Survival of the Best Fit: Exposure to Low-Wage Countries and the (Uneven) Growth of US Manufacturing Plants*

Andrew B. Bernard†
Tuck School of Business at Dartmouth & NBER

J. Bradford Jensen‡
Institute for International Economics

Peter K. Schott§
Yale School of Management & NBER

April, 2003

Abstract

This paper examines the role of international trade in the reallocation of U.S. manufacturing activity within and across industries from 1977 to 1997. It introduces a new measure of industry exposure to international trade, motivated by the Heckscher-Ohlin model, which focuses on where imports originate rather than their overall level. Results demonstrate that plant survival as well as output and employment growth are negatively associated with the share of industry imports sourced from the world's lowest-wage countries. Within industries, activity is reallocated towards capital-intensive plants. Plants are also more likely to alter their product mix (i.e. switch industries) in response to trade with low-wage countries. Plants altering their product mix switch to industries that are more capital- and skill-intensive.

Keywords: Low-Wage Country Import Competition, Heckscher-Ohlin, Manufacturing Plant

JEL classification: F11, F14 , L25, L60

*We thank Bruce Blonigen, Robert Feenstra and Gordon Hansen for helpful suggestions. The research in this paper was conducted at the Center for Economic Studies. Results and conclusions are those of the authors and do not necessarily indicate concurrence by the Bureau of the Census or by the NBER. The paper has been screened to insure that no confidential data are revealed. It has not undergone the review that Census gives its official publications.v0.66

†100 Tuck Hall, Hanover, NH 03755, *tel*: (603) 646-0302, *fax*: (603) 646-0995, *email*: andrew.b.bernard@dartmouth.edu

‡1750 Massachusetts Avenue, Washington, DC, 20036-1903, *tel*: (202) 328-9000, *email*: jbjensen@iie.com

§135 Prospect Street, New Haven, CT 06520, *tel*: (203) 436-4260, *fax*: (203) 432-6974, *email*: peter.schott@yale.edu

1. Introduction

U.S. manufacturing has undergone significant change over the past 40 years. Relative to other sectors of the economy, it has shrunk substantially. Employment has declined from 26% of all workers in 1960 to 14% in 2000, while output as a share of GDP has fallen from 27% to 16%. At the same time, significant reallocation has occurred across industries within manufacturing: T-shirts and televisions are out, PDAs and pharmaceuticals are in.

International trade is a prime suspect in these trends. Indeed, as U.S. trade barriers have fallen, low-wage countries like China and India have begun exporting to the U.S. many of the more labor-intensive products formerly produced at home. This product cycling – where the U.S. moves out of labor-intensive products like T-shirts and televisions as lower-cost developing countries move in – is a key feature of standard trade models. Given high relative wages, it is virtually impossible for the U.S. to survive head-to-head competition with the world's most labor-abundant countries in labor-intensive industries.

This paper examines the reallocation of industries within manufacturing, as well as the reallocation of manufacturing plants within industries. We match plant-level input and output data to a new measure of U.S. exposure to international trade motivated by the Heckscher-Ohlin factor proportions framework. We address three questions. First, is plant survival less likely, and is plant employment and output growth disproportionately lower, for plants in industries where the world's lowest-wage economies have greater U.S. import presence? Second, within industries, are capital- and skill-intensive plants – i.e. the plants most likely to be producing goods in line with U.S. comparative advantage – more likely to survive and grow relative to labor-intensive plants? Finally, do U.S. manufacturing plants adapt to imports from low-wage countries by altering their product mix towards industries where the U.S. possesses comparative advantage?

Our analysis provides the first evidence linking U.S. manufacturing plant outcomes to international trade from low-wage countries. A key contribution of our analysis is the finding that the *origin* of imports, rather than their overall level, is significantly related to industry and plant reallocation over time. This evidence supports a key implication of the factor proportions framework which has labor-intensive industries (and plants) in a capital-abundant country like the U.S. being most at risk from an increasingly open world trading system.

We find both statistically significant and economically meaningful links between low-wage imports and plant outcomes. First, the probability of plant survival as well as employment and output growth from 1977 to 1997 are lower for plants in industries where low-wage country import presence is high. Our findings indicate that a 10 percentage point increase in the share of low-wage country imports is associated with a 3.3 percentage point increase in the probability of plant death, and a 1.3 percentage point decline in year-on-year plant employment growth rates. Second, within industries, plant survival as well as employment and output growth are higher for capital-intensive plants. Third, the probability that a plant alters what it produces (i.e. switches industries) rises with the presence of low-wage countries and declines with the plant's capital intensity. If a plant does switch industries, it moves into an industry that is more capital- and skill-intensive, and that has a lower share of low-wage country imports.

Our approach is unique in two respects. First, motivated by the factor proportions framework, we measure an industry's exposure to international trade in terms of where imports originate instead of their magnitude. We identify this exposure via the share of industry imports sourced from countries with less than 5% of U.S. per capita GDP. Use of this value share allows for a cleaner test of the implications of the framework than previously used proxies (e.g. import penetration). Low-wage country value shares also have practical advantages over traditionally used measures of import competition. Unlike import penetration, they do not incorporate information about domestic production. Unlike import price indexes, they can be computed for disaggregate products and are available for a long time series.

A second difference between this paper and previous work is our examination of plants rather than industries, and our finding that plant outcomes are related to plant input-intensities. One interpretation of this result – motivated by the factor proportions framework – is that variation in a plant's input intensity signals variation in the types of goods it produces within an industry. The most capital- and skill-intensive plants in the U.S. Optical Instruments industry, for example, likely produce capital- and skill-intensive microscopes rather than labor-intensive magnifying glasses. As a result, these plants compete less directly with the labor-intensive magnifying glass imports from low-wage, labor-abundant countries. Consideration of plant characteristics provides a more complete analysis of the link between international trade and plant survival and growth, and pushes our inquiry one step closer to the agents making decisions. This advantage allows us to examine a richer set of potential reactions to international trade, such as plant shutdowns and plant-level industry switches.

This paper is most closely related to existing industry-level studies of the effect of import competition on employment. The earliest of these efforts examine one or a few industries over a relatively short period of time and find little or no association between the level imports and industry employment growth (Krueger 1980; Grossman 1987; Mann 1988). More recent efforts based on larger sets of industries have established a negative correlation between employment growth and either imports (e.g. Freeman and Katz 1991, Sachs and Shatz 1994) or changes in import prices (e.g. Revenga 1992). Sachs and Shatz (1994) conclude industry employment levels fall between 1978 and 1990 due to imports from developing, rather than developed, countries. Here, we consider both cross- and within-industry changes due to foreign competition for a comprehensive set of disaggregate industries. In addition, we focus on plant outcomes (survival, growth, and product-switching) in the face of exposure to low-wage country imports predicted by the Heckscher-Ohlin model.

The remainder of the paper is organized as follows. The next section summarizes the theoretical framework guiding our analysis and outlines testable hypotheses. Sections 3 and 4 summarize our data and the construction of our low-wage country import value shares. Sections 5 and 6 present our econometric results and robustness checks. Section 7 concludes.

2. The Factor Proportions Framework

A key implication of the Heckscher-Ohlin trade model is that the industries produced in a country are a function of its relative endowments: in an open world trading system, relatively capital- and skill-abundant countries like the U.S. are expected to produce a more capital- and skill-intensive mix of industries than relatively labor-abundant countries like China. The standard Lerner (1952) diagram for depicting this equilibrium is displayed in the left panel of Figure 1. It illustrates the relative level of development of two countries – the U.S. and China – in a world of two factors and four industries. Industries are represented by unit value isoquants, with the capital intensity of industries increasing from Apparel to Chemicals. Exogenous world prices identify relative wages – which anchor isocost lines – for each cone of diversification.[1] The equilibrium depicted in Figure 1 has four cones of diversification: the U.S. is in the capital-abundant cone and produces Machinery and Chemicals while China is in the labor-abundant cone and produces Apparel and Textiles.

In the figure, the U.S. offers high wages (w_{US}) relative to its return to capital (r_{US}) due to its capital abundance. As a result, U.S. production of labor-intensive Apparel and Textiles is unprofitable. The negative profits that would be earned in those sectors can be seen by comparing the amount of capital and labor that can be bought for one dollar in the U.S. versus the amount of capital and labor needed to produce one dollar's worth of Apparel or Textile output. Relatively high capital costs in China, on the other hand, render production of capital-intensive Chemicals and Machinery unprofitable in that country. Though Figure 1 builds intuition for these relationships using just two factors, these results are easily generalized to a world of many factors and goods (Leamer 1987).

Removal of trade barriers leads to a reallocation of output and employment across industries as the industries formerly receiving protection disappear. The logic of this reallocation can be seen by comparing the right and left panels of Figure 1. In the right panel, trade barriers drive a wedge between the U.S. domestic prices of Apparel and Textiles, represented by grey unit value isoquants, and their world prices, represented by dashed isoquants. World prices for both industries are lower than the protected U.S. domestic price, and these lower world prices are represented by unit value isoquants that are further from the origin (where more capital and labor are required to produce one dollar's worth of output). When trade barriers are removed, the U.S. jumps to the equilibrium depicted in the left panel, where as noted above, Apparel and Textiles production is not viable.[2]

[1] "Cone" refers to the set of endowment vectors that select each pair of industries.

[2] While it is possible for firms in formerly protected industries to survive the removal of trade barriers via productivity improvements, the gains required to overcome competition from the world's lowest wage countries is likely considerable, even more so for the most

A difficulty in using the Heckscher-Ohlin model to motivate an inquiry into plant behavior is that the model focuses on countries, factors and industries, not plants. This focus is especially problematic given the growing evidence of within-industry plant heterogeneity: if plants in an industry are all representative of that industry (i.e. if they all produce an identical good), their production techniques and outcomes should be identical.

One way to reconcile the model with observed plant heterogeneity is to assume plants produce a bundle of products within an industry. This bundle is hidden from the researcher, who can only observe the primary industry in which the plant operates. This interpretation of plants is useful for two reasons. First, observed plant characteristics, particularly plant input intensities, can be used to augment the relative coarseness of the observed industries used to track plant output. This interpretation assumes labor-intensive plants within an industry in the U.S. are more likely than capital-intensive plants to be producing the labor-intensive goods emanating from low-wage countries. Second, viewing firms as bundles of products provides an explanation for why the removal of trade barriers does not result in the immediate death of *all* plants in a newly unprotected industry. Under protection, plants are indifferent to producing capital- and labor-intensive goods, with the result that some plants may produce both types while others produce only one type. When trade barriers fall, plants solely producing labor-intensive products disappear along with their product lines. However, plants that formerly produced both types of goods do not necessarily die. Instead, they may reallocate resources toward more viable products.

We consider three testable hypotheses from the factor proportions framework:

Hypothesis 1 *Across industries, plant survival and plant growth decrease with an industry's exposure to imports from low-wage countries.*

The first hypothesis is a cross-industry prediction that follows directly from Figure 1. It implies plant survival and plant growth is lower for industries at odds with U.S. comparative advantage, i.e. industries where exposure to imports from low-wage countries is high.

labor-intensive industries. Nevertheless, our empirical analysis below controls for plant productivity.

Hypothesis 2 *Within industries, plant survival and plant growth is increasing in plant capital and skill intensity and plant productivity.*

The second hypothesis is a within-industry prediction that assumes plant input techniques are correlated with underlying product variation: labor-intensive plants within an industry are assumed to produce labor-intensive products within that industry, and are therefore assumed to be more at odds with U.S. comparative advantage than capital-intensive plants. As a result, labor-intensive plants are expected to fail or shrink relative to capital-intensive plants. The implication with respect to plant productivity is recognition of the fact that sufficiently high productivity can allow U.S. plants producing labor-intensive goods to survive head-to-head competition with labor-abundant countries.

Hypothesis 3 *Plants that switch industries move towards more capital- and skill-intensive industries and industries facing less exposure to imports from low-wage countries.*

In addition to failing or shrinking in response to the removal of trade barriers, plants may adapt by re-orienting their output away from that of low-wage countries. Approximately ten percent of the plants in our sample change their industry across the four panels we study. We investigate whether these plant responses are related to international trade.

3. U.S. Exposure to Low-Wage Country Imports

We introduce a new measure of industry import exposure to examine the link between U.S. manufacturing plant outcomes and international trade. This measure is motivated by consideration of the factor proportions framework. It differs from traditional measures of import competition, including import penetration and import price indexes, by focusing on where imports originate. As a result, our measure captures important heterogeneity in the types of goods within industries that labor- versus capital- and skill-abundant countries export to the U.S.

We measure an industry's exposure to imports from low-wage countries via the value share (VSH) of imports originating in these countries,

$$VSH_{it} = \frac{M_{it}^L}{M_{it}}, \tag{1}$$

where M_{it}^L and M_{it} are the value of imports from low-wage countries and the total value of imports in industry i in year t, respectively. VSH is bounded by zero and unity; a VSH of unity indicates all of an industry's imports originate in countries whose wages are very low compared to those of the U.S..[3]

We classify a country as low-wage in year t if its per capita GDP is less than 5% of U.S. per capita GDP.[4] GDP is useful for classifying countries because it is available for a much larger sample of countries than, for example, estimates of manufacturing wages. Our cutoff captures an average of 50 countries per year, and this set of countries includes China and India as well as most African nations. Table 1 provides a list of countries meeting the criteria in all years of the sample.

We choose a 5% cutoff for several reasons. Most important, it represents the world's most labor-abundant cohort of countries and therefore the set of countries most likely to have an effect on U.S. manufacturing plants according to the factor proportions framework. Second, though this cohort of countries is responsible for a relatively small *level* of exports, it accounts for a relatively significant share of U.S. import growth over time. Among countries with less than 30% of U.S. GDP per capita, the cohort of countries below the 5% cutoff experienced the largest increase in import share, by far, between 1972 and 1992. Finally, the set of countries defined by this cutoff is relatively stable, in terms of countries entering and leaving the set, over the 1972 to 1992 sample period we consider. Using data and concordances compiled by Feenstra (1996) and Feenstra et al. (2002), we are able to compute VSH for 385 of 459 four-digit SIC (SIC4) manufacturing industries between 1972 and 1992. These 385 industries encompass 88% of manufacturing employment and 91% of manufacturing value.

Table 2 summarizes VSH by two-digit SIC manufacturing industry and year. Years at the top of each column correspond to years for which we

[3] Feenstra (1994) demonstrates that VSH is related to import price indexes. The intuition for this relationship is that unavailable low-wage country varieties effectively have an infinite price, so a price index which includes these unavailable goods declines as they become available, i.e. as VSH rises.

[4] We use current real exchange rates to perform the conversion to U.S. dollars rather than a PPP exchange rate. For such low levels of income the use of current rates does not change the list of countries below the cutoff, while using PPP exchange rates sharply limits the available number of countries and years due to the lack of available data.

can observe plants in the U.S. Census of Manufactures. The VSH for each two-digit industry is an import value weighted average of the four-digit SIC industries it encompasses. To smooth out annual fluctuations, the VSH for year t is the average across years $t-5$ to $t-1$. The final row of the table reports an overall weighted average and standard deviation for aggregate manufacturing.

As indicated in the table, VSH varies substantially across time and industries. It is higher and increases more rapidly among industries with a larger share of labor-intensive products, including Apparel, Textiles and Leather. Across all manufacturing, VSH increases from 1.9% in 1977 to 5.7% in 1992 with much of this increase occurring in the most recent years. The mean and standard deviation for VSH across all four-digit SIC industries and time are 4.6% and 9.2%, respectively. Figure 2 shows the change in the low-wage import share from 1977-1992 for all SIC4 industries plotted against the capital-labor ratio for the industry in 1977. While there is substantial variation in the change of low-wage import shares, the biggest increases in VSH are concentrated in industries with the lowest capital intensities, as predicted by the theory.

To facilitate comparison of VSH with existing measures of international trade, the first two rows of Table 3 report the correlation of VSH with import penetration (imports divided by domestic absorption) and changes in real import price indexes.[5] Correlations in the table are for the pooled sample of industries across the four census years summarized in Table 2.[6] As expected, VSH is positively correlated with import penetration and negatively, but not significantly, correlated with changes in real import prices. The relatively low magnitudes of both correlations suggest that VSH may be picking up a unique attribute in the import data. The weak correlation with changes in real import prices may be due to the sparseness and relatively high level of industry aggregation of the import price indexes.

[5] Three-digit import price indexes are from Feenstra (1996). Though the availability of these indexes increases with time, they cover less than one third of SIC3 industries and are generally unavailable prior to the mid-1980s. As a result, the import price correlation in Table 3 is based upon an aggregation of VSH to SIC3 industries and therefore encompasses far fewer observations than the other correlations in the table.

[6] The correlations are net of time effects: each measure of import exposure is regressed on time dummies, and residuals from these regression are used to compute correlations.

Table 3 also reports the correlation of VSH with the value shares of alternate sets of countries that may be influential in U.S. outcomes. These groups include the OECD, the Asian Tigers and three definitions of "middle" income countries.[7] As indicated in the table, VSH is negatively correlated with the OECD value share and positively associated with the Tiger value share. Results are similar for the three middle value shares: VSH is positively correlated with the 5-25% group, uncorrelated with the 25-50% group, and negatively correlated with the 50-75% group. In our regression analysis below, we demonstrate the robustness of the link between plant outcomes and low-wage country import exposure to the inclusion of value shares from these alternate sets of countries.

In addition to its conceptual advantages, VSH has three practical advantages over traditional import measures. Most important, it is largely robust to shocks affecting both domestic production and imports. Import penetration ratios, for example, can induce negative correlation with plant output and employment growth due to the presence of domestic production in the denominator. In addition, because it is computed from product-level trade data, VSH is available for a wide range of aggregation. Finally, it can be computed for a long time series.

4. U.S. Manufacturing Plant Activity

Manufacturing plant data comes from the Censuses of Manufactures (CM) of the Longitudinal Research Database (LRD) of the U.S. Bureau of the Census starting in 1977 and conducted every fifth year through 1997. The sampling unit for the Census is a manufacturing establishment, or plant, and the sampling frame in each Census year includes detailed information on inputs, output, and products on all establishments. Regression analysis covers plant outcomes for four panels: 1977 to 1982, 1982 to 1987, 1987 to 1992 and 1992 to 1997.[8]

From the Census, we construct plant characteristics including the total value of shipments, total employment, total capital stock (K, the book value of machinery, equipment, and buildings) and the quantity of and

[7] OECD countries are the 22 members as of 1992, i.e. excluding Mexico, Korea and subsequent entrants. Asian Tigers are Korea, Taiwan, Singapore and Hong Kong.

[8] We do not consider plant outcomes from earlier Censuses of Manufactures because we do not observe VSH prior to 1972.

the wages paid to non-production (N) and production (P) workers in each Census year. Plant output is recorded at the four-digit SIC level of aggregation, which is our definition of industry for the remainder of the paper. Plant failure (alternately plant death or plant shutdown) is defined as the cessation of operations of the plant and represents a 'true' death, i.e. plants that merely change owners between Census years remain in the sample.

In constructing our sample, we make several modifications to the basic data. First, while the LRD does contain limited information on very small plants (so-called Administrative records), we do not include these records in this study due to the lack of information on inputs other than total employment. Second, we drop any industry whose products are categorized as 'not elsewhere classified' because these 'industries' are typically catch-all categories for relatively heterogenous products. In practice, this corresponds to any industry whose four-digit code ends in '9'. This reduces the number of industries in the sample to 337. Finally, we drop any manufacturing establishment that does not report one of the required input or output measures. We are left with roughly 443,000 observations encompassing roughly 245,000 plants in the four panels.

4.1. Measuring Plant Factor Input Intensities

Two input intensities can be observed in the LRD. Plant capital intensity is measured as the log of the ratio of plant capital stock to plant production workers. Skill intensity is harder to measure as there is relatively little information in the LRD on the characteristics of the workforce. We measure plant skill intensity as the non-production worker wagebill to production worker wagebill ratio,

$$N/P\ Wagebill\,Ratio \;=\; \frac{w_N N}{w_P P}, \tag{2}$$

where w_N and w_P are the wages of non-production and production workers, respectively. We use the wagebill ratio rather than the raw input ratio (N/P) to account for unobserved skill variation across plants and regions (Bernard and Schott 2002).

4.2. Measuring Plant Productivity

As noted above, productivity gains can play an important role in a plant's ability to survive low-wage country competition. As a result, our regressions control for plant total factor productivity (TFP). As is well known, accurately measuring a plant's multi-factor productivity is quite difficult. Since we have only single observations for many of the establishments in the sample, we are constrained in our choice of productivity measures. We estimate a simple five-input production function in logs for each industry and year using two types of capital, two types of labor and purchased inputs.[9] We recognize this procedure's inability to control for the co-movement of markups and productivity, or the co-movements of variable inputs and productivity. By construction the measure is mean zero for each industry in each period.

5. Empirical Results: Plant Survival and Growth

Plant outcomes between years t and $t+5$ are related to a set of year t plant characteristics ($\mathbf{Z}_{pt}$), the average import share of low-wage countries in the preceding five years (VSH_{it}), and interactions of plant input intensities and productivity with VSH_{it} ($\mathbf{X}_{ipt}$),

$$Outcome_p^{t:t+5} = f(\mathbf{Z}_{pt}, VSH_{it}, \mathbf{X}_{ipt}). \tag{3}$$

We relate the levels of plant and industry characteristics in year t to changes in plant outcomes across Census years t to $t+5$ to mitigate endogeneity of contemporaneous behavior and plant characteristics.[10]

We consider three types of plant outcomes. The first is plant death, which we estimate via probit,

$$\Pr\left(Death_p^{t:t+5}\right) = \Phi\left(\mathbf{Z}'_{pt}\boldsymbol{\alpha} + VSH'_{it}\beta + \mathbf{X}'_{ipt}\boldsymbol{\gamma}+\delta_t\right). \tag{4}$$

Our set of plant characteristics encompasses log total employment ($N+P$), age, log TFP, log capital intensity (K/P) and the N/P wagebill ratio from

[9] Using industry cost shares from Bartelsman et al. (2000) to generate plant TFP estimates does not alter any of the conclusions.

[10] As noted earlier, to smooth out annual fluctuations in the data, we computed VSH_{it} as the average of VSH_i across the preceding five years (i.e. $t-5$ to $t-1$).

equation (2).[11] Our inclusion of controls for plant size (total employment) and plant age is motivated by the empirical work of Dunne et al. (1988, 1989) and subsequent theoretical models by Hopenhayn (1992a,b), Olley and Pakes (1996) and others.[12] Equation (4) also includes time fixed effects, δ_t; industry or plant fixed effects are also added to some specifications, as noted.

The additional plant outcomes we consider are changes in plant employment and plant real output, which we estimate by OLS,

$$\Delta Employment_p^{t:t+5} = c + \mathbf{Z}'_{pt}\boldsymbol{\alpha} + VSH'_{it}\beta + \mathbf{X}'_{ipt}\boldsymbol{\gamma} + \delta_t + \boldsymbol{\varepsilon}_{pt}, \qquad (5)$$

$$\Delta Real\ Output_p^{t:t+5} = c + \mathbf{Z}'_{pt}\boldsymbol{\alpha} + VSH'_{it}\beta + \mathbf{X}'_{ipt}\boldsymbol{\gamma} + \delta_t + \boldsymbol{\varepsilon}_{pt}. \qquad (6)$$

Plant output is deflated with industry shipment deflators available in the NBER Productivity Database compiled by Bartelsman et al. (2000).[13] For symmetry, we use the same plant characteristics in (5) and (6) as in the death specification.[14] All three specifications control for plant capital and skill intensity as well as plant productivity.

The hypotheses derived earlier from the factor proportions framework give us predictions on the coefficients for VSH_{it} and $\mathbf{X}_{ipt}$. With plant death as the dependent variable, $\beta > 0$ indicates that plant failure is positively associated with industry exposure to low-wage imports (Hypothesis 1), while $\boldsymbol{\gamma} < 0$ indicates the probability of plant death is relatively lower for more capital- and skill-intensive plants in those same industries (Hypothesis 2).

[11] The LRD does not record the precise start year for any plant. Instead, we only know the first year the plant appears in a Census of Manufactures starting with the 1963 Census. Our measure of plant age is the difference between the current year and the first recorded Census year. Plants that are in their first Census are given an age of zero.

[12] The closed-economy model in Olley and Pakes (1996) also predicts faster growth for more capital intensive and productive plants.

[13] http://www.nber.org/nberces/nbprod96.htm

[14] Numerous studies on mean reversion in plant employment growth have documented the relationship between initial size and age and subsequent changes in employment (e.g. Hall 1987 and Blonigen and Tomlin 2001). While we are not interested in testing Gibrat's law *per se*, we include the log of initial employment as well as plant age in all our specifications.

For the specifications considering plant growth, $\beta < 0$ indicates reallocation of employment and output away from industries where the U.S. is at a comparative disadvantage (Hypothesis 1), while $\gamma > 0$ indicates reallocation towards more capital- and skill-intensive plants within those industries (Hypothesis 2).

Because our sample of plants includes deaths and births, we follow Davis and Haltiwanger (1992) in using a normalized growth rate in our analysis. For employment, this normalization is

$$\Delta Employment_p^{t:t+5} = \left(\frac{Employment_p^{t+5} - Employment_p^t}{\frac{1}{2}\left(Employment_p^{t+5} + Employment_p^t\right)} \right) /5. \quad (7)$$

The annualized growth rate is equal to 2 for new plants and -2 for dying plants. Because we cannot observe the characteristics of plants prior to their birth, we are unable to include birth observations in our empirical specifications below.[15]

5.1. Plant Shutdown and Exposure to Low-Wage Country Imports

Table 4 summarizes the estimated relationship between the probability of plant death between Census years t and $t+5$ and the average industry exposure to imports from low-wage countries across years $t-5$ to $t-1$. We estimate this relationship with and without interactions of VSH and plant characteristics, as well as with and without industry fixed effects. All specifications include year fixed effects to control for aggregate variation in plant death rates.

The first two columns of Table 4 report the marginal probability of failure for specifications with levels of VSH and plant characteristics. The results indicate that plant death is more likely for smaller, younger and less productive plants. These results are consistent with earlier research by Dunne et al. (1988, 1989). We also find plant death to be inversely related to capital intensity and unrelated to our measure of skill intensity.

As predicted by the theory, the positive and statistically significant coefficient on VSH in columns one and two indicates that the probability

[15] To the extent that employment growth due to births is lower (higher) in industries with a greater low-wage import presence, the degree of reallocation due to low-wage imports may be understated (overstated).

of plant death increases with an industry's exposure to imports from low-wage countries. Comparison of the first and second column indicates that this relationship persists with the inclusion of industry fixed effects.[16] The results in column 1 indicate that a 10 percentage point increase in VSH (roughly one standard deviation) is associated with an increase in the probability of death of 3.3 percentage points. The average probability of death in the sample is 26.6%.

The last two columns of Table 4 include interactions of VSH with plant capital intensity, skill intensity and productivity. VSH by itself remains positive and significant in both columns as predicted by the theory. The interaction of VSH and capital intensity is negative and significant in both specifications, indicating that capital-intensive plants within industries are relatively less like to shut down between Census years in the face of low-wage imports. The point estimates in columns three and four indicate that a one standard deviation jump in plant log capital intensity is associated with declines in the probability of death of 1.8 and 1.0 percentage points, respectively. The skill intensity interaction is negative and significant when industry fixed effects are included in the specification, but the economic magnitude of this relationship is negligible. This finding suggests that either skill-intensity is not relevant in the presence of low-wage imports or that the measure of skill intensity is a poor proxy for skills in use at the plant.[17] The coefficient on the VSH-productivity interaction is negative but statistically insignificant in both columns.

5.2. Plant Employment Growth and Exposure to Low-Wage Country Imports

Table 5 summarizes the estimated relationship between plant employment growth and industry exposure to imports from low-wage countries. As in the previous section, we estimate this relationship with and without

[16] It is well known that plant birth and death rates covary across industries, in large part due to variations in the sunk costs of entry. See Dunne et al (1988, 1989). We include industry fixed effects to control for any unobserved industry-specific determinants of plant failures.

[17] In results not reported here, we find more support for the importance of skill in plant outcomes when we use the log average wages for production workers and for non-production workers as alternative measures of skill.

interactions of VSH and plant characteristics, as well as with and without industry and plant fixed effects. All specifications include year fixed effects.

The first two columns of Table 5 report results with levels of VSH and plant characteristics. The first column has year but no industry fixed effects, while the second column has both year and industry fixed effects. The results indicate that employment growth is higher for larger, older and more productive plants. Plant employment growth is also positively and significantly associated with capital intensity but unrelated to our measure of skill intensity.

As predicted by the theory, the negative and statistically significant coefficient on VSH in columns one and two indicates that plant employment falls with its industry's exposure to imports from low-wage countries. The point estimate in column one indicates that a 10 percentage point increase in VSH is associated with a 1.3 percentage point lower annual employment growth.

The final three columns of Table 5 report results including interactions of VSH with plant characteristics. The three columns differ according to their inclusion of industry and plant fixed effects. Across all three specifications, employment growth continues to be negatively and significantly related to the level of VSH. Furthermore, the positive and significant coefficient on the VSH-capital interaction indicates that higher within-industry plant capital intensity mitigates exposure to low-wage imports. The interaction of plant productivity with VSH is positive and significant only in the final specification, which includes plant fixed effects. Interactions of VSH with skill intensity are statistically insignificant.

5.3. Plant Output Growth and Exposure to Low-Wage Country Imports

The negative relationship between plant employment growth and industry exposure to imports from low-wage countries has two interpretations. The first is that plants facing such import competition shrink (or die). The second is that plants substitute away from relatively expensive U.S. labor and towards relatively inexpensive U.S. capital. Under the second interpretation, plant employment can decline as output remains constant (or increases). To differentiate between these scenarios, we investigate the relationship between real output growth and VSH in Table 6.

The results in Table 6 indicate that output and employment respond similarly to low-wage country import exposure. The coefficient on VSH is negative and statistically significant across specifications. Interactions of VSH and plant input intensities and productivity, shown in the final three columns, indicate reallocation of output over time to more productive and more capital-intensive plants within industries. The interaction of VSH and plant skill intensity is positive and significant in the specification containing industry fixed effects.

5.4. Robustness

In this section we demonstrate the robustness of the relationship between plant outcomes and exposure to low-wage country imports after controlling for measures of international trade based upon alternate sets of potentially influential countries. We report robustness results for the plant death and plant employment specifications but omit results for real output growth, which are similar, to save space. For both specifications, we compare the point estimates on VSH after adding an additional international trade measure. To simplify reporting, we use the specification with plant characteristics and levels of VSH and including year and industry fixed effects.[18]

Table 7 summarizes our robustness findings for the plant death specification. The first column of the table reproduces the results of the second column of Table 4. Each subsequent column includes an additional measure of international trade. Results indicate that inclusion of these additional controls does not affect the sign or significance of the VSH coefficient; low-wage imports are associated with increased probabilities of plant death in every column. Results also indicate that the additional controls are statistically significant, though signs vary depending upon the measure. Increases in aggregate import penetration are positively associated with plant failure. The coefficients for all other measures, however, are negative. These results imply that exposure to imports from the OECD, the Asian Tigers, and various cohorts of middle income countries are actually associated with an *increased* probability of plant survival while exposure to low-wage imports increases the probability of plant death.

[18] Similar results are obtained for a specification that includes interactions of the import measures with plant characteristics.

Table 8 summarizes the robustness results for the employment growth specification. The first column of the table reproduces the results of the second column of Table 5, and subsequent columns include additional international trade measures. As above, inclusion of additional controls does not affect the sign or significance of the VSH coefficient; in all columns, higher levels of low-wage import shares are associated with lower subsequent annual plant employment growth rates. The sign and statistical significance of additional controls vary depending upon the measure. Aggregate import penetration is positive but statistically insignificant, as is the OECD value share. The Tiger value share is positive and statistically significant, indicating that increased industry exposure to Asian Tiger imports is associated with *higher* plant employment growth. The coefficients for all three middle-income country cohorts are also positive and significant.

The robustness results presented in this section emphasize that the relationship between manufacturing plant outcomes and low-wage country imports holds even when controlling for aggregate import penetration or imports originating in other types of countries. In particular, the negative relationship between import shares and plant performance is unique to low-wage countries.

5.5. Discussion

The results of this section demonstrate a clear relationship between imports from low-wage countries and reallocation across and within U.S. manufacturing plants. The robustness tests demonstrate that this relationship survives even after including additional measures of trade exposure based upon alternate groups of countries thought to be important for U.S. manufacturing.

There are two major explanations for the negative association between plant survival and growth and industry exposure to imports from low-wage countries. The explanation guiding our analysis and emphasized by the factor proportions framework has competition from low-wage countries forcing U.S. plants out of product markets at odds with U.S. comparative advantage. Under this explanation low-wage countries enter and the U.S. responds. Our results are consistent with this view: U.S. manufacturing is reallocating towards a more capital-intensive mix of manufacturing and the movement is strongest where the presence of low-wage country imports is greatest in prior years.

An alternative explanation emphasizes either causality in the opposite direction or an omitted variable that affects both plant performance and the share of imports from low-wage countries. Under this interpretation low-wage countries enter product markets being abandoned by the U.S., perhaps as a result of domestic productivity growth or skill-biased technological change. We attempt to distinguish between these views by controlling for industry (and plant) fixed effects as well as by relating future plant outcomes (t to $t+5$) to prior levels of low-wage country import exposure (the average from $t-5$ to $t-1$). For our findings to be consistent with an endogenous response of low-wage countries to future changes in the U.S. industries, low-wage countries must be entering industries today that they expect will be growing more slowly 5 to 10 years later.

As a final robustness test, we attempt to control for industry characteristics that might be correlated with increased low-wage country import shares and subsequent plant performance. While there are numerous possible candidate theories to explain relative performance across industries, we focus on productivity growth, persistence in employment growth rates, and skill-biased technological change (via relative wages). In Table 9, in addition to industry fixed effects, we control for productivity growth, employment growth, and changes in the industry non-production to production worker relative wage; in all three cases, changes are from $t-5$ to t. The results indicate that the coefficient on VSH remains unchanged in sign, level and significance for both the plant death and employment growth specifications. Even in the presence of these additional controls, low-wage import shares continue to be strongly negatively correlated with plant outcomes.

Based on the robustness of the relationship between low-wage import shares and plant performance, we conclude against the explanation that our results are driven by reverse causation or omitted variables.

6. Empirical Results: Industry Switching

In this section, we investigate the third implication of plant behavior motivated by the factor proportions framework: within-plant product-mix upgrades (Hypothesis 3).

The LRD tracks plant output according to the primary industry of the plant. Plants whose production spans four-digit industries are assigned the industry of their predominant products.[19] It is reasonable to assume that a large fraction of product mix changes by a plant likely occur within four-digit industries, and therefore will not affect the assigned industry code. On the other hand, some of these changes may occur across four-digit industries. In this section, we analyze these observable switches in product mix to determine if they are related to industry exposure to imports from low-wage countries.[20] Though plants producing roughly equal amounts of two industries may "switch industries" spuriously, this random variation should bias us against finding any systematic changes in the capital- and skill-intensity of a plant's old and new industries.

Roughly 25,000 U.S. manufacturing plants switch industries in our four panels, an average of 7.8% of surviving plants in each five-year period. Table 10 compares the industry capital intensity, skill intensity and VSH across these plants' old and new industries using t-tests. For each switch occurring between years t and $t+5$, we compare contemporaneous industry characteristics, i.e. the characteristics that the old and new industries have in year t. Results indicate that destination industries are 2.1% more capital intensive, 6.8% more skill intensive, and face lower shares of low-wage country imports (2.1 percentage points) than the industries left behind. These differences are statistically significant at the 1% level for input intensities and at the 10% level for VSH.

Table 11 addresses whether the probability of switching and the magnitude of changes in old versus new industry capital and skill intensity are related to VSH. The first column reports probit results using plant controls and interactions with VSH identical to those used earlier. The results indicate that the probability of switching is positively associated with exposure to low-wage country imports. Within industries, however, plant

[19] For a multi-product plant that produces in more than one SIC4 industry, its primary SIC4 industry is given by the industry that represents the greatest share of plant output. Some plants may have less than 50% of total output in their primary industry category.

[20] Bernard and Jensen (2001) find that plants that switch industries have a higher probability of becoming exporters. This movement into more viable products is consistent with the view that plants escape low wage country competition by upgrading their product mix.

capital intensity is negatively associated with industry switching. These results are consistent with the factor proportions framework: plants in industries subject to intense competition from low-wage countries are more likely to re-orient production away from this competition, but are less likely to do so if their output within that industry faces less direct competition.

The second and third columns of Table 11 regress the percent difference in industry factor intensity for switching plants on plant characteristics and VSH. Results in column two indicate that plants leaving industries with high VSH move to industries with higher capital intensity than the average switching plant. The third column indicates no statistically significant relationship between changes in industry skill intensity and VSH.

The evidence presented in this section suggests that U.S. manufacturing plants may adjust to competition from low-wage countries by altering the mix of goods they produce.

7. Conclusions

Imports from low income countries were the fastest growing component of U.S. trade from 1972 to 1997, increasing far more rapidly than aggregate imports. This paper considers the role of imports from low-wage countries in the evolution of U.S. manufacturing industries and plants over time. We find that plant survival and growth are negatively associated with the share of industry imports originating in low-wage countries, and that this relationship is robust to alternate measurements of international trade.

Using the plant-level data, we find strong evidence that low-wage imports have differential effects on plants within an industry based on their input characteristics. Capital-intensive plants are substantially less likely to close, and grow more quickly, than the average plant. In contrast, neither skill-intensity nor productivity significantly improved plant outcomes in the face of low-wage competition. These results suggest that exposure to increased imports from low-wage countries has accelerated the process of capital deepening both across and within manufacturing industries.

We also provide evidence that U.S. manufacturing plants may adjust their product mix in response to competition from low-wage countries. Plants that switch industries move to sectors that are more capital and skill intensive and have lower import shares from low-wage countries. Plants facing higher shares of low-wage imports are more likely to switch industries and to move into industries with relatively higher capital intensity. This evidence of reallocation across and within manufacturing industries is consistent with key implications of the Heckscher-Ohlin model of trade, which has low-wage countries forcing the U.S. out of product markets at odds with its comparative advantage.

This paper only begins to examine the role of increased trade with low-income countries on firms and industries in the U.S. Additional theoretical and empirical progress is needed on the menu of responses available to firms, including investment, workforce upgrading, and product switching and innovation. To the extent that manufacturing output is not uniform across regions within the U.S., our results also suggest significant variation in the regional effects of low-wage country competition in terms of industry structure, wage levels and income inequality.

References

Bartelsman, Eric J., Randy A. Becker, and Wayne B. Gray. 2000. The NBER-CES Manufacturing Industry Database. NBER Technical Working Paper 205.

Bernard, Andrew B. and J. Bradford Jensen. 2001. Why Some Firms Export. NBER Working Paper # 8349.

Bernard, Andrew B. and Peter K. Schott. 2002. Factor Price Equality and the Economies of the United States. Tuck School mimeo, revised version of NBER Working Paper #8068.

Blonigen, Bruce A. and KaSaundra Tomlin. 2001. Size and Growth of Japanese Plants in the United States. *International Journal of Industrial Organization,* 19(6):931-52.

Davis, Steven J. and John Haltiwanger. 1992. Gross Job Creation, Gross Job Destruction, and Employment Reallocation. *Quarterly Journal of Economics* 107(3):819-863.

Dunne, Timothy, Mark J. Roberts, and Larry Samuelson. 1988. Patterns of Firm Entry and Exit in U.S. Manufacturing Industries. *Rand Journal of Economics* 19(4):495-515.

Dunne, Timothy, Mark J. Roberts, and Larry Samuelson. 1989. The Growth and Failure of U.S. Manufacturing Plants. *Quarterly Journal of Economics* 104(4):671-698.

Feenstra, Robert C. 1994. New Product Varieties and the Measurement of International Prices. *American Economic Review* 84:157-177.

Feenstra, Robert C. 1996. U.S. Imports 1972-1994: Data and Concordances. NBER Working Paper 5515.

Feenstra, Robert C., John Romalis and Peter K. Schott. 2002. U.S. Imports, Exports, and Tariff Data, 1989-2001. NBER Working Paper 9387.

Freeman, Richard and Lawrence Katz. 1991. Industrial Wage and Employment Determination in an Open Economy, in Immigration, Trade and the Labor Market, edited by John M. Abowd and Richard B. Freeman. Chicago: University of Chicago Press.

Grossman, Gene. 1987. The Employment and Wage Effects of Import Competition. *Journal of International Economic Integration* 2(1):1-23.

Hall, Bronwyn H. 1987. The Relationship Between Firm Size and Firm Growth in the U.S. Manufacturing Sector. *Journal of Industrial Economics* 35(4):583-606.

Hopenhayn, Hugo. 1992a. Entry, Exit, and Firm Dynamics in Long Run Equilibrium. *Econometrica* 60(5):1127-1150.

Hopenhayn, Hugo. 1992b. Exit, Selection and The Value of Firms. *Journal of Economic Dynamics and Control* 16:621-653.

Krueger, Anne, O. 1980. “Impact of Foreign Trade on Employment in U.S. Industry” edited by J. Bleck and B. Hindley, Current Issues in Commercial Policy and Diplomacy. New York: St Martin’s Press.

Leamer, Edward E. 1987. Paths of Development in the Three-Factor, n-Good General Equilibrium Model. *Journal of Political Economy* 95:961-999.

Lerner, Abba. 1952. Factor Prices and International Trade. *Economica* 19(73):1-15.

Mann, Catherine L. 1988. The Effects of Foreign Competition in Prices and Quantities on Employment in Import-Sensitive Industries. *International Trade Journal II* (Summer):409-444.

Olley, Steven G. and Ariel Pakes. 1996. The Dynamics of Productivity in the Telecommunications Equipment Industry. *Econometrica* 64(6):1263-97.

Revenga, Ana L. 1992. Exporting Jobs? The Impact of Import Competition on Employment and Wages in U.S. Manufacturing. *Quarterly Journal of Economics* 107(1):255-284.

Sachs, Jeffrey D. and Howard J. Shatz. 1994. Trade and Jobs in U.S. Manufacturing. *Brookings Papers on Economic Activity* 1994(1):1-69.

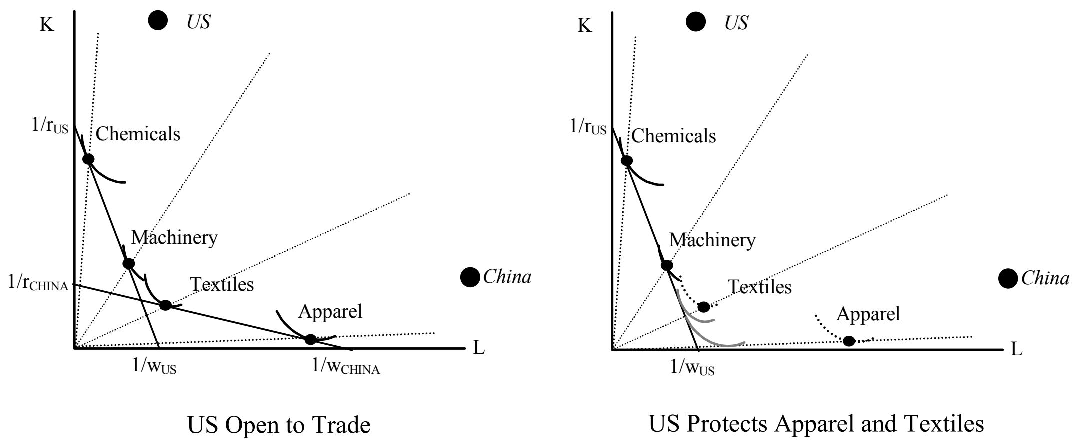

Figure 1: Industry Specialization in the Factor Proportions Framework

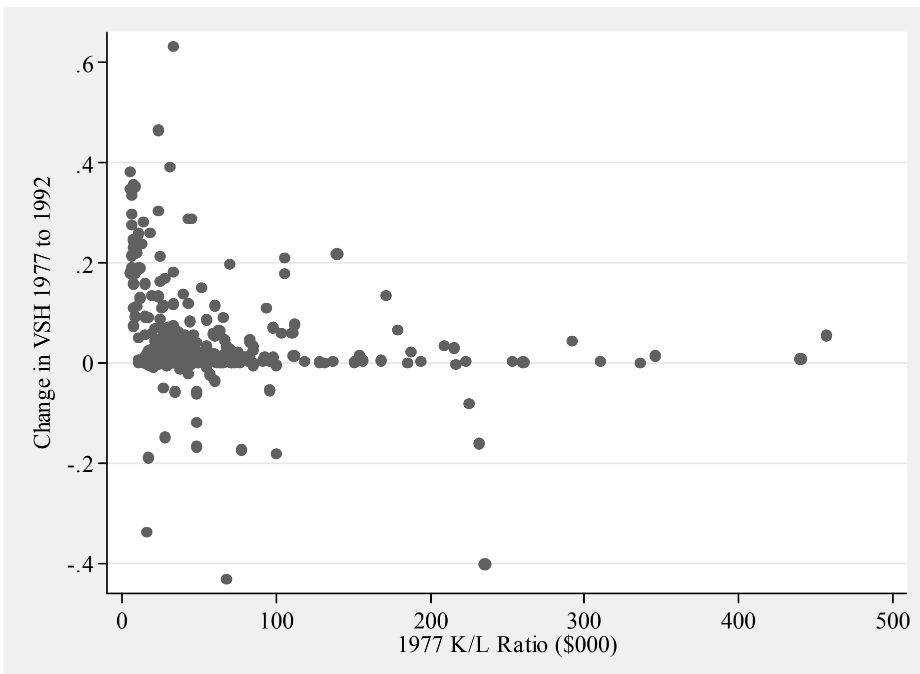

Figure 2: Changes in Low-Wage Import Shares by Industry Capital Intensity, 1977-1992

Afghanistan	China	India	Pakistan
Albania	Comoros	Kenya	Rwanda
Angola	Congo	Lao PDR	Samoa
Armenia	Equatorial Guinea	Lesotho	Sao Tome
Azerbaijan	Eritrea	Madagascar	Sierra Leone
Bangladesh	Ethiopia	Malawi	Somalia
Benin	Gambia	Maldives	Sri Lanka
Bhutan	Georgia	Mali	St. Vincent
Burkina Faso	Ghana	Mauritania	Sudan
Burundi	Guinea	Moldova	Togo
Cambodia	Guinea-Bissau	Mozambique	Uganda
Central African Rep	Guyana	Nepal	Vietnam
Chad	Haiti	Niger	Yemen

Table 1: Low-Wage Countries 1972 to 1992

Two-Digit SIC Industry	1977	1982	1987	1992
20 Food	8.7	3.6	5.6	8.8
21 Tobacco	6.2	1.2	14.6	14.5
22 Textile	10.5	13.3	17.7	19.0
23 Apparel	7.6	11.0	19.7	31.9
24 Lumber	3.7	2.8	7.6	8.6
25 Furniture	1.1	2.3	3.3	4.7
26 Paper	0.0	0.1	0.2	0.5
27 Printing	0.2	0.5	0.5	2.9
28 Chemicals	0.9	1.6	2.1	1.8
29 Petroleum	1.5	3.6	5.3	6.8
30 Rubber	0.3	0.6	1.4	12.6
31 Leather	3.6	4.3	6.4	19.7
32 Stone	0.7	1.2	1.6	4.0
33 Primary Metal	1.4	2.2	2.6	3.6
34 Fabricated Metal	0.5	1.1	1.5	3.6
35 Industrial Machinery	0.2	0.3	0.4	0.9
36 Electronic	0.6	1.9	3.2	5.0
37 Transportation	0.0	0.0	0.0	0.1
38 Instruments	0.3	0.4	0.7	2.8
39 Miscellaneous	5.7	6.4	9.4	19.2
Average Across All SIC4	1.9	2.2	3.2	5.7
Std Dev Acoss All SIC4	5.1	4.2	6.4	10.1

Notes: Table reports VSH across two-digit SIC manufacturing industires and time. VSH is the share of U.S. import value originating in countries with less than 5% of U.S. per capita GDP. Shares for each two-digit industry are weighted averages of underlying product observations, using U.S. import values as weights. Figures for each year are the average for the preceding five years (e.g. the reported share for 1977 is the average of shares from 1972 to 1976). Years correspond to the four manufacturing Census panels used in the regression analysis. The final two rows of the table present a weighted average and standard deviation for all four-digit SIC manufacturing industries.

Table 2: Low-Wage Import Share Across Two-Digit SIC Manufacturing Industries and Time

Measure of Import Exposure	Correlation with Low-Wage Country Import Value Share (VSH)
Import Penetration	0.16
Change in Real Import Price Index	-0.06
OECD Value Share	-0.60
Tiger Value Share	0.16
Middle (5-25%) Value Share	0.20
Middle (25-50%) Value Share	-0.04
Middle (50-75%) Value Share	-0.29

Notes: Correlations are computed across industries and Census years (1977, 1982, 1987 and 1992) and control for time effects. All correlations except for real import price changes are significant at the 10% level. Correlations are for four-digit SIC industries (1533 observations) except for the import price correlation, which is based upon three-digit industries (92 observations). Import penetration is total import value divided by domestic absorption. OECD and Tiger value shares are the share of industry imports originating in OECD countries (except Mexico, Korea and newer entrants) and Asian tigers (Korea, Taiwan, Singapore and Hong Kong), respectively. Middle value shares are based upon the set of countries with the noted per capita GDP relative to the U.S. Three-digit SIC (1972 revision) import price indexes are from Feenstra (1996) and are deflated by the U.S. PPI. Import price changes are computed as the average annual change in the real index across Census years. The import price correlation is based upon an aggregation of VSH to three-digit industries.

Table 3: Correlation of Low-Wage Country Value Share with Other Measures of Import Exposure

Independent Variables	Plant Death$_{t:t+5}$	Plant Death$_{t:t+5}$	Plant Death$_{t:t+5}$	Plant Death$_{t:t+5}$
log(Employment$_{pt}$)	-0.044 ***	-0.058 ***	-0.044 ***	-0.058 ***
	(0.001)	(0.001)	(0.001)	(0.001)
Age$_{pt}$	-0.005 ***	-0.004 ***	-0.005 ***	-0.004 ***
	(0.000)	(0.000)	(0.000)	(0.000)
log(TFP$_{pt}$)	-0.073 ***	-0.074 ***	-0.072 ***	-0.073 ***
	(0.002)	(0.002)	(0.003)	(0.003)
log(K/P$_{pt}$)	-0.024 ***	-0.013 ***	-0.016 ***	-0.010 ***
	(0.001)	(0.001)	(0.001)	(0.001)
N/P Wagebill Ratio$_{pt}$	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Low Wage Value Share (VSH$_{it}$)	0.321 ***	0.163 ***	0.687 ***	0.344 ***
	(0.009)	(0.022)	(0.020)	(0.030)
x log(TFP$_{pt}$)			-0.030	-0.036
			(0.027)	(0.027)
x log(K/P$_{pt}$)			-0.141 ***	-0.073 ***
			(0.007)	(0.008)
x N/P Wagebill Ratio$_{pt}$			0.000	-0.001 **
			(0.000)	-(0.001)
Industry Fixed Effects	None	SIC4	None	SIC4
Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	443,755	443,756	443,757	443,757
Log Likelihood	-245,466	-239,976	-245,231	-239,936

Notes: Plant-level probit regression results where the reported coefficients represent the change the marginal probability of plant death at the mean of the regressors. Robust standard errors adjusted for clustering at the plant level are in parentheses. Dependent variable indicates plant death between years t and t+5. N/P Wagebill Ratio is total plant wages paid to non-production workers (N) divided by total plant wages paid to production workers (P). VSH is the share of U.S. import value originating in countries with less than 5% of U.S. per capita GDP. Final three control variables are interactions with VSH. Regressions cover four panels: 1977-82, 1982-87, 1987-92 and 1992-97. ***Significant at the 1% level; **Significant at the 5% level; *Significant at the 10% level. Coefficients for the regression constant and dummy variables are suppressed.

Table 4: Plant Death and Exposure to Imports from Low-Wage Countries

Independent Variables	ΔEmployment$_{t:t+5}$	ΔEmployment$_{t:t+5}$	ΔEmployment$_{t:t+5}$	ΔEmployment$_{t:t+5}$	ΔEmployment$_{t:t+5}$
log(Employment$_{pt}$)	0.010 ***	0.013 ***	0.010 ***	0.013 ***	-0.096 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Age$_{pt}$	0.001 ***	0.001 ***	0.001 ***	0.001 ***	-0.011 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
log(TFP$_{pt}$)	0.050 ***	0.050 ***	0.050 ***	0.050 ***	0.033 ***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
log(K/P$_{pt}$)	0.018 ***	0.016 ***	0.014 ***	0.015 ***	0.008 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
N/P Wagebill Ratio$_{pt}$	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Low Wage Value Share (VSH$_{it}$)	-0.125 ***	-0.071 ***	-0.310 ***	-0.149 ***	-0.467 ***
	(0.005)	(0.009)	(0.009)	(0.014)	(0.031)
x log(TFP$_{pt}$)			-0.003	-0.002	0.049 ***
			(0.013)	(0.012)	(0.027)
x log(K/P$_{pt}$)			0.069 ***	0.030 ***	0.094 ***
			(0.003)	(0.004)	(0.009)
x N/P Wagebill Ratio$_{pt}$			0.000	0.000	-0.008
			(0.000)	(0.000)	-(0.008)
Industry/Plant Fixed Effects	None	SIC4	None	SIC4	Plant
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	443,755	443,756	443,757	443,757	443,757
R^2	0.04	0.06	0.04	0.06	0.77

Notes: Plant-level OLS regression results. Robust standard errors adjusted for clustering at the plant level are in parentheses. Dependent variable is normalized plant employment growth between years t and t+5 (see text for normalization). N/P Wagebill Ratio is total plant wages paid to non-production workers (N) divided by total plant wages paid to production workers (P). VSH is the share of U.S. import value originating in countries with less than 5% of U.S. per capita GDP. Final three control variables are interactions with VSH. Regressions cover four panels: 1977-82, 1982-87, 1987-92 and 1992-97. ***Significant at the 1% level; **Significant at the 5% level; *Significant at the 10% level. Coefficients for the regression constant and dummy variables are suppressed.

Table 5: Plant Employment Growth and Exposure to Imports from Low-Wage Countries

Independent Variables	ΔOutput$_{t:t+5}$	ΔOutput$_{t:t+5}$	ΔOutput$_{t:t+5}$	ΔOutput$_{t:t+5}$	ΔOutput$_{t:t+5}$
log(Employment$_{pt}$)	0.016 ***	0.017 ***	0.016 ***	0.017 ***	-0.073 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Age$_{pt}$	0.001 ***	0.001 ***	0.001 ***	0.001 ***	-0.008 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
log(TFP$_{pt}$)	-0.007 ***	-0.006 ***	-0.009 ***	-0.009 ***	-0.100 ***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)
log(K/P$_{pt}$)	0.010 ***	0.003 ***	0.005 ***	0.001 ***	-0.026 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
N/P Wagebill Ratio$_{pt}$	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Low Wage Value Share (VSH$_{it}$)	-0.133 ***	-0.055 ***	-0.378 ***	-0.174 ***	-0.448 ***
	(0.005)	(0.010)	(0.010)	(0.015)	(0.033)
x log(TFP$_{pt}$)			0.060 ***	0.061 ***	0.085 ***
			(0.014)	(0.013)	(0.032)
x log(K/P$_{pt}$)			0.092 ***	0.045 ***	0.093 ***
			(0.003)	(0.004)	(0.009)
x N/P Wagebill Ratio$_{pt}$			0.000	0.001 ***	-0.004
			(0.000)	(0.001)	-(0.004)
Industry/Plant Fixed Effects	None	SIC4	None	SIC4	Plant
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	443,755	443,756	443,757	443,757	443,757
R^2	0.04	0.06	0.04	0.06	0.74

Notes: Plant-level OLS regression results. Robust standard errors adjusted for clustering at the plant level are in parentheses. Dependent variable is normalized plant real output growth between years t and t+5 (see text for normalization). N/P Wagebill Ratio is total plant wages paid to non-production workers (N) divided by total plant wages paid to production workers (P). VSH is the share of U.S. import value originating in countries with less than 5% of U.S. per capita GDP. Final three control variables are interactions with VSH. Regressions cover four panels: 1977-82, 1982-87, 1987-92 and 1992-97. ***Significant at the 1% level; **Significant at the 5% level; *Significant at the 10% level. Coefficients for the regression constant and dummy variables are suppressed.

Table 6: Plant Real Output Growth and Exposure to Imports from Low-Wage Countries

Independent Variables	Plant Death$_{t:t+5}$	Plant Death$_{t:t+5}$	Plant Death$_{t:t+5}$	Plant Death$_{t:t+5}$	Plant Death$_{t:t+5}$	Plant Death$_{t:t+5}$	Plant Death$_{t:t+5}$
log(Employment$_{pt}$)	-0.058 ***	-0.057 ***	-0.057 ***	-0.057 ***	-0.057 ***	-0.057 ***	-0.057 ***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Age$_{pt}$	-0.004 ***	-0.004 ***	-0.004 ***	-0.004 ***	-0.004 ***	-0.004 ***	-0.004 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
log(TFP$_{pt}$)	-0.074 ***	-0.073 ***	-0.074 ***	-0.074 ***	-0.074 ***	-0.074 ***	-0.074 ***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
log(K/P$_{pt}$)	-0.013 ***	-0.013 ***	-0.013 ***	-0.013 ***	-0.013 ***	-0.013 ***	-0.013 ***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
N/P Wagebill Ratio$_{pt}$	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Low Wage Value Share (VSH$_{it}$)	0.163 ***	0.122 ***	0.147 ***	0.116 **	0.140 ***	0.136 ***	0.160 ***
	(0.022)	(0.024)	(0.022)	(0.025)	(0.023)	(0.022)	(0.021)
Import Penetration$_{it}$		0.052 **					
		(0.021)					
OECD Value Share$_{it}$			-0.031 ***				
			(0.010)				
Tiger Value Share$_{it}$				-0.048 ***			
				(0.014)			
Middle (5-25%) Value Share$_{it}$					-0.027 ***		
					(0.010)		
Middle (25-50%) Value Share$_{it}$						-0.089 ***	
						(0.015)	
Middle (50-75%) Value Share$_{it}$							-0.029 ***
							(0.009)
Industry Fixed Effects	SIC4	SIC4	SIC4	SIC4	SIC4	SIC4	SIC4
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	443,757	418,826	443,757	443,757	443,757	443,757	443,757
Log Likelihood	-239,976	-226,705	-241,684	-241,683	-241,686	-241,671	-241,684

Notes: Plant-level probit regression results where the reported coefficients represent the change the marginal probability of plant death at the mean of the regressors. Robust standard errors adjusted for clustering at the plant level are in parentheses. Dependent variable indicates plant death between years t and t+5. N/P Wagebill Ratio is total plant wages paid to non-production workers (N) divided by total plant wages paid to production workers (P). VSH is the share of U.S. import value originating in countries with less than 5% of U.S. per capita GDP. Import penetration is total imports divided by domestic absorption. OECD and Tiger value shares are share of imports originating in the OECD (less Mexico and Korea) and Korea, Taiwan, Singapore and Hong Kong, respectively. Middle value shares are defined according to the noted relative per capita GDP cutoffs. Regressions cover four panels: 1977-82, 1982-87, 1987-92 and 1992-97. ***Significant at the 1% level; **Significant at the 5% level; *Significant at the 10% level.

Table 7: Robustness of Plant Death Results to Alternate Measures of Import Exposure

Independent Variables	ΔEmployment$_{t:t+5}$	ΔEmployment$_{t:t+5}$	ΔEmployment$_{t:t+5}$	ΔEmployment$_{t:t+5}$	ΔEmployment$_{t:t+5}$	ΔEmployment$_{t:t+5}$	ΔEmployment$_{t:t+5}$
log(Employment$_{pt}$)	0.013 ***	0.012 ***	0.013 ***	0.013 ***	0.013 ***	0.013 ***	0.013 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Age$_{pt}$	0.001 ***	0.001 ***	0.001 ***	0.001 ***	0.001 ***	0.001 ***	0.001 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
log(TFP$_{pt}$)	0.050 ***	0.049 ***	0.050 ***	0.050 ***	0.050 ***	0.050 ***	0.050 ***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
log(K/P$_{pt}$)	0.016 ***	0.017 ***	0.016 ***	0.016 ***	0.016 ***	0.016 ***	0.016 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
N/P Wagebill Ratio$_{pt}$	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Low Wage Value Share (VSH$_{it}$)	-0.071 ***	-0.067 ***	-0.069 ***	-0.028 **	-0.053 ***	-0.050 ***	-0.069 ***
	(0.009)	(0.010)	(0.010)	(0.011)	(0.010)	(0.010)	(0.009)
Import Penetration$_{it}$		0.012					
		(0.009)					
OECD Value Share$_{it}$			0.003				
			(0.004)				
Tiger Value Share$_{it}$				0.049 ***			
				(0.006)			
Middle (5-25%) Value Share$_{it}$					0.023 ***		
					(0.004)		
Middle (25-50%) Value Share$_{it}$						0.082 ***	
						(0.006)	
Middle (50-75%) Value Share$_{it}$							0.014 ***
							(0.004)
Industry Fixed Effects	SIC4	SIC4	SIC4	SIC4	SIC4	SIC4	SIC4
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	443,757	418,826	443,757	443,757	443,757	443,757	443,757
R^2	0.04	0.06	0.06	0.06	0.06	0.06	0.06

Notes: Plant-level OLS regression results. Robust standard errors adjusted for clustering at the plant level are in parentheses. Dependent variable is normalized plant employment growth between years t and t+5 (see text for normalization). N/P Wagebill Ratio is total plant wages paid to non-production workers (N) divided by total plant wages paid to production workers (P). VSH is the share of U.S. import value originating in countries with less than 5% of U.S. per capita GDP. Import penetration is total imports divided by domestic absorption. OECD and Tiger value shares are share of imports originating in the OECD (less Mexico and Korea) and Korea, Taiwan, Singapore and Hong Kong, respectively. Middle value shares are defined according to the noted relative per capita GDP cutoffs. Regressions cover four panels: 1977-82, 1982-87, 1987-92 and 1992-97. ***Significant at the 1% level; **Significant at the 5% level; *Significant at the 10% level.

Table 8: Robustness of Plant Employment Growth Results to Alternate Measures of Import Exposure

Independent Variables	Plant Death$_{t:t+5}$	ΔEmployment$_{t:t+5}$
log(Employment$_{pt}$)	-0.058 ***	0.013 ***
	(0.001)	(0.000)
Age$_{pt}$	-0.004 ***	0.001 ***
	(0.000)	(0.000)
log(TFP$_{pt}$)	-0.074 ***	0.050 ***
	(0.002)	(0.001)
log(K/P$_{pt}$)	-0.013 ***	0.016 ***
	(0.001)	(0.000)
N/P Wagebill Ratio$_{pt}$	0.000	0.000
	(0.000)	(0.000)
Low Wage Value Share (VSH$_{it}$)	0.162 ***	-0.072 ***
	(0.022)	(0.009)
ΔEmployment$_{i,t-5:t}$	-0.106 ***	-0.079 ***
	(0.024)	(0.011)
ΔTFP$_{i,t-5:t}$	0.097 ***	0.026 **
	(0.025)	(0.011)
ΔRelative Wage$_{i,t-5:t}$	-0.068	-0.051 ***
	(0.043)	(0.019)
Industry Fixed Effects	SIC4	SIC4
Year Fixed Effects	Yes	Yes
Observations	443,757	443,757
Log Likelihood/ R^2	-239,962	0.06

Notes: First column is plant-level probit regression results where the reported coefficients represent the change the marginal probability of plant death at the mean of the regressors. Second column reports OLS regression results. Robust standard errors adjusted for clustering at the plant level are in parentheses. Dependent variable indicates plant outcomes between years t and t+5. N/P Wagebill Ratio is total plant wages paid to non-production workers (N) divided by total plant wages paid to production workers (P). VSH is the share of U.S. import value originating in countries with less than 5% of U.S. per capita GDP. Final three control variables are log differences from t-5 to t in industry employment, TFP and non-production to production-worker wage. Regressions cover four panels: 1977-82, 1982-87, 1987-92 and 1992-97. ***Significant at the 1% level; **Significant at the 5% level; *Significant at the 10% level. Coefficients for the regression constant and dummy variables are suppressed.

Table 9: Robustness to The Inclusion of Additional Industry Controls

Characteristic	Mean Difference Across Plants Between New and Old Industries	T Statistic (Mean=0)	P Value
Plant Capital Intensity (K/P)	2.1%	5.8	0.00
Plant N/P Wagebill Ratio	6.8%	9.1	0.00
Industry Low Wage Value Share (VSH)	-2.1%	1.6	0.09

Notes: Calculations based upon a sample of 25,423 plants that switched their four-digit SIC industry over four five-year panels: 1977-82, 1982-87, 1987-92 and 1992-97.

Table 10: Characteristics of Old and New Industries for Plants that Switch Industries

Independent Variables	ΔIndustry$_{t:t+5}$	ΔK/P$_{t:t+5}$	ΔN/P Wagebill Ratio$_{t:t+5}$
log(Employment$_{pt}$)	0.051 ***	0.000	-0.016 ***
	(0.003)	(0.003)	(0.008)
Age$_{pt}$	-0.012 ***	0.000	-0.003 ***
	(0.000)	(0.000)	(0.001)
log(TFP$_{pt}$)	-0.011	0.055 ***	0.250 ***
	(0.014)	(0.012)	(0.031)
log(K/P$_{pt}$)	-0.021 ***	-0.035 ***	0.018 *
	(0.004)	(0.004)	(0.010)
N/P Wagebill Ratio$_{pt}$	0.000	0.002	-0.001
	(0.000)	(0.001)	(0.005)
Low Wage Value Share (VSH$_{it}$)	0.363 ***	0.564 ***	0.016
	(0.110)	(0.059)	(0.093)
x log(TFP$_{pt}$)	-0.190		
	(0.157)		
x log(K/P$_{pt}$)	-0.177 ***		
	(0.036)		
x N/P Wagebill Ratio$_{pt}$	0.000		
	(0.002)		
Observations	325,502	25,423	25,423
R^2	na	0.01	0.00
Log Likelihood	-89,684	na	na

Notes: First column is plant-level probit regression results where the reported coefficients represent the change the marginal probability of plant death at the mean of the regressors. Second and third columns are OLS regression results. Robust standard errors adjusted for clustering at the plant level are in parentheses. Dependent variable in first column indicates plant changes four-digit SIC manufacturing industry between years t and t+5. Dependent variables in second and third columns are log difference of plant capital (K/P) and skill (N/P Wagebill Ratio) intensity, respectively, between years t and t+5. N/P Wagebill Ratio is total plant wages paid to non-production workers (N) divided by total plant wages paid to production workers (P). VSH is the share of U.S. import value originating in countries with less than 5% of U.S. per capita GDP. Final three control variables are interactions with VSH. Regressions cover four panels: 1977-82, 1982-87, 1987-92 and 1992-97. ***Significant at the 1% level; **Significant at the 5% level; *Significant at the 10% level.

Table 11: Industry Switching and Exposure to Imports from Low-Wage Countries