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The Impact of Trade Prices on Employment and Wages in the United States

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Abstract

This paper investigates the sensitivity of sectoral employment and wages in the United States to changes in foreign trade prices for 1980–90. Previous studies have concentrated mainly on the impact of changes in import prices on employment and wage levels. This paper estimates the impact of changes in both import and export prices on employment and wages in each of 12 three-digit standard industrial classification (SIC) manufacturing sectors. The basic conclusion is that, for most sectors, changes in trade prices do not have significant effects on employment and wages, although they generally have a larger impact on employment than on wages.

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SUMMARY

The increased share of foreign trade in the U.S. economy and the gradual decline in U.S. manufacturing employment over the past two decades have raised concerns about the impact of foreign trade on employment and wages in U.S. industries. This paper addresses these concerns by examining how changes in trade prices affect employment and wages in 12 three-digit standard industrial classification (SIC) U.S. manufacturing sectors during 1980–90.

Earlier studies have looked at the effects of import prices on employment and wage levels, but this paper contends that it is also important to examine the effects of export prices in order to capture the overall impact of trade. While employment and wage levels in some industries may decline as a result of increased import competition, they may increase in other industries that expand and prosper from increased export competition.

The results of the paper suggest that trade prices do not significantly affect employment and wages in most of the sectors examined. Furthermore, the coefficient estimates on export prices tend to be larger than the coefficient estimates on import prices, implying that export prices have a larger impact. Finally, the coefficients are generally larger in the employment regressions than in the wage regressions, suggesting a larger impact of trade prices on employment levels than on wage levels.

I. INTRODUCTION

In the past two decades the U.S. economy has opened widely to international trade. U.S. industries consequently appealed for protectionism as they attributed fluctuations in industry employment to changes in import and export competitiveness. In particular, U.S. manufacturing employment and production began to decline in the mid-1970's initiating an era of U.S. "de-industrialization" that was said to be linked with greater trade competition.

Several authors have studied the relationship between changes in the international trade environment and employment and wages in U.S. industries.[2] Grossman (1986, 1987) and Revenga (1992) have investigated the sensitivity of sectoral employment and wages to changing import competitiveness. Both authors use import prices as indicators of the degree of import competitiveness of U.S. industries. These studies argue that, theoretically, a decline in the domestic price of an imported good should shift the demand curves for domestically produced substitutes downward and hence lower employment in those domestic industries. The response of employment to changes in demand is expected to be dampened by wage adjustments. If domestic wages fall or fail to rise quickly in the face of growing import competition, employers would be more willing to keep a larger number of workers.

The empirical results of these studies, however, yielded somewhat different conclusions about the effects of changes in import prices. Grossman (1987) found that import prices affected employment in only one of eight industries, and affected wages in only two of eight industries. He thus concluded that changes in import prices have largely insignificant effects on employment and wages. Revenga (1992), on the other hand, found that changes in import prices had statistically significant effects on both employment and wages, but for all industries pooled together under the assumption that they would all have the same response to trade.[3]

Both Grossman and Revenga ignore the fact that many sectors in the U.S. economy export their products and thus benefit from trade. Therefore, although some sectors may suffer because of increased import competition, others may prosper and expand if they are export-competitive. Just as total output demand for import-competing industries depends on import prices, demand in export-competing industries should depend on export prices. If the export price of a product rises as foreign demand for that product rises, domestic production and consequently employment would normally be expected to increase.

Furthermore, in many sectors of the economy there is a high degree of intra-industry

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[2]The growing concerns about the effects of trade also fall into the broader context of issues arising from increasing worldwide globalization. A comprehensive discussion of the opportunities and challenges arising from globalization can be found in the issue of the IMF's *World Economic Outlook*, May 1997.

[3]Deardorff and Hakura (1994) provide a survey of the literature on the effects of trade on wages.

trade where the products produced by some of the industries are *both* exported and imported. Therefore, it is necessary to study the impact of both export *and* import prices on employment and wages in these sectors. For some industries import competition in the form of low import prices will reduce the domestic product's demand and employment. However, at the same time, if the industries can export their own products, higher export prices that raise employment and output levels may compensate for the impact of low import prices on employment. Therefore, the overall impact of changing trade competitiveness on employment is ambiguous. Also, the estimated effect of import price changes on employment when export prices are omitted will depend on how import and export prices move together. For example, if export and import prices are negatively correlated, excluding export prices from the regressions will bias the import price coefficients downward when both of the trade prices are positively correlated with employment levels. Furthermore, the correlation between export and import prices may vary from industry to industry.

The aim of this paper is to examine the impact of both changes in export and import prices on employment and wages of production workers by adopting a modified version of Grossman's methodology following Haveman (1992). Unlike Grossman, Haveman allows changes in the competitive environment faced by exporters to influence overall product demand, domestic employment, and wages. Here, a separate analysis is conducted for each industrial sector. Grossman (1987) estimates separate regressions for each sector but omits export prices. Revenga (1992) not only ignores the impact of changing export prices, but also her regressions are estimated using pooled cross-section time-series data on thirty-eight industries rather than examining each sector independently. Haveman (1992) also estimates a pooled cross-section time-series regression of the impact of changing trade prices on displacements. Using a pooled cross-section time-series regression assumes that all industries have the same production function up to an affine transformation and that a single regression can capture the sensitivity of employment and wages to changes in the trade environment for all sectors. If industries have different responses to trade competition this will not be captured by the pooled cross-section time-series regression.

It is important to keep in mind that there may be alternative explanations for the significant drop in production jobs in the United States during the 1980s. For example, another explanation that is frequently analyzed holds that major changes in technology, due in large part to the computer revolution, caused shifts in employment away from production workers and toward nonproduction workers. However, this paper focuses solely on the effects of foreign trade on the various sectors.

The paper is organized as follows. Section II describes the model. A general equilibrium specification of the long-run equilibrium is presented, and reduced-form equations for industry employment and wages are derived. Section III presents the empirical evidence. And, finally, Section IV concludes. Data sources and the industries selected for study are discussed in the Appendix.

II. MODEL SPECIFICATION

A set of structural equations can be specified that identify all of the structural variables that influence the allocation of labor to an industry. From these, three different specifications of the reduced-form equations that relate industry employment and wages to the exogenous structural variables are derived. The reduced form equations can be used to provide empirical estimates of the sensitivity of sectoral employment and wages to developments in the external environment.

Output, Y_i in the ith traded goods sector is produced according to a Cobb-Douglas production function using inputs of labor L_i, capital K_i, and energy E_i:

$$Y_i = Ae^{\pi t} K_i^{a_1} L_i^{a_2} E_i^{(1-a_1-a_2)} e^{\varepsilon_i} \qquad a_1, a_2, A > 0, \tag{1}$$

where π reflects the rate of Hicks-neutral technological progress, t indexes time, and ε is a stochastic variable, i.i.d. $N(0,\sigma^2)$. Labor and capital are assumed to be nontraded inputs. Energy, on the other hand, is assumed to be a traded input and is therefore available in an infinitely elastic supply. Equating the marginal value product for each input with its price yields the derived demand for each input, assuming profit-maximizing industries. Thus,

$$L_i = \frac{a_2\, p_i\, Y_i}{w_i} \tag{2}$$

$$K_i = \frac{a_1\, p_i\, Y_i}{r_i} \tag{3}$$

$$E_i = \frac{(1 - a_1 - a_2)\, p_i\, Y_i}{P_e}, \tag{4}$$

where p_i is the price of sector i's output, w_i is the wage rate in sector i, r_i is the rental rate on capital in sector i, and P_e is the price of energy.

The relative amounts of capital and labor that are supplied to each sector are functions of their respective rates of return in a particular sector relative to the aggregate. Thus,

$$\frac{K_i}{K_a} = C\left(\frac{r_i}{r_a}\right)^c \qquad c, C > 0 \tag{5}$$

and

$$\frac{L_i}{K_a} = D\left(\frac{w_i}{w_a}\right)^d \qquad d,D>0\,, \tag{6}$$

where K_a and L_a are the aggregate amounts of capital and labor available in the economy, and are the same for each sector. However, it is important to note that equations (5) and (6) represent approximations to true functions of factor supply to a sector, since the total amount of a factor (whether it is capital or labor) that is supplied to all of the sectors is constrained to equal the aggregate amount of the factor that is available in the economy.

The values of *c* and *d* reflect the degree of mobility of the nontraded inputs between sectors. The model does not impose any restrictions on the values of *c* and *d*. However, it is most likely that the values of *c* and *d* are near-infinite in the long run. Perfect mobility of capital and labor between sectors in the long run suggests near-zero wage effects, as a slight deviation of one sector's relative wage is sufficient to create a flow of labor to or from that sector.

Following Grossman, the aggregate wage and rental rates, w_a and r_a, are determined by the aggregate stocks of the nontraded factors and the price of the traded factor, energy (since the supply of energy is assumed to be perfectly elastic at price P_e). They are specified as:

$$\frac{r_a}{P_a} = F K_a^{f_1} L_a^{f_2} P_e^{f_3} \qquad f_1 < 0, F > 0 \tag{7}$$

$$\frac{w_a}{P_a} = G K_a^{g_1} L_a^{g_2} P_e^{g_3} \qquad g_2 < 0, G > 0\,, \tag{8}$$

where P_a is the aggregate price level. This is equivalent to the restriction that the aggregate returns of the factors equal their marginal physical product.[4]

As suggested earlier, if the goods produced by a sector are both imported and exported, the output of the sector will depend on both the domestic price of the imported good and the export price of the domestic good. Total demand for an industry's output is defined as:

$$Y_i = B\left(\frac{P_i^m}{P_i}\right)^{b_1}\left(\frac{P_i^x}{P_i}\right)^{b_2}\left(\frac{P_a}{P_i}\right)^{b_3} Q^{b4} \qquad b_1, b_2, b_3, b_4 > 0, \quad B > 0\,, \tag{9}$$

where P_i^m is the exogenous price of imported goods in sector *i*; P_i^x is the exogenous world

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[4]Thus, the aggregate returns of factors are derived only from an aggregate production function rather than from the sectoral production functions.

price of sector i output, which is assumed to be equivalent to the U.S. price of exports if U.S. exports are perfect substitutes for foreign goods from that sector; and Q is the level of aggregate industrial production. The higher is the level of industrial activity in the economy, as measured by Q, the higher is the demand for the good produced by sector i. The supply of imports is assumed to be perfectly elastic.

The output of sector i is assumed to be an imperfect substitute for the imported good and an aggregate basket of domestically produced goods. The demand for the domestic product therefore depends on its price relative to the price of the imported product (P_i^m) and that of the aggregate basket of goods (P_a). A reduction in the relative price of the domestic good will raise demand and production in sector i. Thus, the elasticities of demand between the domestically produced good and imports and between the domestically produced good and the aggregate bundle, b_1 and b_3, are positive.

U.S. exports are assumed to be perfect substitutes for foreign products from the perspective of U.S. producers. Therefore, an increase in foreign demand for a sector's goods will be reflected by an increase in its export price. It is also assumed that U.S. producers can differentiate between production for the domestic market and production for export. U.S. producers will supply more goods for export as the price of exports rises relative to the domestic price, implying a positive value for b_2. Therefore, an increase in the price received for exports will induce producers to expand production since it signifies an increase in foreign demand. Changes in export or import prices that are accompanied by a change in the domestic price of a product are assumed not to reflect a change in international competitiveness. For example, a global change in the costs of materials can simultaneously affect all prices.

Equations (1) through (9) together determine the nine endogenous variables $Y_i, K_i, L_i, E, P_i, r_i, w_i, r_a, w_a$ in terms of the seven exogenous variables, $K_a, L_a, P_e, P_a, P_i^m, P_i^x$ and Q. Reduced-form equations for employment and wages can be obtained by taking logarithms and solving the system for the endogenous variables in terms of the exogenous variables. The reduced form equations for employment and wages are derived as:

$$\ln L_i = \Omega_0 + \Omega_1 t + \Omega_2 \ln K_a + \Omega_3 \ln L_a + \Omega_4 \ln P_e + \Omega_5 \ln P_a + \Omega_6 \ln P_i^m + \Omega_7 \ln P_i^x + \Omega_8 \ln Q + u_i \tag{10}$$

$$\ln w_i = \beta_0 + \beta_1 t + \beta_2 \ln K_a + \beta_3 \ln L_a + \beta_4 \ln P_e + \beta_5 \ln P_a + \beta_6 \ln P_i^m + \beta_7 \ln P_i^x + \beta_8 \ln Q + v_i \tag{11}$$

The coefficients on the import and export prices in the employment and wage equations are given by:

$$\Omega_6 = b_1 \cdot \delta,\ \Omega_7 = b_2 \cdot \delta,\ \beta_6 = b_1 \cdot \delta/d \text{ and } \beta_7 = b_2 \cdot \delta/d,$$

where

$$\delta = \frac{d}{(1+d)+a_2(b_1+b_2+b_3-1)+a_1(b_1+b_2+b_3-1)(1+d)/(1+c)}.$$

A positive cross-price elasticity of demand between the good produced by sector i and the aggregate basket of goods implies that Ω_5 should be positive. The coefficients Ω_6 and Ω_7 measure the sensitivity of employment to changes in the international environment. The theory predicts that the coefficient Ω_6 will be positive. The main assumption behind the expected signs of the coefficients Ω_5 and Ω_6 is that people substitute toward products from sector i the higher are the prices of substitutes. The assumptions that exports are perfect substitutes for foreign products and that domestic producers can differentiate between goods produced for export and goods produced for domestic consumption permit us to define the demand function for a particular sector in terms of the U.S. export price and to expect Ω_7 to be positive. A positive income elasticity of demand for the goods of sector i implies that Ω_8 is also positive. The remaining coefficients can be of either sign.

The response of wages in sector i to changes in the exogenous variables serves to dampen the employment response. For example, if export prices are high, export-competing firms can afford to raise the wages of their employees. However, higher wages for employees implies that firms will be less likely to hire more new workers despite expanding production. On the other hand, if wages fall in the face of import competition, employers will be more willing to maintain a large number of employees. The predicted signs of the coefficients on the import and export price variables in the reduced-form wage equation are the same as those for the employment equation.

A positive coefficient on the export price variable is expected if the assumptions described above hold. However, if the assumptions are incorrect, export prices could be endogenously rather than exogenously determined. If U.S. exports are imperfect, rather than perfect, substitutes for foreign goods from the perspective of foreign consumers, then a rise in the U.S. export price of a good may not reflect an overall rise in the price of the good on world markets, but rather a rise in the U.S. export price relative to world markets. Demand for the U.S. export good would consequently fall. This scenario would lead us to expect a negative relationship between export prices, and employment and wages in a sector. And, OLS estimates of equations (10) and (11), which do not account for the endogeneity of export prices would be biased downward. An instrumental variables (IV) strategy or two-stage least squares (2SLS) estimation is needed in order to obtain unbiased and consistent estimates of the effects of export prices on employment and wages.

Appropriate instruments for export prices must be correlated with export prices, employment, and wages but they should not enter the reduced-form equations directly nor be caused by either export prices, employment, or wages. Thus the instruments should not be correlated with shocks that affect employment and wages in the United States. Therefore, for this purpose a geometric weighted average of the gross domestic product of the countries that account for more than 5 percent of the relevant industry's exports is employed as an instrument for export prices. The weights used to construct the geometric average are given by $w_j = x_{US}^j / X_{US}$, where x_{US}^j represents U.S. exports to country *j*, and X_{US} represents total U.S. exports for that particular industry in 1990. In addition, a geometric average of the nominal exchange rate of countries that account for more than 5 percent of industry exports was used. The weights needed to create the geometric average are defined as for the geometric average of the gross domestic product of countries. Exchange rates are not simultaneously determined with employment and wage levels to the extent that they are determined by macroeconomic factors. Yet they are correlated with export prices and so can be conveniently used as instruments.

In the remaining sections of the paper, equations (10) and (11) are referred to as the first specification of the reduced-form equations. Two other regression specifications are also formulated. First, if a sector is subject to a high degree of import competition and is unable to export its products (for example, U.S. manufacturing and export of televisions has ceased), the demand for the domestic product (equation(9)) will no longer depend on the price of exports from that sector. Excluding the export price from equation (9) will correspondingly alter the reduced-form equations:

$$\ln L_i = \Omega_0 + \Omega_1 t + \Omega_2 \ln K_a + \Omega_3 \ln L_a + \Omega_4 \ln P_e + \Omega_5 \ln P_a + \Omega_6 \ln P_i^m + \Omega_7 \ln Q + u_i \tag{12}$$

$$\ln w_i = \beta_0 + \beta_1 t + \beta_2 \ln K_a + \beta_3 \ln L_a + \beta_4 \ln P_e + \beta_5 \ln P_a + \beta_6 \ln P_i^m + \beta_7 \ln Q + v_i \tag{13}$$

Equations (12) and (13) give us the second specification of the reduced-form equations and are similar to those estimated by Grossman (1987). Alternatively, if a particular sector is primarily an exporter, we can exclude the impact of import prices on demand for its output. This will eliminate the import price variable from the reduced-form equations (leaving only the impact of export prices) and it gives us the third specification of the regressions.

Although there is a high degree of intra-industry trade in most sectors, particularly if we examine sectors at a high level of aggregation, there are three important reasons to estimate all three regression specifications.[5] First, for some of the major U.S. importing sectors (such as footwear) only import price indexes are available. Also, for some of the main exporting sectors (such as aircraft and parts) only export price indexes are available. Second, by comparing the results of the first and second specifications, we can determine the extent to which previous studies that estimated the sensitivity of employment and wages may have been biased by omitting the export price variable. Third, we can observe the sensitivity of the export price coefficients to the omission of import prices by comparing the first and third regression specifications.

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[5]Due to data availability, sectors are examined at the three-digit SIC level in this paper.

III. EMPIRICAL RESULTS

The reduced-form wage and employment equations were estimated using quarterly observations from December 1980 through December 1991.[6] The regressions were estimated with both current and lagged values of all of the explanatory variables included in order to allow time for markets to adjust and to move from one long-run equilibrium to another. Unfortunately, there is no theoretical basis for determining the appropriate lag structure. A variety of lag structures was experimented with. The regressions were estimated several times with lags of different length on all of the explanatory variables. A major constraining factor was the limited number of observations for each sector. Therefore, regressions using polynomial distributed lags of various degrees were also estimated in order to reduce the number of parameters to be estimated. Since the results were essentially the same, and to avoid running into degrees of freedom problems, two lags were included for all the variables. Further experimentation with the dynamic specification did not improve the estimates. For example, including the lagged dependent variable in the regressions did not significantly change the estimated long-run elasticity on the import and export price variables. It also did not seem appropriate to arbitrarily impose restrictions on the lag structure, although that might have improved the efficiency of the estimates by reducing the number of irrelevant variables.[7]

Tables 1 and 2 present the OLS estimates.[8] The dependent variable in Table 1 is employment measured as average person-hours. The dependent variable in Table 2 is the industry wage. Only the coefficients on the import and export price variables are reported in Tables 1 and 2. These coefficients are the long-run or total elasticities (the sum of the current

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[6]A discussion of the data sources and the industries selected for study can be found in the Appendix. Not all of the sectors had export and import prices for the entire period from December 1980 until December 1991. Therefore, depending on the availability of data for each sector, the time period under study was altered slightly. For example, the first and third regression specifications for the meat products sector were restricted to begin from March 1983 because of lack of data on export prices. The second specification regression was conducted for the whole time period. Also, the availability of only export price data beginning from December 1983 for the plastic material sector and import price data beginning from June 1983 for the electronic components and accessories sector restricted the time periods of the regressions for those sectors.

[7]A discussion of the treatment of lags and the difficulties associated with determining the appropriate lag structure can be found in Goldstein and Khan (1985).

[8]All of the data are not seasonally adjusted. Therefore, it was necessary to include seasonal dummies in all of the regressions.

and lagged coefficients) on the import and export price variables (standard errors are in parentheses[9]).

All of the equations were tested for autocorrelation of the residuals. Following Solon (1984), first-, second- and third-order autocorrelations were obtained from autoregressions (including an intercept term) of the residuals. Since the autocorrelations are not consistent for a short time series, they were compared to autocorrelation values reported in Solon (1984) to correct for inconsistency. There was no significant evidence of autocorrelation of the residuals. The average of the first-order autocorrelations across industries obtained from regressions of the OLS residuals in the employment regressions that included both of the trade prices was 0.07.

Column 1 of Tables 1 and 2 present the estimates obtained from the first regression specifications based on equations (10) and (11) respectively, that include both the import and export variables as explanatory variables. The second column presents the estimates obtained when the export price is excluded as an explanatory variable (the second specification corresponding to equations (12) and (13)) and the third column presents the coefficients from the third specification that are estimated with the import price variable excluded.

The coefficients in Table 1 represent the total elasticity of employment due to changes in the import price or the export price. For example, in the first specification, a 1 percent rise in the price of an imported substitute will cause a 0.35 percent rise in average hours worked in the broadwoven fabric mills, manmade fiber and silk sector. Moreover, the total impact on employment of a 1 percent rise in the import price and a 1 percent rise in the export price in that sector is a 1.897 percent rise in employment (calculated as the sum of the coefficients on the import and export price variables). Similarly, the coefficients reported in Table 2 represent the total elasticities of wages with respect to the import and export prices.

As predicted by the theory, almost all of the coefficient estimates on the import price variable in Table 1 are positive, although many are not significant. In particular, the estimated coefficient estimates on the import price variable in specification two are similar in magnitude to those obtained by Grossman (1987). Furthermore, comparing the coefficient on the import price in the regressions of specification one, to those of specification two, reveals that excluding the export price variable does not significantly alter the magnitude of the coefficient estimates in most cases. At the same time, several of the coefficient estimates on the export price variables in Table 1 are negative, and many of these are significant at the 5 percent level.

There are a number of possible explanations as to why several of the coefficients in all three specifications of the reduced form equations in Table 1 are insignificant. First, the sample size for each sector may be too small to generate precise estimates of the coefficients. This also restricted the number of lags included in the regressions to two lags. Therefore, the

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[9]The standard errors on the summed coefficients are obtained from an F-test of the hypothesis that the sum of the coefficients is equal to zero. An F-test with one degree of freedom is equivalent to the square of the t-test.

full effects of changes in trade prices may not have been captured if it takes longer than two quarters for price changes to affect employment and wages. Second, it is reasonable to expect that import and export prices in a perfectly competitive economy will be highly collinear. For example, exchange rate fluctuations simultaneously affect the import and the export prices, causing them to move together. One potential remedy for collinearity is to drop one of the explanatory variables.[10] Therefore, it may be preferable to obtain estimates of the impact of changes in the import and export prices on employment and wages separately from specifications two and three.

The coefficients on the import price variables do not alter significantly in a comparison of regression specifications one and two. On the other hand, the coefficients on the export price variables are either less negative or more positive in specification three than in specification one. However, for many sectors the coefficient on the export price is still negative in specification three.

There are a number of reasons why the export price variable might not be positively correlated with employment and wages. Following the discussion in Section II, it could be that export prices are endogenous. If foreign consumers view U.S. exports as imperfect substitutes for other goods, high prices on U.S. exports relative to world markets will reduce foreign demand for them. This occurs despite the fact that high demand for U.S. exports would be reflected by higher export prices. Therefore, an instrumental variables (IV) estimation strategy was used — 2SLS — to correct for the simultaneity of the export prices. The results are discussed below.

In addition, there are reasons why U.S. producers may not be as responsive to changes in prices as are consumers.[11] One possible explanation is illustrated by considering a simple model of exchange rate pass-through. Suppose there are two countries: the United States and Germany. A depreciation of the dollar stimulates demand for U.S. exports of, say, computer and office equipment, thus raising the dollar price. If the exchange rate change had no other effects, the depreciation of the dollar would have simply raised the volume of computer and office equipment traded and its dollar price. However, if the industry uses traded (imported) inputs, the depreciation of the dollar relative to the mark raises the costs of production and shifts the industry supply curve to the left, pushing up export prices still further, but reducing the volume of trade. By this mechanism, the overall response of

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[10]See Johnston (1984, p.253) for a detailed explanation.

[11]It is also important to note that the response of producers to price changes depends on the structure of the industry. Many of the sectors that contribute a large share of U.S. exports may be monopolistic (such as the aircraft and parts industry) or oligopolistic (such as the motor vehicle industry) rather than competitive. Changes in demand in monopolistic and oligopolistic industries will lead to endogenously rather than exogenously set prices.

employment to changes in the exchange rate and export prices is dampened.[12] Also, if U.S. exports are subject to voluntary restraint agreements or if imports of U.S. products in foreign markets are subject to quota restrictions U.S. industries may be unable to sell more of their products abroad even if export prices rise. Thus, export price variations under these conditions will not alter the production and employment levels in the United States.

Table 3 reports the IV (or 2SLS) estimates from the second-stage regressions conducted to correct for the endogeneity of the export prices. In the first-stage regressions, the export prices were regressed on all of the exogenous variables, including the variables that capture the geometric average of the gross domestic product of countries that account for more than 5 percent of an industry's exports.[13] The coefficients in the first-stage regressions of the contemporaneous export prices on the contemporaneous average of the gross domestic product of country's that receive more than 5 percent of U.S. exports have the expected negative sign and the regression R^2 values are extremely high. It is evident from Table 3 that the coefficients on the export prices in the employment regressions are mainly positive — two of the four sectors that had negative coefficients in the OLS regressions have positive coefficients in the IV regressions, and most of the sectors that had positive coefficients in the OLS regressions have larger positive coefficients in the IV regressions.[14] However, almost all of the coefficients on the import prices are now negative rather than positive. The effect that using instruments has on the coefficients is consistent with strong collinearity between the import and export prices. Since in many cases the import and export prices are positively correlated, the IV estimation strategy will make the coefficient on the export price variable more positive and the coefficient on the import price variable less positive or more negative. This is because if the trade prices are collinear, one can be more confident about the effect of increasing both of the trade prices simultaneously rather than about the effect of increasing one or the other. So, if the effect of the export prices increases for any reason (including using instruments), the estimated effect of the import prices will go down. Furthermore, none of the coefficients in the IV analysis are significant at conventional significance levels.

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[12]Ideally, a price index of inputs used in production should be included in the regressions for each industry in order to account for the indirect effects of trade from one industry to another. However, constructing industry-specific input prices is a difficult procedure since inputs used in production are not categorized for each industry according to the SIC system.

[13]Since the reduced-form equations for employment and wages are estimated including two lags of the export price variable, contemporaneous and two lagged values of the gross domestic products of the countries that receive U.S. exports were used as instruments. Also, for the broadwoven fabric mills, manmade fiber, and silk sector, and the construction and related machinery sector it was found appropriate to include the contemporaneous geometric average of the exchange rates of countries that receive more than 5 percent of U.S. exports as an additional instrument.

[14]All of the sectors that are classified as import sectors have positive coefficients on the export price variable in the IV regressions.

An additional caveat is that all of the model specifications in the OLS and IV analyses are estimated under the presumption that the import prices are determined independently of the level of employment and wages. However, there is sufficient reason to believe that neither the import nor the export prices are exogenous. The United States is a large economy. Therefore, shifts in U.S. demand alter world prices, as well as domestic employment and wages. Similarly, shifts in the supply of products from a sector will not only alter the domestic prices of the goods from that sector but will also affect export prices. These supply shifts may also contribute to the large, negative coefficients on the export prices generated in the OLS regressions. For example, the 1980s may have been a period of declining production and employment, and higher export prices for some of the sectors studied.[15] Other disturbances, such as changes in tastes or material costs, may also simultaneously affect employment, wages and trade prices.

An IV technique is employed to correct for the endogeneity of both trade prices. Source-weighted industry exchange rates both contemporaneous and with two lags were used to instrument for the import price variables. The instrument is constructed as a geometric average of the nominal exchange rate of countries that account for more than 5 percent of industry imports, where the weights, w_j are given by $w_j = m^j_{US}/M_{US}$, where m^j_{US} is U.S. imports from country *j* in 1990 and M_{US} is U.S. total imports for that particular industry. Revenga (1992) used this method to correct for the endogeneity of import prices. Her 2SLS estimates of the elasticity of employment with respect to the import prices are much larger in magnitude from the OLS estimates. Applying the IV technique (using source-weighted exchange rates as instruments for both trade prices) to my data did not move the OLS estimates in any particular direction to be more positive or more negative. Also, using contemporaneous and lagged source-weighted exchange rates as instruments for import prices, and contemporaneous and lagged weighted gross domestic products of the countries that receive more than 5 percent of U.S. exports as instruments for the export prices did not alter the results significantly and did not make the import price coefficients more positive. The only effect of the IV technique was to vastly reduce the efficiency of the estimates.[16] Furthermore, the standard errors of Revenga's estimates also rose when the IV strategy was applied, thus reducing the significance of her estimates.

OLS estimates of the responsiveness of wages to changes in the competitive environment, reported in Table 2, are vulnerable to many of the same criticisms as the employment elasticities. Again, many of the coefficients are insignificant. The coefficients on the import and export price variables in all three regression specifications are smaller in magnitude than the employment coefficients. This result implies that the response of wages to

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[15]Unfortunately, data on production levels are not available on a quarterly (nor monthly) basis for three-digit SIC industries. Therefore, it was impossible to estimate the impact of changes in the trade prices on the output levels of the industries.

[16]The estimates are too weak to warrant reporting.

changing trade patterns is slight and that most of the adjustment occurs through intersectoral mobility of labor. The elasticities are not significantly different across the import-competing sectors, the export-competing sectors, and the two-way trade sectors for all three regression specifications.

Again, the IV technique did not alter the wage elasticities significantly, but only reduced the efficiency of the estimates. The results from instrumenting for the export prices using the gross domestic products of countries that receive U.S. exports are also presented in Table 3. Revenga, on the other hand, finds that the wage elasticity goes from being slightly negative in the OLS estimates to positive (but smaller in magnitude than the employment elasticity) after instrumenting. However, in her study the change in the sign and magnitude of the coefficient on the import price is accompanied by a significant rise in the standard errors of her estimates.

IV. CONCLUSIONS

The increased share of trade in the U.S. economy over the past two decades has raised concerns about the effects of international competition on employment and wage levels. Previous studies have concentrated mainly on the effects of import prices on employment and wages in U.S. industries. This paper extends the approach taken by Haveman (1992), who also incorporates the effects of changes in export prices, by examining the effects of changing import and export prices separately for each of twelve three-digit SIC manufacturing sectors.

Three alternative regression specifications were estimated using OLS which include: (i) import prices only (this replicates Grossman's approach), (ii) export prices only, and (iii) both trade prices. Furthermore, an IV technique was employed in order to address the issue of endogeneity of the trade prices. The estimations revealed four main conclusions.

First, changes in import and export prices do not have significant effects on employment and wage levels for most of the sectors in both the OLS and IV regressions. These results may be partly a consequence of the limited number of observations for each sector, which in turn imposes limitations on the lag structure employed in the regressions. Truncating the trade price variables at two lags may not have permitted the capturing of the full effects of changes in trade prices.

Second, the coefficients are generally larger in the employment regressions than in the wage regressions, suggesting a larger impact of trade prices on employment levels than on wage levels.

Third, the coefficient estimates on export prices tended to be larger than the coefficient estimates on import prices, suggesting a larger impact of export prices on employment and wages.

Fourth, while import prices are generally positively correlated with employment and wages in the OLS regressions, the same cannot be said about export prices where the results are mixed. Negative correlations between export prices and the employment and wage levels suggest that U.S. exports in this sector are imperfect substitutes for foreign goods: an increase in U.S. export prices relative to prices of other countries would reduce foreign demand for U.S. exports. The IV analysis corrects for the endogeneity of the export prices. However, although the coefficients on export prices become mainly positive and large in the IV regressions, the estimates are no longer significant.

Table 1. Ordinary Least Squares Regressions: The Sensitivity of Employment to Import and Export Prices

		Specification 1			Specification 2		Specification 3	
SIC Code	Industry Name	Import Price	Export Price	R-squared	Import Price	R-squared	Export Price	R-squared
	Import-Competing Sectors							
222	Broadwoven Fabric Mills,	0.3532	1.5440	0.9721	0.3270 *	0.9598	1.6930 **	0.9533
	Manmade Fiber and Silk	(0.2563)	(1.4099)		(0.1561)		(1.0001)	
357	Computer and Office	0.4246 **	-1.3942 **	0.9931	0.4051 **	0.9909	-1.8821 *	0.9910
	Equipment	(0.2158)	(0.7536)		(0.2085)		(0.7256)	
365	Household Audio and	0.3244	0.4489	0.9614	0.4510	0.9501	1.9715	0.9284
	Video Equipment	(0.3741)	(1.0979)		(0.3067)		(1.2036)	
371	Motor Vehicles and	0.7288	-5.1431 *	0.9744	-0.2275	0.9627	-5.0334 *	0.9698
	Equipment	(0.7194)	(2.3703)		(0.5830)		(1.5552)	
314	Footwear, except rubber				0.2064	0.9894		
					(0.3352)			
	Two-Way Trade Sectors							
367	Electronic Components	0.2052	-0.9578	0.9867	0.6410 *	0.9710	-0.2677	0.9731
	and Accessories	(0.2462)	(0.8335)		(0.2312)		(0.3123)	
201	Meat Products	-0.0641	0.0531	0.9972	0.0629	0.9958	-0.0210	0.9968
		(0.1769)	(0.1498)		(0.0649)		(0.0592)	
356	General Industrial	0.0835	-4,1997 *	0.9835	0.0134	0.9544	-2.7117 *	0.9697
	Machines	(0.0563)	(0.8081)		(0.1708)		(0.8788)	
352	Farm and Garden						-0.8927	0.9763
	Machinery						(1.1262)	
	Export-Competing Sectors							
353	Construction and	-0.1969	2.0008	0.9903	-0.2484	0.9889	2.7611 **	0.9892
	Related Machinery	(0.2412)	(1.7795)		(0.2302)		(1.5688)	
282	Plastic Material						0.0083	0.9793
	and Synthetics						(0.1297)	
372	Aircraft and Parts						-1.5361 *	0.9698
							(0.5607)	

Notes: Dependent variable is employment measured as average person-hours.
Figures in parentheses indicate standard errors.
* denotes significance at the 5 percent level.
** denotes significance at the 10 percent level.

Table 2. Ordinary Least Squares Regressions: The Sensitivity of Wages to Import and Export Prices

SIC Code	Industry Name	Specification 1: Import Price	Specification 1: Export Price	Specification 1: R-squared	Specification 2: Import Price	Specification 2: R-squared	Specification 3: Export Price	Specification 3: R-squared
	Import-Competing Sectors							
222	Broadwoven Fabric Mills,	-0.0530	0.5597 *	0.9930	0.0043	0.9990	0.1984	0.9991
	Manmade Fiber and Silk	(0.0448)	(0.2465)		(0.0267)		(0.1565)	
357	Computer and Office	0.2689 *	1.1934 *	0.9952	0.1711	0.9980	1.1553 *	0.9977
	Equipment	(0.0833)	(0.2909)		(0.1029)		(0.3858)	
365	Household Audio and	-0.4417	-0.2843	0.9837	-0.6199 *	0.9829	0.0514	0.9800
	Video Equipment	(0.3221)	(0.9452)		(0.2379)		(0.8445)	
371	Motor Vehicles and	-0.1471	-0.8505	0.9863	-0.3806 *	0.9933	-0.8403	0.9931
	Equipment	(0.2255)	(0.7431)		(0.1731)		(0.5730)	
314	Footwear, except rubber				0.0109	0.9989		
					(0.0649)			
	Two-Way Trade Sectors							
367	Electronic Components	-0.0646 **	0.1291	0.9999	-0.0874 *	0.9998	0.1162 *	0.9997
	and Accessories	(0.0335)	(0.1133)		(0.0269)		(0.0563)	
201	Meat Products	0.0159	-0.0182	0.9994	0.0035	0.9939	-0.0032	0.9994
		(0.0367)	(0.0237)		(0.0292)		(0.0120)	
356	General Industrial	-0.0726 **	-0.1039	0.9986	-0.0559	0.9985	-0.1279	0.9980
	Machines	(0.0397)	(0.2544)		(0.0334)		(0.2427)	
352	Farm and Garden						0.4355	0.9583
	Machinery						(0.6248)	
	Export-Competing Sectors							
353	Construction and	0.0208	0.4990	0.9952	0.0174	0.9932	0.7132 **	0.9946
	Related Machinery	(0.0565)	(0.4170)		(0.0599)		(0.3671)	
282	Plastic Material						0.0267	0.9995
	and Synthetics						(0.0531)	
372	Aircraft and Parts						0.3564 *	0.9993

Notes: Dependent variable is wages measured as average hourly earnings per week.
Figures in parentheses indicate standard errors.
* denotes significance at the 5 percent level.
** denotes significance at the 10 percent level.

Table 3. Instrumental Variables Regressions Including both Import and Export Prices

		Dependent Variable					
		ln Employment			ln Wages		
SIC Code	Industry Name	Import Price	Export Price	R-squared	Import Price	Export Price	R-squared
	Import-Competing Sectors						
222	Broadwoven Fabric Mills,	-0.2934	11.9899	0.7584	-0.1798	2.2878	0.9928
	Manmade Fiber and Silk	(1.7471)	(15.5845)		(0.2968)	(2.6492)	
357	Computer and Office	1.0426	2.7292	0.9760	0.1901	1.6050	0.9963
	Equipment	(0.7139)	(3.7071)		(0.2936)	(1.5244)	
365	Household Audio and	-1.3789	8.2671	0.5989	1.2180	-6.5625	0.7858
	Video Equipment	(4.0260)	(21.2397)		(3.1910)	(16.8324)	
371	Motor Vehicles and	-2.1612	1.6030	0.9160	-0.9389	1.0662	0.9855
	Equipment	(5.8820)	(13.8481)		(1.6744)	(3.9488)	
	Two-Way Trade Sectors						
367	Electronic Components	-0.2212	-1.9218	0.9610	-0.0094	0.3961	0.9994
	and Accessories	(0.8428)	(3.7081)		(0.1308)	(0.5778)	
201	Meat Products	-0.2102	0.0785	0.9963	0.0070	-0.0023	0.9991
		(0.4041)	(0.3775)		(0.0839)	(0.0023)	
356	General Industrial	-0.2458	-5.1264	0.9831	-0.1026	-0.0023	0.9981
	Machines	(0.3475)	(3.7117)		(0.1089)	(0.0236)	
	Export-Competing Sectors						
353	Construction and	-0.2050	6.7900	0.9544	-0.1489	-0.0675	0.9921
	Related Machinery	(0.9611)	(14.1091)		(0.1158)	(1.6872)	

Notes: Figures in parentheses indicate standard errors.
The source-weighted average of the GDP of the countries that receive more than 5 percent of U.S. exports is used as the instrument in these regressions with the exception of the broadwoven fabric mills, manmade fiber and silk sector, and the construction and related machinery sector where the source-weighted average of the exchange rates of countries that receive more than 5 percent of U.S. exports is also used.

DATA AND VARIABLE CONSTRUCTION

Twelve three-digit SIC manufacturing sectors were chosen for study primarily based on whether they were generally regarded as being export or import competitors. In this way, we can determine if the sensitivity of the sectors to trade prices varies depending on whether a sector is primarily an exporter or an importer. In addition, an import-penetration ratio (IPR), defined as imports as a fraction of domestic sales, and an export-penetration ratio (EPR), defined as export sales as a fraction of domestic production, were calculated for each industry. A comparison of the ratios for each industry was used to categorize the industries as import-competing or export-competing (Table A1).

All the industries that had an IPR-EPR ratio of greater than 1.5 were considered to be import-competing. Industries with an IPR-EPR ratio less than 0.5 were considered export-competing. Since the values of IPR and EPR are similar for several industries, and it would be incorrect to classify them as solely import-competing sectors or export-competing sectors, they were classified in a separate category as sectors with two-way trade. Table A1 reveals that several industries have an IPR-EPR ratio that is close to one, thus justifying the use of the first specification of the reduced form equations, which include both the export and the import prices.

The period of study was restricted by the availability of import and export price indexes for the three-digit SIC sectors. The import and export price indexes for the period of December 1980–December 1991 were obtained from the Bureau of Labor Statistics. The price indices are published on a quarterly basis and they represent the third month of each quarter. The indexes are Laspeyres indexes with weights based on 1985 U.S. trade values.[17] There is strong positive correlation between the trade prices for a number of sectors (Table A2). This is not surprising since many changes in the economy, such as exchange rate fluctuations or changes in overall costs of materials, can move the trade prices in the same direction. Alternatively, trade liberalization may be expected to lead the trade prices to move in opposite directions. For example, lower tariffs imply lower prices for imports, which would increase domestic demand for imports as well as demand for foreign currency. The domestic currency would then depreciate, leading to an increase in the domestic (dollar) price of exports.[18] From Table A2 it is evident that there is a negative correlation between the import and export prices for three of the eight sectors for which data on both trade prices are available. Two of these sectors were classified as import-competing sectors, and the third was classified as a sector with a high degree of two-way trade.

The source of the data on employment and wages is the Bureau of Labor Statistics'

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[17]Bureau of Labor Statistics. *Handbook of Methods*. The export prices are based on f.a.s. (free alongside ship) prices at the U.S. port of exportation. On the other hand, the import prices are based on c.i.f. (cost, insurance, freight) prices at the U.S. port of importation.

[18]A devaluation of the U.S. dollar can also partially increase the dollar price of imports.

Employment and Earnings. The product of the number of production workers and the average number of hours worked per week was used as a measure for industry employment. Production worker average hourly earnings per week was used as a measure for the wage variable in each industry.

Data for the aggregate price level, aggregate industrial production, aggregate labor force and aggregate capital stock were taken from the *Survey of Current Business*. The producer price index was used as a proxy for the aggregate price level. Data for the price of energy was obtained from the Citibank Economic database. All of these data, except for the aggregate capital stock, were available on a monthly basis and were converted to quarterly data. The data on the aggregate capital stock were obtained from revised estimates of *Fixed Reproducible Tangible Wealth in the U.S. for 1925-1990* published in (various issues) of the *Survey of Current Business*. The data are published on an annual basis. Thus, a procedure of interpolation was used to obtain quarterly estimates of the aggregate capital stock.[19]

In order to construct instruments for the export prices, data for export volumes by country in 1990 were taken from *Statistics Canada*. The data for the export volumes are only available according to the Standard International Trade Classifications (SITC) system. Therefore, following Revenga (1992), a concordance between the SITC and SIC systems was developed using the *U.S. Foreign Trade Statistics: Classifications and Cross-Classifications* that is published by the Department of Commerce. The procedure involved using the concordance between the Tariff Schedules of the United States Annotated (TSUSA) and the SIC systems and then obtaining the corresponding SITC categories using the Schedule A classifications.

Quarterly data for the gross domestic products of the countries that account for more than five percent of the industry's exports are obtained from the OECD's *Main Economic Indicators: Historical Statistics 1969-1988*.[20] The data was supplemented by data on gross domestic product for the period after 1988 or for the countries that are not included in the OECD publication by using data on gross domestic product from the IMF's *International Financial Statistics*. For some of the countries only annual gross domestic product is available. A process of linear interpolation was used to obtain quarterly data in these cases. The nominal exchange rates of various countries from 1980 to 1991 are obtained from the IMF's *International Financial Statistics*.

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[19]A log-linear interpolation was used where $lnK_{T,j} = j\,ln\,(1+\alpha_T) + lnK_{T-1,4}$ for j = quarter 1, 2, 3 and $ln\,(1+\alpha_T) = (lnK_{T,4} - lnK_{T-1,4})/4$.

[20]Some countries only report gross national product and so this was used instead.

Table A1. Industry Characteristics

SIC code	Industry Name	IPR 1/	EPR 2/	IPR/EPR
	Import-Competing Sectors			
222	Broadwoven Fabric Mills, Manmade Fiber and Silk	0.09	0.04	2.26
357	Computer and Office Equipment	0.55	0.06	9.82
365	Household Audio and Video Equipment	0.55	0.11	4.90
371	Motor Vehicles and Equipment	0.23	0.09	2.68
314	Footwear, except rubber	0.61	0.02	28.39
	Two-Way Trade Sectors			
367	Electronic Components and Accessories	0.24	0.18	1.34
201	Meat Products	0.04	0.04	0.87
356	General Industrial Machines	0.14	0.15	0.98
352	Farm and Garden Machinery	0.15	0.15	0.97
	Export-Competing Sectors			
353	Construction and Related Machinery	0.13	0.28	0.45
282	Plastic Material, Synthetics	0.04	0.11	0.35
372	Aircraft and Parts	0.10	0.37	0.27

Source: NBER Trade Database.
Note: Based on 1984 trade data.
1/ IPR is calculated as imports as a fraction of domestic sales.
2/ EPR is calculated as exports as a fraction of domestic production.

Table A2. Correlations Between Import Prices and Export Prices

SIC code	Industry Name	Pearson Correlations
	Import-Competing Sectors	
222	Broadwoven Fabric Mills, Manmade Fiber and Silk	0.91
357	Computer and Office Equipment	-0.69
365	Household Audio and Video Equipment	-0.24
371	Motor Vehicles and Equipment	0.96
	Two-Way Trade Sectors	
367	Electronic Components and Accessories	-0.60
201	Meat Products	0.36
356	General Industrial Machines	0.89
	Export-Competing Sectors	
353	Construction and Related Machinery	0.82

Source: Bureau of Labor Statistics.

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