Temporary import and export quotas and the current account

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This paper provides a comprehensive analysis of temporary import and export quotas in a two-period optimization model imposing much weaker restrictions on preferences and production technologies than in the existing literature. We demonstrate that under net substitutability the imposition of a temporary quota which reduces imports by a small amount improves the current account and causes an appreciation of the real exchange rate. If the initial equilibrium is quota restricted, the effects of tightening the quota are ambiguous. By contrast, under substitutability, a tightening of export quotas necessarily leads to a current account deficit *regardless* of the nature of the initial equilibrium.

1. Introduction

Historically, countries have employed quantitative restrictions (QRs) at least as frequently as tariffs to combat imbalances in the current account. Yet, a disproportionately large attention has been given in the literature to the analysis of the effects of tariffs on trade balance. The analysis of the effects of quotas on the current account has largely been ignored. In the present paper we intend to correct partially this imbalance in the literature.

Traditionally, the current account effects of tariffs have been studied in one-period models [Johnson (1958), Dornbusch (1980) and Mussa (1976)]. During the 1980s there has been a shift, however, towards dynamic models based on intertemporal utility maximization. Papers by Razin and Svensson (1983), van Wijnbergen (1987), Edwards (1989), Lopez and Rodrik (1990),

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and Lopez and Panagariya (1990) deal with various aspects of current account effects of tariffs in two-period intertemporal optimization models.[1] An important advantage of dynamic models is that they enable us to distinguish between temporary and permanent restrictions.

This paper focuses on the effects of a temporary quota restriction (QR) on the current account and the real exchange rate. To our knowledge, the only author who has analyzed the effects of temporary QRs on trade balance and the real exchange rate is Djajic (1987).[2] Djajic uses a two-period optimization model of a small country with one importable, one exportable and one nontraded good. The importable is not produced and the exportable is not consumed at home. Preferences are homothetic and additively separable over time. The introduction of an import quota involves finite (i.e. noninfinitesimal) movements from the free trade equilibrium. Djajic shows that under Edgeworth substitutability, the introduction of a temporary import quota has an ambiguous effect on the current account and that '(T)he imposition of an unanticipated temporary quota may entail an *instantaneous real depreciation*' of the exchange rate in the case of Edgeworth complementarity.

In the present paper we provide a comprehensive analysis of temporary quotas in a two-period optimization model. We present the analysis in a much more general framework than has been done so far. We do not require preferences to be either homothetic or separable over time so that goods can be net (Hicks) substitutes or complements. By contrast, most authors assume homothetically separable preferences which, with two consumed goods, necessarily imply net substitutability.[3] We also allow for domestic production of the importable as well as domestic consumption of the exportable.

Our contribution to the literature may be summarized as follows. First, we analyze the effects of changes in QRs at the free trade as well as quota restricted equilibrium. We demonstrate that if goods are net substitutes in both consumption and production, the introduction of a *small* temporary import restriction (i.e. the imposition of a quota that reduces imports below the free trade level by a small amount) necessarily improves the current account. Moreover, given net substitutability, the introduction of a small temporary restriction on imports leads to an appreciation of the real exchange rate both in the current and future periods.

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[1]Additional papers based on dynamic models include Obstfeld (1980), Calvo (1981), Sachs (1981) and Svensson and Razin (1983). These papers analyze the effects of changes in the terms of trade and capital controls on the current account.

[2]Contributions dealing with permanent quotas include Mussa (1974), Blejer and Hillman (1982) and Kimbrough (1985).

[3]It is important to distinguish Hicks complementarity from Edgeworth complementarity. The former obtains when, at constant utility, an increase in the price of good i reduces the demand for good j. By contrast, the latter obtains when an increase in the consumption of good i increases the marginal utility of good j. It is possible for goods to be Hicks substitutes but Edgeworth complements.

Second, if the initial equilibrium is quota restricted, a small tightening of the quota has an ambiguous effect on the current account as well as the real exchange rate. Thus, the effect of a temporary quota on the current account is not qualitatively different from that of a temporary tariff. At the free trade equilibrium both instruments lead to an unambiguous improvement in trade balance, while at an initially restricted equilibrium both have an ambiguous effect.[4]

Third, if (i) the importable in the current period is a net complement with the nontraded good in both periods in production as well as consumption and (ii) net substitutability holds elsewhere, a small tightening of the temporary import quota leads to an unambiguous depreciation of the real exchange rate in each period relative to the level prevailing in the initial equilibrium. Interestingly, these results hold regardless of whether the initial equilibrium is characterized by free trade or a quota restriction.

Finally, we consider the effects of temporary export quotas on trade balance. In the static, small-country models, the effects of import and export quotas are qualitatively the same. But we demonstrate that this result does not hold for temporary import and export quotas in dynamic models. In particular, if all goods are net substitutes in consumption as well as production, a small tightening of the export quota leads to a current account deficit regardless of the nature of the initial equilibrium.

The paper is organized as follows. In section 2 we outline the model and summarize some second-order conditions. In section 3 we analyze the effects of an import quota on the real exchange rate and the current account. In section 4 we consider the effects of export quotas. Finally, we make some concluding remarks in section 5.

2. The model

Consider a small open economy producing and consuming three goods, an importable, an exportable and a nontradable. Denote the three goods by subscripts 1, 2 and 3, respectively. There are two time periods, distinguished by superscripts 1 and 2, and referred to as the current and future periods. We denote the current and future prices of the nontraded good, good 3, by p^1 and p^2. Since the country is assumed to be small in the world markets, we can set the spot prices of traded goods in both periods at unity. We assume that imports of good 1 are subject to a quota in period 1 and that quota licenses are auctioned away competitively. Proceeds from the auction are redistributed among consumers. Letting ε be the quota premium, the economy's intertemporal budget constraint may be written as

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$$E(1+\varepsilon,1,p^1,\delta,\delta,\delta p^2;u)=R^1(1+\varepsilon,1,p^1)+R^2(\delta,\delta,\delta p^2)+\varepsilon m^1, \qquad (1)$$

where $E(\cdot)$ is the expenditure function and $R^1(\cdot)$ and $R^2(\cdot)$ are revenue functions in the current and future periods. We assume that $E(\cdot)$ and the $R^j(\cdot)$ $(j=1,2)$, have the usual properties of expenditure and revenue functions including continuity, twice differentiability and linear homogeneity in all prices. Furthermore, the expenditure function is concave and revenue function convex in all prices. The variable u denotes the level of welfare, δ is the discount factor and m^1 is the exogenously fixed level of imports. We assume that the country can borrow and lend at the fixed world interest rate.

We let E_i $(i=1,2,\ldots,6)$ denote the first partial derivative of $E(\cdot)$ with respect to the ith argument. For $i=1,2,3$, the E_i's represent demand for the three goods in period 1, and for $i=4,5,6$, they represent demand in period 2. $R_i^j(\cdot)$ is the partial derivative of $R^j(\cdot)$ with respect to the ith argument $(i=1,2,3;j=1,2)$ and represents the supply of good i in period j. For notational convenience, it is useful to define the excess demand functions for the three goods in the two periods. We write

$$Z_i(1+\varepsilon,1,p^1,\delta,\delta,\delta p^2;u)\equiv E_i(\cdot)-R_i^1(\cdot), \qquad i=1,2,3, \qquad (2a)$$

$$Z_i(1+\varepsilon,1,p^1,\delta,\delta,\delta p^2;u)\equiv E_i(\cdot)-R_{i-3}^2(\cdot), \qquad i=4,5,6. \qquad (2b)$$

The import quota on good 1 in period 1 and market-clearing conditions for the nontraded good in the two periods, respectively, imply

$$Z_1(\cdot)=m_1, \qquad (3)$$

$$Z_3(\cdot)=0, \qquad (4)$$

$$Z_6(\cdot)=0. \qquad (5)$$

where we recall that m^1 represents the exogenously fixed quantity of imports in period 1 and $Z_3(\cdot)$ and $Z_6(\cdot)$ are the excess demands for the nontraded good in periods 1 and 2.

Eqs. (1) and (3)–(5) are four equations in four endogenous variables, u, ε, p^1 and p^2. For an exogenously specified level of m^1, we can solve these equations for the four variables. The current account balance is given by

$$B^1=-\delta B^2=\delta[Z_5(\cdot)+Z_4(\cdot)], \qquad (6)$$

where $Z_4(\cdot)$ stands for imports of good 1 and $-Z_5(\cdot)$ for exports of good 2 in period 2.

We conclude this section by summarizing some second-order conditions

which will play an important role in the comparative statics analysis in the next section. For this purpose, let us define the matrix

$$
\begin{bmatrix} \zeta_{33} & \zeta_{36} \\ \zeta_{63} & \zeta_{66} \end{bmatrix}
$$

$$
\equiv \begin{bmatrix} (-1/Z_{11})(Z_{31})^2 + Z_{33} & (-1/Z_{11})\delta Z_{16}Z_{31} + \delta Z_{36} \\ (-1/Z_{11})\delta Z_{61}Z_{13} + \delta Z_{63} & \delta^2[(-1/Z_{11})(Z_{61})^2 + Z_{66}] \end{bmatrix}.
\tag{7}
$$

Intuitively, ζ_{ij} represents the effect of a change in the jth price (i.e. p^1 or p^2) on the ith excess demand (i.e. Z_3 or Z_6) holding all other variables except ε constant. We adjust ε to ensure that eq. (3) continues to hold. Observe that $\zeta_{36} = \zeta_{63}$ as expected.

As shown by Diewert (1981), concavity of the expenditure function combined with convexity of revenue functions in prices implies that the diagonal elements of the above matrix are nonpositive and the determinant of the matrix is positive. Following the standard practice we assume, for purposes of comparative statics analysis in the next section, that these inequalities hold in the strict form. Formally, we write

$$
\zeta_{33}, \zeta_{66} < 0 \quad \text{and} \quad |\zeta| \equiv \zeta_{33}\zeta_{66} - (\zeta_{36})^2 > 0.
\tag{8}
$$

Throughout the paper we assume that excess demands for the nontraded good across periods exhibit substitutability. This assumption guarantees that $\zeta_{36} \ (= \zeta_{63})$ is positive.

3. The effects of a change in the import quota

We are now in a position to consider the effects of a change in the temporary quota on the real exchange rate and balance. Differentiating (1) and (3)–(5) totally, we have

$$
Z_u \cdot \mathrm{d}u = \varepsilon \cdot \mathrm{d}m^1,
\tag{9}
$$

$$
Z_{11}\mathrm{d}\varepsilon + Z_{13}\mathrm{d}p^1 + \delta Z_{16}\,\mathrm{d}p^2 + Z_{1u}\,\mathrm{d}u = \mathrm{d}m^1,
\tag{10}
$$

$$
Z_{31}\mathrm{d}\varepsilon + Z_{33}\mathrm{d}p^1 + \delta Z_{36}\,\mathrm{d}p^2 + Z_{3u}\,\mathrm{d}u = 0,
\tag{11}
$$

$$
Z_{61}\mathrm{d}\varepsilon + Z_{63}\mathrm{d}p^1 + \delta Z_{66}\,\mathrm{d}p^2 + Z_{6u}\,\mathrm{d}u = 0,
\tag{12}
$$

where we note that $Z_u \equiv E_u$ and $Z_{1u} \equiv E_{1u}$.

Eq. (9) states the usual result that in a small open economy distorted only

by a quota the change in real income equals the quota premium times the increase in imports.[5] Eq. (10) states that the changes in the demand for imports induced by changes in ε, p^1, p^2 and u must equal the exogenous expansion of the quota. Finally, eqs. (11) and (12) state that the net change in the excess demand for the nontraded good due to changes in the endogenous variables must be zero in each period.

In analyzing the effects of a temporary quota on the real exchange rate and trade balance, we distinguish between two effects: a wealth effect and a substitution effect. The former is defined to include the effect resulting purely from a change in utility, *holding all prices constant*. The latter includes all effects operating through prices and consists of a direct and an indirect substitution effect. The direct substitution effect results from a change in prices, holding utility constant. The indirect substitution effect results from price changes induced by the change in utility.

3.1. Effects on the real exchange rate

We first consider the effects of the import quota on the real exchange rate. We define the real exchange rate as the price of the nontraded good in terms of the exportable. Under this definition, the real exchange rate coincides with the price of the nontraded good. We solve eqs. (9) and (10) for du and $d\varepsilon$ and substitute the solutions into (11) and (12) to obtain two equations in p^1 and p^2. Solution of the latter, in turn, yields:

$$(1/A) \, dp^1/dm^1 = [\zeta_{66} Z_{31} - \zeta_{36} Z_{61}] \cdot \{1 - (\varepsilon Z_{1u}/Z_u)\}$$

$$+ (\varepsilon Z_{11}/Z_u) \{\zeta_{66} Z_{3u} - \zeta_{36} Z_{6u}\}, \tag{13}$$

$$(1/A) \, dp^2/dm^1 = [-\zeta_{63} Z_{31} + \zeta_{33} Z_{61}] \cdot \{1 - (\varepsilon Z_{1u}/Z_u)\}$$

$$- (\varepsilon Z_{11}/Z_u) \{\zeta_{63} Z_{3u} - \zeta_{33} Z_{6u}\}, \tag{14}$$

where $A \equiv -1/(|\zeta| Z_{11}) > 0$.

In terms of the definitions introduced earlier, in each of these equations the first term on the right-hand side is the substitution effect and the second term the wealth effect. The first term has two parts. The first part, obtained by multiplying the term in square brackets by 1, is the direct substitution effect. This part represents the effect of a change in m^1 on p^1 and p^2 through

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[5]Since $Z_u(=E_u)$ is the reciprocal of the marginal utility of income, $Z_u du$ equals the change in real income in terms of the numeraire.

a change in ε, holding utility constant. The second part, obtained by multiplying the term in square brackets by $-\varepsilon Z_{1u}/Z_u$, is the indirect substitution effect. This part represents the effect on nontraded goods prices of the change in ε induced by the change in u. As long as all goods are normal, $\varepsilon Z_{1u}/Z_u < 1$ and the direct effect dominates unambiguously. Thus, the sign of the (net) substitution effect is the same as that of the direct substitution effect. Finally, the wealth effect, given by the last term in (13) and (14), is the effect resulting directly from the change in utility, holding ε constant.

The sign of the direct and hence net substitution effect depends critically on the substitutability properties of excess demands for various goods. Two cases may be distinguished. In the first case, we assume that excess demands for all goods exhibit net (Hicks) substitutability. In the second case, we assume that (i) the import demand for good 1 exhibits complementarity with the excess demand for the nontraded good in each period and (ii) net substitutability prevails everywhere else. In what follows we refer to these two cases as the substitutability and complementarity cases, respectively.

Consider first the case of an initial free trade equilibrium. In this case, a small restriction on imports does not affect utility and the indirect substitution effect and the wealth effect are absent. Formally, $\varepsilon = 0$ at the free trade equilibrium and the second part of the first term and the second term in (13) and (14) disappear. Thus, the effect of the quota is determined entirely by the direct substitution effect. This effect is positive in the substitutability case and negative in the complementarity case. In the former case, a tightening of the quota raises ε which, in turn, raises the excess demand for the nontraded good and leads to an appreciation of the real exchange rate in each period (p^1 and p^2 rise). In the latter case, the excess demand declines and the real exchange rate depreciates. These effects are shown in column 2 of table 1.

If the initial equilibrium is quota restricted, ε is positive initially. Therefore, in addition to the direct substitution effect similar to the one obtained at the free trade equilibrium, we also have the indirect substitution effect and the wealth effect. The former effect is the same as in the previous case while the latter ones operate through a change in utility. A tightening of the quota reduces utility, which affects the excess demand for the nontraded good directly as well as through ε. Ceteris paribus, the decline in utility lowers ε and gives rise to the indirect substitution effect. This effect is negative in the substitutability case and positive in the complementarity case. The wealth effect, defined as the effect of the change in utility at constant ε, reduces the demand for the nontraded good and is negative under substitutability as well as complementarity. The signs of different effects are shown in rows 1 and 2 and columns 3–5 in table 1.

As already noted, the net substitution effect has the same sign as the direct substitution effect. Thus, in the substitutability case this effect is positive,

Table 1

Effect of a small reduction in imports via a quantitative restriction.

Effect on 1	Free trade in the initial equilibrium 2	Quota exists in the initial equilibrium				
		Substitution effect			Wealth effect 6	Total effect 7
		Direct 3	Indirect 4	Net 5		
Real exchange rate (p^1, p^2)						
1. Substitutability case	+	+	−	+	−	?
2. Complementarity case	−	−	+	−	−	−
Balance in period 2 (B^2)						
3. Substitutability case	−	−	+	?	+	?
4. Complementarity case	?	?	?	?	+	?

while in the complementarity case it is negative. Since the wealth effect is always negative, the overall effect of a tightening of the quota on the nontraded goods prices is ambiguous in the substitutability case and negative (i.e. depreciation of the real exchange rate) in the complementarity case.

3.2. Effects on the current account balance

Let us now turn to the effects of a quota on the current account balance. The effect is evaluated most easily by looking at the balance in the second period. Totally differentiating B^2 in (6) we have

$$
\frac{dB^2}{dm^1} = -\left[(Z_{41} + Z_{51}) \left\{ \frac{\partial \varepsilon}{\partial m^1} + \frac{\partial \varepsilon}{\partial u} \frac{\partial u}{\partial m^1} \right\} + (Z_{43} + Z_{53}) \right.
$$

$$
\times \left\{ \frac{\partial p^1}{\partial m^1} + \frac{\partial p^1}{\partial u} \frac{\partial u}{\partial m^1} \right\}
$$

$$
\left. + (Z_{46} + Z_{56}) \left\{ \frac{\partial p^2}{\partial m^1} + \frac{\partial p^2}{\partial u} \frac{\partial u}{\partial m^1} \right\} + (Z_{4u} + Z_{5u}) \frac{\partial u}{\partial m^1} \right]. \tag{15}
$$

As in the case of the real exchange rate, we can divide the total effect on B^2 into substitution and wealth effects. These effects are given, respectively, by the first three and the last terms on the right-hand side of (15). The direct substitution effect is given by the sum of the terms involving the direct partials of ε, p^1 and p^2 with respect to m^1, while the indirect substitution

effect is represented by the sum of partials involving $\partial u/\partial m^1$ in the first three terms.

If the initial equilibrium is characterized by free trade, utility does not change in response to the introduction of a small quota and the indirect substitution effect and the wealth effect are absent. Assuming substitutability everywhere, the effect of a reduction in m^1 is to raise ε, p^1 and p^2. Each of these changes increases the excess demand for the importable as well as exportable in period 2. Thus, trade balance in period 2 is worsened unambiguously, as shown in row 3, column 2 of table 1. Put differently, the current account, B^1, improves.

An improvement in the current account following an *appreciation* of the real exchange rate may seem counter-intuitive. It is important to note, however, that in terms of the first-period effects, the appreciation itself affects the current account in the expected direction. Thus, the increase in ε and appreciation of the real exchange rate which accompany the quota do reduce exports in period 1 and exert a negative effect on the current account as expected. This effect is counteracted, however, by the reduction in imports in period 1 brought about directly by the temporary quota. Our analysis of the second-period trade balance shows that this positive effect is larger than the negative effect owing to the appreciation of the exchange rate, with the result that there is a net improvement in the current account.

In the complementarity case, the introduction of a small import restriction at the free trade equilibrium leads to a *decline* in p^1 and p^2, although ε continues to rise. The former change generates a positive effect and the latter one a negative effect on the second-period trade balance. The net result of these two effects is ambiguous in general. Thus, as shown in row 4, column 2 of table 1, the effect of the introduction of a quota on the trade balance in period 2 and hence the current account is ambiguous in this case.

Finally, let us allow for a quota in the initial equilibrium. For brevity, we consider only the substitutability case and report the results in the complementarity case in table 1. We must now add the indirect substitution effect and the wealth effect to the direct substitution effect. The indirect substitution effect is the effect of the decline in u on the current account operating through prices, ε, p^1 and p^2. We know from our analysis in subsection 3.1 that, ceteris paribus, the reduction in u reduces ε, p^1 and p^2 (see columns 4 and 6 of row 1 in table 1). These changes, in turn, lower the excess demand for exportables and importables in period 2. Thus, the indirect substitution effect on trade balance in period 2 is positive, as shown in row 3, column 4 of table 1. Because this is the opposite of the direct substitution effect, the net substitution effect is ambiguous.[6] The wealth effect of the quota consists of the effect of the decline in u at constant prices and is positive, as

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[6]Recall that the total effect of the quota on p^1 and p^2 is ambiguous in the substitutability case. Therefore the net substitution effect on the trade balance must also be ambiguous.

shown in row 4, column 6. The overall effect of the quota on the trade balance is ambiguous.

4. Effects of a temporary export quota

We now consider the effects of an export quota. Recall that in the static, small country model, import and export quotas have the same qualitative effects. We show that this does not hold true for temporary import and export quotas in the present model.

The simplest way to analyze the effects of export quotas is to assume that the country exports good 1 and that m^1 is negative. Then a tightening of the export quota is equivalent to an increase in m^1 (i.e. a reduction in the absolute value m^1). We can conclude immediately from (13) and (14) that in the substitutability case a small reduction in exports in period 1 at the free trade equilibrium leads to an unambiguous *decline* in the nontraded goods prices in both periods relative to their level in the original equilibrium. Intuitively, the introduction of the export quota lowers the price of the exportable (ε becomes negative) and, given substitutability, reduces the excess demand for, and hence the price of, the nontraded good in each period. In the complementarity case, the opposite happens.

If an export quota exists initially in the substitutability case, the net substitution effect operates in the same direction as the direct substitution effect. Moreover, the wealth effect lowers the demand for the nontraded good in both periods and, thus, reinforces the substitution effect. Nontraded goods prices decline unambiguously in both periods relative to their levels in the initial equilibrium. In the complementarity case, the effect of a further tightening of the quota on the real exchange rate becomes ambiguous.[7] The substitution effect raises the nontraded goods prices while the wealth effect lowers them.

Assuming that trade is free initially and net substitutability prevails everywhere, we see from (15) that the introduction of a small export quota (i.e. an increase in m^1) leads to an unambiguous improvement in trade balance in period 2, or equivalently to a deterioration of the current account. If good 1 exhibits complementarity with excess demands for the nontraded good, the effect on the current account is ambiguous.

An important point to note is that in the substitutability case, even if the initial equilibrium is quota ridden, the effect of a tightening of the quota on the current account is unambiguously negative. A tighter export quota reduces each of ε, p^1 and p^2 which, in turn, reduces the excess demand for tradables in period 2. Moreover, utility declines and reinforces this effect. Thus, trade balance in period 2 improves and that in period 1 worsens.

[7]Strictly speaking, changes in the real exchange rate must now take into account the change in the domestic price of the exportable. For the sake of simplicity, the discussion in the text relies on the price of the nontraded good in terms of the world price of the exportable.

5. Concluding remarks

We have presented a comprehensive analysis of the effects of temporary import and export quotas on the current account and the real exchange rate in a two-period model. Since a summary of our results has already been provided in the Introduction, here we simply note that conclusions depend critically on whether or not complementarities in consumption and production are important and whether or not the initial equilibrium is characterized by free trade.

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