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## Model Exercise: How Tariffs Work

*You will learn how to change an import tariff in the UNI-CGE model for a single commodity. You will learn to use trade theory as a guide to identify and interpret the most relevant results of a tariff removal. You will also examine two general equilibrium effects from a change in one tax rate.*

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## 1. INTRODUCTION

Countries impose import tariffs for many reasons, including protecting industries and jobs, generating government tax revenue or preserving foreign exchange. Some countries have a mercantilist view that exports benefit their economy whereas imports can be harmful -- high tariffs could support import substitution, boost exports and improve the balance of trade.

In this exercise, you will use the UNI-CGE model with the **India** database to explore the effects of an increase in a tariff on one commodity. First, you will review the theory of a tariff. Then, using theory as a guide, you will select the key variables and parameters in the UNI-CGE model to observe in this analysis, and you will make predictions about the effect of the tariff experiment on those variables. Your experiment will remove the tariff on India's Agri-food sector. You'll review the results of your tariff experiment and check whether the outcome of your experiment is consistent with theory. You can then use the ideas from theory to explain the results of your experiment to your audience.

You will then extend your analysis to explore the general equilibrium effects of removing a single tariff. These include how a tariff on imports affects exports of other commodities and the macro effects of changing one tax.

## 2. REVIEW THE THEORY OF REMOVING AN IMPORT TARIFF

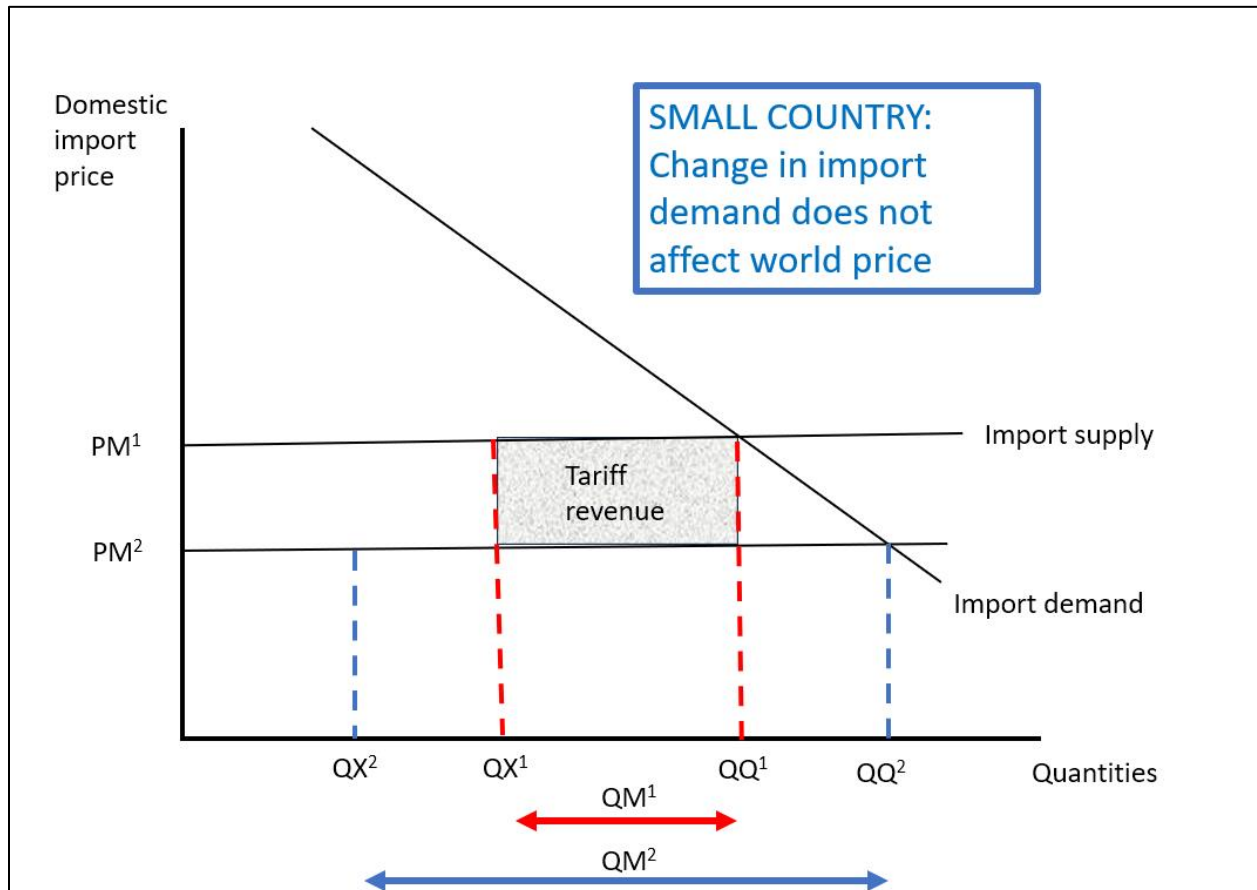
The effects of removing an import tariff on a commodity  $C$  are described in Figure 1. In the figure, variables are named using the UNI-CGE model notation. Initially, domestic production of  $C$  is quantity  $QX1$ , the imported quantity is  $QM1$  and domestic consumption of the composite commodity  $C$  is quantity  $QQ1$ . The domestic price of the imported good,  $PM$ , is defined in the UNI-CGE model as the world price in foreign currency ( $pwm$ ) multiplied by the exchange rate ( $EXR$ ), multiplied by the tariff rate  $(1+TM(c))$ .

$$PM(c) = pwm(c) * EXR * (1 + TM(c))$$

The initial domestic import price,  $PM_1$ , includes a non-zero tariff, shown as the distance between  $PM_1$  and  $PM_2$ . The government earns the tariff rate times the imported quantity, shown as the shaded rectangle in Figure 1.

The world price of commodity C is a parameter in the UNI-CGE model, with a fixed value, so it is expressed in lower case. A fixed world import price implies that the importing country is small in world markets. The flat import supply curve in the Figure illustrates that a change in quantity of imports that the country demands will not affect the world price.

**Figure 1. Effects of removing an import tariff on domestic import price and quantity**



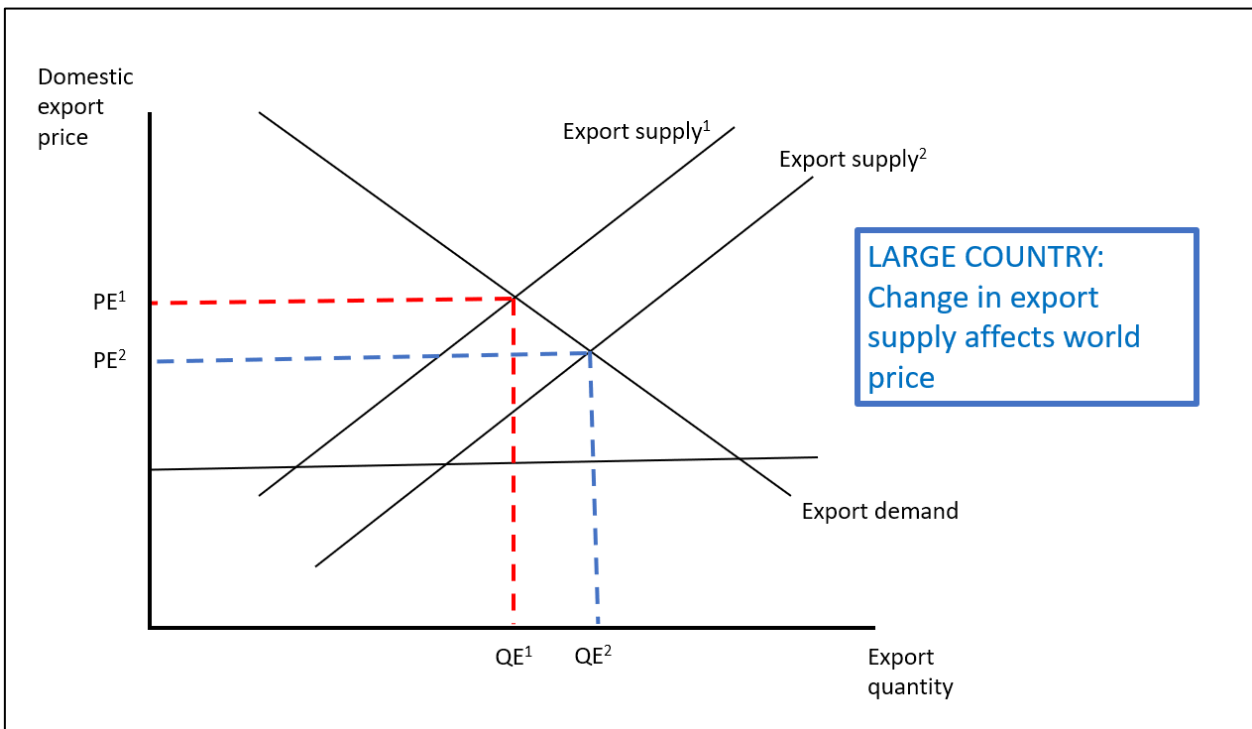
The removal of a tariff causes the domestic import price to fall by the full amount of the tariff, to  $PM_2$ . The quantity of imports rises as the price falls, to  $QM_2$ . Producers respond to the lower domestic price by reducing their production to  $QX_2$ . Consumer demand for the composite commodity C increases to  $QQ_2$ , but imports now account for a larger share of consumption.

### 3. SOME GENERAL EQUILIBRIUM EFFECTS

#### A. Effects on Production and Export of Other Commodities

A general equilibrium model describes not only the effects of an import tariff on the commodity it is imposed on, it also describes the effects of the tariff on the rest of the

**Figure 2. Effects of removing import tariff on a commodity on another commodity's exports**



economy. Figure 2 illustrates an example of a general equilibrium effect: a change in

imports of good C leads to changes in exports of other commodities even though there have been no changes in tariffs or taxes on those commodities.

This occurs because when production of C falls, its demand for intermediate and factor inputs to fall, causing input prices, wages and rents to fall. Other industries will respond by hiring those resources and expanding their own production, which increases their available export supply. .

In Figure 2, the export demand curve is downward sloping because in the UNI-CGE model, countries can be large in their world export markets (depending on the assumed value of the elasticity of export demand parameter, EDE). QE1 is the initial quantity of exports and PE1 is the initial domestic export price. In the UNI-CGE model, PE is defined as the product of the world price variable, PWE, the exchange rate and any export tax, TE:

$$PE(c) = (1-TE(c)) * EXR * PWE(C)$$

Lower competition with commodity C for productive resources causes production costs in this industry to fall and shifts its export supply curve rightward. As its export supply rises to QE2, the world price falls, causing the domestic export price to fall to PE2.

## **B. Macro Effects: Two Examples**

***Trade balance and exchange rate effects*** An increase in imports moves a country's trade balance toward a trade deficit. In the UNI-CGE model, the default closure is to fix the trade balance and let the exchange rate adjust to maintain it. With this closure, the exchange rate will depreciate if imports grow; more units of the domestic currency are needed to purchase a unit of foreign currency. Depreciation makes imports more expensive, dampening the effect of tariff removal on the domestic import price and import quantity. Depreciation will also make exports cheaper in foreign markets, helping to boost exports. Therefore, the exchange rate change adjusts both imports and exports

as it supports a fixed balance of trade.

**Tax revenues in general equilibrium** Most countries have tax structures that levy many types of taxes on many types of economic activity, such as production taxes or subsidies and export taxes. A change in one tax may affect the revenue generated by other taxes if it results in economy-wide changes in economic activity. For example, removing the tariff on India's imports of agri-food may cause output to increase in manufacturing sectors. If there are output taxes on manufacturing, or input taxes on its use of labor and capital, then tax revenues linked to manufacturing will also change in response to the change in the agri-food import tariff.

## 4. VIEW THE BASE DATA

Open the UNI-CGE vXXX model. Define **India** as the country to be analyzed by following the instructions in “How to Upload a Country Data File” and selecting “**IND.**” This tells the UNI-CGE model to load the India country data file, SAM-IND.xlsx. The command in the UNI-CGE model is shown below.

```
$SETGLOBAL CNTY IND
```

Follow the instructions in the exercise “Run the UNI-CGE Model” to go through the check list and run the model. Check the output files (.LST, Excel or GDX) to make sure no experiments are turned on. Run an experiment now - all changes in all results should have a value of zero, or almost zero.

DO NOT make any changes to the SAM-IND.xls file until instructed to do so in subsequent steps of this exercise. NEVER change anything on the “Index” sheet.

What are India's initial import tariff rates  $TM0(C)$  on each commodity? In the .lst, Excel or GDX file, search for variable  $TM0(c)$ . Write the tariff rates in Table 1. What are the

import elasticities of demand (ESUBQ) for each commodity? You will find these in the Excel country data file on the ELAS worksheet. What are the structural shares of activities in GDP, and their dependence on imports and exports? From the structure table for India, report the shares in Table 1.

Table 1 – Base data on India’s tariffs and economic structure						
Activity	Name in model	Initial import tariff (TM0)	Import demand elasticity (ESUBQ)	Activity shares in GDP	Share of imports in demand	Share of exports in production
Agriculture/Food	c-AgrFood	22.1	0.7	18	5	5
Energy	c-Energy					
Electrical equipment	c-Electr					
Other MFG	c-OthrMfg					
Construction	c-Const					
Other Services	c-OthrSer					

## 5. MAKE PREDICTIONS ABOUT THE EFFECTS OF THE TARIFF

In table 2, use the theoretical model of a tariff reduction to make predictions about the effects of an experiment that eliminates the import tariff in India’s agri-food sector.

**Table 2. Predictions about outcomes of elimination the agri-food tariff using economic theory**

	Agri-Food				Other MFG		
	Domestic import price (PM)	Quantity of imports (QM)	Quantity of output (QX)	Quantity of consumption (QQ)	Domestic export price (PE)	Quantity of output (QX)	Quantity of exports (QE)
<b>Prediction</b>	-						
<b>% change after tariff removal</b>							

## 6. RUN THE POLICY EXPERIMENT

- i. Locate the Experiments section of the UNI-CGE model. Use the command “CTRL+F, to search for the term “EXPERIMENTS”
- ii. Locate the example of an experiment that changes an import tariff, by scrolling the Experiments section to find “Experiment – change an import tariff”
- iii. To change the import tariff on a single commodity, add or edit GAMS code to define the commodity and the new tariff rate. In this exercise, you will define the new tariff rate on India’s AGRFood commodity as zero by adding the following code:

**TM.FX("C-AGRFood") = 0.0 ;**

- iv. Solve the model by clicking on the green arrow in the top menu. Be sure to check that the model runs with GDX creation, by clicking on the drop-down menu and selecting “Run with GDX Creation.”



- vi. Verify your experiment following the steps in the guide “How To Define, Run and Verify an Experiment.” Check that TM.L for India’s AgriFood activity is now zero.
- vii. Complete table 2, reporting the percent change in output and prices for two commodities: AgriFood and Other Manufacturing (OTHRMFG). You will find these results by following a guide on How To Read Results in a .LST, Excel or GDX file.
- viii. Complete table 3, Macro Effects of Removing Tariff on AgriFood Imports. In the GDX file, the percent change in macro results are reported as Parameter RES\_SCAL\_PC.

Table 3. Macroeconomic effects of removal of import tariff on AGRI-Food in India (% change)	
Government tax revenue (YG)	
Total import tariff revenue (MTAX)	
Total export tax revenue (ETAX)	
Exchange rate (EXR)	
Trade balance (FSAV)	

## 7. DISCUSSION

1. Using data from Table 1 on the sectoral structure of India’s GDP and the role of trade in each sector, how important is it to analyze the Agri-Food import tariff in an economy-wide model like the UNI-CGE model? Explain why.

2. In Table 2, are all sectoral results for AGRI-Food the same sign as you predicted? You can use the theory of a tariff to help you understand and explain these results.
3. Results for the OthrMFG sector are general equilibrium effects. Explain at least two reasons why exports of OthrMFG increase when import tariffs fall on AgriFood. You may want to view the changes in their use of labor and capital by searching in the .LST or GDY files for variable QF\_PC to use in your answer.
4. One result in the OthrMFG sector will not be the expected sign – its domestic export price. Explore these two reasons why that can occur:
  - i. Is India a large or small country in the OthMFG? What is the elasticity of foreign demand, EDE? It is reported in both the India country excel file and in the .lst file after you run the experiment. Is this best described by a downward sloping export demand curve in Figure 2 or a flat export demand curve?
  - ii. Check the effect of tariff removal on India's exchange rate. Refer back to the equation for PE in Section 3 of this exercise to understand why this occurs.
5. Total government tax revenue fell slightly despite the large fall in the import tax revenue. Why does export tax revenue increase? Explain why a change in one tax rate has an effect on revenue from other taxes.
6. Explain why India's exchange rate depreciates.