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State and Regional Variation in the Effects of Trade on Job Displacement in the US Manufacturing Sector, 1982-1999

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Abstract Worker-level data from the 1984–2000 Displaced Worker Surveys are employed to examine the effects of trade on manufacturing workers' probabilities of job displacement. Observed changes in import and export penetration rates yield increases in displacement probabilities for the North Central, Middle Atlantic and South Central regions yet lower displacement probabilities for the Plains/West and Pacific regions. Changes in import and export price indexes lead to increases in displacement probabilities for the Pacific, Southeast and Northeast regions and decreases for the South Central and Middle Atlantic regions. However, while the influences of imports and exports on job displacement vary considerably across states and regions, the estimated net effect of trade on displacement probabilities is minor, generally speaking, when compared to the combined influence of other factors.

Keywords Trade · Job displacement · State and regional variation

Introduction

US manufacturing employment declined from 26.4% of total employment in 1970 to 11.8% in 2004. More striking, the sector employs fewer workers at the beginning of the 21st century than in the early 1970s. Coinciding with the proportional and absolute employment declines, the sum of imports and exports relative to Gross Domestic Product increased from 8.1 to 24.8% (US Department of Commerce, Bureau of the Census 2006; 1985). In recent years, acceleration of manufacturing sector job loss, record trade deficits and media focus on offshoring have reinforced the perception of trade causing the demise of US manufacturing. For example, a

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2006 USA Today/Gallup Poll reports 65% of respondents "believe increased trade between the US and other countries" mostly hurts US workers and 50% of respondents believe increased trade mostly hurts US companies. Responses to both questions were more negative than they had been in 1999 (59% and 39, respectively) when identical questions were posed (USA Today/Gallup 2006; 1999).

Prior research finds positive relationships between imports and job loss and between exports and job creation. However, many factors (business cycle fluctuations, waning domestic demand, capital deepening, technological advances and declining unionization) have coincided with observed labor market outcomes. The link between trade and job displacement varies based on industry- and worker-specific factors. Workers in industries that are labor-intensive, employ below-average levels of technology, and are disproportionately exposed to import competition are more likely to be displaced.[1] Being a minority, female, lesser-educated or not a union member increase the probability of displacement (White 2006). As labor force demographics and industrial composition vary across locales, geographic variation in the effects of trade on displacement is expected.

Utilizing worker-level data from the 1984–2000 Displaced Worker Surveys (DWS) with industry-level data from a number of sources, we estimate the influence of trade on the individual's probability of job displacement. Value and price-based measures of imports and exports are used in turn. Binomial Logit specifications are estimated to produce log-odds coefficients which, when applied to individual worker observations, permit estimation of displacement probabilities. Cleaving our data by region and by state, we examine variation in average displacement probabilities across locales and conduct counterfactual exercises to consider the corresponding influences of imports and exports. The results provide a more complete understanding of variation in the labor market effects of trade and may contribute to a more enlightened debate regarding trade and job displacement.

Confirming prior research, a positive relationship is revealed between increasing import penetration rates and job displacement. Similarly, we find reductions in import price indexes are correlated with higher displacement probabilities. We also report that displacement probabilities decrease as export penetration rates increase and as export price indexes decrease. Examining the influences of changes in penetration rates and price indexes across states and regions reveals considerable variation; however, the net effect of trade on displacement probabilities is minor compared to the combined influence of other factors. For example, growing domestic demand and business cycle upturns lower displacement probabilities, countering the influences of technological advances and capital-deepening. Education, work experience and union affiliation act to lower displacement probabilities, while female workers and minority workers are significantly more likely to experience displacement. The following section introduces the theoretical intuition and estimation equations. We then present the data and provide a discussion of the econometric results and counterfactual exercises.

[1] Kletzer (2002); Blanchflower (2000); Belman and Lee (1996) and Dickens (1988) review the literature.

Econometric Specification

Following Mann (1988); Freeman and Katz (1991), and Kletzer (2002), a dynamic partial equilibrium framework is used to examine the relationship between trade and job displacement. Eqs. 1 and 2 present employment change, at the industry level, as functions of industry characteristics and changes in the level and composition of industry sales or prices. L represents 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 and P^X are the import and export price levels, respectively, V is a vector of industry-specific variables, Δ, is the difference operator, and j and t are industry and time subscripts, respectively.

$$\Delta \ln L_{jt} = f\left(\Delta \ln D_{jt}, \Delta \ln \left[\frac{M}{D}\right]_{jt}, \Delta \ln \left[\frac{X}{D}\right]_{jt}, \Delta \ln V_{jt}\right) \tag{1}$$

$$\Delta \ln L_{jt} = f\left(\Delta \ln P^D_{jt}, \Delta \ln P^M_{jt}, \Delta \ln P^X_{jt}, \Delta \ln V_{jt}\right) \tag{2}$$

Equations 1 and 2 posit that the influences of trade and other factors on employment vary across industries. Just as industries vary across sectors of an economy, workers vary both within and across industries. Since, for individual workers, the occurrence of job displacement is a binary outcome, we employ a dependent variable, DISP_{ijt}, which is equal to one if the worker reports being displaced and zero otherwise. We assume the probability that a worker suffers a displacement is a function of the individual's demographic characteristics and attributes and the characteristics of the worker's industry of employment. To test this proposition, we modify Eqs. 1 and 2 to include a vector of worker-specific characteristics, H_{it}. Addition of ε^1 and ε^2, assumed independently and identically distributed error terms, results in our estimation equations.

$$\text{DISP}_{ijt} = \gamma_0 - \gamma_1 \Delta \ln D_{jt} + \gamma_2 \Delta \ln \left[\frac{M}{D}\right]_{jt} - \gamma_3 \Delta \ln \left[\frac{X}{D}\right]_{jt} + \gamma_V \Delta \ln V_{jt} + \gamma_H H_{it} + \varepsilon^1_{ijt} \tag{3}$$

$$\text{DISP}_{ijt} = \delta_0 + \delta_1 \Delta \ln P^D_t - \delta_2 \Delta \ln P^M_{jt} + \delta_3 \Delta \ln P^X_{jt} + \delta_V \Delta \ln V_{jt} + \delta_H H_{it} + \varepsilon^2_{ijt} \tag{4}$$

As stated, we employ changes in import and export penetration rates and changes in import and export price indexes in this analysis.[2] This follows from the notion that a worker's probability of job displacement is related to *changes* in the levels of trade-related and other industry-level variables rather than to levels per se. Trade

[2] Due to a lack of domestic price indexes, we assume domestic price effects pass through to export prices. Thus, coefficients on export price variables capture the effects of chages in export and domestic prices.

theorists may prefer the use of price indexes since changes in product prices may affect intermediate goods prices and associated factor demands; thus, influencing wages and/or employment.[3] Unfortunately, price measures are often less than ideal as prices often change for reasons unrelated to trade. Additionally, if goods are sufficiently heterogeneous within broad industry classifications, aggregation may produce indexes which inaccurately represent prices for particular industries. In an attempt to ameliorate these limitations, we employ both value and price measures of trade-related variables.

To quantify the influences of imports on the probability of job displacement, we employ 2-year changes in industry-level import penetration rates and import price indexes.[4] Bernard and Jensen (1995) report higher employment growth at US exporting firms as compared to non-exporters. Accordingly, 2-year changes in industry-level export penetration rates and export price indexes are included to capture associated job-creating effects. Controlling for domestic demand shifts, a measure of domestic market size, again at the industry-level, is included. As prior studies have identified displacement as a counter-cyclical occurrence (Farber 2005; Schmitt 2004; Kletzer 1998; Fallick 1996; Carrington 1993), we control for the influence of business cycle fluctuations by including the 1-year change and lagged 1-year change in the manufacturing sector capacity utilization rate. As technological advances may decrease the demand for unskilled labor (Lawrence and Slaughter 1993; Krugman and Lawrence 1994; Berman et al. 1994; Berman et al. 1998; Kletzer 1998), we control for such advances by including industry-level Solow residuals constructed using constant returns to scale Cobb-Douglas production functions (Solow 1957). To control for labor-intensity, industry capital-labor ratios are derived as the value of industry plants and equipment relative to production employment. Worker-specific dummy variables representing gender (female), race (minority), and union affiliation are included as is a measure of potential work experience that is constructed as age minus years of education minus six.

Data

The matching of individual observations to corresponding industry-level data produces a data set containing 85,194 worker observations which spans the years 1982–1999 (US Department of Commerce, Bureau of the Census 2001a).[5] Import and export data for 77 industries are from the National Bureau of Economic

[3] Jacobson et al. (1993); Stevens (1997) and Kletzer and Fairlie (2003) examine displacement-related wage and earnings losses.

[4] Annual, 3- and 4-year changes in trade-related variables were also employed. The results indicate a stronger link exists between trade and displacement over 2- and 3-year horizons. Given the similarity in results across estimations employing 2- and 3-year changes, we report only the results obtained when 2-year changes in trade-related variables are utilized.

[5] Industry affiliation was coded, for the 1984–2000 period, using the CIC system. Beginning in 2002, DWS observations are classified using the North American Industrial Classification System. The lack of a reliable CIC-to-NAICS concordance prohibits undertaking analysis for more recent surveys.

Research (NBER) Trade Database (Feenstra 1997; 1996) and the US International Trade Commission.[6] Annual data on industry shipments, employment, payroll, capital stock and capital investment for the years 1982–1996 are from the NBER-Center for Economic Studies (NBER-CES) Manufacturing Industry Database (Bartelsman and Gray 1996). Data from the Annual Survey of Manufactures (ASM) extends the NBER-CES data through 1999. Price index data for 45 industries are from the International Price Program of the US BLS.

The DWS is a biennial supplement to the Current Population Survey (CPS). Workers are classified 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 or insufficient demand or due to worker's position or shift being abolished. Workers who were self-employed or who, at the time of their survey, expected to be recalled to their former job are not considered by the DWS to have been displaced. The DWS indicates industry of employment as of the worker's survey date and, if applicable, the industry from which the worker was displaced. This permits examination of the effects of changes in industry-level variables on the individual's displacement probability.

The DWS industry affiliation variable is coded at the three-digit Census of Population Industrial Classification (CIC) level. Industry-level trade and productivity data for the years 1982–1996 are coded at the four-digit 1972 Standard Industrial Classification (SIC) code level and, for the years 1997–1999, are coded at the six-digit North American Industry Classification System (NAICS) level. Price index data (1982–1999) are coded using the Standard International Trade Classification (SITC, rev. 3) system. To facilitate analysis, sources were merged to a common industry classification. The four-digit 1972 SIC data were converted to corresponding 1987 SIC codes and then aggregated to the three-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 to permit matching of import and export price index data to three-digit CIC industry codes.[7] A NAICS-to-SIC concordance (Bayard and Klimek 2003) was employed to map data from the ASM to SIC industry codes and then to CIC-coded worker observations.

One limitation of the DWS data is recall bias. The further into the past displacement occurred, the less likely the separation will be reported as displacement (Evans and Leighton 1995). This leads, potentially, to an understatement of job displacement. To counter recall bias, we limit recall periods to the two calendar years prior to the survey year. This limiting also improves the reliability of the "non-displaced" control group. While the DWS does not provide information regarding occupational tenure, the Job Tenure and Occupational Mobility (JTOM) supplement to the CPS (US Department of Commerce, Bureau of the Census 2001b) does provide such information. Since the JTOM and the DWS are subsets of the CPS, we assume that DWS and JTOM respondents have similar tenures. Since the JTOM survey indicates 87% of respondents have at least one year of tenure with their

[6] An industry listing is provided in the Appendix.

[7] The concordance created for this study, which permits mapping of data from the four-digit SITC (rev. 3) industry level to the four-digit 1987 SIC industry level, is available upon request.

survey-date employer, we follow Addison et al. (2000, 1995) and employ the 2-year recall window as a compromise due to the biennial nature of the DWS. An additional limitation of the DWS is that workers who voluntarily change jobs in response to anticipated displacements cannot be identified and, thus, are not classified as having been displaced. This also potentially understates the extent of job displacement.

Table 1 presents descriptive statistics for worker- and industry-level variables for the full sample and for both displaced and non-displaced cohorts. Relative to the full sample, displaced workers are, on average, younger but are otherwise not significantly different in terms of measured demographic characteristics. Displaced workers, however, tend to have worked in industries facing relatively higher increases in import penetration rates and slower growth in the size of the domestic

Table 1 Descriptive statistics

Variable	All workers	Displaced	Non-displaced
Displaced	0.0793	–	–
	(0.366)	–	–
Age (in years)	38.8726	36.8231***	38.9688*
	(11.2987)	(10.5698)	(11.3227)
Educational attainment (in years)	12.7315	12.7536	12.7304
	(2.5772)	(2.4639)	(2.5824)
Experience (in years)	20.6782	20.0235	20.7089
	(13.064)	(12.937)	(13.168)
Female	0.3191	0.3326	0.3184
	(0.4661)	(0.4712)	(0.4659)
Minority	0.2373	0.273	0.2356
	(0.4254)	(0.4455)	(0.4244)
Union	0.053	0.0332	0.0539
	(0.2441)	(0.1793)	(0.2259)
Δ ln import penetration rate (2-year Δ)	0.0813	0.104**	0.0803
	(0.2035)	(0.1845)	(0.2043)
Δ ln export penetration rate (2-year Δ)	0.116	0.094	0.1214
	(0.2937)	(0.301)	(0.2933)
Δ ln domestic Market (2-year Δ)	0.0986	0.0863*	0.0992
	(0.1137)	(0.1226)	(0.1132)
Δ ln technology (2-year Δ)	0.0982	0.1048	0.098
	(0.1474)	(0.1372)	(0.1479)
Ln capital-labor ratio	75.9953	67.8676*	76.3769
	(81.3267)	(73.5951)	(81.6523)
Δ ln import price index (2-year Δ)	0.0285	0.0191	0.0289
	(0.0901)	(0.0903)	(0.09)
Δ ln export price index (2-year Δ)	0.0262	0.0118***	0.0264
	(0.0616)	(0.0609)	(0.0616)
Δ ln capacity utilization rate	0.0157	0.0291	0.0159
	(0.0753)	(0.0819)	(0.075)

Non-weighted arithmetic means presented. SDs are in parentheses. *T* tests of differences in mean values between stratified samples and the full sample were employed. Sample sizes are as follows: 85,194 worker observations (6,756 displaced workers); 693 industries (all variables except the price indexes); 405 price indexes; 18 capacity utilization rates

*Denote significance at the 10% level

**Denote significance at the 5% level

***Denote significance at the 1% level

market. These industries also appear to be more labor-intensive and to have experienced slower growth in export prices.

Observed displacement rates vary considerably across states and regions. Table 2 presents average manufacturing sector displacement rates for each state and region, over consecutive 2-year windows, during the years 1982–1999. Average displacement rates in Michigan and Ohio were 9.59 and 9.35%, respectively. Workers in Washington DC (2.11%), Delaware (4.51%) and Hawaii (5.29%) faced much lower rates of job displacement. The North Central region has, at 8.84%, the highest regional displacement rate. This is noteworthy as this region has been, traditionally, the principle location for US manufacturing activity. In many cases, state and region

Table 2 Observed state displacement rates (2-year periods), 1982–1999

State/region	(a)	(b)	(c)	State/region	(a)	(b)	(c)
Northeast	7.45	0.363	13,863	S. Central (cont)	7.83	0.371	9,858
Connecticut	7.02	0.346	1,285	Kentucky	6.17	0.356	1,060
Maine	7.96	0.326	1,048	Louisiana	8.80	0.385	543
Massachusetts	7.89	0.365	3,342	Mississippi	8.51	0.323	1,275
New Hampshire	7.74	0.323	1,340	Missouri	7.95	0.367	1,223
New York	7.55	0.408	4,779	Oklahoma	8.22	0.332	952
Rhode Island	6.60	0.341	1,161	Tennessee	8.83	0.385	1,463
Vermont	6.01	0.296	908	West Virginia	8.88	0.396	709
Middle Atlantic	7.45	0.339	10,223	Plains/West	7.48	0.355	7,271
Delaware	4.51	0.279	980	Idaho	7.40	0.354	1,004
Maryland	6.86	0.342	619	Iowa	6.67	0.337	1,220
New Jersey	6.76	0.339	3,193	Kansas	7.84	0.364	1,105
Pennsylvania	9.19	0.417	4,082	Montana	8.15	0.300	524
Virginia	6.83	0.341	1,191	Nebraska	7.75	0.362	936
Washington, DC	2.11	0.192	168	North Dakota	7.96	0.291	443
Southeast	7.74	0.367	9,977	South Dakota	8.05	0.350	835
Florida	8.92	0.332	2,152	Wyoming	8.33	0.292	239
Georgia	7.51	0.357	1,390	Southwest	8.45	0.360	5,622
North Carolina	7.35	0.353	4,786	Arizona	6.52	0.290	747
South Carolina	7.51	0.357	1,649	Colorado	8.07	0.318	825
North Central	8.84	0.440	19,105	New Mexico	8.29	0.374	384
Illinois	8.49	0.405	4,056	Nevada	7.41	0.252	326
Indiana	8.21	0.402	1,947	Texas	9.10	0.374	3,340
Michigan	9.59	0.534	4,894	Utah	6.62	0.293	965
Minnesota	8.56	0.380	1,260	Pacific	7.67	0.381	9,265
Ohio	9.35	0.459	5,042	Alaska	8.03	0.298	250
Wisconsin	7.18	0.362	1,906	California	7.45	0.314	6,775
South Central	7.83	0.371	9,858	Hawaii	5.29	0.302	301
Alabama	7.20	0.350	1,352	Oregon	8.87	0.347	993
Arkansas	6.63	0.336	1,281	Washington	8.66	0.342	946

Columns marked “(a)” contain average observed displacement rates, columns marked “(b)” contain standard deviations, and columns marked “(c)” contain sample sizes. Values presented are geometric averages of displacement incidence, calculated over state and regional areas, using 2-year DWS recall periods. For example, the average rate of displacement in Connecticut over the nine DWS recall periods (that span the years 1982–1983, 1984–1985, 1986–1987, 1988–1989, 1990–1991, 1992–1993, 1994–1995, 1996–1997, and 1998–1999) is 7.02%. *T* tests of differences in state and region mean values from the overall mean indicates that all mean displacement rates, with the exception of that corresponding to the State of Missouri, are statistically significant from the overall mean displacement rate at the 1% level of significance.

displacement rates appear similar to the national displacement rate of 7.93%; however, for all locales (except Missouri) displacement rates differ significantly from the national rate at the 1% level.

Effects of Trade on Estimated Displacement Probabilities

Examination of possible variation in the influences of imports and exports on displacement probabilities across states and regions is carried out by first estimating the relationships between trade-related variables and job displacement at the national level.[8] Columns (a) and (b) of Table 3 present results obtained when estimating Eqs. (3) and (4), respectively. We apply the resulting estimated log-odds coefficients to individual worker observations to generate average estimated displacement probabilities for each state and region. We then conduct counterfactual exercises to quantify the individual and combined effects of imports and exports on estimated displacement probabilities during the 1982–1999 period.

Beginning with results presented in column (a), we report a positive coefficient on the variable measuring the change in import penetration rates and a negative coefficient on the export penetration rate variable. Both coefficients are significant at the 1% level. This is taken to imply that, as expected, increases in industry-level import penetration rates increase displacement probabilities, and increases in export penetration rates lower the likelihood of displacement. Turning to the results presented in column (b), we find a negative coefficient on the variable representing changes in import price indexes and a positive, albeit weakly significant, coefficient on the export price index variable. This indicates that decreases in import prices, which may signal increased competitiveness of imports, correspond to higher probabilities of job displacement. Increases in export prices, perhaps due to decreased competitiveness of domestic producers, correlate with higher displacement probabilities. We take this as evidence of a statistical association between trade and job displacement and as confirmation of the results of prior research.

Increases in domestic demand reduce the probability of job displacement. This is intuitive as higher product demand may entail increased demand for factor inputs. Illustrating the counter-cyclical nature of displacement, increased capacity utilization is found to reduce displacement probabilities. Technological innovations increase employment if lower prices and increased output result; however, if technology substitutes for labor, innovations may displace labor. The positive coefficients, although insignificant, suggest this latter effect may dominate. Workers in more capital-intensive industries appear less likely to be displaced. Possibly, due to greater capital access, such workers are more productive; however, if the nature of import competition is such that foreign workers are engaged in labor-intensive production processes, domestic workers in more labor-intensive industries may face more intense import competition than do workers in capital-intensive industries. It also may be that production techniques in relatively capital-intensive industries require workers to have higher levels of education and training to effectively operate the

[8] Examination of the trade–displacement relationship using industry data for states and/or regions would be preferable; however, data limitations hinder analysis at such a level of detail.

Table 3 Determinants of Job Displacement, 1982–1999

Dependent variable: $Displaced_{it}$ (logit estimations)		
Variable	*Value Measures* (a)	*Price Measures* (b)
Δ ln import penetration $rate_{jt}$	0.526***	
	(0.1096)	
Δ ln export penetration $rate_{jt}$	−0.224***	
	(0.0813)	
Δ ln import price $index_{jt}$		−0.653**
		(0.2897)
Δ ln export price $index_{jt}$		0.5876*
		(0.34)
Δ ln domestic $market_{jt}$	−0.635***	
	(0.1959)	
Δ ln $technology_{jt}$	0.076	0.102
	(0.1405)	(0.1466)
Δ ln capacity utilization $rate_t$ (1-year Δ)	−1.868***	−3.027***
	(0.461)	(0.3552)
Δ ln capacity utilization $rate_{t-1}$ (lagged 1-year Δ)	−3.536***	−2.311***
	(0.6848)	(0.4912)
Ln capital-labor $ratio_{jt}$	−0.005**	0.003*
	(0.002)	(0.0017)
$Female_i$	0.159***	0.033*
	(0.0378)	(0.0175)
$Minority_i$	0.193***	0.157**
	(0.0562)	(0.0629)
$Union_{it}$	−0.447***	−0.503***
	(0.0928)	(0.1145)
$Experience_{it}$	−0.021***	−0.015***
	(0.0065)	(0.0048)
Educational $attainment_i$	−0.013***	−0.008*
	(0.0041)	(0.0045)
Constant	−2.167***	−2.37***
	(0.901)	(0.2286)
N	85,194	60,101
Log-likelihood function	−15,161.80	−10,787.88
χ^2 (test for joint significance)	868.37***	480.52***
Pseudo R^2	0.15	0.13

Log-odds ratios reported. SEs are in parentheses.
*denote statistical significance 10% levels
**denote statistical significance at the 5% level
***denote statistical significance at the 1%

capital. If so, replacing such workers may be sufficiently difficult as to lower the likelihood of job displacement.

Regarding worker characteristics, greater educational attainment and potential work experience both reduce displacement probabilities. As education represents ability while experience measures general training, higher ability workers may be more productive. If so, firms would be less likely to displace such workers. An alternative explanation regarding the experience variable is that the coefficient is capturing a “last in, first out” labor shedding process. Female and minority workers face higher displacement probabilities. This may be the result of labor market discrimination or, possibly, industry demographics. For example, women and minorities comprise large shares of the apparel industry workforce, which in recent years has faced substantial import competition. We also see that union coverage corresponds with lower displacement probabilities.

We apply the coefficients reported in Table 3 to individual worker observations to arrive at the estimated displacement probabilities presented in Table 4. The probabilities are state and region averages that span consecutive 2-year recall windows.[9] Considerable variation is found across geographic locales. Average estimated displacement probabilities range from 3.21% (Washington, DC) to 9.78% (Louisiana). Workers in the North Central region (comprised of Illinois, Indiana, Michigan, Minnesota, Ohio and Wisconsin) faced a substantial likelihood of job displacement. Of these states, Ohio fared the worst with probabilities of 7.98 and 9.22%. The estimates for Michigan are comparable: 7.97 and 9.09%. Similar numbers are derived for the Southeastern region. Manufacturing workers in the Pacific, Southwest and Plains/West regions appear least-likely to suffer job displacement. States within these regions have among the lowest average estimated displacement probabilities.

Undertaking counterfactual exercises, we estimate average displacement probabilities under two scenarios. First, we permit all other variables, including those related to exports, to change by observed amounts while holding import penetration rates and import price indexes constant at their 1982 levels. This is done by setting coefficients on the variables which represent changes in import penetration rates and changes in import price indexes equal to zero.[10] The resulting percentage point changes in average estimated displacement probabilities, presented in columns (a) and (b), respectively, of Table 5 are estimates of the effects of changes in import penetration and import prices on displacement probabilities. We see that the North Central region realizes the greatest decreases in displacement probabilities, ranging from 0.16 to 0.8 percentage points. This implies that increases in import penetration rates and decreases in import prices affect displacement probabilities in the North Central region more so than in other regions.

At the state-level, workers in Ohio, where displacement probabilities are estimated to decrease by 0.19 to 1.13 percentage points, and Michigan (0.23 to 1.11 percentage points) appear to have been affected by import penetration and import prices to the greatest extent. Workers in the Middle Atlantic region are affected similarly, with displacement probabilities reduced by 0.10 to 0.76 percentage points. The reduced probabilities for the Middle Atlantic region are driven by New Jersey (0.18 to 1.05 percentage points) and Pennsylvania (0.15 to 0.95 percentage points). Moving geographically west and southwest, we see diminished effects of imports. For example, the Plains/West and Pacific regions realize decreases in displacement probabilities of only 0.11 to 0.14 percentage points

[9] Estimated probabilities are derived as $\widehat{P}_i = \frac{e^{\widehat{L_i}}}{1+e^{\widehat{L_i}}}$, where $\widehat{L}_i = \widehat{\alpha}_0 + \widehat{\beta}_x X_i$. Values for the vector $\boldsymbol{X_i}$ are values that correspond to individuals.

[10] We acknowledge the limitations of our assumption that imports, exports and other factors that potentially influence the likelihood of displacement are independent and proceed cautiously with this in mind.

Table 4 Average estimated displacement probabilities (presented as %)

State/region	(a)	(b)	State/region	(a)	(b)
Northeast	7.68	7.58	S. Central (cont)	7.49	8.24
Connecticut	7.31	7.78	Kentucky	7.17	8.04
Maine	6.52	7.61	Louisiana	5.50	9.78
Massachusetts	7.45	7.64	Mississippi	8.53	8.02
New Hampshire	7.21	7.41	Missouri	7.79	7.57
New York	8.28	7.66	Oklahoma	6.40	8.05
Rhode Island	7.61	7.40	Tennessee	8.19	7.61
Vermont	8.02	7.35	West Virginia	8.00	9.05
Middle Atlantic	7.72	7.21	Plains/West	7.03	7.49
Delaware	5.95	9.52	Idaho	5.75	7.66
Maryland	7.26	7.51	Iowa	7.68	7.45
New Jersey	8.69	8.17	Kansas	7.49	7.72
Pennsylvania	8.73	7.97	Montana	6.81	8.13
Virginia	8.23	7.65	Nebraska	7.89	7.45
Washington, DC	3.77	3.21	North Dakota	7.19	7.58
Southeast	8.35	7.99	South Dakota	7.13	7.26
Florida	8.41	7.73	Wyoming	5.40	6.41
Georgia	8.18	7.78	Southwest	7.20	7.69
North Carolina	8.72	8.02	Arizona	6.29	7.32
South Carolina	8.32	8.34	Colorado	6.99	7.36
North Central	8.84	7.81	New Mexico	7.61	8.02
Illinois	8.52	7.96	Nevada	7.85	7.30
Indiana	8.30	7.52	Texas	7.16	8.31
Michigan	9.09	7.97	Utah	7.63	7.36
Minnesota	8.90	7.26	Pacific	7.20	7.56
Ohio	9.22	7.98	Alaska	7.17	8.05
Wisconsin	8.31	7.65	California	7.25	7.50
South Central	7.49	8.24	Hawaii	6.12	7.74
Alabama	7.47	8.04	Oregon	7.69	7.43
Arkansas	8.12	7.72	Washington	7.65	7.28

Columns (a) and (b) present average displacement probabilities, estimated at the state and region levels, using individual worker observations and the log-odds coefficients reported in columns (a) and (b) of Table 3.

and 0.12 to 0.14% points, respectively. Effectively, those locales with the highest displacement rates tend to see the greatest reductions.

The second counter-factual exercise permits observed changes in all variables, including import-related variables, except export penetration rates and export price indexes which are held constant at their 1982 levels. Similar to the first counterfactual exercise, this is completed by setting the coefficients on the variables representing changes in export penetration and export prices equal to zero. This permits estimation of the effects of export-related variables on average estimated displacement rates. The corresponding influences of changes in export penetration rates and in export price indexes are presented in columns (c) and (d), respectively. The Southeast and Plains/West regions are the most affected. Displacement probabilities increase by 0.09 to 0.31 percentage points in the Southeast region and by 0.09 to 0.23 percentage points in the Plains/West region. Interestingly, the North Central region realizes the smallest increase in displacement probabilities (0.11 to 0.13 percentage points). Comparing across states, a number realize increases of slightly more than one-half of one percentage point in displacement probabilities

Table 5 Counterfactual exercises

State/region	(a)	(b)	(c)	(d)	State/region	(a)	(b)	(c)	(d)
Northeast	−0.34	−0.13	0.18	0.09	S. Central (cont)	−0.56	−0.14	0.17	0.16
Connecticut	−0.06	−0.15	0.07	0.11	Kentucky	−0.29	−0.14	0.23	0.16
Maine	−0.07	−0.15	0.12	0.08	Louisiana	−0.13	−0.12	0.15	0.20
Massachusetts	−0.52	−0.08	0.13	0.07	Mississippi	−0.32	−0.15	0.29	0.10
N. Hampshire	−0.62	−0.09	0.10	0.08	Missouri	−0.26	−0.16	0.22	0.12
New York	−0.37	−0.15	0.28	0.09	Oklahoma	−0.06	−0.10	0.02	0.07
Rhode Island	−0.59	−0.07	0.12	0.07	Tennessee	−0.36	−0.14	0.29	0.13
Vermont	−0.32	−0.12	0.29	0.08	West Virginia	−1.04	−0.09	0.00	0.27
Middle Atlantic	−0.76	−0.10	0.17	0.14	Plains/West	−0.14	−0.11	0.23	0.09
Delaware	−0.18	−0.08	0.17	0.36	Idaho	−0.02	−0.05	0.09	0.05
Maryland	−0.64	−0.12	0.08	0.12	Iowa	−0.24	−0.10	0.25	0.13
New Jersey	−1.05	−0.18	0.06	0.16	Kansas	−0.35	−0.20	0.28	0.08
Pennsylvania	−0.95	−0.15	0.19	0.14	Montana	−0.16	−0.14	0.26	0.05
Virginia	−0.32	−0.11	0.25	0.10	Nebraska	−0.23	−0.11	0.31	0.09
Washington, DC	−0.12	−0.14	0.27	0.08	North Dakota	−0.13	−0.08	0.27	0.06
Southeast	−0.35	−0.15	0.31	0.09	South Dakota	−0.07	−0.05	0.03	0.08
Florida	−0.35	−0.14	0.33	0.09	Wyoming	−0.08	−0.18	0.20	0.12
Georgia	−0.23	−0.12	0.27	0.08	Southwest	−0.18	−0.09	0.15	0.08
North Carolina	−0.40	−0.15	0.33	0.09	Arizona	−0.02	−0.04	0.02	0.04
South Carolina	−0.36	−0.19	0.27	0.08	Colorado	−0.07	−0.03	0.03	0.04
North Central	−0.80	−0.16	0.11	0.13	New Mexico	−0.32	−0.12	0.18	0.12
Illinois	−0.64	−0.16	0.13	0.14	Nevada	−0.23	−0.15	0.28	0.07
Indiana	−0.63	−0.18	0.10	0.14	Texas	−0.26	−0.09	0.24	0.12
Michigan	−1.11	−0.23	0.09	0.17	Utah	−0.29	−0.06	0.28	0.08
Minnesota	−0.66	−0.07	0.06	0.07	Pacific	−0.14	−0.12	0.15	0.05
Ohio	−1.13	−0.19	0.13	0.17	Alaska	−0.25	−0.08	0.23	0.04
Wisconsin	−0.61	−0.14	0.10	0.11	California	−0.06	−0.09	0.01	0.06
South Central	−0.56	−0.14	0.17	0.16	Hawaii	−0.02	−0.20	0.07	0.05
Alabama	−0.24	−0.09	0.22	0.09	Oregon	−0.27	−0.09	0.27	0.06
Arkansas	−0.21	−0.12	0.28	0.12	Washington	−0.27	−0.12	0.28	0.06

due to changes in value measures; however, the influences of changes in price indexes is, by comparison, considerably weak.

Summation of the respective effects of imports and exports presented in Table 5 yields measures of the net effects of trade on average estimated displacement probabilities. Table 6 presents these estimates. We see the net effects of trade are quite minimal relative to either observed average displacement rates (presented in Table 2) or average estimated displacement rates (presented in Table 4). With respect to the value measures of trade, displacement probabilities for the North Central, Middle Atlantic and, to a lesser extent, the South Central regions are affected more than the probabilities of other regions. The influences of trade on displacement probabilities in the Northeast, Southeast and Southwest regions are positive although of lesser magnitude. In the cases of the Pacific and Plains/West regions, changes in import and export penetration rates are estimated to have a combined effect of decreasing average estimated displacement probabilities. Across all regions the combined effects of changes in import and export price indexes are relatively small in magnitude.

Across states, we find variation in the influences of trade on average estimated displacement probabilities. For example, displacement probabilities for Michigan,

Table 6 Net change in average estimated displacement probabilities due to imports and exports (presented as %)

Trade measure: state/Region	Value (a)	Price (b)	State/region	Value (a)	Price (b)
Northeast	0.16	0.04	S. Central (cont)	0.39	−0.02
Connecticut	−0.01	0.04	Kentucky	0.06	−0.02
Maine	−0.05	0.07	Louisiana	−0.02	−0.08
Massachusetts	0.39	0.01	Mississippi	0.03	0.05
New Hampshire	0.52	0.01	Missouri	0.04	0.04
New York	0.09	0.06	Oklahoma	0.04	0.03
Rhode Island	0.47	0.00	Tennessee	0.07	0.01
Vermont	0.03	0.04	West Virginia	1.04	−0.18
Middle Atlantic	0.59	−0.04	Plains/West	−0.09	0.02
Delaware	0.01	−0.28	Idaho	−0.07	0.00
Maryland	0.56	0.00	Iowa	−0.01	−0.03
New Jersey	0.99	0.02	Kansas	0.07	0.12
Pennsylvania	0.76	0.01	Montana	−0.10	0.09
Virginia	0.07	0.01	Nebraska	−0.08	0.02
Washington, DC	−0.15	0.06	North Dakota	−0.14	0.02
Southeast	0.04	0.06	South Dakota	0.04	−0.03
Florida	0.02	0.05	Wyoming	−0.12	0.06
Georgia	−0.04	0.04	Southwest	0.03	0.01
North Carolina	0.07	0.06	Arizona	0.00	0.00
South Carolina	0.09	0.11	Colorado	0.04	−0.01
North Central	0.69	0.03	New Mexico	0.14	0.00
Illinois	0.51	0.02	Nevada	−0.05	0.08
Indiana	0.53	0.04	Texas	0.02	−0.03
Michigan	1.02	0.06	Utah	0.01	−0.02
Minnesota	0.60	0.00	Pacific	−0.01	0.07
Ohio	1.00	0.02	Alaska	0.02	0.04
Wisconsin	0.51	0.03	California	0.05	0.03
South Central	0.39	−0.02	Hawaii	−0.05	0.15
Alabama	0.02	0.00	Oregon	0.00	0.03
Arkansas	−0.07	0.00	Washington	−0.01	0.06

Values presented in column (a) and (b) are summations of values presented in columns (a) and (c) and in columns (b) and (d), respectively, of Table 5 for each corresponding state or region multiplied by −1.

Ohio and New Jersey are affected quite a bit more due to trade than, say, probabilities for California, Colorado and Oklahoma. The change in Michigan's average estimated displacement probability ranges from an increase of 0.06 to 1.02 percentage points. Similarly, displacement probabilities for workers in Ohio and New Jersey rise from 0.02 to 1.00 percentage points and from 0.02 to 0.99 percentage points, respectively. Utah, on the other hand, sees trade-induced changes in displacement probabilities ranging from a decrease of 0.02 to an increase of 0.01 percentage points. Colorado realizes probability changes ranging between −0.01 and 0.04 percentage points. Likewise, Kentucky workers see estimated changes as low as −0.02 percentage points and as high as only 0.06 percentage points. As at the regional level, much more variation is seen when comparing across value measures than across price measures.

While the estimated effects of trade on displacement are, at times, quite small in absolute magnitude, we can gain a more clear understanding of the influence of trade by considering the relative proportional effects of changes in value and price measures on average estimated displacement probabilities. These proportional effects, calculated as trade-induced changes in displacement probabilities (from Table 6) divided by corresponding estimated displacement probabilities (from Table 4), are presented in Table 7. Figure 1a and b illustrate the effects. Based on observed changes in penetration rates, a majority of states (34 of 51) and regions (6 of 8) are estimated to have experienced increased displacement probabilities with probabilities for 13 states and 3 regions estimated to increase by more than 5%. The North Central, Middle Atlantic and South Central regions appear most affected. Figure 1a reveals a geographic concentration of negative trade effects in the North Central and Middle Atlantic regions and in several neighboring states. Probabilities for Michigan, New Jersey, Ohio and West Virginia are estimated to rise by more than 10% due to observed changes in penetration rates. However, 15 states (those not shaded in Fig. 1a) and 2 regions (Plains/West and Pacific) are estimated to have realized decreased displacement probabilities due to changes in penetration rates.

Table 7 Estimated effect of trade on average estimated displacement probabilities (presented as %)

State/region	(a)	(b)	State/region	(a)	(b)
Northeast	2.08	0.53	S. Central (cont)	5.21	−0.24
Connecticut	−0.14	0.51	Kentucky	0.84	−0.25
Maine	−0.77	0.92	Louisiana	−0.36	−0.82
Massachusetts	5.23	0.13	Mississippi	0.35	0.62
New Hampshire	7.21	0.13	Missouri	0.51	0.53
New York	1.09	0.78	Oklahoma	0.63	0.37
Rhode Island	6.18	0.00	Tennessee	0.85	0.13
Vermont	0.37	0.54	West Virginia	13.00	−1.99
Middle Atlantic	7.64	−0.55	Plains/West	−1.28	0.27
Delaware	0.17	−2.94	Idaho	−1.22	0.00
Maryland	7.71	0.00	Iowa	−0.13	−0.40
New Jersey	11.39	0.24	Kansas	0.93	1.55
Pennsylvania	8.71	0.13	Montana	−1.47	1.11
Virginia	0.85	0.13	Nebraska	−1.01	0.27
Washington, DC	−3.98	1.87	North Dakota	−1.95	0.26
Southeast	0.48	0.75	South Dakota	0.56	−0.41
Florida	0.24	0.65	Wyoming	−2.22	0.94
Georgia	−0.49	0.51	Southwest	0.42	0.13
North Carolina	0.80	0.75	Arizona	0.00	0.00
South Carolina	1.08	1.32	Colorado	0.57	−0.14
North Central	7.81	0.38	New Mexico	1.84	0.00
Illinois	5.99	0.25	Nevada	−0.64	1.10
Indiana	6.39	0.53	Texas	0.28	−0.36
Michigan	11.22	0.75	Utah	0.13	−0.27
Minnesota	6.74	0.00	Pacific	−0.14	0.93
Ohio	10.85	0.25	Alaska	0.28	0.50
Wisconsin	6.14	0.39	California	0.69	0.40
South Central	5.21	−0.24	Hawaii	−0.82	1.94
Alabama	0.27	0.00	Oregon	0.00	0.40
Arkansas	−0.86	0.00	Washington	−0.13	0.82

Values are derived by dividing the estimated changes in displacement probabilities that are attributable to imports and exports (presented in Table 6) by the corresponding state/region estimated displacement probabilities (presented in Table 4).

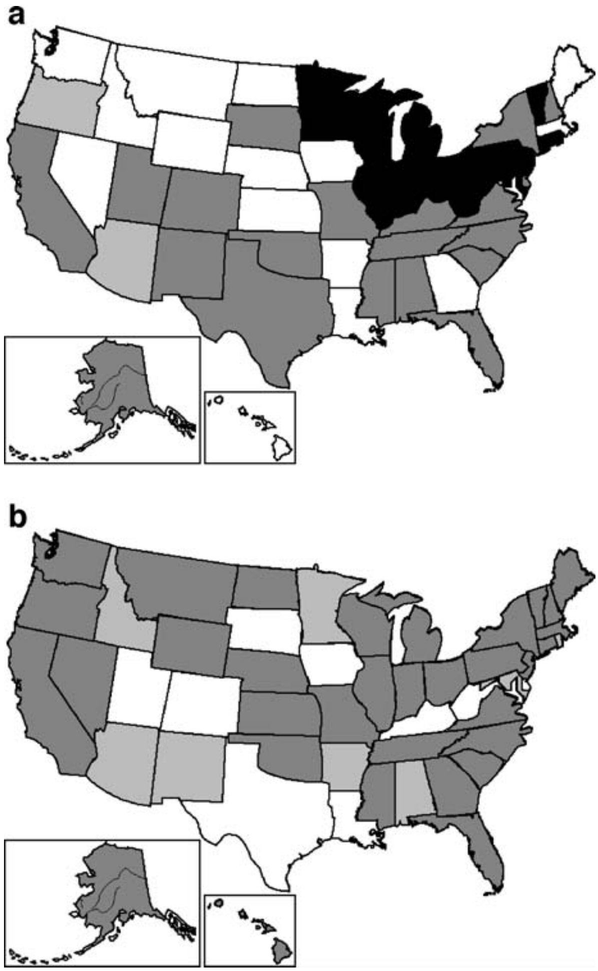

Fig. 1 *States shaded black* are those where the estimated net effect of trade is an increase in the average displacement probability of 5% or more. *Dark gray shading* indicates the net effect of trade is an increase of up to 5% on average displacement probability. *Light gray shading* identifies states where trade is estimated to not affect displacement probability. States for which the net effect of trade is a decrease in average displacement probability are *not shaded*. Classification is based upon values reported in Table 7. **a** Net estimated change in displacement probabilities—value measure. **b** Net estimated change in displacement probabilities—price measure

In response to observed changes in import and export price indexes, only 9 states are estimated to have experienced lowered displacement probabilities. To the contrary, 34 states experience increased displacement probabilities; however, none are estimated to have increased by even as much as 5%. Six of the eight regions are estimated to face higher displacement probabilities, with the Middle Atlantic and South Central regions realizing decreased probabilities. It is important to note that, while the signs of estimated changes in displacement probabilities are telling pieces of information, it should be stressed that the magnitudes of estimated changes in displacement probabilities are often quite minimal; especially when considered in relation to estimated changes produced using value measures.

Conclusion

Examining the trade–displacement relationship, imports are found to be positively associated with higher displacement probabilities while exports correspond to lower displacement probabilities. However, numerous other industry-level factors collectively influence displacement to a greater degree than do changes in trade-related variables. For example, growing domestic demand and business cycle upturns lower displacement probabilities, while technological advances and capital-deepening tend to increase the likelihood of displacement. Similarly, worker characteristics tend to affect the likelihood of displacement: Union membership, educational attainment and greater experience lower probabilities; Female workers and minority workers, all else equal, face higher displacement probabilities. This study contributes to a more complete understanding of the trade–displacement relationship and may enhance the public debate relating to the labor market effects attributable to trade.

We report clear variation, across geographic locales, in the effects of trade on average estimated displacement probabilities. While many states and regions have experienced ambiguous effects of changes in import and export penetration rates, displacement probabilities of workers in the North Central region appear most affected due to trade. Displacement probabilities in Michigan, Ohio and New Jersey are affected quite a bit more due to trade than are probabilities in numerous other states. To the contrary, the Pacific and Plains/West regions appear to have experienced a net trade-related effect of decreased displacement probabilities. Overall, 22 states appear unambiguously worse-off in terms of changes in displacement probabilities, due to changes in penetration rates and changes in price indexes, while only Louisiana and Iowa appear unambiguously better-off. Considering the effects of changes in price indexes, we see probabilities in most states and regions affected detrimentally; however, the magnitudes of such effects are, generally, quite low.

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Appendix

Appendix: Industry Listing (CIC codes and industry name. Asterisks denote industries for which price index data were available).

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; **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.

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