STATE-LEVEL EMPLOYMENT IMPLICATIONS OF TRADE POLICY

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Abstract

This paper provides an extension of the model of industry employment and wage effects of trade policy in Riker (2021). The model assumes that U.S. labor is immobile between states, at least in the short run, and this allows for significant differences in wage and industry employment changes in *different parts of the country* in response to changes in national trade policy. We apply the model to the Other Fabricated Metal Product Manufacturing sector, NAICS code 3329, and simulate the effects of hypothetical tariff elimination on industry employment, wages, and the value of domestic shipments in each state over different time horizons.

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1 Introduction

This paper provides an extension of the partial equilibrium model of industry employment and wage effects of trade policy in Riker (2021). The model assumes that U.S. labor is immobile between states, at least in the short run. This allows for variation in wage and industry employment changes across the country in response to changes in national trade policy. The model incorporates data on fixed and variable labor inputs, inter-industry labor mobility, and the distribution of industry production across states.

We apply the model to the U.S. Other Fabricated Metal Product Manufacturing sector, NAICS code 3329, and simulate the effects of hypothetical tariff elimination on industry employment, wages, and the value of domestic shipments in each state in the short run and the long run. Model simulations demonstrate that industry employment and wage effects can vary significantly between the short run and the long run within the industry across states.

The rest of the paper is organized into four parts. Section 2 describes how we extend the model to capture state-level labor market effects. Section 3 discusses the data requirements of the state-segmented model and the approach to calibrating model parameters. Section 4 applies the model to data for NAICS code 3329. Section 5 concludes.

2 Modeling Framework

In the model, there is monopolistic competition in industry i, with CES preferences for the differentiated products of firms within the industry and Cobb-Douglas preferences across industry composites. In the long run, the number of domestic firms in industry i in sub-national region r, N_{ir}, is determined by free entry and exit and a zero profit condition. In the short run, N_{ir} is fixed.[1] Labor supply pools are segmented into sub-national regions,

[1]This distinction between the short run and the long run is explained in more detail in Riker (2021).

indexed by r; on the other hand, the national product market is perfectly integrated.[2]

Equation (1) is the variable component of labor demand associated with the domestic shipments of each firm in industry i in region r, E_{vir}.

$$E_{vir} = A_i \; (P_i)^{\sigma_i - 1} \; (p_{ir})^{-\sigma_i} \; \theta_{ir} \tag{1}$$

A_i is total expenditures on the products of industry i in the integrated domestic product market.[3] σ_i is the elasticity of substitution between the differentiated products of domestic and foreign firms in the industry. θ_{ir} is the unit labor requirement for domestic production in industry i in region r. P_i is the CES price index for industry i. The right-hand side of (1) is implicitly a decreasing function of wages through the price p_{ir} and the price index P_i.

$$P_i = \left(\sum_r N_{ir} \; (p_{ir})^{1-\sigma_i} \; + \; b_i \; (p_i^* \; \tau_i)^{1-\sigma_i} \right)^{\frac{1}{1-\sigma_i}} \tag{2}$$

N_{ir} is the number of symmetrically differentiated domestic firms in industry i in region r. b_i is a calibrated demand asymmetry parameter that controls for the number of foreign varieties, home bias, and international quality differences. $\tau_i \geq 1$ is the power of the tariff, which is equal to one plus the tariff rate. p_i^* is the foreign producer price.[4] p_{ir}, the producer price of domestic firms in industry i who are located in region r, is a fixed mark-up over variable labor costs.

$$p_{ir} = \left(\frac{\sigma_i}{\sigma_i - 1} \right) \; \theta_{ir} \; w_r \tag{3}$$

w_r is the wage rate in the region.

[2] In contrast, Riker (2020a) develops a sub-national model of trade policy that includes geographic segmentation of product markets, as well as segmentation of labor markets, due to inter-regional domestic shipping costs.

[3] This is a constant share of aggregate expenditures and is an exogenous variable. The model treats the exports of the domestic industry as exogenous and focuses on employment associated with the domestic shipments.

[4] Foreign producer prices and tariffs are treated as exogenous variables in the model.

π_{ir} is the profits of each of the N_{ir} symmetrically differentiated domestic firms in industry i and region r.

$$\pi_{ir} = \frac{1}{\sigma_i} \; A_i \; (P_i)^{\sigma_i - 1} \; (p_{ir})^{1-\sigma_i} \; - \; w_r \; f_{ir} \tag{4}$$

Profits are equal to zero in the long run, though not necessarily in the short run. $w_r f_{ir}$ is the fixed cost of each firm, for example the labor cost of overhead.

E_{ir} is total domestic employment in industry i in region r. It is the sum of the firms' variable labor inputs, $N_{ir}\ E_{vir}$, and their fixed labor inputs, $N_{ir}\ f_{ir}$.

$$E_{ir} = N_{ir} \; E_{vir} \; + \; N_{ir} \; f_{ir} \tag{5}$$

Finally, equation (6) represents a set of labor market clearing conditions, one equation for each of the sub-national regions indexed by r. The equations sum over all other industries (indexed by k) in the same regional labor supply pool as industry i. Workers are mobile across industries, and this arbitrages the wage rate *within the region*, but only across industries that use similar skills and are therefore in the same labor supply pool.[5]

$$E_{ir} \; + \; \sum_{k \neq i} \; E_{kr} = E_r \tag{6}$$

E_r is the total supply of labor in the relevant regional pool.[6] As noted above, workers are not mobile across regions, at least in the short run.

Next, we log-linearize the model and express (1) through (6) in percent changes in the short run. We assume that all exogenous variables other than tariff rates remain constant, including A_i, p_i^*, θ_{ir}, and f_{ir}. On the other hand, employment, prices, shipments, and wages

[5]The relationship between labor mobility and labor supply pools is discussed in more detail in Riker (2020b).

[6]It is straightforward to extend the model to allow for some wage elasticity of E_r rather than assuming that it is constant, as in (6).

adjust in response to the tariff change.

In the short run, fixed costs are sunk, irreversible expenditures that have not yet recurred. With prices a constant mark-up over marginal costs, variable profits are always positive, and incumbent firms will not exit, even if a tariff reduction leads to negative total profits. Likewise, in the short run even if a tariff increase leads to positive total profits, firms cannot enter for a while due to a time-to-build. In the long run, when these fixed costs would recur and new entry is feasible, firms decide whether to exit the market, remain in the industry, or enter based on the total profits they would earn.

In the short run, $\hat{N}_{ir} = 0$, the zero profit condition is not necessarily binding, and the changes in equilibrium prices and quantities are characterized by (7) through (11).[7]

$$\hat{E}_{vir} = (\sigma_i - 1) \hat{P}_i - \sigma_i \hat{p}_{ir} \tag{7}$$

$$\hat{P}_i = (1 - m_i) \sum_r \left(\frac{D_{ir}}{D_i} \right) \hat{p}_{ir} + m_i \hat{\tau}_i \tag{8}$$

$$\hat{p}_{ir} = \hat{w}_r \tag{9}$$

$$s_{ir} \hat{E}_{vir} + \sum_{k \neq i} s_{kr} \hat{E}_{vkr} = 0 \tag{10}$$

$$\hat{E}_{ir} = \left(\frac{E_{vir}}{E_{ir}} \right) \hat{E}_{vir} \tag{11}$$

m_i is the initial import penetration rate in industry i. s_{ir} is the share of the total labor supply pool in region r that is initially employed in industry i, $\frac{E_{ir}}{E_r}$. D_{ir} is the value of domestic shipments from producers in industry i in region r, and D_i is the national value of

[7] For a variable x, $\hat{x}$ is the proportional change in x, equal to $\frac{dx}{x}$.

domestic shipments from producers in the industry. In the short run, the amount of variable labor inputs, E_{vir}, adjusts in proportion to the change in production, but total employment adjusts less than proportionally, since fixed labor inputs do not adjust in the short run.

In the long run, the zero profit condition is binding, both variable labor inputs and total industry employment adjust in proportion to the change in production, and the size of each firm is invariant to the tariff rate. With free entry and a perfectly integrated national product market, price changes are the same across regions, and this implies that wage changes are also the same, regardless of whether labor is mobile between the regions. In the long run of this model, the changes in industry employment, wages, and the value of domestic shipments are indeterminate at the regional level.[8] For this reason, changes in industry employment, wages, and the value of domestic shipments can be calculated at the *national* level using the simpler long-run model in Riker (2021).

3 Data Inputs and Calibration of the Model

The data requirements of the model are the initial import penetration rate in industry i (m_i), the initial share of workers in industry i that are variable inputs in the short run ($\frac{E_{vi}}{E_i}$), and the share of the region's labor supply pool that is initially employed in the industry (s_{ir}). For the model application that follows, we calculate m_i as the ratio of the landed duty paid value of imports to the sum of the value of these imports and the value of domestic shipments of the industry. $\frac{E_{vir}}{E_{ir}}$ is the ratio of production workers to total employment in the industry in each region. s_{ir} as the industry's share of total employment in the relevant regional labor supply pool.

As discussed in Riker (2021), there are two alternatives for calibrating the remaining parameters of the model. If the model user has a reliable estimate of $\frac{E_{vi}}{E_i}$, the share of

[8]This is the case in the long run whether there is inter-regional labor mobility or not.

variable labor inputs in the industry at the national level, then the elasticity of substitution σ_i can be calibrated by setting σ_i equal to $\frac{E_i}{E_i - E_{vi}}$. If the model user *instead* has a reliable estimate of σ_i but is uncertain about $\frac{E_{vi}}{E_i}$, then $\frac{E_{vi}}{E_i}$ can be calibrated by setting it equal to $\frac{\sigma_i - 1}{\sigma_i}$.

4 Application to a Specific Industry

To illustrate the model, we apply it to the Other Fabricated Metal Product Manufacturing sector (NAICS code 3329), which includes producers of metal valve and pipe fittings, ball and roller bearings, arms, and ammunition.[9] We use annual state-level data for the sector from the 2019 Annual Survey of Manufactures.[10] We define each state's labor supply pool as a group of NAICS four-digit industries within the same NAICS three-digit code. We aggregate together all other industries in the state's labor supply pool into a "rest of 332" aggregate.[11] We use annual trade data for 2019 from the ITC/DOC Trade Dataweb.[12]

Tables 1 through 5 report the inputs of the extended model. These include national imports, exports, and total shipments of the industry, its initial tariff rate, and its implied elasticity of substitution and import penetration rate. The tables also include state-level data on employment of production and non-production workers in the modeled industry and in the rest of the industries in the relevant labor supply pool.

Tables 6 and 7 report the short-run percent changes in domestic industry employment, wage, and the value of domestic shipments from tariff elimination, estimated by applying (7) through (11) to the model inputs in Tables 1 through 5. Across the 48 states in the model, the median percent change in variable employment in the industry in the short run is -5.39%.

[9] The model is coded in a Mathematica notebook file available on request from the author.

[10] These data are publicly available at `census.gov/programs-surveys/asm/data.table.html`.

[11] Alternatively, the relevant labor supply pool would be the entire manufacturing sector if workers' skills are more broadly transferable across industries. This alternative is considered in Section 5 below.

[12] These data are publicly available at `dataweb.usitc.gov`.

There is a wide range of employment effects, with New Mexico the largest in absolute value (at -5.98%) and New Hampshire the smallest (at -4.03%). The percent changes in wages ranged from -1.14% to -0.61%, with a median of -0.77%.

Table 8 reports the estimated long-run effects, based on the national model in Riker (2021). As expected, the long-run effects in Table 8 are larger than the median short-run effects in Tables 6 and 7. However, there is no longer variation across the states in the long run, for the reasons explained in Section 2.

5 Conclusions

We extend the model in Riker (2021) by assuming that workers cannot move between subnational regions, and this generates estimates of short-run local labor market effects while keeping the equations of the model tractable and the data requirements modest. The simulations in our application of the extended model show that the magnitudes of the effects on industry employment and wages can vary significantly between the short run and the long run within the industry across states.

The model can be applied to less aggregated industries and geographic areas, as long as there are available data for each industry-location pair. The Annual Survey of Manufactures is a useful source of data for NAICS four-digit industry-by-state modeling of the U.S. manufacturing sector. For finer product disaggregation or for other sectors of the economy, model users will probably need to develop a method for constructing the input data by allocating available aggregated data.

Another potential extension of the model would allow for segmentation of product markets as well as labor markets. Assuming a perfectly integrated national product market greatly simplifies the model, and it is a conventional assumption in the literature on trade and local labor market effects, including Autor, Dorn and Hanson (2013) and Hakobyan and

McLaren (2016). However, it is probably an unrealistic description of the geographically diverse U.S. economy, as discussed in Riker (2020a).

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Table 1: National Inputs for the Model

	NAICS 3329	Rest of NAICS 332
Total Shipments	5,418,502,000	370,601,818,000
Exports	321,016,231	41,914,226,632
Imports	1,552,989,638	81,673,450,645
Import Penetration Rate m_i	23.4%	19.9%
Elasticity of Substitution σ_i	3.86	4.13
Initial Tariff	15.6%	

Table 2: State-Level Inputs for the Model, NAICS 3329

State	Total Employment	Production Workers	Industry Employment Share
Alabama	3,982	3,044	0.20
Arizona	5,550	2,843	0.37
Arkansas	3,945	3,451	0.46
California	17,838	11,885	0.16
Colorado	940	735	0.08
Connecticut	4,955	3,595	0.22
Delaware	305	181	0.19
Florida	4,910	3,587	0.17
Georgia	4,679	3,768	0.19
Idaho	1,774	1,503	0.42
Illinois	17,022	13,451	0.26
Indiana	10,613	8,045	0.24
Iowa	3,951	3,019	0.25
Kansas	2,071	1,582	0.15
Kentucky	3,093	2,482	0.17
Louisiana	3,963	3,111	0.30
Maine	702	542	0.18
Maryland	623	471	0.09
Massachusetts	4,386	3,106	0.18
Michigan	9,955	7,227	0.15
Minnesota	6,223	4,671	0.18
Mississippi	2,580	2,220	0.26
Missouri	5,349	4,153	0.23
Montana	404	311	0.24

Table 3: State-Level Inputs for the Model, NAICS 3329

State	Total Employment	Production Workers	Industry Employment Share
Nebraska	1,610	1,406	0.24
Nevada	693	563	0.15
New Hampshire	5,002	3,164	0.65
New Jersey	3,414	2,260	0.19
New Mexico	126	< 126	0.06
New York	7,995	6,268	0.21
North Carolina	8,763	7,099	0.31
North Dakota	226	172	0.10
Ohio	15,842	12,367	0.19
Oklahoma	5,295	3,716	0.28
Oregon	1,820	1,302	0.14
Pennsylvania	11,755	8,369	0.18
Rhode Island	1,011	768	0.11
South Carolina	8,413	6,524	0.63
South Dakota	1,117	861	0.30
Tennessee	11,116	4,526	0.44
Texas	25,525	18,690	0.27
Utah	2,567	1,891	0.28
Vermont	432	164	0.24
Virginia	1,654	1,318	0.11
Washington	2,356	1,677	0.11
West Virginia	578	415	0.14
Wisconsin	9,196	7,029	0.15
Wyoming	300	240	0.29

Table 4: State-Level Inputs for the Model, Rest of NAICS 332

State	Total Employment	Production Workers
Alabama	20,003	15,102
Arizona	15,079	11,587
Arkansas	8,485	6,161
California	108,228	83,166
Colorado	11,286	8,663
Connecticut	22,803	17,399
Delaware	1,642	1,177
Florida	29,323	21,567
Georgia	25,131	18,755
Idaho	4,188	3,201
Illinois	65,040	49,167
Indiana	44,919	35,424
Iowa	15,573	12,089
Kansas	14,151	10,523
Kentucky	18,252	14,401
Louisiana	13,254	10,111
Maine	3,885	3,084
Maryland	6,711	4,925
Massachusetts	24,053	18,364
Michigan	67,683	52,358
Minnesota	33,765	25,848
Mississippi	9,872	7,890
Missouri	23,625	18,252
Montana	1,685	1,277

Table 5: State-Level Inputs for the Model, Rest of NAICS 332

State	Total Employment	Production Workers
Nebraska	6,641	4,892
Nevada	4,720	3,610
New Hampshire	7,715	5,321
New Jersey	17,939	13,014
New Mexico	2,037	1,692
New York	38,036	28,345
North Carolina	28,504	22,263
North Dakota	2,273	1,752
Ohio	83,080	63,343
Oklahoma	19,236	15,063
Oregon	13,176	9,532
Pennsylvania	65,981	50,001
Rhode Island	8,958	7,257
South Carolina	13,439	10,244
South Dakota	3,681	2,684
Tennessee	25,235	20,063
Texas	93,021	72,051
Utah	9,034	6,717
Vermont	1,803	1,401
Virginia	15,032	10,853
Washington	20,776	16,100
West Virginia	4,234	3,341
Wisconsin	61,988	47,226
Wyoming	1,035	823

Table 6: Short Run Effects with Geographic Segmentation of Labor (% Change)

State	Variable Employment	Wage Rate	Value of Shipments
Alabama	-5.37	-0.78	-6.15
Arizona	-4.77	-0.94	-5.71
Arkansas	-4.48	-1.02	-5.50
California	-5.51	-0.74	-6.25
Colorado	-5.87	-0.64	-6.51
Connecticut	-5.30	-0.80	-6.09
Delaware	-5.42	-0.76	-6.18
Florida	-5.50	-0.74	-6.24
Georgia	-5.42	-0.76	-6.18
Idaho	-4.60	-0.98	-5.59
Illinois	-5.13	-0.84	-5.97
Indiana	-5.22	-0.82	-6.04
Iowa	-5.16	-0.83	-5.99
Kansas	-5.59	-0.72	-6.30
Kentucky	-5.49	-0.74	-6.23
Louisiana	-5.00	-0.88	-5.88
Maine	-5.44	-0.76	-6.20
Maryland	-5.83	-0.65	-6.48
Massachusetts	-5.44	-0.76	-6.19
Michigan	-5.58	-0.72	-6.30
Minnesota	-5.43	-0.76	-6.19
Mississippi	-5.13	-0.84	-5.97
Missouri	-5.26	-0.81	-6.07
Montana	-5.21	-0.82	-6.03

Table 7: Short Run Effects with Geographic Segmentation of Labor (% Change)

State	Variable Employment	Wage Rate	Value of Shipments
Nebraska	-5.20	-0.82	-6.02
Nevada	-5.59	-0.72	-6.30
New Hampshire	-4.03	-1.14	-5.17
New Jersey	-5.40	-0.77	-6.17
New Mexico	-5.98	-0.61	-6.59
New York	-5.33	-0.79	-6.11
North Carolina	-4.97	-0.88	-5.85
North Dakota	-5.80	-0.66	-6.46
Ohio	-5.40	-0.77	-6.17
Oklahoma	-5.08	-0.85	-5.94
Oregon	-5.62	-0.71	-6.33
Pennsylvania	-5.45	-0.75	-6.21
Rhode Island	-5.74	-0.68	-6.41
South Carolina	-4.08	-1.13	-5.20
South Dakota	-4.98	-0.88	-5.86
Tennessee	-4.55	-1.00	-5.55
Texas	-5.08	-0.85	-5.94
Utah	-5.05	-0.86	-5.91
Vermont	-5.21	-0.82	-6.03
Virginia	-5.75	-0.67	-6.42
Washington	-5.73	-0.68	-6.41
West Virginia	-5.63	-0.71	-6.34
Wisconsin	-5.58	-0.72	-6.30
Wyoming	-5.03	-0.87	-5.90

Table 8: Model Outputs without Geographic Segmentation of Labor

	Long Run (% Change)
Employment for Domestic Shipments	
Variable Labor Inputs	-8.21
Fixed Labor Inputs	-8.21
Wages	-1.08
Value of Domestic Shipments	-9.30