

CHAPTER 4

SIMULATED IMPACT OF THE SAFEGUARD MEASURES

Introduction

The request letter asked the Commission to provide an analysis of the economy-wide effects of the safeguard remedies using appropriate simulation models. In this chapter a computable general equilibrium (CGE) model is used to illustrate the potential effects of the steel safeguard measures on the U.S. economy including the impact on tariff revenues and terms-of-trade effects.¹ A CGE model captures economywide linkages between industries, and it can thus illustrate both the possible net impact of the safeguard measures on the U.S. economy as well as the possible distribution of the impacts on steel-producing and steel-consuming industries. A detailed description of the general equilibrium model and its sensitivity to particular assumptions is given in appendix G.

The model simulates a comparative static experiment, that allows a comparison of the simulated U.S. economy with, and without, the safeguard measures imposed. In the benchmark representation of the U.S. economy, U.S. trade, commodity, and primary factor markets are assumed to be in equilibrium. The imposition of the safeguard measures displaces the economy from its equilibrium, and the model computes the new equilibrium in terms of quantities and relative prices for all markets, including imports.

The model includes two assumptions common in the CGE literature: constant returns to scale and perfect competition. Thus, the illustrative impacts discussed here do not incorporate effects owing to market power. The net impact of these additional factors can not be predicted *a priori*. A formal quantitative model with extensive firm and industry level data, which are generally not available, would be required to analyze these impacts. The model, however, uses standard assumptions to approximate the general equilibrium while highlighting the economywide impacts of the safeguard measures.

The data used to calibrate the equilibrium incorporate many of the important determinants of the impact of the safeguard measures.² These include a careful quantification of the safeguard measures,³ measurement of the share of covered product imports from covered countries, and input cost shares for all intermediate inputs (including those for steel and steel-containing products) and primary factors such as returns to labor and capital. Table 4-1 presents input cost shares for steel inputs. The model also

¹ Terms-of-trade are the relative price of a country's exports compared to its imports. By reducing the demand for imports, a tariff levied by a large country causes the prices of those imported goods to fall on the world market relative to the country's exports, therefore improving its *terms of trade*. See Alan Deardorff's *Glossary of International Economics*, <http://www.econ.lsa.umich.edu/>, downloaded Aug. 7, 2003.

² An analysis of the factors that might be expected to determine the effect of the safeguard measures is presented in appendix D.

³ The methodology used to quantify and apply the safeguard measures in the simulation model are presented in appendix G. The calculations use publicly available data on those tariffs applied to covered steel products imported from covered countries. The Commission was unable to find a publicly available quantification of specific product exclusions granted to certain importers of covered products from covered countries. It is likely that including such exclusions in the calculated model shock would slightly reduce the overall reported welfare loss, and would likely fall within the lower range of estimated welfare loss presented in the sensitivity analysis appearing in table 4-2 and appendix G.

incorporates parameters that characterize the sensitivity of demand for domestic and imported commodities to price changes, and that characterize the relationship between primary factors and output. The model assumes that intermediate material inputs are used in fixed proportions to output.⁴ The data in the model reflect U.S. imports of steel products and aggregate economic conditions as they existed just prior to implementation of the safeguard measures in March 2002.

The analysis focuses on those impacts that arise from the relative price changes resulting from the imposition of safeguard tariffs.⁵ Implementation of the safeguard measures increases the domestic (gross of tariff) price of imported steel, reduces U.S. demand for imported steel, and increases U.S. demand for domestic steel. The import-competing domestic steel industry responds to higher steel prices by expanding output. The steel-consuming industries pay higher prices for steel inputs. Steel-consuming industries respond to this competitive disadvantage by reducing output. The degree to which steel-consuming industries reduce output depends on how much steel they use and the demand characteristics for their output. The reallocation of resources implied by the safeguard measures also affects labor income, returns to capital, and tariff revenue. The model simulation results quantify these offsetting effects in an economywide framework.

Economy-wide Effects

Within the simulation model, the most relevant summary measure of the economy-wide effects of the safeguard measures is the simulated change in welfare, as measured by *equivalent variation*.⁶ As outlined in appendix G of this report, there is uncertainty regarding the Commission's estimated welfare impact. The central estimate of the change in welfare depends critically on an assumed steel import-supply elasticity of ten. The sensitivity of the welfare estimate to the assumed import-supply elasticity arises because this parameter determines the terms-of-trade impact of the policy. Terms-of-trade effects and their importance for the steel-safeguard simulations are discussed at length in appendix G.

The Commission simulations estimated that the effect of the safeguard measures on the U.S. welfare ranged from a welfare gain of \$65.6 million to a welfare loss of \$110.0 million, with a central estimate of a welfare loss of \$41.6 million (see table 4-2). Halving the import-supply elasticity (setting it at five) generates a simulated welfare increase resulting from the steel safeguard measures of \$65.6 million. Doubling the import-supply elasticity (setting it at twenty) generates a simulated welfare loss

⁴ This indicates that there is no direct substitution between steel and plastic, for example, as intermediate inputs, but as the price of steel increases intermediate and final demand for products that use steel intensively will fall relative to products that use plastic intensively.

⁵ To isolate the impacts on steel-consuming industries of the policy instrument, a tariff on imports of steel, the model tracks the flow of income to capital in each industry, but abstracts from a reallocation of capital across industries. In the short run it is assumed that the capital stock in an industry is held fixed (insensitive to price changes). Long-run reallocations of capital are not examined. Abstracting from minor capital-reallocation effects allows the Commission to analyze the direct and indirect price impacts on a detailed set of steel-consuming industries. The calculated model shock is based on the tariff levels imposed in the first year of relief. The tariff levels decline in years 2 and 3.

⁶ Equivalent variation is the economywide welfare impact of a policy change in monetary terms and it is defined as the amount of income that would have to be given (or taken away from) the economy *before* the policy change to leave the economy as well off as the economy would be *after* the policy change. A positive figure for equivalent variation implies that the policy change would improve economic welfare. H.R. Varian, *Intermediate Economics: A Modern Approach*, fifth edition, New York: W.W. Norton & Company, 1999, p. 252-253.

Table 4-1
Purchased steel products: Cost shares of material inputs and value shares of gross output by industry categories, 1997

Description	Cost share of purchased steel to all materials ¹	Value share of purchased steel to total output ²
	----- Percent -----	
Iron and steel mills:³		
Iron and steel mills ⁴	25.5	18.8
Iron, steel pipe and tube from purchased steel ⁴		
Rolled steel shape manufacturing ⁴		
Steel wire drawing ⁴		
Other ferrous metals:		
Custom roll forming	46.2	31.0
Ferroalloy and related product manufacturing	2.8	1.7
Ferrous metal foundries	4.6	2.6
Iron and steel forging and stamping	32.7	18.3
Upstream:		
Coal mining	1.8	1.0
Energy	0.3	0.1
Iron ore mining	3.4	2.3
Fabricated metal products:		
Ball and roller bearing manufacturing	11.9	6.4
Cutlery and flatware except precious manufacturing	7.1	2.8
Electroplating anodizing and coloring metal	7.0	3.1
Enameled iron and metal sanitary ware manufacturing	11.7	4.7
Fabricated structural metal manufacturing	24.2	13.5
Hand and edge tool manufacturing	16.9	8.1
Hardware manufacturing	16.8	8.7
Industrial pattern manufacturing	2.2	0.8
Kitchen utensil pot and pan manufacturing	7.6	4.8
Machine shops	8.5	4.2
Metal can, box, and other container manufacturing	16.9	13.1
Metal coating and nonprecious engraving	31.7	17.2
Metal heat treating	1.5	0.7
Metal tank heavy-gauge manufacturing	37.0	19.9
Metal valve manufacturing	8.9	4.2
Metal window and door manufacturing	16.4	9.4
Miscellaneous fabricated metal product manufacturing	12.3	6.9
Ornamental and architectural metal work manufacturing	29.2	15.7
Other ordnance and accessories manufacturing	0.9	0.3
Plate work manufacturing	34.6	16.8
Power boiler and heat exchanger manufacturing	25.4	12.3
Prefabricated metal buildings and components	37.0	26.6
Saw blade and handsaw manufacturing	30.6	14.7
Sheet metal work manufacturing	21.6	10.9
Small arms manufacturing	7.7	3.5
Spring and wire product manufacturing	45.6	24.1
Turned product and screw nut and bolt manufacturing	23.3	10.9
Durable manufacturing:		
Construction and mining machinery and equipment	8.3	5.8
Durable manufacturing, not elsewhere classified	2.3	1.5
Electric power transformers and motors	12.7	8.0
Electronic and electrical equipment	1.1	0.6
Farm and garden machinery and equipment	13.1	8.3
Industrial machinery and equipment	7.8	4.7
Major household appliances	8.6	6.2
Metal furniture	11.0	5.8
Motor vehicle parts	11.1	7.9
Motor vehicles and equipment	0.6	0.5
Other transport equipment	1.5	1.0
Railroad rolling stock manufacturing	11.2	8.4
Ship building and repairing	8.2	4.5

Table 4-1—Continued
Purchased steel products: cost shares of material inputs and value shares of gross output by industry categories, 1997

Description	Cost share of purchased steel to all materials ¹	Value share of purchased steel to total output ²
	-----Percent-----	
Other sectors:		
Agriculture and forest products	0.4	0.2
Commercial and institutional buildings	0.9	0.5
Construction maintenance and repair	1.7	0.9
Highway street bridge and tunnel construction	0.8	0.4
Manufacturing and industrial buildings	0.2	0.1
Nondurable manufacturing	0.2	0.1
Other new construction	0.8	0.4
Residential construction	1.4	0.8
Resource extraction, not elsewhere classified	2.2	1.3
Services	0.1	0.0
Water, sewer, and pipeline construction	5.0	3.0

¹ Calculated from the ratio of steel inputs to the sum of all material inputs.

² Calculated from the ratio of steel inputs to the sum of all material inputs plus value-added factors (capital, labor, and indirect business taxes).

³ Industry categories including subject products.

⁴ Not delineated separately among consuming industries in the baseline table.

Source: Compiled from official statistics of the U.S. Department of Commerce, Bureau of Economic Analysis, 1997 Benchmark Input-Output Accounts.

Table 4-2
CGE simulation: Welfare sensitivity analysis of the safeguard measures

Import-Supply Elasticity:	<i>Million dollars</i>
5	65.6
10 (central assumption)	-41.6
20	-110.0

Source: USITC calculations

resulting from the steel safeguard measures of \$110.0 million. In the context of income, the range of estimated welfare changes from respectively halving and doubling the central import-supply response is from a positive 0.0006 percent to a negative 0.0011 percent of gross domestic product (GDP). Table 4-2 also reports an estimated central welfare loss of \$41.6 million attributable to the safeguard measures, which amounts to 0.0004 percent of U.S. GDP. The Commission performed a more detailed set of sensitivity analyses on the model, which appear in appendix G.

Table 4-3 also reports the changes in other key income indicators.⁷ The simulation model suggests that the increase in tariff revenue is likely to be offset by decreases in labor and capital income. The resulting change in GDP is a decline of about \$30 million (a change of less than 0.0003 percent).⁸

⁷ These are nominal measures that are inherently dependent on the unit of measure chosen. As noted above, the true-cost-of-living index was selected as the deflator.

⁸ In general, changes in income need not reflect, either quantitatively or qualitatively, the changes in welfare. Economic theory indicates that changes in welfare are more appropriate because they are not dependent on an arbitrary deflator, called a *numeraire* commodity or unit in which prices are measured. Often, the numeraire is
(continued...)

Table 4-3
CGE simulation: Summary income changes from safeguard measures using central elasticity assumptions

	<i>Million dollars</i>
Income Changes:	
Tariff revenue	649.9
Labor income ¹	-386.0
Capital income	
Iron and Steel Industry ²	239.5
Other industries where capital income increases ³	67.4
Industries (including steel-consuming) where capital income decreases	<u>-601.2</u>
	-294.3
GDP	<u>-30.4</u>

¹ The net effect on all labor in the U.S. economy. The model assumes a stylized labor market in which homogenous labor can move between industries.

² Domestic iron and steel is an aggregation of those industry categories of the input-output tables that would include the steel products covered by the safeguard measures: 331111 (iron and steel mills), 331210 (iron, steel pipe and tube from purchased steel), 331221 (rolled steel shape manufacturing), and 331222 (steel wire drawing). This definition of steel is broader than products covered by the safeguard measures. As this table presents income changes rather than percentage changes, use of the broader category does not understate the changes.

³ Other benefiting industries include iron ore mining, ferroalloy and related product manufacturing, coal mining, custom roll forming, energy and services, which includes ports and their related service providers.

Source: USITC calculations.

Industry Specific Effects

The model simulation results shown in table 4-4 suggest that the relative price of domestic iron and steel⁹ would increase by 0.43 percent resulting from the imposition of the safeguard measures; the average price of domestic and imported iron and steel would increase by more than twice as much (0.94 percent).¹⁰ As a result of these price changes, returns to capital in the iron and steel industry would increase by \$239.5 million (3.03 percent), and returns to capital in industries where returns to capital fell, decreased by \$601.2 million (0.01 percent), as shown in table 4-3. Other industries where capital income increases (e.g., iron ore mining, ferroalloy and related product manufacturing, coal mining, custom roll forming, energy and services) would experience increased capital returns of \$67.4 million (0.04 percent).

example, the requirement that prices sum to some constant. Alan Deardorff's *Glossary of International Economics*, <http://www.econ.lsa.umich.edu/>, downloaded Aug. 7, 2003.

⁹ Domestic iron and steel is an aggregation of those industry categories of the input-output tables that would include the steel products covered by the safeguard measures: 331111 (iron and steel mills), 331210 (iron, steel pipe and tube from purchased steel), 331221 (rolled steel shape manufacturing), and 331222 (steel wire drawing). This definition of steel is broader than products covered by the safeguard measures. Using this broader definition means that the simulation will understate the impact of the safeguard measures on firms producing covered products when measured by percentage changes, but will not understate the impact when measured by absolute changes.

¹⁰ These price impacts are small relative to the actual safeguard duties applied to specific shipments for a number of reasons. First, the level of commodity aggregation in the U.S. benchmark input-output accounts dictate that the domestic steel market is very broad and includes many non-covered products (see table 4-1 for the classification of Iron and Steel Mill Products). Second, there is a specific technology assumed for how domestic varieties and imported varieties of steel are combined (see appendix G). This technology indicates that only a portion (which depends on the proportion of covered imports) of the price increase on covered imports is passed on to the price index on combined domestic and imported steel. Finally, there is also a terms-of-trade effect, by which the safeguard measures reduce the world price of steel further mitigating the gross-of-tariff price increase.

Table 4-4

CGE simulation: Industry specific results from safeguard measures using central elasticity assumptions

	Measures of price changes				Change in Revenue
	Change in Output	Change in Labor Inputs	Change in	Change in	
			Producer Price	Composite Price	
-----Percent-----					Million dollars
Iron and Steel ¹	1.98	3.04	0.43	0.94	2,515.3
Other Ferrous Metals:					
Custom roll forming	0.07	0.06	0.32	0.32	16.3
Ferroalloy and related product manufacturing	0.56	1.19	0.35	0.27	13.2
Ferrous metal foundries	-0.11	-0.13	0.02	0.02	-18.6
Iron and steel forging and stamping	-0.12	-0.45	0.11	0.11	-0.8
Total					10.2
Other Upstream:					
Coal mining	0.14	0.28	0.08	0.09	64.8
Energy	0.01	0.03	0.02	0.02	89.0
Iron ore mining	1.92	2.26	0.15	0.17	49.4
Total					203.2
Fabricated Metal Products:					
Ball and roller bearing manufacturing	-0.10	-0.15	0.04	0.04	-4.0
Cutlery and flatware, except precious metal manufacturing	-0.03	-0.04	0.00	0.00	-0.6
Electroplating anodizing and coloring metal	-0.02	-0.02	0.02	0.02	0.2
Enameled iron and metal sanitary ware manufacturing	-0.02	-0.06	0.02	0.02	0.0
Fabricated structural metal manufacturing	-0.05	-0.08	0.12	0.12	13.8
Hand and edge tool manufacturing	-0.10	-0.16	0.05	0.04	-4.2
Hardware manufacturing	-0.12	-0.21	0.04	0.04	-10.7
Industrial pattern manufacturing	-0.07	-0.07	-0.01	-0.01	-0.8
Kitchen utensil pot and pan manufacturing	-0.08	-0.14	0.03	0.02	-0.9
Machine shops	-0.03	-0.03	0.04	0.04	2.9
Metal can box and other container manufacturing	-0.05	-0.07	0.13	0.14	14.8
Metal coating and nonprecious engraving	-0.02	-0.04	0.16	0.16	14.3
Metal heat treating	-0.02	-0.04	-0.01	-0.01	-1.2
Metal tank heavy gauge manufacturing	-0.23	-0.37	0.13	0.15	-5.6
Metal valve manufacturing	-0.06	-0.12	0.01	0.01	-13.7
Metal window and door manufacturing	-0.02	-0.04	0.09	0.09	7.8
Miscellaneous fabricated metal product manufacturing	-0.12	-0.23	0.03	0.03	-12.3
Ornamental and architectural metal work manufacturing	-0.03	-0.04	0.15	0.15	6.5
Other ordnance and accessories manufacturing	-0.01	0.00	0.00	0.00	-0.3
Plate work manufacturing	-0.12	-0.18	0.14	0.14	0.8
Power boiler and heat exchanger manufacturing	-0.21	-0.34	0.04	0.06	-7.4
Prefabricated metal buildings and components	-0.17	-0.21	0.26	0.29	4.5
Saw blade and handsaw manufacturing	-0.15	-0.27	0.08	0.08	-1.0
Sheet metal work manufacturing	-0.06	-0.09	0.09	0.09	7.0
Small arms manufacturing	-0.05	-0.09	0.01	0.01	-0.7
Spring and wire product manufacturing	-0.01	-0.14	-0.04	-0.04	-2.3
Turned product and screw nut and bolt manufacturing	-0.14	-0.23	0.06	0.06	-16.0
Total					-9.3

Table continued.

Table 4-4--Continued

CGE simulation: Industry specific results from safeguard measures using central elasticity assumptions

	Measures of price changes				Change in Revenue <i>Million dollars</i>
	Change in Output	Change in Labor Inputs	Change in	Change in	
			Producer Price	Composite Price	
-----Percent-----					
Durable Manufacturing:					
Construction and mining machinery and equipment	-0.18	-0.28	0.04	0.04	-39.0
Durable manufacturing nec	-0.04	-0.06	0.01	0.00	-93.6
Electric power transformers and motors	-0.18	-0.30	0.04	0.04	-30.5
Electronic and electrical equipment	-0.03	-0.05	-0.01	-0.01	-217.2
Farm and garden machinery and equipment	-0.13	-0.26	0.04	0.04	-25.2
Industrial machinery and equipment	-0.13	-0.20	0.02	0.03	-284.5
Major household appliances	-0.12	-0.18	0.04	0.04	-16.3
Metal furniture	-0.06	-0.10	0.04	0.03	-7.1
Motor vehicle parts	-0.24	-0.30	0.07	0.07	-365.8
Motor vehicles and equipment	-0.08	-0.14	0.02	0.02	-162.2
Other transport equipment	-0.08	-0.10	0.00	0.01	-124.5
Railroad rolling stock manufacturing	-0.21	-0.26	0.09	0.09	-12.4
Ship building and repairing	-0.04	-0.05	0.05	0.06	1.1
Total					-1,377.2
Other Industries:					
Agriculture and forest products	-0.01	-0.02	-0.01	-0.01	-56.1
Commercial and institutional buildings	-0.01	-0.01	0.01	0.01	3.7
Construction maintenance and repair	0.00	0.00	0.01	0.01	14.0
Highway street bridge and tunnel construction	0.00	0.00	0.00	0.00	1.8
Manufacturing and industrial buildings	0.00	-0.01	0.00	0.00	-0.1
Nondurable manufacturing	-0.01	-0.02	-0.01	-0.01	-299.2
Other new construction	-0.01	-0.01	0.01	0.01	4.6
Residential construction	-0.01	-0.01	0.01	0.01	-0.9
Resource extraction nec	-0.01	-0.04	0.00	0.00	-21.0
Services	0.00	0.00	0.00	0.00	-210.0
Water, sewer, and pipeline construction	-0.01	-0.01	0.03	0.03	5.6
Total					-557.6
Grand Total					784.5

¹ Domestic iron and steel is an aggregation of those industry categories of the input-output tables that would include the steel products covered by the safeguard measures: 331111 (iron and steel mills), 331210 (iron, steel pipe and tube from purchased steel), 331221 (rolled steel shape manufacturing), and 331222 (steel wire drawing). This definition of steel is broader than products covered by the safeguard measures. Using this broader definition means that the simulation will understate the impact of the safeguard measures on firms producing covered products when measured by percentage changes, but will not understate the impact when measured by absolute changes.

Source: USITC calculations.

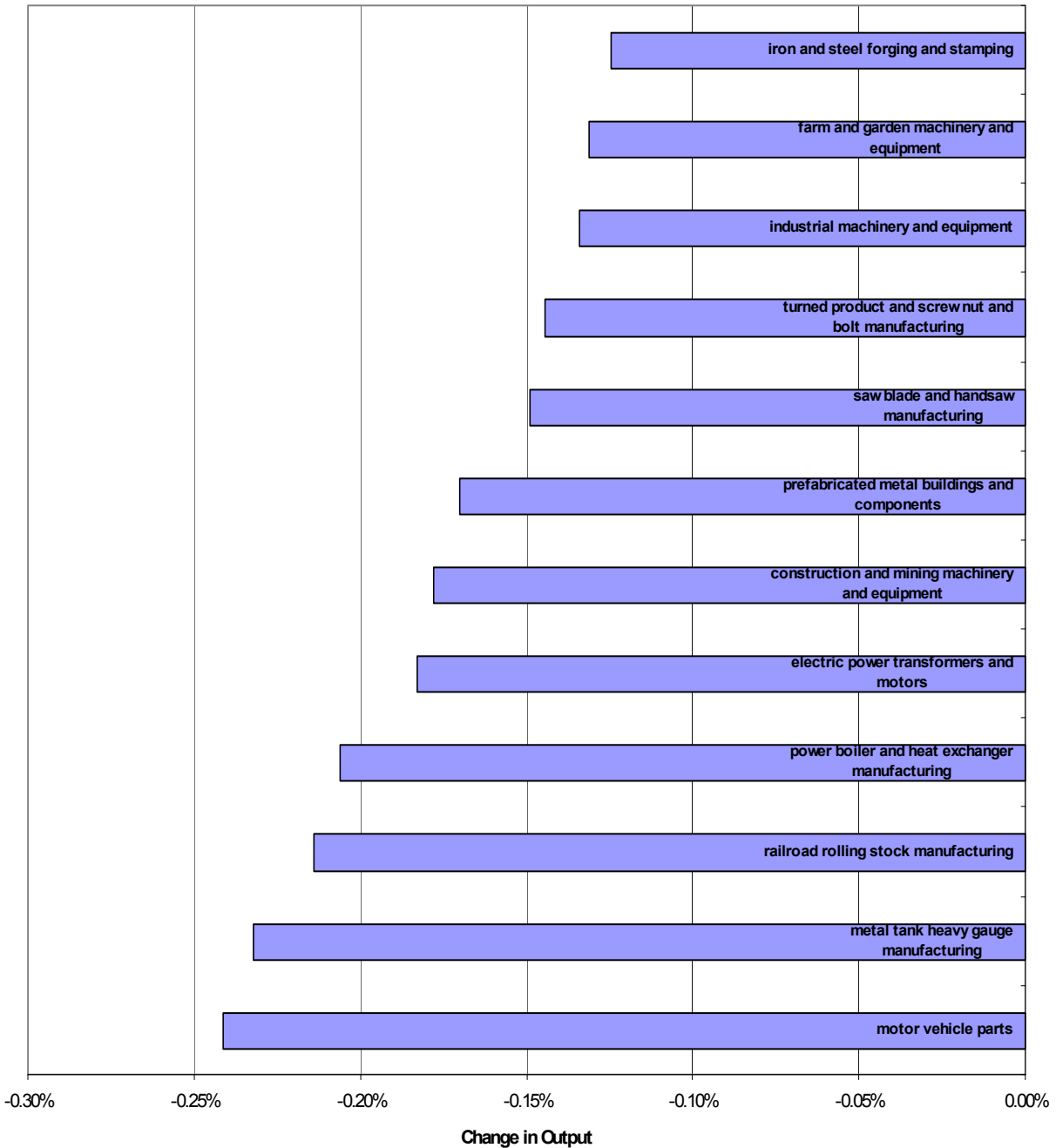
The impact of the safeguard measures on the output of steel-consuming industries varies across industries (table 4-4).¹¹ Industries that have relatively high steel and steel containing products cost shares

¹¹ Output changes are short-run estimates because the simulation does not consider reallocation of capital across industries because of the safeguard measures. The model is one of industry-specific capital. Assuming industry-specific capital is appropriate given the temporary nature of the safeguard measures and the length of the average productive life of capital in the steel-consuming industries. It is likely that manufacturers will react to temporary cost increases by continuing to operate at reduced earnings. If the safeguard measures were to persist

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are typically most affected. Figure 4-1 presents the 12 industries that are the most affected by the safeguard measures, in terms of reduced output. All 12 industries have high input cost shares of steel.

Figure 4-1
CGE Simulation: Steel consuming industries with the largest percent change in output using central elasticity assumptions



Source: USITC calculation

beyond three years, however, then output changes would be larger as capital is reallocated overseas or to more profitable industries.

The simulation results suggest that the motor vehicle parts industry contracts the most under the safeguard measures, with output falling by 0.24 percent (table 4-4). This result is not surprising given the motor vehicle parts industry's high cost share of steel and steel containing products (11.1 percent just for steel; table 4-1). Also included among the 12 industries in figure 4-1 are five industries that produce fabricated metal products; these industries face substantial competition from imported fabricated metal products.

The estimated impact of the safeguard measures on ports and their related service providers are accounted for in the service sector. As reported in table 4-3, revenue for services fell by an estimated 210.0 million dollars as a result of the safeguard measures.

Another way to compare the impacts on different industries is to examine the absolute change in revenue by industry. The advantage of examining revenue is that it is comparable across industries, while the disadvantage is that it can vary widely depending on the choice of nominal measurement units.¹² Revenue in the 12 most affected industries falls by between \$365 million (motor vehicle parts) and \$25 million dollars (farm and garden machinery and equipment). Detailed results for all industries are presented in table 4-4.

¹² Nominal measures like revenue are inherently dependent on the unit of measure chosen. In this analysis, the true-cost-of-living index was selected as the deflator. See A. Deaton and J. Muellbauer, *Economic and Consumer Behavior* (Cambridge, England: Cambridge University Press, 1980) for background on the true-cost-of-living index. The modeled equilibrium only indicates relative prices so revenue changes are only obtained once an arbitrary numeraire commodity is chosen. By holding the true-cost-of-living index constant across the simulation analysis the Commission selects units of welfare as the numeraire commodity.