

The Economics of Modeling Tariff-Rate Quotas

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1. Introduction

A major negotiating point in the Uruguay Round of GATT was that of *tariffication*, whereby quotas and other non-tariff barriers to trade were to be converted into tariff equivalents and then *bound*. The objective of tariffication was to make the extent of border protection much more transparent, and, hence, make reductions in protection easier to negotiate. In the process of setting tariff bindings, however, there was a potential for importing countries to increase their level of protection through what has been termed *dirty* tariffication. Specifically, countries picked the lowest available import price and the highest internal domestic price in order to overstate the base tariff that would be bound under the Uruguay Round Agreement on Agriculture (URAA). Due to concerns over the high bindings being proposed, and also the insistence of negotiators on achieving minimum *market access* commitments, countries were required to establish *tariff-rate quotas* (TRQs). The purpose of TRQs was to preserve historical levels of market access, and to allow for additional imports under non-prohibitive tariffs (Morath, 1997; Abbott and Paarlberg, 1998).

As Moschini (1991) notes, TRQs have not been a very common instrument of trade policy, consequently the literature contains little economic analysis of their trade distorting effects. Probably the most extensive early treatment is by Rom (1979) who presents two key rationales for the use of TRQs. First, he argues that TRQs may be used to avoid the *trade diversion* effects following the formation of a customs union. Specifically, existing imports from third countries can be maintained at zero tariffs, while future increases in imports are subject to the common external tariff. Second, Rom argues that TRQs can be used to provide *preferential treatment* for developing countries, whereby they would be allowed to export at lower tariffs, subject to quantity constraints.¹ The

¹ Anderson and Young (1982) have also shown that tariff-rate quotas are optimal trade policy instruments in the face of uncertainty.

objective of this position paper is twofold. First, to lay out the basic economic analysis of TRQs, drawing together the limited amount of literature already published; second, to propose a method for incorporating TRQs into the trade model that will be used to evaluate the upcoming World Trade Organization (WTO) trade negotiations. In addition, outstanding questions related to the administration of TRQs, tariff preferences, imperfect competition, and data needs are addressed.

2. Economic Analysis of TRQs

Definition

In terms of a basic definition, TRQs are not the same as an ordinary quota, no absolute maximum being set on the total amount of imports that can be permitted into a country over a given time period (Rom). Instead, TRQs can be treated as a variable tariff, where the tariff varies by discrete amounts depending on import levels (Moschini). Typically, TRQs implemented under the URAA operate as a two-tiered tariff, where, over a specified time period, a lower *in-quota* tariff is levied on imports that enter under a minimum access commitment, while a higher *over-quota* tariff is levied on imports in excess of agreed market access (Skully, 1998).² Abbott and Paarlberg note that in the URAA, in-quota tariffs were usually bound at or above historical levels, while over-quota tariffs were often bound at prohibitive levels. As a result, many TRQs are effectively acting as quotas, generating attendant *quota rents*.

² The tariff structure becomes more complex if the both the in-quota and over-quota tariffs are divided into Most Favored Nation (MFN) and preferential, country-specific tariffs (see Morath).

Basic Workings of TRQs

In order to understand the basic workings of TRQs, and to provide background for the proposed method of incorporating TRQs into the WTO modeling framework, a simple, competitive, partial equilibrium setting is developed at this point. This draws on analysis laid out in previous papers by Abbott and Paarlberg, Meilke, Moschini, and Skully. The case of a TRQ acting in the same manner as a *pure* quota is illustrated in Figure 1. In panel (a), which represents the domestic market, an importing country's domestic supply and demand curves $S(p^d)$ and $D(p^d)$ are drawn, where p^d is the domestic price. The autarky price p^a determines the vertical intercept of the importing country's excess demand curve (ED) in panel (b), which describes the world market, where ED is defined as $\{D(p^d) - S(p^d)\}$. In addition, in panel (b), a series of excess supply curves are drawn.³ ES is the relevant excess supply curve if no tariff were applied by the importing country, ES' is the excess supply curve including the in-quota tariff t^i , while ES'' is the excess supply curve including the over-quota tariff t^o , where both tariffs are *ad valorem*. The effective excess supply curve is made up of ES' for import levels below the minimum access level Q , and by ES'' for import levels in excess of the minimum access level. At Q , there is a discontinuity between ES' and ES'' , the height of which is a function of the difference between the in and over-quota tariffs, given the level of market access. Equilibrium is drawn in panel (b) where ED intersects the effective excess supply curve in the discontinuity. Imports are the agreed level of minimum access, Q , and the equilibrium domestic price is p_e^d . In terms of its effect on domestic price, this equilibrium is equivalent to a pure quota set at Q . The equilibrium in Figure 1 also illustrates a case where the over-quota tariff t^o is much higher

³ The analysis can also be conducted by rotating excess demand curves to reflect the different tariffs (see Boughner and Gorter, 1998). The analysis presented here fits most closely with the proposed method of incorporating TRQs into a trade model.

than that necessary to make the TRQ bind. The vertical difference between k and e is commonly termed the *water* in the over-quota tariff, which may either be the result of either dirty tariffication, a lower intervention price relative to the URAA base period, or some other factor.

In terms of the welfare calculus, under a pure quota, total quota rents would be given by the rectangle $abce$, whereas with a binding TRQ, part of this is captured by the importing country's government as tariff revenue, $fbcg$, leaving the area $afge$ as quota rents. Who gains these rents is a function of how the TRQ is administered. Skully shows that if the rights to import under the minimum level of access are auctioned off competitively by the importing country, it will fully capture the rents, $afge$. If methods other than auctioning are used, the rents are captured by private agents, either in the importing country or exporting countries. In addition, unless the rights to import are freely tradable after allocation, methods of administration such as license on demand, first-come-first-served (FCFS), and historical allocation allow for *extra-marginal* suppliers to fill either part or all of the quota Q . As a result, a part of the rents are allocated to pay extra-marginal factors of production. For example, in Figure 1, panel (b), if the rights to import under the minimum access Q are not allocated competitively, the relevant section of the effective excess supply curve can be rotated up from $h'g$ to $h'e$ to approximate the higher production costs of extra-marginal suppliers. This inefficiency is then added to the usual deadweight loss triangle, which is ejc when measured relative to free trade, and eig when compared to a simple *ad valorem* tariff of t^i .

Additional TRQ Equilibria

In addition to the equilibrium drawn in Figure 1, three other equilibria can be illustrated. Assuming the same domestic elasticities of supply and demand and a series of different autarky prices, these equilibria are illustrated in Figure 2, along with that drawn in Figure 1. In *Case 1*, ED_1 does not

intersect excess supply at all. The autarky price $p^a = p_1^d$ is globally lower than the border price inclusive of the in-quota tariff, as a result of which there are no imports and, hence, *zero fill* of the TRQ. In *Case 2*, ED_2 intersects ES' , which is below the minimum access level Q , so that there is *partial* TRQ fill at q' . The in-quota tariff is binding, the equilibrium domestic price, inclusive of the tariff t^i , being p_2^d , so that the effects of the TRQ are equivalent to a tariff. *Case 3* is the equilibrium already outlined in Figure 1 where ED_3 intersects excess supply in the discontinuity, while in *Case 4*, ED_4 intersects ES'' , such that the over-quota tariff is binding. The amount imported q'' exceeds Q , i.e., there are over-quota imports, and the equilibrium domestic price is p_4^d inclusive of the over-quota tariff t^o . Tariff revenue consists of area $fbcg$ due to application of the in-quota tariff on Q units imported under agreed minimum access, and area $eijh$ due to application of the over-quota tariff on $q'' - Q$. In addition, compared to *Case 3*, owners of the rights to import under the minimum access now earn larger quota rents of $afge$, which is clearly larger than the rents earned in *Case 3*. Again, depending on the method of quota rights allocation, some of these rents may be paid out to extra-marginal factors of production, adding to the inefficiency of the TRQ. The deadweight loss of *Case 4*, relative to the free trade equilibrium, is the area hjk .

Comparative Statics of Trade Liberalization and TRQs

Having outlined the welfare effects of TRQs, the comparative statics of various trade liberalization scenarios are now laid out. Following Meilke, we divide these into two types of changes to TRQs that might be implemented in the upcoming round of WTO trade negotiations.⁴ The first type of change relates to the possibility that the over-quota tariff t^o is reduced. As should

be obvious from Figure 2, if the relevant equilibrium is either *Case 1* or *Case 2*, lowering the over-quota tariff up to the in-quota tariff will have no effect on the final equilibrium.

In Figure 3, if the relevant pre-liberalization equilibrium is *Case 3*, there is a range of reductions in the over-quota tariff from h to e , over which there will be no effect on the domestic price, the world price or the level of imports, and quota rents will be unaffected. If the over-quota tariff is lowered below e , as given by the excess supply curve ES''' , market access Q is no longer binding. The domestic price falls to p_3^d' , the world price increases to p^w' , imports increase to q' , quota rents fall by the area $abce$, and the importing country earns additional tariff revenue on those units $q' - Q$ sold in excess of minimum access where the new over-quota tariff is applied. In addition, the deadweight loss relative to free trade falls to the area jkl .

If *Case 4* is the relevant pre-liberalization equilibrium, reducing the over-quota tariff to the excess supply curve ES''' generates similar effects to those outlined above. The domestic price falls to p_4^d' , the world price increases to p^w'' , imports increase to q'' , quota rents fall by the area $fghi$, and tariff revenue increases due to those units $q'' - Q$ sold in excess of minimum access where the new over-quota tariff is applied. In addition, the deadweight loss relative to free trade falls to the area mno .

The second type of change to TRQs is the possibility that the minimum level of access Q is increased. The two initial equilibria of interest are *Cases 3 and 4*. As shown in Figure 4, in *Case 3*, where Q is binding, there is a range of increases between a and b in the level of market access Q , e.g., to Q' , where the TRQ continues to bind. However, the domestic price will fall, the world price will rise, and the level of quota rents will fall. Eventually, further increases in Q , say to Q'' , will result

⁴ The focus here is only on the comparative statics of changing the over-quota tariff and minimum access. Abbott and

in partial fill, given excess demand ED_3 does not shift. This generates an equilibrium similar to *Case 2*, whereby the in-quota tariff t^i is binding, the domestic price is $p_3^{d'}$, and the world price is $p^{w'}$, and there are no longer any quota rents. The deadweight loss relative to free trade also declines to the area bef .

In *Case 4*, where the over-quota tariff is binding, there is a range of increases in Q between a and d where there will be no effects at all on prices and quantities; however, TRQ rents increase, and tariff revenue falls. If the level of market access is increased to Q'' , given the excess demand curve ED_4 , then the TRQ is binding. The domestic price falls to $p_4^{d'}$, and the world price increases to $p^{w''}$. Quota rents are now the area $ghij$, tariff revenue is $hmli$, and deadweight loss relative to free trade is jkl .

Supply Management, Export Subsidies, and Floor (Intervention) Prices

At this point, no account has been taken of any policy changes the importing country may implement in order to accommodate increased imports. Meilke discusses a number of different ways an importer could handle an increase in its minimum access commitment. Instead of allowing the domestic price to fall to the market-clearing level, it could restrict domestic supply to make domestic price fall to a lesser extent, with the flexibility to do so at any point in the discontinuous portion of the ES curve where the over-quota tariff is not effective. Alternatively, the country could choose to increase its exports using subsidies within its WTO limits. In this way, a country's choice of policy has an effect on the model's welfare calculus. Meilke's points present issues related to how to model

Paarlberg also trace out the effects on price stability of random shifts in excess demand and supply.

the supply and export equations, and must be borne in mind when running WTO liberalization scenarios. At this point, three policy responses are sketched out.⁵

Effects of Supply Management

Figure 5 illustrates the effect on the ED curve of limiting supply through a production quota for a country that initially finds itself in *Case 3* (full TRQ fill and no over-quota imports). Initially, the domestic price is at p^d and imports are at Q . When the TRQ is expanded to Q' , the country chooses to maintain its domestic price at p^d by reducing domestic supply through a production quota Q^s . The measure reduces domestic welfare while maintaining the margin of TRQ rents.

Effects of Export Subsidies

How do export policies such as export subsidies affect the domestic price and import solutions? For example, an exporting country could be engaged in policies, such as the use of export subsidies, to maintain exports at a level above that required for internal market balance. As a result, even though in-quota and over-quota prices lie above the autarky price, there could be TRQ or even over-quota imports. Figure 6 illustrates this case using a two-panel diagram. p^a lies below both the in-quota and over-quota border prices, yet a surplus of exports using subsidies has caused the country's ED curve to shift from *Case 1* to *Case 2*. Also, a country whose autarky price lies above the world price could export if it uses a large enough export subsidy. This case produces similar results to those in Figure 6, only the initial point of autarky p^a lies above the ES curve. Relative to the previous case, the result here is a higher level of imports.

⁵ Note it is assumed that the importing country is large enough to affect world prices.

Effects of Floor (Intervention) Prices

Figure 7 illustrates the effects of a large country providing price support to producers in the form of an intervention price. Without a floor price, the country would be importing the full TRQ quantity, Q , and the ED curve would intersect the discontinuous portion of the ES curve (*Case 3*). If the country introduces a floor price that makes it attractive to import at the over-quota tariff, imports will increase from Q to q^{io} . The difference between the ED curve and imports, ab , represents excess supply on the domestic market, which must either be placed into intervention stocks or re-exported with subsidy.

From Figure 7 it is also possible to visualize why high over-quota tariffs give countries more latitude to use market price supports. The higher is the over-quota tariff, the longer becomes the vertical, discontinuous segment in the ES curve. As long as the domestic price remains within this discontinuous portion, the country can provide market price support and not face supply management problems due to increased imports.

3. Incorporating TRQs and “Watery” Tariffs Into a WTO Model

Assumptions

Having outlined the basic analysis of TRQs, a method for incorporating TRQs into a trade model is now laid out. In the model, it is assumed that the traded good is homogeneous and that there are no transportation costs. Furthermore, it is assumed that a certain tariff-inclusive form of the “law of one price” holds. There is full price transmission to domestic markets when either the in-quota tariff (*Case 2*) or the over-quota tariff (*Case 4*) is binding, while there is no price transmission

to domestic markets when there are zero imports (*Case 1*) or the TRQ is binding (*Case 3*). Country markets can, therefore, be viewed alternately as open or closed to world trade, depending on the relation of the domestic price to the tariff-inclusive world price. An economy can move from being either open to closed, or vice-versa, as a result of shifts in the excess supply (*ES*) or excess demand (*ED*) curves. These shifts may be due, *inter alia*, to price shocks on either the domestic or world markets, a change in the applied in-quota or over-quota tariffs, or an increase in the TRQ volume.⁶

Locating Intercepts on Excess Demand and Excess Supply Curves

In order to calculate the import and domestic price solutions (i.e., where $ED = ES$), it is first necessary to locate the *ES* and *ED* intercepts relative to each other. The autarky price and its relationship to the excess supply curve are two determinants of the import and domestic price solutions (Figure 8). This can be illustrated using four excess demand curves with similar slopes, but with four different autarky prices (where production $Y =$ consumption C on the domestic market). All four cases assume the same elasticities of domestic supply and demand. The importing country's domestic supply and demand elasticities are also determinants of the solutions (Figure 9). Here all cases assume the same autarky price p^a for the importing country at which excess demand, *ED*, equals zero.

Altering the importing country's tariffs and TRQ volume will generate results similar to those in Figures 8 and 9. Given the assumption of *ad valorem* tariffs, changes in the in-quota and over-quota tariffs cause the excess supply curve, *ES*, to rotate around the point located at its intersection

⁶ In this static one-importer framework, it is assumed, for now, that the country is not exporting the good in question. See Appendix 1 for details about a multiple country model that incorporates export equations.

with the horizontal axis at $p = 0$, which is to the left of the vertical axis. Changes in the TRQ volume will move the discontinuity in the excess supply curve (already illustrated in Figure 4).

Calculating an Import Solution from the Autarky Point

In a country model, the import and domestic price solutions can be calculated relative to the autarky point (Figure 10). First, the model calculates the autarky price from the formula:

$$(1) \quad p^a = p^d * ((Y - C) / (\epsilon^d * C - \epsilon^s * Y) + 1),$$

where p^a is the importing country's autarky price, p^d is the domestic price, Y is domestic production, C is domestic consumption, ϵ^d is the own price elasticity of demand and ϵ^s is the own price elasticity of supply. Autarky production and consumption are equal by definition, and can be calculated from the autarky price:

$$(2) \quad Y^a = Y * (1 + \epsilon^s * (p^a / p^d - 1))$$

$$(3) \quad C^a = C * (1 + \epsilon^d * (p^a / p^d - 1)).$$

The model calculates imports separately, relative to ES' (the in-quota portion) and ES'' (the over-quota portion) as follows:

$$(4) \quad M^{Qi} = \text{MAX} \{0, [(p^w * (1 + t^i) / p^a - 1) * (\epsilon^d * C^a - \epsilon^s * Y^a)]\}$$

$$(5) \quad M^{Qo} = \text{MAX} \{0, [(p^w * (1 + t^o) / p^a - 1) * (\epsilon^d * C^a - \epsilon^s * Y^a)]\},$$

where M^{Qi} and M^{Qo} are in-quota and over-quota imports, respectively. The total import solution equals:

$$(6) \quad \text{MAX} [M^{Qo}, \text{MIN}(Q, M^{Qi})],$$

where Q is the tariff-rate quota volume, obtained from WTO notifications and country tariff-rate quota schedules. In terms of the relation of the ES and ED curves, the import solution can be viewed alternatively as:

$$(7) \quad \text{MAX} [ES''=ED, \text{MIN}(Q, ES'=ED)].$$

This formula returns the theoretically consistent level of imports for all cases. For *Case 1* where the ED intercept lies beneath ES , both M^{Qi} and M^{Qo} are negative, and the formula returns zero imports. For *Case 2* where ED intersects ES' , M^{Qi} is returned by the formula ($M^{Qi} < Q$, and $M^{Qi} > M^{Qo}$) (recall that, assuming $t^i < t^o$, in all cases $M^{Qi} > M^{Qo}$). For *Case 3* where ED lies in the discontinuity, the TRQ volume is returned ($Q < M^{Qi}$, and $Q > M^{Qo}$). In *Case 4*, ED intersects ES'' , and M^{Qo} is returned ($\text{MIN}(Q, M^{Qi})=Q$, and $\text{MAX}(M^{Qo}, Q) = M^{Qo}$).

Domestic Price Solution

From trade theory, it is assumed that a country will import a good as long as the tariff-inclusive border price remains less than the domestic price. In this way, prices act to clear markets. Effectively, the model's import solution backs out the extent of world price transmission to the domestic market. The import solution is stable from one iteration to the next because it is a function of the autarky price, which adjusts only to accommodate shifts in the supply and demand curves (e.g., trend variables) or cross-price elasticity effects. The domestic price p^d adjusts iteratively to balance supply and use on the home market. If the import solution is positive ($p^d > p^{w*}(1+t^i)$ and/or $p^d > p^{w*}(1+t^o)$), then there is excess supply on the domestic market relative to autarky and the domestic price falls from p^d until supply and use come into balance. If the import solution is negative, imports

are zero and the domestic price p^d balances supply and use when it equals the autarky price p^a .⁷ In this way, the import solution “tricks” the model into balancing domestic supply and use at the appropriate market-clearing price.

Figure 11 illustrates the domestic market price and world (linker) price solutions in the cases of zero imports, partial TRQ fill, ED passing through the discontinuous portion of ES , and over-quota imports:

Case 1: the importing country’s autarky price p^a lies below the in-quota price $p^{w*}(1+t^i)$. There is no TRQ fill nor are there any over-quota imports. Because the domestic market is effectively insulated from the world price (no price transmission), the domestic price adjusts to equal supply and use at a level less than the in-quota price.

Case 2: ED intersects ES' , the in-quota portion of the excess supply curve, resulting in partial TRQ fill and a domestic price equal to $p^{w*}(1+t^i)$.

Case 3: ED passes through the discontinuous portion of ES . The import solution equals the TRQ volume, and domestic price adjusts to balance supply and use at a level somewhere between $p^{w*}(1+t^i)$ and $p^{w*}(1+t^o)$.⁸

Case 4: ED curve intersects ES'' , the over-quota portion of the excess supply curve, resulting in over-quota imports and a domestic price equal to $p^{w*}(1+t^o)$.

⁷ Again, for now, it is assumed that the country is not an exporter.

⁸ Several members of the WTO Modeling Group expressed concern that the discontinuity introduced into the ES curve by a TRQ would make it difficult for a model to converge to a price/quantity solution in situations falling under the rubric of *Case 3*, i.e., where the ED curve passes through the discontinuous portion of the ES curve. As can be seen from the above discussion of *Case 3*, the model’s import and domestic price solutions are capable of handling all discontinuities in the ES curve.

4. Net Trade (Total Trade) or Bilateral-Flows (Source-Destination) Approach?⁹

Thus far, a basic model has been developed that gives a theoretically robust solution for imports and the extent of price transmission. However, the model is based on the assumptions that a) the TRQ is globally allocated (no country-specific allocations) and b) there are no country-specific tariff preferences, either in-quota or over-quota. These are important real-world policy factors for the U.S. and EU, two of the three countries that are initially to be modeled. The U.S. has TRQ country allocations for dairy and sugar, and grants tariff preferences to Mexico and Canada under the North American Free Trade Agreement. The EU has TRQ country allocations for nearly all products, and grants both in-quota and over-quota tariff preferences to a wide range of partner countries.

For these reasons, the WTO Modeling Group has identified three relevant modeling issues: 1) country-specific TRQ allocations; 2) country-specific tariff preferences; and 3) methods of TRQ administration.¹⁰ Ideally, the model should be able to measure the effects of changes in these market access variables on producer and consumer surplus, other welfare effects such as deadweight loss, trade diversion, and total TRQ rents as well as their distribution. In this section, the advantages of developing a net trade versus a bilateral-flows model are considered.

Here, two kinds of net trade model are defined, neither of which can solve for the sources and destinations of trade. The first type of net trade model, *net imports*, makes a single calculation for imports, the negative solution to which indicates the country is an exporter. The second type, *total trade*, makes separate calculations for imports and exports. The first type of net trade model is not feasible in this modeling framework. There must be a separate equation to calculate exports, because a country's import equation is partly a function of the import tariff. If the WTO model is to use net

⁹ The authors would like to thank David Skully, Ralph Seeley, and Marinos Tsigas for their input and ideas in this discussion.

¹⁰ Imperfect competition and safeguards are addressed in a later section.

trade equations, at the very least it must break out both imports and exports. Therefore, the Modeling Group's choice of trade model is between a total trade (TT) approach and a bilateral-flows (BF) approach, which breaks out the country sources and destinations of trade.

Indeterminate Methods of TRQ Administration

Before considering the issues of tariff preferences and TRQ allocations, it needs to be explained why neither a total trade nor a bilateral-flows approach which calculates imports solely based on price differences is able to solve for the distribution of TRQ rents under non-competitive methods of TRQ administration. Most methods of TRQ administration are indeterminate with respect to the relationship between an importing country's autarky price p^a and a set of exporter curves ES . First-come first-served (FCFS), license on demand, historical importer licensing, and other methods of tariff-quota administration all ration import rights according to criteria other than price or costs of production, thereby allowing extra-marginal suppliers to capture a portion of the TRQ rents (see Skully). Thus, it is impossible to determine the distribution of TRQ rents solely based on the relationship of the domestic autarky price to the world price. To model the various TRQ administration methods, it would be necessary to include the relevant non-price factors. On the other hand, many of these factors are difficult, if not impossible, to predict. For example, under a FCFS method the distribution of TRQ rents is determined by whoever arrives first at the border. Under a license on demand method, licenses are granted to whoever applies to import, and are proportionally reduced if applied-for volumes exceed the TRQ quantity. It is virtually impossible to develop a model that could predict which portion of those arriving first at the border and license applicants, respectively, will be infra-marginal versus extra-marginal suppliers.

Tariff Preferences and TRQ Allocations

First, considering that a total trade modeling approach does not break out the country sources and destinations of trade, is it possible to develop a TT approach that provides informative input into analysis of the effects of tariff preferences and country-specific TRQ allocations on the distribution of TRQ rents and the extent of trade diversion? Second, under the currently proposed framework for the WTO model, what are the marginal benefits of a bilateral-flows modeling approach in measuring these effects? Keeping these questions in mind, the following section outlines the advantages and disadvantages of using a total trade versus a bilateral-flows approach.

Total Trade (TT) Approach

The main disadvantage of a TT approach is its inability to directly measure the effects of removing tariff preferences or country-specific TRQ allocations on the distribution of TRQ rents and trade diversion. Having said that, aggregate results from a TT approach could be used outside the model to estimate the welfare and rent-distributive effects of tariff preferences or TRQ allocations. Total TRQ rents and welfare effects can be measured from the model's results for imports, domestic price, and world price. Country and commodity experts can use these results to estimate the distribution of TRQ rents *ex post*. Also, the TT approach has some pure advantages over the BF approach. First, because it is simpler, less time would be spent on prototype development. A TT approach does not require an Armington or other framework to estimate changes in the sources and destinations of trade. A model has already been developed that can solve for a TT approach (see Appendix 1). Second, a TT approach is less data-intensive than a BF approach, because it does not require constructing a database of preferential tariffs or TRQ allocations.

Bilateral-Flows (BF) Approach

The main advantage of a BF approach is that it would be able to directly determine the welfare effects of harmonizing over-quota tariffs between MFN and preferential suppliers. When the importing country's *ED* curve lies in Case 4, the over-quota tariff is effective and the relationship between the importer's autarky price and the tariff-inclusive world price is sufficient for a determination of imports and domestic price. In this price-determinate case, there could be marginal benefits in breaking out the sources and destinations of trade.

While a BF approach would also be able to directly determine TRQ fill in a situation of country-specific TRQ allocations, it would be unable to solve for the effects of a TRQ globalization scenario (i.e., made open to all countries on an MFN basis). Country-specific allocation schemes, with or without tariff preferences, give determinate solutions, because one can examine the relationship between the allocated exporting country's price and the importing country's price to determine extent of TRQ fill. Under allocated TRQs, the assumption of one price per country eliminates inefficient TRQ solutions related to FCFS, license on demand etc., as a determinate solution for the model exists. On the other hand, if these allocations were removed (i.e., a scenario in which all TRQs are globalized), the problem becomes one of indeterminacy with respect to price, just as was discussed in the section on methods of TRQ administration. While a BF approach, therefore, can be used to calculate fill for allocated TRQs, it cannot be used with any marginal benefit over a TT approach in a scenario under which those TRQ allocations are removed.

The disadvantages of a BF modeling approach are related to the indeterminacy of most methods of TRQ administration, the high level of commodity aggregation currently proposed for the WTO model, and the need for more prototype development. First, a BF approach would be unable

to determine the effects of removing country-specific TRQ (in-quota) tariff preferences on the distribution of TRQ rents and trade diversion. This is due to the fact that the in-quota import solution depends not only on in-quota tariff preferences, but also on the method of TRQ administration, FCFS, license on demand, historical allocation etc., which in most cases, as noted above, is itself indeterminate with respect to price. With respect to the problem of TRQ rent distribution, this point is generally applicable to all liberalization scenarios. The method of TRQ administration makes most in-quota import solutions indeterminate with respect to price, so a bilateral-flows approach to TRQ (in-quota) fill would often be no more useful than a total trade solution. Second, the BF approach would require more research and development, whether using an Armington approach or a system of equations that calculates imports relative to all combinations of partner countries' *ES* curves. This could take several more weeks, if not months, to complete. Finally, the current framework for the WTO model proposes a high level of aggregation which would effectively reduce the marginal benefits of a BF approach. In a model using high product aggregations for differentiated products such as meats and dairy products, the reality is that there is a good deal of heterogeneity in trade flows. Thus, a BF approach based on a single price in both countries produces solutions that are not necessarily more predictive or useful than those produced by a TT approach.

In summary, the disadvantages of a BF approach appear to outweigh the marginal benefits. In most scenarios involving TRQ (in-quota) preferential tariffs, the BF approach does not have more predictive value than the TT approach. Though a BF approach could be advantageous in calculating the welfare effects of price-determinate scenarios involving either country-specific TRQ allocations or preferential over-quota tariffs, a TT approach can produce prices and quantities which can then be used *ex post* by expert analysts for a particular country and commodity. In light of this, it is recommended that the WTO Modeling Group adopt a TT approach. Appendix II outlines in more

detail possible ways to use a TT approach to analyze the trade diversion and TRQ rent distribution effects of removing TRQ allocations and harmonizing over-quota tariffs.

5. Imperfect Competition and Safeguards

An issue largely ignored by researchers analyzing the URAA was the impact of imperfect competition on the outcome of trade liberalization. It is likely that more attention will be paid to market structure issues in the upcoming WTO negotiations, particularly the role of state trading enterprises (STEs). Casual analysis of the trade literature that has evolved over the past twenty years would suggest that the impact of incorporating imperfect competition into trade models is very sensitive to the assumed market structure, and the manner in which firms' behavior is modeled (see Helpman and Krugman, 1989). This suggests that, like the distribution of rents under different forms of TRQ administration, issues relating to imperfect competition need to be analyzed on a case-by-case basis.

A key question here is which type of market structure would likely need to be incorporated into a model of TRQs. A canonical case in the literature is that of a firm having monopoly power in its domestic market, and the resulting differential effects on domestic prices of tariffs versus import quotas. Bhagwati (1965) shows that an import quota restricting imports by the same amount as a tariff allows a domestic monopolist to restrict its output and raise the domestic price. The corollary of this is that an increase in the level of the quota will have pro-competitive effects in the importing country as the domestic monopolist is constrained in its ability to raise price above the competitive level. This result can also be extended to the case of a non-cooperative domestic oligopoly (see

Helpman and Krugman).¹¹

In the case of a TRQ, the ability of a monopolist in the importing country to raise domestic price above the competitive level depends on whether the TRQ is binding or not, and on the amount of water in the over-quota tariff. If the TRQ is binding, as in *Case 3*, a monopolist in the importing country will be able to extract some monopoly rents, subject to the height of the over-quota tariff. If the TRQ is not binding, as in *Cases 2 and 4*, the monopolist is constrained to price at the tariff-ridden price just like a competitive firm. Consequently, either reducing the over-quota tariff or increasing the level of minimum access may have pro-competitive effects that would need to be added into the welfare calculus. Whether this is a real issue or not is an empirical question: i.e., how many of the country markets included in the WTO model can be characterized as having domestic monopoly/oligopoly market structures?

An STE, which has the rights to import under a TRQ, and, hence, potential monopsony importing power, may be a more relevant market structure to analyze. It may have an impact on TRQ fill, and, hence, on rent distribution and on domestic welfare (see Skully). For example, Alston, Carter and Jarvis (1990) argue that the Japanese Food Agency (JFA) operates a discriminatory import quota scheme for wheat which has the structure of a set of voluntary export restraints (VERs). Alston *et al.* support their argument with evidence that import shares of the U.S. and Australia were too stable over the period of their study. Arnade and Gehlhar (1999) present more recent evidence showing that Japan has had very stable wheat imports from the U.S., Australia, and Canada. Liberalization of this particular TRQ would likely result in a loss of U.S. market share and rents in the Japanese wheat market (Skully). Therefore, STEs that control allocation of a TRQ generate price

¹¹ Rotemberg and Saloner (1989) show that a quota results in a lower price than a tariff under implicit collusion.

indeterminacy similar to other forms of TRQ administration.

Another issue that needs to be addressed is that of safeguards. Under the WTO rules on agriculture, countries with the right to do so in their market access schedule (commodity-by-commodity basis) may invoke a special safeguard with respect to imports. If a country's imports increase too rapidly in either value or volume terms compared with a three-year historical moving average, that country may increase tariffs above the WTO-fixed tariff binding. It would be relatively simple to introduce a variable ceiling into the WTO model based on such a three-year moving average. However, more research is needed to determine how often countries use this instrument, so that reasonable assumptions can be incorporated into the import equation.

6. Data Issues

It will be necessary to obtain data for world prices, domestic prices, in-quota tariffs, over-quota tariffs, TRQ volumes, and commodities subject to country safeguards. For any analysis related to scenarios involving tariff preferences, TRQ allocations, and methods of TRQ administration, it will also be necessary to have access to data on in-quota and over-quota preferential tariffs, TRQ allocations by country, and both within and over quota source-destination historical trade flows.

Both a world price and individual country prices are needed to locate the *ED* and *ES* intercepts relative to each another. The WTO Modeling Group agreed that several countries' application of "watery tariffs", where $p^d < p^{w*}(1+t^o)$ or where $p^d < p^{w*}(1+t^i)$, makes water in tariffs a market access issue that is integral to the model. Therefore, it will be necessary to obtain or construct aggregate data for a world (linker) price, as well as corresponding data for country prices. Over-quota tariffs cannot be used to construct a base year country price in cases where that country has not historically imported more than the TRQ quantity (*Cases 1, 2, or 3*). Also, we should be wary

not to set domestic price at $p^{w*}(1+t^j)$ if a country appears to historically lie in *Case 2* (partial TRQ fill). Partial TRQ fill could be due to a range of reasons unrelated to price, e.g., country-specific allocations or the method of TRQ administration.

One short-term approach to the problem of modeling water in tariffs is to construct accurate world prices for the model, and to assume some degree (if any) of water in the over-quota tariff for each country and commodity. As described above, the long-term approach should be to collect and construct comparable data for domestic prices of countries modeled.

7. Summary

In this paper, the basic economic analysis of TRQs has been laid out, and a method proposed for incorporating them into a trade model. In addition, a number of critical modeling issues were addressed. Specifically, the model outlined in Section 3 ignores the issues of TRQ allocations and country-specific tariff preferences. To that end, alternative trade models were discussed in Section 4, the conclusion being that a total trade approach can provide answers to the trade diversion and TRQ rent distribution effects of removing TRQ allocations and harmonizing over-quota tariffs. Issues relating to imperfect competition, safeguards, and data needs were also addressed.

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Appendix 1: An N -Country Model with Exports and Imports in a Walrasian Framework

As for imports, a separate solution for exports has to be calculated. This is because the model's import solution cannot give a net trade result, i.e., it is a function of the import tariff. It can produce only a non-negative solution for imports. The most practical way to solve separately for exports is to make them a function of the difference between the autarky price and the world price, taking into account the exporting country's elasticities of supply and demand. When incorporating the import, export, and domestic price solutions into an n -country model, the framework is one that balances world imports and exports through a linker price. Equation (A1) solves for a country's exports:

$$(A1) \quad X = \text{MAX} [0, (p^w/p^a - 1) * (\epsilon^s * Y^a - \epsilon^d * C^a)]$$

The country export equation can be viewed as a ready supply from that country onto the world market at the prevailing world (linker) price. The import equations determine to what extent excess supply on the world market finds a home in importing countries. If there is too much export supply relative to import demand, the linker price falls. If there is too little export supply to meet import demand, the linker price rises. The linker price adjusts iteratively until it reaches the Walrasian equilibrium, at which point, $\sum ES = \sum ED$ for all countries in the model.

Appendix 2: Calculating Welfare Effects under Tariff Preferences, TRQ Allocations, and Different Methods of TRQ Administration Using a Total Trade Approach

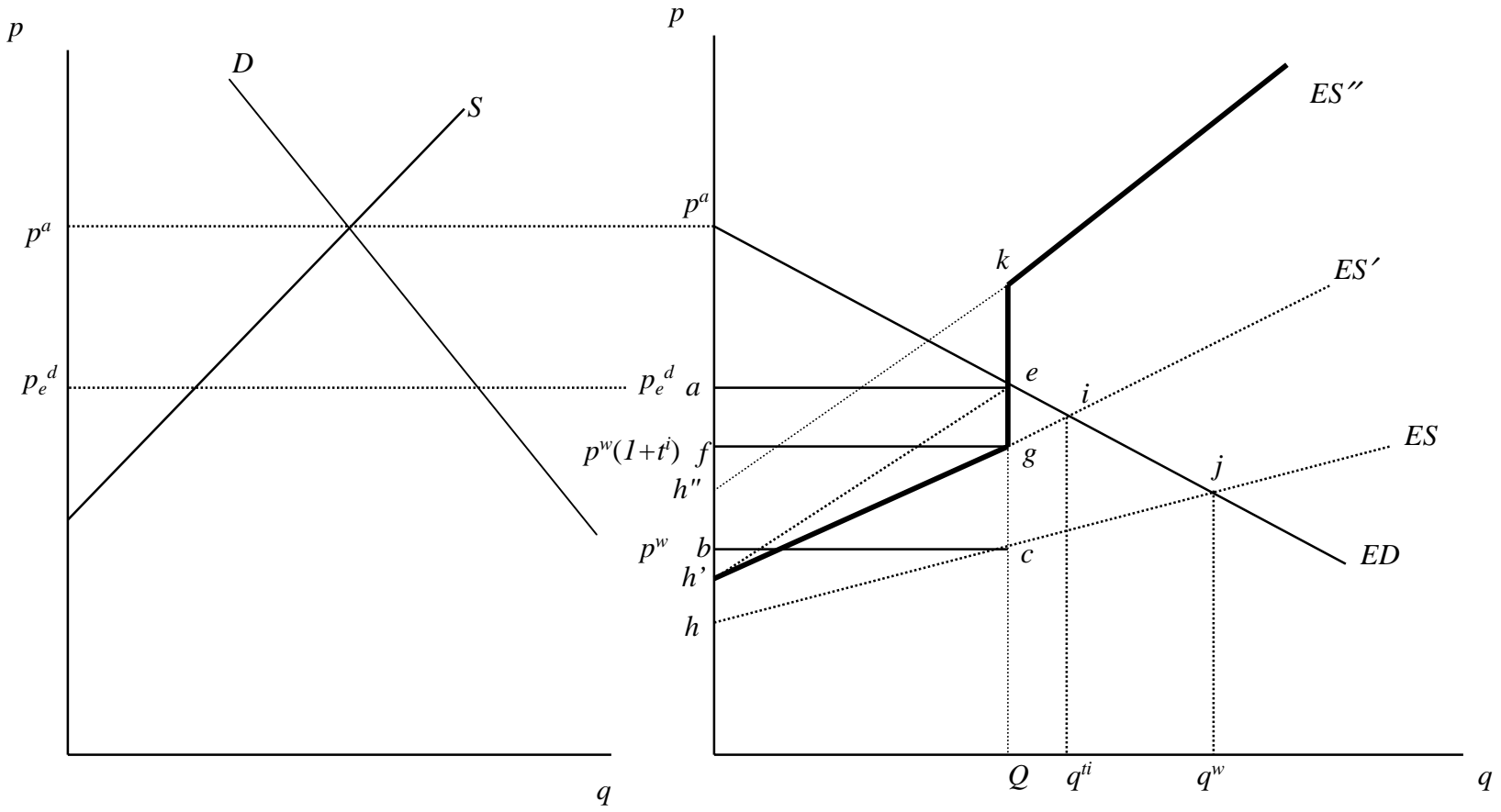
How might a total trade modeling approach provide answers to the trade diversion and TRQ rent distribution effects of removing TRQ allocations and harmonizing over-quota tariffs? First, it is necessary to take imports under tariff preferences into account when calculating the amount of *water* in the MFN tariff. In other words, imports under preferential tariffs should not be mistaken for over-quota imports under the higher MFN tariff. By treating preferential imports as a static variable, a TT approach can measure the extent to which bringing the MFN tariff down increases imports. A TT approach will generate solutions for imports, domestic price, and world price. On a case-by-case basis, it is possible to compare these prices with costs of production in the countries that are granted tariff preferences, to determine whether these preferential countries would continue to export. A similar procedure could be used in the case of removing TRQ allocations. Price solutions in the model could be compared with costs of production in countries given TRQ allocation to estimate the effect on distribution of rents and trade diversion. In this regard, it is possible to see why a TT approach would not necessarily be less data-intensive than a corresponding BT approach. At least for the model itself, the TT approach is less data-intensive because it does not require data on either preferential tariffs or TRQ allocations. However, at least some of these data will be necessary for expert analysis outside the model.

In using a total trade modeling approach to calculate the welfare effects of the above variables, a number of points come to mind:

1. In most cases the TRQ solution is indeterminate: the *distribution of TRQ rents* needs to be determined outside of the model by country and commodity experts.

2. It is possible to differentiate the welfare calculus related to *methods of TRQ administration*, depending on whether it is assumed that the TRQ is either competitively or non-competitively filled. If it is assumed that the TRQ is competitively filled, total TRQ rents can be calculated from the relationship between p^d and $p^{w*}(1+t^i)$. If on the other hand, it is assumed that the TRQ method of administration lets in extra-marginal suppliers, the line between points h' and e in Figure 1 can be used to measure TRQ rents net of extra-marginal factor costs.
3. A TT approach is capable of measuring the welfare effects of *over-quota tariff liberalization scenarios*, even in the presence of over-quota tariff preferences. As in all cases it will be necessary to calculate the “water” in the over-quota MFN tariff. Assuming that preferential imports are static, it is possible to decrease the over-quota MFN tariff and to get the resulting prices and imports from the model. An expert look outside the model at preferential supplier’s costs of production can be used to measure the impact of tariff reductions not only on welfare, but also on imports under preferential agreements.
4. Using the model’s domestic and world prices, it is possible to measure the welfare and rent distribution effects of *removing TRQ allocations*. Again, outside the model it is possible to compare preferential supplier’s costs of production to the importing country’s domestic price, to measure the impact of removing TRQ allocations on imports under preferential agreements, and thereby on the distribution of TRQ rents.
5. *TRQ expansion scenarios* can also be performed, by assuming that the new TRQ quantity is globally allocated (in fact, most minimum access TRQs are globally allocated), solve for prices and imports, and perform the welfare calculus.

Figure 1: Effects of a Tariff -Rate Quota



(a) Domestic Market

(b) World Market

Figure 2: Alternative Tariff- Rate Quota Equilibria

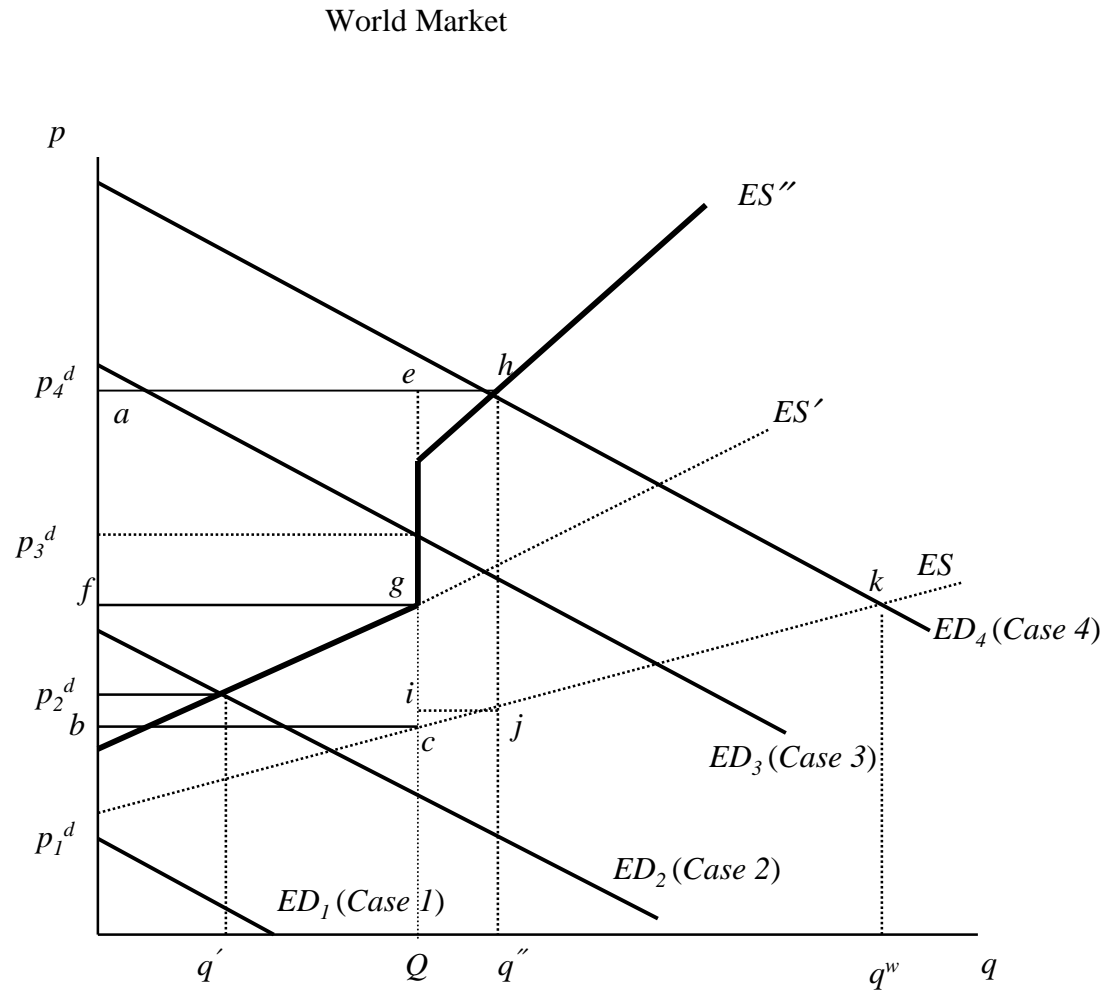


Figure 3: Reduction of the Over-Quota Tariff

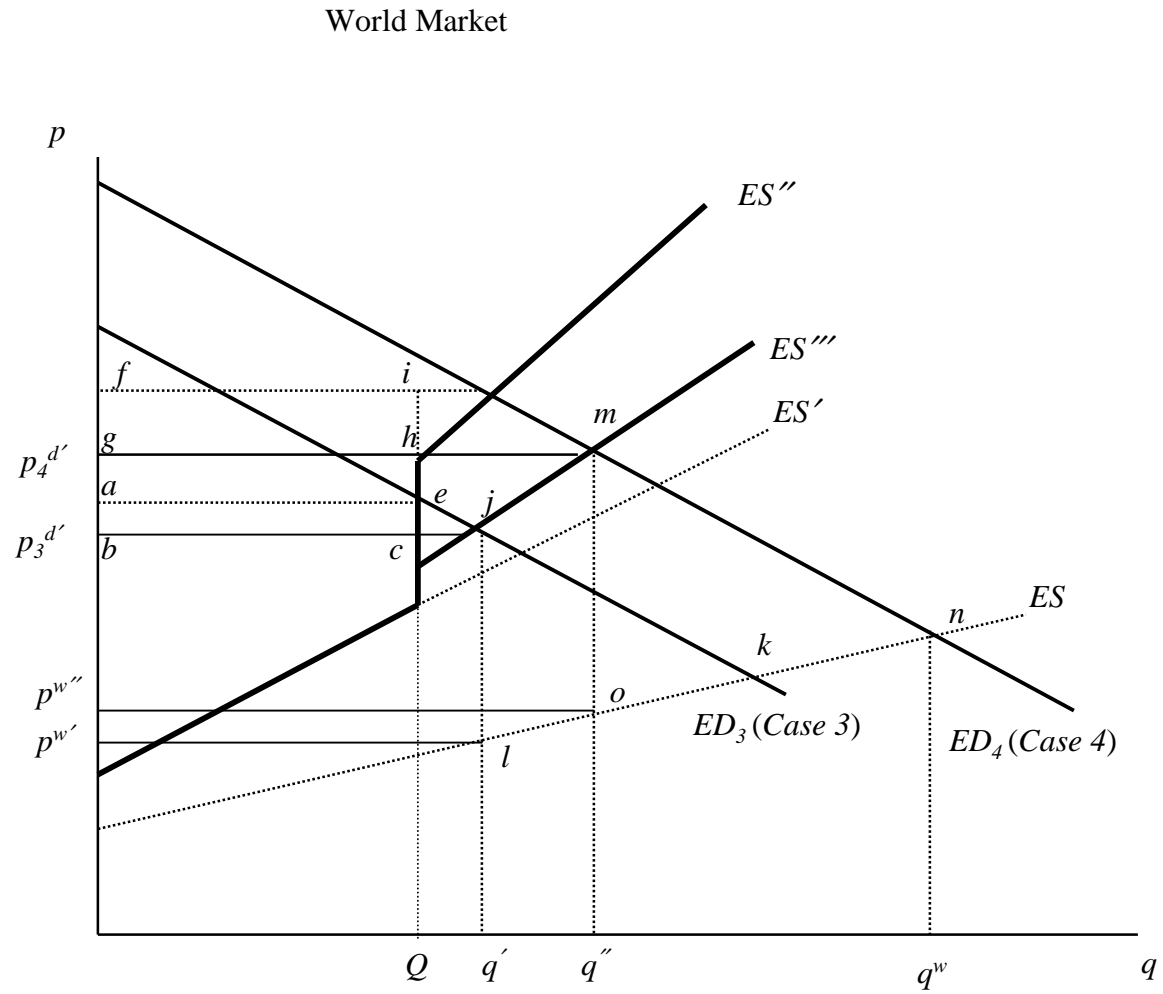


Figure 4: Increase in Market Access

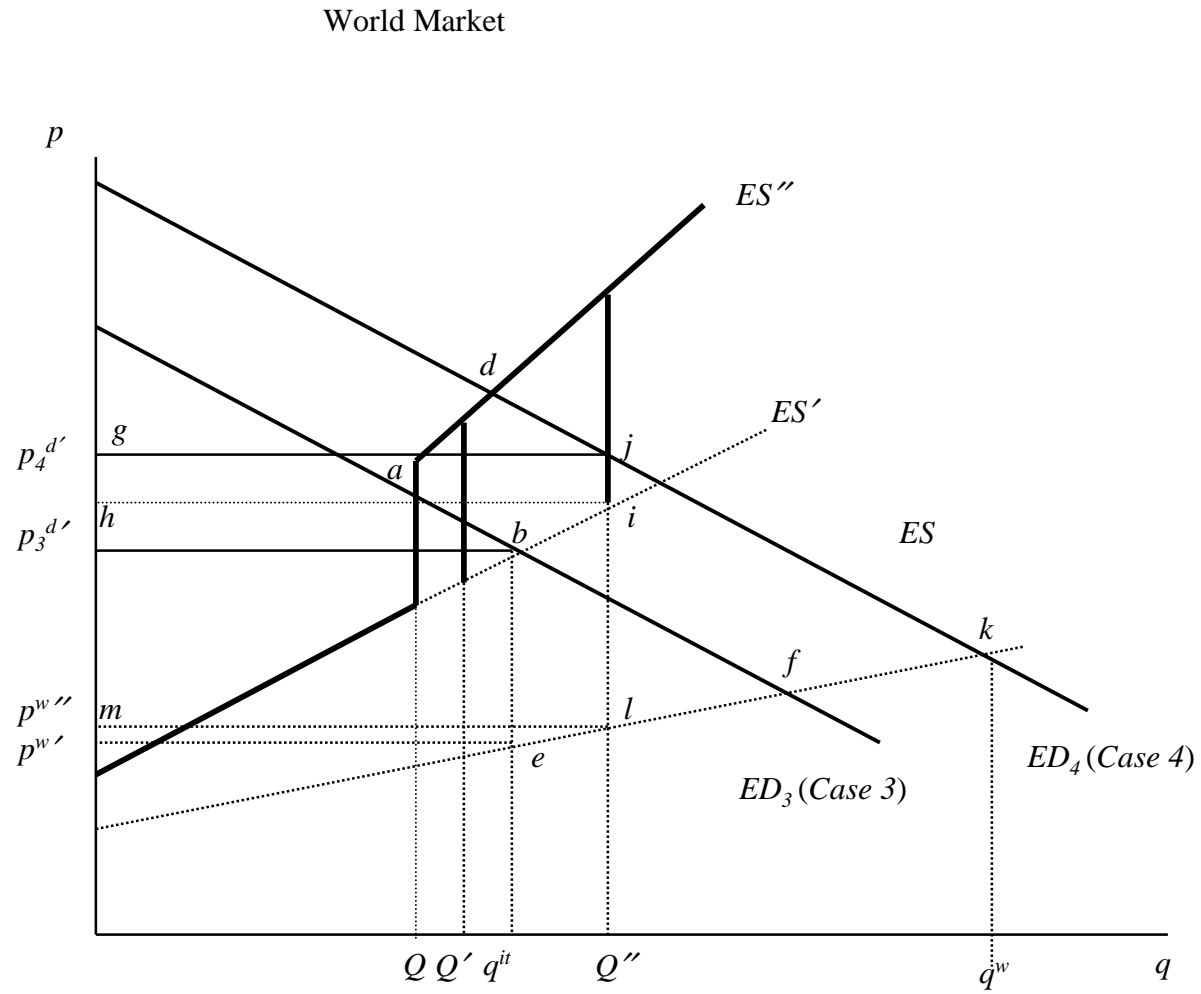
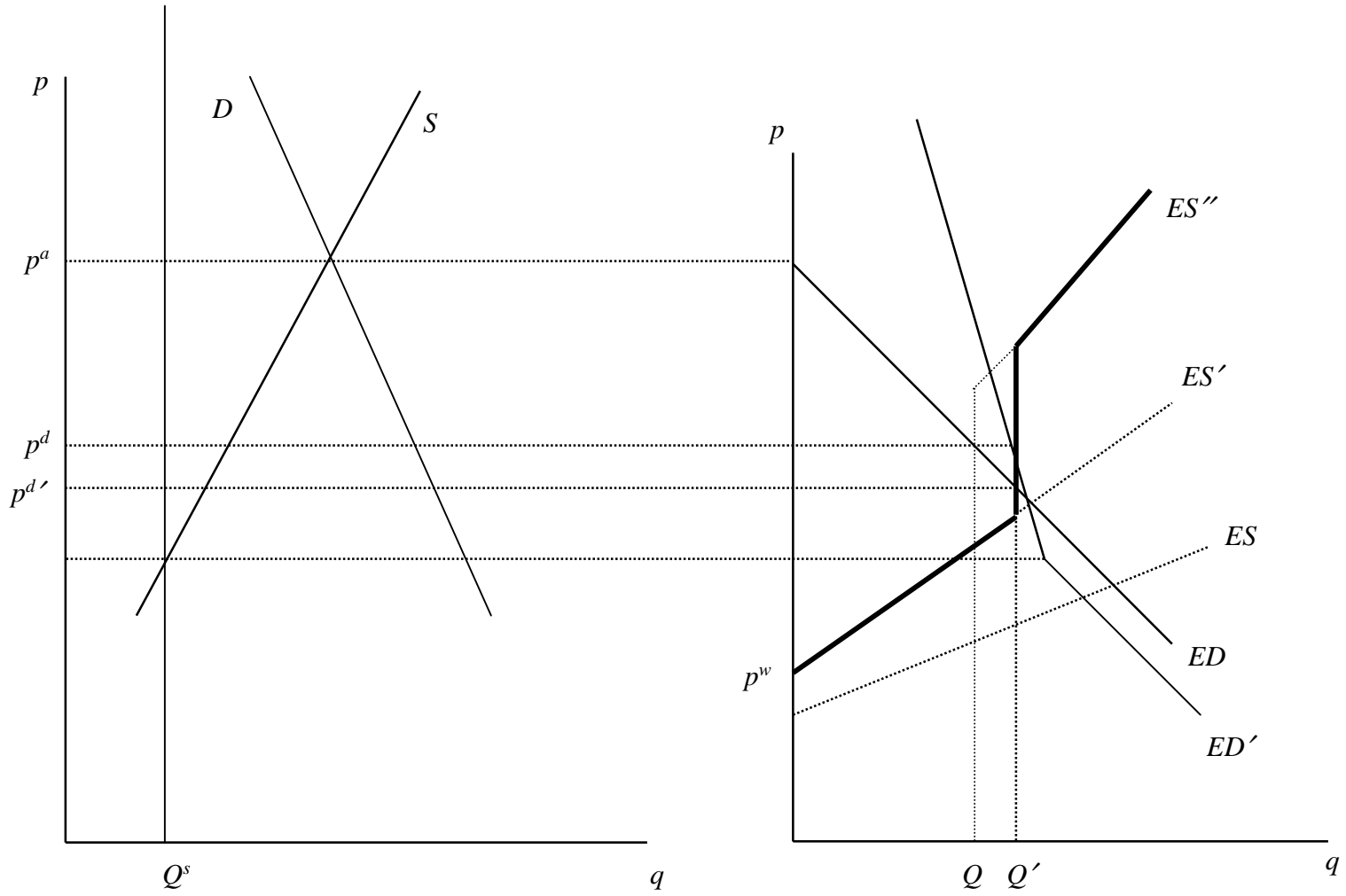


Figure 5: Effects of a Domestic Supply Quota



(a) Domestic Market

(b) World Market

Figure 6: Effect of Export Subsidies on Imports

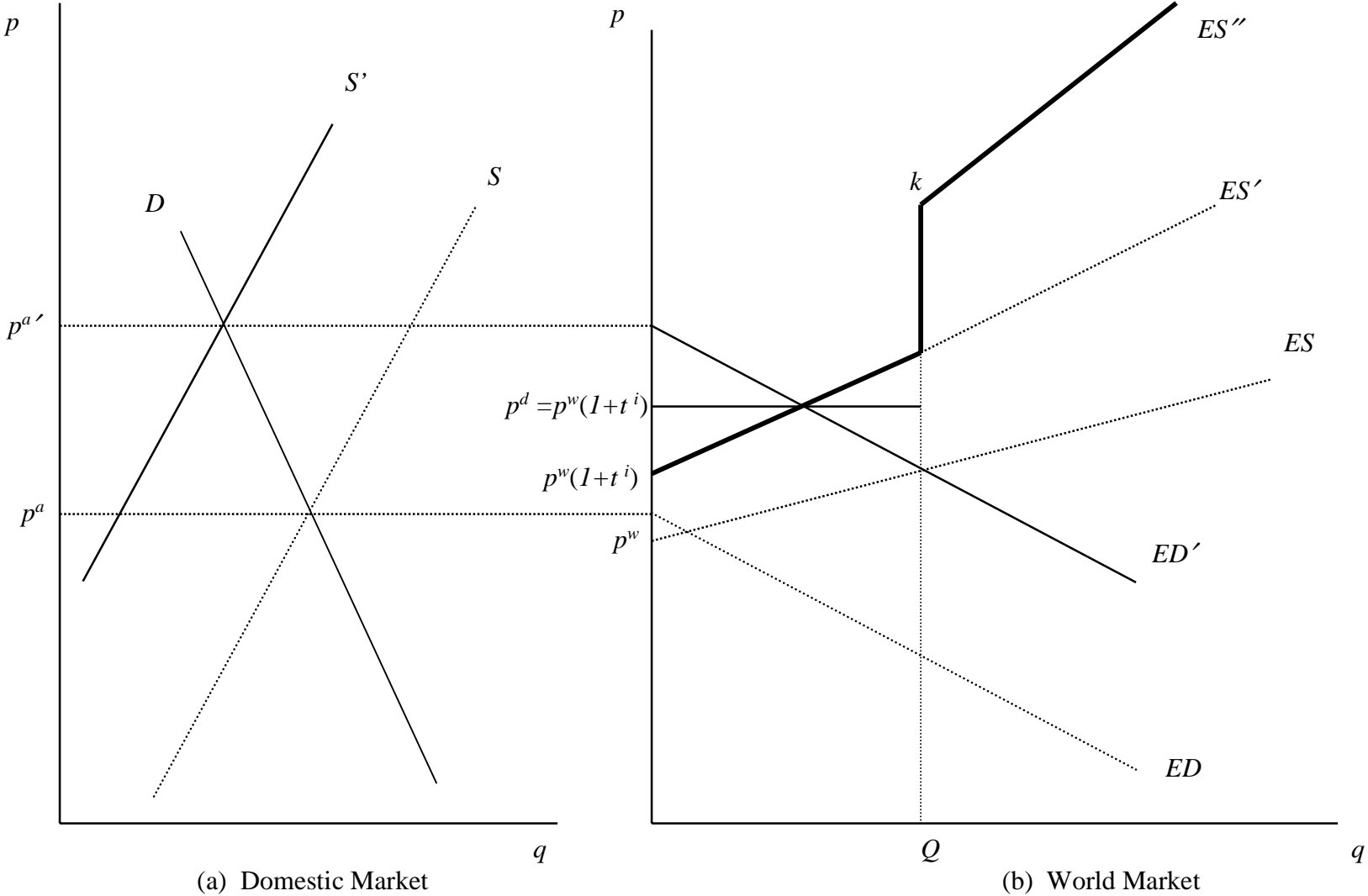
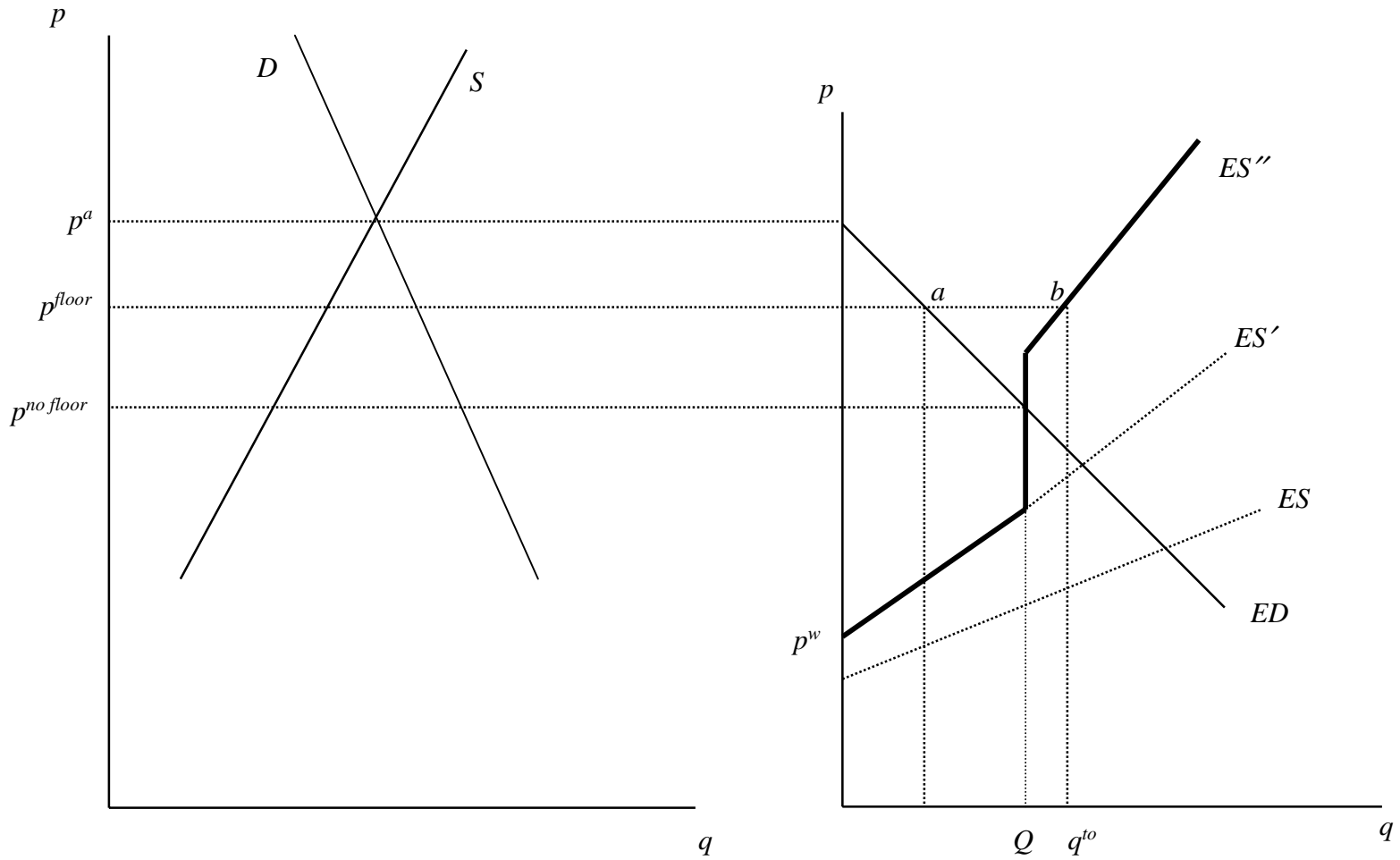


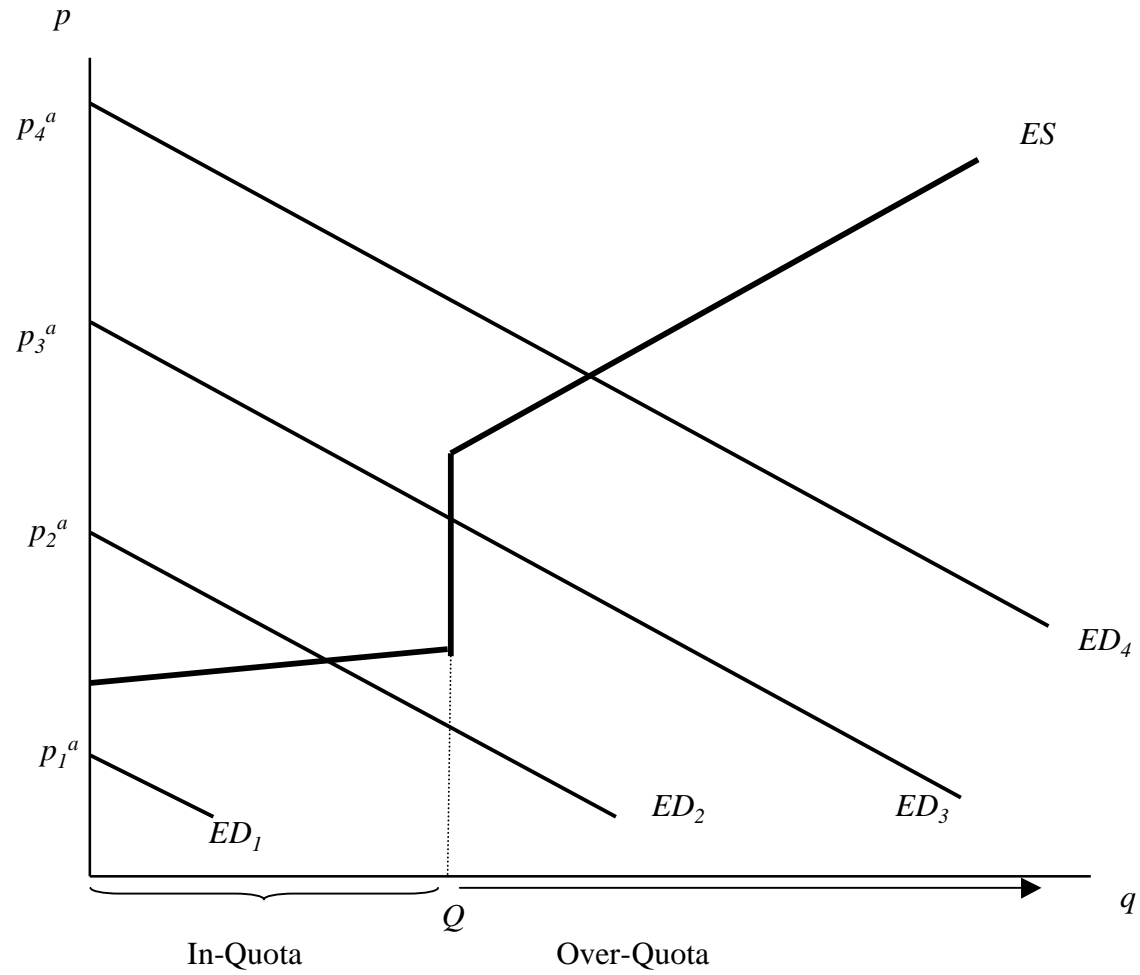
Figure 7: Effects of an Intervention Price



(a) Domestic Market

(b) World Market

Figure 8: Imports Depend on Position of Autarky Price (p^a) Relative to Excess Supply (ES) Curve



**Figure 9: Imports Depend on Elasticities
of Domestic Supply and Demand**

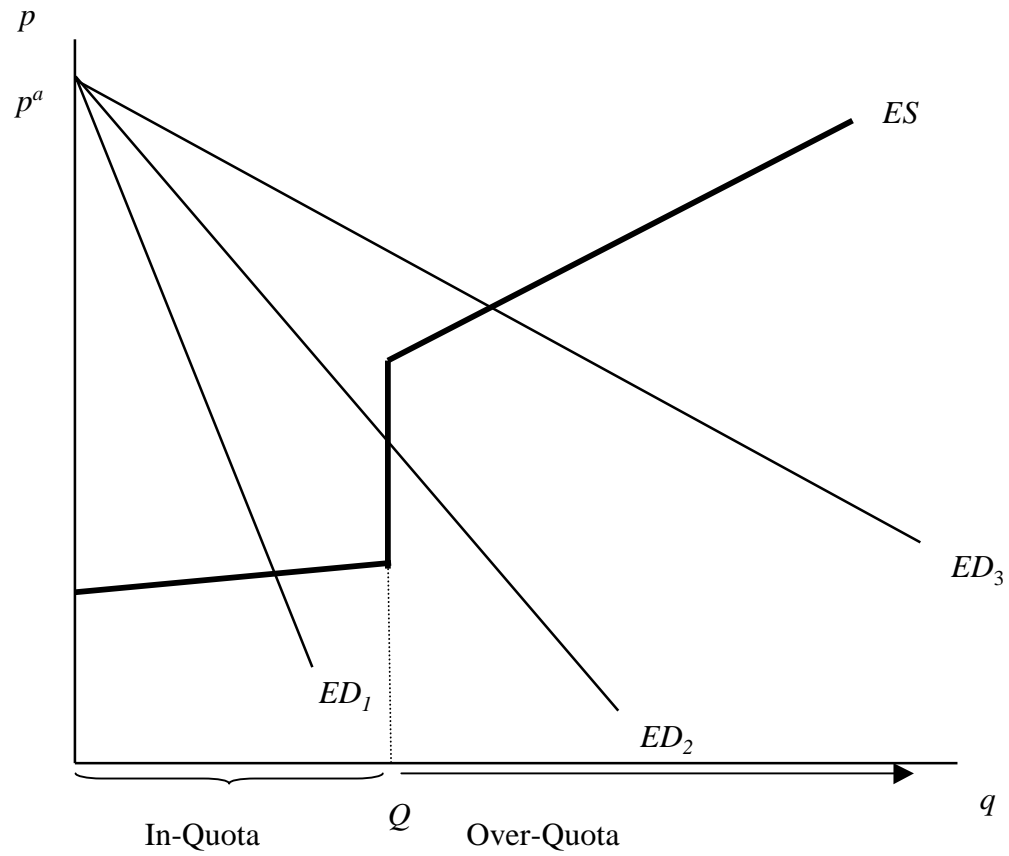


Figure 10: Deriving Autarky Price, Production, and Consumption

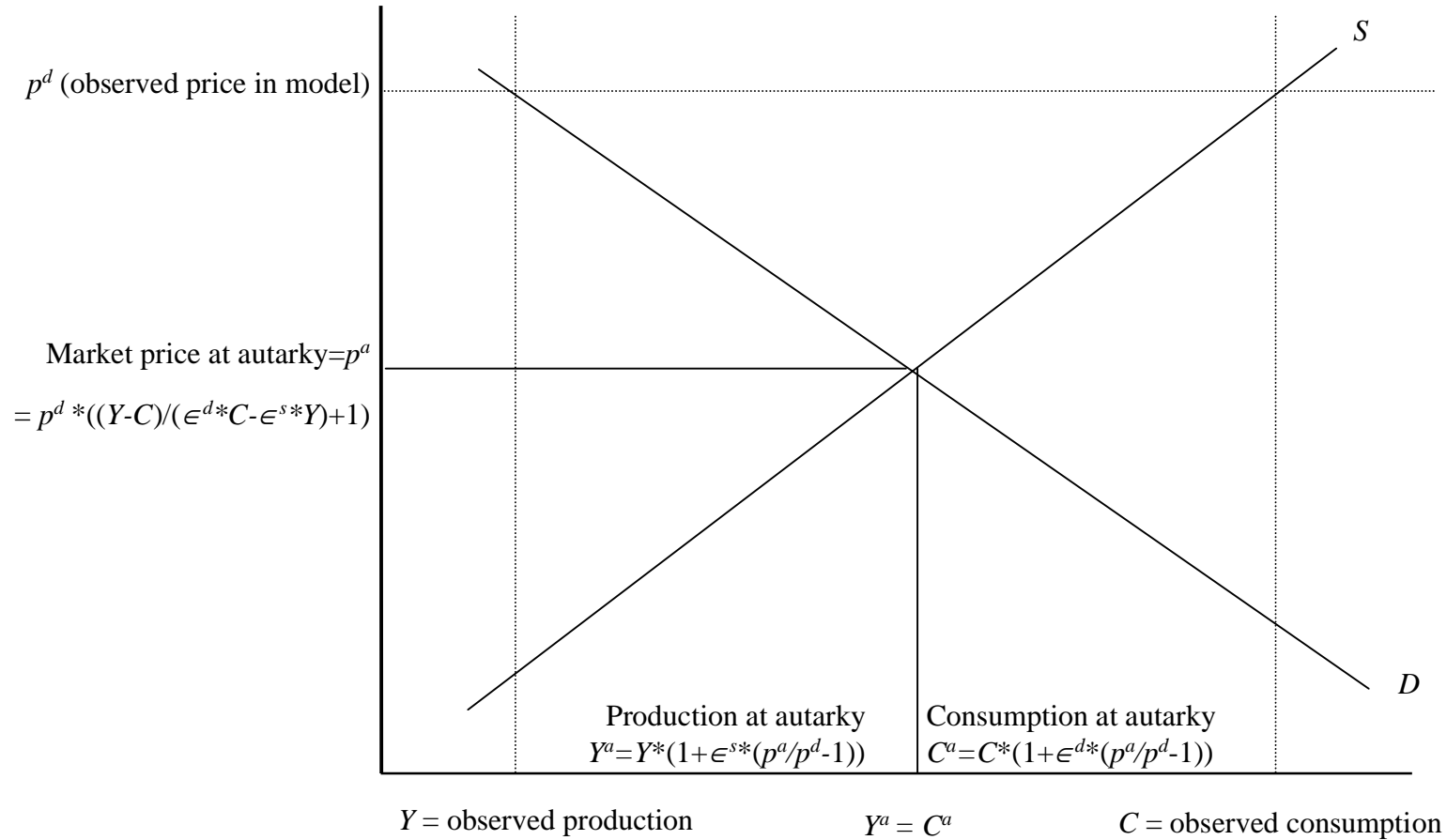


Figure 11: Domestic Market Price Solutions

