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LABOR MARKET SHIFTS AND THE PRICE PUZZLE REVISITED

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ABSTRACT

This paper examines the relationship between price growth and skill intensity across 150 manufacturing industries between 1989 and 1995. There are two main findings. First, wage growth and intermediate goods price increases are passed through to final product prices roughly in proportion to their factor shares. Second, product prices have grown relatively less in sectors that more intensively utilize less-skilled labor. The latter finding is consistent with the Stolper-Samuelson theory of expanded trade with countries that are abundant in less-skilled workers, as well as with some models of technological change.

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Labor Market Shifts and the Price Puzzle Revisited

I. Introduction

The U.S. and most other industrialized countries have experienced a decline in employment of less-skilled workers relative to skilled workers in the past two decades.[1] Also, in the last 15 years the U.S. and many other industrialized countries have experienced a rise in relative wages for more highly skilled workers. These trends are consistent with a major shift in relative demand in favor of skilled workers. Three primary explanations have been considered for these developments: skill-biased technological change, increased international competition, and institutional changes. This paper examines newly available data on product market prices in manufacturing industries to test whether this apparent shift in relative demand for skilled workers is consistent with international competition.

As several authors have hypothesized, an expansion in international trade with countries that are abundant in less-skilled workers could account for an inward shift in demand for less-skilled workers in the labor market at home. In this case, the Stolper-Samuelson (1941) theorem would predict that relative prices of goods produced in industries that more intensively use less-skilled workers would fall.[2] The intuition for this result is that an exogenous expansion in trade with countries abundant in less-skilled workers would reduce the price of goods produced

[1] See, for example, OECD (1994; Chapter 4).

[2] See Leamer (1995) and Baldwin (1995) for discussions of these issues.

by less-skilled workers in the home country, and in a competitive market the wage of factor inputs is a function of final goods prices and technology. With constant technology, the value of marginal product of less-skilled workers would fall as the price of the goods they produce falls.

By contrast, the implications of skill-biased technological change for price growth are ambiguous. As several trade economists have emphasized, technological change that increases total factor productivity (TFP) in sectors that intensively utilize highly skilled workers would lead relative output prices to fall in these sectors, other things being equal. However, within-sector, skill-biased technological change can also lead prices to fall in the sectors that utilize less-skilled workers more intensively. For example, if a machine can perform the tasks that an unskilled worker performs for $5.00 per hour, then the wage of unskilled workers would fall to $5.00 per hour and the sectors that utilize unskilled workers more intensively would experience a fall in output prices relative to other sectors.[3]

In an important paper, Lawrence and Slaughter (1993) examine the relationship between import and export price growth and skill intensity across 30 industries between 1980 and 1989. They reach the surprising conclusion that, if anything, price growth has been slower in skill-intensive industries. Lawrence and Slaughter interpret this finding as evidence that technological

[3]This example is from Hall (1994).

change, not international trade, is the main cause of labor market shifts. Based on finding a rise in the price of imports relative to exports in the U.S. between 1982 and 1989, Bhagwati (1991) also conjectures that goods prices rose more in unskill-intensive industries.

The price-skill relationship has been re-examined by Sachs and Shatz (1994) and Leamer (1993).[4] Unlike the earlier studies, these papers conclude that less-skill-intensive industries have experienced somewhat slower price growth. But the state of the literature on price growth and skill intensity is probably best characterized as ambiguous at this stage. For example, Bhagwati (1995) calls Sachs and Shatz's findings, "interesting but not persuasive."

The lack of a strong, positive relationship between price growth and skill intensity presents a puzzle for explanations of labor market shifts, because it is inconsistent with increased international competition, declining unions, as well as many forms of technological change. For example, Hall (1994, p. 76) writes, "Lawrence and Slaughter's finding that skill-intensive goods have not become relatively more expensive is simply paradoxical, not supportive of any theory of structural change." For purposes of this paper, the lack of a positive relationship between price growth and skill intensity is called the "price puzzle."

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[4]In a related literature, Grossman (1987) and Revenga (1992) find a weak, positive relationship between wages and import prices, and a stronger one between employment and import prices.

In this paper, newly available Bureau of Labor Statistics (BLS) data on price growth and several measures of skill intensity are used to try to understand the price puzzle. A key advantage of the data set is that input and output goods prices are available at the 4-digit SIC level. In addition, the data cover the 1989-95 period, which corresponds to a period of rapidly rising wage dispersion. The richer data set allows for a more rigorous estimation equation. Section II presents a simple model of price growth. Section III describes the data and presents alternative estimates. To preview the main findings: the data are more consistent with a positive association between skill intensity and price growth than with no association or a negative association. At least between 1989 and 1995, prices have grown relatively slowly in industries that are relatively less-skill intensive. This finding holds regardless of how skill intensity is measured. Furthermore, the relationship between skill-intensity and price growth is roughly of the right order of magnitude to be consistent with the shift in relative wages among skill groups over this time period. The conclusion tries to interpret this relationship.

II. Models of Price Growth

With the exception of Leamer (1995), the estimation model used in the previous literature has been rather *ad hoc*. Lawrence and Slaughter simply estimate a bivariate regression of price growth on the fraction of workers in an industry who are classified as production workers. Sachs and Shatz estimate the same equation, and include a dummy variable indicating whether an industry produces computers.[5] Leamer (1993) inspects price growth for nine aggregated industry groups between 1972 and 1985 based on their skill and capital intensity. Bhagwati (1991) compares aggregate import and export price growth.

To consider a simple model of price growth, assume the zero profit condition holds (or profit is constant) and technology is stable. With these assumptions, price growth in an industry with three inputs -- labor, intermediate goods, and capital -- can be written as:

$$\dot{P}_i = \alpha_{L_i}*\dot{W}_i + \alpha_{I_i}*\dot{P}_{I_i} + \alpha_{K_i}*\dot{r} \ , \qquad (1)$$

where $\dot{P}_i$ is the proportionate increase in the goods price in industry i, α_L is labor's share of sales, $\dot{W}$ is the proportionate growth in wages, α_I is intermediate goods' share of sales, and $\dot{P}_I$ is the proportionate growth in intermediate goods prices, $\dot{r}$ is proportionate growth in the cost of capital.[6] Adding additional inputs to equation (1) is straight forward. Furthermore, if

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[5]Bhagwati (1995) and others criticize Sachs and Shatz for their ad hoc treatment of computer producers.

[6]This equation is obtained by manipulating the total differential of the zero profit condition: $PQ = WL + P_I Q_I + rK$, where P is output price, Q is the quantity of output, W is the wage rate, L is labor, P_I is the price of intermediate inputs, Q_I is the quantity of intermediate goods, r is the cost of capital, and K is the amount of capital. Furthermore, with non-zero profit equation (1) will still hold as long as the output price mark-up is constant over time.

technology changes, then equation (1) would still hold for "effective prices," which subtract off Total Factor Productivity (TFP) growth from goods price growth.

Apart from measurement errors in the data, equation (1) should hold as an identity if the zero profit condition holds throughout. However, because of sampling errors, measurement errors and possible noncompetitive behavior, estimation of equation (1) will entail some error, yielding:

$$\dot{P}_i = \alpha_{L_i} * \dot{W}_i + \alpha_{I_i} * \dot{P}_{I_i} + \alpha_{K_i} * \dot{r} + \varepsilon_i \ , \tag{2}$$

where ϵ represents sampling errors and other sources of noise. In addition, it is common to not subtract off TFP growth from price growth. In this case, if TFP growth is uncorrelated with the share-weighted input price growth variables, it will add harmlessly to the error term. But if TFP is not orthogonal to the other variables on the right-hand-side of (2), it will load on to these variables.

A reduced form version of (2) could be written as:

$$\dot{P}_i = b_{1_i} * \dot{W}_i + b_{2_i} * \dot{P}_{I_i} + \varepsilon_i \ , \tag{3}$$

where we omit $\dot{r}$ because with our data there is no industry-level variation in the cost of capital. Equation (3) is a random coefficients model. Assuming the factor shares are independent of factor price growth, $E[b_1] = E(\alpha_L)$ and $E[b_2] = E(\alpha_I)$.

Alternatively, a reduced form equation can be written as:

$$\dot{P}_i = b_{1_i}\ (\alpha_{L_i}) + b_{2_i}(\alpha_{I_i}) + b_3(\alpha_{K_i}) + \varepsilon_i\ , \tag{4}$$

where $E[b_1] = E(\dot{W})$ and $E[b_2] = E[\dot{P}_I]$. That is, the expected values of the coefficients on the factor shares equal the average factor price growth rates.

A "quasi-reduced form" model can be estimated where:

$$\dot{P}_i = b_{1_i}\ (\alpha_{L_i}) + \dot{P}_{I_i}(\alpha_{I_i}) + \dot{r}(\alpha_{K_i}) + \varepsilon_i. \tag{5}$$

Equation (5) is particularly amenable for estimating differential price growth by skill intensity because, as described below, labor's share can be disaggregated into unskilled labor's share (α_{Lu}) and skilled labor's share (α_{Ls}). The equation then becomes:

$$\dot{P}_i = b_{1_i}\ (\alpha_{L_{U_i}}) + b_{2_i}(\alpha_{L_{S_i}}) + \dot{P}_{I_i}(\alpha_{I_i}) + \dot{r}(\alpha_{K_i}) + \varepsilon_i \tag{5'}$$

where the expected values of b_1 and b_2 equal average wage growth of unskilled and skilled workers, respectively. A necessary implication of the Stolper-Samuelson explanation of trade-induced widening wage inequality is that $b_2 > b_1$. That is, prices are growing relatively faster in the skill-intensive industries, holding cost increases of other inputs constant. Furthermore, $E(b_2) - E(b_1)$ should equal the observed difference in average wage growth between skilled and unskilled workers.

III. Data and Estimation

A. Data

Unpublished, publicly available data on prices from the BLS were assembled to examine the price-skill relationship. Goods prices are from the Producer Price Index (PPI) survey for January 1989 and January 1995.[7] This is a survey of 80,000 items. The BLS attempts to adjust prices for changes in the quality of the goods. The items for "finished processor" industries were aggregated by BLS to four-digit SIC industries. There are 163 finished processor industries in total, out of some 450 four-digit SIC industries.[8] The BLS's PPI data are the primary price input used by the Bureau of Economic Analysis (BEA) for implicit sales deflators. The BEA data were used by Sachs and Shatz and Leamer. In addition, the BLS produced a special tabulation of intermediate goods prices for each industry. For each industry, intermediate goods prices were calculated as the weighted average of the industry's input prices, with input shares (based on the 1987 Input-Output tables) serving as weights.

Data on labor's share and intermediate goods' share were derived from the Annual Survey of Manufacturing. For each

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[7]More precisely, the prices are based on the industry price index level. Proportionate growth in the price index is used as P.

[8]Finished goods industries are defined as those in which over 75 percent of output goes to final demand. The sample used here consists of 150 industries because Annual Survey of Manufacturing data are unavailable for some industries, and because PPI data are unavailable for some finished goods industries. In a later draft of this paper I hope to obtain data for non-finished goods industries.

industry, labor's and intermediate goods' shares were calculated for 1989, 1990 and 1991, and the average of these three values was used. Capital's share was calculated as one minus labor's and intermediate goods' shares. Data on hourly wages were taken from the monthly BLS Current Employment Statistics (form 790) program.[9] The share of workers who are production workers is from the Annual Survey of Manufacturers. We calculated the average education of workers in each three-digit Census industry (CIC) from the Current Population Survey, and assigned these data to the four-digit SIC industries. Table 1 describes each variable in more detail and presents some summary statistics.

An advantage of the data set used here is that the data cover a recent period. Furthermore, the previous literature has not incorporated data on factor shares, or taken into account increases in intermediate goods prices. Finally, the data are available at a more disaggregated level than the data analyzed by Lawrence and Slaughter and Sachs and Shatz.

B. Estimates of Factor Price Pass Through Equations

We first use these data to estimate the "structural" relationship in equation (2). Because of difficulty of measuring TFP, the dependent variable is price growth, $\dot{P}$. The estimating model is:

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[9] One limitation of this wage series is that it only pertains to production workers, who make up about 70 percent of manufacturing workers. Nevertheless, this is probably the best available series because it is current and is based on a very large sample.

$$\dot{P}_i = \gamma + \beta_1 * (\alpha_{L_i}) * \dot{W}_i + \beta_2 * (\alpha_{I_i}) * \dot{P}_{I_i} + \beta_3 (\alpha_{K_i}) \dot{r} + \qquad (6)$$

where β_1 and β_2 are parameters to be estimated. In principle, β_1 and β_2 should equal 1, as in equation (2). There are several reasons why the coefficients might differ from unity, however. First, we omit TFP growth, which might be correlated with the explanatory variables. Second, there is measurement error in the dependent variable and explanatory variables because they were obtained from surveys of finite samples. And third, the rents in an industry may change over time.

Another issue concerns interpretation. Equation (2) is an identity under certain conditions. Therefore, the identity may be manipulated so that any variable is the dependent variable. When an error term is allowed for, however, the endogeneity of the variables becomes an issue. For example, if there is an exogenous increase in output prices in an industry (e.g., because of a change in regulation), workers may be able to capture some rents in the form of higher wages. In this example, causality runs from price growth to wage growth, not vice versa. Ideally, one would like to identify equation (6) using exogenous variations in wage and intermediate goods price growth. In the absence of readily available, legitimate instrumental variables, the term "structural" is used in quotes to describe estimates of equation (6).

With these caveats in mind, Table 2 presents estimates of industry pass-through equations. The regressions are estimated by Weighted Least Squares (WLS), using the 1988 value of sales for each industry as weights.[10] The coefficients in the first column are positive, but less than one. In column (2), capital's share times the percentage change in the interest rate is included. Capital costs are assumed to equal the prime lending rate. (Because the change in the cost of capital is assumed to be constant across industries, the only variability in this variable is from differences in capital's share across industries.) In this model, the coefficients on labor's share times wage growth rises to .81, and the coefficient on intermediate goods' share times price growth rises to .91. Moreover, for both coefficients a t-test would not reject the hypothesis that the coefficients are equal to one at conventional levels of statistical significance. Paradoxically, the coefficient on capital's share times the percentage change in the cost of capital is nearly -1.0. This anomaly may result from difficulties in measuring the cost of capital across industries.

Table 3 presents estimates of the reduced form equations (3) and (4). In column (1), price growth is regressed on wage growth and intermediate goods price growth. The theoretical expectation is that the coefficients will equal the average labor's share and average intermediate goods' share in the industries. This, in fact, is quite close to the case. Each coefficient is within a

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[10]WLS was used because the underlying PPI sample sizes are larger for larger industries. As reported below, the unweighted regressions are qualitatively similar.

standard error of labor's share or intermediate goods' share.

The other reduced form equation is reported in column (2). This equation uses input shares as the explanatory variables. Because labor's share, intermediate goods' share and capital's share sum to one by definition, the intercept is omitted. The theoretical expectation is that the coefficients on the input shares equal the growth in their prices. For wages and intermediate goods prices, this is not to far from the case.[11] As before, capital's share has the "wrong" sign -- the prime rate declined by 20 percent between January 1989 and 1995, yet the coefficient is positive.

In sum, the price pass-through equations suggest that wage and intermediate goods price increases are passed through to final product prices. And the extent of the pass through is roughly consistent with what one would expect with constant industry rents.

C. Differential Pass Through by Skill Level

Following the previous literature, Table 4 presents estimates of price growth equations that include the share of workers in an industry who are production workers as a measure of skill intensity. Column (1) reports the simple bivariate regression, weighted by sales. A scatter diagram of this

[11]As noted earlier, the wage data used here pertain only to production workers. A broader measure of compensation, the BLS Employment Cost Index, shows that fix-weighted hourly labor compensation in manufacturing increased by 27.7 percent between March 1989 and March 1995.

relationship is displayed in Figure 1, where the size of each point is proportional to industry sales. In contrast to Lawrence and Slaughter's findings, the regression shows a negative and highly statistically significant relationship between price growth and the fraction of workers who are production workers. The graph shows that the large industries tend to cluster fairly closely to the fitted regression line. The notable negative outlier is creamery butter. This industry experienced a 35 percent fall in price; industry observers note that this may have been due to a decline in consumer demand resulting from increased health consciousness. The two notable positive outliers are cigars (46 percent increase) and chewing and smokeless tobacco and snuff (57 percent increase).

In column (2) of Table 4 a dummy variable for the computer industry is added. Unlike Sachs and Shatz's findings, including this variable does not appear to affect the coefficient on the share of production workers. Evidently, the negative association between the share of production workers and price growth is not dependent on dummying out the computer industry in this time period. In column (3), intermediate goods' share times price growth is added, and in column (4) capital's share times the growth in the interest rate is added. Although the capital's share interaction continues to have the "wrong" sign, the coefficient on the fraction of production workers is unaffected by the inclusion of these variables.

The inverse relationship between price growth and the fraction of production workers is not driven by extreme values. For example, a median regression yields a coefficient of -0.19 (se=.06) for the model in column (4). Furthermore, unweighted least squares yields a coefficient of -0.15 (se=.06).

Interestingly, in all the models in Table 4 the coefficient on the fraction of workers who are production workers implies a similar magnitude to that estimated by Sachs and Shatz. Sachs and Shatz estimate that between 1978 and 1989 the price of a good for an industry in decile 9 of the fraction of production workers increased by 9 percent less than the price for an industry in decile 1. Here, an increase in the share of production workers by 40 percent (approximately the difference between decile 9 and decile 1 in Sachs and Shatz's data), yields a price decline of about 5 percent in the six years between 1989 and 1995; extrapolating to 11 years yields a 9 percent decline. Is this a big or small effect? Sachs and Shatz's estimates are commonly thought of as small. But since production workers' share of sales is less than 20 percent in manufacturing, price changes of this magnitude would require large wage declines for production workers to maintain constant profits, other things being equal.

To illustrate the data further, Table 5 presents key variables for the top 10 and bottom 10 industries, ranked by the fraction of workers who are production workers. Industries with a high fraction of production workers are primarily in the textile and apparel industries. Industries with a low fraction of production workers are more diverse, encompassing such industries as book publishing, laboratory instruments, calculators, and aircraft. The average years of education for workers in the bottom 10 industries is 13.0, compared to 11.1 for the top 10. Weighted by volume of sales, the top 10 industries experienced 7 percent lower price growth than the bottom 10 industries, on average. This is about what one would expect, since the difference in the fraction of production workers between the top and bottom 10 industries is almost .50, and the coefficient estimate for the fraction of production workers in Table 4 is approximately -0.13.

Leamer (1995) is critical of Lawrence and Slaughter's use of production workers' share of employment as an inverse measure of skill intensity. In particular, he argues that many high-skilled occupations are classified as production jobs, and many low-skilled occupations are classified as nonproduction jobs. In addition, he notes that average production workers' wages were relatively stable in relation to average nonproduction workers' wages between 1960 and 1986. In view of this stability, one would not expect price changes associated with the fraction of production workers in these years. The wage of nonproduction workers relative to production workers increased by 10 percent between 1986 and 1989, however, and continued to rise at about the same pace in the early 1990s.

Another, perhaps more serious, problem with the production workers' share variable is that industries may have an identical share of workers who are production workers, but very different labor shares. For example, consider two "low-skill" industries, denoted A and B, which both have 90 percent of workers classified as production workers, but labor's share equals 50 percent in industry A and 10 percent in industry B. If the wage of unskilled workers' falls economy wide, one would not expect identical goods price declines in these two industries. The share of workers who are production workers is at best a crude measure of skill intensity.

D. Additional Measures of Skill Intensity

Three additional measures of skill intensity are employed in Table 6. First, consistent with the model in equation (5'), labor's share is broken down into unskilled and skilled labor's share. This is accomplished by assuming that each worker's pay consists of two additive components: payment for raw labor and payment for skilled labor. The unskilled component of each worker's pay is assumed to equal the annual earnings of a high school drop out. Thus, for each industry unskilled labor's share (α_{Lu}) is calculated as: $\alpha_{Lu} = (N * W_u)/(\text{Sales})$, where N is the number of workers, W_u is the annual average earnings of high school dropouts, and Sales is the value of shipments. Skilled labor's share (α_{Ls}) is calculated as: $\alpha_{Ls} = (TP - N*W_u)/\text{Sales}$, where TP is the total payroll in the industry.

The results in column (1) indicate that prices are growing much faster in industries with a high share of skilled labor. According to the model in equation (5'), the difference between the coefficients on skilled and unskilled labor's share represents the differential wage growth between the two groups. The difference between the coefficients on skilled and unskilled labor's share is 0.52, and this gap is statistically significant at the .0001 level. A median regression and unweighted least-squares regression yield qualitatively similar results to the weighted regression model, but the gap between the coefficients on skilled and unskilled labor's share is smaller in the unweighted regression (0.20) and median regression (0.31) models.

A comparison of the differential price growth and differential wage growth requires knowledge of skilled and unskilled workers' wages. A plausible assumption is to take high school drop outs as representing unskilled workers, and those with a college degree or higher as representing skilled workers. Between 1989 and the first quarter of 1995, the (nominal) median weekly earnings of high school dropouts increased by 3 percent, while the (nominal) median weekly earnings of workers with a college degree or higher increased by 22 percent.[12] Thus, with this assumption and model, the relative decline in wages of unskilled workers is less than the amount implied by price changes associated with differential skill shares in the weighted regression, and about the same as in the unweighted regression.

Second, the average education of workers in the industry is

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[12]These data are based on the Current Population Survey (CPS), and refer to full-time wage and salary earners age 25 and over. Due to a redesign of the CPS in 1994, the data are not strictly comparable. However, the CPS data do not show a break in the downward trend of relative wages of high school drop outs in 1994.

used as a measure of skill intensity.[13] These results are shown in Column (2). Figure 2 shows the bivariate relationship between price growth and average education. Consistent with the earlier findings, the regression indicates that prices are rising more quickly in industries that tend to have workers with a higher level of average education (t-value=3.2). For example, between 1989 and 1995, prices grew about 5.5 percent more slowly in the industry at the first decile of the education distribution (11 years of education) compared to the industry at the ninth decile (13.5 years of education). Although it is outside the range of the industry-level data, one could calculate the differential price change associated with a college education and high school education (i.e., a four year differential in average education). In this case, the estimates imply that prices grew almost 9 percent faster for college graduates. This estimate is quite close to the observed differential in wage growth for these two groups: between 1989 and 1995:Q1, earnings increased by 21.3 percent for workers with exactly four years of college, and by 13.3 percent for workers with exactly 12 years of education.

Finally, the education data are used to create a new "human capital's share" variable. Human capital's share is defined as

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[13]Average education was derived from the 1989-1991 Outgoing Rotation Group Files of the Current Population Survey (CPS). The CPS data are available at the 1980 three-digit Census Industry Classification (CIC) level. The CIC classifications were converted to 1977 SIC codes, and then to 1987 SIC codes. The education data were assigned to four-digit 1987 SIC codes. It is interesting to note that the raw correlation between average education and the share of production workers is -0.61.

α_{HC} = $(N*E*\rho*W_M)/(Sales)$, where N is the number of workers, ρ is the rate of return to a year of education (assumed to be .08), E is average education in the industry, and W_M is the average annual earnings in manufacturing. Non-human capital's share α_{NHC} is calculated as the residual of human capital's share from overall labor's share: $\alpha_{NHC} = \alpha_L - \alpha_{HC}$. These results, reported in column (3), also indicate that prices are growing more quickly in industries that are more human-capital intensive. A test of the hypothesis that the coefficients on human capital's share and non-human capital's share are identical rejects at the .01 level. Again, the implied change in wages associated with skill are quite large based on the regression model.

IV. Conclusion

As the following passage from Bhagwati (1995) indicates, the empirical price-skill relationship has been considered a major puzzle for explanations of widening wage dispersion based on increased international competition:

> In short, the necessary empirical evidence on price behavior during the 1980s for the <u>absolutely critical element</u> in this particular <u>trade explanation</u> [Stolper-Samuelson] is exceptionally weak, at best."

This paper reports fairly robust evidence that price growth was relatively lower in less-skill intensive industries between 1989 and 1995. This finding is consistent with Sachs and Shatz (1994) and Leamer (1993), but inconsistent with Lawrence and Slaughter (1993). The magnitude of the price changes is roughly compatible with the observed wage changes for skilled and unskilled workers in this period, and may even "over predict" the expansion in skill differentials that occurred in the 1990s.

What does this finding imply for the role of trade versus technology in explaining labor market shifts? Is the absolutely critical evidence now available? Did the critical relationship exist in the first half of the 1990s, but not before?

Unfortunately, the findings in this paper raise more questions than they answer. Had price growth been slower in the skill-intensive industries, then expanded trade with low-wage countries would be an unlikely explanation for the momentous labor market shifts that are occurring in the U.S. The observed price changes are consistent with the Stolper-Samuelson explanation of rising skill-based wage differentials and several other explanations, including technological change and institutional change. Perhaps the most positive conclusion to be reached is that, to the extent the price puzzle took trade off the table as a plausible explanation of recent labor market shifts, the findings in this paper suggest that it should be put back on the table, where it can compete with other explanations that are also consistent with a positive association between output prices and skill intensity.

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Figure 1: Price Growth versus Fraction Production Workers

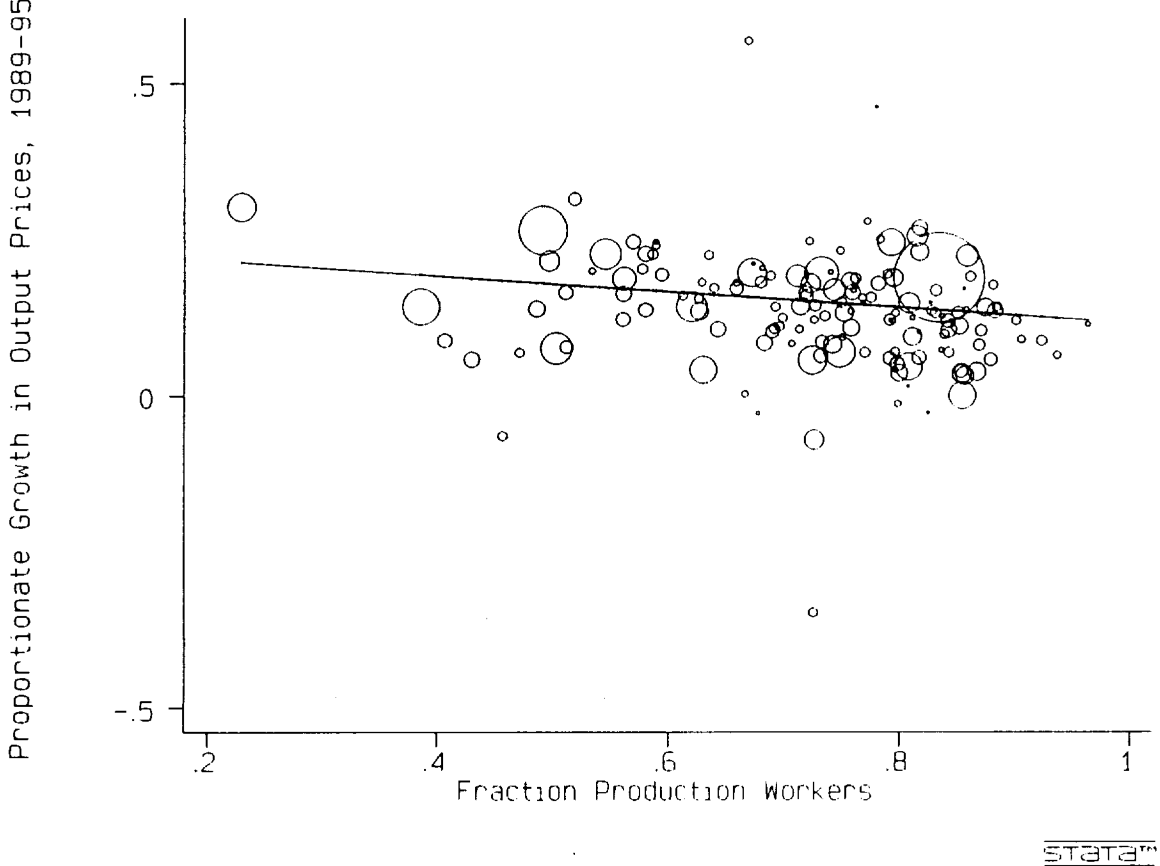

Figure 2: Price Growth versus Average Education Level

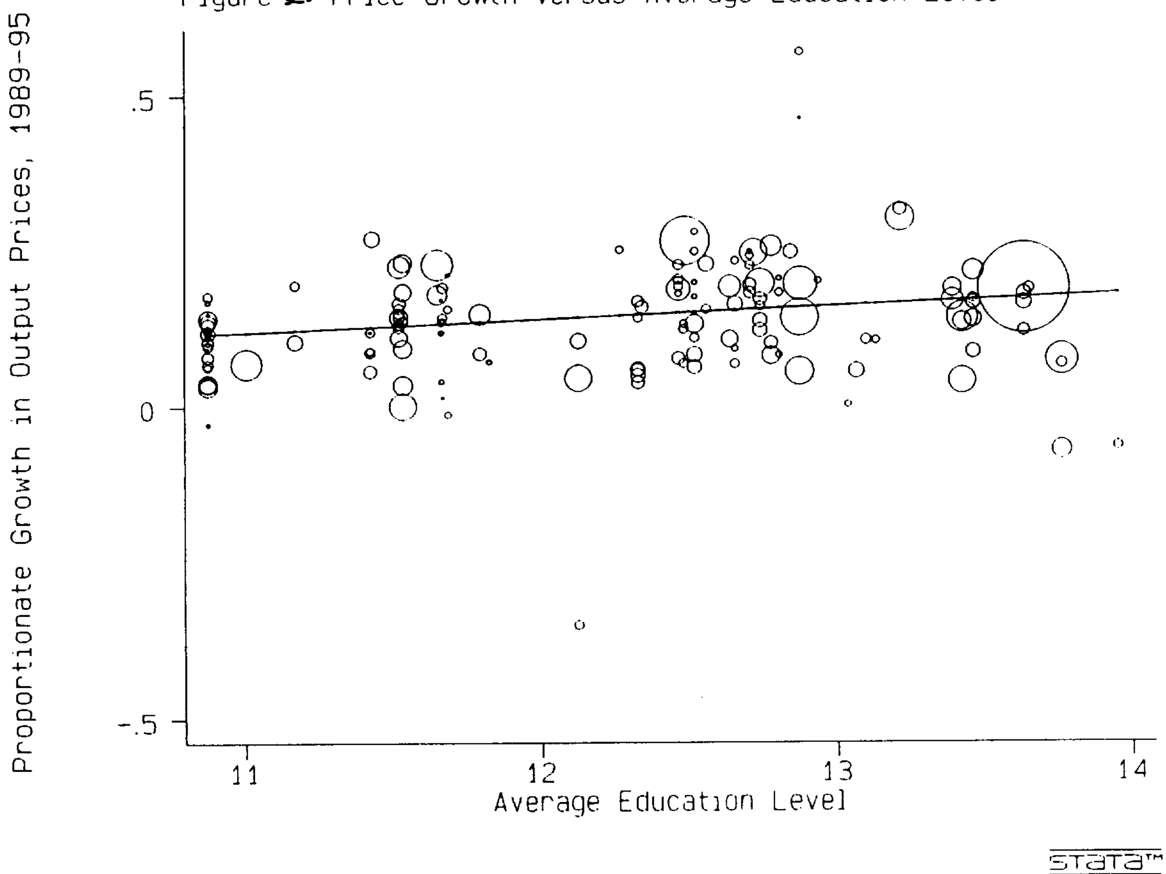

TABLE 1: Description of Data

Variable	*Description*	Weighted Mean [SD]
$\dot{P}$	**Output Price Growth**. Proportionate growth in prices from January 1989 to January 1995 based on data from the BLS Producer Price Index survey. This variable is available for 150 four-digit SIC finished goods manufacturing industries.	0.154 [0.080]
α_L	**Labor's Share of the Value of Shipments**. This variable was calculated by taking the average of the ratio of total compensation to the value of shipments from 1989 to 1991 for each industry. The data are from the Annual Survey of Manufacturing (1989-1991).	0.190 [0.093]
α_I	**Intermediate Goods' Share of the Value of Shipments.** This variable was calculated by taking the average of the ratio of material costs and energy expenditures to the value of shipments from 1989 to 1991. The data are from the Annual Survey of Manufacturing (1989-1991).	0.538 [0.142]
α_K	**Capital's Share of the Value of Shipments.** This variable was calculated by subtracting intermediate goods' share and labor's share from one. The data are from the Annual Survey of Manufacturing (1989-1991).	0.272 [0.139]
Fraction Production Workers	**Production Worker's share of Total Employment.** This variable was calculated by taking the average ratio of the number of production workers to the total number of workers from 1989 to 1991. The data come from the Annual Survey of Manufacturing (1989-1991).	0.708 [0.152]

$\dot{P}_I$	**Input Price Growth.** Proportionate growth in intermediate goods prices between January 1989 and January 1995, based on data from the BLS Producer Price Index survey. The BLS produced a special tabulation of intermediate goods prices for each industry using input shares from the BEA's 1977 Input-Output tables as weights.	0.115 [0.044]
$\dot{W}$	**Average Hourly Earnings Growth.** Proportionate growth in wages of production workers from January 1989 to January 1995 based on data from the BLS Current Employment Statistics survey.	0.217 [0.086]
$\dot{r}$	**Percentage Change in the Bank Prime Loan Rate** from January 1989 to January 1995. The bank prime loan rate is one of the several base rates used by banks to price short-term business loans.	-0.190 [0.000]
α_{L_U}	**Unskilled Labor's Share of Value of Shipments.** This variable was calculated by multiplying the average annual earnings of a high school dropout in 1989 by the number of employees in 1989 and dividing by the value of shipments in 1989. Employment and sales data are from the Annual Survey of Manufacturing and high school dropout wage data are from the Current Population Survey.	0.109 [0.080]
α_{L_S}	**Skilled Labor's Share of Value of Shipments.** This variable was calculated by subtracting the average annual earnings of a high school dropout times the average number of employees in 1989 from total labor compensation and then dividing that quantity by the average value of shipments in 1989. Employment and sales data are from the Annual Survey of Manufacturing and high school dropout wage data are from the Current Population Survey.	0.081 [0.061]

NOTE: Weighted means were calculated using the 1988 value of shipments as weights.

TABLE 2: "Structural" Factor Price Pass-Through Regressions

Dependent Variable: Proportionate Increase in Output Prices, 1989-1995

Independent Variable	Mean [SD]	*(1)*	*(2)*
Intercept	----	0.103 (0.017)	0.016 (0.031)
$\alpha_L * \dot{W}$	0.041 [0.028]	0.632 (0.226)	0.810 (0.225)
$\alpha_I * \dot{P}_I$	0.061 [0.028]	0.419 (0.230)	0.911 (0.267)
$\alpha_K * \dot{r}$	-0.052 [0.026]	----	-0.960 (0.287)
R^2		0.079	0.145
Root MSE		0.077	0.075
Number of Observations		150	150

NOTE: Standard errors are in parentheses. Regressions were estimated using WLS, where weights are 1988 value of shipments. See Table 1 for variable definitions.

TABLE 3: Reduced-Form Factor Price Pass-Through Regressions

Dependent Variable: Proportionate Increase in Output Prices, 1989-1995

Independent Variable	Mean [SD]	*(1)*	*(2)*
Intercept	----	0.033 (0.022)	----
$\dot{W}$	0.195 [0.087]	0.243 (0.069)	----
$\dot{P}_I$	0.118 [0.043]	0.593 (0.136)	----
α_L	0.239 [0.087]	----	0.238 (0.057)
α_I	0.494 [0.113]	----	0.113 (0.023)
α_K	0.272 [0.139]	----	0.176 (0.035)
R^2		0.181	0.024
Root MSE		0.073	0.079
Number of Observations		150	150

NOTE: Standard errors are in parentheses. Regressions were estimated using WLS, where weights are 1988 value of shipments. See Table 1 for variable definitions.

TABLE 4: Regressions of Price Growth on Skill Intensity

Dependent Variable: Proportionate Increase in Output Prices, 1989-1995

Independent Variable	Mean [SD]	*(1)*	*(2)*	*(3)*	*(4)*
Intercept	----	0.243 (0.030)	0.247 (0.030)	0.219 (0.033)	0.161 (0.033)
Fraction Production Workers	0.708 [0.152]	-0.126 (0.042)	-0.131 (0.042)	-0.133 (0.041)	-0.123 (0.041)
Computer Dummy	0.002 [0.044]	----	-0.251 (0.144)	-0.219 (0.143)	-0.199 (0.142)
$\alpha_I * \dot{P}_I$	0.061 [0.028]	----	----	0.486 (0.227)	0.806 (0.272)
$\alpha_K * \dot{r}$	-0.052 [0.026]	----	----	----	-0.592 (0.285)
R^2		0.057	0.077	0.105	0.131
Root MSE		0.078	0.077	0.076	0.075
Number of Observations		150	150	150	150

NOTE: Standard errors are in parentheses. Regressions were estimated using WLS, where weights are 1988 value of shipments. Computer dummy equals one if industry manufactures computers (SIC 3578). See Table 1 for variable definitions.

TABLE 5: Top 10 and Bottom 10 Industries Ranked by Production Worker Share of Total Employment

SIC Code	Industry	Fraction Production Workers	$\dot{P}$	$\dot{P}_I$	$\dot{W}$	α_L
TOP 10:						
2384	Robes and Dressing Gowns	0.965	0.114	0.092	0.236	0.213
2322	Men's and Boy's Underwear and Nightwear	0.938	0.064	0.092	0.217	0.288
2252	Hosiery, nec	0.924	0.088	0.102	0.248	0.280
2254	Knit Underwear and Nightwear Mills	0.907	0.090	0.095	0.287	0.255
2251	Women's Hosiery, Except Socks	0.903	0.120	0.099	0.161	0.250
3144	Women's Footwear, Except Athletic	0.886	0.142	0.146	0.146	0.256
2321	Men's and Boy's Shirts, Except Work Shirts	0.885	0.137	0.089	0.275	0.277
2326	Men's and Boy's Work Clothing	0.883	0.179	0.091	0.244	0.297
2253	Knit Outerwear Mills	0.885	0.058	0.083	0.261	0.293
2325	Men's and Boy's Trousers and Slacks	0.876	0.142	0.089	0.240	0.218
	Weighted Mean	0.892	0.119	0.094	0.240	0.260
BOTTOM 10:						
2731	Book Publishing	0.229	0.302	0.181	0.186	0.180
2086	Bottled and Canned Soft Drinks	0.387	0.143	0.103	0.208	0.114
3826	Laboratory Analytical Instruments	0.407	0.088	0.082	0.180	0.322
3845	Electromedical Apparatus	0.430	0.080	0.550	0.287	0.260
3578	Calculators and Accounting Machines	0.456	-0.063	-0.013	0.306	0.247
3489	Ordinance and Accessories, nec	0.471	0.069	0.117	0.157	0.654
3823	Process Control Instruments	0.486	0.140	0.074	0.265	0.355
3721	Aircraft	0.491	0.266	0.175	0.356	0.266
3825	Instruments to Measure Electricity	0.497	0.217	0.051	0.418	0.371
3661	Telephone and Telegraph Apparatus	0.503	0.076	0.061	0.133	0.252
	Weighted Mean	0.438	0.190	0.123	0.273	0.243

NOTE: Weighted means were calculated using the 1988 value of shipments as weights.

TABLE 6: Regressions of Price Growth on Alternative Measures of Skill Intensity

Dependent Variable: Proportionate Increase in Output Prices, 1989-1995

Independent Variable	Mean [SD]	*(1)*	*(2)*	*(3)*
Intercept	----	0.009 (0.033)	-0.215 (0.092)	0.219 (0.033)
Unskilled Labor's Share (α_{Lu})	0.109 [0.080]	-0.013 (0.076)	----	----
Skilled Labor's Share (α_{Ls})	0.081 [0.061]	0.511 (0.100)	----	----
Average Education Level	12.627 [0.898]	----	0.022 (0.007)	----
Non-Human Capital's Share (α_{NHC})	-0.001 [0.018]	----	----	-0.743 (0.344)
Human Capital's Share (α_{HC})	0.191 [0.094]	----	----	0.175 (0.070)
$\alpha_I * \dot{P}_I$	0.061 [0.028]	0.898 (0.259)	0.929 (0.269)	0.944 (0.271)
$\alpha_K * \dot{r}$	-0.052 [0.026]	-0.962 (0.283)	-0.680 (0.281)	-0.928 (0.297)
R^2		0.217	0.129	0.145
Root MSE		0.072	0.075	0.075
Number of Observations		150	150	150

NOTE: Standard errors are in parentheses. Regressions were estimated using WLS, where weights are 1988 value of shipments. See Table 1 and text for variable definitions.