9-2006

Import Competition and the Probability of Job Displacement in US Manufacturing, 1983-1999

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Abstract The trade-displacement relationship is examined using observations from the 1984-2000 Displaced Worker Surveys and corresponding industry data. Increases in import penetration and decreases in import prices correlate with higher displacement rates. Considerable variation in the effects of import competition on displacement probabilities is found across worker types. For example, the estimated displacement probability for a minority female who is not a union member but who has completed some college coursework ranges from 6.44 to 7.13 percent. This is significantly higher than the range estimated (1.02 to 1.24 percent) for college-educated, white, male union members. Setting import competition values equal to zero, we see estimated displacement probabilities for such workers decrease by 0.05 to 0.07 percentage points. Non-union, minority female workers with some college education realize reductions of 0.40 to 2.56 percentage points in their probabilities. Thus, workers most at risk of displacement are also most affected by import competition.

Keywords: Import competition, job displacement, manufacturing, trade liberalization

JEL Classifications: F14, F16

1. Introduction

Between 1970 and 2001, manufacturing employment as a share of U.S. employment decreased from 26.4 to 13.3 percent while trade as a share of Gross Domestic Product increased from 10.8 to 23.5 percent (U.S. Census Bureau, 1995; 2003). Protectionists frequently cite domestic job loss as an expected outcome of trade liberalization. Employment contraction in the U.S. manufacturing sector since 2001, coupled with persistent trade deficits, has reinforced this expectation. In 2002, the U.S. Congress expanded the Trade Adjustment Assistance program and approved a demonstration wage insurance program to serve trade-displaced workers. Future job losses, if perceived to result from outsourcing or the liberalizing of trade in services, may lead policymakers to revisit the scope and structure of such assistance programs. This study quantifies the effects of import competition on the probability of job displacement and informs policy by examining variation in such effects across a variety of worker types.

The Heckscher-Ohlin-Samuelson model predicts increased trade with labor-abundant nations results in a reallocation of U.S. production from labor-intensive to capital-intensive goods. Prior studies have documented a positive relation between imports and domestic job loss. Kletzer

(2002), Blanchflower (2000), Belman and Lee (1996) and Dickens (1988) provide reviews of the literature. This labor reallocation entails a potentially costly adjustment for affected workers as downward sticky wages may lead to unreplaced attrition and job displacement. Unreplaced attrition reduces employment as employers choose to not replace workers who voluntarily terminate their employment. Displacement is a more serious employment consequence as it is involuntary and as the typical displaced worker is found to experience significant associated losses, including a potentially prolonged period of unemployment and reduced earnings once reemployed (Jacobson, LaLonde and Sullivan, 1993; Stevens, 1997; and Kletzer and Fairlie, 2003).

We first estimate displacement probabilities for thirty-two worker types – defined by level of education, gender, race and union affiliation – and then examine the effects of import competition on these probabilities. A more complete understanding of variation in the labor market effects of import competition across worker types may aid policymakers when designing programs to assist the workers most in need. It may also lead to a more enlightened and fruitful debate regarding the anticipated effects of trade liberalization. Individual worker observations from the 1984 through 2000 Displaced Worker Surveys (DWS) are matched to industry data to examine the trade-displacement relationship. Confirming the findings of prior research, changes in import penetration rates and import prices, employed separately as measures of import competition, reveal a positive relationship between import penetration and displacement probabilities. Similarly, reductions in import price index values correlate with higher displacement rates. Extending the literature, we report considerable variation across worker types with respect to the associated effects on displacement probabilities.

Broadly speaking, we find non-union, lesser-educated, female and minority workers more likely to suffer job displacement. For example, the displacement probability for a minority female who is not a union member but who has completed some college coursework is estimated to range from 6.44 to 7.13 percent. This is significantly higher than the estimated range of displacement probabilities (1.02 to 1.24 percent) for college-educated, white, male union members. Setting import competition values equal to zero and re-estimating displacement probabilities, we see the workers most at risk of displacement are also the most affected by import competition. We proceed as follows. Section 2 introduces the theoretical intuition and estimation equations. Section 3 presents the data, Section 4 discusses the empirical results and Section 5 concludes.

2. Econometric Specification

Mann (1988), Freeman and Katz (1991), and Kletzer (2002) each employ partial equilibrium frameworks to analyze trade-related labor market dynamics. Following their leads, equations (1) and (2) present industry employment change as a function of industry characteristics and changes in the level and composition of industry sales and prices. L represents industry employment, D is the domestic market, $\frac{M}{D}$ is the import penetration rate, $\frac{X}{D}$ is the export penetration rate, P^D is the domestic price level, P^M is the import price level, P^X is the export price level, V is a vector of industry-specific variables, Δ is the difference operator, j and t are industry and time subscripts,

respectively, and ε^1 and ε^2 are assumed i.i.d. error terms. Derivation of equations (1) and (2) is provided in the appendix.

$$\Delta \ln L_{jt} = \alpha_0 + \beta_1 \Delta \ln D_{jt} - \beta_2 \Delta \ln \left[\frac{M}{D}\right]_{jt} + \beta_3 \Delta \ln \left[\frac{X}{D}\right]_{jt} + \delta_V d\Delta \ln V_{jt} + \varepsilon^1_{jt} \quad (1)$$

$$\Delta \ln L_{jt} = \alpha_0 + \beta_1 \Delta \ln P^D_{jt} + \beta_2 \Delta \ln P^M_{jt} + \beta_3 \Delta \ln P^X_{jt} + \delta_V \Delta \ln V_{jt} + \varepsilon^2_{jt} \quad (2)$$

Just as firms vary within industries and as industries vary within an economy, workers vary both within and across industries. For the individual, however, displacement is a binary outcome. To facilitate estimation of displacement probabilities, a binary dependent variable, $DISPLACED_{ijt}$, is employed. The dependent variable is equal to one if the worker reported being displaced and zero otherwise. We assume a worker's displacement probability to be a function of the individual's characteristics and the characteristics of the worker's industry of employment. Accordingly, to estimate the relationship between trade and job displacement, we modify equations (1) and (2) to include a vector of worker-specific characteristics, H_{it}, and employ a logistic functional form. Equations (3) and (4) illustrate.

$$DISPLACED_{ijt} = \alpha_0 + \beta_1 \Delta \ln D_{jt} - \beta_2 \Delta \ln \left[\frac{M}{D}\right]_{jt} + \beta_3 \Delta \ln \left[\frac{X}{D}\right]_{jt} + \delta_V \Delta \ln V_{jt} + \delta_H H_{it} + \varepsilon^1_{ijt} \quad (3)$$

$$DISPLACED_{ijt} = \alpha_0 + \beta_1 \Delta \ln P^D_t + \beta_2 \Delta \ln P^M_{jt} + \beta_3 \Delta \ln P^X_{jt} + \delta_V \Delta \ln V_{jt} + \delta_H H_{it} + \varepsilon^2_{ijt} \quad (4)$$

In the analysis to follow, due to unavailability of industry-level domestic consumer price indexes, P^D_{jt} is assumed equal to P^X_{jt}. Implicitly, this assumes that domestic price effects pass through to export prices. Thus, the estimated coefficients on the P^X_{jt} variables capture the cumulative effects of both changes in export prices and domestic prices.

3. Data

Individual observations from the 1984-2000 Displaced Worker Surveys (DWS) have been matched to corresponding industry data, producing a data set that contains 101,187 worker observations which spans the years 1983-1999 (U.S. Department of Commerce, 2001a). Industry trade data for 77 manufacturing industries are from the NBER Trade Database (Feenstra, 1997; 1996) and the U.S. International Trade Commission trade database.[2] The NBER-CES Manufacturing Industry Database (Bartelsman and Gray, 1996) provides annual data on industry shipments, employment, payroll, capital stock and capital investment. Import and export price index data for 29 industries are from the International Price Program of the U.S. BLS. In the remainder of this section, the DWS data and variable construction are discussed.

3.1 U.S. Current Population Survey – Displaced Worker Survey

The DWS is conducted biennially and each survey collects detailed information regarding workers' demographic characteristics and labor market experiences, including displacement incidence, for a large, random sample of approximately 60,000 households. The DWS defines a worker as having been displaced if they left a job due to a plant or company closing or moving, or, in the event the plant or company is still operating, the job was lost due to slack/insufficient demand or due to worker's position or shift being abolished. Workers who were self-employed at the time of displacement or who, at the time of their survey, expected to be recalled to their former job are not considered to have been displaced. The DWS indicates industry of employment as of the survey date for all workers and, if applicable, the industry from which the worker was displaced. This allows examination of the effects of changes in industry-level import competition on the individual's displacement probability.

The DWS industry affiliation variable is coded at the 3-digit Census of Population Industrial Classification (CIC) level. Industry trade and productivity data (1981-1996) are coded at the 4-digit 1972 Standard Industrial Classification (SIC) code level while the price index data (1981-1999) are coded using the Standard International Trade Classification (SITC, rev. 3) system. To facilitate the empirical analysis, data sources have been merged into a common industry classification. Specifically, the 4-digit 1972 SIC data were converted to corresponding 1987 SIC codes and then aggregated to the 3-digit level. An SIC-to-CIC industry concordance (Bartelsman and Gray, 1996) was employed to map the SIC data to corresponding CIC industry codes. Similarly, an SITC-to-SIC concordance was developed by the author to facilitate matching of import and export price index data to CIC industry codes.[3]

A limitation of the DWS data is recall bias, which results when a respondent fails to accurately recollect past events. The further into a worker's past that a displacement occurred, the less likely the job separation is to be reported as displacement. Thus, displacement incidence may be underreported for years early in the recall period. To counter recall bias, we abbreviate recall periods to include only the calendar year prior to the survey. This also increases the reliability of the non-displaced worker control group. Data on occupational tenure, in general, and job tenure with the same employer are provided by the Job Tenure and Occupational Mobility (JTOM) supplement to the CPS (U.S. Department of Commerce, 2001b). The JTOM indicates 87 percent of respondents have at least one year of tenure with their survey-date employer. Similarly, 93 percent of respondents report tenure 6 or more months. Since the JTOM and the DWS are subsets of the CPS and representative of the labor force, we proceed under the assumption that the DWS and JTOM respondents have similar tenures.

Table 1 presents descriptive statistics. Relative to the full sample, displaced workers tend to be younger and less educated. Additionally, the typical displaced worker is more likely to be female, a minority, and not a union member. Such workers also tend to have worked in relatively labor-intensive industries that have witnessed relatively slow growth in both domestic and foreign demand. These industries also have experienced, on average, greater increases in import penetration rates and have seen import prices rise at a slower rate. Mean values for non-displaced workers mirror the full sample with the exception that such workers are more likely to be union members.

3.2 Variable Construction

As stated at the outset, two measures of import-competition are employed: changes in import penetration rates and changes in import price indexes. Trade theorists, assuming relative goods prices dictate factor prices, may prefer use of changes in import price indexes as the relevant import competition measure. This follows as the threat of lower import prices may reduce domestic goods prices and factor prices, thus affecting wages or, with downward sticky wages, employment. Unfortunately, import price measures are not entirely ideal. Changes in relative prices can occur due to reasons not associated with trade and price indexes may not accurately measure prices across sectors of an industry where goods are likely to be heterogeneous. This underscores the rationale for using both quantity and price measures of import-competition.

As a lag may exist between changes in import competition and labor market adjustment, both two- and three-year changes in import penetration rates and import price indexes are employed.[4] Bernard and Jensen (1995) report higher employment growth at U.S. exporting firms as compared to non-exporters. Accordingly, two- and three-year changes in industry export penetration rates are included to capture associated job-creating effects. To control for domestic demand shifts, measures of the size on the domestic market, at the industry-level, are included. Again, two- and three-year changes are employed. Prior studies have identified displacement as a counter-cyclical occurrence (Farber, 2005; Schmitt, 2004; Kletzer, 1998; Fallick, 1996; Carrington, 1993). To control for the influence of business cycle fluctuations, variables representing a one-year change and a lagged one-year change in the manufacturing sector capacity utilization rate are included.

Technological advances may reduce the demand for unskilled labor (Lawrence and Slaughter, 1993; Krugman and Lawrence, 1994; Berman, Bound and Griliches, 1994; Berman, Bound and Machin, 1998; Kletzer, 1998). To control for such changes, industry-level Solow residuals are constructed from constant returns to scale Cobb-Douglas production functions, assuming constant expenditure shares (Solow, 1957). As with the trade variables, both two- and three-year changes in the technology variable are employed. Controlling for labor-intensity, industry capital-labor ratios are calculated as the capital stock divided by production employment. Worker-specific dummy variables representing gender (female), race (minority), and union affiliation are also included. Lastly, a variable representing potential work experience is constructed as age minus years of education minus six.

4. Effects of Increased Import Competition on the Probability of Displacement

Results from estimating equations (3) and (4) are presented in Table 2. Columns (a) and (b) present positive and significant log-odds coefficients on two- and three-year changes in import penetration rates. Similarly, columns (c) and (d) report negative coefficients on two- and three-year changes in import price indexes; however, only the coefficient in column (d) is significant. Countering the effects of imports, increases in domestic or foreign demand reduce the probability of displacement. This follows from the expectation that higher demand for domestic production, either to be consumed within the U.S. or abroad, may entail an increase in labor demand.

Increases in the capacity utilization rate and its lagged value reduce probabilities, illustrating the counter-cyclical nature of job displacement. Improvements in technology are capable of increasing employment if productivity gains lead to lower product prices and, hence, increased output; however, if employers substitute technological advances for labor, such improvements may be labor-displacing. The positive log-odds coefficients presented in columns (a) and (b) indicate that, if both effects are present, the latter appears to dominate. All else equal, workers in capital-intensive industries are less likely to be displaced. This is intuitive for two reasons. First, due to the presence of more capital, such workers are expected to be more productive and, hence, less likely to be displaced. Second, if the nature of import competition is such that foreign workers are engaged in labor-intensive production processes, then domestic workers in more labor-intensive industries would face more import competition than would workers employed in capital-intensive industries.

Regarding worker characteristics, higher levels of education and experience are associated with lower displacement probabilities. Relative to college graduates, the null classification, workers in all other education classifications are significantly more likely to experience a job displacement. Similarly, the log-odds coefficient on the experience variable is negative and significant in each specification. Education represents ability while experience measures general training. Workers of higher ability or higher levels of training may be more productive. If so, firms would be less likely to displace such workers. An alternative explanation regarding the experience variable is that, given the high correlation between potential work experience and age, a "last in, first out" labor shedding process is being captured by the coefficient.

Female and minority workers face higher displacement probabilities. Positive and significant log-odds coefficients are reported for each variable in each specification. This may be the result of labor market discrimination or, possibly, industry characteristics. For example, women and minorities comprise a disproportionately large share of the apparel industry workforce, which in recent years has faced substantial import competition. Union coverage is also associated with lower displacement probabilities. This is unsurprising as industries with higher unionization rates face lower levels of import competition.

Estimated displacement probabilities are presented in Table 3-A.[5] For the typical worker, the estimate ranges from 3.57 to 4.15 percent, depending on specification chosen. To consider variation in displacement probabilities across worker types, we classify workers according to level of educational attainment, race, gender and union membership. The result is 32 worker types which, for each, a range of displacement probabilities are calculated. White, male workers who are college graduates and union members are least likely to be displaced. Displacement probabilities for such workers range from 1.02 to 1.24 percent. Minority, female workers who have completed some college coursework but are not union members are at the other end of the spectrum; for these workers, estimated displacement probabilities range from 6.44 to 7.13 percent.

Columns (e) through (h) in Table 3-B present changes in estimated displacement probabilities if we set values for import competition measures equal to zero.[6] Across all worker types, we see displacement probabilities reduced. For the typical worker, the probability of displacement falls

by 0.55 to 0.57 percentage points when import penetration measures are set equal to zero. Similarly, setting the three-year change in import price index values equal to zero lowers the displacement probability by 0.15 percentage points.[7] However, just as considerable variation is found across worker types with respect to displacement probabilities, we find significant differences in the effects of import competition. For example, college-educated, white, male union members (who face displacement probabilities of 1.02 to 1.24 percent) see probabilities fall by only 0.05 to 0.07 percentage points. Minority, female workers who have completed some college but are not union members, realize decreases in probabilities of 0.40 to 2.56 percentage points. Thus, those workers most at risk of displacement are also most affected by import competition.

5. Conclusion

We examine the trade-displacement relationship using individual worker observations from the 1984-2000 Displaced Worker Surveys. Confirming prior research, we report that rising import competition is positively associated with higher displacement rates. Extending the literature, we consider variation in displacement probabilities across worker types and investigate the associated effects of import competition on the estimated displacement probabilities. Non-union, lesser-educated, female and minority workers are identified as being more likely to suffer job displacement. Additionally, these workers appear most affected by import competition.

This study provides a more complete understanding of the trade-displacement relationship. The findings may enable policymakers to better target specific worker types when formulating public policies to assist displaced workers. For example, identification of industries facing rising import competition, coupled with examination of industry labor force demographics, may allow for proactive responses to trade-related job displacement. This may enable a reduction in both the social costs of displacement (decreased productivity and/or inefficient expenditure of public funds) and the personal costs borne by displaced workers. Further, the finding of heterogeneity across worker types, with respect to the effects of import competition, may provide the trade liberalization debate with a more accurate depiction of the interrelation between import competition and job displacement.

Appendix

A. Derivation of Estimation Equations

Following Mann (1988), Freeman and Katz (1991), and Kletzer (2002) we assume competitive factor markets and allow the demand for labor to be given as

$$\Delta \ln L_{jt} = -\eta \Delta \ln W_{jt} + \Delta \ln Z_{jt} + \Delta \ln V_{jt} \quad \text{(A.1)}$$

where L_{jt} is industry employment, η is the elasticity of labor demand, W_{jt} is the industry wage rate, Z_{jt} is a vector of factors that may exogenously shift product demand and thus may shift the labor demand curve, V_{jt} is a vector of industry-specific variables, Δ is the difference operator, ln denotes the natural logarithm, and j and t are industry and time subscripts, respectively. Equation (A.2) gives an expression for labor supply.

$$\Delta \ln L_{jt} = \lambda \Delta \ln W_{jt} + \Delta \ln R_{jt} \quad \text{(A.2)}$$

where L_{jt} is the industry supply of labor, λ is the elasticity of labor supply, and R_{jt} is a vector of factors underlying potential labor supply shifts. In equilibrium, labor market clearing dictates that equation (A.1) is equal to equation (A.2). Solving for $\Delta \ln W_{jt}$ yields

$$\Delta \ln W_{jt} = \left(\frac{1}{\lambda + \eta} \right) \left[\Delta \ln Z_{jt} + \Delta \ln V_{jt} - \Delta \ln R_{jt} \right] \quad \text{(A.3)}$$

Substituting equation (A.3) into equation (A.2) yields the change in industry employment.

$$\Delta \ln L_{jt} = \left(\frac{\lambda}{\lambda + \eta} \right) \left[\Delta \ln Z_{jt} + \Delta \ln V_{jt} \right] - \left(\frac{\lambda}{\lambda + \eta} - 1 \right) \Delta \ln R_{jt} \quad \text{(A.4)}$$

Estimation of equation (A.4) to examine the effects of shifts in labor supply and product demand on industry employment would be a mistake due to potential simultaneity caused by wage and employment pressures on prices and thus on shipments. Following Freeman and Katz (1991), we assume that output prices depend solely on production costs. The relation between wages and sales is represented as follows. Let production be given by equation (A.5).

$$\Delta \ln Q_{jt} = -\psi \Delta \ln P_{jt} + \Delta \ln Z_{jt} \quad \text{(A.5)}$$

where Q_{jt} is industry output, P_{jt} is the industry price level, and ψ is the price elasticity of product demand. Z_{jt} is a vector of exogenous product demand shifters. Assuming that P_{jt} depends solely on production costs and that labor is the only factor input we have P_{jt} determined solely by wages.

$$\Delta \ln P_{jt} = \phi \Delta \ln W_{jt} + \upsilon_{jt} \quad \text{(A.6)}$$

where ϕ represents labor's share of total costs and υ_{jt} is an assumed i.i.d. error term. Setting $\Delta \ln R_{jt}$ and $\Delta \ln V_{jt}$ equal to zero for now, equation (A.3) and equation (A.4) become

$$\Delta \ln W_{jt} = \theta \Delta \ln Z_{jt} \tag{A.7}$$

$$\Delta \ln L_{jt} = \Omega \Delta \ln Z_{jt} \tag{A.8}$$

where $\theta = \frac{1}{\lambda + \eta}$ and where $\Omega = \frac{\lambda}{\lambda + \eta}$. Equations (A.7) and (A.8) illustrate that both wages and employment change in response to exogenous shifts in product demand. Substituting equation (A.6) into equation (A.5) and assuming that $\varepsilon_{jt} = 0$ yields equation (A.9).

$$\Delta \ln Q_{jt} = -\psi\phi \Delta \ln W_{jt} + \Delta \ln Z_{jt} \tag{A.9}$$

Using the identity that $\Delta \ln S_{jt} = \Delta \ln P_{jt} + \Delta \ln Q_{jt}$ (where S_{jt} is industry sales) and substituting equation (A.9) into the identity we have

$$\Delta \ln S_{jt} = -\psi\phi \Delta \ln W_{jt} + \Delta \ln Z_{jt} + \Delta \ln P_{jt} \tag{A.10}$$

Further substituting equation (A.6) into equation (A.10) and assuming that $\varepsilon_{jt} = 0$ we have

$$\Delta \ln S_{jt} = (1 - \psi)\phi \Delta \ln W_{jt} + \Delta \ln Z_{jt} \tag{A.11}$$

Solving equation (A.11) for $\Delta \ln Z_{jt}$ yields

$$\Delta \ln Z_{jt} = \Delta \ln S_{jt} - (1 - \psi)\phi \Delta \ln W_{jt} \tag{A.12}$$

Substituting equation (A.7) into equation (A.12) for $\Delta \ln W_{jt}$ yields

$$\Delta \ln Z_{jt} = \left(\frac{1}{(1 + (1 - \psi)\phi\theta)} \right) \Delta \ln S_{jt} \tag{A.13}$$

Substituting equation (A.13) into (A.8) yields an expression relating changes in sales to changes in employment. Defining $\Lambda = \left(\frac{\Omega}{(1 + (1 - \psi)\phi\theta)} \right)$ we can write the change in employment as

$$\Delta \ln L_{jt} = \Lambda \Delta \ln S_{jt} \tag{A.14}$$

Decomposing industry sales into its component parts, domestic sales, exports, and imports, we rewrite the identity of Sales = Domestic + Exports – Imports as $S_{jt} = D_{jt} + X_{jt} - M_{jt}$. Taking log-differences to approximate for percent changes and dropping industry and time subscripts yields

$$\frac{\Delta S}{S} = \left(\frac{D}{S}\right)\frac{\Delta D}{D} + \left(\frac{X}{S}\right)\frac{\Delta X}{X} - \left(\frac{M}{S}\right)\frac{\Delta M}{M} \tag{A.15}$$

If we let $\frac{\Delta S}{S} = \hat{S}$, $\frac{\Delta D}{D} = \hat{D}$, $\frac{\Delta X}{X} = \hat{X}$, $\frac{\Delta M}{M} = \hat{M}$, then equation (A.15) can be written as

$$\hat{S} = \left(\frac{D}{S}\right)\hat{D} + \left(\frac{X}{S}\right)\hat{X} - \left(\frac{M}{S}\right)\hat{M} \tag{A.16}$$

Allowing $\hat{\kappa} = \frac{X}{S} = \hat{X} - \hat{S}$ and $\hat{\rho} = \frac{M}{S} = \hat{M} - \hat{S}$ implies that $\hat{X} = \hat{\kappa} + \hat{S}$ and $\hat{M} = \hat{\rho} + \hat{S}$. Substituting these identities into equation (A.16), recognizing $\hat{\kappa} = \frac{X}{S}$, $\hat{\rho} = \frac{M}{S}$, and reintroducing industry and time subscripts allow equation (A.16) to be written as follows.

$$\hat{S}_{jt} = \hat{D}_{jt} + \left[\frac{\hat{\kappa}}{(1 - \hat{\kappa} + \hat{\rho})}\right]\left(\frac{X}{S}\right)_{jt} - \left[\frac{\hat{\rho}}{(1 - \hat{\kappa} + \hat{\rho})}\right]\left(\frac{M}{S}\right)_{jt} \tag{A.17}$$

Substituting equation (A.17) into equation (A.14) yields

$$\Delta \ln L_{jt} = \Lambda\omega_1 \Delta \ln D_{jt} + \Lambda\omega_2 \Delta \ln\left(\frac{X}{S}\right)_{jt} - \Lambda\omega_3 \Delta \ln\left(\frac{M}{S}\right)_{jt} \tag{A.18}$$

where $\omega_1 = 1$, $\omega_2 = \left[\frac{\hat{\kappa}}{(1 - \hat{\kappa} + \hat{\rho})}\right]$, and $\omega_3 = \left[\frac{\hat{\rho}}{(1 - \hat{\kappa} + \hat{\rho})}\right]$. Re-writing equation (A.18) such that $\beta_1 = \omega_1$, $\beta_2 = \Lambda\omega_2$ and $\beta_3 = \Lambda\omega_3$ yields equation (A.19).

$$\Delta \ln L_{jt} = \beta_1 \Delta \ln D_{jt} + \beta_2 \Delta \ln\left(\frac{X}{S}\right)_{jt} - \beta_3 \Delta \ln\left(\frac{M}{S}\right)_{jt} \tag{A.19}$$

The model developed thus far can be altered to consider changes in domestic, export, and import price levels. Equations (A.1) through (A.4) remain the same; however, equation (A.5) becomes

$$\Delta \ln Q_{jt} = -\psi_1 \Delta \ln P_{jt}^{D} + \psi_2 \Delta \ln P_{jt}^{M} + \psi_3 \Delta \ln P_{jt}^{X} \tag{A.20}$$

where P_{jt}^{D}, P_{jt}^{M}, and P_{jt}^{X} are the domestic, import and export price level, respectively, and $\Delta \ln Z_{jt} = 0$. Using the identity of $\Delta S_{jt} = \Delta Q_{jt} + \Delta P_{jt}$ to add ΔP_{jt} to equation (A.20) we have that

$$\Delta \ln S_{jt} = (1-\psi_1)\Delta \ln P_{jt}^{D} + \psi_2 \Delta \ln P_{jt}^{M} + \psi_3 \Delta \ln P_{jt}^{X} \quad \text{(A.21)}$$

Substituting equation (A.21) into equation (A.14) yields

$$\Delta \ln L_{jt} = \Lambda\left[(1-\psi_1)\Delta \ln P_{jt}^{D} + \psi_2 \Delta \ln P_{jt}^{M} + \psi_3 \Delta \ln P_{jt}^{X}\right] \quad \text{(A.22)}$$

where $\Lambda(1-\psi_1)$ is the domestic price elasticity of demand, $\Lambda\psi_2$ is the import price elasticity of demand, and $\Lambda\psi_3$ is the export price elasticity of demand. Re-writing equation (A.22) such that $\beta_1 = \Lambda(1-\psi_1)$, $\beta_2 = \Lambda\psi_2$ and $\beta_3 = \Lambda\psi_3$ yields equation (A.23).

$$\Delta \ln L_{jt} = \beta_1 \Delta \ln P_{jt}^{D} + \beta_2 \Delta \ln P_{jt}^{M} + \beta_3 \Delta \ln P_{jt}^{X} \quad \text{(A.23)}$$

Appending a vector of industry-specific variables, $\Delta \ln V_{jt}$, to equations (A.19) and (A.23), addition of assumed i.i.d error terms and an intercept term yields equations (A.24) and (A.25).

$$\Delta \ln L_{jt} = \alpha_0 + \beta_1 \Delta \ln D_{jt} - \beta_3 \Delta \ln\left(\frac{M}{S}\right)_{jt} + \beta_2 \Delta \ln\left(\frac{X}{S}\right)_{jt} + \beta_v \Delta \ln V_{jt} + \varepsilon_{jt}^{1} \quad \text{(A.24)}$$

$$\Delta \ln L_{jt} = \alpha_0 + \beta_1 \Delta \ln P_{jt}^{D} + \beta_2 \Delta \ln P_{jt}^{M} + \beta_3 \Delta \ln P_{jt}^{X} + \delta_v \Delta \ln V_{jt} + \varepsilon_{jt}^{2} \quad \text{(A.25)}$$

These final two equations correspond to equations (1) and (2) in the paper.

B. Industry Listing (Asterisks denote industries for which price index data were available).

CIC	Industry Description
100*	Meat products
101	Dairy products
102*	Canned, frozen and preserved fruits and vegetables
110	Grain mill products
111	Bakery products
112	Sugar and confectionary products
120	Beverage industries
121	Miscellaneous food preparations and kindred products
130	Tobacco manufactures
132	Knitting mills
140	Dyeing and finishing textiles, except wool and knit goods
141	Carpets and rugs
142	Yarn, thread and fabric mills
150	Miscellaneous textile mill products
151	Apparel and accessories, except knit goods
152	Miscellaneous fabricated textile products
160*	Pulp, paper, and paperboard mills
161	Miscellaneous paper and pulp products
162	Paperboard containers and boxes
171	Newspaper publishing and printing
172*	Printing, publishing, and allied equipment industries, except newspapers
180*	Plastics, synthetics, and resins
181*	Drugs
182*	Soaps and cosmetics
190	Paints, varnishes, and related products
191*	Agricultural chemicals
192*	Industrial and miscellaneous chemicals
200*	Petroleum refining
201	Miscellaneous petroleum and coal products
210	Tires and inner tubes
211	Other rubber products, and plastic footwear and belting
212*	Miscellaneous plastics products
220	Leather tanning and finishing
221	Footwear, except rubber and plastic
222	Leather products, except footwear
230	Logging
231	Sawmills, planning mills, and millwork
232	Wood buildings and mobile homes
241	Miscellaneous wood products
242*	Furniture and fixtures
250	Glass and glass products
251	Cement, concrete, gypsum, and plaster products
252	Structural clay products

CIC	Industry Description
261	Pottery and related products
262	Miscellaneous nonmetallic mineral and stone products
270*	Blast furnaces, steelworks, rolling and finishing mills
271*	Iron and steel foundries
272*	Primary aluminum industries
280	Other primary metal industries
281*	Cutlery, hand tools, and other hardware
282	Fabricated structural metal products
290	Screw machine products
291	Metal forgings and stampings
292	Ordnance
300*	Miscellaneous fabricated metal products
310*	Engines and turbines
311	Farm machinery and equipment
312*	Construction and material handling machines
320*	Metalworking machinery
321	Office and accounting machines
322*	Computers and related equipment
331*	Machinery, except electrical, not elsewhere classified
340*	Household appliances
341*	Radio, television, and communication equipment
342*	Electrical machinery, equipment and supplies, not elsewhere classified
351*	Motor vehicles and motor vehicle equipment
352	Aircraft and parts
360	Ship and boat building and repairing
361	Railroad locomotives and equipment
362	Guided missiles, space vehicles, and parts
370	Cycles and miscellaneous transportation equipment
371*	Scientific and controlling instruments
372*	Medical, dental, and optical instruments and supplies
380	Photographic equipment and supplies
381	Watches, clocks, and clockwork operated devices
390*	Toys, amusement, and sporting goods
391	Miscellaneous manufacturing industries

Endnotes

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2. An industry listing is provided in the appendix.

3. The concordance created for this study is available upon request from the author.

4. Annual and four-year changes were employed in sets of alternate regressions; however, the magnitude and statistical significance of the resulting coefficients indicate a stronger link exists between imports and displacement using two- and three-year changes in import competition measures.

5. Estimated probabilities are derived as $\hat{P}_i = \frac{e^{\hat{L}_i}}{1+e^{\hat{L}_i}}$, where $\hat{L}_i = \hat{\alpha}_0 + \hat{\beta}_x X_i$ and coefficient values are presented in Table 2. Values for the vector X_i are mean values corresponding to each worker type.

6. Changes in estimated displacement probabilities are derived as $\frac{\partial \hat{P}_i}{\partial X_i} = \hat{P}_i \times (1 - \hat{P}_i) \times \hat{\beta}_x \times X_i$, where X_i is the natural logarithm of the change in the import competition measure for each worker type and $\hat{\beta}_x$ is the corresponding coefficient presented in Table 2.

7. In Table 3-B, we report the change in the estimated displacement probability when the two-year change in the import price index is set equal to zero. However, as the corresponding coefficient presented in Table 2 is not significant from zero, the effective change in displacement probabilities for all worker types is zero.

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Table 1-A: Descriptive Statistics, Worker Observations

Variable	All Workers	Displaced Workers	Non-Displaced Workers
Displaced	0.041	----	----
	(0.198)	----	----
Age (in years)	39.186	37.858**	39.244
	(12.550)	(12.282)	(12.556)
Education (in years)	13.430	13.192**	13.444
	(2.763)	(2.697)	(2.765)
Less than a High School Diploma	0.139	0.157**	0.138
	(0.346)	(0.364)	(0.345)
High School Diploma	0.223	0.222	0.223
	(0.416)	(0.416)	(0.416)
Some College	0.410	0.438**	0.409
	(0.492)	(0.496)	(0.492)
B.A./B.S. or Above	0.228	0.182**	0.230
	(0.420)	(0.386)	(0.421)
Experience (in years)	19.750	18.666**	19.801
	(13.048)	(12.855)	(13.055)
Female	0.342	0.399**	0.340
	(0.475)	(0.490)	(0.474)
Minority	0.130	0.163**	0.129
	(0.337)	(0.369)	(0.335)
Union	0.048	0.017**	0.050#
	(0.214)	(0.129)	(0.217)
N	101,187	4,143	97,044

Values presented are non-weighted arithmetic means. Standard deviations are in parentheses. T-tests of differences in mean values between stratified samples and the full sample were employed. "**", "*", and "#" denote significance from overall mean values at the 1%, 5%, and 10% levels, respectively.

Table 1-B: Descriptive Statistics, Industry Variables

Variable	All Workers	Displaced Workers	Non-Displaced Workers
Δ ln Import Penetration (2-year Δ)	0.083	0.101**	0.082
	(0.217)	(0.205)	(0.218)
Δ ln Import Penetration (3-year Δ)	0.132	0.152**	0.131
	(0.269)	(0.249)	(0.269)
Δ ln Export Penetration (2-year Δ)	0.132	0.109**	0.133
	(0.321)	(0.320)	(0.321)
Δ ln Export Penetration (3-year Δ)	0.209	0.190**	0.209
	(0.399)	(0.411)	(0.399)
Δ ln Domestic Market (2-year Δ)	0.100	0.090**	0.101
	(0.121)	(0.123)	(0.121)
Δ ln Domestic Market (3-year Δ)	0.152	0.139**	0.153
	(0.177)	(0.170)	(0.177)
Δ ln Technology (2-year Δ)	0.102	0.101	0.102
	(0.158)	(0.150)	(0.158)
Δ ln Technology (3-year Δ)	0.156	0.154	0.156
	(0.220)	(0.201)	(0.221)
ln Capital-Labor Ratio	74.417	66.237**	74.786
	(78.837)	(70.390)	(79.178)
N	693	693	693
Δ ln Import Price (2-year Δ)	0.026	0.020**	0.027
	(0.099)	(0.097)	(0.100)
Δ ln Import Price (3-year Δ)	0.041	0.029**	0.042
	(0.138)	(0.138)	(0.138)
Δ ln Export Price (2-year Δ)	0.032	0.030	0.032
	(0.067)	(0.065)	(0.067)
Δ ln Export Price (3-year Δ)	0.052	0.054	0.052
	(0.090)	(0.096)	(0.090)
N	261	261	261
Δ ln Capacity Utilization Rate	0.016	0.025**	0.016
	(0.076)	(0.082)	(0.076)

See Table 1-A notes. As Capacity Utilization Rates employed represent the entire manufacturing sector, the relevant sample size is 18.

Table 2: Determinants of Job Displacement

Dependent Variable: **Displaced$_{it}$ (Logit Estimation)**

	Quantity Measures: 1983-1995		*Price Measures: 1983-1999*	
Variable	(a)	(b)	(c)	(d)
Δ ln Import Penetration$_{jt}$	0.535**	0.345**		
	(0.082)	(0.067)		
Δ ln Export Penetration$_{jt}$	-0.312**	-0.19**		
	(0.06)	(0.048)		
Δ ln Import Price$_{jt}$			-0.22	-0.837**
			(0.318)	(0.266)
Δ ln Export Price$_{jt}$			0.841#	0.719#
			(0.484)	(0.379)
Δ ln Domestic Market$_{jt}$	-0.508**	-0.476**		
	(0.158)	(0.123)		
Δ ln Technology$_{jt}$	0.201	0.26*		
	(0.125)	(0.104)		
Δ ln Capacity Utilization Rate$_t$	-3.565**	-3.429**	-1.088	-1.253
(1-year Δ)	(0.687)	(0.678)	(0.973)	(1.03)
Δ ln Capacity Utilization Rate$_t$	-5.619**	-6.021**	-4.631**	-2.733*
(lagged 1-year Δ)	(0.686)	(0.691)	(1.04)	(1.109)
ln Capital-Labor Ratio$_{jt}$	-0.001**	-0.001**		
	(0.0003)	(0.0003)		
Female$_i$	0.165**	0.167**	0.132**	0.163**
	(0.036)	(0.036)	(0.051)	(0.053)
Minority$_i$	0.258**	0.26**	0.251**	0.235**
	(0.047)	(0.047)	(0.067)	(0.071)
Union$_{it}$	-1.111**	-1.113**	-1.112**	-1.101**
	(0.129)	(0.129)	(0.18)	(0.193)
Experience$_{it}$	-0.009**	-0.009**	-0.01**	-0.01**
	(0.001)	(0.001)	(0.002)	(0.002)
Less than High School Diploma$_i$	0.44**	0.441**	0.273*	0.228**
	(0.062)	(0.062)	(0.09)	(0.095)
High School Diploma$_i$	0.387**	0.391**	0.125#	0.098
	(0.058)	(0.058)	(0.076)	(0.079)
Some College$_i$	0.302**	0.296**	0.327**	0.323**
	(0.048)	(0.048)	(0.065)	(0.069)
Constant	-3.151**	-3.156**	-3.202**	-3.224**
	(0.057)	(0.058)	(0.065)	(0.069)
N	82,292	82,315	43,240	39,901
Log-Likelihood Function	-14,409.90	-14,412.92	-7,335.08	-6,674.61
χ^2 (test for joint significance)	473.40**	463.21**	159.90**	147.91**
Pseudo R^2	0.16	0.16	0.11	0.11

Log-odds ratios reported. Standard errors are in parentheses. "**", "*", and "#" denote statistical significance at the 1%, 5%, and 10% levels, respectively. Column (a) presents estimation results wherein 2-year changes in import penetration rates, exports, domestic market and technology are employed as explanatory variables. Column (b) presents results when 3-year changes are employed. Columns (c) and (d) present results when the 2-year and 3-year changes in the import and export price indices are employed, respectively.

Table 3-A: Estimated Displacement Probabilities, by Worker Type

Worker Type	*Estimated Displacement Probabilities* (a)	(b)	(c)	(d)
All Workers	3.57%	3.59%	4.02%	4.15%
Education: Less than High School diploma				
Minority female non-union workers	6.70%	6.83%	5.91%	5.85%
Minority female union workers	2.35%	2.36%	1.98%	2.03%
Minority male non-union workers	5.51%	5.69%	5.13%	4.95%
Minority male union workers	1.86%	1.94%	1.75%	1.73%
White female non-union workers	5.27%	5.40%	4.69%	4.71%
White female union workers	1.72%	1.76%	1.54%	1.54%
White male non-union workers	4.46%	4.58%	4.20%	4.10%
White male union workers	1.46%	1.51%	1.38%	1.36%
Education: High School diploma				
Minority female non-union workers	6.56%	6.75%	5.48%	5.05%
Minority female union workers	2.21%	2.29%	1.81%	1.71%
Minority male non-union workers	5.58%	5.72%	4.85%	4.35%
Minority male union workers	1.83%	1.85%	1.56%	1.44%
White female non-union workers	5.13%	5.25%	4.25%	3.99%
White female union workers	1.75%	1.77%	1.45%	1.37%
White male non-union workers	4.35%	4.44%	3.78%	3.44%
White male union workers	1.42%	1.44%	1.25%	1.13%
Education: Some college				
Minority female non-union workers	6.44%	6.61%	7.01%	7.13%
Minority female union workers	2.10%	2.16%	2.35%	2.50%
Minority male non-union workers	5.33%	5.49%	6.10%	6.08%
Minority male union workers	1.78%	1.83%	2.06%	2.05%
White female non-union workers	4.87%	4.98%	5.41%	5.59%
White female union workers	1.67%	1.72%	1.90%	1.97%
White male non-union workers	4.09%	4.21%	4.74%	4.77%
White male union workers	1.36%	1.40%	1.59%	1.64%
Education: B.A./B.S. or above				
Minority female non-union workers	4.88%	5.01%	5.38%	5.45%
Minority female union workers	1.61%	1.69%	1.83%	1.88%
Minority male non-union workers	4.06%	4.16%	4.64%	4.57%
Minority male union workers	1.32%	1.37%	1.55%	1.58%
White female non-union workers	3.77%	3.87%	4.22%	4.33%
White female union workers	1.30%	1.33%	1.45%	1.50%
White male non-union workers	3.12%	3.21%	3.58%	3.60%
White male union workers	1.02%	1.06%	1.20%	1.24%

Columns (a) through (d) present probabilities constructed using log-odds coefficients reported in Columns (a) through (d), respectively, of Table 2.

Table 3-B: Change in Estimated Displacement Probabilities, by Worker Type

Worker Type	*Change in Estimated Displacement Prob. (Import Competition Value = 0)* (e)	(f)	(g)	(h)
All Workers	-0.55%	-0.57%	-0.01%	-0.15%
Education: Less than High School diploma				
Minority female non-union workers	-1.56%	-1.64%	0.00%	-0.21%
Minority female union workers	-0.41%	-0.28%	0.01%	-0.02%
Minority male non-union workers	-0.86%	-0.98%	-0.02%	-0.22%
Minority male union workers	-0.07%	-0.14%	0.00%	-0.08%
White female non-union workers	-1.24%	-1.31%	-0.01%	-0.18%
White female union workers	-0.12%	-0.12%	-0.01%	-0.10%
White male non-union workers	-0.62%	-0.67%	0.00%	-0.19%
White male union workers	-0.08%	-0.09%	-0.01%	-0.06%
Education: High School diploma				
Minority female non-union workers	-0.74%	-1.03%	0.00%	-0.06%
Minority female union workers	-0.10%	-0.15%	0.00%	-0.03%
Minority male non-union workers	-0.28%	-0.48%	-0.01%	-0.11%
Minority male union workers	-0.05%	-0.06%	0.00%	-0.03%
White female non-union workers	-0.63%	-0.74%	-0.01%	-0.06%
White female union workers	-0.02%	-0.04%	-0.01%	-0.03%
White male non-union workers	-0.20%	-0.29%	-0.01%	-0.09%
White male union workers	-0.04%	-0.04%	0.00%	-0.04%
Education: Some college				
Minority female non-union workers	-2.50%	-2.56%	0.00%	-0.40%
Minority female union workers	-0.29%	-0.26%	-0.01%	-0.16%
Minority male non-union workers	-1.28%	-1.39%	-0.02%	-0.31%
Minority male union workers	-0.17%	-0.17%	0.00%	-0.15%
White female non-union workers	-1.38%	-1.41%	-0.02%	-0.31%
White female union workers	-0.17%	-0.17%	0.00%	-0.12%
White male non-union workers	-0.78%	-0.85%	-0.02%	-0.28%
White male union workers	-0.09%	-0.10%	0.00%	-0.12%
Education: B.A./B.S. or above				
Minority female non-union workers	-1.42%	-1.46%	-0.01%	-0.09%
Minority female union workers	-0.02%	-0.08%	0.00%	-0.22%
Minority male non-union workers	-0.91%	-0.94%	-0.01%	-0.14%
Minority male union workers	-0.04%	-0.07%	0.00%	-0.12%
White female non-union workers	-0.76%	-0.80%	0.00%	-0.12%
White female union workers	-0.09%	-0.09%	0.00%	-0.09%
White male non-union workers	-0.51%	-0.55%	0.00%	-0.12%
White male union workers	-0.05%	-0.05%	0.00%	-0.07%

Columns (e) through (h) present changes in the estimated displacement probabilities presented in Columns (a) through (d) of Table 3-A, respectively, assuming a zero value for the corresponding measure of import competition.