

A COMPARISON OF PARTIAL EQUILIBRIUM MODELS OF TARIFF RATE QUOTAS

Ross Hallren

David Riker

ECONOMICS WORKING PAPER SERIES

Working Paper 2017-09-B

U.S. INTERNATIONAL TRADE COMMISSION

500 E Street SW

Washington, DC 20436

September 2017

Office of Economics working papers are the result of ongoing professional research of USITC Staff and are solely meant to represent the opinions and professional research of individual authors. These papers are not meant to represent in any way the views of the U.S. International Trade Commission or any of its individual Commissioners. Working papers are circulated to promote the active exchange of ideas between USITC Staff and recognized experts outside the USITC and to promote professional development of Office Staff by encouraging outside professional critique of staff research.

A Comparison of Partial Equilibrium Models of Tariff Rate Quotas

Ross Hallren and David Riker

Office of Economics Working Paper 2017-09-B

September 2017

ABSTRACT

In this short paper we consider the impact of a TRQ on industry-specific imports and domestic production using two different types of partial equilibrium models, an Armington CES model and a Krugman CES model of trade. In the Armington model with only adjustment on the intensive margin of trade, a TRQ that fills has the same effect on trade as a flat tariff at the out-of-quota rate. On the other hand, when there is also adjustment on the extensive margin of trade, as in a Krugman or Melitz model of trade, the two policies are not equivalent and the in-quota rate has an effect on trade and domestic production even when the TRQ fills.

Ross Hallren

Office of Economics, Research Division

Ross.Hallren@usitc.gov

David Riker

Office of Economics, Research Division

David.Riker@usitc.gov

1. Introduction

A tariff rate quota (TRQ) is a tariff schedule with a step: there is an in-quota tariff rate on import volumes below the quota volume and a higher out-of-quota tariff rate on imports above the quota volume. In this paper we model the impact of a TRQ on the volumes of subject imports and domestic production using two alternative partial equilibrium (PE) models of international trade. Our first PE model is an Armington (1969) CES model with perfect competition and infinitely elastic supply. Our second PE model is a Krugman (1980) CES model with product differentiation, fixed costs of trade and production, and monopolistic competition.

We describe the two models and then we run several simulations of changes in trade policy, using illustrative data inputs, and compare the estimates from the alternative models. We focus on a scenario in which the TRQ fills, which means that the volume of subject imports is greater than or equal to the quota volume. In the Armington CES model, whenever the TRQ fills, the out-of-quota tariff rate affects the volumes of trade and domestic production, but the in-quota rate and the TRQ quota amount do not affect trade or domestic production. In this model, a TRQ with a specific ad valorem out-of-quota rate has the same effect on trade and domestic production as a flat tariff at the same ad valorem rate.

In contrast, in a Krugman CES model with fixed costs of trade and production, all of the parameters of the TRQ (the in-quota rate and quota volume, as well as the out-of-quota rate) affect the volumes of trade and domestic production, even if the TRQ fills and the out-of-quota rate applies. In this case, the in-quota rate affects the incentives for foreign producers to enter the market by transferring infra-marginal tariff revenues.

2. Armington CES Model with Infinite Elasticities of Supply and Perfect Competition

In the first model, we assume that there is perfect competition and the elasticity of supply for each producer is infinitely elastic. There are constant returns to scale and factor prices are set in the broader economy and are not significantly affected by the policy changes (a partial equilibrium assumption). Although this is a restrictive assumption about the elasticity of supply, it makes the Armington model more comparable to the Krugman model discussed below.

The prices of producers in source country j are equal to their exogenous marginal costs c_j .

$$p_j = c_j \quad (1)$$

Equation (2) is the industry price index for the market.

$$P = \left(\sum_j b_j \left(p_j (1 + \tau_j) \right)^{1-\sigma} \right)^{\frac{1}{1-\sigma}} \quad (2)$$

The b_j parameters represent potential asymmetries in preferences for the domestic and foreign varieties indexed by j . The variable τ_j is the applicable tariff rate in the home country on varieties from source country j .

Equation (3) is the demand function corresponding to the CES preferences.

$$q_j = Y b_j P^{\sigma-1} \left(p_j (1 + \tau_j) \right)^{-\sigma} \quad (3)$$

The variable Y is total expenditures on all varieties of the product. We assume that Y is a constant share of aggregate expenditures (an assumption that there are Cobb-Douglas preferences between the different industries) and that aggregate expenditures are exogenous (another partial equilibrium assumption). The tariff rate on subject imports is equal to the in-quota rate τ_s^{in} if q_s is less than the quota volume and is equal to the out-of-quota rate τ_s^{out} if q_s is greater than the quota volume. (The subscript s indicates imports *subject* to the TRQ.) We focus on the second scenario, where the TRQ fills and marginal tariff rate is τ_s^{out} .

Equation (4) calibrates the preference parameters if initial prices are set equal to one.

$$b_j = m_j \quad (4)$$

The variable m_j is the initial market share for the varieties from source country j .

We solve for the change in the volume of subject imports and domestic production due to the TRQ, holding Y and c_j fixed, by substituting equations (1) and (4) into equations (2) and (3). We consider three alternative trade policy scenarios. In all of the scenarios, the baseline tariff rate is 0

percent. In the first alternative, the out-of-quota tariff rate is 20 percent and the in-quota rate is 0 percent. In the second alternative, the out-of-quota rate is higher (30 percent, rather than 20 percent) but the in-quota rate is still 0 percent. In the third alternative, both the in-quota rate and the out-of-quota rate are 20 percent. This third alternative is equivalent to a flat 20 percent tariff rate on all import volumes. The model includes three source countries (or groups of countries) for the products of the industry: domestic production (d), subject imports (s) and imports from the rest of the world (r).

We simulate the effects of the policies on the volumes of subject imports and domestic production using the specific model inputs listed in Table 1. To illustrate the differences among the policy alternatives, we make several assumptions about market shares and elasticities. We assume that domestic producers have a 60 percent market share, while subject imports have a 30 percent share. We assume that the total size of the market is 100 units, while the quota volume is only 5 units. Finally, we assume that the elasticity of substitution among varieties from different sources is 4.

Table 1: Inputs and Estimated Outcomes in the Armington CES PE Model

	Policy Scenario 1	Policy Scenario 2	Policy Scenario 3
Model Inputs			
Elasticity of Substitution (σ)	4	4	4
Market Share – Subject Imports (m_s)	0.30	0.30	0.30
Market Share – Domestic Product (m_d)	0.60	0.60	0.60
Market Share – Imports from the Rest of the World (m_r)	0.10	0.10	0.10
In-Quota Tariff Rate on Subject Imports (τ_s^{in})	0.0	0.0	0.2
Out-of-Quota Tariff Rate on Subject Imports (τ_s^{out})	0.2	0.3	0.2
Quota Volume (q_s^*)	5	5	5
Total Market Size (Y)	100	100	100
Estimated Outcomes			
Volume of subject imports under the TRQ	16.56	12.56	16.56
Percentage change in the volume of subject imports	-44.80	-58.35	-44.80
Percentage change in the volume of domestic production	14.47	19.54	14.47

In all three policy scenarios, the TRQ fills (the volume of subject imports under the TRQ is higher than the quota volume in the TRQ), and the policy reduces the volume of subject imports while increasing domestic production. The in-quota rate and the quota volume have no effect on q_s or q_d , because they do not affect the volume of subject imports. In this model, the TRQ has the same effect on the volume of imports and domestic production as a flat tariff rate set at the TRQ's out-of-quota rate. This is illustrated by the equivalence of outcomes in the first and third policy scenarios in Table 1. These two policy scenarios have different implications for the amount of tariff revenue collected, but they have identical implications for the volumes of subject imports or domestic production. In contrast, the higher out-of-quota rate in the second policy scenario results in a greater reduction in the volume of subject imports and a greater increase in domestic production.

3. Krugman CES Model with Constant Marginal Costs

In the second model, there are n_j different firms from source country j . Each firm produces a unique variety. Again, the model includes three source countries (or groups of countries) that supply the products of the industry to the domestic market. There are n_s varieties of subject imports, n_d varieties of domestic product, and n_r varieties of imports from the rest of the world. In this monopolistic competition model, there is entry until profits are driven to zero, and n_s , n_d and n_r are endogenously determined within the model.

The price of producer j is a constant mark-up over its constant marginal cost c_j .

$$p_j = \left(\frac{\sigma}{\sigma-1} \right) c_j \quad (5)$$

The industry price index reflects the number of varieties available in the market.

$$P = \left(\sum_j n_j b_j \left(p_j (1 + \tau_j) \right)^{1-\sigma} \right)^{\frac{1}{1-\sigma}} \quad (6)$$

Equation (3) is the demand function for the sum of all n_j suppliers from source country j .

$$q_j = n_j Y b_j P^{\sigma-1} \left(p_j (1 + \tau_j) \right)^{-\sigma} \quad (7)$$

Equation (4) is the profits that a firm from source country j earns from selling in the domestic market.

$$\pi_j = \frac{1}{\sigma n_j} Y b_j P^{\sigma-1} \left(p_j (1 + \tau_j) \right)^{1-\sigma} - f_j + TS_j \quad (8)$$

The variable f_j is a fixed cost of serving the market from source country j , and TS_j is each supplier's tariff savings at the out-of-quota rate in the TRQ, relative to its tariff costs if there were a flat tariff at the out-of-quota rate in the TRQ. Initially, there is no TRQ, and TS_s is equal to zero.

TS_d and TS_r are equal to zero in all of the policy scenarios. Under the TRQ:

$$TS_s = \left(\tau_s^{out} - \tau_s^{in} \right) p_s \frac{q_s^*}{n_s} \quad (9)$$

Equation (9) assumes that the import quota is allocated equally among the n_s firms that supply subject imports.

Finally, equation (10) calibrates the preference parameters if the initial prices in the model are set equal to one.

$$b_j = \frac{m_j}{n_{j0}} \quad (10)$$

The variable n_{j0} is the initial number of suppliers from source country j . In order to maximize comparability to the Armington CES model, we assume that $n_{d0} = n_{s0} = n_{r0} = 1$.

We solve for the change in the volume of subject imports and domestic production due to the TRQ, holding Y and c_j fixed, by solving for the new equilibrium number of firms n_s , n_d and n_r based on the zero profit conditions defined by equations (5), (6), (8) and (9). The model inputs in Table 2 are identical to the values in Table 1.

Table 2: Inputs and Estimated Outcomes in the Krugman PE Model

	Policy Scenario 1	Policy Scenario 2	Policy Scenario 3
Model Inputs			
Elasticity of Substitution (σ)	4	4	4
Market Share – Subject Imports (m_s)	0.30	0.30	0.30
Market Share – Domestic Product (m_d)	0.60	0.60	0.60
Market Share – Imports from the Rest of the World (m_r)	0.10	0.10	0.10
In-Quota Tariff Rate on Subject Imports (τ_s^{in})	0.0	0.0	0.2
Out-of-Quota Tariff Rate on Subject Imports (τ_s^{out})	0.2	0.3	0.2
Quota Volume (q_s^*)	5	5	5
Total Market Size (Y)	100	100	100
Estimated Outcomes			
Volume of subject imports under the TRQ	9.70	6.87	7.84
Percentage change in the volume of subject imports	-56.90	-69.47	-65.14
Percentage change in the volume of domestic production	20.69	25.85	24.93

Again the TRQ fills, the volume of subject imports declines, and domestic production increases in all three policy scenarios. In this second model, however, there are adjustments in the number of firms participating in the market, often called the extensive margin of trade, and larger absolute changes in the volumes of subject imports and domestic production. Once we incorporate these adjustments on the extensive margin of trade, there are important new distinctions between the policy alternatives. In this monopolistic competition model, the in-quota tariff rate and the quota volume affect q_s or q_d , because they affect the number of market participants. A low in-quota rate transfers infra-marginal tariff revenues to the foreign producers. The TRQ no longer has the same effect on the volume of imports and domestic production as a flat tariff set at the TRQ's out-of-quota rate, so the first and third policy scenarios are no longer equivalent. These two policy scenarios have different implications for the amount of tariff revenue collected, but also for the volume of subject imports. The reduction in the volume of subject imports is much larger for a flat 20 percent

tariff than for the TRQ with an in-quota rate of 0 percent. The increase in the domestic production is almost as large from raising the in-quota rate from 0 percent to 20 percent (switching from the first policy scenario to the third policy scenario) as it is from raising the out-of-quota rate from 20 percent to 30 percent while keeping the in-quota rate at 0 percent (switching from the first policy scenario to the second policy scenario).

4. Conclusions and Areas for Future Research

We have assessed the effects of a TRQ on imports and domestic production using two different types of partial equilibrium models, an Armington CES model and a Krugman CES model of trade. In the Armington model with only adjustment on the intensive margin of trade, a TRQ that fills has the same effect on trade as a flat tariff at the out-of-quota rate. In the Krugman model, on the other hand, the two policies are not equivalent and the in-quota rate has an effect on trade and domestic production even when the TRQ fills.

A next step would be to consider a Melitz (2003) model of trade with heterogeneity in the firms' variable costs of supplying the market. In a Melitz model, there is adjustment on the extensive margin of trade, so the impact on subject import volumes and domestic production will depend on all of the parameters of the TRQ, like in the Krugman model, and not only on the out-of-quota rate. However, now there is an additional complexity: the impact on subject import volumes and domestic production will depend on the allocation of the TRQ. It will depend on whether the duty-free quota volume is available to any importer, on a first-come-first-served basis, allocated to the more productive firms who would serve the foreign markets anyway, or allocated to the marginal firms who would only serve the foreign markets if they can enter duty-free.

References

- Armington, Paul S. (1969): "A Theory of Demand for Products Differentiated by Place of Production." *Staff Papers (International Monetary Fund)* 16(1): 159-78.
- Krugman, P. (1980): "Scale Economies, Product Differentiation, and the Pattern of Trade." *American Economic Review* 70(5): 950-959.
- Melitz, Marc J. (2003): "The Impact of Trade on Aggregate Industry Productivity and Intra-Industry Reallocations." *Econometrica* 71: 1695-1725.