

Tariffs on Imports from China:

The Estimated Impacts on the U.S. Economy

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Summary

In response to a Section 301 investigation finding that China's intellectual property rights (IPR), forced technology transfers and innovation practices are harming U.S. companies, the Trump Administration is considering the imposition of tariffs of 25 percent on U.S. imports of selected products from China. China has responded with threats to impose tariffs of 25 percent on imports from the United States of selected products. The president then asked his administration to consider imposing additional duties totaling \$100 billion on an unspecified list of products imported from China. China answered it would respond (presumably in kind) should the United States go forward with those tariffs.

This study estimates the economic impact of the proposed U.S. tariffs and China's proposed retaliation in three different scenarios: (1) U.S. tariffs alone on \$50 billion in goods imported from China, (2) U.S. tariffs on \$50 billion in imports plus Chinese retaliation of \$50 billion of U.S. goods exported to China, and (3) U.S. tariffs plus Chinese retaliation plus another \$100 billion in U.S. and Chinese duties. We find, for the scenario we deem most probable (2), that the imposition by the United States of 25 percent tariffs on imports of selected products from China, coupled with promised retaliation by China, would have significant net negative impacts on the U.S. economy and U.S. employment, particularly over the one to two years after application.

- The U.S. tariffs and follow-on retaliation by China would hurt U.S. farmers, factory workers, and workers in construction and services sectors. Farmers would see a "hit" of 6.7 percent to their net incomes, and jobs in the sector would drop by over 67,000. Manufacturing employment would rise in some sectors, but fall in others; net jobs would drop by nearly 11,000. For employment as a whole, more than four jobs would be lost for every one gained, with the gains in metals and machinery coming at the expense of agriculture, transportation equipment, and services.
- Overall, U.S. output would decline by nearly \$3 billion, and nearly 134,000 workers would lose jobs, most of them less-skilled workers.

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- Tariffs plus retaliation will hurt every state, including those in the so-called “Rust Belt.”

If the tariff wars escalate to our third scenario (imposition of an additional \$100 billion in tariffs by both countries), we find that:

- The “hit” to U.S. farmers would more than double. Farmer income would drop by 15 percent; jobs in the sector would decline by nearly 181,000. While manufacturing as a whole would gain as production that would otherwise occur in China and other countries returns to the United States, some manufacturing sectors would see output and employment declines. The job losses in agriculture would overwhelm any net gains to manufacturing.
- Overall, U.S. output would decline by \$49 billion, and nearly 455,000 workers would lose jobs, most of them less-skilled workers.

1. Introduction

On March 22, 2018, the Office of the U.S. Trade Representative (USTR) issued a report that found certain acts, policies or practices of the Chinese government relating to technology transfer, intellectual property and innovation were adversely impacting U.S. companies.¹ In response to that report, President Donald Trump instructed USTR to, among other actions, develop and publish a list of \$50 billion of products imported from China upon which the United States could assess 25 percent duties.² USTR published a list of about 1,300 products on April 3, stating that the government attempted to select products, “with the lowest consumer impact”³. In fact, more than one-quarter of the products on the Administration’s proposed tariff list are consumer goods (see Table 1; selected consumer goods are in blue).⁴

Within hours of publication, China responded with a retaliation tariff list of nearly \$50 billion worth of U.S. exports. The Chinese list is comprised of 108 categories of products that would be subject to a 25 percent Chinese tariff should the United States moves forward with its tariffs. (see Table 2)

The back and forth did not end here, however. On April 5 the White House issued a statement from the President stating that he had instructed USTR to “consider whether \$100 billion of additional tariffs would be appropriate under section 301 and, if so, to identify the products upon which to impose such tariffs.”⁵ China’s Ministry of Commerce responded immediately that it would “fight back resolutely.”

¹ Office of the United States Trade Representative, Executive Office of the President, “Findings of the Investigation into China’s Acts, Policies, and Practices Related to Technology Transfer, Intellectual Property, and Innovation Under Section 301 of the Trade Act of 1974,” March 22, 2018, <https://ustr.gov/sites/default/files/Section%20301%20FINAL.PDF>.

² “President Trump Announces Strong Actions to Address China’s Unfair Trade,” March 22, 2018, <https://ustr.gov/about-us/policy-offices/press-office/press-releases/2018/march/president-trump-announces-strong>.

³ Office of the United States Trade Representative, “Notice of Determination and Request for Public Comment Concerning Proposed Determination of Action Pursuant to Section 301: China’s Acts, Policies, and Practices Related to Technology Transfer, Intellectual Property, and Innovation,” *Federal Register*, 83 FR 14906, April 6, 2018, p. 8, <https://www.federalregister.gov/documents/2018/04/06/2018-07119/notice-of-determination-and-request-for-public-comment-concerning-proposed-determination-of-action>.

⁴ In research issued earlier in April, Trade Partnership Worldwide estimated the impacts on consumers of four consumer products on the proposed list: televisions, monitors, batteries and ink cartridges. We found that the tariffs would significantly increase the costs to consumers of imports from China. Moreover, in the cases of televisions and monitors in particular, it is not easy for importers to shift sourcing to other suppliers because the products made in China are quite different than those made in China. Therefore, consumer prices for these products will be impacted by the tariffs. See Trade Partnership Worldwide, LLC, “Estimated Impacts of Proposed Tariffs on Imports From China: Televisions, Monitors, Batteries and Printer Cartridges,” April 11, 2018.

⁵ The White House, Office of the Press Secretary, “Statement from President Donald J. Trump on Additional Proposed Section 301 Remedies,” April 5, 2018, <https://www.whitehouse.gov/briefings-statements/statement-president-donald-j-trump-additional-proposed-section-301-remedies/>. While most media reports of this action state that Trump asked for consideration of tariffs on an additional \$100 billion in *trade*, rather than an additional

Some Administration officials have argued that the economic impact of the tariffs is overblown. They do acknowledge that the impact will be negative but suggest that it will be small in the aggregate.⁶ The President himself has acknowledged that the U.S. economy would be adversely impacted by the tariffs and retaliation stating, “I’m not saying there’s not gonna be any pain.”⁷

Table 1
U.S. Products Subject to Proposed U.S. Tariffs

	Value of Imports From China, 2017 (Millions \$)	China’s Share of U.S. Total 2017 Imports (Percent)
All Products Proposed	\$46,173.3	6.9%
Chemicals, rubber, plastics	3,301.5	3.1
Medicines, vitamins	548.7	0.8
Printer ink, cartridges	2,552.3	29.4
Ferrous metals (iron/steel products)	135.3	0.8
Other metals	1,235.1	7.7
Metal products (iron/steel and aluminium)	2,252.8	16.8
Motor vehicles and parts	3,034.1	1.3
Motor vehicles	1,658.5	0.8
Parts	1,347.1	6.3
Other transport equipment	1,438.5	2.5
Electronic equipment	10,539.5	27.7
Televisions	3,898.2	35.0
Monitors	586.4	31.7
Other office equipment	1,901.2	21.5
Semiconductors and related products	1,089.8	28.5
Machinery and equipment	24,098.3	12.5
Agriculture machinery	388.4	13.5
Textile/leather products machinery	115.9	12.0
Batteries	182.3	18.7
Household appliances	281.1	16.9
Other manufacturers	138.1	3.9

Source: The Trade Partnership from Census data.

\$100 billion in *tariffs*, no subsequent communications from the Administration or its representatives have changed the wording of the Statement or otherwise indicated it was a in error (i.e., the word “tariffs” should have been “trade”). Therefore, in this research we take the President at his word and model a third scenario for another \$100 billion in tariffs.

⁶ See for example, “Commerce Secretary Wilbur Ross: China tariffs amount to only 0.3% of US GDP,” CNBC, April 4, 2018, <https://www.cnbc.com/2018/04/04/commerce-secretary-wilbur-ross-china-tariffs-amount-to-0-point-3-percent-of-us-gdp.html>, Eli Okun, “Mnuchin: China trade dispute won’t have ‘meaningful impact’ on U.S. economy,” *Politico*, April 8, 2018, <https://www.politico.com/story/2018/04/08/mnuchin-china-trade-economy-508264>.

⁷ “EXCLUSIVE: President Donald Trump Discusses Economy, NY Baseball, & White House Correspondents Dinner on 77 WABC,” April 6, 2018, <http://www.wabcradio.com/2018/04/06/trump-exclusive/>.

Administration officials have not released any research that quantifies impacts of the proposed U.S. tariffs, coupled with proposed Chinese retaliation on the U.S. economy and U.S. jobs in any detail: e.g., the overall impact on GDP, exports (bilateral and in total), imports and jobs. This research provides an independent assessment of those impacts. It considers all of the ways in which raising tariffs impact the U.S. economy, including: declines in imports from China, increases in imports from other countries, increases and decreases in domestic production, rising costs to farmers, manufacturers and services providers, and employment shifts (wages fall and/or workers lose jobs in some cases; wages rise and workers gain jobs in others). To reflect these complex relationships, we employ a model specifically designed to capture these factors (briefly described in Section 2.1 and detailed in Appendix A). Results are reported in Section 3.

Table 2
U.S. Products Subject to Proposed Chinese Tariffs

	Value of U.S. Exports to China, 2017 (Millions \$)	China's Share of U.S. Exports, 2017 (Percent)
All Products Proposed	\$49,709.9	16.5%
Vegetables, fruits, nuts	466.1	3.7
Cherries	122.9	18.6
Oranges	48.5	7.7
Pecans (in shell)	30.8	10.1
Oilseeds (soybeans)	12,356.0	57.3
Cotton	971.3	16.7
Meats products (swine)	487.9	9.1
Beverages, tobacco products	144.0	3.1
Wine	73.4	5.2
Gas (liquefied propane)	1,650.1	13.6
Chemicals, rubber, plastics	4,854.2	11.2
Diagnostic, lab reagents	600.7	9.9
Ferrous metals (iron/steel products)	117.8	12.6
Motor vehicles and parts	10,356.6	17.9
Passenger vehicles	9,636.0	23.9
Other transport equipment	15,713.3	14.6
Other manufactures	1,953.9	23.2

Source: The Trade Partnership from Census data.

2. Methodology

This section briefly summarizes the model used for analysis; a detailed description of our approach is provided in Appendix A. Also described are the assessment scenarios for potential impacts of U.S. and Chinese retaliatory tariffs.

2.1 The model

We base our analysis on the Global Trade Analysis Project (GTAP) database and its related “computable general equilibrium” (CGE) model. The GTAP database reports data for international trade and national inter-industry relationships and national income accounts, as well as tariffs, some nontariff barriers and other taxes, for 140 countries and regions. Our model incorporates the GTAPv10 database; we have further updated the data from the 2014 benchmark year to better reflect the U.S. economy in 2016, our base year for analysis. [We have not included in our baseline recent changes to U.S. and Chinese tariffs from the steel and aluminum Section 232 investigations because, at this writing, the status of those tariffs remains in flux. On May 1 (or thereafter), one or more countries may be exempted from the tariffs, and a process is in play to exclude individual steel and aluminum products from their scope. Picking one coverage option to include in our baseline analysis would be arbitrary. Effects from the final set of Section 232-related tariffs would be on top of those discussed here.]

The CGE model enables us to see how the imposition of tariffs affects supply chains and the locations where goods are produced. This mix of supply chain and location effects in turn drive changes in productivity, new investment, and the prices paid by consumers. In some instances, U.S. production and related employment may increase; in others, they will decline. These changes will also affect consumers, even if the product on which a tariff is assessed is not purchased in a retail store. For example, when the price of a good (parts or finished goods) or service increases because a tariff is imposed,⁸ consumers (be they manufacturers or households) buy less, firms make less still, and workers lose jobs or see their wages decline. Less spending by consumers (and producers) reverberates throughout the economy, with reduced sales and employment impacts on supplier industries and reduced spending by families and individuals on nights out at restaurants or movie theaters, for example. Lower spending on these services can trigger job losses in those sectors as well.

As noted above, the base year for our analysis is 2016, the most recent year for which detailed state-level employment and output data are available from the Bureau of Economic Analysis. We compare the actual U.S. economy and employment in a base year (2016) to the same 2016 economy after the United States assesses new (Section 301) tariffs on selected imports from China, and China assesses new retaliatory tariffs on selected U.S. exports to China. We focus on the short-term (one to two years after imposition of the duties).

Also considered are the impacts of the tariffs on the U.S. workforce in the short-run, i.e., the first year or two of their imposition. To do this, wages are treated as only somewhat “sticky”

⁸ See U.S. International Trade Commission, *The Economic Effect of Significant U.S. Import Restraints: Ninth Update 2017*, Inv. No. 332-325, Pub. No. 4726, Chapter 3, <https://www.usitc.gov/publications/332/pub4726c.pdf> for an excellent assessment of how imported services increasingly incorporate the value of U.S. tariffs on goods.

but with tight labor markets. This is meant to reflect current conditions and means that changes in demand for labor (positive or negative) are reflected in part by changes in employment, and in part by changes in wages. In the longer term (i.e., should the tariffs remain in effect ten years and longer), the labor impact would more appropriately be felt entirely by wage changes rather than employment changes. The approach followed reflects the growing, but still not complete, tightness in labor supply in the U.S. market in the shorter term. We examine the employment impacts on workers in different occupation/skill categories in the United States. Employment impact estimates are net, taking into account potential increases as well as decreases in employment as demand increases in some cases for U.S. products, and declines in others.

2.2 Scenarios

Three scenarios are considered:

- (1) U.S. application of the 25 percent tariffs on selected imports of \$50 billion in goods imported from China shown in Table 1;
- (2) Application of tariffs in Table 1 plus application of the Chinese retaliatory tariffs on \$50 billion in U.S. exports to China shown in Table 2, and
- (3) Scenario (2) plus the impacts of additional U.S. tariffs totaling \$100 billion on imports from China plus additional Chinese tariffs totaling \$100 billion on imports from the United States.

3. Results

This section summarizes the results for national level effects (section 3.1), and state-level effects (section 3.2).

3.1 U.S. national level results

As shown in Table 3, U.S. tariffs on selected imports from China would have a negative impact on the United States; coupled with Chinese tariffs on an equal value of selected imports from the United States, which impact would increase substantially. Table 4 presents more detailed, by sector, employment impacts of the three tariff scenarios.

For all three scenarios, some sectors and workers gain from the tariffs; while others lose. More lose than gain. Particularly noteworthy is the “hit” to agriculture, both regarding farm property income (net farm-land income above labor and input costs) and employment. While some manufacturing sectors benefit from increased domestic output due to reduced imports from China, other manufacturing sectors lose, and services sectors lose overall as well. In short, the tariffs benefit some politically important manufacturing sectors, but at the expense of other politically important sectors, with a net negative impact on the economy, both in terms of output and jobs.

Table 3
Estimated Annual Impacts of Imposing Tariffs on Imports from China, and Chinese Retaliation

	Scenario (1): U.S. Tariffs, No Retaliation	Scenario (2): (1) Plus Retaliation	Scenario (3): (2) Plus \$100B in Additional Tariffs
GDP (percent)	-0.01%	-0.02%	-0.26%
GDP (value in billions of 2016 dollars)	-\$1.6	-\$2.9	-\$49.2
U.S. farm property income (percent change)	-0.66	-6.67	-15.01
U.S. Exports to the World (value in billions of 2016 \$)	-\$18.6	-\$33.5	-\$172.7
U.S. Imports from the World (value in billions of 2016 \$)	-\$12.6	-\$29.5	-\$203.4
U.S. Exports to China (value in billions of 2016 \$)	-\$2.8	-\$35.5	-\$105.5
U.S. Imports from China (value in billions of 2016 \$)	-\$41.9	-\$46.7	-\$341.2
U.S. Employment (number)	-76,169	-133,676	-454,796
- Higher skilled workers (a)	-20,431	-27,396	-123,362
- Lower skilled workers (b)	-55,737	-106,280	-331,434
Change in U.S. Wages (percent)	+0.01	-0.01	-0.12

(a) Higher skilled workers include, for example, managers, professionals, technicians and similar workers.

(b) Lower skilled workers include, for example, store, sales and other services workers; office and administrative staff, production workers, machine operators, and farm workers.

U.S. Tariffs Alone

U.S. imposition of 25 percent tariffs on selected Chinese imports would reduce U.S. GDP by over \$1.6 billion (by 0.01 percent). By making U.S. output more expensive, for example, U.S. exports to the world would drop by \$18.6 billion. U.S. imports from the world would also decline as production of some goods otherwise be sourced from China is manufactured instead by U.S. producers. A net decline in U.S. GDP demonstrates that gains to U.S. producers are not outweighed by costs to other sectors of the economy.

The net reduction in U.S. output has an impact on U.S. employment: net employment declines by over 76,000 workers. Lower-skilled workers, who account for 73 percent of the lost jobs, experience most of those job losses. Some employment losses are due to declines in output in certain goods and services sectors. While some sectors gain jobs, most lose (see Table 4). Noteworthy is the net loss of jobs in manufacturing as a whole (-5,566 jobs), and the net loss to agriculture (-7,176), both key sectors politically. Services sector jobs bear the brunt of the impact, with total net losses estimated at 58,996.

Table 4
Estimated Employment Impacts by Major Sector
 (Number)

	Scenario (1): U.S. Tariffs, No Retaliation	Scenario (2): (1) Plus Retaliation	Scenario (3): (2) Plus \$100B in Tariffs
Agriculture	-7,156	-67,248	-180,904
Energy	-4,561	-569	-13,305
Manufacturing	-5,566	-10,952	+132,475
Processed foods, beverages, tobacco	-1,838	+1,889	-8,241
Petroleum and coal, including gas distribution	-131	-168	-757
Chemicals, rubber, plastics	-1,768	-3,396	-6,655
Motor vehicles	-1,540	-9,526	-21,957
Aircraft, other transport equipment	-3,047	-27,573	-48,773
Machinery, electronics	+20,614	+28,696	+67,804
Metals and metal products	+7,571	+11,069	+45,188
Other goods	-25,426	-11,943	+105,866
Services	-58,886	-54,907	-393,063
Construction	-23,468	-29,455	-135,779
Wholesale, retail and transportation services	-6,554	-3,417	-10,040
Finance and insurance	-4,476	-2,154	-23,528
Business and professional services, ICT services	-31,588	-8,832	-76,875
Other services	+7,200	-11,049	-146,841
Total	-76,169	-133,676	-454,796

Source: Authors' estimates.

U.S. Tariffs + Chinese Retaliation

If the United States imposes 25 percent tariffs on imports of selected products from China and China responds with 25 percent tariffs on imports of selected goods from the United States, the damage to the U.S. economy and workers nearly doubles. U.S. and Chinese tariffs would reduce U.S. GDP by \$2.9 billion (by 0.02 percent). By making U.S. output more expensive, for example, U.S. exports to the world would decrease by \$33.5 billion. U.S. imports from the world would also decline as production of some of the goods otherwise sourced from China would be manufactured instead by U.S. producers (in addition 37 percent of products otherwise sourced from China shifts to other countries). The damage to farmers increases 10-fold from Scenario 1 as agricultural products figure heavily on China's retaliation list. For example, U.S. oilseed output is cut by 14.2 percent as U.S. oilseed exports to China drop by \$7.4 billion.

The reduction in U.S. output has an impact on U.S. employment: net employment declines by nearly 134,000 workers. Again, lower-skilled workers, who account for nearly 80 percent of the lost jobs, experience most of those job losses. Job losses in the agriculture sector soar to over 67,000; net losses in manufacturing double when China retaliates. While some U.S. sectors gain net jobs (machinery, electronics, metals and metal products), they come at a high price to other manufacturing sectors – notably transportation equipment. Job losses (175,330) outweigh gains

(41,654) by a factor of more than four to one. [Section 3.2 reports the breakdown of these job impacts down by state.]

U.S. Tariffs + Chinese Retaliation + \$100 Billion in Additional Tariffs

Escalation of tariffs and counter-tariff imposition envisioned in Scenario 3 would come at huge cost to the U.S. economy, multiplying the damage from Scenario 2 17-fold. U.S. and Chinese imposition of an additional \$100 billion in tariffs would reduce U.S. GDP by over \$49 billion (by 0.26 percent and would cut U.S. exports to the world by \$173 billion. U.S. imports from the world would decline to the disadvantage of U.S. consumers and manufacturers who need competitively priced imports as inputs to U.S. production. The negative impact on farmers would more than double from the 25 percent tariff plus retaliation scenario.

Net U.S. employment would drop by nearly 455,000 jobs. Again, lower-skilled workers would pay a disproportionate price, accounting for 73 percent of the lost jobs. Net U.S. manufacturing employment overall increases as production that would otherwise have gone to make goods imported from China is brought back to the United States; however, the manufacturing employment increase is more than outweighed by losses to agriculture and services. Even within manufacturing, net job losses occur: in food and beverage products, chemicals and transportation equipment, for example.

3.2 State results

We disaggregated our national employment results to show the employment impacts of tariffs plus retaliation by state (Scenario 2, the most likely scenario in our view should tariffs be imposed) in Table 5. Every state loses employment if the U.S. tariffs are imposed and China retaliates. Job losses vary by state, depending on economic structure and size of the state economy.

Table 5
Estimated Annual State Employment Impacts of Imposing Tariffs on Imports from China, and Chinese Retaliation (Scenario 2)

Alabama	-2,798	Montana	-935
Alaska	-355	Nebraska	-1,526
Arizona	-3,007	Nevada	-631
Arkansas	-1,675	New Hampshire	-312
California	-18,551	New Jersey	-1,908
Colorado	-2,266	New Mexico	-1,014
Connecticut	-1,923	New York	-4,316
Delaware	-280	North Carolina	-3,410
District of Columbia	-203	North Dakota	-808
Florida	-7,128	Ohio	-3,368
Georgia	-3,969	Oklahoma	-2,009
Hawaii	-578	Oregon	-2,427
Idaho	-1,294	Pennsylvania	-3,418
Illinois	-2,302	Rhode Island	-349
Indiana	-2,809	South Carolina	-1,705
Iowa	-1,856	South Dakota	-799
Kansas	-2,755	Tennessee	-2,734
Kentucky	-2,659	Texas	-12,099
Louisiana	-1,785	Utah	-1,346
Maine	-1,081	Vermont	-397
Maryland	-1,760	Virginia	-3,320
Massachusetts	-1,779	Washington	-5,609
Michigan	-3,237	West Virginia	-748
Minnesota	-2,299	Wisconsin	-1,574
Mississippi	-1,818	Wyoming	-459
Missouri	-3,512	TOTAL	133,677*

* The sum of the states does not add to the national total because the national total includes areas (e.g., Puerto Rico and U.S. possessions) that are not detailed above.

Source: Authors' estimates.

4. Conclusions

The proposed tariffs on U.S. imports of selected products, coupled with retaliation by China, would have significant net negative impacts on the U.S. economy and U.S. workers. These impacts would be felt in nearly every sector, and in every U.S. state.

5. References

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Appendix A: Methodology In Detail

To estimate the economic effects of imposing tariffs on U.S. imports from China and China's imports from the United States, we employed the Global Trade Analysis Project (GTAP) database, which is integrated in a computable general equilibrium (CGE) model. The mathematical structure of our model, starting with the GTAP database, follows Egger et al., augmenting the basic Eaton-Kortum-Armington structure of the GTAP model with monopolistic competition, depending on the sector.⁹

The GTAP database covers international trade and economy-wide interindustry relationships and national income accounts, as well as tariffs, some non-tariff barriers and other taxes. While our GTAP model database is based on version 10 (for 2014 data), we have updated the data to better reflect the U.S. economy in 2016. We have also estimated the trade elasticities and used in the model an extended version of the gravity model database employed by Egger et al. (2015).

The model simulates the percentage changes in aggregate economic measures, including U.S. real GDP and aggregate employment, when moving from the baseline or reference level (in this case the U.S. economy and trade regime in effect in 2016 to the counterfactual (the imposition of new tariffs on selected goods by the United States, and then by China). The model results are then converted into percentage changes when moving from counterfactual levels to the actual levels that prevailed in the baseline. The results reported reflect the potential impacts of the tariffs within the first one to two years.

Economists use this type of model to compare the global economy (GDP, trade flows, employment and other variables) before a policy action is taken (called *ex ante* analysis), and after a policy action is taken (called *ex post* analysis).¹⁰ For the immediate impact (short term) we use a version of the model where wages are somewhat "sticky," but not entirely so (we use a labor supply elasticity of 0.5).

We disaggregate the job impacts into "skilled" and "unskilled" labor categories based on the five GTAP labor categories as detailed in the concordance in Appendix Table A.3. We map these categories against employment levels according to sectors used by the U.S. Bureau of Economic Analysis (BEA) for 2016 employment and estimate the share of each GTAP skill category that is employed in each BEA sector. Jobs data from BEA are provided at national and state level by industry on a NAICS sector basis. The Bureau of Labor Statistics (BLS) provides a more limited set of data on jobs (not all employment in the BLS data is included in the broader BEA employment counts). However, the BEA data do provide both a break down by occupational categories and by NAICS. On the basis of the share of NAICS level employment by occupational

⁹ See Francois, J., Manchin, M., & Martin, W. (2013). "Market structure in multisector general equilibrium models of open economies." In D. Jorgenson and P. Dixon eds., *Handbook of computable general equilibrium modeling*, vol. 1, Elsevier, and Egger, Peter, Joseph Francois, Miriam Manchin, and Douglas Nelson. "Non-tariff barriers, integration and the transatlantic economy." *Economic Policy* 30, no. 83 (2015): 539-584.

¹⁰ See the various chapters in D. Jorgenson and P. Dixon eds. (2013), *Handbook of computable general equilibrium modeling*, vol. 1, Elsevier.

category in the BLS data, we have allocated BEA employment across industries according to occupational category. We then incorporated the skilled/unskilled disaggregation into the model following Walmsley and Carrico 2016.

Finally, for state-level analysis, we first map state-level data on employment and Gross State Employment for NAICS sectors from BEA to corresponding model sectors. We then map national changes in production and employment at industry level to the corresponding state data at the model sector level. The impact on states therefore reflects the variation in the output and employment structure across state economies.

Table A.1
Sector Concordances

GTAP no.	GTAP Sector	Our Model Sector No.	Our Model Sectors	NAICS No.	NAICS Category
1	PDR - Paddy rice	1	Agriculture	11	Agriculture, Forestry, Fishing and Hunting
2	WHT – Wheat	1	Agriculture	11	Agriculture, Forestry, Fishing and Hunting
3	GRO - Cereal grains n.e.c.	1	Agriculture	11	Agriculture, Forestry, Fishing and Hunting
4	V_F - Vegetables, fruit, nuts	1	Agriculture	11	Agriculture, Forestry, Fishing and Hunting
5	OSD - Oil seeds	1	Agriculture	11	Agriculture, Forestry, Fishing and Hunting
6	C_B - Sugar cane, sugar beets	1	Agriculture	11	Agriculture, Forestry, Fishing and Hunting
7	PFB - Plant-based fibers	1	Agriculture	11	Agriculture, Forestry, Fishing and Hunting
8	OCR - Crops n.e.c.	1	Agriculture	11	Agriculture, Forestry, Fishing and Hunting
9	CTL - Bovine cattle, sheep and goats, horses	1	Agriculture	11	Agriculture, Forestry, Fishing and Hunting
10	OAP - Animal products n.e.c.	1	Agriculture	11	Agriculture, Forestry, Fishing and Hunting
11	RMK - Raw milk	1	Agriculture	11	Agriculture, Forestry, Fishing and Hunting
12	WOL - Wool, silk-worm cocoons	1	Agriculture	11	Agriculture, Forestry, Fishing and Hunting
15	COA – Coal	2	Energy	21	Mining, Quarrying, and Oil and Gas Extraction
16	OIL – Oil	2	Energy	21	Mining, Quarrying, and Oil and Gas Extraction
17	GAS – Gas	2	Energy	21	Mining, Quarrying, and Oil and Gas Extraction
43	ELY - Electric power	2	Energy	21	Mining, Quarrying, and Oil and Gas Extraction
44	GDT - Gas manufactured and distributed	2	Energy	21	Mining, Quarrying, and Oil and Gas Extraction
19	CMT - Bovine meat prods	3	Processed foods	311	Food Manufacturing
20	OMT - Meat and fish products n.e.c.	3	Processed foods	311	Food Manufacturing
21	VOL - Vegetable oils and fats	3	Processed foods, beverages, tobacco	311	Food Manufacturing
22	MIL - Dairy products	3	Processed foods, beverages, tobacco	311	Food Manufacturing
23	PCR - Processed rice	3	Processed foods, beverages, tobacco	311	Food Manufacturing
24	SGR – Sugar	3	Processed foods, beverages, tobacco	311	Food Manufacturing
25	OFD - Food products n.e.c.	3	Processed foods, beverages, tobacco	311	Food Manufacturing
14	FSH – Fishing	3	Processed foods, beverages, tobacco	311	Food Manufacturing
26	B_T - Beverages and tobacco products	4	Processed foods, beverages, tobacco	312	Beverage and Tobacco Product Manufacturing
32	P_C - Petroleum, coal products	5	Petroleum and coal products	324	Petroleum and Coal Products Manufacturing
33	CRP - Chemical, rubber, plastic products	6	Chemical, rubber, plastic products	325, 326	Chemical Manufacturing + Plastics and Rubber Products Manufacturing

35	I_S - Ferrous metals	7	Metals and metal products	331, 332	Primary Metal Manufacturing + Fabricated Metal Product Manufacturing
36	NFM - Metals n.e.c.	7	Metals and metal products	331, 332	Primary Metal Manufacturing + Fabricated Metal Product Manufacturing
37	FMP - Metal products	7	Metals and metal products	331, 332	Primary Metal Manufacturing + Fabricated Metal Product Manufacturing

GTAP no.	GTAP Sector	Our Model Sector No.	Our Model Sectors	NAICS No.	NAICS Category
38	MVH - Motor vehicles and parts	8	Motor vehicles and parts	3361, 3362, 3363	Motor Vehicle Manufacturing + Motor Vehicle Body and Trailer Manufacturing + Motor Vehicle Parts Manufacturing
40	ELE - Electronic equipment	9	Machinery, electronics	334	Computer and Electronic Product Manufacturing
27	TEX – Textiles	10	Other goods	313, 314	Textile Mills + Textile Product Mills
28	WAP - Wearing apparel	11	Other goods	315	Apparel Manufacturing
29	LEA - Leather products	12	Other goods	316	Leather and Allied Product Manufacturing
30	LUM - Wood products	13	Other goods	321, 322, 323	Wood Product Manufacturing + Paper Manufacturing + Printing and Related Support Activities
31	PPP - Paper products, publishing	13	Other goods	321, 322, 323	Wood Product Manufacturing + Paper Manufacturing + Printing and Related Support Activities
39	OTN - Transport equipment n.e.c.	14	Aircraft, other transportation equip.	3364, 3365, 3366, 3369	Aerospace Product and Parts Manufacturing + Railroad Rolling Stock Manufacturing + Ship and Boat Building + Other Transportation Equipment Manufacturing
41	OME - Machinery and equipment n.e.c.	15	Machinery, electronics	333, 335	Machinery Manufacturing + Electrical Equipment, Appliance, and Component Manufacturing
13	FRS – Forestry	16	Other goods	327, 337, 339	Non-metallic Mineral Product Manufacturing + Furniture and Related Product Manufacturing + Miscellaneous Manufacturing
18	OMN - Minerals n.e.c.	16	Other goods	327, 337, 339	Non-metallic Mineral Product Manufacturing + Furniture and Related Product Manufacturing + Miscellaneous Manufacturing
34	NMM - Mineral products n.e.c.	16	Other goods	327, 337, 339	Non-metallic Mineral Product Manufacturing + Furniture and Related Product Manufacturing + Miscellaneous Manufacturing
42	OMF - Manufactures n.e.c.	16	Other goods	327, 337, 339	Non-metallic Mineral Product Manufacturing + Furniture and Related Product Manufacturing + Miscellaneous Manufacturing
46	CNS – Construction	17	Construction	23	Construction
50	ATP - Air transport	18	Wholesale, retail and transport services	481	Air Transportation
49	WTP - Water transport	19	Wholesale, retail and transport services	483	Water Transportation
48	OTP - Other transport	20	Wholesale, retail and transport services	482, 484, 485, 486, 487, 488, 493	Rail, Truck, Transit and Ground, Passenger, Pipeline, Scenic and Sightseeing Transportation, + Support Activities for Transportation + Warehousing and Storage

GTAP no.	GTAP Sector	Our Model Sector No.	Our Model Sectors	NAICS No.	NAICS Category
47	TRD - Trade and distribution	21	Wholesale, retail and transport services	42, 44-45, 72	Wholesale and Retail Trade, Accommodation and Food Services
51	CMN - Communications	22	Business and professional services, ICT services	491, 492, 51	Information + Postal Service + Couriers and Messengers
52	OFI - Financial services	23	Finance and insurance	521, 522, 523, 525	Monetary Authorities-Central Bank + Credit Intermediation and Related Activities + Securities, Commodity Contracts, and Other Financial Investments and Related Activities + Funds, Trusts, and Other Financial Vehicles
53	ISR – Insurance	24	Finance and insurance	524	Insurance Carriers and Related Activities
54	OBS - Other business services, IT services	25	Business and professional services, ICT services	53, 54, 55, 56	Real Estate and Rental and Leasing + Professional, Scientific, and Technical Services + Management of Companies and Enterprises + Administrative and Support and Waste Management and Remediation Services
55	ROS - Recreational and other services	26	Other services	71	Arts, Entertainment, and Recreation
45	WTR - Water and sewer services	27	Other services	22, 61, 62, 81, 99	Utilities + Educational Services + Health Care and Social Assistance + Other Services (except Public Administration) + Federal, State, and Local Government (excluding state and local schools and hospitals)
56	OSG - Other public services	27	Other services	22, 61, 62, 81, 99	Utilities + Educational Services + Health Care and Social Assistance + Other Services (except Public Administration) + Federal, State, and Local Government (excluding state and local schools and hospitals)
57	DWE - Residential services, dwellings	27	Other services		

Table A.2
Country/Regions

Australia	Ecuador	Lithuania	Kuwait
New Zealand	Paraguay	Luxembourg	Oman
China	Peru	Malta	Qatar
Hong Kong	Uruguay	Netherlands	Saudi Arabia
Japan	Venezuela	Poland	Turkey
Korea	Costa Rica	Portugal	United Arab Emirates
Taiwan	Guatemala	Slovakia	Egypt
Cambodia	Honduras	Slovenia	Morocco
Indonesia	Nicaragua	Spain	Tunisia
Laos	Panama	Sweden	Benin
Malaysia	El Salvador	United Kingdom	Burkina Faso
Philippines	Dominican Republic	Switzerland	Cameroon
Singapore	Trinidad and Tobago	Norway	Cote d'Ivoire
Thailand	Austria	Iceland & Lichtenstein	Ghana
Viet Nam	Belgium	Albania	Guinea
Bangladesh	Cyprus	Bulgaria	Nigeria
India	Czech Republic	Belarus	Senegal
Pakistan	Denmark	Croatia	Ethiopia
Sri Lanka	Estonia	Romania	Kenya
Canada	Finland	Russia	Madagascar
United States	France	Ukraine	Malawi
Mexico	Germany	Tajikistan	Mauritius
Argentina	Greece	Armenia	Rwanda
Bolivia	Hungary	Georgia	Tanzania
Brazil	Ireland	Iran	Uganda
Chile	Italy	Israel	Zambia
Colombia	Latvia	Jordan	Zimbabwe
			South Africa
			Rest of the World

Table A.3
Mapping of BEA occupation data to GTAP labor categories

(Percent)

GTAP Code	GTAP category	BEA Code	BEA category	Share of total*
c1_off_mgr_pros	Senior officials and managers, professionals, lawmakers	11-0000	Management Occupations	5.05
c1_off_mgr_pros	Senior officials and managers, professionals, lawmakers	13-0000	Business and Financial Operations Occupations	5.19
c1_off_mgr_pros	Senior officials and managers, professionals, lawmakers	15-0000	Computer and Mathematical Occupations	2.97
c1_off_mgr_pros	Senior officials and managers, professionals, lawmakers	17-0000	Architecture and Engineering Occupations	1.78
c1_off_mgr_pros	Senior officials and managers, professionals, lawmakers	19-0000	Life, Physical, and Social Science Occupations	0.82
c1_off_mgr_pros	Senior officials and managers, professionals, lawmakers	21-0000	Community and Social Service Occupations	1.44
c1_off_mgr_pros	Senior officials and managers, professionals, lawmakers	23-0000	Legal Occupations	0.77
c1_off_mgr_pros	Senior officials and managers, professionals, lawmakers	25-0000	Education, Training, and Library Occupations	6.15
c1_off_mgr_pros	Senior officials and managers, professionals, lawmakers	27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	1.35
c2_2tech_aspros	Technicians, technical professionals	29-0000	Healthcare Practitioners and Technical Occupations	5.93
c3_service_shop	Shop workers, sales workers, other service workers	31-0000	Healthcare Support Occupations	2.88
c3_service_shop	Shop workers, sales workers, other service workers	33-0000	Protective Service Occupations	2.41
c3_service_shop	Shop workers, sales workers, other service workers	35-0000	Food Preparation and Serving Related Occupations	9.25
c3_service_shop	Shop workers, sales workers, other service workers	37-0000	Building and Grounds Cleaning and Maintenance Occupations	3.15
c3_service_shop	Shop workers, sales workers, other service workers	39-0000	Personal Care and Service Occupations	3.22
c4_clerks	Office clerks, administrative staff	41-0000	Sales and Related Occupations	10.35
c4_clerks	Office clerks, administrative staff	43-0000	Office and Administrative Support Occupations	15.69
c5_ag_othlowsk	Production workers, machine operators, farm workers	45-0000	Farming, Fishing, and Forestry Occupations	0.33
c5_ag_othlowsk	Production workers, machine operators, farm workers	47-0000	Construction and Extraction Occupations	3.98
c5_ag_othlowsk	Production workers, machine operators, farm workers	49-0000	Installation, Maintenance, and Repair Occupations	3.89
c5_ag_othlowsk	Production workers, machine operators, farm workers	51-0000	Production Occupations	6.49
	Production workers, machine operators, farm workers	53-0000	Transportation and Material Moving Occupations	6.93
			Total	100.00