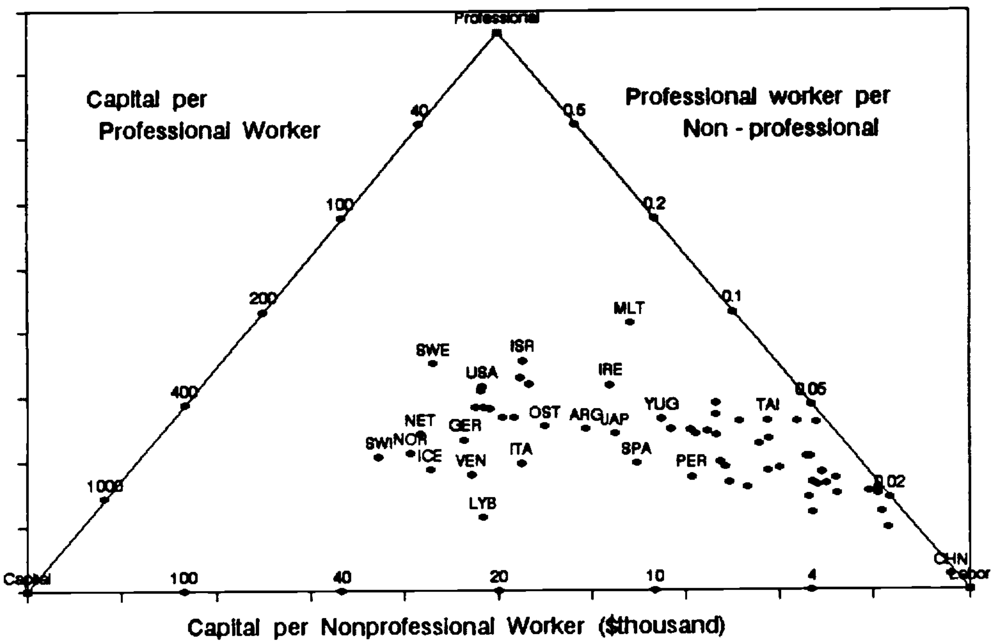


Figure 15

1988 Factor Supplies

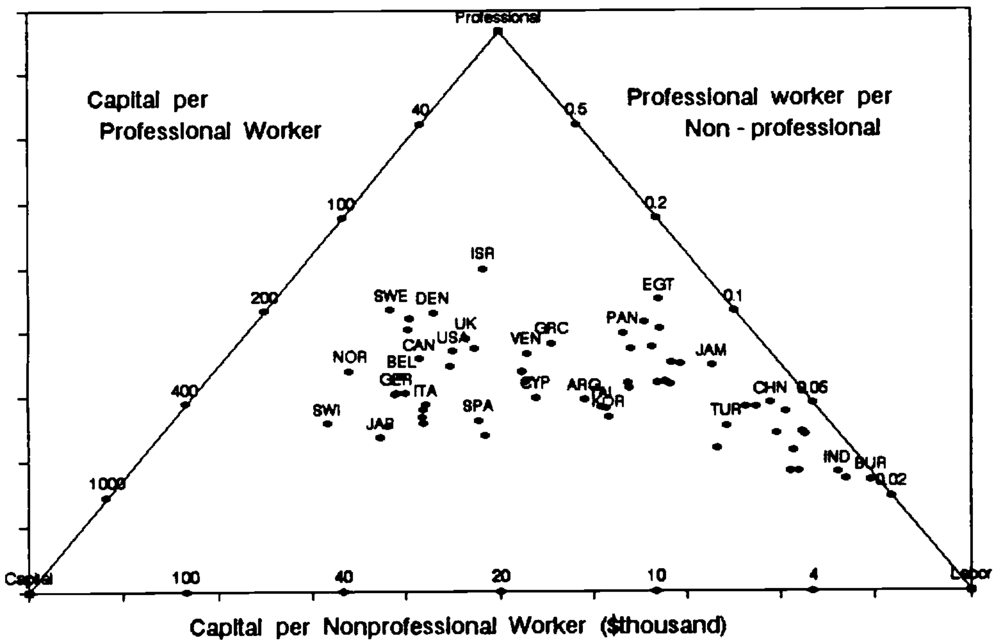


Figure 16

Labor-Intensive Net Exports Per Worker

Labor-Intensive Net Exports Per Worker

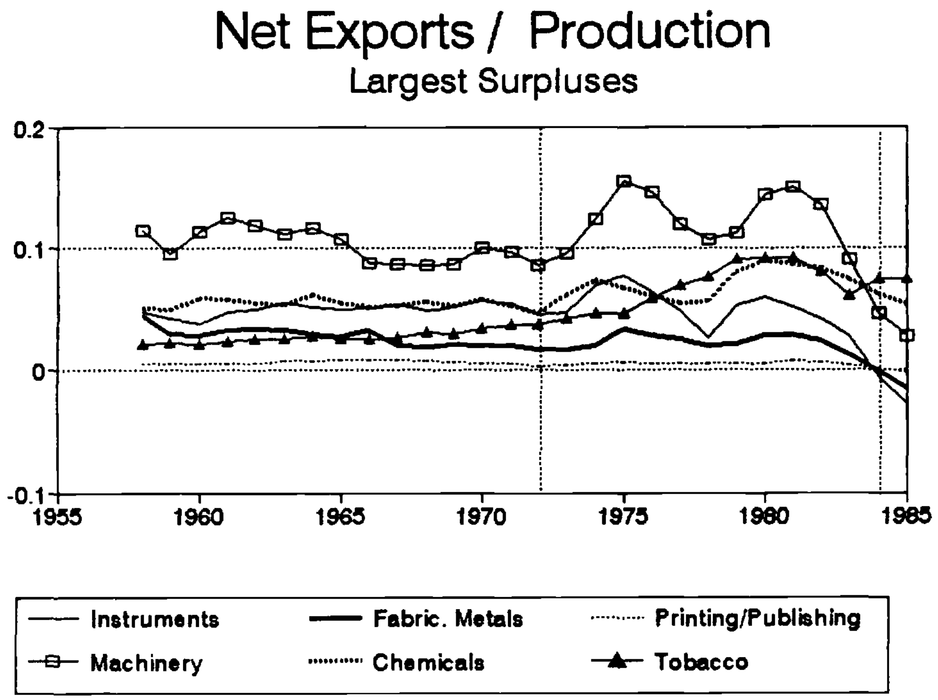


Figure 19

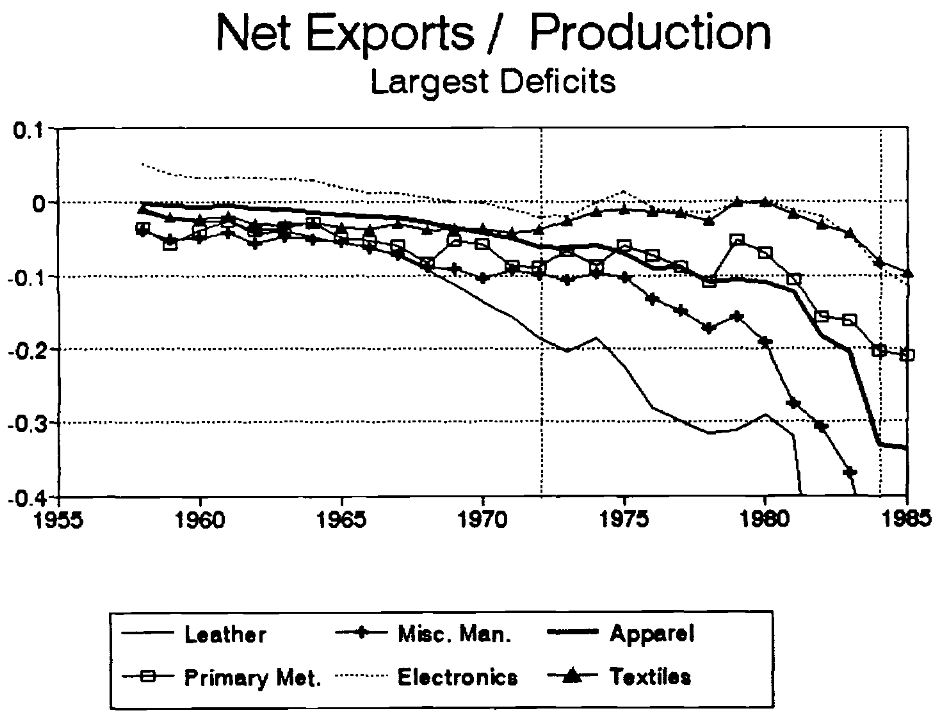


Figure 20

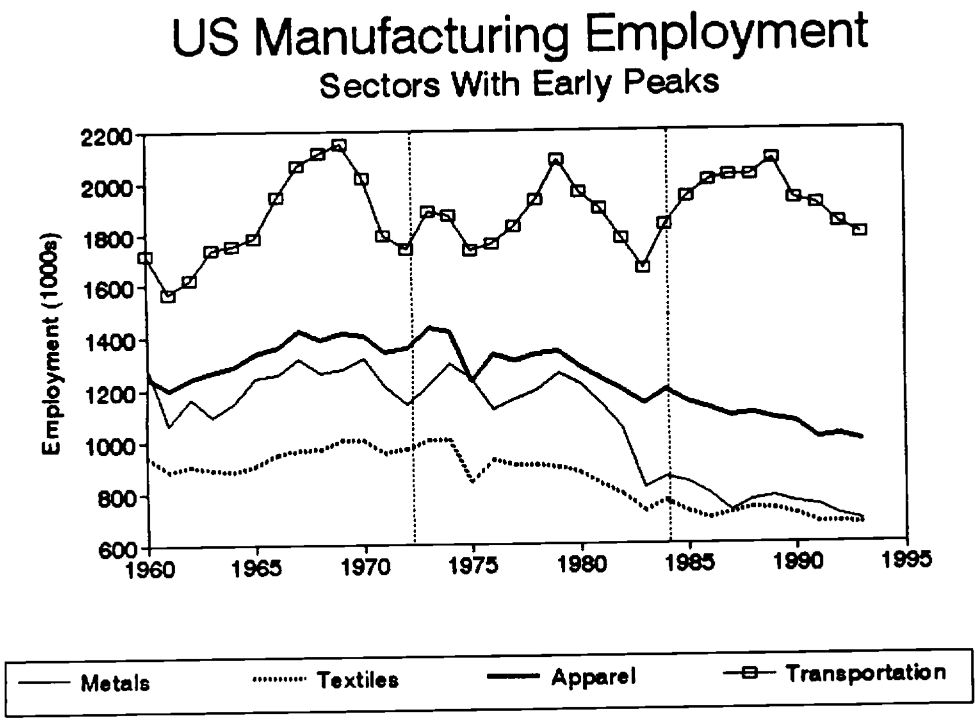


Figure 21

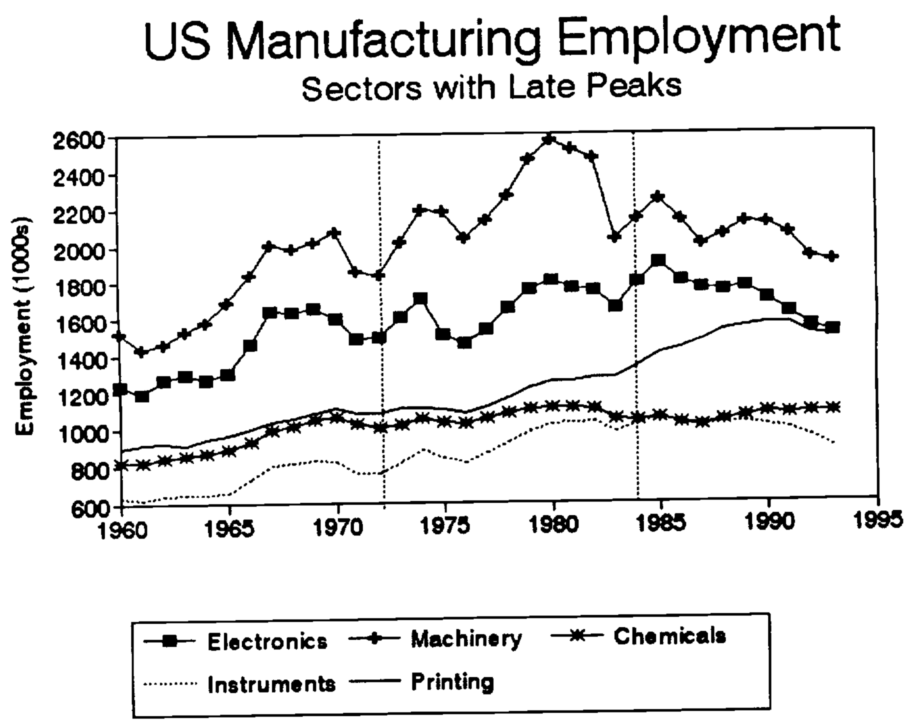
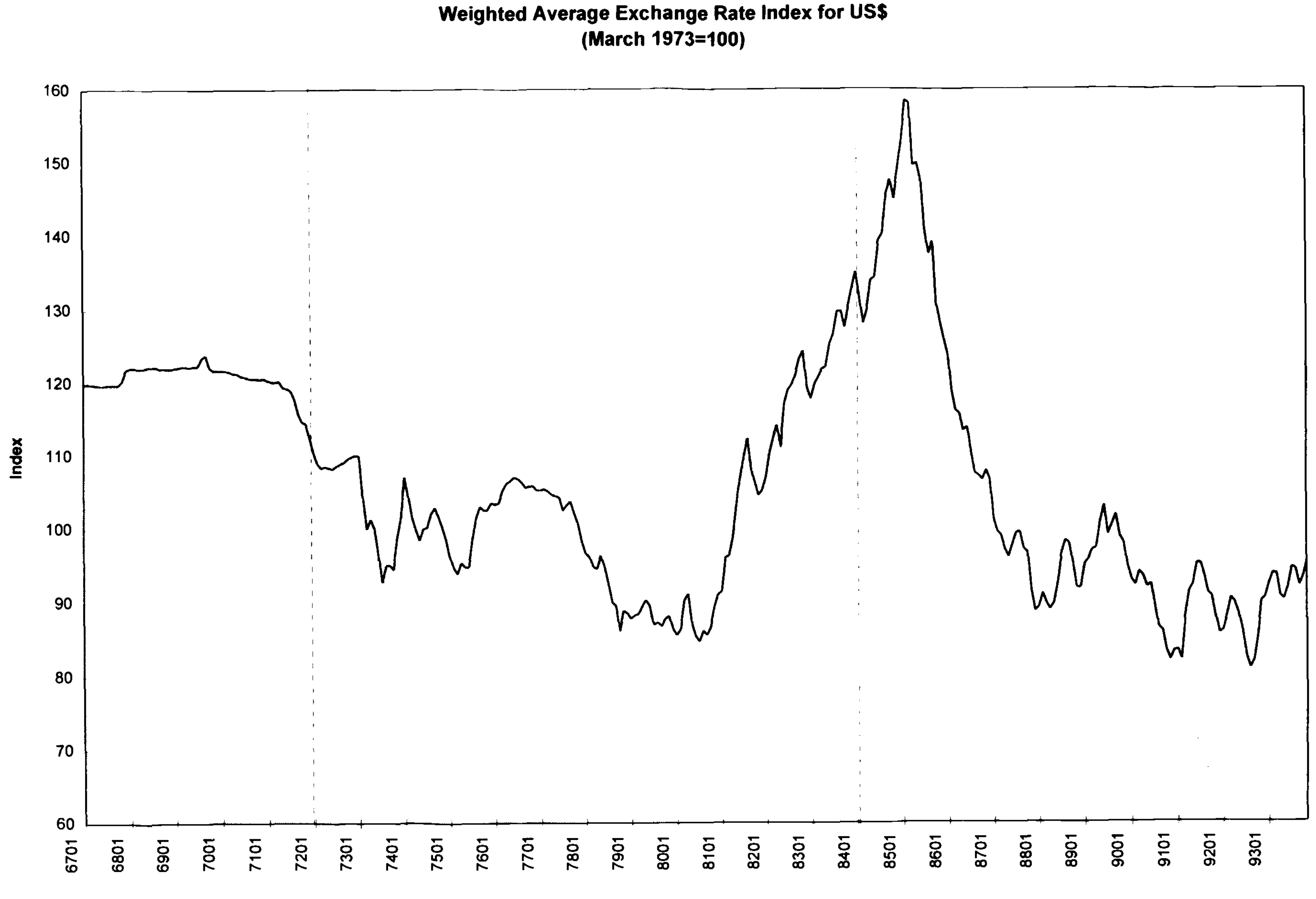


Figure 22


Weighted Average Exchange Rate Index for US$
(March 1973=100)
Index
160
150
140
130
120
110
100
90
80
70
60
6701
6801
6901
7001
7101
7201
7301
7401
7501
7601
7701
7801
7901
8001
8101
8201
8301
8401
8501
8601
8701
8801
8901
9001
9101
9201
9301

US Trade Surplus

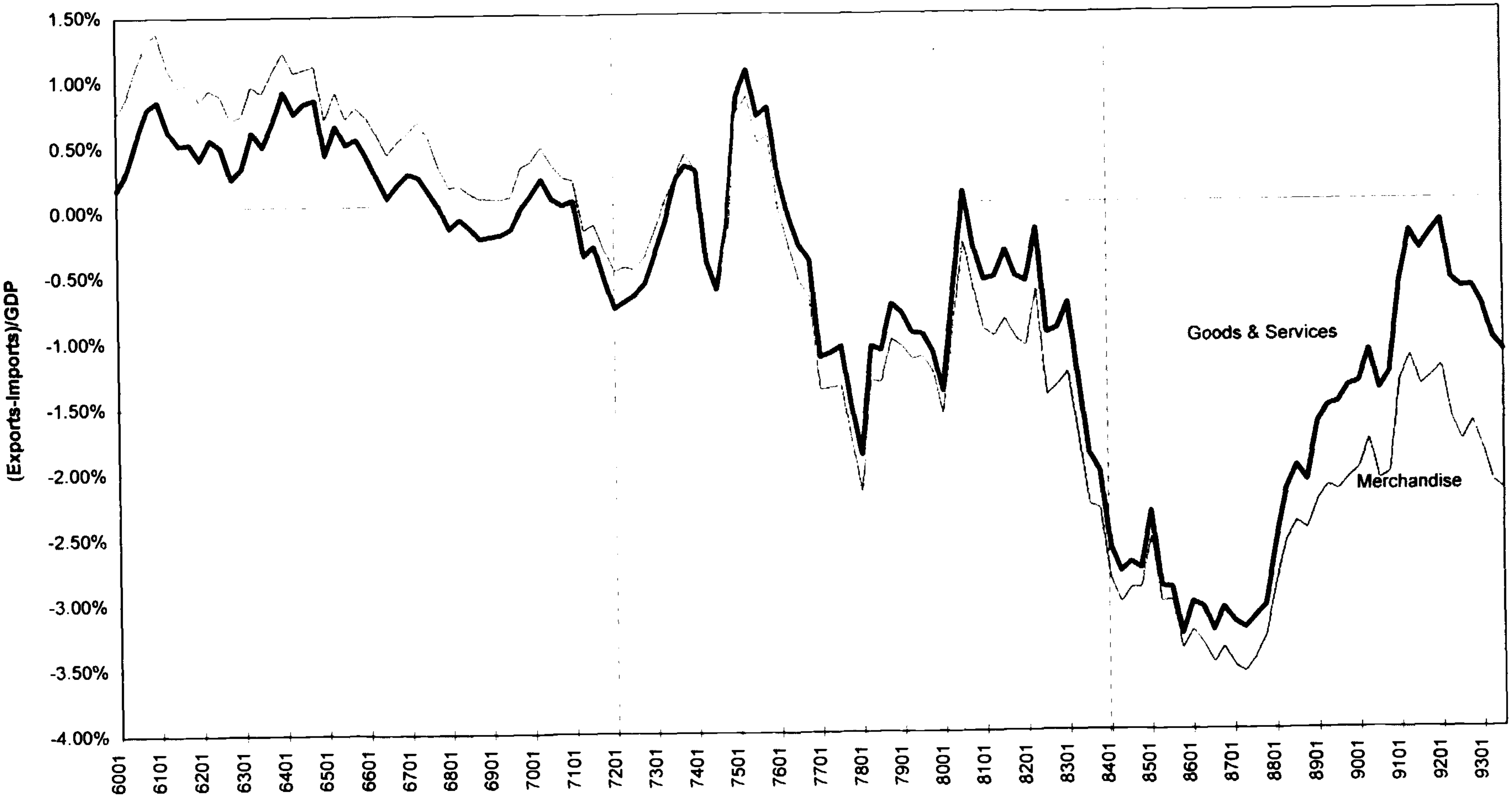
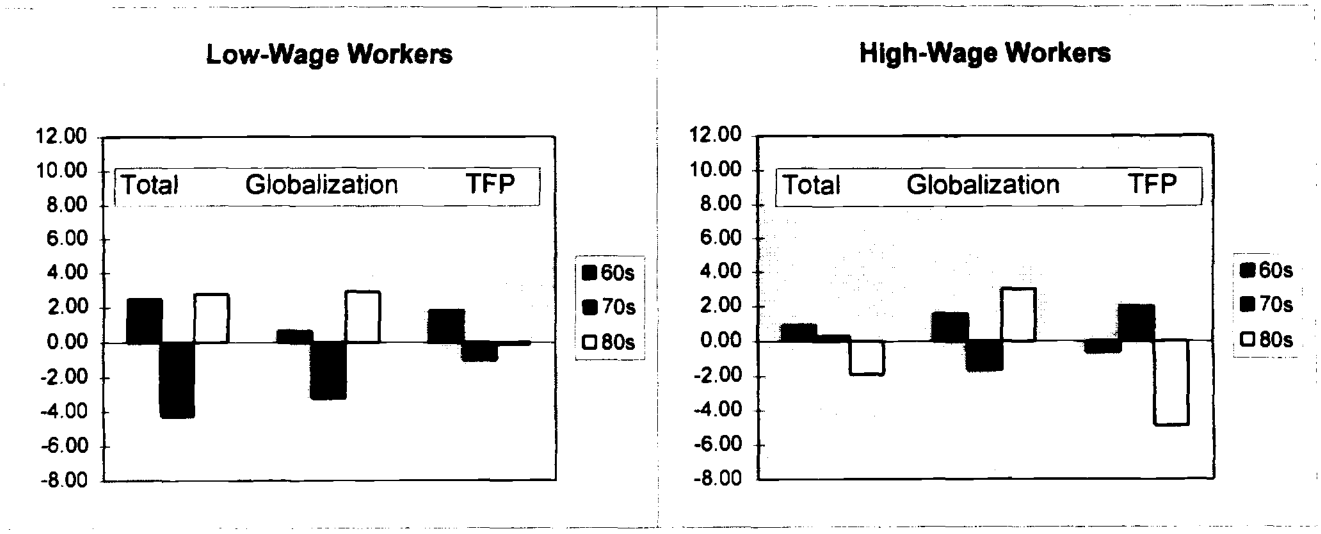


Figure 25

Mandated Wage Changes: 0% Pass-through



Mandated Wage Changes: 100% Pass-through

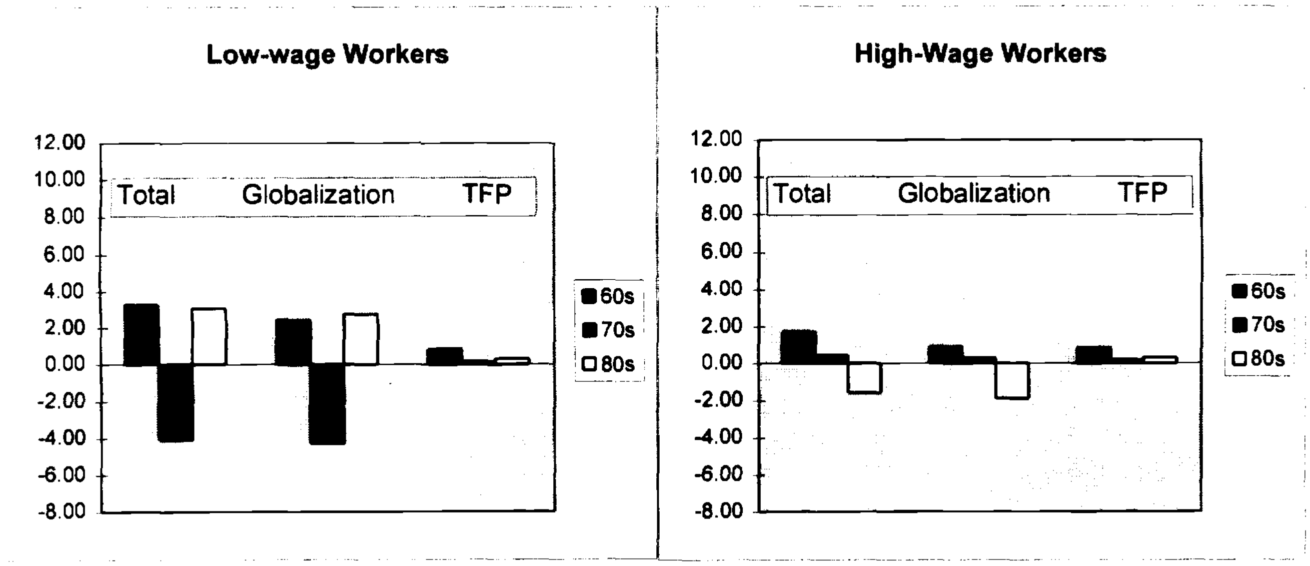
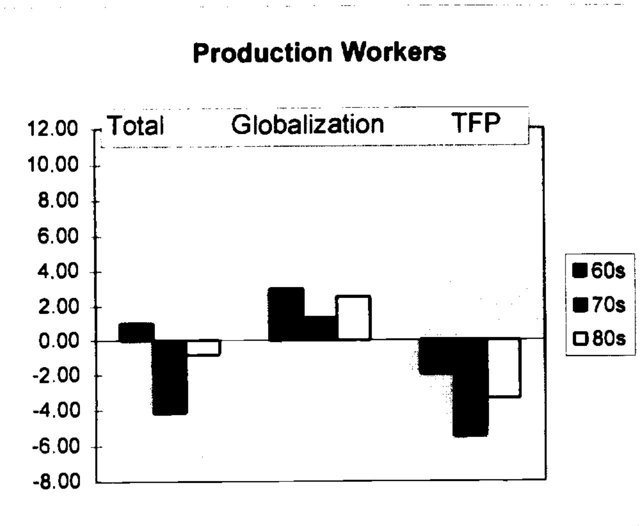
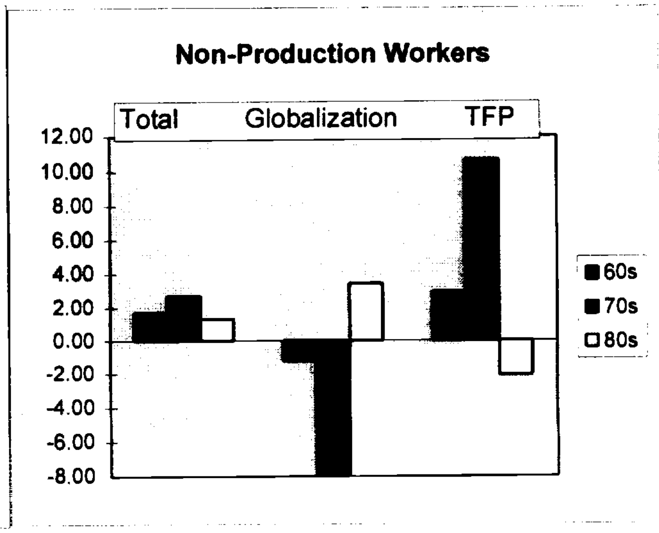


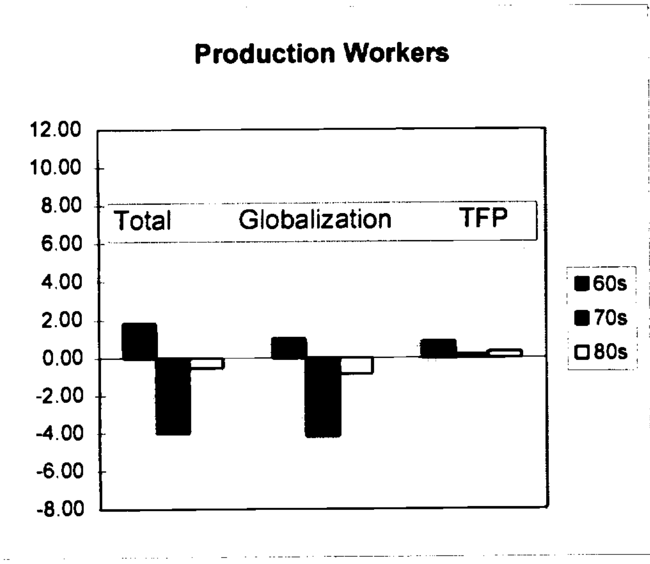
Figure 26

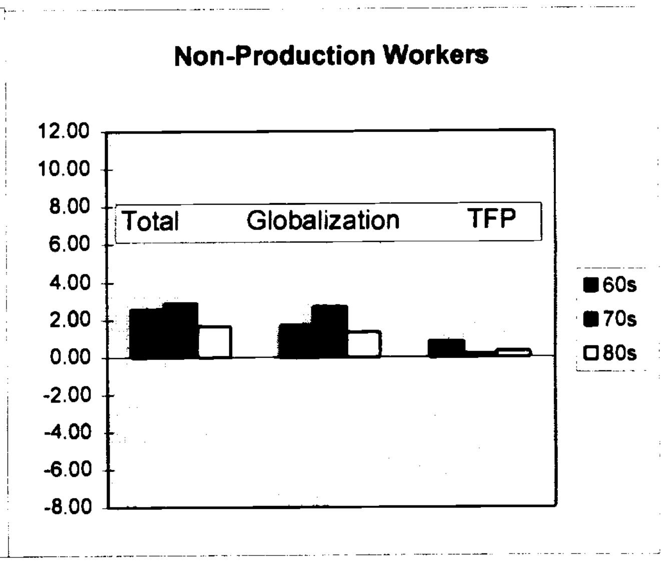
Mandated Wage Changes: 0% Pass-through





Mandated Wage Changes: 100% Pass-through





Lerner-Pearce Diagram

Fixed Input Technologies

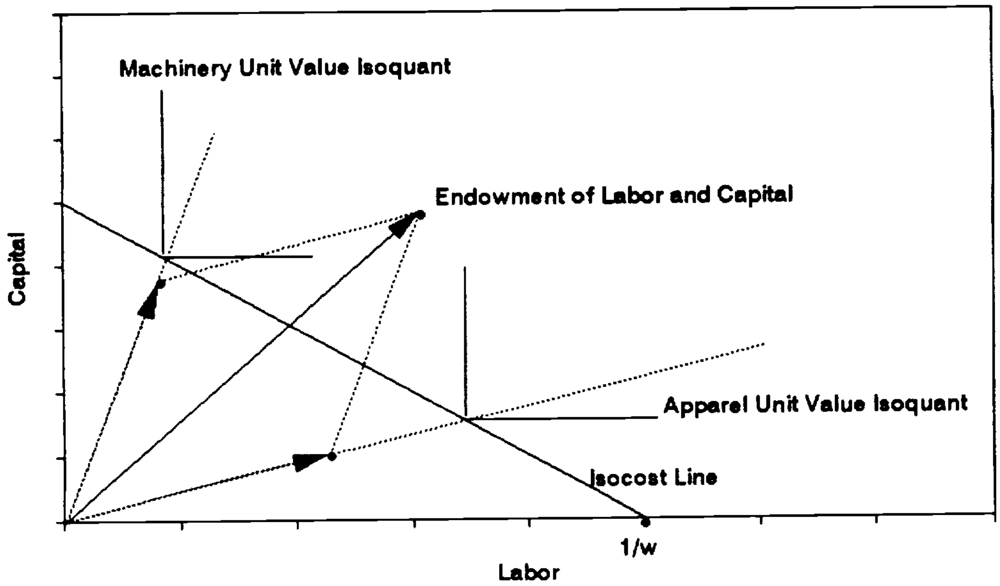


FIGURE A1

Factor Endowment Triangle

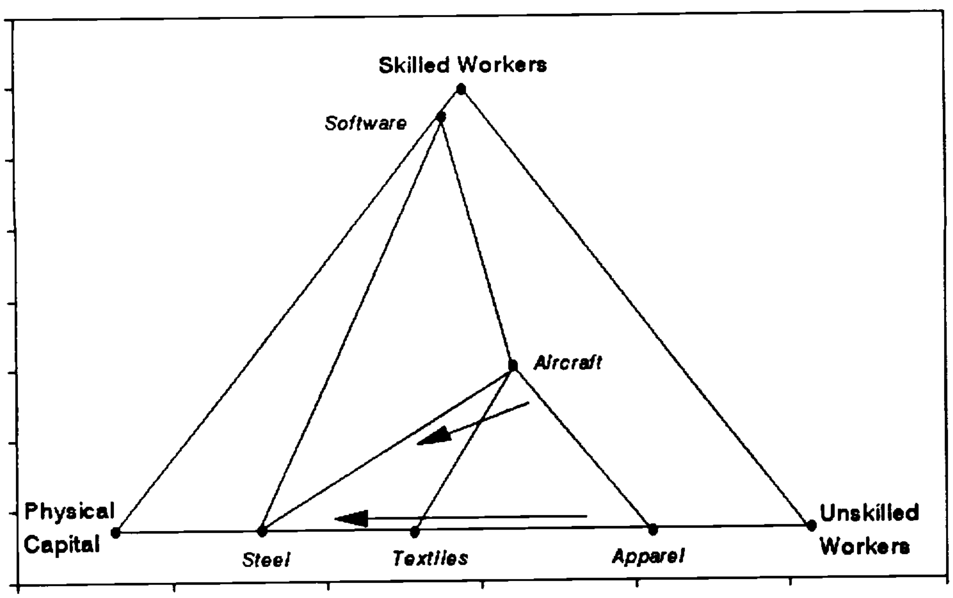


FIGURE A2

Lerner-Pearce Diagram

Specialization Choice: Moderate Wages

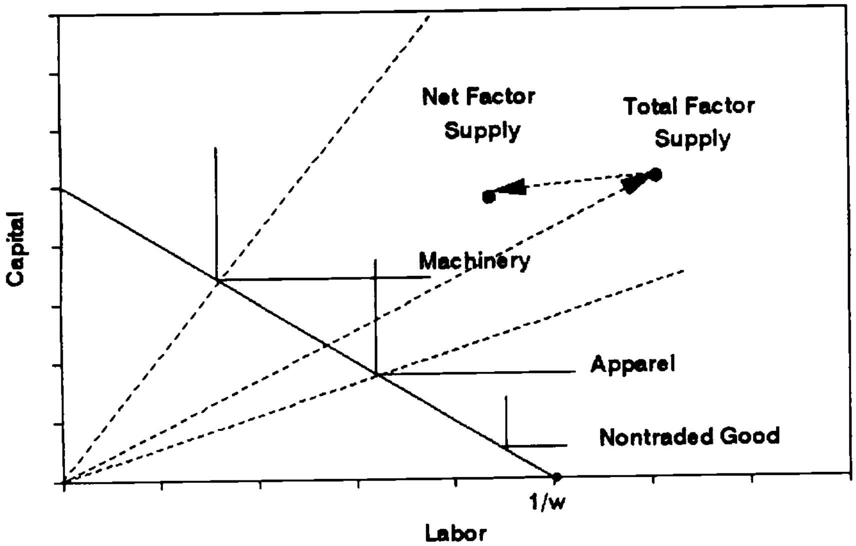


FIGURE
A3

Lerner-Pearce Diagram

Specialization Choice: High Wages

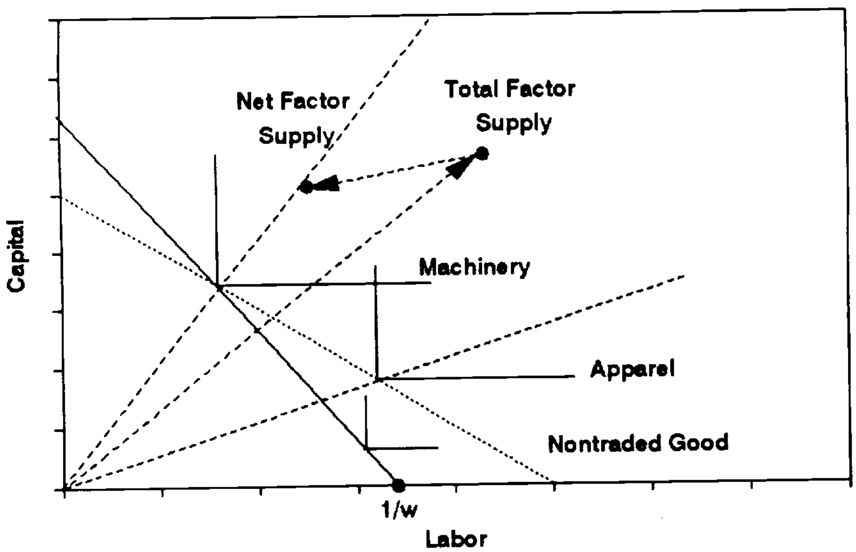


FIGURE
A4

Lerner-Pearce Diagram

Effect of Technical Change on Wages

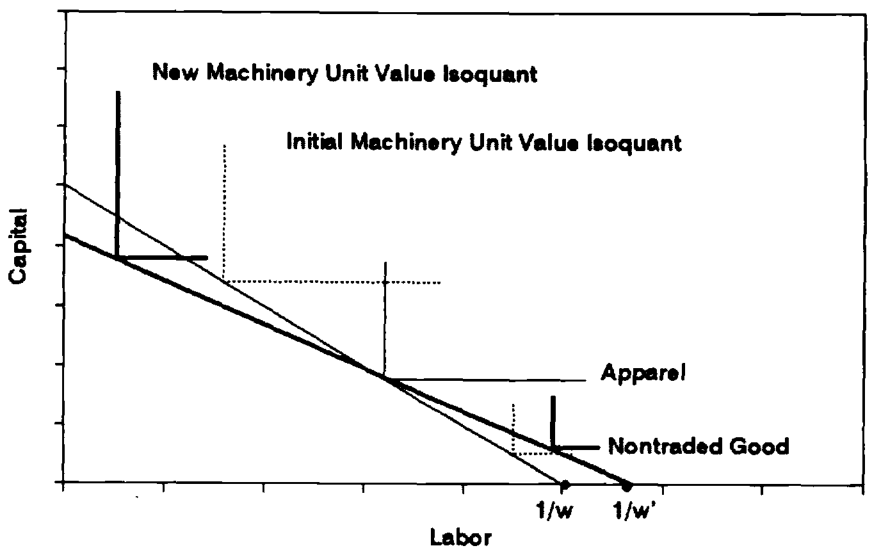


FIGURE
A5

List of Tables

Table 1

Employment Percentiles of Distribution of Production Hourly Wages Across Sectors*
Deflated by PPI

					Annualized Rate of Growth				Growth			
	1961	1971	1981	1991	'61-'71	'71-'81	'81-91	'61-'91	'61-'72	'71-'82	'81-92	'61-'92
10th Percentile	5.79	7.42	6.17	7.32	2.52	-1.83	1.72	0.79	28.26	-16.90	18.63	26.44
Median	8.66	11.04	9.64	11.03	2.46	-1.34	1.35	0.81	27.51	-12.66	14.32	27.31
90th Percentile	11.13	14.98	14.46	16.10	3.02	-0.35	1.08	1.24	34.62	-3.46	11.33	44.68
PPI	0.27	0.34	0.81	1.00								

*Interpretation: In 1961, 10 percent of workers were employed in sectors that paid $5.79 per hour or less.

Descriptive Statistics: Earnings Data
(not weighted by employment levels)
Income Inequality Measures in Bold

Hourly Wages of Production Workers

Year	1961	1971	1981	1991
Mean	2.27	3.53	7.61	11.11
Median	2.28	3.55	7.46	10.82
Maximum	3.89	6.20	15.06	27.67
Minimum	1.19	2.00	3.42	4.00
Std. Dev	0.52	0.77	2.21	3.30
Coeff.Var.	**0.23**	**0.22**	**0.29**	**0.30**
Range/Median	**1.18**	**1.18**	**1.56**	**2.19**
Range/Minimum	**2.28**	**2.10**	**3.40**	**5.92**
Observations	450	450	450	450

Average Annual Earnings ($1,000s)

	Production Workers				Nonproduction Workers				
Year	1961	1971	1981	1991	1961	1961*	1971	1981	1991
Mean	4.53	6.98	14.94	22.53	7.33	7.17	10.89	22.99	35.98
Median	4.63	7.05	14.60	21.87	7.33	7.29	10.99	22.95	35.55
Maximum	8.13	11.86	29.06	83.00	20.29	9.86	15.25	38.80	54.47
Minimum	2.20	3.66	5.88	4.00	2.87	2.87	4.93	12.25	17.50
Std. Dev	1.11	1.63	4.58	7.53	1.54	1.01	1.49	4.06	6.52
Coeff.Var.	**0.24**	**0.23**	**0.31**	**0.33**	**0.21**	**0.14**	**0.14**	**0.18**	**0.18**
Range/Median	**1.28**	**1.16**	**1.59**	**3.61**	**2.38**	**0.96**	**0.94**	**1.16**	**1.04**
Range/Minimum	**2.69**	**2.24**	**3.94**	**19.75**	**6.07**	**2.44**	**2.09**	**2.17**	**2.11**
Observations	450	450	449	448	449	438	450	450	450

Ratio of Nonproduction/Production Earnings

	1961	1961*	1971	1981	1991
Mean	**1.62**	**1.58**	**1.56**	**1.54**	**1.60**
Median	**1.58**	**1.57**	**1.56**	**1.57**	**1.63**

* Vetted Sample

Table 3

Descriptive Statistics: TFP Annualized Compound Growth Rate

Year	1961-1971	1971-1981	1981-1991
Mean	0.78	0.00	0.33
Value Added Weighted Mean	0.79	0.17	0.46
Median	0.66	-0.08	0.36
Maximum	10.78	18.33	11.88
Minimum	-4.46	-10.56	-11.66
Std. Dev	1.72	2.18	1.78
Coeff. Var.	2.19	1831.41	5.43
Observations	450	450	449

Table 4

Cross-section Correlations of Price Inflation Rates with Various Series
450 four-digits SIC Manufacturing Sectors

	Unweighted			Weighted by employment		
	1961-1971	1971-1981	1981-1991	1961-1971	1971-1981	1981-1991
Capital per worker	-0.17	0.36	-0.33	-0.14	0.42	-0.24
Capital per earnings	-0.19	0.31	-0.34	-0.15	0.41	-0.23
Average wages	0.07	0.30	-0.13	0.06	0.16	-0.13
Nonproduction wages (average)	-0.03	0.14	-0.12	-0.06	0.09	-0.18
Production wages (average)	0.10	0.35	-0.12	0.09	0.37	-0.09
Ratio of Nonproduction to Production workers	0.07	0.01	0.08	0.08	-0.13	0.10
Materials Costs as a share of value of shipments	-0.14	0.12	-0.38	-0.08	0.15	-0.27

Note: Weighted Correlations are estimated as the square root of the R-squared from the weighted OLS regressions where the dependent variable is the price inflation and the independent variable is the seria of interest. Sign is determined by the sign of the corresponding coefficient. Weights are defined as the average employment for each sector over 19961-91 period.

Table 5

Average Factor Shares
450 SIC industries

	1961	1971	1981	1991	Formula for Earnings
Labor	0.32	0.32	0.27	0.26	PAY
Total					
High-wage	0.25	0.21	0.17	0.17	wH*(PAY- (wL)*EMP)/(wH-wL)
Low-wage	0.07	0.11	0.09	0.09	wL*(-PAY+(wH)*EMP)/(wH-wL)
Production	0.22	0.21	0.17	0.16	PRODW
High-wage	0.14	0.13	0.12	0.13	wH*(PRODW-(wL)PRODE)/(wH - wL)
Low-wage	0.08	0.08	0.05	0.03	wL*(-PRODW+(wH)PRODE)/(wH - wL)
Nonproduction	0.10	0.11	0.09	0.10	(PAY-PRODW) = NPRODW
High-wage	0.07	0.09	0.06	0.07	wH*(NPRODW-(wL)NPRODE)/(wH - wL)
Low-wage	0.03	0.02	0.03	0.03	wL*(-NPRODW+(wH)NPRODE)/(wH - wL)
Capital	0.07	0.08	0.08	0.09	.1*((PLANT+EQUIP)*PIINV+INVENT)
Plant and Equipment	0.05	0.06	0.06	0.07	.1*(PLANT+EQUIP)*PIINV
Plant	0.03	0.03	0.03	0.03	.1*(PLANT)*PIINV
Equipment	0.02	0.03	0.03	0.04	.1*EQUIP*PIINV
Inventories	0.02	0.02	0.02	0.02	.1*INVENT
Materials	0.61	0.60	0.65	0.65	MATCOST
Energy	0.02	0.02	0.04	0.03	ENERGY
Other	0.59	0.58	0.61	0.62	MATCOST-ENERGY

Note: Total Earnings = PAY+.1*((PLANT+EQUIP)*PIINV+INVENT)+MATCOST
wH and wL refer to the highest and lowest earnings per worker across the 450 sectors in the given year /1.

Production					
wH	8.13	11.86	29.06	83.00	Max(PRODW/PRODE)
wL	2.20	3.66	5.88	4.00	Min(PRODW/PRODE)
Nonproduction					
wH	14.93	15.25	38.80	54.47	Max((PAY-PRODW)/(EMP-PRODE))
wL	2.87	4.93	12.25	17.50	Min((PAY-PRODW)/(EMP-PRODE))
Total					
wH	9.00	13.39	36.13	46.81	Max(PAY/EMP)
wL	1.92	4.03	7.32	12.01	Min(PAY/EMP)

/1 Labor shares have been calculated on vetted samples. Nonproduction wage estimates for 1961, 1981 and 1991 include observations that greatly deviate from the rest of the sample. These observations were excluded from the calculation of all labor shares for the corresponding year and subsequently are excluded from the later regressions (Tables 5-8)
For total wages only 1 observation in 1991 (=3, SIC 2794) was excluded.

Excluded observations and their SIC codes:

Year	Nonprod. wage	SIC code	Code interpretation
1961	0.93	2519	Household furniture, not classified elsewhere
	20.28	3942	Dolls and stuffed toys
	20.25	2647	Paper products?
	16.40	3519	Internal combustion engines, not classified elsewhere
1981			
	65.66	3339	Primary nonferrous metals, not classified elsewhere
1991			
	205	2384	Robes and dressing gowns
	2	2794	Printing?

Table 6

Regressions of Inflation and TFP Growth on Beginning-of-Period Earnings Shares
450 Four-digit SIC Manufacturing Sectors
Capital and Labor

	Annualized Price Inflation			Annualized Price Inflation plus Annualized TFP Growth			Annualized TFP Growth		
	1961-71	1971-81	1981-91	1961-71	1971-81	1981-91	1961-71	1971-81	1981-91
Estimates									
Labor Share	3.27	5.73	5.31	3.19	6.50	2.51	-0.07	0.78	-2.80
Capital Share	-5.32	7.27	-4.07	7.93	9.24	9.30	13.25	1.98	13.37
Materials Share	(1)	(1)	(1)	(1)	(1)	(1)	(2)	(2)	(2)
Standard Errors									
Labor Share	0.32	0.73	0.66	0.23	0.31	0.39	0.39	0.78	0.68
Capital Share	1.49	2.88	2.34	1.05	1.24	1.38	1.80	3.08	2.39
Mean Dependent Variable	1.91	8.01	2.38	2.74	8.18	2.70	0.83	0.17	0.32
S.D. dependent var	2.10	5.78	2.88	2.15	5.18	2.17	1.91	3.12	2.24
S.E. of regression	1.44	2.89	2.14	1.02	1.24	1.26	1.74	3.09	2.18
	0 % Pass-through			100 % Pass-through					
Mandated Annualized Earnings Growth Due to Price Changes Unrelated to Technology: Estimates minus Inflation									
Labor	1.35	-2.29	2.93	1.28	-1.51	0.13			
Capital	-7.24	-0.75	-6.45	6.02	1.23	6.92			
Mandated Annualized Real Earnings Growth Due to Technological Change									
Labor	-0.07	0.78	-2.80	0.83	0.17	0.32			
Capital	13.25	1.98	13.37	0.83	0.17	0.32			
Total Mandated Annualized Earnings Growth									
Labor	1.28	-1.51	0.13	2.11	-1.34	0.45			
Capital	6.02	1.23	6.92	6.85	1.40	7.25			
"Share" due to "globalization" : Absolute Effect / Sum of Absolute Effects									
Labor	95%	75%	51%	61%	90%	29%			
Capital	35%	27%	33%	88%	88%	96%			

(1) The materials share coefficient is set equal to the sector-specific materials inflation rate.
(2) Materials input shares are excluded because the pass-through is assumed to apply to value-added prices

Table 7

Regressions of Inflation and TFP Growth on Beginning-of-Period Earnings Shares
450 Four-digit SIC Manufacturing Sectors
Capital and High-wage and Low-wage Labor.

	Annualized Price Inflation			Annualized Price Inflation plus Annualized TFP Growth			Annualized TFP Growth		
	1961-71	1971-81	1981-91	1961-71	1971-81	1981-91	1961-71	1971-81	1981-91
Estimates									
Labor									
High-wage	3.47	6.34	5.36	2.81	8.30	0.47	-0.65	1.96	-4.89
Low-wage	2.58	4.79	5.26	4.38	3.75	5.13	1.80	-1.04	-0.14
Capital Share	-5.46	6.56	-4.14	8.30	7.17	11.54	13.75	0.61	15.68
Materials Share	(1)	(1)	(1)	(1)	(1)	(1)	(2)	(2)	(2)
Standard Errors									
Labor									
High-wage	0.45	1.03	0.98	0.32	0.43	0.56	0.54	1.10	0.99
Low-wage	1.08	1.34	1.13	0.76	0.55	0.65	1.30	1.43	1.15
Capital Share	1.51	3.00	2.47	1.07	1.24	1.41	1.82	3.20	2.50
Mean Dependent Variable	1.91	8.01	2.38	2.74	8.18	2.70	0.83	0.17	0.32
S.D. dependent var	2.10	5.78	2.88	2.15	5.18	2.17	1.91	3.12	2.24
S.E. of regression	1.44	2.89	2.14	1.01	1.20	1.22	1.73	3.09	2.16
	0 % Pass-through			100 % Pass-through					
Mandated Annualized Earnings Growth Due to Price Changes Unrelated to Technology: Estimates minus Inflation									
Labor									
High-wage	1.56	-1.67	2.98	0.90	0.29	-1.91			
Low-wage	0.67	-3.23	2.89	2.46	-4.27	2.75			
Capital	-7.37	-1.46	-6.52	6.39	-0.85	9.16			
Mandated Annualized Real Earnings Growth Due to Technological Change									
Labor									
High-wage	-0.65	1.96	-4.89	0.83	0.17	0.32			
Low-wage	1.80	-1.04	-0.14	0.83	0.17	0.32			
Capital	13.75	0.61	15.68	0.83	0.17	0.32			
Total Mandated Annualized Earnings Growth									
Labor									
High-wage	0.90	0.29	-1.91	1.73	0.46	-1.59			
Low-wage	2.46	-4.27	2.75	3.29	-4.10	3.07			
Capital	6.39	-0.85	9.16	7.21	-0.68	9.48			
"Share" due to "globalization" : Absolute Effect / Sum of Absolute Effects									
Labor									
High-wage	70%	46%	38%	52%	63%	86%			
Low-wage	27%	76%	95%	75%	96%	90%			
Capital	35%	70%	29%	89%	83%	97%			

(1) The materials share coefficient is set equal to the sector-specific materials inflation rate.
(2) Materials input shares are excluded because the pass-through is assumed to apply to value-added prices

Table 8

Regressions of Inflation and TFP Growth on Beginning-of-Period Earnings Shares
450 Four-digit SIC Manufacturing Sectors
Capital and Production and Non-production Labor.

	Annualized Price Inflation			Annualized Price Inflation plus Annualized TFP Growth			Annualized TFP Growth		
	1961-71	1971-81	1981-91	1961-71	1971-81	1981-91	1961-71	1971-81	1981-91
Estimates									
Labor									
Nonproduction	0.68	0.06	5.82	3.62	10.70	3.71	2.94	10.64	-2.11
Production	4.90	9.34	4.89	2.92	3.83	1.52	-1.98	-5.50	-3.37
Capital Share	-5.95	6.71	-3.86	8.04	9.66	9.79	13.99	2.95	13.65
Materials Share	(1)	(1)	(1)	(1)	(1)	(1)	(2)	(2)	(2)
Standard Errors									
Labor									
Nonproduction	0.81	1.59	1.26	0.58	0.66	0.74	0.98	1.65	1.28
Production	0.57	1.15	1.10	0.41	0.48	0.64	0.69	1.20	1.12
Capital Share	1.48	2.83	2.38	1.06	1.17	1.39	1.79	2.94	2.43
Mean Dependent Variable	1.91	8.01	2.38	2.74	8.18	2.70	0.83	0.17	0.32
S.D. dependent var	2.10	5.78	2.88	2.15	5.18	2.17	1.91	3.12	2.24
S.E. of regression	1.42	2.84	2.14	1.02	1.18	1.25	1.72	2.95	2.18
	0 % Pass-through			100 % Pass-through					
Mandated Annualized Earnings Growth Due to Price Changes Unrelated to Technology: Estimates minus Inflation									
Labor									
Nonproduction	-1.23	-7.95	3.45	1.71	2.68	1.33			
Production	2.99	1.32	2.51	1.01	-4.18	-0.86			
Capital	-7.87	-1.31	-6.24	6.12	1.65	7.41			
Mandated Annualized Real Earnings Growth Due to Technological Change									
Labor									
Nonproduction	2.94	10.64	-2.11	0.83	0.17	0.32			
Production	-1.98	-5.50	-3.37	0.83	0.17	0.32			
Capital	13.99	2.95	13.65	0.83	0.17	0.32			
Total Mandated Annualized Earnings Growth									
Labor									
Nonproduction	1.71	2.68	1.33	2.54	2.85	1.65			
Production	1.01	-4.18	-0.86	1.83	-4.01	-0.54			
Capital	6.12	1.65	7.41	6.95	1.82	7.73			
"Share" due to "globalization" : Absolute Effect / Sum of Absolute Effects									
Labor									
Nonproduction	29%	43%	62%	67%	94%	81%			
Production	60%	19%	43%	55%	96%	73%			
Capital	36%	31%	31%	88%	91%	96%			

(1) The materials share coefficient is set equal to the sector-specific materials inflation rate.
(2) Materials input shares are excluded because the pass-through is assumed to apply to value-added prices