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# EFFECTS OF REDUCING TARIFFS AND ENDOGENOUS PRODUCTIVITY GROWTH

by

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# EFFECTS OF REDUCING TARIFFS AND ENDOGENOUS PRODUCTIVITY GROWTH

**Yinhua Mai***

ABSTRACT

*In this study, the effects of China's WTO commitments of reducing tariff and non-tariff barriers are analysed using a Computable General Equilibrium (CGE) model of China. In particular, this study draws the attention of policy makers to a different regional employment outcome when trade-liberalisation induced productivity improvements are taken into account. Trade-liberalisation induced productivity improvements occur when local producers survive import competition by seeking (most likely importing) input-saving technologies and production practice. Such endogenous productivity improvements, based on empirical estimates, are endogenously represented in the model.*

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D58, F14, O53

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## 1. Introduction

The effects of China's entry to the World Trade Organization (WTO) have been vigorously studied in recent years. A rich body of literature estimating the effects of China's accession commitments in tariff reductions using CGE models has emerged (for examples, Zhai and Li 2000, Li and Lejour 2001, Lejour 2001, Fan and Zheng 2001, Ianchovichina and Martin 2001, Li, Zhai and Liu 2001, Francois and Spinanger 2002, Mayes and Wang 2002, and Mai, Brown and Feng 1998). In these analyses, the estimated benefits from reductions in tariff and non-tariff barriers are generally low. For example, the tariff reductions are estimated to elevate China's real GDP by only 0.8 per cent in Li and Lejour 2001, 0.08-1.66 per cent in Lejour 2001, 0.06-0.62 per cent in Fan and Zheng 2001, 2.2 per cent in Ianchovichina and Martin 2001, and about 1 per cent (in real GNE) in Mai et. al. 1998. The absence of endogenous productivity growth has been listed in literature as one possible reason for the generally low estimates (Ianchovichina and Martin 2001, and Mai et. al. 1998). However, not much work on the effects of trade liberalisation under an assumption of endogenous productivity growth has been published. This study is therefore devoted to compare the effects of China's WTO tariff commitments with and without the assumption of endogenous productivity growth. This study shows that the percentage increase in real GDP due to the tariff reductions could be doubled when endogenous productivity growth is assumed. Furthermore, this study shows that the impact of the tariff reductions on the employment in different regions in China can be quite different with and without the assumption of endogenous productivity growth.

Endogenous productivity growth occurs when local producers survive import competition by seeking input-saving technologies and production practices. A liberalising industry has a good chance to experience endogenous productivity growth when it has existing economies of scale (especially in exporting) and when it resides in a country that lies far from technology frontiers. The latter factor enables it to import advanced technologies that are readily available in the rest of the world.

In this paper the effects of China's commitments in reducing tariffs and tariff equivalents of non-tariff barriers are analysed using a CGE model of China. In Section 2 of this paper I introduce the analytical framework, the PRCGEM model, and changes to the model made for this analysis. In Section 3 I present estimates of the effects of reducing tariff and non-tariff barriers with and without the endogenous productivity growth. In Section 4 I present the effects on different regions in China. Section 5 contains concluding comments.

## 2. The Modelling Framework

The analytical framework used in this analysis is an enhanced version of PRCGEM, a comparative static CGE model of China (see Zheng and Fan 1999 for details about PRCGEM). The core CGE structure of PRCGEM resembles that of the ORANI model (see Dixon et al 1982 and Horridge 2001). The effects of any policy changes on different regions in China can be simulated with a top-down regional extension.

In this analysis, PRCGEM is adapted to run in a recursive dynamic fashion. A system of equations and variables that captures shifts in technology and consumer tastes was added so as to develop a baseline of practical use. (See Dixon and Rimmer 2002 for how to develop such a baseline). The effects of any policy changes are represented as deviations from the baseline.

In the baseline simulation, historical data and forecasts for macroeconomic indicators published by specialist forecasting agencies including the World Bank, Economist Intelligence Unit, China Bureau of Statistics, and Chinese Academy of Social Sciences are incorporated into the model. These indicators include growth in real GDP, consumption, investment, employment, exports and imports at macroeconomic level, and output for aggregated sectors at the industry level (Table 1). The trend of changes in technology and consumer tastes estimated from historical Chinese data (Mai, Horridge and Perkins, 2003) is also incorporated into the baseline.

**TABLE 1**
**BASELINE: HISTORY AND FORECASTS**
**AVERAGE ANNUAL GROWTH 2000-2006, PER CENT**

| | 2000-2006 |
|---|---|
| GDP | 7.6 |
| Consumption | 6.0 |
| Investment | 10.3 |
| Exports | 10.4 |
| Imports | 11.0 |
| | |
| Output of aggregated sectors | |
| Agriculture | 3.0 |
| Mining | 6.0 |
| Manufacturing | 8.7 |
| Construction | 10.4 |
| Services | 8.3 |

Source: baseline simulation.

The policy scenarios are simulated under long-run assumptions for factor markets. Labour is mobile between industries, but economy-wide labour supply is constrained by long-run population growth. Capital, on the other hand, is mobile between countries and industries within a country. Capital flows into and out of China in response to its rate of return on capital. Within China, capital flows into the industries that have higher rates of return.

To capture endogenously the effects of the trade-liberalisation induced productivity improvements, extra data and equations are added into PRCGEM. The new equation used to calculate the endogenous productivity improvements is presented in Box 1. The calculation is based on Productivity Commission's time series estimates (Chand, McCalman and Gretton 1998), taking into account the distance of a country from technology frontier represented by the United States, and a country's revealed comparative advantage in a certain product (for details see Box 1).

**BOX 1 TRADE-LIBERALISATION INDUCED PRODUCTIVITY GOWTH**

The following is the new equation calculating the trade-liberalisation induced productivity growth in the PRCGEM model.

```
Equation Ea1prim
(all,i,IND)
a1prim(i) =
CTYWEIGHT * PCEST(i) * RCPADV1(i) * t0imp(i)
                  + fa1prim(i) ;
```

**PCEST** is the Productivity Commission's estimates of the endogenous productivity growth based on Australian data. Chand, McCalman and Gretton (1998) estimated that, on average, 1 per cent reduction in industry assistance led to a 0.15 per cent increase in value added.

**CTYWEIGHT** shows the distance of China from the technology frontier measured by the difference between per capita GDP of China and that of the United States. The further away China is from the technology frontier represented by the United States, the larger chance an industry in China has to improve its productivity when confronted with import competition. This is because that there are advanced technologies that are readily available for China to import. CTYWEIGHT is an index with Australia = 1, because PCEST is estimated based on Australian data.

**RCPADV1** is the index of revealed comparative advantage measured by the ratio of the share of China's exports of commodity i in the world's export of i to the share of the China's total exports in the world total exports. The more established China is in exporting commodity i, the larger chance China has to improve its productivity in producing i due to its existing economies of scale.

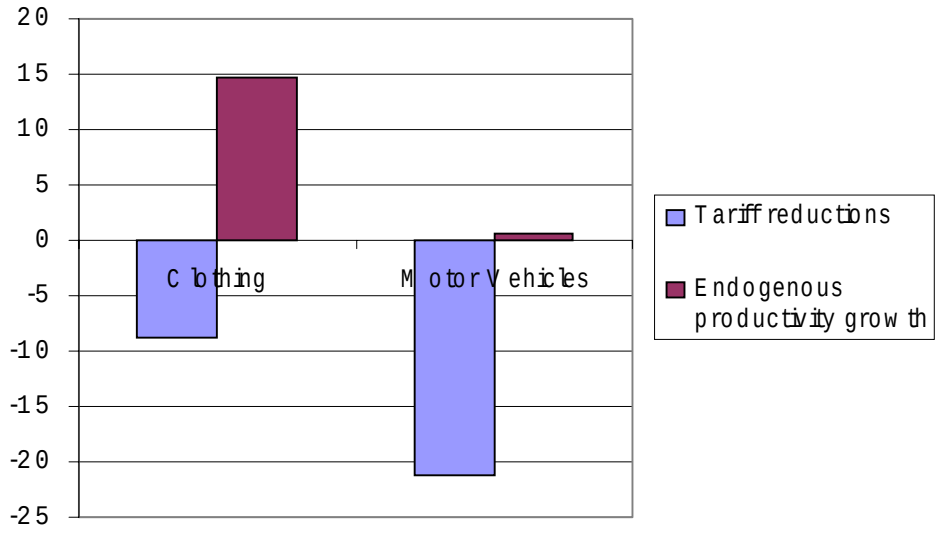
**t0imp** is the power of tariff on imports of commodity i into China.

**a1prim** is the trade liberalisation induced productivity growth in industry i.

**fa1prim** is a shift term that can be used to activate or dis-activate this equation by choosing model closures.

Figure 1 shows the endogenous productivity growth induced by the reductions in tariffs (and tariff equivalents of non-tariff barriers) simulated in this study for the Clothing and Motor Vehicles industries respectively. Although the Motor Vehicles industry has a larger reduction in border protections, the induced productivity growth is much smaller for the Motor Vehicles industry than for the Clothing industry. This is because that China is a well established exporter in Clothing. On the other hand, the Motor Vehicle industry in China serves mainly the domestic markets.

**Figure 1 Tariff reductions and endogenous productivity growth**




## 3. Effects of tariff reductions and endogenous productivity growth

China's WTO commitments of reductions in tariffs and the tariff equivalents of non-tariff barriers were well summarised in Mayes and Wang (2002) and are simulated in this study for agricultural and manufactured products (See Appendix A Table A.1). I assume that the reductions in tariffs and non-tariff barriers are implemented over five years during 2002 and 2006.

The tariff reductions are simulated under two scenarios:

- Scenario 1: tariff reductions with the endogenous productivity growth; and
- Scenario 2: tariff reductions without the endogenous productivity growth.

The results for the two simulations are presented in Tables 2 to 5.

### *3.1. Macroeconomic Effects*

Table 2 shows that, as a result of the tariff reductions, China's real GDP is likely to be 2 per cent higher than the baseline by 2006 taking into account the endogenous productivity growth induced by the tariff reductions. Without the endogenous productivity growth, China's real GDP is likely to be 1 per cent higher than the baseline by 2006 (Table 2). China's gain in real GDP from the tariff reductions is much higher with the endogenous productivity growth than without it.

The tariff reductions lead to lower import prices. As investment goods are import-intensive, the prices of capital creation fall, leading to a higher rate of return on capital in China. The resulting increases in investment and capital lead to a higher real GDP under both scenarios.

**TABLE 2**
**MACRO EFFECTS OF REDUCING TARIFF AND NON-TARIFF BARRIERS**
**PERCENTAGE DEVIATION FROM BASELINE BY 2006, PER CENT**

| | With endogenous productivity improvement | Without endogenous productivity improvement |
|---|---|---|
| GDP | 1.95 | 0.96 |
| Consumption | 1.95 | 0.96 |
| Investment | 2.31 | 1.98 |
| Exports | 8.94 | 6.31 |
| Imports | 10.47 | 8.86 |
| Real exchange rate | 1.13 | 1.66 |

Source: Policy simulations.

Furthermore, under Scenario 1, the gain in real GDP is also contributed by the endogenous productivity growth (Table A.1 in Appendix A shows the endogenous productivity growth induced by the tariff reductions simulated). Under the circumstance of Scenario 1, primary factors are used more efficiently compared with the case of Scenario 2. China therefore gains more from the tariff reductions under Scenario 1 where removing protection prompts firms to improve their productivity.

The higher level of real GDP allowed Chinese consumers to enjoy a higher level of consumption. As a result of the higher levels of consumption and investment, China imports at a higher level compared with the baseline (Table 2 and 4). Another factor behind the higher imports is a substitution away from domestically produced goods and towards imports as post-duty import prices fall following the tariff reductions.

Table 2 shows that exports increase following the tariff reductions. This is due to a real depreciation. China's real exchange rate, defined as the ratio of CIF import price index (the pre-duty price) over GDP price index, depreciates following the tariff reductions. This is because the tariff reductions lead to lower post-duty prices of imports that, in turn, lead to lower production costs and therefore lower GDP price index.

### *3.2. Industry Results*

The effects of the tariff reductions on individual industries are governed by a number of factors. The lower (post-duty) import prices following the tariff reductions lead to the substitution away from domestically produced goods and towards imports. Industries that serve primarily domestic markets therefore suffer. On the other hand, the real depreciation benefits industries that supply to export markets. Furthermore, the endogenous productivity growth induced by the tariff reductions helps industries that achieve those productivity improvements to become more competitive in both domestic and export markets.

Clothing is a typical industry that serves both export and domestic markets. It is, however, more export oriented compared with heavy manufacturing industries such as the Motor Vehicle industry. It therefore gains significantly from the real

depreciation. Furthermore, because of the large tariff reductions on Clothing and its existing economies of scale in exporting, the Clothing industry is also a good candidate for achieving endogenous productivity improvements when faced with import competition. Its gain from the real depreciation and productivity improvements therefore offset its loss in domestic markets. Table 3 and 4 show that the output and exports of the Clothing industry rise significantly above the baseline as a result of the tariff reductions. The gains to the Clothing industry in terms of output and exports are much higher when the endogenous productivity growth is taken into account (Tables 3 and 4).

The Motor Vehicle industry, on the other hand, is almost entirely oriented towards domestic markets before China's accession to the WTO. Its loss in domestic markets is therefore great and not offset by any gains in exports. While there are large reductions in tariffs on Motor Vehicles and Parts, its lack of economies of scale in exporting prohibits the Motor Vehicle industry from achieving large productivity gains induced by the tariff reductions (see Figure 1 or Table A.1 in Appendix A). The Motor Vehicle industry therefore stands out as the loser from the tariff reductions in terms of output and exports (Tables 3 and 4).

**TABLE 3**

EFFECTS OF REDUCING TARIFF AND NON-TARIFF BARRIERS:
SECTORAL OUTPUT
PERCENTAGE DEVIATION FROM BASELINE BY 2006, PER CENT

| | With endogenous productivity improvement | Without endogenous productivity improvement |
|---|---|---|
| Agriculture | 0.38 | -0.44 |
| Mining | 0.92 | 0.65 |
| Manufacturing | 2.25 | 0.92 |
| Cotton textile | 7.19 | 2.23 |
| Clothing | 13.38 | 5.49 |
| Bricks and tiles | 2.07 | 1.49 |
| Iron and steel | 0.73 | 0.44 |
| Machinery NEC | 1.02 | 0.70 |
| Motor vehicles and parts | -9.68 | -9.94 |
| Electronic appliances | 6.00 | 4.38 |
| Construction | 2.32 | 1.97 |
| Services | 2.28 | 1.24 |

Source: Policy simulations.

**TABLE 4**
EFFECTS OF REDUCING TARIFF AND NON-TARIFF BARRIERS:
EXPORTS AND IMPORTS BY COMMODITY
PERCENTAGE DEVIATION FROM BASELINE BY 2006, PER CENT

| | Exports | | Imports | |
|---|---|---|---|---|
| | With endogenous productivity improvement | Without endogenous productivity improvement | With endogenous productivity improvement | Without endogenous productivity improvement |
| Agriculture | -5.03 | -2.33 | 23.86 | 18.49 |
| Mining | -0.20 | 1.50 | 3.35 | 1.93 |
| Manufacturing | 9.67 | 6.61 | 11.45 | 9.90 |
| Cotton textile | 12.57 | 6.80 | 17.89 | 14.86 |
| Clothing | 18.44 | 8.15 | 15.36 | 16.31 |
| Bricks and tiles | 3.14 | 3.50 | 5.35 | 3.93 |
| Iron and steel | 2.54 | 3.05 | 7.41 | 6.26 |
| Machinery NEC | 3.34 | 3.75 | 11.75 | 10.45 |
| Motor vehicles and parts | -0.73 | -0.20 | 36.68 | 35.23 |
| Electronic appliances | 13.26 | 11.99 | 19.36 | 17.73 |

Source: Policy simulations.

## 4. Regional Effects

The PRCGEM model has a top-down regional extension that allows the calculation of the effects of any policy changes on different regions in China according to their shares in the national output for different industries. The effects of the reductions in tariffs and non-tariff barriers on different regions in China are presented in Table 5.

While all regions registered positive output deviations from the baseline following the tariff reductions, some regions' gains are above the national average and some below. The regions that have above national-average increase in regional output are Tianjin, Shanghai, Jiangsu, Zhejiang, Guangdong, and Fujian (Table 5). These regions accommodate export-oriented light manufactures that, as discussed above, benefit substantially from the tariff reductions. In particular, Guangdong that hosts a lion's share of the exporting Clothing industry registered the highest output deviation from the baseline, especially when the trade-liberalisation related productivity growth is taken into account (Table 5).

The effects of the endogenous productivity growth on regional employment have the most significant policy implications. When a region achieves a higher level of output following the tariff reduction, we would expect it to also generate more employment. This is indeed the case without the endogenous productivity growth. The forth column of Table 5 shows a pattern of labour force being drawn from relatively more agriculture-intensive regions to where the export-oriented industries are located, primarily the six regions that has registered above national-average output gains. However, when the trade-liberalisation induced endogenous productivity growth is taken into account, those six regions show negative employment deviation from the baseline (the second column of Table 5). This is mainly because that improved productivity means firms in these regions employ less primary factor inputs (including labour) per unit of output.

**TABLE 5**
EFFECTS OF REDUCING TARIFF AND NON-TARIFF BARRIERS:
GROSS OUTPUT BY REGION
PERCENTAGE DEVIATION FROM BASELINE BY 2006, PER CENT

| | With endogenous productivity improvement | | Without endogenous productivity improvement | |
|---|---|---|---|---|
| | Output | Employment | Output | Employment |
| Liaoning | 1.56 | -0.12 | 0.76 | -0.06 |
| Jilin | 0.81 | -0.44 | 0.02 | -0.56 |
| Heilong | 1.24 | -0.02 | 0.59 | -0.19 |
| Beijing | 1.83 | -0.24 | 0.88 | 0.05 |
| **Tianjin** | **2.04** | ***-0.23*** | **0.99** | ***0.08*** |
| Hebei | 1.79 | 0.12 | 0.85 | -0.01 |
| Shandong | 1.76 | -0.01 | 0.81 | -0.01 |
| **Shanghai** | **2.12** | ***-0.57*** | **0.97** | ***0.10*** |
| **Jiangsu** | **2.27** | ***-0.20*** | **1.07** | ***0.19*** |
| **Zhejiang** | **2.51** | ***-0.12*** | **1.22** | ***0.31*** |
| **Guangdong** | **2.28** | ***-0.02*** | **1.19** | ***0.21*** |
| **Fujian** | **1.99** | ***-0.04*** | **0.97** | ***0.04*** |
| Hainan | 1.46 | 0.29 | 0.68 | -0.08 |
| Shanxi | 1.87 | 0.53 | 0.99 | 0.20 |
| Shaanxi | 1.70 | 0.14 | 0.81 | -0.01 |
| Henan | 1.71 | 0.26 | 0.79 | -0.03 |
| Anhui | 1.68 | 0.17 | 0.75 | -0.04 |
| Jiangxi | 1.50 | 0.11 | 0.58 | -0.17 |
| Hubei | 1.44 | -0.18 | 0.48 | -0.26 |
| Hunan | 1.50 | 0.17 | 0.62 | -0.14 |
| Guanxi | 1.38 | 0.06 | 0.50 | -0.24 |
| Sichuan | 1.48 | 0.14 | 0.63 | -0.12 |
| Guizhou | 1.30 | 0.22 | 0.45 | -0.24 |

Source: Policy simulations.

## 5. Concluding Comments

This study shows that China's tariff reductions for its WTO entry lead to a much larger increase in real GDP if firms seek to improve their productivities when confronted with import competition. However, the regions that achieve larger (than national average) increases in output may not generate more employment as firms in these regions seek to use inputs (including labour) more efficiently.

While the gains from tariff reductions could be doubled by the presence of endogenous productivity growth, the estimated benefits is still only about 2 percentage points increase in GDP. Furthermore, the magnitude of the gains from the tariff reductions is likely to be much smaller than that presented in this study if various duty exemptions are taken into account.

The author believes that the real gain from China's WTO accession does not come from reductions in tariffs and non-tariff barriers. Tariff reductions represent only a small part of the policy reform under the context of China's accession to the WTO. The most important reform for the WTO accession is the investment liberalisation of the heavy manufacturing and key services industries, that is, the opening up of the industries currently dominated by State-Owned Enterprises to domestic as well as foreign private investment (Mai 2001). The gains from the investment liberalisation are much more dramatic (Mai et. al. 2003). Compared with the benefits of the investment liberalisation, the gains from the tariff reductions are almost negligible. While the tariff reductions deliver negative impacts on the Motor Vehicle industry, the investment liberalisation does the contrary. The investment liberalisation under the context of China's WTO accession delivers significant benefits to heavy manufacturing industries including the Motor Vehicle industry (Mai et. al. 2003).

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## Appendix A

### TABLE A.1
### REDUCTIONS IN TARIFFS AND TARIFF EQUIVALENTS OF NON-TARIFF BARRIERS AND ENDOGENOUS PRODUCTIVITY IMPROVEMENTS
### PERCENTAGE CHANGE BETWEEN 2002-2006, PERCENT

| | Reductions in tariffs and tariff equivalents | Endogenous productivity improvements |
|---|---|---|
| Grains | -6.81 | n.a. |
| Other Crops | -8.26 | n.a. |
| Forestry | -10.02 | n.a. |
| Livestock | -6.57 | n.a. |
| Other agriculture | -8.26 | n.a. |
| Fishing | -9.19 | n.a. |
| Crude Oil | -2.08 | n.a. |
| Natural gas | -0.95 | n.a. |
| Logging | -6.33 | n.a. |
| Grain milled | -9.84 | 5.54 |
| Meat processing | -7.04 | 3.03 |
| Egg and diary products | -7.04 | 0.13 |
| Fish processing | -9.47 | 3.30 |
| Sugar refinery | -4.95 | 0.60 |
| Other food products | -5.52 | 1.90 |
| Wines | -20.23 | 4.23 |
| Other beverages | -11.94 | 2.40 |
| Tobacco | -11.94 | 2.40 |
| Cotton textile | -8.12 | 8.03 |
| Wool textile | -9.93 | 9.82 |
| Hemp textile | -2.92 | 2.88 |
| Silk textile | -8.36 | 8.26 |
| Knitting mills | -11.12 | 11.00 |
| Other textile manufacturing | -10.85 | 10.73 |
| Clothing | -8.77 | 14.69 |
| Leather products | -2.67 | 6.64 |
| Sawmill products | -7.42 | 2.73 |
| Furniture | -9.79 | 3.63 |
| Paper products | -8.91 | 1.03 |
| Printing and publishing | -2.08 | 0.23 |
| Sports equipment | -7.79 | 10.96 |
| Petroleum refinery | -1.34 | 0.16 |
| Coking | -1.49 | 0.18 |
| LNG | -1.49 | 0.18 |
| Basic chemical products | -2.57 | 0.64 |
| Presticide | -1.69 | 0.42 |
| Organic chemical products | -3.79 | 0.95 |
| Household chemical products | -8.73 | 2.23 |
| Synthetic chemical products | -4.13 | 1.04 |
| Other chemical products | -4.13 | 1.04 |
| Pharmaceuticals | -6.10 | 1.54 |
| Chemical fibre | -12.75 | 3.31 |

Source: Policy simulations. Column one is author's calculation based on Table 4 in Mayes and Wang 2002.

## TABLE A.1 CONTINUED
## REDUCTIONS IN TARIFFS AND TARIFF EQUIVALENTS OF NON-TARIFF BARRIERS AND ENDOGENOUS PRODUCTIVITY IMPROVEMENTS
## PERCENTAGE CHANGE BETWEEN 2002-2006, PERCENT

| | Reductions in tariffs and tariff equivalents | Endogenous productivity improvements |
|---|---|---|
| Rubber products for industry use | -2.43 | 0.60 |
| Rubber products for household use | -2.43 | 0.60 |
| Plastic products for industry use | -6.19 | 1.57 |
| Plastic products for household use | -6.19 | 1.57 |
| Cement | -0.35 | 0.17 |
| Cement products | -1.59 | 0.76 |
| Bricks and tiles | -2.52 | 1.21 |
| Glass products | -2.82 | 1.35 |
| Ceramic products | -11.57 | 5.70 |
| Fireproof products | -3.55 | 1.71 |
| Other non-metallic mineral products | -3.79 | 1.83 |
| Iron and steel | -4.27 | 1.15 |
| Non-ferrous metal products | -1.19 | 0.16 |
| Metal products for industry use | -3.16 | 1.78 |
| Metal products for household use | -3.16 | 1.78 |
| Boilers | -6.48 | 2.01 |
| Metal work machinery | -1.84 | 0.56 |
| Special machinery | -6.57 | 2.04 |
| Agricultural machinery | -5.38 | 1.66 |
| Household machinery | -6.57 | 2.04 |
| Other special equipment | -1.54 | 0.47 |
| Other machinery | -6.57 | 2.04 |
| Railway equipment | -9.01 | 1.89 |
| Motor vehicles and parts | -21.27 | 0.66 |
| Ships and boats | -8.12 | 1.70 |
| Aircraft | -9.52 | 2.00 |
| Other transport equipment | -11.35 | 2.40 |
| Generators | -5.33 | 1.65 |
| Household electrical equipment | -7.70 | 3.24 |
| Other electrical machinery | -6.05 | 1.87 |
| Computers | -11.39 | 4.85 |
| Electronic appliances | -10.07 | 4.26 |
| Other electronic equipment | -6.29 | 1.95 |
| Meters | -3.55 | 1.09 |
| Other industry machinery | -5.95 | 8.40 |
| Other household machinery | -5.95 | 8.40 |

Source: Policy simulations. Column one is author's calculation based on Table 4 in Mayes and Wang 2002.