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Strategic Interaction of International Markets: An Application to the Dairy Market

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Abstract

This paper studies the relation between the government's objectives to sustain income in the dairy sector and the possibility to capture rent in the world market. To do this, two different governmental policies were considered: a direct export subsidy and a price discrimination scheme. These policies were analyzed under strategic and non-strategic scenarios. The results indicate that when there is non-strategic interaction and there exists a low opportunity cost of public funds, the two policies have the same effect on total welfare and lead to the same wealth transfer to producers. When there is a strategic interaction among producers, the price discrimination scheme leads to higher consumer welfare but lower producer benefit, being the net result on total welfare determined by the relative weights of the agents in the welfare function. From the producers' point of view, the export subsidy is preferred to the price discrimination scheme when there is imperfect competition in the world market.

JEL Classification: Q17, F12
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Introduction

A lot of literature has been developed since Brander and Spencer's (1981) contribution in the modeling of strategic interactions in international trade, which provides a valuable insight into the potential design of multilateral trade regimes and, in particular, provides a foundation to policies at the level of international coordination.

The purpose of this paper is to apply part of this literature to study the strategic interaction in the world market of dairy products. Specifically, this document studies the relationship between the government's objectives to sustain income in the dairy sector and the objectives of the capture of rent in the world market. The government's objective to support the agricultural producer can be explained by the relative lower income the agricultural sectors receive when compared to other sectors of the economy, the presence of highly organized interest groups with strong lobby campaigns, and the government's objective to guarantee an alimentary security.

This paper considers two different governmental policies: a direct export subsidy and a price discrimination scheme. These policies are analyzed under two different scenarios: first, imperfect competition in the world market, which implies that the policy has a strategic effect, and, second, under a non-strategic scenario in which the policy serves just as an income support to the agricultural producer.

This document is organized as follows. The first includes the theoretical framework, which corresponds to a summary of the main results of the literature in strategic trade policy. However, being strategic trade policy such a wide and heavily surveyed field, this revision will focus only on that literature that I believe is useful for the later application to the dairy market. The second section contains a description of the main features of the world market of dairy products, and the set up of four different models, which are fully developed in the appendix number two. Given the complexity of the solutions of the generic implementation of the price discrimination models, this document will focus only on numeric solutions, whose main results are discussed in the third section. Finally, the conclusions summarize the main results derived from this work.

I. Strategic Trade Policy

The term *strategic trade policy* refers to a trade policy that conditions or alters a strategic relation between firms. Therefore, firms must have a mutually recognized strategic interdependence, which means that the payoff of one firm must be directly affected by the individual strategy choices of others firms, and this must be understood by the firms themselves.

Brander and Spencer's (1985) contribution on the modeling of strategic interactions in international trade, demonstrates that strategic trade policy provides means of shifting profits towards domestic firms when export markets are imperfectly competitive. The governmental policies are advantageous, principally because they provide a mean of pre-commitment not otherwise available for individual firms. Intervention to alter the strategic interaction between oligopolistic firms can shift profit toward domestic firms and thereby improve welfare, being an important basis of the trade policy.

The study of the strategic trade policy is fundamentally an application of non-cooperative game theory, and therefore uses the Nash Equilibrium as the central equilibrium concept. Strategic interaction between firms creates an opportunity for governmental action to modify the terms of that interaction. A variety of governmental policy instruments have been considered in the literature: export tax/subsidy, direct quantity constraints on exports, and subsidies for research and development among others.

In the Brander and Spencer model, an export subsidy/tax is the only instrument available for the governments, and each country has a single Cournot firm. Baye (1992) considers the case of quotas and Cooper and Riezman (1989) expand the instrument set considered by Brander and Spencer, to include the possibility of subsidies and quantity controls. Finally, the work of Hwang and Shulman (1993) considers also non-intervention as a strategic choice.

One necessary assumption in all these models is that governments can credibly commit their policy choice before the firms make their own choices. Then, strategic trade policy requires some degree of

pre-commitment by governments, as reflected by the common assumption that the government moves before private agents; though, it is important to understand the basis of the government's power to commit.

Brander and Spencer consider a two-stage game on which the government moves first choosing the policy level. Then, in the second stage firms play a Cournot game, that is, a simultaneous move one-shot game in which outputs are strategic variables. They set this game in a third market model[1], on which, one or more firms from a domestic country and one or more firms from a foreign country compete only in a third market. In this setting there is no domestic consumption of the good, which allows the government to separate the profit shifting motives, from actions devoted to influence consumers' welfare. Additionally, this assumption implies that the domestic government can do nothing to directly hinder the foreign firm.

They also assume that there is a single factor of production, that the rest of the economy can be aggregated into a single numeraire sector, and that the utility is linear in income, which serves to eliminate many of the usually general equilibrium issues from consideration.

The policy instrument considered in the model is an export subsidy, whose direct effect is to help a domestic firm vis a vis its foreign rival. Introducing or increasing an export subsidy to the domestic firm causes the output of the domestic firm to rise and the output of the foreign firm to fall.

The strategic interaction of the firms is given by the Hahn stability condition, which requires that each firm's marginal revenue declines as the output of any other firm raises, that is $\Pi_{xy}<0$. This means that the marginal value of increasing the firm's strategic variable (x), decreases when a strategic variable of a rival (y) increases.

Because x and y are strategic substitutes, the best response function of the domestic and the foreign firms are sloping downwards. Then, as

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[1] Brander (1995) also analyzes the case of reciprocal markets. However, for the purpose of this paper the third market model is the only one considered.

the domestic export subsidy increases, total quantity raises, price falls, profit of the domestic firm increases, and those of the foreign firm fall.

The key point is that the firm's gross profits rise more than the amount of the subsidy and the loss in the terms of trade, implying a net gain to the domestic economy. The subsidy has the effect of committing the firm to a more aggressive best response function, which in turn moves the foreign industry to produce less. The optimal domestic subsidy moves the firm to a Stakelberg leader level and the foreign firm to a Stakelberg follower. This explains why the domestic government has the incentive to take a prior policy action that alters the strategic interaction between firms.

Brander (1995) considers some extensions to this basic model, whose results could be summarized as follows:

Allowing the foreign government to be active does not alter the structure of the analysis, since provided that *x* and *y* are strategic substitutes, both governments supply positive subsidies. Within this framework they show that the government subsidy firm is at the Nash Equilibrium, although both firms earn lower profits as a result of intervention. Under symmetry, this government level game has a form of prisoners' dilemma, both producing countries are worse off at the strategic subsidy equilibrium than they would be under free trade, but each has a unilateral incentive to intervene.

In practice raising subsidy revenue imposes a distortional cost on the economy, implying that the opportunity cost (δ) of a public fund dollar would exceed 1. If δ is sufficiently high, the implied policy is tax, rather than subsidy. Another important concession leading to the same result, is when considering the possibility of the domestic government putting less weight on the shareholder's welfare than on the tax payer's welfare.

With multiple domestic and foreign firms, the domestic subsidy now has the effect of increasing the output of domestic rivals. This effect tends to reduce the profit of the i^{th} domestic firm and implies an additional cost of the domestic subsidy. If the number of domestic firms

were large and the number of foreign firms were negligible, then a subsidy would certainly be damaging for the national interest, as domestic firms would compete excessively from a national point of view. As the number of foreign firms grows relative to the number of domestic firms, a subsidy to the domestic firms becomes more attractive. The model can also be readily extended to the case of differentiated products as long as the goods are strategic substitutes.

However, it is important to point out that the policy conclusion of the strategic subsidy model is seen to be exactly reversed when assuming Bertrand rather than Cournot competition; thus, determining the nature of competition seems to be very important in the setting of the strategic trade policy.

The 1955 GATT agreements placed constraints on the use of price and export subsidies, being thus necessary to examine the role of other policies such as Research and Development (R&D), investment subsidies, and more relevant for the dairy industry, the use of price discrimination schemes. As quoted by Brander, the work of Bagwell and Staiger (1994) considers a similar model, allowing the effect of R&D to be explicitly stochastic, and finds that for the case in which R&D simply reduces the mean, but does not change the variance of the cost distribution, R&D's choices are strategic substitutes, regardless the nature of the competition. This suggests that R&D's subsidies might be more robust than export subsidies for strategic policy tools.

The case of export quotas can be seen as an exact analogy of a subsidy/tax policy. The work of Baye (1992) studies quotas as a commitment in the Stakelberg trade equilibrium. In the Baye's model a Stakelberg game is set up in a reciprocal market scenario and a quota in the quantity imported from the foreign country (the follower) is imposed unilaterally by the domestic government in the first stage of the game.

It is straightforward to deduce from Baye's paper what would be the results in a third market scenario, with an export quota imposed unilaterally by the domestic government in the first stage of the game followed by firms playing a Cournot game. The quantity policy is similar to the quantity controls employed in many international commodity agreements; these voluntary export restraints, such as the out-

put quotas employed by the OPEC, take the form of production limit no production dictate, and have a strategic value not present in competitive markets.

Under free trade, the home and the foreign firm will be better off if the domestic firm "promises" not to expand the exports in the case that the foreign firm reduces its exports, obtaining a higher payoff in the collusive outcome. Of course, such a commitment is not credible, as the domestic and the foreign firm would have an incentive to defect, leading to a classical prisoner dilemma. However, the imposition of a government-enforced quota provides a mechanism for the domestic firm to credibly commit to produce no more than the quota. This induces the foreign firm to reduce exports and both firms enjoy higher profits.

Baye considers a reciprocal market model, and thus takes into account the effect of the policy on consumers. Since a third market model is considered here, neither government has to take into account the effect on consumers' surplus. An important remark is that the Baye's model does not consider any strategic behavior by the foreign government as does the Brander and Spencer's model.

One weakness of the results in the Brander and Spencer and Baye's models is that they explicitly constrain the government's choice. For example, in the Brander and Spencer's model, the government can choose to subsidize or tax exports, but other policies are not considered.

Cooper and Riezman (1989) provide a step in this direction by contrasting the use of export subsidies with direct quantity interventions. One important conclusion of this paper is that these two models of intervention lead to identical results when only a single government is intervening and there is no uncertainty. However, this equality fails when more than one government intervenes.

Cooper and Riezman explore the trade-off between the strategic advantage of quantity controls and the cost of their inflexibility. They find that in markets with high volatile demand, governments will control the actions of their firms with subsidies; countries with large number of firms will tax their exports, while countries with few firms will

subsidize, which agrees to the results of Brander and Spencer. Furthermore, in both cases total output is higher than when the government does not intervene in the market.

They also find that in more stable markets, governments will choose to use quantity controls on total market output that on average will be less than the equilibrium output without intervention. In this case both countries are better off than in the equilibrium without intervention, since output is restricted. As in the Baye's model, if governments intervene with direct quantity controls, the outcome in the last stage of the game is determined by the government's actions directly in the prior stage of the game.

The principal result of Cooper and Riezman is that the form of intervention depends on the variability of the environment, being an important determinant of the profit shifting policies.

Finally, the work of Hwang and Shulman (1993) considers non-intervention as a strategic choice. They consider the government previous decision of implementing a subsidy policy, as different from the later decision of selecting the particular policy level. Their results indicate that by introducing non-intervention as a different stage 1 policy choice, non-intervention is much more likely to arise than if the policy regime and the level of the policy where chosen simultaneously. If the government can commit itself to non-intervention in stage 1, then it reduces the optimal stage 2 subsidy chosen by the other country. This is an additional advantage of non-intervention that does not arise when the regime choice and the subsidy level choice are compressed into a single step.

To summarize, perhaps the most robust finding in the analysis of strategic trade policy, is that imperfect competition of the oligopoly type, almost always creates apparent unilateral incentives for intervention. Trade policy will of course be more attractive if the industry has substantially above normal profits. For example, the optimal subsidy will be increasing in the relative cost advantage of the domestic firm, and firms that need help to compete with a foreign rival are the less attractive targets for strategic assistance from a welfare maximizing government point of view.

II. Modeling the Milk Market

A. The World Dairy Market

The dairy industry has the particularity of using a non-tradable input, raw milk, which is processed into the final commodities the consumer receives. The raw milk has two main components, cream and protein, both of which are combined to process milk into final commodities like butter, cheese, and skim milk powder among others. Some of these final goods are tradable, but some are not.

In the world market of dairy products there are two main producers, the European Union[2] and Oceania[3]. In Oceania there are few instruments of agricultural policy, but there exists a dairy board that acts as a monopoly, the domestic market is very small and the production is mainly to export. (See appendix 1.)

On the other hand, in most of the countries of the European Union (E.U.) the dairy industry is the main agricultural activity, constituting around 18% of the total agricultural product of the region. The European Union counts as well with a very large domestic market, being this, one of the main differences with New Zealand and Australia. (See appendix 1.)

The EU has a very strong agricultural policy to support dairy farm income. This policy gives a high weight to producer's surplus, and consists mainly of import quotas, export subsidies, domestic production and consumption subsidies, intervention prices and production quotas (Bouamra, Réquillart; 1999).

Additionally, the presence of the domestic market allows the government to support the income of the dairy sector through the non-tradable products, which could be considered as an indirect aid to the tradable sector. Thus, it is important to recognize that there is a link between the tradable and non-tradable goods in the producer side because of a non-separable cost of production.

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2 Denmark, France, Germany, Ireland, Italy, Netherlands, Spain, United Kingdom.

3 Australia, New Zealand.

The European dairy production has a higher cost when compared to the international standards, making its products less competitive in the world market. Therefore, a subsidy equal to the difference between the world price and the cost of production is set by the EU.government in order to allow the producers to place their goods in the third market. A quota on production, being this external parameter decided for several years, restricts the maximum quantity of subsidized exports.

The 1995 GATT agreements have generated a significant move toward agricultural markets' liberalization, which restricts the instruments traditionally used to sustain farm income in the European Union and raises the question of other policies available to the policy makers such as the price discrimination scheme and its possible strategic effects.

This scheme of price discrimination has been widely used in the United States and Canada and relies on the fact that dairy markets involve multiple commodities with different elasticities, which provides the opportunity of transferring income to the producer through price discrimination (Bouamra *et al*.; 2001). The price discrimination scheme consists of increasing prices in markets with more inelastic demand, which increases the income of producers from these products and enables them to reduce the price of tradable products, having thus an indirect strategic effect in the world market of dairy products.

The purpose of the models developed below is to understand the role of strategic trade policy within the framework of policies implemented to sustain the income of agricultural producers. In particular, two different policies are going to be considered: a direct subsidy to the exports of dairy products financed by the tax payers, and a price discrimination scheme on which the consumers of dairy products are the only ones who bear the cost of the transfer to producers.

B. The Models

The formulation of the models is based on the following assumptions, which were made in some cases to match the reality of the world market of dairy products, and in others, to simplify the solution of the models:

1. The profit of the firm is the objective function to be maximized by Oceania's dairy monopoly, defined from now on as the foreign firm, and defined as the domestic firm by the European Union producers.
2. There is no strategic intervention by Oceania's Government.
3. There is no domestic consumption in Oceania's market.
4. There is domestic consumption of the good in the European Union.
5. Non-separable costs of production of the tradable and non-tradable goods are increasing in the European Union. This cost is equal to the cost of production in Oceania.
6. Since a non-separable cost of production is assumed in the domestic market, the policies adopted by the government will have a negative effect on the quantity sold in the domestic market, thus affecting the consumer's surplus. This spillover effect on consumers has to be taken into account when deciding the optimal policy level.
7. Both players export to a third market only, thus there is no reciprocal effect.
8. For simplicity, the demand functions for the dairy products in the domestic market and in the world market are assumed to be linear.
9. The domestic demand is assumed to have lower price elasticity than the world demand and a higher reservation price.
10. Since there is a vertical relation in the production of dairy goods, the welfare effect of the policies can be measured in a single market, in this case the upstream level, the milk producer.
11. The objective function of the EU government is a welfare function that takes into account the producer surplus, the consumer surplus and the taxpayer surplus. The government decides which policy to use depending on the relative weight of the agents in the welfare function.
12. The quota on milk production is not considered for several reasons. First of all, the imposition of a quota as a strategic parameter does not allow the use of a subsidy as a strategic trade policy instrument. As mentioned in the theoretical framework, the strategic role of the subsidy is to move firms to a Stakelberg leader position

shifting the firms to a more aggressive best response function, but the presence of a quota impedes this possibility, which could be explained as follows.

Despite both instruments reach the same profit shifting results, they both make it through opposite channels. In the subsidy the firms are able to play more aggressively, while in the quota the firms are restricted on the quantity they can put on the third market. Thus, since the quota eliminates any strategic effect of the export subsidy, it is necessary to consider just one instrument at a time.

Several models where run using the quota as a strategic variable obtaining similar results as the models with export subsidy. However, since the quota on milk production is decided for several years, this limits its strategic role in the market, being this another reason to exclude quota from the analysis.

13. The dynamics of the model is considered as a Brander two-stage game, where the government commits in the first stage on its policy level, and then, in the second stage the domestic firm and the foreign firm decide the level of production and exports.

14. Two possible market scenarios are considered. One scenario considers no strategic interaction in the world market, thus, the European Union firms act as price takers in the domestic market, and both the Oceania's and European firms act as price takers in the third market. The other scenario is imperfect competition in which the European firm is a monopoly in the domestic market and plays a Cournot game with the Oceania's monopoly in the third market, thus having a strategic interaction in the third market.

15. There is complete information, thus it is necessary to find the Subgame Perfect Nash Equilibrium of this dynamic game. As usual, the game is solved by backward induction, which implies that the result is equilibrium in every sub-game, that is, excluding non-credible threats.

Solutions of the generic implementation of the trade policy models, especially those related to the price discrimination scheme are very complex. Therefore, as a first step to understand the relation between the government's objectives to sustain income in the dairy sector and its strategic effect, the implementation of the models

assumed specific functional forms. Additionally, specific numerical values for the reservation prices, the cost functions, and the price elasticity, were defined according to the characteristic of the dairy market described in the basic set up. However, it is important to clarify that this is just a first attempt to model the world market of dairy products and that a better and more refined definition of the market is required to be included in future research work.

Six different models have been considered. The first two correspond to the strategic and non-strategic scenarios without policy, and are introduced as a benchmark to compare the different policy instruments. Afterwards, it is included a description of the export subsidy and price discrimination scheme under the two market scenarios, leaving to the next section the analysis of the results. The algebraic resolution of the models, including the definition of the specific parameters regarding the technology and preferences is explained in the appendix number two.

III. Optimal Policy

Given the specific numerical values for the reservation prices, the cost functions, and the price elasticity of demand, it is possible to obtain the equilibrium quantities and prices for the two benchmark models and the respective measures of the surplus obtained by the different agents, which result is summarized in table 1.

Table 1. Free Market

	Non-Strategic Interaction	Strategic Interaction
EU Exports	31	39
NZ Exports	85	56
Total Quantity in the third Market	116	95
Production for the EU Market	54	29
EU Price	85	184
Third Market Price	85	107
EU Firms Surplus	3 580	7 212
EU Consumer Surplus	5 799	1 680
EU Tax Payer Surplus	0	0
Total EU Welfare	9 379	8 892

EU = European Union
NZ = New Zealand (Oceania)

These results show that under strategic interaction the firm makes use of the market power it has in the domestic market lowering the quantity and increasing the price. Besides, the total quantity is reduced in the third market inducing a higher price.

The fact of having a lower elasticity in the domestic market allows the domestic firm to take a higher share of output in the third market than in the case of non-strategic interaction. Thus, in the case of imperfect competition, even without trade policies, the firm is already using a price discrimination scheme that allows it to get higher profit.

However, the increase in the producer's surplus is not compensated by the loss of the consumers in the domestic market, having imperfect competition a negative effect in the total domestic welfare.

The decision the government faces between a direct subsidy or a price discrimination scheme, and the choice of the optimal policy level, depends not only on the characteristics of the market but also on the relative weight the government gives to the producers, the consumer and the taxpayer in the welfare function.

Several models were run for different possible combinations of weights in the welfare function, in order to obtain some insights of the relation between the relative weights, the optimal policy and the existence or absence of strategic interactions in the market. The analysis is organized as follows: First, the results under direct export subsidies are analyzed taking as a benchmark the no policy scenarios described in table 1; second, the price discrimination scheme is analyzed within the same framework, and finally the two policy instruments are compared.

In the case of *direct export subsidies* four scenarios were considered with different combinations of weights for the producer, the consumer and the taxpayer. Since the primary objective of the government is to transfer income to the agricultural producers, the more relevant scenarios to analyze are the ones that give higher weight to the producer surplus in the welfare function. This objective can be explained by the relative lower income the agricultural sector receives when compared to the other sectors of the economy, the presence of strong in-

terest groups with well organized lobby campaigns, and the need for the government to guarantee an alimentary security.

Table 2a. Export

	Scenario 1		Scenario 2	
	Non-Strategic	Strategic Interaction	Non-Strategic	Strategic Interaction
Weights	b=1 c=1 t=1	b=1 c=1 t=1	b=1.5 c=1.2 t=1	b=1.5 c=1.2 t=1
EU Exports	22	39	38	114
NZ Exports	89	54	81	29
Total Qua. Third	111	93	119	143
Production EU	56	29	52	21
EU Price	78	184	90	218
Third Market Price	89	107	81	57
Export Subsidy	-11	0.19	9	192
Firms Surplus	3 025	7 220	4 055	23 915
Consumer	6 173	1 679	5 510	850
Taxpayer	247	-7	-332	-22 022
EU Welfare	9 444	8 892	11 260	14 871
Benchmark Welfare	9 379	8 892	12 328	12 834

b = relative weight of the producer surplus in the welfare function.
c = relative weight of the consumer surplus in the welfare function.
t = relative weight of the taxpayer surplus in the welfare function.

The scenario 1 considers equal weights on the welfare function that implies no opportunity cost of public funds and a government that cares equally for both consumers and producers. In this setting the optimal policy under non-strategic interaction of firms, is to tax the exports, which reduces its quantity and increases the production for the domestic market. The net effect is a reduction in the total quantity of milk produced by the domestic industry. The tax induces a reduction of the domestic price of milk having a positive impact on the consumer surplus and the taxpayer, and a negative effect on the producers' profit.

The result of this policy is an increase on the total welfare of the economy, as shown in table 2a. The fact that by intervening in the non-strategic scenario the government can obtain a higher aggregate welfare, is related to the fact that there exists an increasing cost function an thus a policy that reduces the production can increase welfare.

Under imperfect competition, additionally to the effects mentioned before, a tax would have also a negative strategic impact lowering even more the surplus of the domestic firms, which is not compensated by the increase in the consumer surplus and thus it is not optimal. Nevertheless, the profit shifting effect of an export subsidy does outweigh the reduction in the consumer surplus leading thus to a positive export subsidy as the optimal policy within this framework. In this case the optimal subsidy is very close to zero, but just because of the specific values that are assumed for the demand functions and the cost functions. In fact, when using a more inelastic domestic demand the value of the subsidy increases.

The scenario 2 considers the case where the government wants to transfer income to the agricultural producers and thus gives them a higher weight on the welfare function. Additionally, the government is concerned for the welfare of the consumer, being the taxpayer the one with the lowest weight indicating no opportunity cost of public funds.

In this scenario, if there is non-strategic interaction, the government gives a low subsidy to the producers, which as usual increases the producer surplus at a cost of consumers and taxpayer's welfare. On the other hand, if there is imperfect competition, the government will give a huge subsidy to the producers to take advantage of the *profit shifting effect* in the third market. This policy will increase the producer's surplus, but will induce a very strong reduction of the consumer surplus and great cost for the taxpayer. As a result, the total weighted welfare will increase justifying the use of the policy.

The scenario 3 considers the opportunity cost of public funds that put the taxpayer with a higher weight than the consumer, but still with a lower weight than the producer. As expected, in the non-strategic case, the optimal subsidy is rather low because of the higher weight of the taxpayer. Once more, the level of subsidy is higher under strategic interaction, since the additional benefits coming from the profit shifting effect in the third market offset the distortional effect of raising the funds for the subsidy, plus the spillover effect on the consumer's surplus.

In scenario 4 there is no opportunity cost of public funds but the government gives a higher weight to the consumer surplus with respect

to the producer's one. This fact makes the government reduce the optimal level of subsidy being even negative for the case of non-strategic interaction since there is no negative strategic effect in the third market. The presence of a domestic market for the product, reduces the incentive to use a direct subsidy on exports as a strategic trade policy because of the negative impact it has on the consumer surplus, even if there is no dead weight loss generated from the resources used to subsidize exports.

Table 2b. Export Subsidy

	Scenario 3		Scenario 4	
	Non-Strategic Interaction	Strategic Interaction	Non-Strategic Interaction	Strategic Interaction
Weights	b=1.5 c=1 t=1.2	B=1.5 c=1 t=1.2	b=1.2 c=1.5 t=1	B=1.2 c=1.5 t=1
E.U Exports	36	60	16	50
NZ. Exports	82	47	92	50
Total Qua. Third Market	118	107	108	100
Production EU. Market	53	27	57	28
EU. Price	89	193	73	189
Third Market Price	82	93	92	100
Export Subsidy	7	54,00	-19	27
Firms Surplus	3 943	10 215	2 655	8 543
Consumer Surplus	5 576	1 421	6 449	1 549
Taxpayer Surplus	-244	-3 218	307	-1 316
EU. Welfare	11 196	12 882	13 166	12 784
Benchmark Welfare	10 711	12 509	12 890	11 183

b = relative weight of the producer surplus in the welfare function
c = relative weight of the consumer surplus in the welfare function
t = relative weight of the taxpayer surplus in the welfare function

The main results of the export subsidy policy can also be deduced from the first order condition of the optimization program of the government. At the optimal subsidy level, the weighted marginal benefit for the producer must be equal to the weighted marginal reduction in the consumer surplus plus the marginal cost for the taxpayer, taking into account the opportunity cost of public funds.

$$\underset{(+)}{\alpha \frac{d\,\Pi(x(s), y(s); z(s))}{ds}} + \underset{(-)}{\beta \frac{d\,c(z(s))}{ds}} + \underset{(-)}{\gamma \frac{d\,tp(x(s), s)}{ds}} = 0 \qquad (43)$$

The higher the relative weight of the consumer and the taxpayer in the welfare function, the higher the marginal benefit it has to generate to the producers in order to implement the policy. Thus, a higher weight for the agents hindered by the policy lower the optimal subsidy, being the optimal level always higher under imperfect competition because of the profit shifting effect that comes from the strategic interaction in the third market. However, it is necessary to take into account that the strategic effect also increases the loss in the consumer surplus for a given level of subsidy.

The weights of the taxpayer and the consumer are substitutes in the sense that both act against a high level of subsidy. The degree of substitution depends on how inelastic is the domestic demand since this determines how strong is the spillover effect on consumers.

Because the profit shifting effect enhances the positive effects on the producers and also the negative effect on the consumers, the strategic interaction increases the response of the optimal policy to a change in the relative weights.

The analysis of the price *discrimination scheme* considers two possible scenarios. The first one considers an equal weight for the consumer and the producer, and the second one considers a higher weight for the producer in the welfare function.

The scenario 5 shows that if the government is equally interested on both consumer and producer's welfare, its optimal policy under non-strategic interaction is to reduce the price in the domestic market, which induces a higher consumer surplus and a reduction of the producer welfare, being this result analogous to the one considered in scenario 1.

Under strategic interaction, the effect on welfare is even higher because under the free market scenario the producer was already profiting from the lower elasticity in the domestic market, charging a higher price for its domestic production. When the government assumes the control of the price discrimination policy, it takes into account the impact on consumers welfare, thus the optimal governmental policy reduces the domestic price with respect to the non intervention sce-

nario which increases the consumer surplus and reduces the producer benefit, leading to a net increase of the aggregate welfare.

Table 3. Price Discrimination

	Scenario 5		Scenario 6	
	Non-Strategic Interaction	Strategic Interaction	Non-Strategic Interaction	Strategic Interaction
Weights	b=1 c=1	b=1 c=1	b=1.5 c=1	b=1.5 c=1
EU. Exports	22	35	37	48
NZ. Exports	89	55	82	51
Total Qua. Third Market	111	90	118	99
Production EU. Market	56	55	52	51
EU. Price	75	78	93	97
Third Market Price	89	110	82	101
Average Price	79	90	88	99
Firms Surplus	3 096	4 085	3 906	4 888
Consumer Surplus	6 347	6 160	5 348	5 173
Taxpayer Surplus	0	0	0	0
EU. Welfare	9 443	10 245	11 207	12 506
Benchmark Welfare	9 379	8 892	11 169	12 498

b = relative weight of the producer surplus in the welfare function.
c = relative weight of the consumer surplus in the welfare function.

The scenario 6 shows that if the government has an interest on supporting the producer's income reflected by a higher relative weight in the welfare function, the result will depend on the nature of the interaction between firms.

In the non-strategic framework, the introduction of the price discrimination scheme allows the firms to profit from a higher price set by the government in the domestic market, and allows them to sell more in the third market. This increases the firm's benefits at expenses of a reduction in the consumer surplus, but generating a net increase in the aggregate welfare of the economy.

On the other hand, under imperfect competition the results will be different. If the government cares enough for the consumers, it will reduce the price in the domestic market with respect to the free market case, which implies a reduction in the producer surplus and an

increase in the consumer's welfare. Just in case of a very low valuation of the consumer surplus in the welfare function a government's policy improves the producers' welfare.

To summarize, when the government controls the price discrimination, the firm cannot exercise its market power in the domestic market any more. Since the government also takes into account the consumer welfare when setting the optimal price discrimination, it sets a lower domestic price level than if the price discrimination were performed directly by the firms, which implies that price discrimination schemes reduce the benefit of the firm in a strategic interaction framework. In a non-strategic policy, the government's intervention increases the producer welfare since it allows them to get a higher price than without the policy.

When comparing the two policies, one could say that, if *the government cares equally for the producers and consumers welfare and there is no opportunity cost of public funds* it is possible to compare scenario 1 of subsidy with scenario 5 of price discrimination. When there is non-strategic effect of the policies, these two scenarios give slightly the same result in terms of aggregate welfare, however, in the price discrimination the cost of the policy is borne only by the consumer, while in the subsidy the cost is shared with the taxpayer. The total welfare level achieved by the two policies is the same.

If there is *imperfect competition* the price discrimination scheme leads always to a higher aggregate welfare, but to a lower producer benefit, since the government now controls the price in the domestic market.

In the case where the government cares more for the producer than the consumer's welfare and there is a low distortion generated by the funding of the subsidy, one could compare scenario 3 with scenario 6. For the case of non-strategic interaction the two policies give almost the same result, leading the subsidy to a slightly lower aggregate welfare because of the dead weight loss generated by its funding.

In the case of imperfect competition, the subsidy gives higher aggregate welfare and larger benefit to producers being the consumer the less beneficiated with this policy. However, this result holds only for a low opportunity cost of public funds.

Thus, from the producers' point of view, if there is *imperfect competition* in the domestic market, the export subsidy is preferred than the price discrimination, since it allows them to exercise directly the price discrimination in the domestic market, and additionally to receive an export support.

It is important to point out that the results will change if we consider non-strategic interaction in the domestic market and oligopolistic competition in the third market. Under this scenario the price discrimination and the subsidy will have the same strategic effect being the two policies close substitutes. Additionally, in the case of a very high opportunity cost of public funds the price discrimination will always dominate the subsidy as a strategy to transfer income to producers and take advantage of the strategic interaction in the third market.

Another important remark is that in all these scenarios both the European Union firm and the Oceania firm were at the same time price takers or in oligopolistic competition. It would be interesting to examine the results holding constant the market power the Oceania dairy board has in the third market and changing the position of the European Union firms.

Conclusions

This paper studied the relation between the government's objectives to sustain income in the dairy sector and the possibility of rent capture on the world market. To do this, two different governmental policies were considered: a direct export subsidy and a price discrimination scheme. These policies were analyzed under two different scenarios. First, the case of imperfect competition was considered in the world market, which implies that the policy has a strategic effect, shifting profits toward the domestic firms. Second, consideration was given to the case of non-strategic interaction on which the policy serves just as an income support to the agricultural producer.

One important characteristic of the European Union dairy market is the presence of domestic consumption of the good, being thus necessary to compare the profit shifting effect of the policy to transfer income to producers, with the reduction of the consumer surplus because of the lower output in the domestic market.

Additionally, the fact of having an inelastic domestic demand enables the firm to perform a price discrimination scheme in a free market scenario that leads it to take a higher share of output in the third market and thus higher profits.

When analyzing the export subsidy, the results indicate that the weights of the taxpayer and the consumer in the welfare function are substitutes, in the sense that both yield a reduction of the optimal level of subsidy. The presence of a domestic market for the product reduces the incentive to use a direct subsidy on exports as a strategic trade policy because of the negative impact it has on the consumer surplus, even if there is no dead weight loss generated form the resources used to subsidize exports. However, the taxpayer weight has higher influence in determining the optimal policy level. The strategic interaction increases the response of the optimal subsidy to a change in the relative weights, because the profit shifting effect enhances the positive impacts on the producers and the indirect negative effect on the consumers.

When the government controls the price discrimination, the firm cannot exercise its market power in the domestic market any more. Since the government also takes into account the consumer welfare when setting the optimal price discrimination, it sets a lower domestic price level than if the price discrimination were performed by the firms themselves. This implies that a price discrimination scheme reduces the benefit of the firm under imperfect competition. However, under non-strategic interaction the policy increases the producer welfare since allows the producer to get a higher price in the domestic market.

When there is non-strategic interaction between firms and there is no opportunity cost of public funds the two policies have the same strategic effect and lead to the same transfer to producers. However, in the price discrimination case the cost of the policy is borne only by the consumer of dairy products while with the subsidy the cost is shared between consumers and taxpayers.

Under imperfect competition, the price discrimination scheme leads to higher consumer welfare, but to lower producer benefit, being the net result on total welfare determined by the relative weights of the agents surplus in the welfare function. In the case where the govern-

ment cares more about the producer than the consumer, there is a low distortion generated by the funding of the subsidy, and the firms are price takers, the two policies give almost the same result, leading the subsidy to a slightly lower aggregate welfare because of the dead weight loss generated by its funding.

From the producers' point of view, if there is *imperfect competition* in the domestic market, the export subsidy is always preferred than the price discrimination, since it allows them to exercise directly the price discrimination in the domestic market, and additionally to receive an export support.

These results are the first step to understand the effects of the policies on the agricultural producer. In that sense, further steps in that process will require a distinction between the farm producers and the processors when modeling the milk market, and to enhance the kind of policies considered. Additionally, given to its enormous influence on the results, a very important and necessary improvement to the models developed so far, is to calibrate the parameters and to consider more general functions to model the preferences and the technology.

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Appendix 1. Selected Statistics of the World Dairy Products

BUTTER
(1,000 Metric Tons)

	1996	1997	1998	1999	2000(p)	2001 (f)
Production						
European Union	1.533	1.513	1.513	1.513	1.491	1.450
Oceania	462	454	497	492	526	521
Others	2.880	2.890	3.020	3.196	3.398	3.691
Total	4.875	4.857	5.030	5.201	5.415	5.662
Consumption						
European Union	1.496	1.504	1.472	1.475	1.490	1.465
Oceania	90	84	89	90	85	84
Others	3.034	3.107	3.248	3.347	3.559	3.853
Total	4.620	4.695	4.809	4.912	5.134	5.402
Exports						
European Union	144	173	127	110	119	114
Oceania	313	426	420	396	477	468
Others	152	104	39	36	37	48
Total	609	703	586	542	633	630

(p) preliminary
(f) forecast

Source: USDA-FAS Counselor/Attache Reports, Official Statistics

CHEESE
(1,000 Metric Tons)

	1996	1997	1998	1999	2000(p)	2001(f)
Production						
European Union	5.220	5.337	5.337	5.363	5.569	5.612
Oceania	498	525	571	565	631	702
Others	5.341	5.526	5.654	5.895	6.059	6.130
Total	11059	11388	11.562	11.823	12.259	12.444
Consumption						
European Union	4.588	4.758	4.852	4.912	4.995	5.027
Oceania	208	235	240	240	238	245
Others	5.769	106.128	6.116	6.338	6.515	6.679
Total	10.565	111.121	11.208	11.490	11.748	11.951
Exports						
European Union	485	467	399	360	426	399
Oceania	284	361	383	412	470	490
Others	78	101	105	104	109	112
Total	847	929	887	876	1.005	1.001

(p) preliminary
(f) forecast

Source: USDA-FAS Counselor/Attache Reports, Official Statistics

SKIM MILK POWDER
(1,000 Metric Tons)

	1996	1997	1998	1999	2000(p)	2001 (f)
Production						
European Union	1.096	1.034	981	969	902	811
Oceania	431	449	446	468	465	445
Others	1.458	1.549	1.517	1.607	1.717	840
Total	2.985	3.032	2.944	3.044	3.084	2.096
Consumption						
European Union	809	870	812	855	782	762
Oceania	54	55	48	46	39	36
Others	2.048	1.938	1.876	2.001	1.959	2.118
Total	2.911	2.863	2.736	2.902	2.780	2.916
Exports						
European Union	166	236	146	220	273	199
Oceania	317	420	396	445	448	420
Others	215	327	324	402	338	362
Total	698	983	866	1067	1.059	981

(p) preliminary
(f) forecast

Source: USDA-FAS Counselor/Attache Reports, Official Statistics

WHOLE MILK POWDER
(1,000 Metric Tons)

	1996	1997	1998	1999	2000(p)	2001(f)
Production						
European Union	916	963	1024	1005	953	911
Oceania	446	500	524	527	610	685
Others	1.123	1.129	1.174	1.265	1.278	1.301
Total	2.485	2.592	2.722	2.797	2.841	2.897
Consumption						
European Union	411	462	498	490	469	464
Oceania	51	55	53	55	54	54
Others	1.528	1.612	1.681	1.766	1.795	1.875
Total	1.990	2.129	2.232	2.311	2.318	2.393
Exports						
European Union	480	479	515	524	494	503
Oceania	368	455	469	501	551	639
Others	96	97	139	181	160	135
Total	944	1.031	1.123	1.206	1.205	1.277

(p) preliminary
(f) forecast

Source: USDA-FAS Counselor/Attache Reports, Official Statistics

Appendix 2. Algebraic Resolution of the Models

A. Benchmark Model under Strategic Interaction

In this scenario the domestic and the foreign firm play a Cournot game, deciding the exported quantities to the third market. The domestic firm decides the level of exports and production for the domestic market that maximizes its benefit, taken as given the choice made by the foreign firm. The program of the domestic firm is thus given by:

$$\underset{x,z}{Max}\ \Pi(x,y,z) = p(z)\ z + pw(x,z)\ x - \frac{(x+z)^2}{2} \qquad (1)$$

Where:
z = domestic production of the non-tradable dairy products.
x = domestic exports of dairy products to the third market.
y = foreign exports of dairy products to the third market.
$p(x)$ = inverse demand function in the domestic market, given by:
$p(z) = 300 - 4z$.
$pw(x,y)$ = inverse demand function in the world market given by:
$pw(x,y) = 200 - x - y$ which is the equation that links the production decision of the domestic producer to the respective decision of the foreign firm.

Taking the first order conditions and solving for x and z yields the domestic firm best response function in the third market:

$$x(y) = \frac{1{,}500 - 9\,y}{26} \qquad (2)$$

As expected, this function is negative related to the exports brought to the market by the foreign firm, having a downward slope.

Additionally, the domestic production for the domestic market is obtained; which, given the non-separability of cost, is negative related to the export decision of the domestic firm and thus positively related to the choice of production of the foreign firm:

$$z(y) = \frac{700 + y}{26} \qquad (3)$$

At the same time, the foreign firm chooses the quantities brought to the third market, so that it maximizes its benefit function given by:

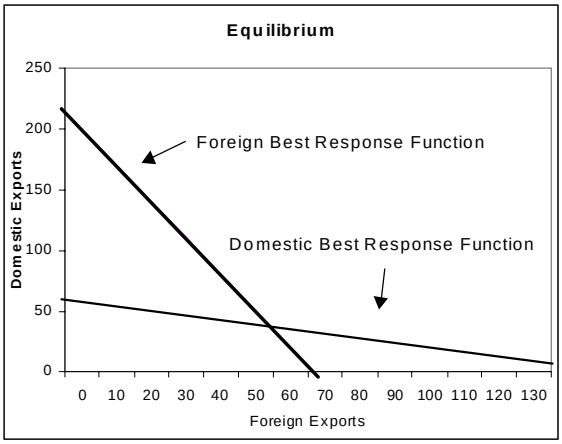
$$\underset{y}{Max}\ \Pi f(x,y) = pw(x,y)\,y - \frac{y^2}{2} \tag{4}$$

Taking the first order condition and solving for y, yields the foreign firm best response function:

$$y(x) = \frac{200 - x}{3} \tag{5}$$

Solving for *x* and *y* the two best response functions given by equation (2) and (5), the values of exports to the third market at the equilibrium path are given by $x = 39.13$, $y = 53.62$, $z = 29$.

A graphical representation of the equilibrium is shown in the graph below and a complete description of the results is shown in table1:



B. Benchmark Model under Non-Strategic Interaction

Under non-strategic interaction the program of the firm is again to maximize the benefit function defined in (1) with respect to *x* and *z* but this time taking the domestic and the foreign prices as given.

The first order condition of this optimization problem with respect to x and z yields:

$$\frac{\partial \Pi}{\partial x} = pw - x - z = 0 \tag{6}$$

$$\frac{\partial \Pi}{\partial z} = p - x - z = 0 \tag{7}$$

Conditions (6) and (7) imply that $p = pw$ and taking the domestic demand defined as:

$$z = \frac{300 - p}{2} \tag{8}$$

yields the level of domestic exports to the third market:

$$x = \frac{5pw - 300}{4} \tag{9}$$

The foreign firm maximizes its benefit function (4) with respect to y and taking as given the world price, leading to the following first order condition:

$$y = pw \tag{10}$$

Thus taking the inverse demand function in the third market, equation (9) and (10) and solving for x, y and pw yields: $x = 30.76$, $y = 84.61$, $z = 53.84$.

The main results of the two models presented so far, are summarized in table 1 in the document.

C. Export Subsidy under Strategic Interaction

1. Second stage. At this stage when the domestic firm decides the level of production for the foreign and the domestic markets, not only takes into account the level of production of the foreign firm, but also

the level of subsidy defined by the government at the first stage of the game. The program of the firm is now defined as:

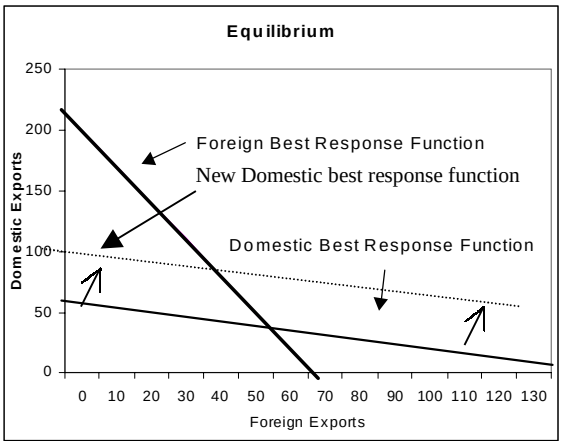
$$\underset{x,z}{Max}\ \Pi(x,y,z) = p(z)\,z + pw(x,y)\,x - \frac{(x+z)^2}{2} + s\,x \tag{11}$$

Taking the first order condition and solving x and z yields once more the domestic best response function and the production for the domestic market:

$$x(y,s) = \frac{1{,}500 + 9s - 9\,y}{26} \tag{12}$$

$$z(y,s) = \frac{700 - s + y}{26} \tag{13}$$

Equation (12) shows that a higher subsidy places the firm in a more aggressive best response function, thus having a positive strategic effect in the third market but a negative effect in the domestic market.



Since a non-intervention policy by the foreign government is assumed, the best response function of the foreign firm is again given by equation (5). Solving the two best response functions for x and y yields the values of exports brought to the third market as a function of the government subsidy, from which the value of production for the domestic

market and the prices for the domestic and the third market are obtained:

$$x(s) = \frac{900 + 9s}{23} \tag{14}$$

$$y(s) = \frac{3{,}700 - 9s}{69} \tag{15}$$

$$pw(s) = \frac{7{,}400 - 18s}{69} \tag{16}$$

$$z(s) = \frac{2{,}000 - 3s}{69} \tag{17}$$

$$p(s) = \frac{4}{69}(3{,}175 + 3s) \tag{18}$$

Thus, as mentioned before, a higher subsidy induces at the equilibrium a higher level of domestic exports allowing the domestic firms to get a higher share of the third market, but at the same time inducing a stronger reduction in the production for the domestic market and therefore a higher price.

2. First stage**.** At this stage the government chooses the level of subsidy that maximizes the domestic welfare given by the weighted sum of the producer surplus, the consumer surplus and the tax payer surplus, taking into account the response of the firms to this policy, that is, equations (14) through (18). The program of the government is thus given by:

$$\underset{s}{Max}\ W(s) = \alpha\ \Pi(x(s),y(s);z(s)) + \beta\ c(z(s)) + \gamma\ tp(x(s),s) \tag{19}$$

Where :

$b(x(s),y(s);z(s))$ is the producer surplus given by equation (11)

$$c(z(s)) = \frac{(e\text{-}p(s))\ z(s)}{2} \text{ is the consumer surplus} \tag{20}$$

$tp(x(s),s) = -x(s),s$ is the tax payer surplus (21)

The first order condition of this optimization program implies that at the optimal subsidy the weighted marginal benefit for the producer is equal to the weighted marginal reduction in the consumer surplus plus the marginal cost for the tax payer, taking into account the opportunity cost of public funds. The final result will depend thus on the relative weights of the agents in the welfare function, being a positive subsidy optimum only if the profit shifting effect of the policy outweighs the reduction in the consumer surplus and the opportunity cost of public funds. The result for given values of the weights is analyzed in section 4 of the main document.

D. Export Subsidy under Non-Strategic Interaction

1. Second stage. Under non-strategic interaction the program of the domestic firm is again to maximize (11) but this time taken as given the domestic and the foreign price and the level of subsidy. The first order conditions of this optimization problem imply that $p = pw + s$. Thus taking into account the demand in the domestic market defined by equation (8) the level of product brought by the domestic firms to the third market is:

$$x = \frac{5\,pw - 300 + 5s}{4} \tag{22}$$

The first order conditions of the program of the foreign monopoly imply price equal marginal cost once more, thus, taking the inverse demand function in the third market, equation (22) and equation (10) and solving for x, pw and y yields:

$$x'(s) = \frac{400 + 10s}{13} \tag{23}$$

$$y'(s) = \frac{1{,}100 - 5s}{13} \tag{24}$$

$$pw'(s) = \frac{1{,}100 - 5s}{13} \tag{25}$$

$$z'(s) = \frac{700 - 2s}{13} \tag{26}$$

$$p'(s) = \frac{4}{13}(275 + 2s) \tag{27}$$

In this case, the subsidy also has a positive effect on the domestic exports to the third market and therefore a negative impact on foreign exports. The increase in the domestic exports is not offset by the decrease in the foreign exports, and then the subsidy induces a stronger reduction in the price in the third market.

Despite of the non-strategic interaction in the market, there is still a reduction in the domestic production because of the non-separable cost function. The increase in the production for the third markets increases also the cost of production for the domestic market leading to a reduction of the supply and an increase of the price in the domestic market.

2. First stage. As before, in this stage the government chooses the level of subsidy that maximizes the domestic welfare given by equation (19), taking into account the response of the firms to this policy, that is equations (23) through (27) . The result as before depends on the relative weights of each agent in the welfare function.

When comparing the effect of a subsidy under strategic and non-strategic interaction, it seems that since under strategic interaction the firm is already profiting from a price discrimination policy, the marginal effect of an introduction of an export subsidy is lower than in the non-strategic framework.

E. Price Discrimination under Non-Strategic Interaction

As mentioned before, the price discrimination scheme is that the government buys the milk to the agricultural producers and then sells the milk at a differentiated price depending on its final use, charging a higher price for non-tradable goods, mainly fluid milk, and other dairy products with inelastic demands. This policy generates additional income that can be redistributed to the farmers by paying them the average price the government receives after the price discrimination.

1. Second stage. Under this policy the program of the domestic firm is to maximize its benefit taking as given the average price paid by the government. The problem of the firm is then:

$$\underset{x,z}{Max}\ \Pi(x,y,z) = pm(x+z) - \frac{(x+z)^2}{2} \tag{28}$$

where *pm* is the average price the government pay to the producers defined as:

$$pm = \frac{p\,z + pw\,x}{(x+z)} \tag{29}$$

The first order condition implies that the average price must be equal to the marginal cost $pm = x + z$, which after using equation (29) becomes:

$$(x+z)^2 - pw\,x - p\,z = 0 \tag{30}$$

The solution of this expression has two roots, which after replacing the domestic demand for equation (8) becomes:

$$x = \frac{1}{4}(p + pw - 300 - 2\sqrt{300\,p - p^2 - 300\,pw + p\,pw + pw^2}) \tag{31}$$

$$x = \frac{1}{4}(p + 2\,pw - 300 + 2\sqrt{300\,p - p^2 - 300\,pw + p\,pw + pw^2}) \tag{32}$$

The first of these roots is always negative for values of $p \in (0.300)$ and values of $pw \in (0.200)$, while the second root is always positive, thus we discard the first root and take the second as the result of the optimization program of the firm.

The foreign firm first order condition is still given by equation (10). Then, solving (10), (32) and the inverse demand function for *x* and *y* yields two possible roots, but the first root is not coherent once more, since it implies negative quantities and therefore it is omitted. The results corresponding to the second root are:

$$x(p) = \frac{1}{12}(2p - 200 + \sqrt{10{,}000p - 500{,}000 - 26p^2}) \quad (33)$$

$$y(p) = \frac{1}{24}(2{,}600 - 2p - \sqrt{10{,}000p - 500{,}000 - 26p^2}) \quad (34)$$

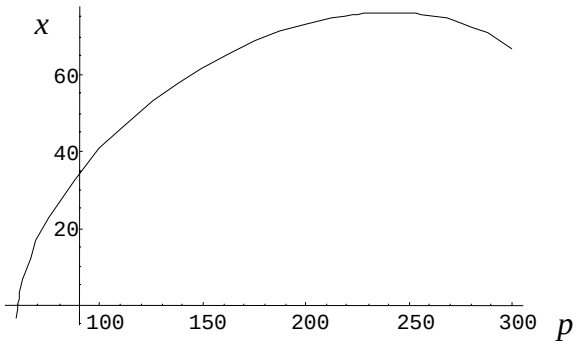
$$pw(p) = \frac{1}{24}(2{,}600 - 2p - \sqrt{10{,}000p - 500{,}000 - 26p^2}) \quad (35)$$

$$z(p) = 75 - \frac{p}{4} \quad (8)$$

$$pm(p) = \frac{1}{12}(700 - p + \sqrt{10{,}000p - 500{,}000 - 26p^2}) \quad (36)$$

Equation (33) indicates that the higher the domestic price, that is, the higher the price discrimination, the higher the quantity of domestic exports in the third market, being its marginal effect decreasing as is shown in the following graph

EU Exports vs Price Discrimination



As in the case of the direct subsidy, the price discrimination reduces New Zealand's exports to the third market, but not enough to offset the effect of the higher European quantity in the market, being the final result an increase in the total quantity of dairy products in the third market and thus a reduction in its price. The price discrimination hinders the domestic consumer by reducing the quantity in the domestic market.

2. First stage**.** In this stage the government decides the optimal price discrimination, that is, the optimal price at which it is going to sell the

milk in the domestic market, taking into account the optimal response of the firms to its policy choice given by equations (33) through (36).

The program of the government is then given by:

$$\underset{p}{Max}\ W(p) = \alpha\ \Pi(x(p),y(p);z(p)) + \beta\ c(z(p)) \qquad (37)$$

As shown in equation (37) the optimal price discrimination depends on the relative weights of the producer and the consumer in the welfare function.

F. Price Discrimination under Strategic Interaction

1. Second stage. Under this policy the program of the domestic firm is to maximize its benefit function given by equation (28) but this time considering the effect of its exports on the world price and thus in the average price paid by the government .

The first order condition is once more given by the following equation

$$(x+z)^2 - pw(x,y)\,x - pz = 0 \qquad (30)$$

Where:

$pw(x, y) = 200 - x - y$.

As before, the solution of this expression for x has two roots, one positive and one negative. The expression of the positive root representing the best response function in the third market is given by

$$x(p,y) = \frac{1}{8}(100 + p - 2y + \sqrt{4y^2 - 9p^2 - 4p\,(y - 950) - 400\,(425 + y)}\ ) \qquad (38)$$

This expression indicates that the higher the level of price discrimination the more aggressive the best response function of the domestic firm, for a given quantity of foreign export in the third market.

Taking equation (38) and the best response function of the foreign firm given by equation (5) and solving for *x* and *y* yields the values of exports brought to the third market as a function of the government price discrimination, from which the level of production for the domestic market and the price in the two markets are obtained. Again, the result of the negative root is omitted for obvious reasons.

$$x(p) = \frac{1}{20}(3p - 100 + \sqrt{66p(400 - p) - 1{,}340{,}000}) \tag{39}$$

$$y(p) = \frac{1}{60}(4{,}100 - 3p - \sqrt{66p(400 - p) - 1{,}340{,}000}) \tag{40}$$

$$pw(p) = 200 - \frac{1}{20}(3p - 100 + \sqrt{66p(400 - p) - 1{,}340{,}000}) - \frac{1}{60}(4{,}100 - 3p - \sqrt{66p(400 - p) - 1{,}340{,}000}) \tag{41}$$

$$z(p) = 75 - \frac{p}{4} \tag{8}$$

$$pm(p) = \frac{1}{20}(1{,}400 - 2p + \sqrt{66p(400 - p) - 1{,}340.000}) \tag{42}$$

2. First stage. In this stage the government decides the optimal price discrimination, that is, it optimizes equation (36) taking into account the optimal response of the firms to its policy choice given by equations (39) to (42).