DIFFERENCES IN EXPOSURE TO INTERNATIONAL TRADE ACROSS DEMOGRAPHIC GROUPS

David Riker

ECONOMICS WORKING PAPER SERIES
Working Paper 2023–05–A

U.S. INTERNATIONAL TRADE COMMISSION
500 E Street SW
Washington, DC 20436

May 2023

The author thanks Peter Herman, Ross Jestrab, and Bill Powers for helpful comments and suggestions on an earlier draft. Office of Economics working papers are the result of ongoing professional research of USITC Staff and are solely meant to represent the opinions and professional research of individual authors. These papers are not meant to represent in any way the views of the U.S. International Trade Commission or any of its individual Commissioners.

Differences in Exposure to International Trade Across Demographic Groups
David Riker
Economics Working Paper 2023–05–A
May 2023

Abstract

We estimate the exposure of demographic groups of U.S. workers to international trade using employment-weighted averages of the trade intensities of U.S. manufacturing industries in 2021. Differences in the race and education of the workers have larger effects on the measures of trade exposure than differences in their gender, ethnicity, or occupation. The measures of trade exposure are based on publicly available data and can be applied to many different demographic aggregations and years of data. They can be applied broadly to U.S. trade with all countries or narrowly to U.S. trade with specific partner countries.

David Riker
Research Division, Office of Economics
david.riker@usitc.gov

1 Introduction

International trade is one of many factors that can shift U.S. labor demand and lead to changes in employment levels.[1] Exposure to trade can be measured as the impact on U.S. employment from negative or positive trade shocks, including changes in tariff rates, transport costs, and foreign production costs. Exposure to trade in a particular industry depends on the industry's trade intensity, measured by its import penetration rate (i.e., the share of imports in total U.S. expenditure on the production of an industry) and its export share (i.e., the contribution of exports to the total shipments of a domestic industry). Exposure to trade also depends on the substitutability of foreign and domestic varieties of the industry's products in consumer demands.

There are often large differences in the average trade exposure of demographic groups due to differences in the distribution of their employment across manufacturing industries. To quantify these differences, we calculate prospective, model-based measures of trade exposure for several demographic groups in 2021. The measures are straightforward to calculate with publicly available data.

The measures that we calculate are similar to measures of import and export exposure in Ebenstein, Harrison, McMillan and Phillips (2014). In order to estimate the impact of globalization on U.S. labor market, Ebenstein et al. (2014) estimate a retrospective econometric model that regresses the wages of U.S. workers on their individual characteristics and exposure measures that are employment-weighted averages of imports, exports, and offshoring at the industry- and occupation-level.[2]

Like Ebenstein et al. (2014), we calculate employment-weighted average measures of trade exposure, but for a different purpose.[3] Our measures of trade exposure are derived from an

[1]Other factors that shift labor demand include changes in domestic demand, technology, and cost of materials and other inputs in production.

[2]The sample period in Ebenstein et al. (2014) is 1984–2002.

[3]Autor, Dorn and Hanson (2013) also use employment share-weighted measures of exposure to imports

industry-specific partial equilibrium simulation model and are not used in a retrospective econometric analysis like Ebenstein et al. (2014). Our model generates prospective estimates of U.S. workers' potential exposure to changes in labor demand due to future import and export shocks. We also adopt a different assumption about labor supply: the wage model in Ebenstein et al. (2014) assumes upward-sloping labor supply, while our employment model assumes perfectly elasticity labor supply.

Section 2 introduces our theoretical model and derives the formulas for the import and export exposure of U.S. workers. Section 3 describes the data sources. Section 4 reports estimates of trade exposure by demographic group. Section 5 focuses on the workers' exposure to trade with specific partner countries. Section 6 concludes with ideas for extending the analysis.

2 Measures of Trade Exposure

First, we derive the measures of trade exposure based on an industry-specific partial equilibrium model of international trade with conventional functional forms. We assume that the value of domestic shipments of industry i has the constant elasticity of substitution (CES) form in equation (1).

$$v_i = \theta_i \; Y \; (P_i)^{\;\sigma_i \;-\; 1} \; (p_i)^{\;1 \;-\; \sigma_i} \tag{1}$$

p_i and v_i are the prices and value of shipments of each domestic producer in the industry. Y is aggregate expenditure in the domestic market, θ_i is the expenditure share of products in industry i, σ_i is the elasticity of substitution between domestic and imported varieties, and P_i is the CES industry price index in equation (2).

and exports. They focus on the economic impact of imports from China between 1990 and 2007.

$$P_i = \left(n_i \; (p_i)^{\;1 \; - \; \sigma_i} \; + n_i^* \; (p_i^* \; \tau_i)^{\;1 \; - \; \sigma_i} \right)^{\frac{1}{1 \; - \; \sigma_i}} \tag{2}$$

n_i and n_i^* are the numbers of domestic and foreign varieties in the industry, p_i^* is the price of foreign varieties, and $\tau_i > 1$ is a trade cost factor for imports that is increasing in tariffs, transport costs, and any other domestic barriers to trade.

Equations (3) and (4) are comparable equations for the value of industry exports and the industry's CES price index in the foreign market.

$$v_i^* = \theta_i^* \; Y^* \; (P_i^*)^{\;\sigma_i \; - \; 1} \; (p_i \; \tau_i^*)^{\;1 \; - \; \sigma_i} \tag{3}$$

$$P_i^* = \left(n_i \; (p_i \; \tau_i^*)^{1 \; - \; \sigma_i} \; + n_i^* \; (p_i^*)^{1 \; - \; \sigma_i} \right)^{\frac{1}{1 \; - \; \sigma_i}} \tag{4}$$

Y^* is aggregate expenditure in the export market, θ_i^* is the expenditure share of products of industry i, and $\tau_i^* > 1$ is the trade cost factor for exports that is increasing in foreign tariffs, transport costs, and any other foreign barriers to trade.

We assume that production in industry i has a Leontief technology that combines labor and materials in fixed proportions. w is the marginal cost of labor, and c is the marginal cost of materials. a_{wi} and a_{ci} are industry-specific unit factor requirements. Equation (5) is the domestic producers' margin cost of production in industry i.

$$mc_i = a_{wi} \; w \; + a_{ci} \; c \tag{5}$$

Finally, we assume that there is monopolistic competition in the domestic and export markets.[4] There is a continuum of firms, each with monopoly power in the unique variety

[4]The models of monopolistic competition and trade in differentiated products in Krugman (1980), Melitz (2003), Chaney (2008), Helpman, Melitz and Rubinstein (2008), and subsequent studies also assume that consumers have CES preferences.

that it produces. The assumption of a continuum of varieties simplifies the pricing decisions of firms: each firm takes the industry's price index as given, since its own contribution to this price index is infinitesimal. Each firm perceives that the own-price elasticity of demand for its variety is a constant, so its price is a constant mark-up over its marginal cost of production.

$$p_i = \left(\frac{\sigma_i}{\sigma_i \ - \ 1}\right) \ (a_{wi} \ w \ + \ a_{ci} \ c) \tag{6}$$

Using the approach to calibrating σ_i from Ahmad and Riker (2019), equation (6) implies equation (7):

$$\sigma_i = \frac{p_i}{p_i - a_{wi} \ w - a_{ci} \ c} = \frac{V_i}{V_i - W_i - C_i} \tag{7}$$

V_i is the value of total shipments of domestic producers in industry i, W_i is total domestic wage payments in the industry, and C_i is the industry's total cost of materials.

Equations (8), (9), and (10) are percent changes in domestic labor demand, imports, and exports in industry i resulting from changes in the trade cost factors. They are first-order log-linear approximations evaluated at the initial equilibria in the domestic and foreign markets. To simplify these expressions, we hold all other economic fundamentals constant, including Y, Y^*, w, c, a_{wi}, a_{ci}, θ_i, θ_i^*, and σ_i.[5]

$$\hat{L}_i = \left(\frac{L_i \ - \ L_i^*}{L_i}\right) \hat{M}_i \ + \ \left(\frac{L_i^*}{L_i}\right) \hat{E}_i \ - \ \hat{p}_i \tag{8}$$

$$\hat{M}_i = (\sigma_i \ - \ 1) \, \mu_i \ \hat{\tau}_i \tag{9}$$

[5]We also hold the foreign producer price (p_i^*) constant. The delivered price in the domestic market ($\tau_i \ p_i^*$) is not constant when τ_i changes. We assume that n_i and n_i^* remain fixed in the short run.

$$\hat{E}_i = (1 - \sigma_i)(1 - \chi_i)\ (\hat{\tau}_i^* + \hat{p}_i) \tag{10}$$

L_i is total employment of domestic manufacturers in industry i, and L_i^* is their employment associated with exports, so $\frac{L_i^*}{L_i} = \frac{E_i}{V_i}$, where E_i is the value of the industry's exports. $\hat{L}_i$ is the proportional (or percent) change in employment in the domestic industry, $\frac{dL_i}{L_i}$, and $\hat{\tau}_i$ and $\hat{\tau}_i^*$ are the proportional changes in the foreign and domestic trade cost factors. μ_i and χ_i are the industry's import penetration rate and its exports as a share of expenditures in the foreign market. L_i, M_i, and E_i are endogenous variables that change in response to changes in trade costs. p_i is an endogenous variable that does not change, because it is fixed according to equation (6).

Equations (11) is the reduced-form expression for the percent change in domestic labor demand in response to the changes in trade costs. It is derived by substituting Equations (9) and (10) into Equation (8).

$$\hat{L}_i = \left(\frac{L_i - L_i^*}{L_i}\right)(\sigma_i - 1)\,\mu_i\ \hat{\tau}_i + \left(\frac{L_i^*}{L_i}\right)(1 - \sigma_i)(1 - \chi_i)\ \hat{\tau}_i^* \tag{11}$$

The first term on the right-hand side of equation (11) is the labor demand effects of trade shocks through imports, and the second term is the labor demand effects through exports.

Equation (12) is an accounting identity that links the percent change in total labor demand for domestic workers in group g to the industry-specific shifts in labor demand in equation (11).

$$\hat{L}_g = \sum_i \left(\frac{L_{gi}}{L_g}\right)\ \hat{L}_i \tag{12}$$

$L_g = \sum_i L_{gi}$ is total domestic employment of workers in group g across all industries, and L_{gi} is domestic employment of group g workers in industry i.

Equation (13) is the percent change in labor demand for workers within group g due to changes in foreign and domestic trade cost factors in all of the industries ($\hat{\tau}_i$ and $\hat{\tau}_i^*$).

$$\hat{L}_g = \sum_i \left(\frac{L_{gi}}{L_g}\right) \left(\left(\frac{V_i - E_i}{V_i}\right)\left(\frac{M_i}{V_i - E_i + M_i}\right) \hat{\tau}_i - \left(\frac{E_i}{V_i}\right) \hat{\tau}_i^*\right)(\sigma_i - 1) \tag{13}$$

M_i is the value of its imports. We simplify equation (13) by assuming that the industry's exports account for only a negligible share of the total export market, so χ_i in equation (11) is set equal to zero.[6] As long as labor supply is perfectly elastic or wages are otherwise fixed, equation (13) is also the percent change in employment of workers in group g.[7]

Equations (14) and (15) are the measures of exposure to imports (*imp*) and exports (*exp*) for group g. They are equal to the percent change in L_g for simultaneous ten-percent increases in trade costs on imports and exports ($\hat{\tau}_i = \hat{\tau}_i^* = 0.10$).

$$X_g^{imp} = \sum_i \left(\frac{L_{gi}}{L_g}\right)\left(\frac{V_i - E_i}{V_i}\right)\left(\frac{M_i}{V_i - E_i + M_i}\right)(\sigma_i - 1)\ 0.10 \tag{14}$$

$$X_g^{exp} = \sum_i \left(\frac{L_{gi}}{L_g}\right)\left(\frac{E_i}{V_i}\right)(1 - \sigma_i)\ 0.10 \tag{15}$$

Since $\sigma_i > 1$, the measure of exposure to imports is positive (an increase in tariffs on imports increases domestic labor demand), and the measure of exposure to exports is negative (an increase in foreign tariffs on exports reduces domestic labor demand).

According to equation (11), the exposure of an industry's total labor demand depends on its trade intensity and the extent of substitution between domestic and imported varieties. According to equations (14) and (15), the exposure of a specific group of workers depends on these factors and also on the distribution of the employment of group members across

[6]This simplifying assumption can be relaxed if there are data available on total expenditures on products of the industry in the foreign market.

[7]Alternative assumptions about labor supply would break the equivalence between the percent changes in labor demand in equation (13) and the percent changes in domestic industry employment. For example, differences in adjustment costs across the demographic groups would result in additional differences in employment effects.

the industries.

The exposure measures to imports and exports can be combined together or considered separately, as in equations (14) and (15). When the net exposure $X_g^{imp} - X_g^{exp}$ is positive, it indicates that reciprocal ten-percent increases in trade costs on imports and exports will increase labor demand for group g. The sign of a group's net exposure depends on employment shares and trade intensities. Its magnitude, but not its sign depends on the value of σ_i.

To simplify the model, we have assumed that the effects of trade shocks on labor demand are industry-specific. The model could be generalized by incorporating inter-industry input-output linkages and economy-wide resource constraints. In that case, trade shocks in one industry would spill over to other industries, and reduced-form exposure measures would not be simple weighted averages based on industry shares of employment. Caliendo and Parro (2022) makes this point using several different examples. The data requirements of these generalizations would be difficult to meet.

3 Data Sources

We focus on the U.S. manufacturing sector. We use data on shipments, payrolls, and costs of materials by NAICS three-digit manufacturing industries in 2021, the most recent release of the U.S. Census Bureau's Annual Survey of Manufactures (ASM).[8] We use data on the 2021 free alongside value of domestic exports and the landed duty-paid value of imports for consumption by NAICS three-digit industry from the U.S. International Trade Commission's Trade Dataweb.[9] We calibrate the elasticity of substitution parameters for each industry using equation (7).

[8] These data are publicly available at `https://www.census.gov/programs-surveys/asm/data/tables.html`.

[9] These data are publicly available at `https://dataweb.usitc.gov/`.

In addition to these industry-level data, we use individual-level data that record the demographic characteristics of U.S. workers. The data on industry and occupation of individual workers, as well as their age, education, race, ethnicity, and gender are public use micro-data files from the Annual Social and Economic (ASEC) supplement of the Current Population Survey.[10]

Table 1 reports the estimated elasticity of substitution (σ_i), export share of shipments $\left(\frac{E_i}{V_i}\right)$, and import penetration rate $\left(\frac{M_i}{V_i - E_i + M_i}\right)$ for each of the 21 NAICS three-digit manufacturing industries. There is significant variation in these three elements of trade exposure. The elasticity of substitution values range from 1.81 for beverage and tobacco products to 4.54 for transportation equipment. Export shares range from 4.90% for beverages and tobacco products to 51.40% for leather and allied products. Import penetration rates range from 8.15% for printing and related products to 95.23% for leather and allied products.

Table 2 reports the manufacturing share of employment $\frac{L_{gi}}{L_g}$ within 16 different groups based on workers' education, age, gender, race, ethnicity, and occupation and for an aggregate of all U.S. workers. The share of each group's U.S. workers employed in the manufacturing sector is larger for high school graduates who have not graduated from college, workers who are forty or older and male, and workers who are Asian, Hawaiian, Pacific Islander and not Hispanic.

[10]These data are publicly available at `https://cps.ipums.org/cps/`.

Table 1: Characteristics of the Manufacturing Industries in 2021

Manufacturing Industry Name and NAICS Code	Elasticity of Substitution	Export Share of Shipments (%)	Import Penetration (%)
Food manufacturing (311)	3.33	8.41	10.08
Beverage and tobacco products (312)	1.81	4.90	16.90
Textile mills (313)	3.54	29.48	37.38
Textile product mills (314)	3.24	11.74	62.82
Apparel (315)	3.19	31.90	94.24
Leather and allied products (316)	3.44	51.40	95.33
Wood products (321)	2.74	5.00	20.00
Paper manufacturing (322)	2.96	12.10	12.46
Printing and related products (323)	2.91	6.00	8.15
Petroleum and coal products (324)	4.86	14.94	12.63
Chemical manufacturing (325)	2.08	28.08	34.99
Plastic and rubber products (326)	2.88	11.80	25.73
Nonmetallic mineral products (327)	2.56	7.71	19.81
Primary metal products (331)	2.90	21.18	39.04
Fabricated metal products (332)	2.97	10.05	21.82
Machinery manufacturing (333)	3.19	31.60	44.92
Computers and electronics (334)	2.88	35.84	69.48
Electrical equipment et al. (335)	2.92	30.33	62.94
Transportation equipment (336)	4.54	22.50	35.96
Furniture (337)	3.10	5.57	47.00
Miscellaneous manufacturing (339)	2.39	27.37	60.32

Table 2: Manufacturing Share of U.S. Employment by Demographic Group

Demographic Group	Manufacturing Share of Group Employment in 2021 (%)
Education	
Not a High School Graduate	9.804
High School, Not College, Graduate	10.323
College Graduate	7.444
Age	
Forty and Older	9.835
Younger Than Forty	8.220
Gender	
Female	5.668
Male	12.190
Race	
American Indian, Aleut, or Eskimo Only	8.560
Asian, Hawaiian, or Pacific Islander Only	10.140
Black Only	7.494
White Only	9.292
All Other	8.286
Ethnicity	
Hispanic	8.567
Not Hispanic	9.218
Occupation	
Production Worker	66.940
Not a Production Worker	5.976
All Workers	9.102

4 Estimates of Trade Exposure

Table 3 reports our estimates of trade exposure by demographic group. The estimates provide a relative measure, a ranking of trade exposure across the groups within each category. They also provide an absolute measure with a clear economic interpretation: the import exposure measure is the percent increase in labor demand for U.S. workers in the demographic group resulting from a ten-percent increase in trade costs on imports, and the export exposure measure is the percent decrease in labor demand for U.S. workers in the group resulting from a ten-percent increase in trade costs facing U.S. exports in the industry.

According to Table 3, trade exposure for both imports and exports is larger (in absolute value) for college graduates, workers who are younger than forty and male, workers who are Asian, Hawaiian, or Pacific Islander and not Hispanic, and non-production workers.[11] Differences in race and education have larger effects on the measure of trade exposure than differences in age, gender, ethnicity, or occupation. This is indicated by the ratio of the highest value within each category to the average for all workers at the bottom of the table.

[11] This first set of calculations groups workers by each demographic characteristic in isolation. Later we group workers by combinations of the demographic characters.

Table 3: U.S. Workers' Exposure to Trade by Demographic Group in 2021

Demographic Group	Index of Exposure to Imports	Index of Exposure to Exports
Education		
Not a High School Graduate	5.005	-3.126
High School, Not College, Graduate	5.750	-4.181
College Graduate	6.145	-4.843
Age		
Forty and Older	5.735	-4.292
Younger Than Forty	5.943	-4.353
Gender		
Female	5.746	-4.209
Male	5.853	-4.362
Race		
American Indian, Aleut, or Eskimo Only	5.064	-3.799
Asian, Hawaiian, or Pacific Islander Only	6.301	-4.894
Black Only	5.687	-4.219
White Only	5.807	-4.287
All Other	5.627	-4.063
Ethnicity		
Hispanic	5.499	-3.850
Not Hispanic	5.886	-4.411
Occupation		
Production Worker	5.757	-4.077
Not a Production Worker	5.861	-4.462
All Workers	5.822	-4.317

It is straightforward to redefine the demographic groups by combining two or more worker characteristics. Table 4 reports two examples, one that combines ethnicity and education and a second that combines gender and age.

Table 4: Exposure to Trade for Groups that Combine Demographic Characteristics

Demographic Group	Index of Exposure to Imports	Index of Exposure to Exports
Hispanic college graduate	6.528	-5.029
Non-Hispanic college graduate	6.110	-4.826
Hispanic non-college graduate	5.290	-3.610
Non-Hispanic non-college graduate	5.755	-4.168
Females forty and older	5.759	-4.250
Males forty and older	5.728	-4.310
Females younger than forty	5.727	-4.151
Males younger than forty	6.034	-4.438

The trade exposure measures are largest (in absolute value) for non-Hispanic college graduates and males who are younger than forty. While the ranking of the groups by the magnitude of their import and export exposure measures are often the same, including for all of the groups in Table 3, that are not always the case. Table 4 provides a counter-example. While females forty or over are the group that is second-most exposed to imports, they are the group third-most exposed to exports, behind males forty and over. This difference in ranking reflects differences in the industry shares of employment of older male and female workers in the data.

It is also possible to define the demographic groups more finely than the aggregated groups in Tables 2, 3 and 4. For example, Table 5 reports exposure measures for all 19 race groups in the ASEC data for 2021.[12] Table 6 reports exposure measures for a more detailed breakout of education into five groups. Table 7 reports exposure measures for a more detailed breakout of age into six groups. Table 8 reports exposure measures for a more detailed breakout of ethnicity into nine groups.

Table 5: Race Detail on Trade Exposure of U.S. Manufacturing Workers

Demographic Group	Index of Exposure to Imports	Index of Exposure to Exports
American Indian-Asian	5.856	-4.031
American Indian-Hawaiian/Pacific Islander	9.867	-7.968
American Indian/Aleut/Eskimo	5.064	-3.799
Asian only	6.340	-4.927
Asian-Hawaiian/Pacific Islander	3.297	0.867
Black	5.687	-4.219
Black-American Indian	6.761	-5.475
Black-Asian	8.627	-5.218
Four or five races, unspecified	6.112	-3.818
Hawaiian/Pacific Islander only	5.391	-4.104
Two or three races unspecified	1.464	-1.147
White	5.807	-4.287
White-American Indian	5.005	-3.700
White-American Indian-Hawaiian/Pacific Islander	2.148	-1.957
White-Asian	6.540	-5.351
White-Black	6.483	-4.169
White-Black-Hawaiian/Pacific Islander	2.717	-3.033
White-Black-American Indian	5.339	-4.446
White-Hawaiian/Pacific Islander	4.166	-2.158

[12] The names of the rows in Table 5 correspond to the names of the race groups reported in the ASEC data.

Table 6: Education Detail on Trade Exposure of U.S. Manufacturing Workers

Demographic Group	Index of Exposure to Imports	Index of Exposure to Exports
Less than high school diploma	5.005	-3.126
High school diploma or equivalent	5.690	-4.096
Associate's degree	6.021	-4.567
Bachelor's degree	6.079	-4.709
Graduate degree	6.279	-5.117

Table 7: Age Detail on Trade Exposure of U.S. Manufacturing Workers

Demographic Group	Index of Exposure to Imports	Index of Exposure to Exports
20s	6.046	-4.347
30s	5.935	-4.427
40s	5.560	-4.197
50s	5.873	-4.412
60s	5.680	-4.201
70s and above	6.425	-4.470

Table 8: Ethnicity Detail on Trade Exposure of U.S. Manufacturing Workers

Demographic Group	Index of Exposure to Imports	Index of Exposure to Exports
Central American (Exclusing Salvadoran)	5.577	-3.432
Cuban	5.164	-3.544
Dominican	5.239	-3.602
Mexican	5.450	-3.789
Puerto Rican	5.865	-4.516
Salvadoran	4.936	-3.656
South American	5.699	-4.358
Other Hispanic	6.323	-4.517
Not Hispanic	5.866	-4.411

5 Exposure To Specific Trade Partner Countries

The export shares and import penetration rates reported in Table 1 and the estimates of trade exposure in Section 4 aggregate U.S. imports across all source countries and aggregate U.S. exports across all destination countries. In this section, we focus instead on certain trade partners, specifically Brazil, China, and India, and we only consider trade cost shocks that are specific to the country's trade with the United States. In this way, we assess the relative *country exposures* of specific groups of U.S. workers.

Table 9 reports the import penetration rate for these three specific trade partner countries for each of the NAICS three-digit U.S. manufacturing industries. This is a key input of the import exposure measure. There is significant variation across the manufacturing industries and across the three countries. China stands out among the three, with generally higher import penetration rates, though Brazil's import penetration rates exceeds China's in beverage and tobacco products, petroleum and coal products, and primary metal products, and India's rate exceeds China's rate in petroleum and coal products.

Table 9: Import Penetration Rates by Country in 2021

Manufacturing Industry Name and NAICS Code	Brazil (%)	China (%)	India (%)
Food manufacturing (311)	0.28	0.48	0.24
Beverage and tobacco products (312)	0.04	0.03	0.02
Textile mills (313)	0.12	8.74	4.53
Textile product mills (314)	0.16	44.42	20.38
Apparel (315)	0.35	75.26	36.52
Leather and allied products (316)	7.51	79.91	18.48
Wood products (321)	1.51	2.56	0.25
Paper manufacturing (322)	0.87	2.02	0.17
Printing and related products (323)	0.02	3.97	0.19
Petroleum and coal products (324)	0.34	0.02	0.55
Chemical manufacturing (325)	0.22	2.98	1.79
Plastic and rubber products (326)	0.23	10.05	0.61
Nonmetallic mineral products (327)	0.91	6.35	1.11
Primary metal products (331)	2.00	1.40	0.72
Fabricated metal products (332)	0.19	7.98	0.79
Machinery manufacturing (333)	0.61	10.42	1.11
Computers and electronics (334)	0.09	35.84	0.81
Electrical equipment et al. (335)	0.49	31.20	1.09
Transportation equipment (336)	0.27	2.79	0.33
Furniture (337)	0.54	25.90	1.40
Miscellaneous manufacturing (339)	0.30	29.04	9.96

Table 10 includes the same demographic groups as Table 3, but it is specific to shocks to U.S. trade with Brazil. The exposure measures for trade with Brazil are much smaller than the measures for all imports in Table 3, reflecting the smaller import penetration rates in Table 9. The ranking of groups by the magnitude of the exposure measure is the same as Table 3 for exports (more exposure for college graduates, young males, Asian, Hawaiian, or Pacific Islander and non-Hispanic workers, and non-production worker) but different than Table 3 for imports for the race, education, ethnicity, and occupation groups (more exposure for American Indian, Aleut, or Eskimo and Hispanic workers, non-high school graduates, and production workers). Another important difference in the Brazil-specific measures is that the export exposure measure for all workers at the bottom of the table is greater in absolute value than the import export measure, which means that a ten-percent increase in the trade costs on both U.S. imports and exports would lower combined trade exposure. (For the calculations in Table 3 for all imports, the opposite is the case.) Tables 11 and 12 reports similar measures for trade with China and India.

Table 10: Brazil-Specific Trade Exposure Measures for U.S. Manufacturing Workers

Demographic Group	Index of Exposure to Imports	Index of Exposure to Exports
Education		
Not a High School Graduate	0.097	-0.058
High School, Not College, Graduate	0.091	-0.099
College Graduate	0.074	-0.125
Age		
Forty and Older	0.083	-0.104
Younger Than Forty	0.091	-0.105
Gender		
Female	0.080	-0.096
Male	0.088	-0.108
Race		
American Indian, Aleut, or Eskimo Only	0.122	-0.090
Asian, Hawaiian, or Pacific Islander Only	0.057	-0.114
Black Only	0.097	-0.105
White Only	0.087	-0.104
All Other	0.098	-0.087
Ethnicity		
Hispanic	0.087	-0.084
Not Hispanic	0.086	-0.109
Occupation		
Production Worker	0.093	-0.094
Non-Production Worker	0.082	-0.110
All Workers	0.086	-0.104

Table 11: China-Specific Trade Exposure Measures for U.S. Manufacturing Workers

Demographic Group	Index of Exposure to Imports	Index of Exposure to Exports
Education		
Not a High School Graduate	1.938	-0.227
High School, Not College, Graduate	2.107	-0.323
College Graduate	2.357	-0.424
Age		
Forty and Older	2.159	-0.351
Younger Than Forty	2.203	-0.347
Gender		
Female	2.446	-0.341
Male	2.065	-0.353
Race		
American Indian, Aleut, or Eskimo Only	2.254	-0.290
Asian, Hawaiian, or Pacific Islander Only	3.170	-0.497
Black Only	1.811	-0.316
White Only	2.126	-0.341
All Other	2.229	-0.319
Ethnicity		
Hispanic	2.250	-0.291
Not Hispanic	2.163	-0.361
Occupation		
Production Worker	2.073	-0.305
Non-Production Worker	2.241	-0.376
All Workers	2.177	-0.349

Table 12: India-Specific Trade Exposure Measures for U.S. Manufacturing Workers

Demographic Group	Index of Exposure to Imports	Index of Exposure to Exports
Education		
Not a High School Graduate	0.470	-0.029
High School, Not College, Graduate	0.405	-0.045
College Graduate	0.370	-0.059
Age		
Forty and Older	0.388	-0.049
Younger Than Forty	0.413	-0.048
Gender		
Female	0.562	-0.047
Male	0.330	-0.049
Race		
American Indian, Aleut, or Eskimo Only	0.567	-0.037
Asian, Hawaiian, or Pacific Islander Only	0.481	-0.064
Black Only	0.366	-0.044
White Only	0.392	-0.048
All Other	0.426	-0.043
Ethnicity		
Hispanic	0.555	-0.039
Not Hispanic	0.367	-0.050
Occupation		
Production Worker	0.427	-0.042
Non-Production Worker	0.381	-0.052
All Workers	0.398	-0.048

Tables 13 and 14 report the exposure measures for imports from different partner countries side-by-side. Table 13 reports the trade exposure measure for female workers and the ratio between the measure for females and the measure for all workers. A ratio above one means that female workers are more exposed to import shocks from the particular country than the average of all workers. According to Table 13, female workers are exposed more than the average of all workers to imports from China and India and less than the average for imports from Brazil and the aggregate of imports from all countries.

Table 13: Comparison of Import Exposure Measures Across Countries: Gender

Group	All Imports	Brazil	China	India
Female	5.746	0.080	2.446	0.562
Ratio to All Workers	0.99	0.93	1.12	1.41

Table 14 is a similar comparison for American Indian, Aleut, and Eskimo workers. This group is more exposed than the average of all workers for imports from Brazil, China, and India, and less exposed than the average for the aggregate of imports from all countries.

Table 14: Comparison of Import Exposure Measures Across Countries: Race

Group	All Imports	Brazil	China	India
American Indian, Aleut, or Eskimo	5.064	0.122	2.254	0.567
Ratio to All Workers	0.87	1.42	1.04	1.42

Finally, Table 15 is a similar comparison for college graduates. This group is more exposed than the average of all workers for imports from China and the aggregate of imports from all countries, and less exposed than the average for imports from Brazil and India.

Table 15: Comparison of Import Exposure Measures Across Countries: Education

Group	All Imports	Brazil	China	India
College Graduates	6.145	0.074	2.357	0.370
Ratio to All Workers	1.06	0.86	1.08	0.93

6 Conclusions

The theory-based model of exposure to trade shocks in manufacturing industries translates differences in the distribution of a group's employment across industries and differences in the trade exposure of industries into differences in the exposure of specific demographic groups of U.S. workers to negative and positive trade shocks.

The measure of trade exposure are straightforward to calculate using publicly available data. There are many opportunities to expand the analysis in different directions. Demographic groups can be more narrowly defined, limited only by the detail available in the ASEC data. The groups can be defined as combinations or intersections of demographic characteristics. The measures can focus on trade with different partner countries and in different years. As a prospective measure of trade exposure, the model can identify groups of U.S. workers most likely to be affected by shocks in trade with specific partner countries, and it can identify trade partners likely to have the most effect on particular groups of U.S. workers. The model can also be used for retrospective analysis, for example to attribute a portion of the historical changes in the U.S. employment of specific groups to coinciding changes in trade costs.

References

Ahmad, S. and Riker, D. (2019). A Method for Estimating the Elasticity of Substitution and Import Sensitivity by Industry. U.S. International Trade Commission. Economics Working Paper 2019-05-B.

Autor, D. H., Dorn, D. and Hanson, G. H. (2013). The China Syndrome: Local Labor Market Effects of Import Competition in the United States, *American Economic Review* **103**(6): 2121–2168.

Caliendo, L. and Parro, F. (2022). Chapter 4 – Trade Policy, *Handbook of International Economics* **5**: 219–295.

Chaney, T. (2008). Distorted Gravity: The Intensive and Extensive Margins of International Trade, *American Economic Review* **98**(4): 1707–1721.

Ebenstein, A., Harrison, A., McMillan, M. and Phillips, S. (2014). Estimating the Impact of Trade and Offshoring on American Workers Using the Current Population Survey, *Review of Economics and Statistics* **96**(4): 581–595.

Helpman, E., Melitz, M. and Rubinstein, Y. (2008). Estimating Trade Flows: Trading Partners and Trading Volumes, *Quarterly Journal of Economics* **123**(2): 441–487.

Krugman, P. (1980). Scale Economies, Product Differentiation, and the Pattern of Trade, *American Economic Review* **70**(5): 950–959.

Melitz, M. (2003). The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity, *Econometrica* **71**(6): 1695–1725.