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# International Quota Transfer and Intermediate Goods

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# **INTERNATIONAL QUOTA TRANSFER AND INTERMEDIATE GOODS\***

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# INTERNATIONAL QUOTA TRANSFER AND INTERMEDIATE GOODS

## ABSTRACT

In this paper we use a general equilibrium model to examine the effects of international quota transfer when a quota restricts world commodity production whilst the trade in an intermediate good is not regulated. The analysis shows that, when the quota regime is not internationally transferable, intermediate input trade substitutes for final good trade. In these circumstances, the distortions are lower than expected. International quota transfer increases world welfare proportionally to quota rent gap. Welfare distribution is also conditioned by commodity terms of trade and, particularly, by the outcome of the intermediate good price.

**Keywords:** Production quota; international trade; intermediate goods.

## INTRODUCTION

Production quotas in European Union agriculture are normally transferable between firms within the frontiers of each country, whilst there are practically fixed and not transferable between the different EU Member States.

Economic literature has frequently underlined the dead weight loss that an individually non-transferable quota imposes as compared to the effects of a transferable system (Fulginiti and Perrin, 1993, a; 1995). This is the case because, in an industry under a regime of individually transferable permits, the exchange of licenses between units of production with different marginal costs or productive structures permits efficiency gains until the marginal costs of all the units become equal (Burrell, 1989). This diagnosis can be repeated in the framework of international trade. When a global quota is distributed amongst different economies, the international transfer of licences can imply a world gain in welfare, independent of the way in which this gain is distributed. The international transfer of permits will allow for the production of the regulated good to be reallocated from countries that have a higher opportunity cost to those where this is lower, up to the point where the marginal rate of transformation is the same in all the countries. In this sense, Bureau et al., (1997) have shown that the current allocation of the EU sugar production quota to the different Member States implies an excess burden, as compared to a distribution that is more in accord with comparative advantages. That is precisely what would result if the free transfer of permits were allowed between countries.

Nevertheless, agricultural markets may be vertically related and the existence of an intermediate good, which is an input for the production rationed good, could change the definitive impact of the quota on trade and welfare. For example, when we consider the integration of milk and animal feed markets in the EU; milk production is restricted by a quota while cereals and other animal feed are not or are less restricted. It is no casualty that since 1986, the year of the integration of Spain in the European Community, trade creation on animal feed vegetables has been much more important than trade creation on milk and derivatives (Aguilar, 2001).

Several authors (Larivière and Meilke, 1999; Zhu, Cox and Chavas, 1999; Machemache and Réquillard, 2000) have analysed international markets in which domestic production of an agricultural intermediate input was restricted by a quota; while the final processed good was not restricted. They consider fixed proportions technology. We will explore theoretically the other case: the impact of a final goods production quota on welfare intermediate goods trades. And, we allow for factor substitution.

We use a general equilibrium model in order to analyse the effects on trade and welfare of the international quota transfer. We consider a market in which the production of a final good is restricted by a global quota for the different countries, whilst the market for an intermediate good, which is the input of the final good, is not subject to intervention. Earlier studies on export subsidies have already shown how the existence of an intermediate good modifies the expected effects of this policy (Paarlberg, 1995; Desquilbert and Guyomard, 1998). In our case, the underlying intuition is that the intermediate good trade tends to substitute for that in the final good regulated by quotas. Furthermore, that the change of the commodity terms of trade exerts an influence over

the distribution of the welfare gains generated by the transfer of quotas between two countries

We extend the virtual price model (Neary and Roberts, 1980; Tobin, 1952; Fulginiti and Perrin, 1993,b; Squires and Kirkley, 1996) to international trade in order to allow for supply functions and equilibrium conditions. Quota restrictions are simulated by a production tax cum lump sum subsidy (Parry, 1999). As regards intermediate good supply, we differ from the literature devoted to effective protection or subsidies (Ethier, 1972; Jones, 1972; Sanyal and Jones, 1982; Spencer and Jones, 1992; Woodland, 1977), by analysing the net output of the intermediate good, rather than the gross output (Dixit and Norman, 1980).

The rest of the paper is organised as follows. In Section 1 we present the model. Section 2 is dedicated to an analysis of the effect of international quota transfer. Section 3 closes the paper with a review of the main conclusions. Mathematical calculations have been relegated to two Appendices.

## 1. THE MODEL

The specification of the general equilibrium model uses standard dual techniques (Dixit and Norman, 1980; Wong, 1995). We consider two countries, where country 1 is the domestic country and country 2 is the foreign one. The economy is made up of three goods: the numeraire,  $X_0$ , a final good,  $X_1$ , and an intermediate good,  $X_2$ , used exclusively as an input in the production of good  $X_1$ . All three goods are tradables. The numeraire and the final goods are substitutes in consumption and all the goods are substitutes in production<sup>1</sup>. World production of good  $X_1$  is restricted by a global quota,  $Q$  that is distributed between the two countries, in amount  $q^1$  for the domestic economy and  $q^2$  for the foreign one. The primary production factors of the country, represented by the vector  $Z^i$  ( $i=1,2$ ), are not tradables and remain invariable.

As regards the supply side, production is carried out with the same technology, namely constant scale technology, in the two countries and under conditions of perfect competition. As a result, the profits of the firms are null.

The quota,  $q^i$  restricts supply, thereby generating an unitary quota rent equal to  $t^i$ . Furthermore, we assume that within each country the quota is individually transferable between firms and, therefore, that the quota rent is the same for all the domestic firms. The quota rent  $t^i$  is specific for each economy and depends on the following variables: the actual size of the production quota of the country,  $q^i$ , the price of the final good,  $P_1$ , and the price of the other goods,  $P_2$ ; that is to say,  $t^i = t^i(q^i, P_1, P_2)$ .

National Income in an economy subject to quotas can be represented by a Restricted Gross Domestic Product function (R-GDP),  $G^{c,i}$ , which depends on quota, commodity prices and production factors. Applying the virtual price framework, we could have a

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<sup>1</sup> That is to say, the demand for good  $i$  increases as  $P_j$  rises, there is Non- Jointness in production and the intermediate good is a normal input. Under these conditions, the global gross substitutability of world excess demand is guaranteed, a sufficient condition for the stability of a competitive market (Takayama, 1993).

virtual production tax cum lump sum subsidy<sup>2</sup> equivalent to quota  $q^i$  (Fulginiti and Perrin, 1993,b; Perry, 1999). This levies the supply price of the product with a tax equal to the quota rent,  $t^i$ , and compensates them with a lump sum subsidy equal to  $\pi^i = t^i q^i$ . Thus, under this regime the National Income of country  $i$  is specified using two components. The first is a Non-Restricted Gross Domestic Product function<sup>3</sup> (NR-GDP),  $G^{v,i}$ , that will be maximised for a quantity of production of good one equal to quota,  $q^i$ , when the market price,  $P_1$ , is reduced in a tax,  $t^i$ . The second takes the form of a lump sum subsidy equal to total quota rent.

In the case where the quota is transferred between the countries to a level,  $\xi$  both the virtual tax and the subsidy will also be affected by this transfer. When economy  $i$  acquires quota, its National Income will be given by the following expression (Appendix, A):

$$G^{v,i}(I, P_1 - t^i, P_2, Z^i) + (q^i + \xi^i) t^i - r * \xi^i; \quad i = 1,2 \quad (1)$$

where  $G^{v,i}$  is an NR-GDP function that represents the maximum value of the GDP that country  $i$  can reach with the production factors endowment  $Z^i$  and the international prices of the goods, except that of the good subject to quota, whose price is equal to the market price less the virtual tax. In reality,  $P_1 - t^i$  is the virtual price for which the quota will maximise the NR-GDP function. The second component is the virtual lump sum subsidy, which is equal to total quota rent. Finally, we include the payment for the quota transferred internationally from one country to another, which is equal to the amount transferred,  $\xi^i$  multiplied by the international price of the quota,  $r$ . We consider that the size of the quota of each country,  $q^i$  the amount of quota transferred internationally,  $\xi^i$  and the price of the transferred quota,  $r$  are determined politically and are independent of the decisions of the agents in the model.

For its part, the behaviour of the representative consumer of each economy is given by the expenditure function:

$$E^i(I, P_1, U^i); \quad i = 1,2 \quad (2)$$

where 1 is the price of the numeraire,  $X_0$ ,  $P_1$  is the relative price of good,  $X_1$  and  $U^i$  is the utility of the sole representative consumer of each economy  $i$ . The intermediate good,  $X_2$ , is not consumed.

With these two expressions we can represent the budget equilibrium condition for each country, as well as the commodity market clearing conditions.

For each country the budget equilibrium condition implies that national expenditure has to be equal to national income. Therefore:

$$E^i(I, P_1, U^i) = G^{v,i}(I, P_1 - t^i, P_2, Z^i) + (q^i + \xi^i) t^i - r * \xi^i; \quad i = 1,2 \quad (3)$$

<sup>2</sup> See Parry (1999) for a similar treatment.

<sup>3</sup> In the vicinity of equilibrium there is a relationship between the restricted and the non-restricted GDP function which, following Fulginiti and Perrin (1993,b), is reflected in Appendix A. This relationship is used to determine the function and slopes of the restricted supply, as well as the sign of the Hessian in comparative statics, on the basis of the NR-GDP function in Appendix B.

As the global quota is fixed, it holds that:

$$Q = q^1 + q^2; \quad \xi^1 = -\xi^2 = \xi \quad (4)$$

Finally, we specify commodity market equilibrium conditions, that of the good subject to quotas and that of the intermediate good. Under Walras' Law, one market clearing condition is redundant and, therefore, we only specify the equilibrium market conditions of the goods  $X_1$  and  $X_2$ . According to envelope theorem, the first partial derivative with respect to each price (and which is indicated with the corresponding sub-index) of the expenditure function is the compensated demand of the corresponding good.

Thus, in the market for the good regulated by quotas the equilibrium condition is:

$$E_1^1(I, P_1, U^1) + E_1^2(I, P_1, U^2) - Q = 0 \quad (5)$$

The demand of the two countries has to be equal to the world quota of good 1. In other words, the world excess demand has to be null and the imports  $M_1^i$  of one country equal to the exports of the other:

$$M_1^1 \equiv E_1^1 - q^1 = - (E_1^2 - q^2) \equiv - M_1^2 \quad (6)$$

As good  $X_2$  is an exclusively intermediate good, by Hotellings lemma the first partial derivative with respect to the price  $P_2$  of the NR-GDP (see Appendix B and Dixit and Norman, 1980) is the netput (gross production of intermediate good minus input demand by the final good sector). That is to say, this industry has a negative supply in country  $i$  under the assumption that the input is imported, or a positive one when it coincides with the exports (given that what is not used in the domestic production of good  $X_1$  is exported or, when there is a deficit of this input in the economy, it is imported). In this way, it holds that:

$$G_2^{v,1}(I, P_1 - t^1, P_2, Z^1) + G_2^{v,2}(I, P_1 - t^2, P_2, Z^2) = 0 \quad (7)$$

i.e., the supply of exports of one country has to be equal to the demand for imports of the other ( $X_2^1 = -X_2^2$ ).

In summary, once the quota of each country has been fixed, the excess of demand for good 1 will depend exclusively on consumption. Conversely, the excess of demand of intermediate good 2 is determined exclusively in the production realm.

## 2. COMPARATIVE STATIC

Let us now consider that the factor endowment of the economy is maintained constant and that the international quota transfer varies in a differential,  $d\xi$  starting from a null initial transfer level. We assume that both the resource endowment and the international price of the quota remain constant. In our model, specialisation is incomplete and the domestic economy has comparative advantages in the production of the final good that is subject to quota, as well as in the intermediate good; it is a net exporter for these two goods ( $M_1^1 < 0$ ;  $R_2^{v,1} > 0$ ) and suffers a more restrictive regulation than the foreign market. Therefore, the quota rent in the domestic economy is superior to that of the



foreign economy. From this, we have that there is an economy that demands a quota and a foreign market that transfers it, with the international price of the transferred quota being between the quote rent of the two countries. Under these assumptions, the system of comparative static equations is obtained differentiating those of equilibrium, with the result being the following system of equations:

$$M_1^i dP_1 + E_u^i dU = G_2^{v,i} dP_2 + (t^i - r) d\xi^i \quad i=1,2 \quad (8)$$

$$E_{1,1}^1 dP_1 + E_{1,u}^1 dU^1 + E_{1,1}^2 dP_1 + E_{1,u}^2 dU^2 = 0 \quad (9)$$

$$(G_{2,2}^{v,1} - G_{2,1}^{v,1} (G_{1,1}^{v,1})^{-1} G_{1,2}^{v,1}) dP_2 - G_{2,1}^{v,1} (G_{1,1}^{v,1})^{-1} d\xi$$

$$(G_{2,2}^{v,2} - G_{2,1}^{v,2} (G_{1,1}^{v,2})^{-1} G_{1,2}^{v,2}) dP_2 + G_{2,1}^{v,2} (G_{1,1}^{v,2})^{-1} d\xi = 0 \quad (10)$$

The first equation (8) corresponds to the maintenance of the budget equilibrium condition in each country: the expenditure differential has to be equal to the income differential following the quota transfer. Equations (9) and (10) simply indicate that the differential of the excess of world demand has to be zero in the markets for the two goods. In the case of the excess of world demand for the intermediate good (10), the same is expressed by using the NR-GDP function in accordance with the correspondences established in Appendix B.

Considering that the derivative of the compensated demand with respect to the utility is equal to the derivative of the demand with respect to the income,  $y$  multiplied by the partial derivative of the expenditure function with respect to the utility (Dixit and Norman, 1980), that is to say,  $E_{1,u}^i = C_{1,y}^i E_u^i$ , we can solve the system of equations in order to analyse how the international quota transfer affects the prices of the goods, the welfare of the different countries and the volume of trade.

The first result refers to the world gain in welfare generated by the quota transfer, which would be as follows:

$$E_u^1 dU^1 + E_u^2 dU^2 = (t^1 - t^2) d\xi \quad (11)$$

Its interpretation is the expected one, namely that by transferring the quota of one country to another in which the production of the restricted good has a higher quota rent (lower opportunity costs), the gain in world welfare is directly proportional to the difference in quote rents (or opportunity costs). This is a result similar to the effects of transferring capital between two countries (Wuon, 1994). However, quota rents in our particular case depend on the price of the final good,  $P_1$  the price of the intermediate good,  $P_2$  and on the quota,  $q_i$  (Appendix, B). And, it is important to understand if under a quota regime, trade of the intermediate good could narrow or widen the rent gap and, therefore, could diminish or increase the quota dead weight loss. Then the performance of the intermediate good and its effect on opportunity costs is decisive to understand the quota impact on welfare when there is an intermediate input. This effect will be explained below, in parallel with the analysis of the distribution of welfare gains and the creation of trade by quota transfer.

Solving  $E_u^i dU^i$  in equation (8), we can see the distribution of welfare gains between the two countries. Welfare improvement in each country depends, on the one hand, on the difference between the particular quota rent and the international price of the transfer license and, on the other, on the variation in the commodity terms of trade, that is to say:

$$E_u^i dU^i = (t^i - r) d\xi^i - M_1^i dP_1 + G_2^{v,i} dP_2 \quad (12)$$

Therefore, let us first analyse the effect of the quota transfer on the price of the two goods, namely on that of the intermediate input and on that of the regulated final good. This comes indicated by the following equations:

$$\frac{dP_2}{d\xi} = \frac{-G_{2,q}^{c,1} + G_{2,q}^{c,2}}{G_{2,2}^{c,1} + G_{2,2}^{c,2}} = \frac{-G_{2,1}^{v,1}(G_{1,1}^{v,1})^{-1} + G_{2,1}^{v,2}(G_{1,1}^{v,2})^{-1}}{(G_{2,2}^{v,1} - G_{2,1}^{v,1}(G_{1,1}^{v,1})^{-1}G_{1,2}^{v,1}) + (G_{2,2}^{v,2} - G_{2,1}^{v,2}(G_{1,1}^{v,2})^{-1}G_{1,2}^{v,2})} \quad (13)$$

$$\frac{dP_1}{d\xi} = -\frac{C_{1,y}^1 E_u^1 dU^1/d\xi + C_{1,y}^2 E_u^2 dU^2/d\xi}{E_{1,1}^1 + E_{1,1}^2} \quad (14)$$

The response of the price of the intermediate good to quota transfer (13) is expressed in function of the components of the Hessian of the R-GDP and the NR-GDP functions (Appendix B). Considering the R-GDP function, the price variation depends on the difference between the two countries marginal change in intermediate good net-supply due to a change in final good production, divided by the price derivative of the world market excess supply for the intermediate good. According to the equivalence between the R-GDP and NR-GDP Hessians, and by the convexity of the GDP function, the denominator of this expression is positive. Then, the sign of the variation of the price depends on how the net supply of the intermediate good changes in the two countries when transferring the quota and, particularly, on variations of intermediate input demand in the final sector. If the intermediate good is a normal input, the country that acquires quota will decrease its net supply of the intermediate good, and viceversa. The definitive outcome of the price depends on current differences in intermediate input intensity between the two countries.

Intuitively, we could guess the possible sign of the price variation. If the country that releases the quota does not have comparative advantages in both the final and the intermediate good, it would be a high consumer of the intermediate input. In fact, the two countries have different quota rents and, therefore, face a different virtual price  $P_1$ -t, with this being higher in the foreign country. Considering the concavity of the production functions, it could be thought that in that country the production would be more intermediate input intensive<sup>4</sup>. Thus, it would free a greater quantity of the

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<sup>4</sup> Furthermore, in an economy with three goods, in accordance with the homogeneity condition of degree zero with respect to the supply prices of a good, it holds that:  $G_{1,1}^{v,1}(P_1 - t) + G_{1,2}^{v,1}P_2 + G_{1,0}^{v,1} = 0$ . Similarly, by the symmetry condition of the GDP function, it holds that:  $G_{1,2}^{v,1} = G_{2,1}^{v,1}$ . In this case,

intermediate good by transferring quota than the domestic country would demand by acquiring it and, as a consequence, the price will fall.

Nevertheless, it is impossible to determine a priori the sign of this variation. We try to discover it by using the NR-GDP function (see Appendix B). As the denominator is positive in (13) under the convexity condition with respect to the prices of the NR-GDP function, the sign of the variation in the price again depends exclusively on the numerator. In principle, the sign of the variation in price,  $P_2$  is positive if, and only if, it

hold that:  $\frac{G_{2,1}^{v,1}}{G_{1,1}^{v,1}} < \frac{G_{2,1}^{v,2}}{G_{1,1}^{v,2}}$ . The fulfilment of this condition depends on the sign of the third

derivatives of the NR-GDP function which are, in general, ambiguous (Desquilbet and Guyomard, 1998; Feenstra, 1985, Wong, 1995). Therefore, this question remains undetermined if the production technology is not specified and, indeed, represents one of the limitations of this generic dual approach.

As regards the regulated final good, as in the case under study, the world quota,  $Q$ , will not change. The variation in prices is solved in the integrated market exclusively in the demand ambit. If the demand of the good restricted by quotas is income independent, the price will not be affected by the quota transfer. On the contrary, it would depend on welfare distribution and on the income elasticity of demand.

Indeed, the sign of the denominator in (14) is always negative, in that this is the derivative of the compensated demand with respect to the price itself. Furthermore, in this framework, if  $X_1$  is a normal good,  $C_{1,y} > 0$ , the variation in the price is positive, always provided that the two countries have a gain in welfare, or that the country that has a gain in welfare also has a high demand elasticity of income. Distribution of welfare is affected by changing terms of trade. Therefore, the variation in the price of the good restricted by quotas will ultimately depend on how the price of the intermediate good evolves in the intermediate good market. Thus:

$$\frac{dP_1}{d\xi} = \frac{1}{\partial M_1^1 / \partial P_1 + \partial M_1^2 / \partial P_1} \left[ -C_{1,y}^1 (t^1 - r) - C_{1,y}^2 (r - t^2) - G_2^{v,1} \frac{dP_2}{d\xi} (C_{1,y}^1 - C_{1,y}^2) \right] \quad (15)$$

The denominator in (15) is derivative with respect to the price of the excess of world demand for good 1. It will be negative because we have assumed substitutability in consumption and production (Dixit and Norman, 1980; Takayama, 1993). For its part, if the good is normal, then the first two terms of the sum between brackets are also negative. Therefore, the variation in the price of the final good will be negative only if  $G_2^{v,1} \frac{dP_2}{d\xi} (C_{1,y}^1 - C_{1,y}^2)$  is positive and sufficient high. If the outcome of the

intermediate good price prejudices the domestic economy and if in this economy good 1 is a luxury, then it could eventually happen that the price of good 1 collapses.

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$\frac{G_{1,2}^v}{G_{1,1}^v} = -\frac{P_1 - t}{P_2} - \frac{G_{1,0}^v}{G_{1,1}^v}$  Therefore, with the rest being equal, the relationship being considered will tend to be greater in absolute value in the country that cedes the quota.

As a consequence, the participation of each country in the welfare gains caused by the quota transfer will depend exclusively on the international distribution of the quota rent and on the price change in the intermediate good market. Therefore, as we have assumed that the domestic market is an exporter of the intermediate good and of the non-numeraire final good subjected to quota, a decline of the intermediate good price would deteriorate, directly and through the transmission to the final product price, its commodity terms of trade. In the most extreme case, the quota transfer could prejudice the domestic economy.

In summary, a quota transfer would be of no interest to a country if, as a consequence, it loses a prosperous market for an intermediate input abroad. At least, the model suggests that the benefit of the transfer could be reduced by a worsening of the commodity terms of trade.

Finally, let us analyse whether the quota transfer creates trade in the two sectors, that is to say, in that of the intermediate good and in that of the regulated good. As the equilibrium condition is satisfied in the two markets, it is sufficient to analyse how the exports of the domestic economy will vary with the transfer. The equations are as follows:

$$\begin{aligned} \frac{dX_2^1}{d\xi} &\equiv \frac{dG_2^{c,1}}{d\xi} = G_{2,2}^{c,1} \frac{dP_2}{d\xi} + G_{2,q}^{c,1} \frac{d\xi}{d\xi} = \\ &= \frac{G_{2,1}^{v,1} (G_{1,1}^{v,1})^{-1} (G_{2,2}^{v,2} - G_{2,1}^{v,2} (G_{1,1}^{v,2})^{-1} G_{1,2}^{v,2}) + G_{2,1}^{v,2} (G_{1,1}^{v,2})^{-1} (G_{2,2}^{v,1} - G_{2,1}^{v,1} (G_{1,1}^{v,1})^{-1} G_{1,2}^{v,1})}{(G_{2,2}^{v,2} - G_{2,1}^{v,2} (G_{1,1}^{v,2})^{-1} G_{1,2}^{v,2}) + (G_{2,2}^{v,1} - G_{2,1}^{v,1} (G_{1,1}^{v,1})^{-1} G_{1,2}^{v,1})} \quad (16) \end{aligned}$$

$$\begin{aligned} -\frac{dM_1^1}{d\xi} &= \frac{d\xi}{d\xi} - E_{1,1}^1 \frac{dP_1}{d\xi} - C_{1,y}^1 E_u^1 \frac{dU}{d\xi} = \\ &= 1 - \frac{\varepsilon^2}{\varepsilon^1 + \varepsilon^2} C_{1,y}^1 \left\{ (t^1 - r) + X_2^1 \frac{dP_2}{d\xi} \right\} + \frac{\varepsilon^1}{\varepsilon^1 + \varepsilon^2} C_{1,y}^2 \left\{ (r - t^2) - X_2^1 \frac{dP_2}{d\xi} \right\} \quad (17) \end{aligned}$$

The first equation (16) shows us how the exports of the intermediate good of the domestic economy change when receiving an international quota transfer of the final good. This change depends on the net supply variation of the intermediate good in that economy. Using the components of the Hessian of the NR-GDP function (see Appendix B), the result is clear, namely that the quota transfer restricts intermediate good trade. Effectively, if the intermediate and final goods are substitutes in production, the sign of  $G_{2,1}^v$  is negative while, given the convexity of the NR-GDP function, all the other components of the function are positive. This outcome is logical: if a net exporter country of an intermediate good increase the production of the final good at the expense of a net importer country of the intermediate input, then the exports of the intermediate input would shrink.

This result is important and represents an advance with respect to the analysis of quota systems in partial equilibrium. We say this because it demonstrates that if world

production of a good is restricted by a non transferable quota, the trade in any intermediate input tends to substitute for that of the final good restricted by quota. In summary, there is more trade in the intermediate good under a regime of quotas that are not transferable internationally than under one of transferable quotas.

As we have seen earlier, the effect that this development in intermediate good trade has on its own price and on the price of the other factors is not completely defined. However, if logically the price of the intermediate good increases it will tend to lower the price of the primary production factors in country 2 (Sanyal and Jones, 1982). The net effect could be a lowering of the opportunity cost of the final good in country 2. Then trade of the intermediate input will alleviate the dead weight loss of the non transferable production quotas. At the same time, it will benefit the country that is a net exporter of the intermediate good and prejudice the country which is the net importer of intermediate good (Tribedy, Belodi and Biswas, 1982).

Finally, in equation (17) the variation of the exports of the good regulated by quotas is equal to the increase in production, which is the transferred quota, less the net variation in the demand for the good in the domestic economy. In the expression,  $\varepsilon^1$  and  $\varepsilon^2$  are the import price elasticity of good 1 in the domestic and foreign economies, respectively. The second component of expression (17) suggests the following. First, there is an increase in domestic demand due to the rise in income equal to

$C_{1,y}^1 \left\{ (t^1 - r) + G_2^{y,1} \frac{\partial P_2}{\partial \xi} \right\}$ . Second, this rise in demand would push up the price. Third, the price rise would diminish exports to a greater extent when the relative price elasticity of the foreign country imports  $\left( \frac{\varepsilon_2}{\varepsilon_1 + \varepsilon_2} \right)$  is greater. Therefore, the second

component of this expression is negative and is made-up of the income effect of demand in the domestic economy, multiplied by the relative price elasticity of the demand for imports in the foreign country. The third component affects the demand of the foreign economy, and is symmetric and of the opposite sign to that of the domestic economy.

Of course, in the circumstances where the demand for the good regulated by quotas was income independent in both countries, then the exports of the domestic country would enjoy an increase exactly equal to that of the transferred quota. Therefore, the regime would be impeding the development of trade in the regulated good, although this effect is partially compensated by the intermediate good trade.

### 3. CONCLUSION

In this paper we have used a dual general equilibrium model with two countries and three goods, namely two final goods and one intermediate good which is the input in the industry of the final non-numeraire good. Using this model, we have examined the impact of an international quota transfer in a world market in which the production of the final non-numeraire good is restricted at world level to a fixed quantity,  $Q$ . In our case, the domestic country that receives the quota transfer is also a net exporter of the two goods, i.e. that subject to quota and the intermediate good.

The international quota transfer generates welfare gains that are directly proportional to the quota rent gap between the country that receives the quota and that which cedes it. The distribution of these gains between the two countries is also affected by changes in the commodity terms of trade. In this sense, the effect of the quota transfer over the price of the intermediate good is ambiguous and depends on the variation in the net supply of that good in the two countries. This question remains undetermined if the production technology in the different sectors and the factor endowment of each economy are not specified in a primal model and, indeed, represents one of the limitations of this work.

Furthermore, the price of the final good is insensitive to the quota transfer if the consumption of that good is independent of the income. In the contrary case, the increase in world income will tend to cause the price of this good to rise in the circumstances where both countries obtain welfare gains by way of this transfer, and always provided that we are dealing with a normal good.

Finally, we have made clear that the trade in the intermediate good tends to substitute for that in the final good in a world market subject to production quotas that are not internationally transferable. The development of this trade can affect both the dead weight loss caused by a rigid regime of production quotas, as well as the distribution of welfare between the different countries.

The development of intermediate good trade could lead to an increase in its price. In these circumstances, it is obvious that the increase in the exports of the intermediate good and the increase in its price will benefit countries that enjoy greater comparative advantages in the production of the whole sector, intermediate and final good. This is so because, despite these countries apparently emerging in a more prejudiced state following the coming into force of a non transferable quota regime, because it prevents them from increasing their exports of the final good. By contrast, the worsening of commodity terms of trade will prejudice the country that is a net importer of both goods.

If the increase in the intermediate input price induces a convergence of the opportunity costs of the final good, this would imply an improvement in world welfare, albeit at the cost of a welfare loss in that country.

In summary, the immediate consequence of the application of a regime of quotas that are not transferable internationally is that it jeopardises gains in trade. Nevertheless, if this sector has a tradable intermediate input, then the trade in this intermediate good tends to substitute for that in the final good. In these circumstances, it could happen that the development of trade in the intermediate good would reduce the excess burden caused by a rigid international regime of production quotas, although at the cost of prejudicing the countries that are net importers of this good.

## **Appendix A**

According to Fulginiti and Perrin (1993,b) and Perry (1999), there is equivalence between the restricted and the unrestricted GDP function in the vicinity of the constrained equilibrium. This is expressed as follows:

$$G^c(P_0, P_1, P_2, q, Z) = G^v(P_0, P_1 - t, P_2, Z) + t * q$$

and shows that the GDP at world prices restricted with a production quota,  $q$ , in sector 1 is equal to the GDP at taxed prices of the restricted good plus a lump sum subsidy,  $t * q$ . Therefore,  $P_1 - t$  will be the virtual price at which the optimum production of  $X_1$  will coincide with the quota  $q$ . The quota rent,  $t$ , is equal to the international price of the regulated good,  $P_1$ , less the virtual price of the regulated good. Thus, the quota rent depends on  $P_1$ , on the size of the quota of the country itself,  $q$ , on the price of the good not subjected to restriction,  $P_2$ , and on the variation in the factor endowment  $Z$ . We consider that the factor endowment remains constant and thus it holds that:

$$dt = \frac{\partial t}{\partial P_1} dP_1 + \frac{\partial t}{\partial P_2} dP_2 + \frac{\partial t}{\partial q} dq$$

As the quota rent is equal to the market price subjected to restriction  $P_1$ , less the shadow or virtual price of the regulated good, with this, in turn, being independent of  $P_1$ , it holds that:

$$\frac{\partial t}{\partial P_1} = 1$$

The derivatives of the NR-GDP function with respect to the different prices, under Hotellings lemma, constitute the supply of each product. In our case, the derivative of the NR-GDP function with respect to the virtual price (price of good 1 minus the quota rent) will be the quota,  $q$ . In this way, it holds that:

$$G_1^v(P_0, P_1 - t, P_2, Z) = q$$

$$G_t^v(P_0, P_1 - t, P_2, Z) = -q$$

$$G_{P_1}^v(P_0, P_1 - t, P_2, Z) = G_{P_1}^v(P_0, P_1 - t, P_2, Z) \left( \frac{\partial P_1}{\partial P_1} - \frac{\partial t}{\partial P_1} \right) = 0$$

In summary, the derivative of the NR-GDP function with respect to the virtual price,  $P^v = P_1 - t$ , is equal to the quota,  $q$ . By contrast, as the variation of the rent,  $t$ , is equal to the inverse of the variation of the virtual price, the partial derivative of the NR-GDP function is equal to minus the quota,  $-q$ . Finally, if the quantity restriction is binding, then the supply is insensitive to autonomous variations in the price  $P_1$ .

The NR-GDP function, as a profit function, is homogenous of first degree with respect to the non restricted good market prices and the virtual price,  $P_1 - t$ . Accordingly, it is easy to demonstrate that the R-GDP function is homogenous of first degree in prices  $P_0$ ,  $P_1$  and  $P_3$ . Thus, always provided that we express the rent as a rent relative to the price  $P_0$ , we can take good 0 as numeraire in the two GDP functions.

## Appendix B

In equations (7) and (8), the supply of exports of the netput  $X_2$  of each country is expressed as the partial derivative with respect to the price  $P_2$  of the NR-GDP function. This expression is deduced from a correspondence between the first derivatives of the restricted and unrestricted GDP function, which are expressed in the following way:

$$G_2^c(l, P_1, P_2, q, Z) = G_2^v(l, P_1 - t, P_2, Z) \frac{\partial t}{\partial P_2} + G_2^v(l, P_1 - t, P_2, Z) + \frac{\partial t}{\partial P_2} * q = X_2$$

That is to say, the netput of good  $X_2$ , which is not subject to restriction, is equal to the partial derivative of the NR-GDP function with respect to the price  $P_2$ .

$$G_2^v(l, P_1 - t, P_2, Z) = X_2$$

In equation (10) we can derive the components of the differential of the supply of  $X_2$  in a restricted regime in function of that in a unrestricted regime. Thus:

$$dX_2 \equiv dG_2^c = G_{2,2}^c dP_2 + G_{2,q}^c dq = (G_{2,2}^v - G_{2,1}^v \frac{\partial t}{\partial P_2}) dP_2 - G_{2,1}^v \frac{\partial t}{\partial q} dq$$

It remains to establish both the signs of the derivatives of the quota rent  $t$  with respect to the price of the unrestricted good, as well as the quota. These are obtained by establishing a correspondence between the components of the restricted and unrestricted Hessian.

On the one hand, it holds that the quota rent is equal to the derivative of the R-GDP function with respect to the amount of the quota.

$$G_q^c(l, P_1, P_2, q, Z) = -G_1^v(l, P_1 - t, P_2, Z) \frac{\partial t}{\partial q} + \frac{\partial t}{\partial q} q + t = t$$

Similarly:

$$G_{2,2}^c = \frac{\partial t}{\partial q}; -G_{1,1}^v * \frac{\partial t}{\partial q} = 1 \Rightarrow \frac{\partial t}{\partial P_2} = -(G_{1,1}^v)^{-1} G_{1,2}^v$$

As the NR-GDP function is convex with respect to the prices (as are all profit functions), it holds that the quota rent falls as the quota increases.

Equally, we obtain the derivative of the quota rent with respect to the price of the unregulated good,  $P_2$ .

$$G_{q,2}^c = \frac{\partial t^v}{\partial P_2}; G_{1,2}^v = G_{2,q}^c (G_{q,q}^c)^{-1} \Rightarrow \frac{\partial t}{\partial P_2} = -(G_{1,1}^v)^{-1} G_{1,2}^v$$

If we consider that the two goods, the intermediate and the final, are net substitutes in the production, we can conclude that the quota rent tends to decrease with the price of good 2, which is a logical result.

Thus, we can express the differential of good  $X_2$  as a function of the components of the Hessian of the NR-GDP function:

$$dX_2 \equiv dG_2^c = [G_{2,2}^v - G_{2,1}^v (G_{1,1}^v)^{-1} G_{1,2}^v] dP_2 + G_{2,1}^v (G_{1,1}^v)^{-1} dq$$



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