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AN ANALYSIS OF DAIRY POLICY REFORM AND TRADE LIBERALISATION

TRADE AND ECONOMIC EFFECTS OF MILK QUOTA SYSTEMS

This is the final version of a study which was carried out under the 2003/2004 Programme of Work of the Commitee for Agriculture.

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Foreword

This report is one of several studies that have been carried out under the *Assessing Future Agricultural Markets, Trade and Policies* activity of the 2003-2004 Programme of Work of the OECD's Committee for Agriculture. Within this overall activity, studies were scheduled to provide assessments of the market, trade and welfare impacts of domestic and trade policy reform for selected commodities that currently receive very high support and protection. The report investigates analytically and empirically the market and welfare impacts of milk quota systems and the interaction of quota with other policy tools within a context of specific policy objectives. It also discusses the milk production potential in quota-operating countries following the removal of quotas. The main authors of this report are Pavel Vavra and Roger Martini, economists in the OECD Directorate for Agriculture. Many colleagues in the OECD Secretariat and delegates from Member countries furnished useful comments on earlier drafts of this report.

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Introduction

1. The concept of production quotas or supply management in agriculture is not new and can be traced back to the early 20th century. Generally, a production quota is a limit imposed on the quantity produced. It could have the character of assuring the minimum required production level where under-production might be penalised. However, typically production quotas in OECD countries have a production restricting character and are combined with penalties for exceeding the quota limit.

2. This paper does not intend to present a detailed analysis of every possible aspect of operating a quota system. Indeed, imposing a limit on supply influences all facets associated with production. Quota could influence structural changes in agriculture, the structure of the dairy processing sector, welfare of producers and input suppliers (to some extent consumers)[1], the value of assets in agriculture, production risks, the uptake of new technologies and, of course, production levels and trade. There is a large body of literature dealing with many individual issues related to quota. The quota system in this paper is treated and examined as one possible policy tool. Based on a description and analysis of the reasons for and impacts of milk quotas, the purpose of this paper is to contribute to the understanding of ways to reform or eliminate them.

3. Generally speaking, milk quotas were often introduced to control the growth of surplus production and budgetary expenditures, to maintain market price support, and to provide price stability for dairy farmers. Quotas have thus been largely implemented as a second best alternative to reducing support that has allowed policy makers to continue using a high price support without necessarily aggravating budgetary problems. A quota is a powerful tool which gives policy makers (or producer groups sanctioned by government) a direct control of agricultural product supply. As such, a quota interacts with other policy tools in pursuing defined policy objectives.

4. The importance of quota systems in the OECD dairy sector is demonstrated by the fact that currently more than half of all OECD milk production is governed by quotas. Each quota system implemented in an OECD country has its own special features and has evolved through time. However, it is the inherent nature of a quota, the fact that a quota assumes a value that is likely to be its most important attribute from a dairy policy reform standpoint. The quota is typically a licence to sell milk at the supported price and as such becomes valuable in its own right. The value of the quota, reflecting the difference between an underlying cost of production and a milk price, becomes incorporated into the cost structure of dairy farms with time. Thus, while initially a quota system is often seen as a viable and politically feasible tool, the vested interests and inefficient cost structures that are inherent to a quota may hinder reforms on price support later on.

1 Although consumers are typically not affected directly by a quota system, the presence of quota may facilitate a continuation of high price support measures which indeed do influence consumers.

5. The concept of quota value is often misunderstood and its importance underestimated. This paper presents basic fundamentals that try to facilitate an understanding of the emergence of quota values following its imposition. Important welfare effects of a quota system for owners of farm resources and suppliers of inputs, which are often neglected by standard textbook welfare economics, are evaluated analytically and empirically in the text.

6. In the context of discussions of global liberalisation of dairy markets, the question arises how a supply managed dairy sector would respond if quotas were to be removed alongside border protection. However, the assessment of milk production potential in quota operating countries is complicated by the absence of historical evidence concerning milk supply response as quotas in respective countries are in place already for a considerable amount of time. Given the importance of this response, the aspect of modelling dairy policy reform in the presence of production quotas is discussed in the context of this paper.

7. The remainder of the paper is organised as follows. The ensuing section presents a brief overview of general characteristics of milk quota systems implemented in OECD countries. The second major section discusses theoretical issues of milk production quotas focusing on the quota value. The third section examines analytically and empirically the quota interaction with other policy tools and impacts of changes in quota levels on markets, trade, prices, income and welfare using the *Aglink* and PEM models. The fourth section then describes the modelling of milk supply response in quota countries with the *Aglink* and PEM models which is important in the context of the dairy trade liberalisation analysis presented in a separate document [COM/AGR/TD/WP(2004)20/REV2]. The final section draws conclusions of the paper.

II. Quota programmes – General overview

8. Milk production quotas were typically introduced as a tool to control the growth of surplus production and budgetary expenditures in order to improve the political sustainability of high price support. Quotas were also introduced with the view to stabilise prices and hence the income of farmers.[2] Dairy quota systems vary considerably among OECD countries and are often governed by different mechanisms which can impact on milk production and trade in different ways. In the OECD area a milk supply management system is operated in the European Union, Canada, Switzerland, Norway and Japan (Japan's quota is operated by co-operatives). [3,4] The section below briefly describes the main characteristics of milk production quota systems.[5]

9. Typically, the setting of production quotas relates to the amount of milk being shipped from dairy farms. So defined, the quantity limit is easier to observe than on farm production of milk. The total quantity supplied is usually bound at both national and individual farm level. However, dairy quota programs might have a different coverage of supply. For example, the quota system previously

2 In the closed economy-cobweb framework quota restricts production expansion when price is high, thus limiting a price fall in the following period.

3 Switzerland has recently passed a new law which provides for the abolition of its milk quota from 2009 onwards.

4 A description of individual supply management systems can be found in other sources: for the EU in EU Commission (2002), for Japan in Suzuki and Kaiser (1994), for Canada in Barichello (1999) (alternatively in Lipert (2001), for Switzerland in Swiss Federal Office for Agriculture (2001), for Norway see Annex. A table of dairy quota programmes and their key features in OECD countries can be found in OECD (1990).

5 For detailed discussion on key features of the OECD quota programmes see OECD, 1990.

implemented in Australia concerned fluid milk only while the total milk supply had not been bound.[6] Moreover, market segmentation might be used to specify different quotas for fluid and manufacturing milk.[7] This system operates in Canada, for example. Under the milk supply management system, the Canadian Milk Supply Management Committee (CMSMC) sets a national production target – the Market Sharing Quota (MSQ) – for industrial milk. The MSQ is set with the goal to achieve a domestic market balance in terms of butterfat, and is assigned to provinces largely on the basis of historical shares. The CMSMC monitors the evolution of the MSQ on a monthly basis based on the monthly production and demand situation in order to be market responsive and avoid over-quota production. In addition to the MSQ, each province controls its own production quota for fluid milk, and the entire milk quota – industrial and fluid together – is allocated to producers.

10. When a quota system is implemented an important decision concerns setting of the actual level of quota. The quotas typically have a production limiting character where the reduction of total milk supply might be organised over a period of time progressively of regressively.[8] A quota system usually provides for a mechanism of adjusting the quota amount in order to accommodate the evolution in internal and external markets. The quota adjustment might be conducted on a monthly or an annual basis, or might be subject to discretionary changes as they are considered appropriate, possibly in the context of less frequent, major revisions of underlying legislation. The former might be seen in Canada while the latter in the European Union. For a quota system to be effective, compliance with the quota is a crucial factor. Non-compliance is always penalised, although the magnitude of penalties and stringency of enforcement differ across systems.

11. Quota management is an important feature of a dairy quota programme. In some systems quotas are allowed to be marketed, in others, quotas are managed by administrative means. Under the marketable quota systems producers have the possibility to lease or sell/buy quota. The former practice permits a producer to temporarily lease (typically on an annual basis) additional quota and avert the possibility of penalty for over the quota production. On the other hand, a relatively less efficient producer may make more money by leasing quota out to more efficient competitors than by producing within quota. Selling or buying of quota represents the possibility to transfer quota permanently. It is often the case when quota is transferred between producers that it must be accompanied by farm assets such as land. In any case, many OECD countries' quota regimes contain some restrictions that dissect the total into regional amounts that limit leasing and trading possibilities. In some systems, producers can transfer so-called used quota which the buyer can only use in the following marketing year, or so-called unused quota which can be utilised in the current marketing year. The difference in price of used and unused quota would be likely equal to the prevailing lease price. An example of quota management by administrative means is illustrated in Box 1.

12. Another important feature of the quota system is its duration as given in the enabling legislation. Quota programmes may be of finite duration, with or without the renewal option, or of indefinite duration. As quota values become incorporated into the farm cost structure with time, the duration of the quota programme might itself influence the feasibility of programme termination or continuation. The theoretical issues of quota and emergence of quota value is explained in the following section.

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6. Fluid milk is defined here as milk sold in liquid form for drinking. Other terms used for fluid milk might include: liquid milk, drinking milk, table milk, and town milk.

7. Manufacturing milk is milk used in production of dairy products (i.e. butter, cheese, SMP, WMP, casein etc).

8. For example, the European Union implemented a series of milk quota cuts resulting in an 8% overall reduction in quotas over a nine-year period – 1984/85 to 1993/94 marketing years (Court of Auditors, 2001).

Box 1. Administrative quota management in France

In France, quota is not managed on a commercial basis but by administrative decision, mainly at the level of the *département*. Quota-allocation decisions are based on priority criteria such as, for instance, the support of farmers with the lowest quota or new entrants. Hence, the administrative form of management attempts to keep down farm set-up and structural costs, as farmers do not have to bear the quota management costs they would incur in a commercial system. Moreover, under the French quota administration, the quotas are tied to land, which limits their tradability. Thus, it is not possible to sell quota independently from land (This does not prevent a market valuation of quota but this way quota price is small as the value of quota is carried via the land price). In addition, the levy charged for transfers leading to an increase in farm size allow the quota concentration to be limited and maintains the medium size of farm holdings. The administrative form of management contributes to a territorial development policy and is aimed at (i) preventing the abandonment of dairy farmland and maintaining dairy farming and its related services throughout the country, and (ii) limiting the regional concentration of farms. The administrative management of quota tries to avoid the social externalities resulting from concentration of production at farm level and in specific areas that might ensue if profitability was the sole criterion. The system thus endeavours to preserve the regional production spread, to maintain dairy farming in remote parts of the country such as mountainous areas and to slow down the drift away from traditional farming systems. In spite of that, in certain regions a concentration of dairy farming can nevertheless be observed, with smaller producers being crowded out. At the same time, there is also evidence of increased intensification (Rainelli and Vermersch, 1997) stemming from the fact that fixed quotas are capitalised into land prices.

III. Theory of milk production quotas - Overview

13. The economic theory relating to how quotas impact on markets or, more specifically, on supply, resource allocation and welfare is well established.[9] The pernicious welfare effects of restrictions on production activities in the absence of externalities are well known. Typically, the welfare effects of quotas are compared with the free market situation with the standard conclusion that quota systems are inefficient and cause considerable transfers from consumers to producers (for an example, see Veeman 1982). Harvey (1984) argued that in a political-economy context adoption of quotas (or supply management) may result in increased welfare as measured against a status quo policy that generates even greater distortions and misallocation of resources. Although Guyomard and Mahé (1994) agreed that, in a static approach, quotas could be a welfare improving policy instruments when price cuts are impossible to implement, they argued that a dynamic approach suggests that welfare gains to be expected from the corrective quota instruments are over estimated.

14. The welfare implications of quota imposition as compared to price cuts, the two policy options available to reduce large surpluses, are illustrated in details in Annex 1. Although the analysis presented in the Annex shows that the net welfare gain of the support price cut is larger compared to the net welfare gain of quota limit imposition, the reduction in support prices for dairy products might be too large to be politically feasible. That is, restraining the gap between domestic production and consumption by means of support price cuts might cause politically unacceptable dislocation to the farm sector. On the other hand, quotas allow policy makers to bring the underlying trend in supply under direct control and at the same time permit them to use producer price as an instrument for the pursuit of other policy objectives without direct consequences for supply. Moreover, a reduction in price support levels keeps the marginal and average revenue of output elastic at the new (lower) price and does not change the supply incentives of support. Thus, in case the supply curve shifts to the right due to cost reduction and technological change, it inevitably causes production to increase at the existing level of support price and thereby continues to

9 See Alston (1980), Barichello (1981), Hubbard (1984), Harvey (1984), Barichello (1984), Burrell (1987), Moschini (1989), Burrell (1989), Dawson (1991), Oskam and Speijers (1992), Guyomard and Mahé (1994), Guyomard et al. (1996), Chen and Meilke (1996), Colman et al. (1998), Alston and Spriggs (1998), Turvey *et al.* (2002).

aggravate the surplus problem in the absence of a quota, despite the initial price support cut. Indeed the rightward shift of the supply curve would justify an additional reduction of support prices but the support price reduction is typically a politically sensitive issue.[10]

15. It follows that a quota system gives policy makers a direct control of agricultural product supply without the need to compromise the policy objective of high price support. As such, given that most studies show that farmers are generally risk averse (see (Just (1974), Chavas and Holt (1990)), the package of price support and supply management offers producers that are risk averse greater price stability. However, with the imposition of a quota, several inherent quota features should be considered. Firstly, after quota imposition low-cost efficient milk production is impeded at the expense of high-cost inefficient production. That is, typically, quotas are distributed on the basis of historical production levels rather than efficiency criteria and all producers experience the same percentage cut in their production. As a consequence some low-cost, efficient production is lost whilst some high-cost, inefficient production is maintained. The effect of a quota regime imposition on the efficiency of milk production is elaborated in detail in Annex 2.

16. The analysis presented in the Annex 2 stipulates that when a quota system allows quota to be traded or leased, the efficient producers would lease or buy quota from less efficient producers and the rental price in a competitive market would be bid to a rate equal to the difference between support price and marginal cost. It should be noted that these results, where milk production is reduced while prices are held at the existing support levels, is analytically equivalent to the situation where a quota is imposed at the current production level but the support prices are increased subsequently. Oskam and Speijers pointed out that in general producers with low marginal costs will be willing to buy or lease quotas from producers with higher marginal costs. They noted that pressure to allow for quota markets to develop and to increase quota mobility is inherent in a quota system and improving quota mobility by organising quota trade or leasing would speed up structural development.

17. The analysis in Annex 2 also illustrates another important feature inherent in the quota – an emergence of quota value following quota system implementation. The value of quota, or the quota rent, can be understood as the discounted sum of the future stream of net benefits to producers arising from holding the quota. It could be argued that the value of quota is perhaps its most important attribute from a dairy policy reform standpoint. Dawson (1991) argues that the main criticism of quota systems concerns precisely the value.

18. However, it should be stressed that quota carries a value whether it is tradable or not. Given the fact that producer support is usually tied to the quota, it is less profitable and often not feasible to supply milk without quota. For this reason, a quota right is an income-generating asset and assumes a value for the person who controls it. Thus, even if quota does not assume a price value, the quota has an implicit value that does affect decision-making when, for example, policy is debated or farm assets are transferred or sold.

19. Given the fact that quota assumes a value, the producer welfare impacts of quota policies are not straightforward.[11] If the quantity supplied at current support prices is restricted by a quota level, then one may argue that producers would loose part of their producer surplus (see Annex 1). But would they? The simple analytical framework found in standard textbooks on welfare economics typically assumes that producer surplus accrues to the owner of relatively fixed assets (typically land, in the case of farmers) under the condition that supplies of variable factors are perfectly elastic. However, in reality, the supply of

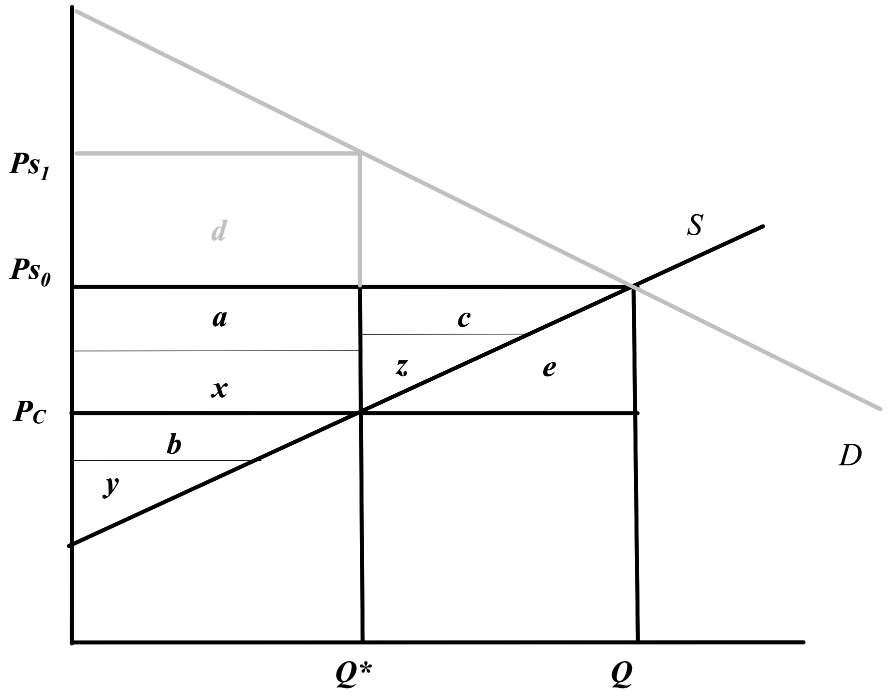
10 Josling (1984) describes the output control and price reduction options in more general terms.

11 When a quota is set at a level that is above quantity demanded domestically at set support prices, then the quota by itself has no direct consequence for consumers assuming that support prices are held constant.

inputs is not infinitely elastic and therefore the producer surplus is distributed across farmers and other input suppliers. Thus, in the long run the benefits of market price support are shared by farmers' own resources and by input suppliers.

20. It is not easy to illustrate this phenomenon in a simple graph. Nevertheless, the following representation reveals important welfare implications of quota imposition - perhaps with repercussions also for prospective quota removal options. Figure 1 illustrates the partition of surplus on the basis of farmer owned resources and purchased input suppliers. For ease of exposition, it is assumed that 50% of surplus goes to farmer's owned resources and 50% goes to input suppliers. [12]

Figure 1. Quota imposition favours farm owners at the expense of input suppliers



21. The figure shows that prior to quota imposition farmers would produce *Q* tonnes of milk at the price P_{S0} with the producer surplus equal to the sum of the areas *a+b+c+x+y+z.* By construction of the experiment the area *a+b+c* represents 50% of the total producer surplus and depicts return accruing to farmers' own resources under the assumptions of this simple exercise. The area *x+y+z* represents the remaining 50% of the total producer surplus and are the returns accruing to input suppliers, again, reflecting the assumption explained in the previous paragraph. If trade in dairy products is fixed such that the domestic price of milk is set to clear the domestic market, then after applying quota of *Q**, a price rise from Ps_0 to Ps_1 is required, and the quota assumes value corresponding to area *a+x+d* while returns to factors other than quota are reduced to area *b*+y. The quota system results in input suppliers losing an amount equal to area *x+z.* Farmers (to the extent that they hold relatively fixed assets, such as land) loose *c* but gain *x,* formerly input suppliers surplus, as part of quota rent.[13]

12 It is difficult to obtain the actual share. The shares estimated with the PEM model are presented later in the paper.

13 The example could be reversed to show that an increase in the quota level allows part of the producer surplus to be recaptured by input suppliers due to rising demand for purchased inputs so that milk producers may loose due to the quota rent erosion.

22. If domestic demand is determined by a target price, such that trade is determined by excess supply, then assuming the domestic price after application of a quota remains at Ps, quota value will be equal to a+x and return to factors is reduced to b+y at a marginal cost of Pc. Again, input suppliers see their returns reduced by x+z. Farmers lose factor rent a+c but gain a+x as quota rent; x is a transfer from input suppliers to producers because of the quota.[14]

23. In reality, the net gain to farmers is conditional on the share of surplus split between farmer's owned factors of production and suppliers of purchased inputs and the size of the production restriction. From a political economy point of view, that owners of farm resources, following a quota imposition might gain part of the producer surplus of input suppliers is a positive development. After all, improving the welfare of farmers is a common goal of agricultural policy. Nevertheless, the benefits of quota in terms of producer surplus will be in the long run capitalised into the value of quota.[15] If quota is tied to land, the benefits will be capitalised into the value of land (see Annex 3). This is indeed a general problem of any increase in farm net returns and is not unique to quota systems. The added complexity in quota systems is that the share of benefits flowing to owners of farm resources is magnified at the expense of input suppliers and the rent accruing to quota reduces the surplus accruing to traditional resources.[16] [17]

24. The capture of input supplier surplus as quota rent explains, in part the high transfer efficiency of quota programs. Transfer efficiency is defined as the ratio of farm income change to change in program expenditure, in the form of either consumer or taxpayer costs. More generally, removing the ability of producers to react to price changes at the margin allows for related market price support policies to be highly transfer efficient, as this production response is a key determinant of transfer efficiency (OECD 2001). To illustrate the change in transfer efficiency of price support resulting from the imposition of a quota system, consider two alternatives using the setup in Figure 1. The first is an increase in price support (either as MPS or output support payments) from Pc to Ps_0 without quota, and the second an increase from Ps_0 to Ps_1 with quota set at Q*. The first case, increasing price from Pc to $Ps_{0,}$ without quota, induces a production increase from Q* to Q, with a cost in terms of MPS level or required total payments equal to the area a+c+e+x+z. Of this, the producer gets a+c, the balance lost to input suppliers and deadweight, and the ratio (a+c)/(a+c+e+x+z) defines the transfer efficiency. In the second case, were support applied to raise prices from Ps0 to Ps1 with production fixed by quota at Q*, program cost is equal to area d, and the increase in producer welfare (through quota rent) is also d, yielding a transfer efficiency of 1, the highest possible.[18]

25. When quotas are used to reduce supply the marginal cost of production of the last "quota" unit falls (compared to higher non-restricted production) and the intensity of use of fixed factors is reduced (see Annex 3). As a consequence, the surplus earned by the "traditional" farm resources fall and the pure profit is bid up into the value of quota. Quota becomes an asset against which loans may be secured, possibly exacerbating the difficulties in reforming dairy policies involving a quota constraint. Moreover, with time, the quota value becomes incorporated into the farm cost structure, resulting in an increase in average costs

14 In that case, when domestic demand is less than Q*, exports will need tax payer support given that world price would normally be less than P_{S0}.

15 For further discussion and some empirical evidence on capitalising government program benefits to quota see Oskam and Speijers and Barichello (1996).

16 If a quota is imposed at the current production level with a subsequent increase in support prices, the rent to quota will be increasing relative to rent accruing to traditional resources.

17 In addition, the simplified analytical framework abstains from a complex relationship between milk producers and processors in quota operating countries. Milk and dairy processors, given their strong bargaining position, might also benefit from the presence of a milk quota system.

18 Note, the high transfer efficiency applies at the margin under binding quota.

so that in the long-run, as Dawson puts it, only the administrative nuisance of supply control remains. The report on feasibility of phasing out quota in the European Union goes even further stating that the system no longer achieves its major objective of stabilising and improving dairy farm incomes (Colman, 2002). This long-run effect brings into question the durability of the above-described transfer efficiency of policies involving quota constraints. If quota rents are not retained by current producers, but stay with those initially vested with the quota, then high transfer-efficiency of price support connected with quota restrictions is a transitory phenomenon.

26. There are other important issues related to quota systems such as the impact on structural change or uptake of new technologies (Oskam and Speijers; Hennessy, 1995). Although Bailey (2004) argues that structural changes in the EU have been slower under the quota system than would otherwise have been the case, restructuring of the dairy sector has continued all the same, albeit with different geographical connotation. That is, while on average the number of farms and cows in the EU has continued to fall as yields improved over time, these numbers have remained more stable in less favoured areas. Hence, it could be argued that the presence of quotas, as they are typically tied to land, might preserve farming structures and allow farming practices in disadvantaged areas to prevail.[19] Nevertheless, the question is, whether the policy objective to preserve farming in less favoured areas could not be better achieved by direct measures as compared to a general quota system. The answer to such a question requires welfare analysis reflecting production jointness and presence of transaction costs.

27. A different issue, although related to structural adjustment in the sector, concerns the situation where some producers completely cease milk production and continue to annually lease their quota. It is arguable whether the income from quota could accelerate the restructuring process and stimulate the cessation of production in these cases.[20] However, it would be difficult to justify the permanent stream of income transfers from the industry to non-producing quota holders. Moreover, with a quota system in place it become "more expensive" to start dairying as this requires the purchase of quota which brings an important question of entry to the industry and the renewal of the dairying population. In this respect, nevertheless, the type of quota administration plays an important role and measures can be and have been adopted that subsidise or otherwise enable entry of new producers which have been discussed elsewhere.[21]

IV. Quota interactions with other policy objectives

28. While the sections above discussed the theoretical background of quotas and the emergence of quota value this section looks at quota as a policy tool and discusses the market and welfare impacts of changing levels of quota within a context of specific policy objectives. The setting of the level of quota represents an important policy decision which interacts with the effects of other policy tools. The impacts on world and domestic dairy markets of changes in the level of quota are conditional on the decision regarding other policy objectives. That is, the quota level has a direct influence on exports and government expenditure on subsidised exports within the objective of holding the supported domestic price unchanged.

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19 However, an experience of allowing quota trade among regions in Canada has shown rapid flow of milk quota and production to more efficient regions.

20 Indeed the cessation of production might be better addressed by different measures as compared to sale of quota. As an example might be taken the structural adjustment package introduced through Dairy Industry Adjustment Act 2000 to help producers cope with the adjustment pressures following the Australia dairy sector reform (ACCC (2001), ABARE (2001)).

21 One option to encourage new producers is to place a siphon on the quota transfers by the market authority which then can be freely or at reduced cost distributed to new entrants (see Burrell (1989) and Swinbank and Peters (1990) for further discussion). In cases where quotas are not traded, when producer ceases production the corresponding quotas are reallocated back to the industry. See also Box 1 discussing the administrative quota management in France.

On the other hand the level of quota determines the cuts in domestic prices required to achieve other objectives such as holding exports or government expenditure on subsidised exports unchanged.

29. The effect of quota policies on income is not obvious, as its impact is best seen as being part of a body of policies, and the impact attributable to the quota policy itself is dependent on the other polices of which that body is composed. A fruitful way of examining the impacts that quota polices have on indicators of interest such as farm income and production, is to look at how the mix of policies has to change in order to target a certain result for one of these indicators.

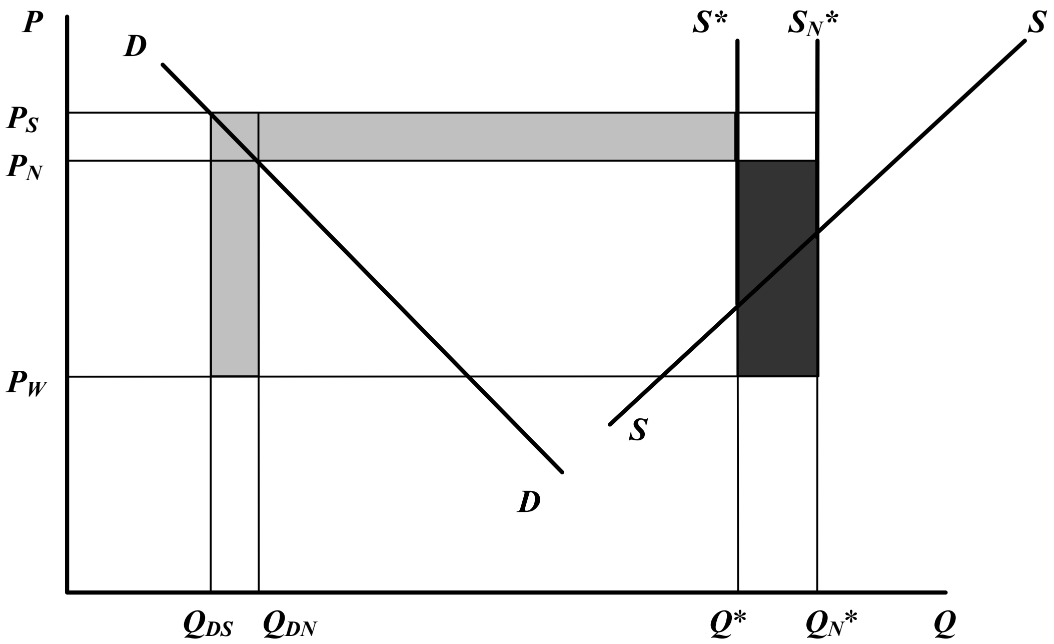
30. The relationship between the quota and certain policy objectives might be illustrated using a simple diagram. Figure 2 schematically depicts the trade-off between the supported domestic price and the quota level given that the policy objective is to leave government expenditure on subsidised exports unchanged. Consider that at the initial level of the supported domestic price P_S and milk quota Q^* consumption equals quantity Q_{DS} of milk while Q^*-Q_{DS} is exported with export subsidies equal to $(Q^*-Q_{DS})\times(P_S - P_W)$. Holding the supported domestic price constant and increasing the quota to the new level Q_N^* increases taxpayers costs (export subsidies) by $(Q_N^*-Q^*)\times(P_S - P_W)$.[22]

31. Nevertheless, policy makers can, for a given level of quota, reduce the supported domestic price so that government expenditure (taxpayers' costs) on subsidised exports would not be affected. Figure 2 illustrates that in order to keep government expenditure unchanged, the domestic price has to be reduced to a new level P_N for which the lighter shaded area equals the darker shaded area in the diagram. That is, the export subsidies before and after quota increase must be equal; mathematically expressed $(Q^*-Q_{DS})\times(P_S - P_W) = (Q_N^*-Q_{DN})\times(P_N - P_W)$. Note that under the new price (P_N) consumers will consume a higher quantity ($Q_{DN.}$).[23]

22 The level of quota is proportional to taxpayers cost. For example, assuming half of the milk production is consumed domestically, a one percent increase in quota level translates to two percent increase in taxpayers' cost (holding the support price constant).

23 It should also be noted that for simplicity the figure represents a small country case which does not have a substantial impact on world markets and prices. For a large country the world price would have to be reduced in the diagram to reflect the impact of increased exports.

Figure 2. Interaction between quota level, domestic price, exports and government expenditures



32. A different scenario can be constructed to evaluate the increase of quota with the objective of holding the volume of dairy product exports constant. In the analytical framework of Figure 2 this scenario could be described as follows: "By how much would the price (P_S) have to be lowered to a new level (P_N) so that for a given increase in quota (from Q^* to Q_N^*) the volume of exports remains constant ($Q^*-Q_{DS} = Q_N^*-Q_{DN}$)." Note that in this scenario the darker shaded area in Figure 2 would be smaller than the lighter shaded area, suggesting that government expenditure on exports would be reduced, by how much remains an empirical question.

33. In order to evaluate numerically the relationship between the quota level, supported domestic prices and welfare under specific economic parameters and policy objectives, empirical analysis has been carried out for a representative OECD country using the Secretariat's models: the partial equilibrium model *Aglink* and the policy evaluation model PEM.

Aglink results of policy simulation analysis- Evaluating the market and trade impacts

34. *Aglink* is a policy specific, partial equilibrium, dynamic model (see Annex 5 for the description of Aglink). The simulation experiments are conducted using the baseline data of the Agricultural Outlook baseline 2003-2008 published in OECD (2003). The dairy component of this model covers production and consumption of milk and main milk products in major OECD and several non-member economy markets, covering both importers and exporters. Thus, the *Aglink* representation of the dairy sector allows to analyse a scenario impact on world markets in tradable dairy products that are explicitly modelled.

35. Following the analytical example of Figure 2, the specific question to be addressed by the first empirical experiment is "how much would domestic prices have to be lowered to accommodate a given increase in milk quota while holding government expenditures on export subsidies constant?" As the level

of the quota is exogenous in only one country/region in *Aglink* – the European Union (EU) – the EU module is used to set up the scenario.[24 25]

36. While Figure 2 depicts the analytics in terms of milk price and milk quantities, in reality milk is often priced and traded in the form of dairy products. The dairy market is also represented in this way in the *Aglink* model. Thus, theoretically there are a large number of permutations for adjusting individual dairy product exports while holding the overall government expenditure on exports constant. For the sake of transparency, the objective of holding the government expenditures on exports constant is achieved by holding the government expenditures on exports for each dairy product constant at the baseline level. To accommodate this assumption, the structure of the model has to be changed as follows. The dairy product prices, which are market clearing variables in the baseline, are changed to:

$$PP_i = XP_i + BaseVAL_i \,/\, EXS_i$$

where *i* stands for individual dairy products, *PP* is the domestic dairy product price, *X*P is the dairy product world price, *EXS* is the volume of subsidised exports and *BaseVAL* represents government expenditures on exports in the baseline (calculated as $EXS_i \times (PP_i - XP_i)$).[26] In this scenario, the volume of subsidised exports becomes the market clearing variable.[27] The above equation determines the direct interaction between the volume of subsidised exports and prices for each quota level. Other policy instruments remain at their baseline level.

37. This construction ensures that government expenditures on subsidised exports for each dairy product will be equal to the baseline level after the increase in the milk quota. However, it should be noted that holding government expenditures on exports constant does not guarantee that world prices would not be affected. The reduction in domestic prices would lower per unit export subsidies, allowing a greater volume of subsidised exports for the same amount of expenditure. Note that export subsidies are limited by the WTO both, in volume and value terms, which prevents any increase over these limits. In this respect the scenario must be viewed as purely illustrative as no account is taken of the respective WTO limits on the volume of subsidised exports.

38. In order to evaluate the market impacts of changes in the quota level, the experiment was undertaken with 1, 1.5 and 2% increases in milk production quota respectively. Table 1 provides results that address the initial question about how much domestic prices would have to be lowered to accommodate a given increase in milk quota while holding total expenditures on export subsidies constant. As illustrated in the table, the reduction in the EU internal prices of dairy products combined with fixed subsidised export expenditures allow greater exports for all dairy products.

39. Thus, for example, if the milk quota were to be increased by 1%, then the required stability in export subsidy expenditures would be achieved by a simultaneous reduction in the butter price of more than 3% and an increase in exports of butter by 5.1%. The producer price of milk in this scenario would fall by 2.4%. As is apparent from the table, world prices for all dairy products would be reduced due to the increased exports from the European Union, which is a dominant player on world dairy markets. Again,

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24 In Canada the quota system is to some extent endogenous – the quota level is set contingent on domestic price support to hold subsidised exports at low levels.

25 The EU is treated as a single block so that spatial effects due to industrial management are not taken into the account.

26 World dairy prices in the Aglink baseline are defined as F.O.B. Northern Europe (OECD 2003a).

27 In the EU component of Aglink intervention stocks are exogenous. It is therefore implicitly assumed that stocks are not a medium term solution to structural surpluses.

these results are purely illustrative as no account is taken of the respective WTO limits on the volume of subsidised exports.

Table 1. Impacts of quota increases on key variables (average changes from baseline for the EU) assuming constant government expenditures on subsidised exports

		% change	% change	% change
Quantity	**Milk**	**1.0**	**1.5**	**2.0**
Domestic Prices	Butter	-3.1	-4.6	-6.0
	Cheese	-1.4	-2.0	-2.7
	SMP	-0.9	-1.4	-1.9
	WMP	-1.2	-1.8	-2.4
	Milk	-2.4	-3.6	-4.7
Subsidised Exports (Volume)	Butter	5.1	7.8	10.5
	Cheese	2.3	3.5	4.6
	SMP	4.5	6.8	9.2
	WMP	2.7	4.0	5.4
Government Expenditure on Subs. Exports	Butter	0.0	0.0	0.0
	Cheese	0.0	0.0	0.0
	SMP	0.0	0.0	0.0
	WMP	0.0	0.0	0.0
World Prices	Butter	-0.6	-0.9	-1.2
	Cheese	-0.3	-0.4	-0.6
	SMP	-0.1	-0.2	-0.2
	WMP	-0.6	-0.9	-1.2

40. The results of the scenarios with 1.5 and 2% increase in quota are similar to those of the 1% quota increase. In the absence of the respective WTO limits on the volume of subsidised exports, the larger the increase in quota the larger the impact on the key variables presented in Table 1. The results illustrate that a 1.5% increase in the milk production quota would be neutral in terms of expenditure on subsidized export of dairy products if the supported domestic price is reduced by 3.6%. For the 2% milk quota increase, the milk producer price would have to be reduced by 4.7%. It is interesting to note that butter prices would have to be reduced substantially more than those for SMP. These results stem to some extent from the fact that in *Aglink* the EU demand for fat is specified as being less elastic than demand for non-fat solids.

41. The results of the scenario where the policy objective is to increase quota while keeping export volumes fixed are reported in Table 2. The *Aglink* simulations are undertaken again with the EU model component of *Aglink*. Table 2 shows the impact of different increases in the level of quota (again 1, 1.5 and 2% respectively). Comparing the results of Table 1 and Table 2, the latter shows more profound cuts in dairy product and milk producer prices as exports are not allowed to increase relative to the first case with fixed expenditure. For example to accommodate a 1% increase in quota, holding the export volume constant, would require a 3% reduction in the producer price of milk.

42. Again, the results of the scenarios with 1.5 and 2% quota increases are similar in direction to those of the one percent increase but confirm that the larger the quota increase, the greater the impact on the key variables. Thus, the two per cent increase in quota would result in a milk producer price reduction

of 6%. As in the first experiment butter prices would be reduced the most, followed by those for WMP, cheese and SMP. Government expenditures on subsidised exports would be reduced for all dairy products with the highest reduction seen for butter, again followed by WMP, cheese and SMP.

Table 2. Impacts of quota increases on key variables (average changes from baseline for the EU) assuming constant volume of subsidised exports

		% change	% change	% change
Quantity	**Milk**	**1.0**	**1.5**	**2.0**
Domestic Prices	Butter	-4.9	-7.3	-9.7
	Cheese	-1.9	-2.8	-3.7
	SMP	-0.2	-0.3	-0.4
	WMP	-2.1	-3.1	-4.1
	Milk	-3.0	-4.4	-5.9
Subsidised Exports (Volume)	Butter	0.0	0.0	0.0
	Cheese	0.0	0.0	0.0
	SMP	0.0	0.0	0.0
	WMP	0.0	0.0	0.0
Government Expenditure on Subs. Exports	Butter	-8.7	-12.9	-17.0
	Cheese	-3.4	-5.0	-6.7
	SMP	-0.7	-1.0	-1.4
	WMP	-6.6	-9.8	-12.9
World Prices	Butter	0.3	0.4	0.5
	Cheese	-0.1	-0.1	-0.2
	SMP	0.0	-0.1	-0.1
	WMP	-0.2	-0.2	-0.3

43. As the volume of exports is held at the baseline level, the scenario could be expected to have a negligible impact on world dairy prices. However, as Table 2 indicates, the impact on world dairy prices is non-trivial. This result begs more explanation. After the United Kingdom accession to the European Union, New Zealand, which is the biggest exporter of butter in the World, was granted a market access quota for butter to the EU market. Thus, New Zealand producers benefit from their special ability to sell some of their butter at EU support prices rather than at lower world prices. It follows that the New Zealand butter export price is partly determined by the world butter price and partly by that on the EU domestic market. As the latter price falls in the *Aglink* scenario, it reduces the rent accruing to New Zealand producers and ultimately reduces the butter prices in New Zealand as well. Lower butter prices in New Zealand lead to a shift in dairy product output - and a small reduction in total butter production – with some consequences for world markets as shown in Table 2.[28]

[28] Note, that the results measure the impact against a baseline of 2003 where the EU policy assumptions reflect the Agenda 2000. Under the agreed CAP reform, the additional 10% cuts in butter support prices (as compared to the Agenda 2000 - see OECD (2004)) would reduce the price gap between the EU and New Zealand and also the positive world price impact estimated in the above scenario arising from the special New Zealand market access for EU butter.

PEM results of policy simulation analysis - Investigating the connections between quota and welfare

44. The Policy Evaluation Model (PEM) is a partial equilibrium static model including 5 major commodity categories and covering six countries plus a rest-of world component (see Annex 5 for a description of the PEM model). It is calibrated to a 2002 base year using primarily data from the OECD PSE database.[29] Elasticity parameters are selected to give the model a medium-term (5-7 years) adjustment horizon. The dairy sector is represented in terms of raw milk equivalents. A single supply of raw milk is demanded by separate domestic markets for milk for fluid and industrial uses. Industrial milk (dairy products are expressed in raw-milk equivalent terms) is a tradable commodity in the model. The slope of the supply function is implicitly determined by the factor supply elasticities and the share of each factor in production, and the supply function is located by the specification of a unit quota rent which defines the difference between producer price and marginal cost at the initial equilibrium point.

45. In this section, the PEM will be used to investigate the interactions between quota and other policies (primarily market price support) related to achieving specific policy outcomes. The focus of the analysis is on welfare impacts in the EU and Canada.

46. All scenarios are combined with a sensitivity analysis that varies all parameters within their plausible ranges as identified in the reports by Abler (2001) and Salhofer (2001). In addition, unit marginal cost is also varied in a range between one half and double its base value. A Monte Carlo approach is used where all parameter values (plus unit marginal cost) are drawn from uniform distributions, and the scenario run using this new parameter set. This is repeated for 500 draws, and the extreme high and low values for all results are identified. These maximum and minimum results define the range of results that alternative but plausible parameter choices would yield.

47. In many cases, this sensitivity analysis produces no variation in the results in each scenario. This is the case where the result is normally constrained (e.g. production under quota), constrained as part of the scenario (e.g. constant export subsidy levels), or immediately derived from such a fixed value. Where this is the case, the sensitivity results are omitted from the reported results in order to conserve space.

48. Policy makers are interested in the impact of policy reform on welfare, and particularly farm income. In fact, policy reforms in the EU have often contained explicit provisions of compensation for any resulting reduction in farm income. The ambiguity of farm income changes for changes in quota was illustrated in Figure 1 in the first section of this paper.

49. As discussed above, total quota rent is a rectangle where the height represents the unit quota rent, i.e. the difference between the producer price and the shadow price (marginal cost of production at the quota level), times the quantity produced.[30] Additional production increases total rent by increasing the "quantity" side of this rectangle (by the amount of the quota increase). However, any increase in production entails a move up the supply function, resulting in an increase in marginal cost as the price of farm inputs are bid up due to increased factor demand. This increase in cost reduces unit quota rent, shrinking the gap between the producer price and shadow price. Thus, for an increase in level of quota, the rectangle that defines total quota rent increases in one dimension and decreases in the other.

50. Farm income is composed not only of total quota rent, but also of returns to factors of production owned by the farm household. Any production increase due to an increase in quota will raise these returns through increases in factor demand. In fact, part of the reduction in unit quota rent (the vertical part of the

29 As is the case in the Aglink model, the EU is treated as a single region in the model.

30 For ways to derive the shadow price in the presence of quota see Moschini (1986) or Consortium INRA-University of Wageningen (2002).

quota rectangle) on total quota rent is returned to producers through their ownership of factors of production. The other part of this reduction in unit quota rent is received by suppliers of purchased inputs who are not farm households. The ability of purchased input suppliers to capture some of this increased surplus is the main cause of farm income losses due to quota changes. This sharing of total producer surplus between farm households and input suppliers was discussed in section III above.

51. Farm income stands alone as having components derived from quota as well as from factors of production. For other actors in the model, welfare changes are calculated as changes in consumer or producer surplus resulting from price changes and with reference to demand or supply functions. For example, the change in consumer welfare is the area defined by the change in consumer price and the demand function (e.g. area *f* in Figure 4 below). Absent an exogenous shift in the consumer demand or input supply functions (none are considered here), there can be no welfare change without a price change in these markets. The terms "change in consumer surplus" or "change in producer surplus" are synonymous with consumer and supplier welfare changes.

52. Each input in the model is represented by a single supply function. The change in welfare for input suppliers as a whole is presented by summing up the change in producer surplus for all purchased inputs in the model. For farm households, the change in producer surplus for each farm own factor is reported separately, though the method of calculation is the same in all cases.

53. Taxpayers pay for the budgetary component of agricultural programs. Their welfare changes as this expenditure changes. Accordingly, the change in taxpayer welfare is equal to the negative of the change in budgetary expenditure on agricultural programs. If spending decreases, taxpayer welfare increases. This item is reported with a subheading specifically for changes in budgetary expenditure on export subsidy programs, as this is a program category of particular interest here.

54. Total welfare change for the EU is the sum of the welfare changes for producers, consumers, input suppliers, and taxpayers. Changes in total welfare are driven by changes in prices in the input markets (for farmers and input suppliers), in the output market (for consumers and farmers), and by changes in budgetary expenditures on programs (for taxpayers). Any changes in welfare in other countries or other sectors that result from the shocks that occur in each scenario are not considered.

55. If the country in question is large enough to influence world prices, any increase in exports brought about by the quota increase will put downward pressure on world prices. This decline in world prices will be transmitted into the domestic market, pushing down domestic prices (assuming a constant domestic-world price differential that allows transmission of price changes from world to domestic markets). Any such reduction in domestic prices will also reduce unit quota rents.[31]

European Union

56. Four experiments were carried out in the EU, each based on a 1% increase in quota, to illustrate the impact on welfare of quotas, and of quotas as part of a set of related policies. Table 3 presents the results of these experiments. Shown in this table are a set of market impacts of the experiment, including domestic and world prices, exports and marginal cost of production. It also shows changes in welfare for the different actors in the model; taxpayers, consumers, farm households, and input suppliers. Farm household welfare is disaggregated into returns to three categories of farm-owned inputs and total quota

31 If border protection is varied to maintain a constant domestic price in the face of a changing world price, this effect on quota rents would not occur.

rent. Reported welfare results are restricted to the dairy sector; although there are clearly welfare spill-over effects in other markets, they will not be considered as part of this paper.[32]

Table 3. Impact of a 1% increase in quota in the EU

		Increase of quota by 1% and…		
	Increase of quota by 1% only	*Holding constant export volume by reducing price*	*Holding constant export subsidy expenditures by reducing price*	*Holding constant export subsidy expenditures and farm income by reducing price and compensating with direct payments*
Commodity Market Impacts:		*~ result of experiment in levels ~*		
Producer Price (€/tonne)	**312.3**	**299.1**	**304.2**	**304.2**
Marginal cost (€/tonne)	**252.9**	**252.9**	**252.9**	**243.4**
	221.4/284.5	*221.4/284.5*	*221.4/284.5*	*212.2/274.6*
Quota rent rate (%)	**0.2**	**0.2**	**0.2**	**0.2**
	9%/30%	*5%/30%*	*6%/27%*	*10%/30%*
Net Exports (m tonnes)	**8.1**	**7.0**	**7.4**	**7.4**
World Price (€/tonne)	**169.3**	**170.3**	**169.9**	**169.9**
	169.3/169.3	*170.3/170.3*	*169.9/169.9*	*169.9/169.9*
		~ result in % change ~		
Producer Price	**-0.3%**	**-4.5%**	**-2.9%**	**-2.9%**
Marginal cost	**0.8%**	**0.8%**	**0.8%**	**-3.0%**
	0.7/0.8	*0.7%/0.8%*	*0.7%/0.8%*	*-3.5/ -2.6*
Net Exports	**16.3%**	***0.0%***	**6.4%**	**6.4%**
World Price	**-0.5%**	**0.0%**	**-0.2%**	**-0.2%**
Economic Impacts:		*~ million EUR ~*		
Taxpayers	**-164.2**	**82.6**	**-10.1**	**-1,069.1**
	-164.3/-164.2	*82.6/82.6*	*-10.1/ -10.1*	*-1,167.7/ -974.6*
of which export subsidies	**-162.6**	**98.4**	***0.0***	***0.0***
Consumers	**106.1**	**1,620.7**	**1,032.2**	**1,032.9**
	105.7/106.5	*1620.7/1620.7*	*1,032.1/1,032.3*	*1,032.5/1,033.3*
Farm Households	**-95.5**	**-1,710.3**	**-1,084.9**	***0.0***
	-142.0/ -50.0	*-1,756.9/ -1,664,3*	*-1,131.3/ -1,038.9*	*fixed*
of which farm owned	**160.7**	**160.8**	**160.8**	**71.4**
	135.4/188.7	*135.5/188.7*	*135.5/188.7*	*20.9/130.9*
of which farm land	**1.2**	**1.2**	**1.2**	**10.9**
	1.1/1.2	*1.14/1.24*	*1.1/1.2*	*7.2/15.5*
of which dairy livestock	**15.8**	**15.8**	**15.8**	**7.0**
	13.1/18.5	*13.1/18.5*	*13.1/18.5*	*1.9/12.6*
of which quota rents	**-273.2**	**-1,888.1**	**-1,262.6**	**-89.4**
	-345.0/ -202.0	*-1,959.8/ -1,816.84*	*-1,334.2/ -1,191.4*	*-146.6/ -36.0*
Input Suppliers	**54.6**	**54.6**	**54.6**	**24.3**
	47.1/62.4	*47.1/62.44*	*47.1/62.4*	*8.6/42.2*
Total	**-100.0**	**46.8**	**-9.0**	**-11.8**
	-137.9/ -60.6	*8.8/86.3*	*-47.0/30.5*	*-119.2/ 88.9*

1. Items constrained constant in italic
2. Minimum-maximum ranges from sensitivity analysis shown below estimate

Source : OECD PEM model

32 These spill-overs will likely be minor in scale compared with the own-sector impact of policy changes. A possible exception is the experiment where direct payments are made to producers. Such payments can bring about significant changes in land distribution.

57. The first column of Table 3 shows the impact of a 1% increase in quota holding all other policy variables constant. Without a change in domestic price policy, domestic consumption will not change significantly, with the result that nearly the full amount of the quota increase will be exported. The increase in exports causes world prices to decline by half a percent. This change will be transmitted back into the domestic market, reducing domestic prices by approximately one-third of a per cent.[33] The increase in domestic production has caused a movement along the supply function and a consequent rise in marginal cost of 0.8%. The combined effect of the domestic price change and increase in marginal cost has reduced unit quota rent from the baseline 20% to 19%.

58. The increase in quota quantity is insufficient to compensate for the decline in unit quota rent, resulting in a reduction of EUR 273 million in the total value of quota. Returns to farm-owned inputs have increased by EUR 177 million, insufficient to fully compensate for the reduced value of quota. Input suppliers' surplus increases because the price of inputs has increased. Demand for inputs is a derived demand based upon the quantity produced of the final output. Increasing quota increases the amount of milk supplied, and therefore the demand for inputs in milk production. The resulting change in input suppliers' surplus amounts to EUR 55 million, and reflects the sharing of total producer surplus between these suppliers and farm households. The change in welfare for input suppliers is less than that for farm-owned inputs because of the relatively elastic supply of purchased inputs (recalling that change in input suppliers' welfare is determined by changes in producer surplus from the supply function of these inputs). Total surplus change to both farm-owned and purchased inputs[34] is around EUR 233 million, significantly below the change in total quota rents. The difference is largely due to the change in domestic prices induced by the world price change as discussed above. Export subsidies have to increase by EUR 162 million in order to fund the 16% increase in exports. This result highlights the role of quotas in limiting expenditures on export subsidy programmes.

59. The sensitivity analysis for this scenario points out the importance of the unit quota rent in the results. The marginal cost displays significant variance, as its level is indeed part of the sensitivity analysis and can vary from between one half to double its base value. This has a strong influence on the total quota rents that form an important part of farm household welfare. This is common to the sensitivity analysis for all scenarios.

60. The previous scenario demonstrates that quota increases by themselves tend to result in the increased production being exported, with an associated increase in expenditures on export subsidies. It should be noted that as in the *Aglink* scenario, the PEM experiments are illustrative and actual WTO limits on export subsidies are not taken into consideration. The second column of Table 3 adds to the previous scenario a restriction on increasing exports. In this case, the increase in production caused by the quota expansion must be taken up by the domestic market in order to preserve current export levels. In order to obtain the required increase in domestic demand, the rate of market price support must be reduced to allow the domestic price to fall. In this experiment, the fall in domestic price amounts to 4.5%. This brings about significant benefits to consumers, in excess of EUR 1.6 billion, as well as benefiting taxpayers by reducing the amount of expenditure on export subsidies. This expenditure declines because, even though the trade volume is unchanged, the difference between the domestic and world price, and therefore the export subsidy rate, has fallen. The reduction in total quota rents is greater than the quota-expansion-alone scenario as this experiment results in a significantly greater fall in domestic prices, and therefore erodes

33 All scenarios include the possibility of price transmission from world to EU domestic prices. The lower the degree of price transmission, the smaller the reduction in domestic price, and so the lower the consumer benefit and higher the producer benefit (or lower producer loss) of the scenario.

34. This figure is the sum of the returns to the three factors of production owned by the farm household (farm owned, land, dairy herd) plus returns to input suppliers as shown in Table 3.

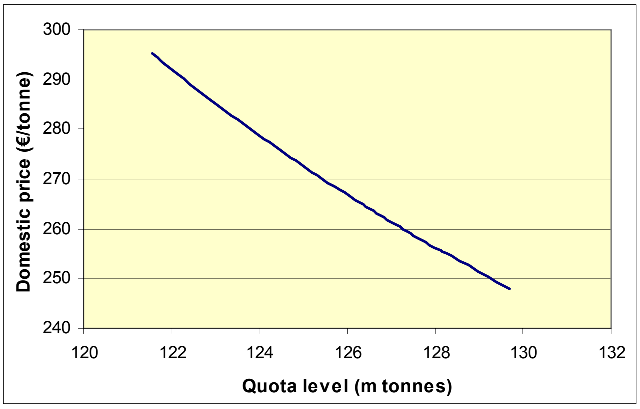
total quota rents to a greater degree. Net welfare for the EU is increased, reflecting the reduced transfer to importers in the rest of the world resulting from subsidised EU exports.

61. The *Aglink* results in the previous section investigated the change in domestic price support levels coincident with an increase in quota, given a restriction on growth in government expenditures on subsidised exports. A similar experiment is done here. It illustrates that domestic price support will be maintained at a higher level when compared to the previous scenario if the quota relaxation is coupled with a constraint on the amount of export subsidy expenditures. This experiment shows that a 1% increase in allowable quota production results in a fall of 2.9% in domestic prices (third column in Table 3). Total export subsidies are the product of exports and the domestic-world price differential; decreasing the domestic price will limit the expansion in exports caused by the quota increase (by stimulating domestic demand) and reduce the price differential. The decreased price differential allows exports to increase by 6.4% while keeping total expenditures on export subsidies constant. The ability to expand exports within fixed export subsidy expenditures is why the reduction in domestic price in this scenario is less than the constant-export volume scenario. This smaller increase in exports compared with the quota-only scenario limits the reduction in the world price of milk to 0.2%, less than half the decline in that scenario.

62. Consumers are the main beneficiaries in this experiment. Policies that increase prices are designed to transfer income from consumers to producers, and the change in price support in this experiment reduces this transfer by over EUR 1 billion. The resulting reduction in total quota rent is even larger, EUR 1 260 million, the difference reflecting the proportion of production that is exported. Total reduction in farm welfare when factor income is included is EUR 1 084 million. Changes in factor income, both farm-owned and for suppliers of purchased inputs, are unchanged from the quota-only scenario as the change in production quantity is the same, governed by the quota shock in both cases.

63. Figure 3 shows the relationship between domestic price and quota level that must hold if export subsidies are to be held constant. The rate of price decline required is such that the quota level is no longer binding on production after an increase of only 5.5%. That is, increasing quota by this amount requires a price reduction of 16% to hold export subsidies constant. The increased production also increases marginal cost by 5%, and the two taken together are enough to completely eliminate unit quota rents.

Figure 3. Relationship between price and quota holding export subsidies constant



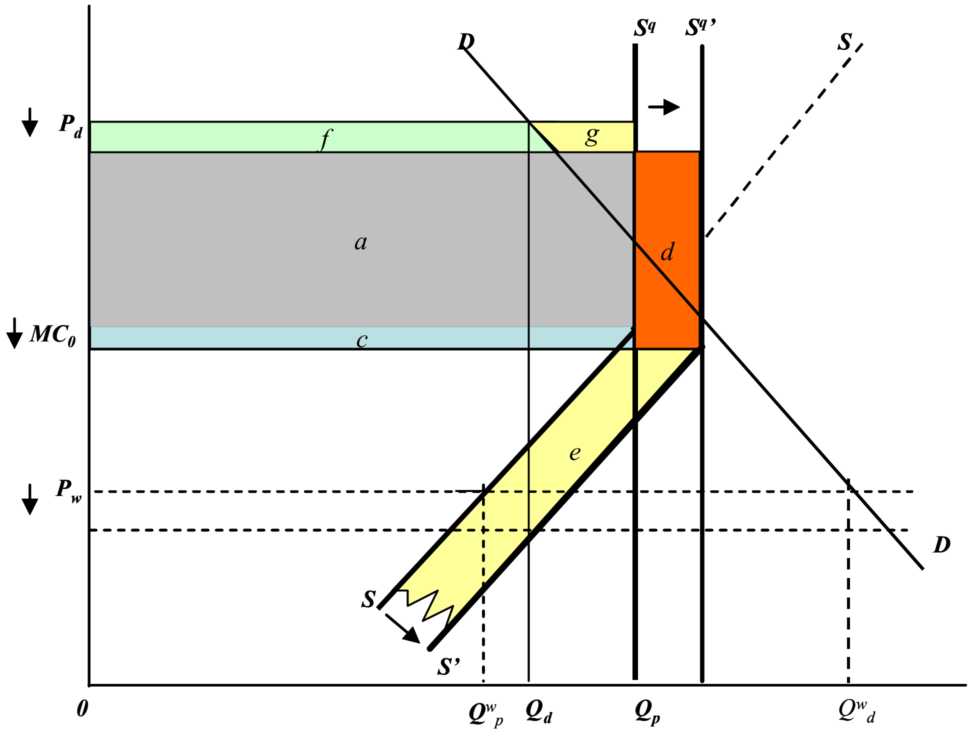
Source: OECD PEM model

64. The decrease in domestic price required by the constraint on export subsidies has a sharply negative impact on farm income. As was mentioned at the outset, such changes in farm income resulting from policy reform raise questions of compensation. The experiment reported in the fourth column of

Table 3 adds to the previous experiment by offering direct payments to dairy producers in an amount sufficient to hold farm household income constant. In the PEM, such direct payments are represented as a subsidy to pasture used by dairy producers (but not other users of pasture).

65. Providing support of this kind reduces the cost structure of the farm operation, and therefore shifts the supply curve down and to the right (the movement from *S* to *S'* in Figure 4). The shift in supply lowers marginal cost for a given level of production (by 3% in this case), and so increases the unit quota rent. Area *c* represents the increase in quota value resulting from this change in unit rents, while area *d* represents the increase in quota value resulting from the increase in quota level itself. If there is a decline in world price as a result of the increase in quota, the effect on total quota rents is equal to areas *f*+*g,* of which *f* is captured by domestic consumers as increased surplus.

Figure 4. Income-compensating payments shift supply



66. The result of this experiment is that even though the compensatory payment is based on the use of a farm input, most of the benefit to farm households is to maintain total quota rents. Why is this the case? The supply of dairy pasture in the model is quite elastic, while the binding quota makes the demand for pasture relatively inelastic. For this reason, the main effect of the payment is to reduce land price, and reducing dairy costs. This is seen in the significant reduction in producer marginal cost in this scenario compared to the others. The reduction in marginal cost leads to the benefits being capitalised into dairy quotas[35]. Input suppliers benefit less under this scenario because the reduction in cost of land resulting

[35] A similar experiment could have been carried out where compensation was in the form of a headage payment; this would have been reflected in the dairy livestock factor. In this case, the factor supply is inelastic (elasticity of 0.5), but still only about one third of the value of the payment accrues as rent to the livestock factor, with the balance supporting quota value.

from the subsidy induces a change in the input mix away from purchased inputs towards land use (extensification).

67. In this experiment, the effect of the price reduction and the cost reduction on unit quota rents nearly washes out, reducing its absolute level by only about EUR 1/tonne and with almost no change in unit quota rents in percentage terms. Farm household factor income increases modestly (by amount *e-c* in Figure 4). The main welfare impact in this scenario is the significant net transfer from taxpayers to consumers of over EUR 1 billion.

68. Sensitivity analysis reveals an important difference between the first and last two scenarios: The plausible range of values for change in total welfare spans zero in scenarios three and four. This ambiguity regarding possible total welfare effects does not exist in scenarios one and two. In the first scenario, net welfare is consistently negative, and consistently positive in the second. The greater complexity of the last two scenarios makes the net welfare outcome less clear. It is worth noting that all of the components of net welfare have consistent signs under the sensitivity analysis; variation in their relative magnitudes drives the net welfare result.

69. Reflecting the underlying hypothesis, the model results show that increasing quota by itself cannot be seen as a move toward increased market liberalisation as for the same level of producer price support, an increase in quota would require an increase in export subsidies (if permitted by the WTO limits), which would subsequently distort world prices further. Moreover, in the PEM experiments shown here, increasing quota (by itself or with an associated compensatory policy change) leads to a decrease in domestic welfare. Think about it this way: Quota policies exist largely to moderate the negative impact of price support policies on government expenditure and trade in order to enhance the political sustainability of high price support. Increasing quota is a reduction in that moderation and not as such a step toward liberalisation unless accompanied by an appropriate reduction in price support. Under these conditions, dairy quota reform can be achieved in a welfare-enhancing manner, as is evidenced by the second experiment. This result was also observed by Bouamra-Mechemache et. al. (2002) who show, that in the presence of market distortions, an elimination of quota results in welfare losses.

Canada

70. In the Canadian quota system for milk production, domestic prices and production quotas are jointly determined to balance domestic supply and demand, allowing for a set level of imports through TRQs. The Canadian dairy system provides quotas for fluid and industrial milk separately, the first being a provincial responsibility and the second federal. The total quota is allocated to producers as a single quantity. The price paid to farmers is a weighted average of prices paid by end users (i.e. fluid, manufacturing use) less marketing charges. In the experiments regarding the Canadian milk system, the policy innovation will be allowable imports, which is also controlled as part of Canadian dairy policy. The amount of allowed imports is doubled in both scenarios, from a base amount of 375 000 tonnes to 750 000 tonnes milk equivalent (Table 4) The first column of Table 4 contains a scenario where production quota (via industrial milk) is increased by 1% This provides an illustration of the transfer efficiency of policies including quota. A quota change in Canada involves, by design, a domestic price change but no change in trade volume. By examining the relative changes in consumer surplus (price support is via MPS, and therefore consumer-funded) and farm welfare, the transfer efficiency of a change in quota level is seen to be 40.3/42.3, or about 95%. While less transfer efficient than a price change with constant quota, which was shown to be 1, this shows that varying the quota level itself is still a very efficient way of transferring welfare to producers.[36]

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36. The argument regarding long-term durability of this transfer applies in this case as well.

71. Figure 5 illustrates the impacts of a policy change increasing allowable imports (via increasing a filled TRQ, for example). The domestic supply schedule is shown, with the vertical range representing the quota restriction on output, and the demand curve for industrial milk products. At the domestic price (set by policy), P_d, there are planned net imports equal to the area Q_d-Q_p. Increasing the amount of allowed industrial milk product imports without changing domestic quota requires that the domestic price be reduced sufficiently for domestic consumption to absorb the full amount of the additional imports. This reduction in the administered price combined with the increased quantity consumed increases consumer surplus by areas *b*+*c*+*d*. Area *b* is total quota rent that is transferred to consumer surplus through the price reduction, and area *a* is remaining total quota rent.

Figure 5. Impact on welfare of an increase in imports

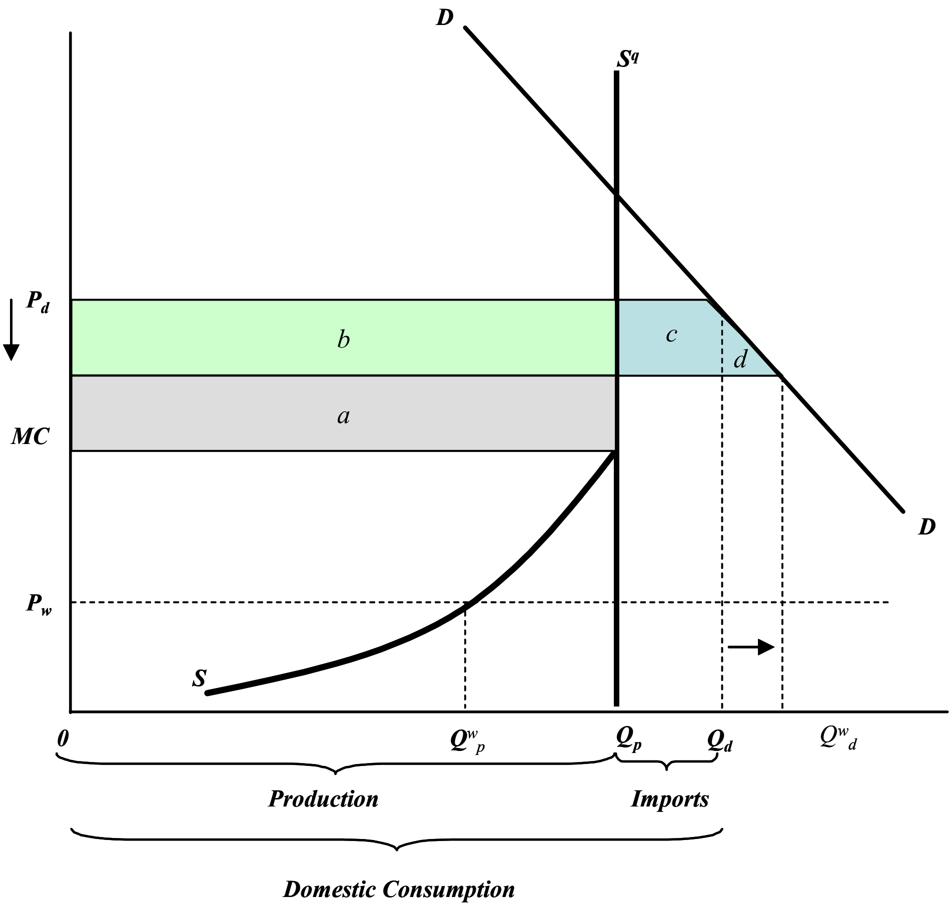

Table 4. Doubling import quantity in Canada

	1% increase in quota only	2x import quantity only	*Hold farm income constant by changing* Industrial quota	*Hold farm income constant by changing* Direct Payments
Commodity Market Impacts:	*~ result of experiment in levels ~*			
Producer Price ($CAD/tonne)	**514.5**	**499.6**	**524.7**	**499.6**
	514.5/514.5	*499.6/499.6*	*521.4/529.1*	*499.6/499.6*
Marginal cost ($CAD/tonne)	**403.6**	**400.6**	**386.3**	**377.8**
	343.3/463.9	*340.8/460.6*	*326.6/446.3*	*317.5/437.9*
Unit quota rent (%)	**22%**	**20%**	**26%**	**24%**
	9%/33%	*8%/31%*	*16%/37%*	*12%/36%*
Domestic Production (m tonnes)	**8.3**	**8.2**	**7.8**	**8.2**
	8.3/8.3	*8.2/8.2*	*7/8/7.9*	*8.2/8.2*
Net Exports (m tonnes)	**-0.4**	**-0.8**	**-0.8**	**-0.8**
	-0.4/-0.4	*-0.8/-0.8*	*-0.8/-0.8*	*-0.8/-0.8*
World Price ($CAD/tonne)	**239.3**	**239.3**	**239.3**	**239.3**
	239.3/239.2	*239.3/239.3*	*239.3/239.3*	*239.3/239.3*
	~ result in % change ~			
Producer Price	**-1%**	**-4%**	**1%**	**-4%**
	1%/1%	*-4%/-4%*	*0.2%/1.7%*	*-4%/-4%*
Marginal cost	**1%**	**0%**	**-4%**	**-6%**
	1%/1%	*0%/0%*	*-4.3%/-3%*	*-7%/-5%*
Domestic Production	**1%**	**0%**	**-5%**	**0%**
	1%/1%	*0%/0%*	*-5.3%/-4.0%*	*0%/0%*
World Price	**0%**	**0%**	**0%**	**0%**
	0%/0%	*0%/0%*	*0%/0%*	*0%/0%*
Economic Impacts:	*~ million $CAD ~*			
Taxpayers	**0.0**	**0.0**	**1.5**	**-164.4**
	0/0	*0/0*	*1.5/1.5*	*-193.4/-139.6*
Consumers	**42.3**	**188.0**	**1.2**	**188.0**
	42.3/42.3	*188/188*	*-31.2/25.4*	*188/188*
Farm Households	**-40.3**	**-169.6**	***0.0***	***0.0***
	-45.7/-35	*-169.6/-169.6*	***fixed***	***fixed***
of which farm owned	**16.9**	**0.0**	**-73.2**	**-13.0**
	13.9/20.3	*0/0*	*-77.3/-69.6*	*-19.1/-6.9*
of which farm land	**0.1**	**0.0**	**-0.6**	**1.0**
	0.1/0.1	*0/0*	*-0.7/-0.5*	*0.5/1.6*
of which dairy livestock	**6.3**	**0.0**	**-28.5**	**-5.1**
	5.1/7.5	*0/0*	*-23.0/-27.0*	*-7.4/-2.7*
of which quota rents	**-63.7**	**-169.6**	**102.3**	**17.0**
	-73.2/-54.6	*-169.6/-169.6*	*98.2/106.9*	*8.9/25.2*
Input Suppliers	**2.4**	**0.0**	**-10.6**	**-1.8**
	2.3/3.1	*0/0*	*-11.1/-10.2*	*-2.3/-1.0*
Total	**4.7**	**18.4**	**-7.8**	**21.7**
	-0.3/9.5	*18.4/18.4*	*-41.6/14.6*	*-7.2/46.4*

1. Items constrained constant in italic
2. Minimum-maximum ranges from sensitivity analysis shown below estimate

Source : OECD PEM model

72. In the first experiment, shown in the second column of Table 4, only the change in allowed imports is considered. No welfare constraints are placed on the scenario, and quotas in both fluid and industrial markets remain constant. There is no change in the fluid market, as products in this market are non-tradable, and the quota supply in that market remains constant. The increase in allowed imports of industrial milk products increases the total supply on the domestic market, and so the price of industrial milk must be reduced to clear the market (Table 4 shows the blend, or all-milk average price). The result is that consumers benefit from reduced prices and farm households lose through the impact of the reduction in price on total quota rent. There is a small increase in net welfare of CAD 18.4 million that is equal to the increased consumer surplus derived from consumption of imported milk products (areas *c* plus *d* in Figure 5). The sensitivity analysis shows variation in unit quota rent (a variable included in the randomised set), but no variation in the change in total quota rent resulting from the scenario. This is because neither quota level nor marginal cost are changing as part of the scenario itself—the change in total quota rent is due entirely to changes in output price.

73. The supply-management system has been the main form of policy support to the Canadian dairy sector for some time now. It is reasonable to assume that the quota system would be the probable tool to compensate producers for the change in allowable imports, if desired. The second experiment, shown in column 3 of Table 4, combines the increased import quantity with an adjustment of industrial quota such that farm welfare remains constant. The welfare-compensating change in quota responding to an increase in imports is to reduce quota. Why? Reducing quota limits the change in domestic price and maintains the unit quota rent. This is worth the trade-off with rents lost from reduced production. While the industrial price has to be reduced in this scenario, it is reduced less than was the case when only imports changed.[37]

74. The only effect of an increase in imports, as seen in the first experiment, is to reduce domestic prices enough to clear the market. This price decline reduces unit quota rent. The welfare-compensating change in quota policy is to reduce production to support domestic prices and counteract this effect. Industrial quota must be reduced nearly the full amount of the increase in imports. In fact, the unit quota rent received by producers has increased from the baseline value of 23% to 26% due to the decline in quantity produced.[38] An interesting result is that the blend price has increased, despite a small reduction in industrial milk price and no change in the fluid price. This is because the weighting of the average price now contains more of the higher-valued fluid milk after the decline in industrial production.

75. Reducing quota more and more in response to successively increased import competition remains the means by which the quota system may be used to compensate farm welfare right up to the point where quota is no longer binding. Quota ceases to become binding at some point because the reduction in domestic quota only moderates, rather than reverses, the decrease in domestic price required by the increase in imports. If the rate of reduction in domestic price exceeds the rate of reduction in marginal cost of production, which also falls as quota is reduced, then there is some point at which unit quota rents are eliminated and the industrial quota ceases to bind.[39] This is shown in Figure 6, which graphs industrial quota level that holds welfare constant as imports are increased. The change in industrial milk price is also shown in Figure 6. This price falls continuously as imports are increased, demonstrating that the reduction in quota is always somewhat less than the increase in imports.

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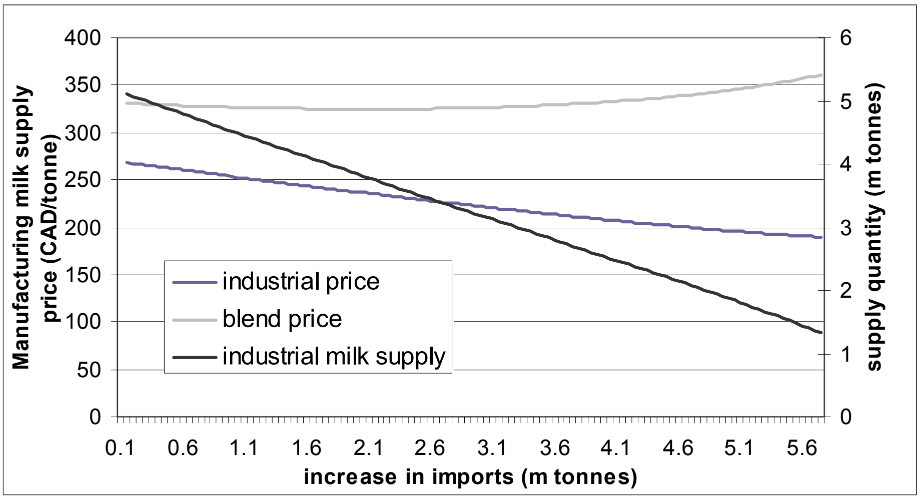
37. Since a quota reduction is welfare-enhancing for the producer, this would imply that the quota quantity lies between the optimal quantity for a monopolist and the quantity that would hold under perfect competition.

38. Unit quota rent, when expressed in percentage terms as is done here, has the price in both the numerator and denominator UQR%=(P-MC)/P

39. Fluid quota continues to bind throughout (fluid price is not changing).

Figure 6. Domestic industrial milk quota and price response to increased imports

Canada, farm income held constant through quota reduction



Source : OECD PEM model

76. An alternative approach to providing compensation to farm households for the change in allowed imports that is more reform-oriented would be to provide compensation in the form of direct payments. Column four of Table 4 presents the result of this experiment. The results are notionally similar to the EU experiment where compensation was provided by direct payments; the payments act to reduce the cost structure and thereby preserve total quota rents. Little net change in quota returns or returns from farm inputs is seen. Input suppliers' surplus reduces marginally as farmers switch to using relatively more of the land input to which the support is applied. Taxpayers are also worse off, by the amount of the new direct payment, but this loss is less than what consumers gain from reduced prices and the outcome is a net social welfare gain.

77. There is little doubt that the value of total quota rent plays an important role in determining total farm welfare where quotas exist. The experiments conducted for the EU and Canada demonstrate that welfare-compensating policy actions tend to have their impact on total quota rent rather than the returns to other farm assets, regardless of the way compensation is provided. The experiments also demonstrate that, other things equal, increasing quota is welfare reducing for producers. This implies that any reform of dairy sectors where quota policies are in place must recognize that quotas are part of a market price support system.

78. In evaluating the welfare effects of quota systems it should be kept in mind that typically quota systems are analysed within the assumption of perfectly competitive markets. However, situations may exist where farmers are facing an oligopsonistic processing and retailing market structure. Where this is the case, an imperfect market at the processing and retail level would provide a more appropriate basis for comparison.

V. Modelling of milk supply in the presence of quota

79. A quota system and border measures supporting domestic prices could be seen to some extent mutually dependent policies. Simply removing production controls without also eliminating (or significantly reducing) market price support and related border measures would likely result in unsustainable overproduction. Conversely, keeping a quota system in place and removing market price

support and border measures would make quotas irrelevant which, though, does not cause a problem of policy instability. Thus, the quota system has to be considered when evaluating a global dairy policy reform scenario.

80. The impact of such a scenario, among other factors, depends heavily on the production response following the removal of milk production restrictions in milk quota countries. This is ever more important as dairy markets are relatively thin and some of the countries operating the quota system belong to the major players on international dairy markets. It follows, that correctly assessing the supply response potential after quota removal is crucial for the analysis. In constructing the supply functions in quota operating countries the assumptions made concerning unit quota rent and supply elasticities are the most important aspects to be decided.

81. The assessment of milk production potential in quota operating countries is complicated by the absence of historical evidence as quotas in respective countries are in place already for a considerable amount of time. Thus, the supply schedule is not directly observable and it is impossible to point out the "true" quota rent, supply elasticity and underlying production potential in quota operating countries.[40] There has been an intensive research and debate concerning the appropriate value of quota rent and a wide range of available values can be found in the literature.[41] All these estimates are conditional on the method and assumptions used in the quota rent calculation (OECD, 2003b).

82. Generally speaking, it seems that for the analysis of the medium to long run production potential in quota operating countries, the full marginal cost method should be considered in constructing the milk supply function. Thus, it is important to include all costs into the cost structure of the dairy sector, *i.e.* also those that are considered fixed in the short run such as labour and capital. Further it could be argued that using quota lease prices, which are annual prices of quota, is not appropriate as it overestimates the long run value of quota. This comes from the fact that the quota lease price reflects short-run considerations such as the threat of over quota production and the need to acquire annual quota to avoid the penalty.

83. The price of quota bought or sold is the more appropriate one to use. However, even the quota rent observed from bought or sold quotas is often strongly influenced by short term market conditions reflecting the need of expanding producers. Hence, prices paid for quota on a segregated quota market for new entrants would seem to be more adequate to use in determining the quota rent. In assessing the quota rent from bough or sold quotas there is a need to consider the appropriate number of years of depreciation, the discount rate, the impact of reform on costs of production and on the price of land and the anticipation of producers about compensation.

Milk supply functions in Aglink and PEM

84. For countries which operate a quota system, the *Aglink* model has not specified the underlying milk supply function and milk production has been fixed at the quota level. In order to assess the impacts of trade liberalisation in the dairy sector supply functions for quota countries needed to be built into the

40 In the discussion concerning assumptions of milk supply functions the term quota rent refers to the unit quota rent (i.e. support price – shadow price) rather than to the total quota rent (i.e. (support price – shadow price) × quota quantity).

41 See for example Moschini (1986), Guyomard *et al.* (1996), Booth *et al*. (1996), Colman *et al*, (2002), INRA & Wageningen (2002), Turvey *et al* (2003) and Jensen and Frandsen (2003). The estimation of supply response in regulated markets was very well summarized in a document by Larivière and Meilke presented at the meeting of the OECD Commodity working Group on Meat and Dairy Products in 1998. Very good overview of various studies estimating milk quota elimination in Europe has been compiled by Salamon (2002).

model. The vertical position of the supply function can be determined from the quota rent or alternatively from the shadow price of quota (marginal cost of production at the quota level). However, this information provides merely a point on the supply curve of the respective country/region at a given moment in time. Thus, in order to identify the supply function it is also necessary to assume the elasticity. Given the multi-commodity and dynamic aspects of *Aglink*, short term and cross-price elasticities with respect to own price and to those for feed and beef also had to be assumed. Moreover, due to the interrelationship of dairy and beef markets, separate functions for dairy cows and milk yields had to be constructed such that their combined elasticity measured up to the targeted supply elasticity. The next paragraphs discuss the basis for these assumptions.

85. In the context of the analysis of dairy policy reform, the Secretariat decided to employ in addition to the *Aglink* model also its PEM model, in order to examine the impact of dairy policy reform on production, consumption, income, welfare, trade, and world prices. In order to use the complementarities of the *Aglink* and PEM models, the PEM assumptions on quota rents and supply elasticities were used also in *Aglink* model.[42] For Canada, the quota rent in PEM (and by construction in *Aglink*) is assumed to correspond to 23% of the price and the long run milk supply elasticity is 0.81, while in the case of the European Union the quota rent is set at 20% of the price and the long run milk supply elasticity is 1.23. The difference in supply elasticity between the two regions is due to the relatively higher intensity of land use in production in Canada, where the EU uses relatively more purchased inputs. Purchased inputs have a higher elasticity of supply, which carries over into the supply elasticity for milk. Other factors influencing the supply elasticity, such as factor substitutability and factor supply elasticities, are nearly identical between these regions; it is differences in factor shares that brings about the different supply elasticities. The parameters underlying the supply function were developed through consultants' reports done as part of the PEM model development process. These reports, by Abler (1998) and Salhofer (1998), applied a meta-analysis to extensive literature reviews of research in the PEM regions to estimate elasticities of factor supply and substitution, as well as provide notional confidence intervals for these parameters.[43] Taken together, these parameters and the model structure provide an implicit supply function, the long run elasticity of which is shown here in the next-to-last row of Table 5 which illustrates the short run and long run elasticity assumptions used in the construction of supply functions in *Aglink*.

86. The estimates of quota rent were also made during the PEM pilot phase. In the case of Canada, an estimate was available in the literature (Moschini, 1986) For the EU and Swiss quota rents, agreement as to their value was reached between participants of the PEM working group, which included technical experts from all participating countries, including the EU, plus some non-participating countries. Subsequent to the pilot phase of the PEM, these were discussed in depth and judged reasonable by the Expert Group meeting on milk quotas organised by the Secretariat in September 2003.

87. The participants of the Expert Group meeting noted the difficulties of estimating milk production response in quota operating countries particularly given the absence of historical evidence as milk quotas are in place already for a considerable amount of time. The most common approaches to estimate quota rent have been identified; the acquisition of quota price from the market where quotas are tradable or alternatively the collection of micro-economic (farm-level) survey data to obtain an estimate of total costs and then derive the marginal cost to obtain the quota rent point (shadow price of quota). It was also noted that for the analysis of the medium to long run production potential in quota operating countries, the full marginal cost is the one to be considered in constructing the milk supply function. A wide range of assumptions on quota rents exists in the literature and it is difficult to pint point a single number.[44]

42 It is worth mentioning that the PEM *demand* elasticities come from the *Aglink* model.

43 These confidence intervals can be used to form the basis of sensitivity analysis of PEM results.

44 For example, in the case of Canada, Hickling (1990) have calculated a considerably higher quota rent of 43% however Meilke et.al. (1996) have argued that a unit quota rent for Canada equal to 20% is a more

Nevertheless, the Expert Group meeting reached an agreement that the quota rent levels assumed in the PEM model were generally appropriate, as were the elasticities of supply used in the model.

Table 5. Elasticity used in Aglink supply functions for Canada and the European Union

	Canada	European Union
Short term		
Milk cow/milk price	0.082	0.078
Milk cow/feed price	−0.023	−0.015
Milk cow/beef price	−0.015	0.06
Partial adjustment coefficient	0.885	0.93
Yield/milk price	0.1	0.12
Yield/feed price	−0.04	−0.05
Production/milk price	0.2	0.198
Production/feed price	−0.063	−0.065
Long term		
Production/milk price	0.81	1.23
Production/feed price	−0.24	−0.264

Different milk production potential assumptions across EU member states

88. It is important to note that the European Union is treated as a single block in the Secretariat's PEM and *Aglink* models which implies a certain limitation for the quota analysis and trade liberalisation scenario. The average quota rent for the EU, assumed in PEM and *Aglink*, may be substantially different from quota rents in individual EU member states. In fact, the quota rents differ substantially amongst EU countries, depending on the institutional set-up for quota allocation and tradability as well as on the efficiency of milk production. The variability is well shown in Table 6 which illustrates quota rent from three studies that are selected to show relatively high, average and low quota rent assumptions.

89. Each study has used considerably different assumptions on quota rents and the table shows that within the broad categories of high, average and low quota rent assumptions there are large differences across the EU member states. The results of these studies are, as can be expected, to a large extent driven by the assumption on initial quota rent. Thus, for example Lips and Rieder has concluded that the changes in raw milk production following a quota system abolition in the European Union differ significantly by country. The authors suggest that Ireland would strongly increase its milk production, countries such Denmark, Italy, Luxembourg, the Netherlands and Spain would show an expansion of their raw milk production while countries such Germany, Greece, Portugal and Sweden would see a decline in quantity produced

90. Comparing the magnitude of quota rents assumed in the above table it is apparent that on average the quota rent used in PEM and *Aglink* for the EU is smaller than those used in INRA-Wageningen

reasonable estimate (based on 1993 Ontario industrial milk quota values). The different assumptions on quota rent adopted in the literature for the European Union are discussed in paragraphs 85-88.

(2002)[45], is of a same (similar on average) magnitude as the ones used in Lips and Rieder (2003) and is larger than those used in Jensen and Frandsen (2003).[46]

Table 6. Milk quota rent assumptions for the European Union (per cent of price)[47]

	INRA-Wageningen Base 1998	Lips and Rieder Base 1997	Jensen and Frandsen Base 1997
Austria	45.9	17	9
Belgium	31.8	20	11.9
Denmark	41.6	26	5.3
Finland	24.4	15	1.6
France	35.2	22	10.5
Germany	45.3	20	12
Greece	36.8	0	2.6
Ireland	49.1	31	7.2
Italy	36.8	23	5.3
Luxembourg	29.2	18	11.9
Netherlands	36.0	23	16.6
Portugal	26.9	0	5.9
Spain	37.5	24	5.8
Sweden	15.2	10	2.2
United Kingdom	42.6	27	8.9

91. Nevertheless, as there are many assumptions underlying the quota rent calculations, the adopted value remains uncertain. Thus, given the fact that the specification of milk supply functions is of crucial importance for modelling dairy policy reform, it seems necessary to undertake a sensitivity analysis with respect to the possible range of the underlying supply function assumptions. A sensitivity analysis is thus conducted on the quota rent and supply elasticity assumptions adapted in *Aglink* in the trade liberalisation scenario. The results of the scenario and the sensitivity analysis results are presented in document [COM/AGR/TD/WP(2004)20/REV2].

Conclusion

92. The analysis in this paper has illustrated some specific market, trade and welfare implications of operating milk quota systems. It should be kept in mind, however, that the analytical and empirical results presented in the paper have to be viewed within the hypotheses and assumptions adopted and within the limits and caveats of the models used.

93. Quotas were typically introduced as a tool to control the growth of surplus production and budgetary expenditures in order to improve the political sustainability of high price support. Simultaneously, the objective of stabilising producer prices could be easier achieved within a system of

45 One of the reasons might be the fact that the calculation of quota rents in these studies has not accounted for fixed cost of land, building etc (see Annex of EU Commission (2002) for the comments).

46 Van Tongeren (2002) has used an assumption of 20 percent quota rent for the European Union using a GTAP model.

47 The first study bases the quota rent assumption on a different year than the other two studies. The average milk price in the EU has slightly declined from year 1997 to 1998. Thus it does not seem that the higher quota rents in the INRA-Wagenningen study would be a result of higher milk prices in the base year.

production quotas. A quota imposition is a welfare reducing instrument when compared to support price cuts. Nevertheless, when decision makers are unwilling to cut support prices, the implementation of quotas could be considered as a welfare improving policy instrument. The efficiency of production under quota depends to some extent on a particular quota administration system. For example one way to rectify the inefficiencies related to quota imposition is to organise a quota trade so that producers with low marginal costs can buy or lease quotas from producers with higher marginal costs. On the other hand, quota trade can bring its own problems, such as increase in structural cost, industry concentration issues etc, so that the pros and cons of different administration system need to be weighted.

94. Nevertheless, from a dairy policy reform stand point, an important consideration is connected to the inherent nature of a quota system – the presence of a quota value. As the producer support is typically tied to the amount of quota, it is less profitable and often not feasible to supply milk without quota and therefore quota is an income-generating asset and assumes a value. With time the value of quota, reflecting the difference between an underlying cost of production and milk price, becomes incorporated into the cost structure of dairy farms.

95. When evaluating a quota system, it is important to keep in mind that a quota is typically contingent on the existence of another policy, namely market price support, and, in many milk producing countries, that market price support is in turn often contingent on the presence of quota. Simply removing production controls without also eliminating market price support would likely be unsustainable; conversely, in the absence of a policy that raises domestic prices over world prices, there is little rationale for limiting the quantity that domestic producers may offer in the marketplace. Thus, quota interacts with the effects of other policy tools and impacts on markets and welfare within a context of specific policy objectives.

96. If an objective is to hold the volume of subsidised exports or government expenditures on subsidised exports constant for a given increase in the quota level, then this increase has to be accommodated by a reduction in the domestic support price. Empirical results of experiments conducted with the *Aglink* model have shown the milk and dairy product price cuts required for a particular increase in quota for a given policy objective. The results, which are primarily driven by the size of demand elasticities, showed that the EU butter price would have to be reduced substantially more than the SMP price, while prices of cheese and WMP would be reduced somewhere in between the butter and SMP price cuts.

97. The PEM empirical analysis of the relationship between quota level and price support in determining farm income in the European Union has shown that an expansion in domestic quota could be welfare-reducing for producers via erosion in the value of quota rents as marginal production costs rise and input suppliers recapture part of the producer surplus as demand for inputs increases. This erosion could be offset by an increase in the level of price support (or other means of delivering support) if the objective is to keep milk producers' welfare unchanged. However, the experiments demonstrate that welfare-compensating policy actions tend to have their impact on quota rent rather than on the returns to other farm assets, regardless of the way compensation is provided. When the focus is on total welfare, the experiments show that dairy quota policy reform will be welfare enhancing if combined with an appropriate reduction in price support.

98. The PEM analysis for Canada focused on a doubling in the import quantity, and also show a loss in producer welfare due to a decline in domestic prices, which entirely translates into a reduction in quota rents. But consumers gain from the drop in prices, with a small improvement in welfare overall. The experiments show that producer welfare can be maintained unchanged if the increase in imports is coupled with a reduction in the quota, or alternatively, a rise in compensatory direct payments. By increasingly reducing quota in response to successive amplifications in imports, farm welfare can be maintained up to

the point where quota is no longer binding, and with marginal impacts on overall welfare. The same can be achieved if lower prices are compensated for by higher direct payments. This also results in a small overall welfare gain, but which comes at the expense of substantially increased costs to taxpayers.

99. In summary, it could be said that quota represents a second best alternative that allows policy makers to continue a policy of high price support without necessarily aggravating budgetary problems. Quotas, as they are normally strictly enforced, also reduce the MPS impact on trade and world markets from excess production, although consumption is still limited by high prices. In most countries, quotas are thus an integral part of price support mechanisms, and exist to make price support sustainable from a budgetary point of view. Quotas exist in the context of market price support and their full impact depends on the other policies that are operated concurrently

100. Nevertheless, a quota system is unlikely to be considered as the best policy option. This is due to the inefficiencies that it may create, the cost that it imposes on consumers, the difficulties and costs of administration that may arise for governments, the difficulty in getting the information on the quota level that would match production (or trade) under free trade and the vested interests that it generates. The existence of quota systems also likely depends on the continuation of high border measures, which is uncertain in the context of multilateral trade reform. That is, quota systems allow a domestic market to be managed only if that market is isolated from external sources of supply. Quota imposition provides gains for initial beneficiaries, but subsequent generations can be locked into a higher cost structure, and the system then perpetuates itself. In other words, the value of quota gets built progressively into the farm cost structure and complicates the reform or removal process of the quota system later on. Thus, to quote Guyomard and Mahé (1994): "Quotas might be an attractive approach to reduce distortion in production, however, they do not benefit consumers and from a political economy stand point quotas are more likely to delay reforms on price support."

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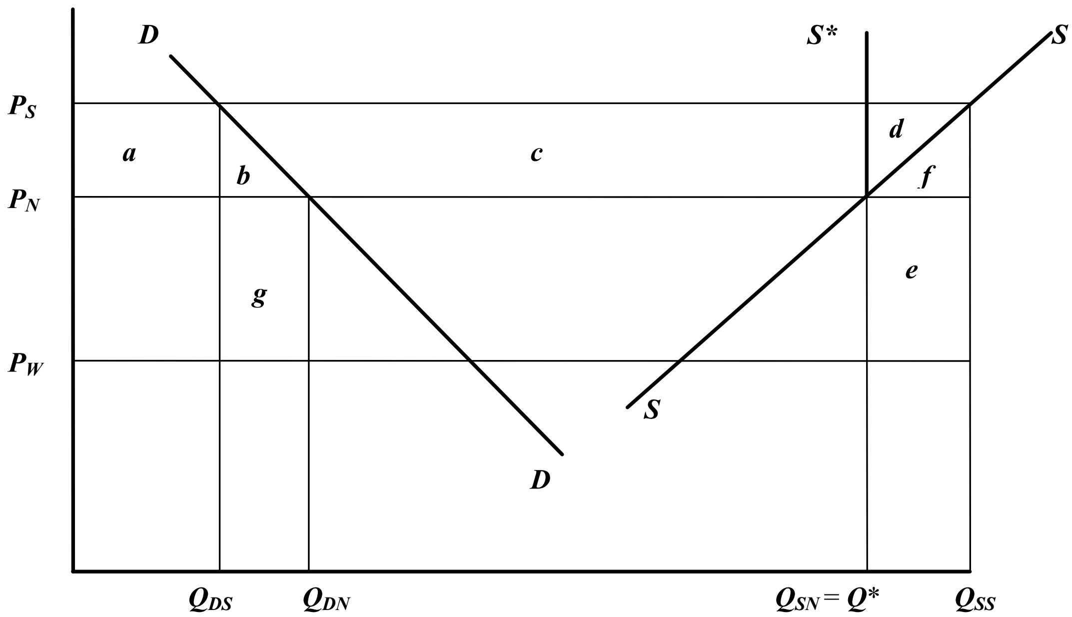
ANNEX 1

WELFARE IMPLICATIONS OF SUPPORT PRICE REDUCTION VERSUS QUOTA LEVEL IMPOSITION

101. In the case that a policy of support prices exists that require import tariffs and significant quantities of export subsidies, it can be shown analytically that lowering support prices as compared to imposing quota limits brings about higher net welfare gains. The domestic welfare implications of these two policy options available to reduce large gaps between domestic production and domestic consumption at support prices are illustrated in Figure A1.1. The figure depicts the impact of output reduction by means of a support price cut and by means of a quota imposition. In this simple analytical setting, the support price reduction is illustrated by a change in the support price from P_S to a new level P_N, which is assumed to remain above the world price P_W. The price change would cause consumers to increase their consumption from quantity Q_{DS} to Q_{DN} and dairy farmers to decrease their milk production from quantity Q_{SS} to Q_{SN} by moving down the supply curve *SS*. The welfare implications of the support price reduction is an increase in consumer surplus by area $a + b$ and a reduction in producer surplus by area $a + b + c + d$. As a result of both the price cut and the consequent decrease in surplus production, the amount of subsidised exports can be reduced from (Q_{SS} - Q_{DS}) to (Q_{SN} - Q_{DN}). Thus, the budgetary costs of disposing of the surplus through export refunds fall by area $b+c+d+e+f+g$. The net welfare gain of support price reduction is thus equal to area $b + g + e + f$.

Figure A1.1. The welfare implications of different policy options available to reduce large surpluses



102. Under the second policy option, the desired level of output Q_{SN} is achieved by the imposition of a quota limit Q^* which shifts the supply curve to SS^* while support price remains at its original level of P_S. At output level Q^*, the supply curve is perfectly inelastic (vertical) as it is assumed that a severe penalty

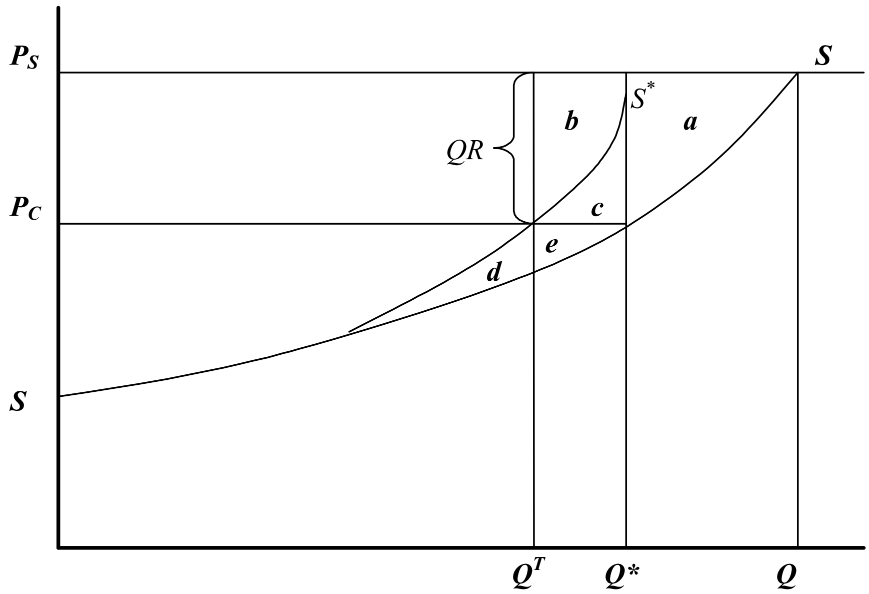
for exceeding the quota is applied, thus discouraging farmers from over-quota production. Consumers continue to face price P_S at which they consume Q_{DS} and are unaffected by the implementation of the new policy. It follows that the change in consumer surplus is zero. The diagram implies that with the imposition of quota dairy farmers lose producer surplus equal to area *d*. This loss is an unavoidable consequence of the output restriction. Due to the quota limit, the surplus production decreases from (Q_{SS} - Q_{DS}) to (Q^* - Q_{DS}) and the budgetary costs of disposing of the surplus are reduced by area *d+e+f*. It follows that the net welfare gain is equal to the area *e+f*. In comparing the two policy option the net welfare gain of the support price cut is larger by area *b+g* as compared to the quota limit imposition. Moreover, this result of greater welfare gains from reducing the support price relative to comparable quota reductions holds for any plausible elasticities of consumer demand and producer supply.

ANNEX 2

INCENTIVE TO EXCHANGE QUOTAS AND EMERGENCE OF QUOTA VALUE

103. Following on the standard theory of the effect of milk production quota on asset values (Harvey,1984, Burrell, 1989, Dawson, 1991, and Colman et al, 1998), Figure A2.1 illustrates schematically the immediate impact of quota imposition on the dairy industry. The quantity of milk produced before the quota regime is represented by *Q*. The farmer's revenue from sale of milk P_S *Q* is shared between its variable resources (area below the supply curve *SS*) and its fixed resources (area above *SS*). The area above the cumulative cost incurred (area above *SS*) is conventionally defined as producer surplus.

Figure A2.1. Development of a quota market and a value of quota



104. Consider the case that a quota system is introduced with quota limit imposed at Q^* and no leasing or trade of this quota is allowed with respect to the initial allocation. Typically, quotas are distributed on the basis of historical production levels rather than efficiency criteria and all producers experience the same percentage cut in their production. As a consequence some low-cost, efficient production is lost from the industry whilst some high-cost, inefficient production is maintained. The implication of this process is shift of the supply curve to the left. The loss in producer surplus due to the leftward shift of supply curve is represented by area *d+e+c*. This loss is a consequence of the initial quota allocation inefficiency. The producer surplus is also decreased by area *a,* but this is the unavoidable consequence of introducing a supply control measure.

105. When the quota system allows quota to be marketable the efficient producers would lease or buy quota from less efficient producers and the rental price in a competitive market would be bid to a rate equal to the difference between support price and marginal cost, P_S - P_C, as shown in Figure A2.1. At this price, the quota market equilibrium would be struck and the quantity (Q^* - Q^T) of quota would be traded. The

producers who lease out or sell quotas would obtain a revenue equivalent to area *b* + *c* where b is the compensation for the loss of income to fixed resources and *c* is a profit. The producers who lease in or buy will gain *b* + *c* + *d* + *e* for the price of *b*+ *c*.

106. The total rental value of quota in a period could be measured by the area (P_S - P_C) Q^*. It follows from the illustration that in a competitive market the quota would move from less efficient producers to the most efficient producers and the supply curve would effectively regain its original position up to the quota limit thus eliminating the initial inefficiencies.

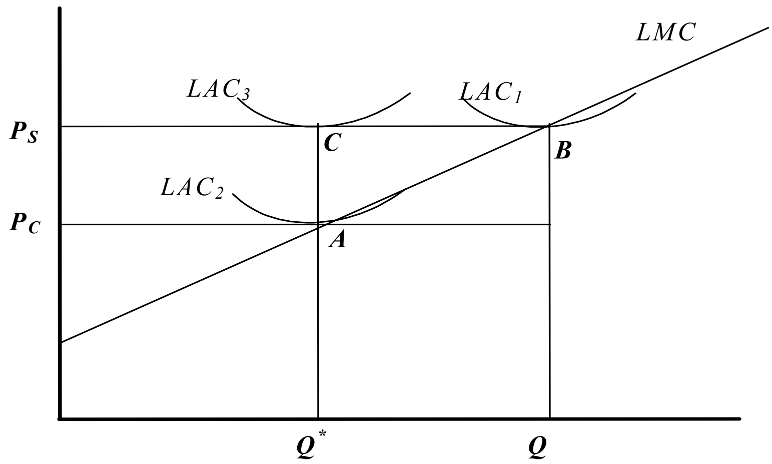
107. To eliminate the initial inefficiencies, Colman (2000) estimated that for the United Kingdom, between 15 and 26% of total quota would have to be transferred from less efficient producers to more efficient producers for the industry to reach profit maximising allocation. For France, Guyomard *et al.* (1996) estimated that in the short-run between 11% and 16% of quota would had to be transferred while for Netherlands, Boots *et al.* (1997) estimated that an extra 10.2% of quota would had to be transferred in order to achieve full economic efficiency.

ANNEX 3

LONG-RUN EFFECTS OF A QUOTA IMPOSITION ON FARM ASSETS AT THE FARM LEVEL

108. The impact of quota on farm assets might be illustrated using an example of a tenant farm. Following Harvey and Hubbard (1984), consider a tenanted farmer for whom the area below the support price, P_S, level and above the long run marginal cost, *LMC*, is economic rent. Presumably, the landowner holds the more scarce asset and can demand a rent from the tenant which is equal to this economic rent. When a competitive sector is in the long run equilibrium, marginal cost (excluding rent) equals average cost (including rent) at the producer price (in the diagram long run equilibrium is represented by price support P_S and production Q). The LAC_1 in the diagram denotes the long run average cost including rents when all inputs are constant. Assume that the support price is maintained at P_S while production is restricted to Q^*.

Figure A3.1. Long-run effects of a quota imposition at the farm level



109. When output is reduced[48] from Q to Q^* the intensity of use of the fixed asset (land) is reduced and the rent accrued to the asset falls by area $P_S\ P_C\ A\ B$. This generates a pure profit equal to area $P_S\ P_C\ A\ C$ as the LAC_1 curve shift down along the LMC curve to LAC_2. However, this profit would be bid up into the quota rent with the unit quota price equal to $P_S - P_C$. If the quota is attached to land the land rent will be increased by the area corresponding to quota rent ($P_S\ P_C\ A\ C$). Oskam and Speijers has illustrated that the value of quota can be determined as the difference between the price of land with and without quotas. Thus, in the long-run equilibrium the quota rent (one way or the other) will be incorporated in the cost structure and the LAC_2 move vertically up to LAC_3 eliminating pure profit.

48 Note that the economic rent created by a quota system are capitalised into the market values or implicit values of quotas in the alternate case noted before, as well. Thus, if a quota is imposed at the current production level and support prices are then increased, the economic rent that is generated will be absorbed by a rising value in the quota.

ANNEX 4

THE DEVELOPMENT OF THE NORWEGIAN MILK QUOTA SYSTEM

1. Background

110. Until recently, all dairy farmers in Norway have been organised as a cooperative. Consequently, all milk produced in Norway has been delivered to and sold through a nationally federated dairy cooperative. Since the 1930`s, this cooperative has played a major role in the process of developing the Norwegian national agricultural policy. The regulatory model in Norwegian agriculture is built on the idea that farmers have a responsibility to produce milk within a limited amount of aggregate supply. The authorities set this amount. In this system, the farmers are responsible of the costs of any potential over-production of milk. The maximum price of milk is regulated and settled in the yearly Agricultural Agreement between the Government and The Norwegian Farmers Union and the Norwegian Small-holders Union.

111. Through the last two decades, various regulatory schemes have been set up to align aggregate milk production with domestic milk demand in Norway. The design of the schemes has been influenced by several factors such as the market situation, international pressures, the political ambitions of domestic milk production, farm-based regional settlements, efficient production of consumer goods and the goal of having a multifunctional agricultural sector in order to maintain environmental and cultural values.

112. Quotas, as a policy instrument to control the supply, were suggested as early as in 1930 and then again in 1956. In the early 1960s, the number of dairy producers that withdrew from the sector was high, and this led to less focus on the issue of quotas. An increased demand for milk in the years 1975-80 made a quota system seem unnecessary. In the late 1970s, a governmental committee was established to evaluate the dairy policy and it concluded that other policy instruments than quotas might be sufficient to regulate the market.

113. The first quota-based regulatory scheme was set up in 1983. This was a reaction to the fact that surplus production in the dairy sector had become an increasing problem. Between 1978 and 1983, aggregate milk production grew by 10%. Although several small farms closed out, productivity growth and investments in farm development more than made up for the loss of production that this caused. Norway led an ambitious agricultural policy in the late 1970s, which led to a rapid growth in producer prices and subsidies. This stimulated investments and production in the agricultural sector. Further more, there was a dramatic fall in dairy demand between 1980 and 1982. In 1982, the production surplus of milk had grown to almost 300 million litres. The need for stronger production control seemed obvious and in 1983 a quota system was introduced. The system has been redesigned and changed several times since then and in the following, a description of the different systems is given.

2. The Two-price Quota Scheme (Initial Period, 1983-1990)

114. The first quota-based scheme was a two-price quota system. The basic mechanism of this regulatory scheme was that if producers delivered milk without holding any quotas or in excess of the quota held, they were paid a lower price for their milk. Over the years, this price became a diminishing share of the ordinary milk price. Initial quotas were allocated to the milk producers according to the

production level held between 1980 and 1982. At the time of implementing this system, the intention was to base the farmer quotas on a moving average of deliveries over the last three years, but this flexibility feature of the system was removed in 1984. However, farmers did have the opportunity to apply for exemptions from the main rules for allocating the quotas. The so-called "two-price steering committee", in which the parties of the Agricultural Agreement (the Government and the two farmers associations) were represented, was given the right to administer the rules and handle the exemptions.

115. In 1984, structural and regionally diversified factors to modify quotas were introduced. To protect small-holders from the potential negative effects a quota could have on the income of marginal farms, the Small-holders Union wanted minimum quotas to be implemented. A minimum quota of 15,000 litres was introduced in 1984. This was later increased to 25,000 litres in 1986 and to 30,000 litres in 1987. For the Farmers union it was more important to introduce a floor in accordance with prior production. In 1986 the argument that it was necessary to also protect the larger producers from large quota reductions won through. This led to the decision that no producer was to be given a quota of less than 84% of the initial quota in 1983.

116. The many exemption rules made many producers eligible receivers of additional quotas. The most important exemption rules were those concerning investments in farm development and entry for new generations or new farms. Between 1983 and 1989, almost 50 % of the farmers increased their quotas through various types of exemptions. The high number of exemption rules opened up for possibilities to exercise discretion when administering the system and evaluating the "productive resources" of a farm.

3. The Quota Buy-out Scheme (1991-94)

117. After almost a decade of practicing the quota system, the scope for redistributing quotas administratively on the basis of exemption rules dried up in 1990. Market demand for dairy products continued to decline and gave rise to a need for reducing the total domestic production as well. Dairy farmers faced lower production quotas each year while yield growth and technological development simultaneously contributed to increase the production capacity.

118. The next regulatory instrument to be set up in the Norwegian dairy sector was "the quota buy-out scheme" (1991). The purpose of the buy-out program was to give farmers incentive to reduce or quit production of dairy products. This was done by offering a financial grant ("the adjustment grant") to the dairy farmers who voluntarily joined the program and thus were obliged to withdraw from milk production for the next seven years. The number of farmers who joined the scheme was limited. In 1992 only 1.6 % of the total production quota had been withdrawn. These withdrawn quotas led to a small reduction in the domestic production since the quotas were not redistributed. Over the next years the quota buy-out scheme attracted even less interest, and in 1994 it was abolished. The system of reducing individual quotas by a factor in order to coordinate the produced amount with the quantity demanded was used until a new quota system was implemented in 1996.

4. The Quota Buy and Sell Scheme (since 1996 - 2003)

119. The buy-out scheme had been an ineffective instrument in the attempt to restructure the dairy sector. This trigged the introduction of a revised system in 1996; the so-called "quota buy and sell scheme". One of the reasons for introducing this system was that economic theory argues that this system will reallocate the quotas to the most efficient farmers and thus contribute to make the agricultural sector more efficient.

120. The buy and sell scheme was based on administratively set prices. The quantity of quotas (measured in litres) demanded was higher than the quantity supplied. Since a market with fixed prices

could not be expected to balance quota supply and demand, the reallocation (sale) of quotas had to be administered in accordance with certain rules. In order to maintain the regional structure of dairy production, Norway was divided into six trading regions. Quotas supplied by farmers selling quotas, should primarily be redistributed within the region. The quota was redistributed by the following principles:

121. All eligible dairy farmers were offered to buy a minimum level of 1000 litres production quota. Beyond this minimum level, available production quantity was to be allocated to each applicant according to the total amount applied for. The amount bought could not exceed 20 % of the previous quota. An upper limit was specified: The maximum production quota that could be held was 130,000 litres. There were some exemptions from this rule.

122. In 1997, 25 million litres of the total quota that was sold by farmers to the state authority was not redistributed (sold) to the farmers that wanted to buy quotas. The quantity that was left to redistribute (sell out) by the state added up to approximately 2 000 litres per buyer. To enter the market as a new producer was only possible if one produced organic milk near dairies that processed organic raw milk or if farmers were forced to switch from sheep to dairy production due to predator problems.

123. In 1997 the two-price system was changed to a levy-system. This meant that the farmers had to pay a levy nearly as high as the milk price for any milk produced beyond the quota system. The total consumption of milk has decreased over the last number of years. For example, in 1992, the Norwegians consumed 1,784 million litres while the quantity had decreased to approximately 1,500 million litres in 2002. The Buy and Sell Scheme has been the main policy instrument to reduce the surplus production of milk. Now, it seems as if the consumed quantity has stabilised at the level of 2002. Nearly all of the total quantity sold in the buy and sell scheme was redistributed (34.7 mill litres) to farmers in 2002. It is expected that the consumption of milk in 2003 will increase slightly. The individual quotas were increased by a marginal factor both in 2002 and 2003.

5. The Quota buy and sell scheme – 30% traded directly between farmers (2003 -)

124. In 2002 the buy and sell-scheme was changed. As earlier, farmers selling their quota can choose to either sell all or nothing. What is new is that the state authority no longer buys the whole quota but only 70 % of it, still at a regulated price. The remaining 30% can be sold at a non-regulated market price directly to other producers who already hold a quota. This requires that the buyer is located within the same region as the seller.

125. This system is implemented in 2003, and approximately 28 million litres will be sold this year. The total volume is redistributed (sold out), i.e. none of the quantity is held back in order to reduce the milk production. In areas where there is a surplus after the quotas have been redistributed, it is opened up for allowing new producers to enter the market. This is limited to the actual surplus within the region. These changes in the buy and sell-scheme only apply to cow-milk. Goat-milk is redistributed in accordance to the buy and sell-scheme established in 1996. The maximum quota at the single farm, after buying quota, is increased to 250,000 litres for cow-milk and 125,000 litres for goat-milk.

126. Another mechanism in the quota policy system is the so-called joint operation. Joint operation is when two or more farmers holding separate quotas cooperate in order to produce milk. The sum of the individual quotas cannot exceed 750,000 litres of milk. The quotas still belongs to the individual farms but the milk is produced in a common production facility.

6. Local milk production and processing outside the quota system (Initiated in 2003)

127. The first of July 2003, the Government made it possible for small-scale local milk producers, to produce milk outside the quota system provided that they produce, process, market and sell the milk themselves. The production limit is 250,000 litres for cow-milk and 125,000 litres for goat-milk. Milk producers can also cooperate in processing milk, provided that the volume does not exceed 500,000 litres. The intension of this change is to diversify the milk products offered in the market, and to stimulate production of local high quality varieties of food.

7. Review of the quota system for goat milk (2003)

128. In the Agricultural Agreement 2003, the Government and the farmer unions agreed to review the quota system for goat milk, and to propose possible changes to increase the room of manoeuvre for the producers delivering goat milk to dairies for industrial processing. A fundamental evaluation of the quota system for goat milk is a part of this review. This sector is facing challenges such as small producer communities and long transportation distances to the processing industry. This review is at an initial phase.

ANNEX 5

A DESCRIPTION OF THE AGLINK AND PEM MODELS

AGLINK MODEL

129. Aglink is a partial equilibrium dynamic supply-demand model of world agriculture, developed by the OECD Secretariat in close co-operation with member countries. It represents annual supply, demand and prices for the principal agricultural commodities produced, consumed and traded in member countries. The overall design of the model focuses particular attention to the potential influence of agricultural policy on agricultural markets in the medium term. Development on the basis of the agricultural economics literature, existing member country models, and on formal Bilateral Reviews has resulted in a model specification which reflects the views of participating member countries, subject to constraints which uniformity across country modules requires. Thus, agricultural markets are modelled specifically to best capture individual policies and particular market settings relevant for each country.

130. Individual country modules modelled in Aglink are calibrated on baseline projections, received from member countries via a so called questionnaire reply system. The country modules are then merged and the entire model (~ 2800 equations) is solved simultaneously to generate the commodity baseline. Model characteristics, key factors and model assumptions related to the Aglink model used in the development of the *Agricultural Outlook* 2003-2008 baseline (OECD, 2003b) and in empirical simulations carried out in this report are described below.

General characteristics and assumptions

131. Aglink is a "partial equilibrium" model for the main OECD agricultural commodity markets relative to supply, consumption and prices. Non-agricultural markets are not modelled, and are treated exogenously to the model. Feedback to the macro-economy is not accounted for. This may be particularly important for Rest of World countries in which agriculture is often a significant part of the domestic economy. Certain markets, such as sheepmeat, fish and wool are also not modelled or incompletely modelled.

132. World markets for agricultural commodities are competitive. Buyers and sellers do not behave as if they had market power, and market prices are determined through a global equilibrium in supply and demand. Domestically produced and traded commodities are viewed to be perfect substitutes by buyers and sellers. In particular, importers do not distinguish commodities by country of origin.

133. Countries/regions modelled endogenously in Aglink are: Argentina, Australia, Brazil, Canada, China, the European Union 15, Hungary, Japan, Korea, Mexico, New Zealand, Poland, Russia, Rest of World, Uruguay, and the United States. Rest of World module is specified without any policy measures in place. Countries/regions accounted for exogenously are: Czech Republic, Norway, Other Independent States, Slovakia, Switzerland and Turkey.

134. The main commodities modelled by Aglink are: Barley, Feed barley, Beef and veal, Butter oil , Butter, Casein, Coarse grains, Cheese, Eggs, Fresh dairy products, Lamb, Maize, Milk, Concentrated milk,

Manioc, Milk powder, Mutton, Non ruminant meat, Other cereals, Other dairy products, Vegetable oils, Oilseed oil, Oilseed meal, Oilseeds, Oats, Pigmeat, Palm oil, Potatoes, Poultry meat, Rice, Rapeseed oil, Rapeseed, Ruminant meat, Rye, Soybean, Special crops, Sunflower, Sunflower oil, Sunflower meal, Sheepmeat, Soybean oil, Soybean meal, Skim milk, Skim milk powder, Sorghum, Vegetable oil, Whole milk powder, Wool, Wheat and Whey powder.

135. Aglink simulates market determination of equilibrium prices for most of its commodities. For these commodities it is assumed that a market price must adjust to equate exactly total demand, including carry-over, to total supplies, including carry-in. Each market uses a specific world reference price. In Aglink, considerable effort was made to retain a calendar year basis for all data. This was not possible for many series, particularly for crops and for dairy.

136. The functional relationships linking supply and demand to prices in Aglink are in most cases linear in the logarithms of the variables. Equation coefficients are partial elasticities. In developing Aglink, an attempt has been made to obtain up-to-date estimates of these elasticities. Many of these new elasticities come from, or are based on, models currently in use in member countries. Some are the result of econometric analysis initiated by the Secretariat, through consultants or by Secretariat staff. Where world market and domestic producer and consumer prices are linked, that link is represented through price equations which are linear in world market prices, converted to local currency terms, margins approximating transportation costs and quality differentials, and border measures -- tariffs, taxes, subsidies etc.

137. In Aglink, trade for each country by commodity pairing is given one of three possible treatments. In a few cases, the level of imports or exports, either bilateral or in total, can be set exogenously. This may be the case, for example, where a trade quota or an access agreement applies. In a few other cases certain bilateral trade links are reflected, for example, poultry trade between the United States and Canada. Finally, and most commonly, trade is the residual of a supply-utilisation identity equation. In these cases it is the modeller's responsibility to identify simulated exports or imports above export limits or below import access.

Dairy markets specific characteristics and assumptions

138. The dairy component of Aglink covers production and consumption of milk and main dairy products in major OECD and several non-member economies markets, covering both importers and exporters. Thus, the *Aglink* representation of the dairy sector allows the analysis of impacts on world markets for tradable dairy products where those markets are explicitly modelled. As for other commodities in Aglink, dairy markets are modelled specifically to best capture individual policies and particular market settings relevant for each country.

139. Milk production in Aglink is expressed as the product of milk cow inventory and milk yield. In Canada and the EU, milk production is determined by the setting of the production quota. Since output prices do not guide producer decisions, price elasticities of milk supply have not been defined for these countries. A 'shadow price' of milk supply in quota countries has to be identified in order to specify an underlying supply function in these countries. This is essential for modelling a scenario which involves a substantial policy change or, alternatively, a total elimination of a quota system (this is discussed in the main text of the report).

140. The milk production link to the beef sector in Aglink is based on a theory of supply in which producers invest in breeding stock by retaining cows and heifers from slaughter when the capital value of these animals exceeds their current market value. The capital value of a beef-breeding cow is a function of the expected income stream earned from future sales of calves. The higher the expected value of future

beef and milk production the greater the investment in the breeding herd. The retention for breeding lowers the availability of animals for slaughter in the short run. Thus, to the extent that current beef prices influence expectations of future beef prices, there exists the possibility of a negative elasticity of beef supply response in the short run.

141. In Aglink, the equations corresponding to investment demand for beef cows, link ending inventories to expected producer prices, feed costs and other factors. The beef and milk production equations link supply in a particular year to the breeding inventories in earlier years and to producer prices for beef and competing products and to costs.

142. Dairy supply is modelled on the assumption that the value of milk components (fat, non-fat solids) will tend to equalise across products. Thus, if demand for a product made primarily from one of the components grows relative to demand for products made from the other then the relative value of components would adjust. That is a unit of fat in cheese would have the same value as unit of fat in WMP or butter, after adjusting for processing costs. Thus, only butter and SMP prices are typically used as proxies for fat and non-fat solids prices.

143. Typically in Aglink, butter production and SMP production are residuals of the market-clearing for milkfat and non-fat solids, respectively. The production of cheese and WMP are logit functions that depend on the price of that good relative to the input cost. This last term is calculated on the basis of the butter and SMP prices and the shares of milkfat and non-fat solids in the various products.

144. In the dairy market, as is the case for other commodities, where world dairy prices and domestic producer and consumer prices are linked, that link is represented through price (transmission) equations which are linear in world market prices, converted to local currency terms, margins approximating transportation costs and quality differentials, and border measures. In several countries, that have a large domestic dairy market and operate with border protection measures, a domestic market clearing price is assumed. In these cases, typically, the trade equations are linked to the evolution of domestic policy and market prices and limits set by the WTO.

145. The world market reference prices for dairy sector are specified as follows: the world prices of butter, cheese, SMP and WMP are the FOB Northern Europe prices denominated in US dollars. The world casein price is approximated by New Zealand casein export price. The world whey powder price is approximated by the US whey powder wholesale price.

PEM MODEL

146. The Policy Evaluation Model (PEM) provides a stylized representation of production, consumption, and trade of milk, and major cereal and oilseeds crops in six OECD countries: Canada, the European Union, Japan, Mexico, Switzerland, and the United States.[49] The PEM allows for a stylised version of existing and hypothetical policies in the participant countries. The purpose of the PEM is to provide a closer connection between measurement of support as done using the PSE and quantitative analysis of the impacts and distribution of such support. In constructing the PEM, three main sets of assumptions were required: 1) those relating to the basic structure of supply and demand response, 2) those relating to the underlying data and the elasticities, and 3) those relating to the primary incidence of support measures on prices and quantities. Economic theory and results of previous studies guided analysts' choices about the structure of the model, the data and economic parameters to use. The classification of support measures in the PSE guided choices about their primary incidence.

49 The European Union is treated in the model as a single region. A version of the PEM model incorporating beef production and trade is currently under development by the Secretariat.

147. The starting point for analysis of policy effects for the PEM is the Producer Support Estimate (PSE). There are eight main categories in the PSE, one for market price support and seven for different kinds of budgetary payments, distinguished by implementation criteria. The PSE data conveys two kinds of information necessary for PEM analyses. First, the PSE indicates the level of, and changes over time in the level of, monetary transfers from consumers and taxpayers to farmers resulting from agricultural policies. Second, support estimates are classified according to the way the associated policy measure is implemented thereby highlighting the 'initial incidence' of the support measure for analytical purposes. Each of the main kinds of support defined in this classification appears in the model with a specific differentiated "initial incidence" on producer and consumer incentive prices.

148. The country 'modules' of the PEM were all developed according to a common structure. Policy experiments were carried out using a model linking these individual modules through world price and trade effects. Commodity supply is represented through a system of factor demand and factor supply equations. Excepting the rest of world module, there are equations representing demand and supply response and prices for at least four categories of inputs used to produce these crops in the study countries. The factor demand equations reflect the usual assumptions of profit maximisation constrained by the production relationship. Supply response corresponding to a medium term adjustment horizon of approximately five years is reflected in the values assumed for the price elasticities of factor supplies and the parameters measuring the substitutability of factors in production as well as the factor shares.

149. No factor is assumed to be completely fixed in production, but land and the other farm-owned factors are assumed to be relatively more fixed (have lower price elasticities of supply) than the purchased factors. Likewise, no factor is assumed freely mobile, but purchased inputs are assumed relatively more mobile (a higher elasticity of supply) than the farm-owned factors. Most supply parameters needed for the model come from systematic reviews of the empirical literature by external consultants. (see D. Abler (2000) and K. Salhofer (2000)). Both reviews were commissioned by the Secretariat to obtain objectively plausible values of the parameters. [50]

150. Each of the country modules has two farm-owned factors: land and a residual "other farm owned factors". The set of purchased factors covered in each country includes, at the least, fertiliser and a residual "other purchased factors".

151. In the PEM, land is assumed heterogeneous, but transformable between one use and another. The farmer acts to maximize profits by allocating land across its possible uses (wheat, coarse grains, oilseeds, rice, other arable uses, milk or beef pasture, other agricultural uses) according to a transformation function.

152. The land transformation function is assumed separable for different categories of use such that the land allocation problem facing the farmer is solved in successive stages. First, the producer chooses to allocate land to rice, other agricultural uses, or to a group of uses including all other arable and pasture uses. This group is then allocated in the second stage between pasture, cereals and oilseeds, and other arable uses. Finally, the cereals and oilseeds group is allocated between wheat, coarse grains, and oilseeds (Figure A5.1).

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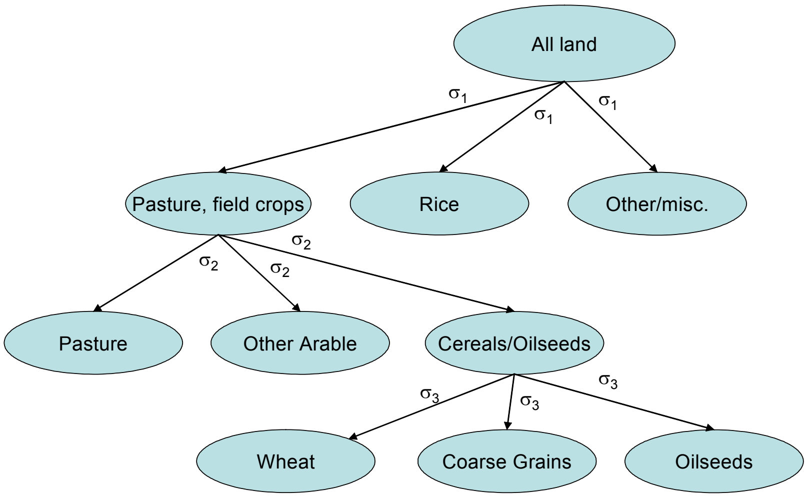
50. Although the own and cross-price elasticities of *crop* supply are not explicit parameters in the PEM crop models, their values can be calculated from knowledge of the elasticities of factor supply, factor substitution and factor shares.

Figure A 5.1 PEM Land Allocation Structure



153. At each of these stages a constant elasticity of transformation (CET) function is used to describe how uses may be allocated. That is, at each level in this decision-making process the transformability of land is the same, but this rate differs between levels. The parameter of the CET function, σ, determines the mobility of land between uses at each stage. As we move downward through this land allocation framework, land becomes more similar in use and therefore more easily fungible between uses. We expect $\sigma_3 > \sigma_2 > \sigma_1$ in general.

154. Commodity demand equations in the PEM models relate domestic consumption of outputs to prices (at the farm level). Co-movement of prices may occur even when policy measures are targeted directly to only one or two commodities because wheat, coarse grain, oilseeds and rice may be substitutes in *both* production *and* consumption[51]. Moreover, depending on the degree to which crops are substitutes in demand, co-movement in their prices may lead to small 'net' changes in quantity demanded for any one crop and thus in their total. That is, the total demand for crops may be highly price inelastic.

155. The PEM does not represent in a fully comprehensive manner the specifics of support programs applying to each individual commodity in each one of the participant countries. Rather, the aim is to represent the 'incidence' of support measures in the same way that 'incidence' is implied by the classification of support measures for the PSEs. In this system, support measures are classified according to the main or primary condition that producers must meet in order to be eligible for the support. Usually, knowledge of the conditions of eligibility of a particular support measure, as revealed by its classification in the PSE, will be enough to infer its "initial incidence".

156. In order to undertake policy simulation experiments the model must be calibrated for a specific base year using the data in the PSE database. This calibration includes all quantities produced, consumed and exported in each country and each commodity of the model, the set of world and domestic prices and the amounts of the different kinds of support creating price wedges. Land quantities are taken from FAO data and other inputs quantities are defined using quantity or constant price volume indexes. Input prices are derived then from cost shares and factor quantities.

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51. Cross-elasticities of demand are assumed to exist between the crop commodities, but not between milk and beef or between these livestock commodities and crops. This assumption is driven primarily by data availability.