Joint Working Party on Agriculture and Trade

AN ANALYSIS OF DAIRY POLICY REFORM AND TRADE LIBERALISATION

TRADE AND ECONOMIC EFFECTS OF MILK PRICE SUPPORT MEASURES

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

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Foreword

This report is one of several studies that have been carried out under the project 'Assessing Future Agricultural Markets, Trade and Policies', an activity on 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 trade and economic effects of milk price support measures. More specifically, the market price support is divided into the support due to trade measures and the support due to domestic discriminatory pricing. The main authors are Pavel Vavra and Roger Martini, economists in the OECD Directorate for Agriculture. Joe Dewbre (of the OECD Directorate for Agriculture) and Nobunori Kuga, now of the Ministry for Agriculture, Forestry and Fisheries – Japan, contributed substantially in the early phases of the work. Many colleagues in the OECD Secretariat and delegates from member countries furnished useful comments on earlier drafts of this report.
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TRADE AND ECONOMIC EFFECTS OF MILK PRICE SUPPORT MEASURES

I. Introduction

1. In almost every OECD country, milk producers receive higher prices because governments intervene in the markets for raw milk and dairy products. Estimated rates of milk market price support are among the highest of all commodities monitored for the PSE. Governments intervene to obtain higher producer prices for raw milk using a package of mutually reinforcing domestic and trade policy measures. The typical package includes: 1) a target price for raw milk, 2) support prices for manufactured dairy products necessary to achieve that target price and 3) tariffs, tariff-rate quotas and export subsidies applied to imports or exports of tradable dairy products to defend the support prices. In a few countries, producer prices may be further enhanced using extra revenues generated via discriminatory pricing on the domestic market. In some countries, marketing quotas are used with other mechanisms to maintain market price support.

2. To facilitate the presentation in this paper, that part of milk price support attributable to a package of target prices, product support prices and trade measures will be referred to frequently as “support due to trade measures”. That part of milk price support that may be attributable to discriminatory pricing arrangements will be referred to simply as “support due to discriminatory pricing”, even though such arrangements themselves may require accompanying border measures. Both kinds of price support impose extra costs on domestic consumers and taxpayers and they distort trade leading to lower world market prices. The purpose of the analysis to be reported in this paper is to estimate and compare the effects of support due to trade measures with any support that may be attributed to discriminatory pricing.

3. Price support achieved through trade measures applied to tradable dairy products, e.g. butter, skimmed and whole milk powder, and cheese, results in domestic prices for those products that are higher than the corresponding world market prices for them. This drives up the prices dairy plants are willing to pay for the raw milk used to make those products which, through competitive domestic market price determination, then leads to higher prices paid for milk for all end uses. Discriminatory pricing arrangements, administered or sanctioned by the government, lead to prices paid for raw milk for some end uses (typically fresh milk products) that are higher than those paid for raw milk for other end uses (typically manufactured milk products). The additional revenue generated is then transferred back to farmers through a pooled or average price scheme.

4. Generally speaking, in countries where governments intervene both in traded dairy product markets and via discriminatory pricing on the domestic market the overall level of support may be reduced, say, either by reducing trade interventions or by reducing the premium (and any associated tariff) charged domestic fluid milk consumers. The analysis to be reported here comprised comparisons of the effects of marginal changes in one or the other of these two types of intervention.

5. The remainder of the paper is divided into three parts. The following section describes some general characteristics of milk price discrimination arrangements and their potential effects. It includes a brief review of past work. In the second major section, a stylised model of milk pricing and policy is used to derive some general, qualitative results concerning differences in the market and trade effects of alternative milk price support measures. The third section presents results of illustrative policy simulation experiments undertaken using the Aglink and PEM models to quantify policy effects on production, demand, trade and welfare. The final section draws conclusions.
II. Milk price discrimination in OECD countries

6. Price discrimination refers to the practice of selling the same product to different buyers at different prices. This can lead to an increase in market receipts if buyers can be segregated into distinct groups in which those least responsive to price (i.e. those with the lowest price elasticity of demand) are charged the highest price. Segregating consumers and charging them different prices is possible of course only if the seller – whether a private company, co-operative, government agency or quasi-government institution – has market power.

7. In some countries, the government sets prices for different end-uses of milk by administrative fiat. Price differences between those various end-uses reflect *inter alia* the additional costs to deliver milk to fluid plants over the costs to market milk to manufacturing plants. In others, price premiums and discounts by end-use are determined by a state-trading agency or by a marketing institution (for example a co-operative) granted monopoly power by the government. The way buyers are segregated may also be different in different countries. The most common, and the main focus of this paper, is an arrangement under which domestic consumers are grouped in different demand categories. In other cases the pricing arrangements may lead to differences in prices charged across export markets.

*Market-driven explanations for milk price differences*

8. This study is concerned with discriminatory pricing arrangements that cause the prices paid for raw milk purchased to be re-sold as fresh fluid milk to be higher than the price of milk purchased to manufacture dairy products. It is important to begin, however, by noting that some differences in the prices paid for fluid versus manufacturing milk might exist even if governments did not intervene at all. Generally, milk destined for fluid use has to meet more stringent sanitary standards than milk used for manufacturing dairy products. Historically, this difference in quality standards explained some differences in between prices of fluid and manufacturing milk.

9. Today, however, most raw milk production in OECD countries would meet quality standards for fluid milk regardless of the end use for which it is purchased. It follows that, in the absence of any differences in quality and sanitary standards, raw milk sales in a particular region will be reallocated according to dairy processors bids so that the price of fluid milk and manufacturing milk will move towards convergence.¹

10. *Average* prices for milk going to fluid use and milk going to manufacturing use (annual averages for example) are, amongst other factors, driven by consumer preferences for fresh – not reconstituted – fluid milk products, transportation and other marketing cost differences, and the daily, weekly, and seasonal patterns of milk production and consumption.

11. Typically, in OECD countries, consumers prefer fresh milk to reconstituted milk from milk powders despite the potential cost advantage of the latter. Hence, consumer preference for fresh milk is a fundamental element of market demand. Supplying fresh fluid milk to meet consumer demand requires a higher price for milk and marketing services in regions of the country with insufficient milk supplies (see Takayama and Judge, 1971). It follows that the higher price for fluid milk is to a large extent linked to transportation costs and seasonality of production issues which will be discussed in turn.

¹ Farmers would always sell milk to the highest bidder and processors would always buy from the lowest seller. Since milk is almost homogeneous in terms of quality with only minor adjustments in price for variations in content, efforts to sell for more or buy for less would fail; there would tend to be a single price for milk at a given place and time.
Transportation and other marketing costs

12. Milk is a bulky, highly perishable commodity subject to bacterial contamination and, as such, cannot be stored on farms for any significant period of time. Raw milk must be handled under strict sanitary conditions and must be marketed quickly either for use in a fluid form or for processing into one of a wide range of storable manufactured dairy products. The considerable costs of transporting bulk raw milk suggests that the majority of milk to be consumed in fluid form will likely be produced and processed relatively close to the point of consumption. However, the costs of producing raw milk relatively close to the point of consumption, mostly near major urban centres, may be higher than the costs of producing milk elsewhere. The cost of the hired labour, animal feed, forage and land used in producing raw milk are typically higher in these more densely populated urban areas than in rural agricultural regions of a country. Because it is cheaper to transport manufactured dairy products than it is to transport raw milk, such production cost advantage may favour location of dairy manufacturing plants away from consuming centres. (Consider that the production of one kilogram of butter requires about twenty-one kilograms of milk and the production of one kilogram of cheese requires about ten kilograms of milk.)

13. Higher transportation costs for raw milk, lower transportation cost for dairy products (in milk equivalent) and regional differences in production costs all combined may create a natural segregation of fluid milk and manufacturing milk markets creating a premium for those producers located nearby major consuming areas even in an unregulated market. To account for transportation costs in an analysis of milk pricing a model addressing spatial variation in prices would need to be adopted. For example, the work of Pratt, et al. from Cornell University (1998) gives an excellent insight into spatial and temporal variation of prices for raw milk, and for milk delivered to plants in different uses. Their model, the U.S. Dairy Sector Simulator Model (USDSS) is a highly disaggregated network flow model that minimises the transportation and processing costs of transforming milk from farm centres into fluid milk and manufactured dairy products at consumption centres. The structure of the mathematical model is such that the shadow prices at each location are interpreted as relative spatial value. Thus, the relative spatial values of milk in fluid use, soft product uses, butter, non-fat dry milk and cheese in major consumption centres are solved for milk at every plant location, and for farm milk at each farm production centre as well. The model generates a fluid milk price surface that ranges up to USD 4.00 per hundredweight, and yielding a national weighted-average fluid milk price differential of about USD 2.47 per hundredweight (cwt) over manufacturing milk price levels. The USD 2.47 included USD 1.32 attributable to transportation costs alone, physically moving the milk from farms to plants. A basic differential of USD 1.15 was included as well. This basic differential was related, inter alia, to costs associated with timing and scheduling milk deliveries for fluid plants in addition to the simple average trucking costs between a farm and a plant. These costs include the need for additional quality control measures needed for fluid milk, additional storage facilities and adequate trucking capability to meet fluid milk processing schedules, and manufacturing capacity for milk when it is not needed in fluid use.

14. The transportation cost issue has been incorporated and analysed in a number of spatial equilibrium model studies (Pratt et al., 1998, McDowell, et al. 1988, McDowell, et al. 1990, Nubern and Kilmer 1997, Cox and Chavas 2001). These studies all find that the presence of non-zero transportation costs generates market driven differences in manufacturing and fluid milk prices. For example, McDowell et al. (1988) estimated that, in the United States, market-driven differentials (per hundred-weight of raw milk) began reflecting interregional transportation costs in the Kentucky-Tennessee region at USD 1.56 and in the Southern Plains region at USD 1.90, increasing to USD 4.08 in Florida.

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It is possible that consumers would replace, within the limits of remaining quality differences, fresh fluid milk with reconstituted milk which would likely erase any differences between fluid milk and manufacturing milk price based on transportation costs. In addition, it is possible that evolution of pasteurisation (UHT) could affect transportation costs.
15. Kawaguchi, Suzuki, and Kaiser (2001) develop an annual interregional trade model that, under assumptions of perfect competition, generated fluid premiums averaging 0.32 with premiums of USD 1.55 and USD 1.95 per cwt generated in the Southeast and in Florida, respectively. This estimation used an annual model with interregional transportation costs, reflecting no seasonality of supply and demand, including no storage and transportation costs incurred by producer cooperatives to deliver milk as scheduled by fluid processors, and by assuming equal supply elasticities in all regions.

Seasonality of milk production

16. Milk is produced continuously throughout the year, typically with marked seasonal variations. Milk production increases during the spring and early summer and contracts during the autumn and winter. In the high producing months the market price of raw milk usually falls somewhat. This is also the season when most of the extra raw milk production is being channelled into processing of manufactured dairy products. During the low producing months unit costs of raw milk production and market prices may rise significantly (both because productivity per cow falls and because feed and other costs of raw milk production may increase). Sending a smaller proportion of raw milk production for manufacturing dairy products accommodates production shortfalls. In sum, over the season, more milk will be sold at lower prices for processing into manufactured dairy products resulting in an annual average price paid for fluid milk greater than that paid for manufacturing milk.

17. The amount of seasonal premium will be larger in those countries where the cost of production between the in-season and off-season period is greater. An extreme example is the case of New Zealand. Milk production in New Zealand is based on grazing with very low production cost during peak season, so dairy farmers follow the so-called curve of nature. Usually during the off-season months (about two months of the year) cows do not produce milk and manufacturing facilities substantially reduce their production or may shut down altogether. The farmers remaining in production to supply the fluid milk market are paid an out-of-season premium by the co-operative, a premium that can amount to as much as 60% of the milk price in the in-season period. However, as the domestic consumption of milk in New Zealand is only a fraction of “in-season” production the difference between the average price and the manufacturing milk price is negligible. In general, it could be said that the higher the share of the fluid milk market in a particular country, the higher might be the impact of seasonal premiums on the fluid and manufacturing milk prices. On the other hand, if the levels of production are not very different between off and in-season, likely owing to fairly constant cost structure regardless of the season, then the differences in prices over the year might not be very large.

18. The seasonal variation in production has sometimes been used to justify milk market regulation; government intervention is deemed a critical element in order to stabilise prices and ensure adequate supplies of fluid milk at all times. Ippolito and Masson (1978) pointed out however, that there is a cost to ensuring “adequate” milk supplies by means of a constant fluid milk premium. These authors note that the fluid milk premium has to be set so as to ensure an adequate supply of milk during low-producing months. However, this price will far exceed the free market price in high-producing months and thus consumers will have to pay an average price of fluid milk that is higher than it would otherwise be. In addition, the constant premium would lead to a higher producer price and consequently higher than otherwise production of processed dairy products in peak production months.

19. Testuri, Kilmer, and Spreen (2001) using the model developed by Pratt et al. examined the seasonal variation in fluid milk differentials in the South-eastern United States for 1997. The study is an extension of Pratt et al. work that included monthly supply and demand information. The months of April and September represent months of lesser and greater milk scarcity. Estimated market differentials (per cwt) for Nashville ranged from USD 3.31 to USD 3.96, and for Miami ranged from USD 5.40 to
USD 6.79. The Federal order Class I differentials are USD 2.60 for Nashville and USD 4.30 in Miami.\(^3\) The authors concluded “that the Class I price differentials should be changed from month to month instead of the same differential being used throughout the year as is the current practice.”

**The price effects of discriminatory pricing, results from previous studies**

20. Milk price discrimination and pooling systems exist in a number of countries. In Canada and the United States premiums for various end-uses of milk are determined under a classified pricing system administered by a government agency. In Japan, although the government does not administer any milk prices, it establishes the regional marketing zones and regulates the distribution of milk. These regulations ensure that milk from lower cost regions cannot be transported to satisfy demands in higher priced fluid milk regions. Until recently fluid milk market regulations were also imposed in Australia and the United Kingdom. However, Australia deregulated its fluid milk market in 2000 (Box 1) and the United Kingdom abolished the classified pricing system in 1994.

21. The impact of price discrimination in domestic milk markets has been analysed in Buxton (1977), Ippolito and Masson (1978), Dahlgran (1980), Helmberger and Chen (1994), Lippert (2001), Chavas and Cox (2001), Australian Bureau of Agricultural and Resource Economics (ABARE) (2001), the Australian Competition and Consumer Commission (2001), FAPRI (2003), USDA (2004a), and USDA (2004b). The analytical and empirical studies illustrate that price discrimination reduces fluid milk consumption and increases the amount of milk available for processing. In addition, the average (pooled) price will be higher than the producer price in the absence of a pricing scheme (holding other support measures constant), and therefore leads to higher production levels. Fluid milk consumers who pay higher prices lose from price discrimination, while consumers of manufactured dairy products likely gain as manufacturing milk prices might be reduced by the scheme. However, empirical studies suggest that the higher cost of fluid milk outweigh any benefit consumers gain from lower prices for manufacturing milk.\(^4\)

22. However, all these results are conditional on the complexity of a particular market and regulatory framework. As price discrimination is usually accompanied by milk distribution restrictions the impact on producers is region specific. These restrictions negatively affect producers in efficient regions while the opposite is true for producers in less-efficient regions. (See the studies by Helmberger and Chen; Chavas and Cox; and by ABARE). Restrictions that protect inefficient producers create sector-wide inefficiency in the sense that the same amount of total output could be produced at lower cost. On aggregate, as Dahlgran (1980) has argued, the average milk producer price might, in theory, be reduced as a result of the system of end-use pricing – a case which he demonstrated using data for the United States. Lippert (2001) has identified the inefficiencies of operating the complex system of end-use pricing and milk supply management\(^5\) in Canada.

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\(^3\) The FMMO Class I differentials are added to a manufacturing milk price to obtain a minimum fluid milk price f.o.b. plants

\(^4\) For the case of the United States, Ippolito and Masson (1978) estimate that the loss to consumers of fluid milk amounts to about USD 334 million while the gain to manufacturing milk consumers is about USD 120 million. Helmberger and Chen (1994) estimate the loss to fluid milk consumers in the United States to be USD 1000 million and the gain to manufacturing milk to be USD 600 million.

\(^5\) 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 to be more market responsive and avoid over-quota production. In addition to the MSQ, each province sets its own production target for fluid milk, and the entire milk quota – industrial and fluid together – is allocated to producers.
23. Cox and Chavez (2001) develop an annual interregional model that includes 11 Federal orders and California. The model includes fluid milk as well as nine manufactured products for which milk components are allocated. The model is used to examine the welfare changes that reduced regulation would generate. In the scenario that would eliminate the dairy price support and both California and Federal order programs, the farm price of milk in the Upper Midwest increases from USD 12.79 to USD 13.28 (+USD 0.49) per hundredweight, while in Florida the price drops from USD 15.29 to USD 12.54 (-USD 2.75), and in the Southeast from USD 14.02 to USD 12.48 (-USD 1.54).

24. Dalgran (1980) estimated welfare shifts from deregulation in a 16-region model. Regional 1976 price effects are not reported, but are summarized as averages. The gap between average fluid and manufacturing milk prices on average falls from USD 1.17 per cwt. to USD 0.46 per cwt. This result suggests that 40% of the price difference is related to interregional transportation costs and regional market conditions. The analysis did not include costs incurred by producer cooperatives to meet the other additional fluid milk marketing costs.

25. USDA (2004a), examined the economic effects of principal US dairy programs including the impact of Federal Milk Marketing Orders. The operation of FMMO was approximated by using FAPSIM model and by incorporating formulas that are used to set the minimum prices for each class. The study assumes that 48% of the current Class I price differential would exist after the program elimination. In the scenario fluid prices decline almost 8% below baseline levels. Consumers respond to this price change by increasing their demand for fluid milk by approximately 2% above the baseline period. Lower milk production coupled with increased fluid milk use reduces the supply of milk available for manufactured dairy products, leading to higher manufactured milk prices.

26. FAPRI (2003) estimated impact of removing US milk federal regulations assuming that after the FMMO elimination USD 0.50 per cwt (approximately 25%) of the fluid milk premium would remain. As fluid milk prices are reduced fluid consumption rises 2.5% in response. The results also show that the largest negative price effects on milk occur in the first few years of the analysis. Once supply adjustment occurs, milk prices return closer to levels found before federal order elimination. An interesting finding of the study is that regions with less than 20% fluid utilization would face higher all milk prices with the elimination of federal orders while those with fluid utilization in excess of 35% would face lower all milk prices.

27. The impacts of removing the fluid milk regulations in Australia are discussed in ABARE (2001). The study draws attention to the regional impact of deregulation pointing out that producers in regions with high fluid milk utilisation (high cost regions) are likely to lose, whereas producers in the more efficient regions, formerly restricted from accessing major fluid markets, stand to benefit. Following the “real-world” experiment offered by domestic market liberalisation, the Australian Competition and Consumer Commission (2001) conclude that following deregulation, milk consumers are better off and that Australian processors and retailers had not captured the benefits to the detriment of consumers. The report also noted that after deregulation milk is likely to continue to be produced relatively close to fluid markets. However, there will be a shift in manufacturing milk production to lower cost dairy regions over time. This would lead to a corresponding shift in the location of dairy manufacturing plants to those regions where dairy farmers are able to produce raw milk at competitive export prices, but still respecting higher transportation costs associated with providing fluid milk to domestic consumers.

28. In the majority of the studies discriminatory pricing arrangements are analysed in the context of a closed economy and not much attention has been paid to the impact of these arrangements on trade. Sumner (1999) is one of the very few studies analysing the trade distorting impact of discriminatory milk pricing arrangements. His study, focusing on the US Federal Milk Marketing Order system shows clearly
that US exports and imports of manufactured dairy products will vary directly with the size of the price premium charged to consumers of fresh milk products.

29. Bouamra-Mechemache et al. (2002) evaluated the options for developing a price discrimination policy in the EU dairy sector. Their analysis shows that the EU price discrimination without the EU quota system would significantly affect world prices and trade due to the increase in output resulting from the higher producer price under price discrimination. With the quota in place the impact on trade is considerably less. The authors claim that as long as price discrimination does not involve price discrimination between domestic and export markets, it might be WTO-compatible and, as such, a domestic price discrimination policy could be a partial substitute for more traditional policy measures.

III. A stylised model of dairy pricing and trade

30. The standard theoretical framework for analysing the market impacts of government intervention in milk pricing is developed in Buxton (1977), Ippolito and Masson (1978) and more recently in Sumner (1999) and Bouamra-Mechemache et al. (2002). Figure 1 constitutes a graphical representation of that framework. Annex 1 contains the algebraic version of the model. In this framework, there are only two end-use milk classes: fluid milk and manufacturing milk. Fluid milk is considered as non-traded with demand supplied exclusively from domestic production. Manufacturing milk is used entirely to manufacture tradable dairy products, the domestic supply of which could be greater (as in this illustration) or less than domestic consumption.

Figure 1. Market effects of alternative milk price support measures

31. The line S in the diagram represents the total supply of raw milk (the marginal cost curve for milk production). There are two demand curves, \( D_f \) representing the demand for fluid milk and \( D_d^A \) representing the combined demand for fluid and manufacturing milk. Demand for manufacturing milk is given by the difference between \( D_d^A \) and \( D_f \). Note that the slopes of the demand curves differ, reflecting a demand for fluid milk that is more inelastic than that for manufacturing milk.

32. To simplify matters, it is assumed that in the absence of government interventions in milk pricing, the price received by producers and paid by purchasers would be the same regardless of whether
the milk is to be used for fluid purposes or for manufacturing dairy products. Moreover, under these ‘free-market’ assumptions the domestic price would be equal (in raw milk equivalent terms) to an appropriately defined world market reference price — labelled $P_w$ in Figure 1.

33. Now, assume there are two policy options for achieving a given producer price for milk — the price labelled $P_d$ in Figure 1. Under the first policy option the government simply sets a flat support price that all purchasers of raw milk must pay. Of course, since that price is above the associated world market price, $P_w$, the government would have to defend it through the imposition of trade measures — export subsidies (as in the present illustration) and tariffs/tariff rate quotas. The intersection of $P_d$ and $S$ determines the level of total milk production, $Q_{sAB}$. The price $P_d$ implies fluid milk consumption and production of $Q_fA$. Manufacturing milk processors buy the rest of milk produced ($Q_{sAB} - Q_fA$) also at the price $P_d$. Part of the manufacturing milk production will be consumed domestically ($Q_{dA} - Q_fA$) and part will be exported ($Q_{sAB} - Q_{dA}$).

34. If we assume that the quantity purchased will have to be exported at the prevailing world price $P_w$, then the per unit export subsidy will equal ($P_d - P_w$) and total expenditure on export subsidies would amount to the area ‘l’ + ‘j’ + ‘g’ + ‘h’. This is the financial transfer to producers from taxpayers. The financial transfer to producers from consumers is represented by the area ‘b’ + ‘d’ + ‘c’ + ‘e’ + ‘i’ + ‘f’.

35. Under the second policy option the government achieves the same targeted producer price $P_d$ by using a combination of a flat support price, $P_mB$ in Figure 1, and an administratively determined fluid milk premium. This premium, represented in the diagram by the difference between $P_fB$ and $P_mB$, is the extra amount that purchasers of raw milk destined for fluid uses must pay. The price producers receive under this arrangement is the weighted average of $P_fB$ and $P_mB$ where the weights are the quantities of milk going to each of the two end uses. In this example, the manufacturing milk price and administered fluid milk premium are set up such that producers receive the target support price $P_d$ at the level of output $Q_{sAB}$.

36. Since farmers face the same incentive price the level of total milk production is the same $Q_{sAB}$ in both cases. Under the combined regime the government can increase producer prices either by increasing the fluid milk premium or by increasing the flat support price. This means that with discriminatory pricing, the same desired target price $P_d$ can be achieved with manufacturing milk prices set at the lower level $P_mB$ as compared to the policy relying only on trade measures. This is because producers under a policy of price discrimination get a part of their price support in consequence of higher prices charged consumers of fluid milk.

37. The diagram illustrates that in response to the increase in the fluid milk price caused by the introduction of the fluid milk premium the fluid milk consumption will fall to $Q_fB$, i.e. a decrease of ($Q_fA$ – $Q_fB$). As a result of the higher fluid milk price and the shift in the starting point the combined demand curve $D_fA$ moves leftward to $D_fB$. It follows that by lowering fluid milk consumption, more milk is left for manufacturing purposes ($Q_{sAB} - Q_{fB}$). At the same time, following the introduction of the fluid milk premium, domestic consumers of manufacturing products will face the lower price $P_mB$. Accordingly, the domestic consumption of manufactured products is higher, and is equal to ($Q_dB$ – $Q_fB$). The difference ($Q_{sAB} - Q_{dB}$) will be exported, attracting a per-unit export subsidy equal to ($P_mB - P_w$) and a lower total

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6. However, as discussed above, the presence of transportation and other marketing costs and seasonal payments will in theory generate a market-driven fluid milk premium. The representation of this ‘natural’ premium would make the graphical analysis intractable. Nevertheless, the analytical framework remains valid if the demand schedules and administered prices as depicted in the diagram are viewed as net of transportation cost and seasonal premiums. (For further discussion see Ippolito and Masson.)

7. Note that applying trade measures [import tariffs, tariff rate quotas (TRQ’s) and export subsidies] is analytically equivalent to supporting price by intervention buying.
expenditure on export subsidies - the amount shown by area ‘h’. Note that the area ‘j’ is effectively being “cross-subsidised” by domestic fluid milk consumers.

38. The total transfer to producers from consumers that follows the introduction of the fluid milk premium can be split into two parts: a transfer due to the discriminatory pricing arrangements and a transfer associated with the flat support price. In Figure 1, the former is represented as area ‘a’ + ‘b’, and the latter is represented as areas ‘d’ + ‘e’ + ‘f’ + ‘g’. (The financial transfer from taxpayers to producers is represented as area ‘h’). Note that since $P_d$ is the weighted average of $P_f^B$ and $P_m^B$, the area ‘a’ is equal to the area ‘c’ + ‘i’ + ‘l’ + ‘j’. The unit market price support created by discriminatory pricing arrangements is now equal to the price gap between $P_d$ and $P_m^B$. The unit market price support attributable to the flat support price is equal to the gap between $P_m^B$ and $P_w$.

39. When milk prices are supported only via the flat support price, fluid milk consumers enjoy greater consumer surplus by area ‘a’ + ‘k’ as compared to when the same amount of price support is achieved under discriminatory pricing. Conversely, consumers of manufactured products under discriminatory pricing benefit from greater consumer surplus as compared to the outcome obtained using trade measures alone (a result that is difficult to represent in the graph due to the shift of the demand curve). In effect, price support achieved using discriminatory pricing shifts the associated cost burden from consumers of manufactured dairy products, and taxpayers if the country is a net exporter, to consumers of fluid milk products. It is important to note that the market and trade impacts are conditional on other policy measures operated. That is, the general analytical model developed above does not take into account policy measures such as quota systems, which allow the trade distorting impact of market price support to be limited.

Impacts of alternative policy regimes on export subsidies and trade

40. Table 1 below synthesises the implications for market price support, implicit budgetary expenditures on export subsidies and net trade (production minus consumption) obtained in comparing a flat support price policy regime that relies exclusively on trade interventions with the regime combining trade measures with discriminatory pricing (a net exporter case). The row labelled ‘TM’ shows the level of market price support, implicit budgetary expenditures on export subsidies and net trade impacts for the trade-measures-only regime. Likewise, the second row shows these outcomes for the combined regime. The third row contains differences obtained by subtracting the results obtained in simulating the combined regime from those obtained in simulating the TM-only regime. Notice that the levels of market price support are, by design, identical between the two regimes.

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8. The area ‘a’ = ‘c’ + ‘i’ + ‘l’ + ‘j’ is equivalent to $(P_f^B - P_d)Q_f^B = (P_d - P_m^B)(Q_{AB}^B - Q_f^B)$. By rearranging the equation we get $P_dQ_f^B + P_d(Q_{AB}^B - Q_f^B) = P_f^BQ_f^B + P_m^B(Q_{AB}^B - Q_f^B)$. By further simplifying we arrive at the formula for the average producer price that is: $P_d = (P_f^BQ_f^B + P_m^B(Q_{AB}^B - Q_f^B)) / Q_{AB}^B$.

9. Given $(P_m^B < P_d)$, the first term is bigger than the second term which implies that consumers of manufactured products under the discriminatory pricing arrangements increase their consumer surplus by:

$$
\Delta CS_m = \left[ \int_0^\tau D_s^w(x)dx - (Q_s^w - Q_s^f)P_m^B \right] - \left[ \int_0^\tau D_s^w(x)dx - (Q_s^f - Q_s^f)P_o \right]
$$

10. The consumer welfare impacts will be conditional on the degree of price transmission along the supply chain. For a discussion on price transmission issues see Box 1 in *Analysis of international dairy trade liberalisation*. 

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12
41. However, the implicit budgetary expenditures on export subsidies are lower under the combined regime. This result is unambiguous (within the limits and assumptions of the analytical framework developed as explained in the first five paragraphs of section III.): the implicit budgetary expenditures on export subsidies will generally be greater for a flat-price, trade measures only regime than for one that combines trade intervention with price-supporting discriminatory pricing arrangements. The reason for this result is clear. Under the discriminatory pricing regime that sets fluid milk prices higher than would be generated by perfectly competitive market forces, consumers are made to pay a larger sum of money for a given aggregate quantity of milk, by “exploiting” the low price responsiveness of demand for fresh milk. The additional consumer expenditure then effectively finances some of the export subsidy that under the flat price regime is financed by the government. In principle, a discriminatory pricing arrangement can even be implemented such that consumers finance the entire (then implicit) export subsidy and the government pays no export subsidy even though exports are sold on world markets below the price received by domestic producers.

Table 1. Selected indicators of trade effects for comparing policy regimes

<table>
<thead>
<tr>
<th>Policy regime:</th>
<th>Market price support</th>
<th>Implicit budgetary expenditures on export subsidies</th>
<th>Net trade</th>
</tr>
</thead>
<tbody>
<tr>
<td>TM(^a)</td>
<td>((P_d-P_m))(^s)Q_{sAB}</td>
<td>((P_d-P_m))(^s) (Q_{sAB} - Q_{dA})</td>
<td>((Q_{sAB} - Q_{dA}))</td>
</tr>
<tr>
<td>TM+DPA(^b)</td>
<td>((P_d-P_m))(^s)Q_{sAB} ((P_m^B-P_m))(^s) (Q_{sAB} - Q_{dB})</td>
<td>((Q_{sAB} - Q_{dB}))</td>
<td></td>
</tr>
<tr>
<td>Difference</td>
<td>-0-</td>
<td>((P_d-P_m^B))(^s) (Q_{sAB} - Q_{dA})</td>
<td>((Q_{dB} - Q_{dA}))</td>
</tr>
<tr>
<td>Combined regime gives</td>
<td>No difference</td>
<td>Smaller implicit budgetary expenditures on export subsidies</td>
<td>Smaller trade impact (ambiguous)</td>
</tr>
</tbody>
</table>

\(^a\) Trade measures only.
\(^b\) Trade measures plus discriminatory pricing arrangements.

Source: OECD Secretariat

42. The implications of the two policy alternatives for the volume of trade itself are not as straightforward. Figure 1 is drawn in such a way that less quantity has to be exported under the combined regime. The reduction in exports \((Q_{sB} - Q_{sA})\) is due to the fact that, in the diagram, the increase in fluid milk price reduces the fluid consumption by less than the decrease in manufacturing milk price boosts the manufacturing milk consumption. However, in general terms, the outcome is ambiguous. In some circumstances, net trade could be greater with the combined regime. The result depends critically on the numerical values of certain economic parameters. Analysis with the algebraic version of the model in Figure 1 permits further insights into these relationships. That analysis is developed fully in Annex 1. The main findings are summarised below. In interpreting these results recall that the comparisons are standardised on a given amount of market price support provided alternately either via a trade measure or via price discrimination.

- The key factors determining relative trade impacts are: the relative magnitudes of the elasticity of demand for fluid versus manufacturing milk, the initial trading status of the country, and the initial relative supported prices of fluid and manufacturing milk.
- In one important special case — that of a country which is not a net exporter of dairy products the only one of these that matters is that the elasticity of demand for fluid milk be less (in absolute value) than the elasticity of demand for manufacturing milk. In this case market support resulting

\(^{11}\) Tariff revenues in the case of a net importer.
from trade measures (tariffs and their equivalents) will always be more trade distorting than market price support due to discriminatory pricing.

- In some other cases though, a lower elasticity of demand for fluid milk is not enough. For a net exporting country, market price support due to discriminatory pricing will be relatively less trade distorting than market price support due to trade measures only if exports represent a “small enough” share of total manufacturing milk use. (The specific condition for this case is developed in the Annex.)

- Moreover, the higher the initial gap between fluid and manufacturing milk prices the more likely that a marginal change in market price support due to a (further) increase in fluid milk prices will be less trade distorting than an equivalent increase in market price support due to trade measures.

- Taken together these conditions narrow the field of situations where price discrimination is relatively more trade distorting to those of a large net exporting country with a low initial fluid milk premium.

IV. Results of policy simulation analysis

43. The purpose of the empirical analysis presented in this section is to quantify the analytical framework developed in part III. (Figure 1) and further elaborated in Annex 1. The empirical analysis is based on simulations with the OECD’s Aglink and PEM models. The main goal of the policy simulation experiments undertaken with these two models was to obtain ‘order of magnitude’ estimates of the impacts of marginal changes in milk price support price support provided either via a flat-price, trade measures regime or via discriminatory pricing. Although different in terms of commodity, country coverage and length of run, these two models share the same analytical framework — the one sketched out in Figure 1 (A description of the Aglink and PEM models is presented in Annex 3).

44. The Aglink analysis addresses potential commodity impacts. The PEM analysis focuses on economic costs and benefits — the potential welfare impacts. In both analyses, the policy experiments were aimed at measuring the effects of reducing the amount of milk market price support provided. In both cases the comparison is of the impacts of two different ways governments might choose to reduce that support. In one, the government reduces support prices for manufactured dairy products by reducing the associated trade measures (tariffs or export subsidies as appropriate). In the other, the government achieves the desired reduction in milk market price support by reducing the fluid milk premium (and any associated border measures applied to fresh dairy product and fluid milk trade).

45. Note that in the first kind of policy simulation experiment the fluid milk premium is not changed. Likewise, in the second kind of policy simulation experiment, the settings for dairy product prices and associated tariffs/export subsidies are left unchanged. The two scenarios are chosen such that the reduction in producer price is the same between them. The difference is in the impact on consumer prices. In one, the price reduction applies equally to all consumers and the extent of price discrimination is left unchanged; in the other the price reduction is restricted just to consumers of fluid milk and the extent of price discrimination is reduced. In the tables, graphs and discussion below the two scenarios are labelled LSP, for Lower Support Price for manufactured dairy products and LFP, for Lower Fluid Premium applying to fluid milk prices.

12. Given the linear nature of the model, changing the exercise by increasing rather than decreasing producer price would not change the main points and findings of the analysis.
Aglink results

46. The dairy component of Aglink covers production and consumption of milk and major dairy products in the principal OECD markets, encompassing both importers and exporters. In general, it would be possible to impose a hypothetical price support and price discrimination scheme in any country covered by Aglink in order to show the main consequences of the analysed support measures for dairy markets and trade. The empirical analysis was undertaken with the Aglink US module. This choice was based on the fact that both market price support and a fluid milk marketing program with pooling are used in the US and the relevant equations already exist in the model.

47. As noted above, the simulations are carried out to quantify the analytical and mathematical concept developed above and in Annex 1. Hence, these scenarios are purely illustrative and do not intend to estimate the impact of classified milk price system adopted in the United States in reality. The analytical framework has been developed here, for the sake of transparency, with only two end-uses of milk whereas in reality in the United States the end-use milk pricing is more complex and refined (see USDA (2004c) and USDA (2004b)).

48. There is a disagreement among researcher whether the classified price system adopted in the United States includes policy subsidy element. While empirical research supports the existence of price differences caused by interregional transportation costs, there is no recent empirical research addressing differences in the marketing costs associated with servicing plants that manufacture dairy products such as cheese versus plants that process fluid milk. This lack of empirical research contributes to the disagreement. However, market-generated prices are higher than Federal order minimum Class I prices in every U.S. market, with differences averaging USD 1.28 per cwt in 2000, USD 1.15 per cwt in 2001, USD 1.44 per cwt in 2002, and USD 1.47 per cwt in 2003 (USDA/AMS Dairy Market Statistics, Annual Summary.) Here, the purpose of the analysis is not to determine whether an administrative premium exist in a particular country or not. Therefore, in the base scenario, the Aglink baseline fluid milk premium was increased marginally to instigate the policy fluid milk premium.13 The manufacturing milk price was left at the baseline level while the all milk producer price was recalculated to account for the fluid milk premium increase.14 In the subsequent policy scenarios, this premium was then reduced to assess the market impacts.

49. The analysis comprises development of two policy scenarios and then compares them to the base scenario. Following the scenario setting described in paragraph 45, the levels of milk and dairy product prices were recalculated from the base scenario levels in such a way as to achieve a required marginal decrease in producer price (to simulate a marginal decrease in milk producer price a 0.5% reduction has been used). In the simulation, the domestic market is allowed to clear at the recalculated prices through changes in trade flows. It is important to note that in the simulations no account is taken of the WTO limits on trade, in terms of subsidised exports or barriers to imports. Thus, the trade flows and their impact on world markets have to be considered only as indicative of the magnitude of possible changes.

50. Annex 2 contains tables showing year by year comparisons of the two scenarios for several key price and quantity variables for each of the seven years in the baseline — 2002 to 2008. Tables 2 and 3

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13 The baseline used for the base and policy scenarios refers to the market and trade projections of the OECD Agricultural Outlook report (OECD, 2003).

14 In the base scenario the fluid milk premium was increased by 5% while all milk producer price increased by about 0.5%.
compare the 7-year averages of those results. Simulated changes in domestic prices\textsuperscript{15} are reported in Table 2, simulated changes in market quantities in Table 3.

Table 2. Average percentage changes of base scenario milk prices resulting from changes in manufacturing milk prices (LSP) and an assumed fluid milk premium (LFP)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Producer price ($P_D$)</th>
<th>Fluid milk price ($P_f$)</th>
<th>Fluid milk premium ($P_f - P_m$)</th>
<th>Manufacturing milk price ($P_m$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LFP scenario</td>
<td>-0.5%</td>
<td>-1.24%</td>
<td>-4.74%</td>
<td>0.0%</td>
</tr>
<tr>
<td>LSP scenario</td>
<td>-0.5%</td>
<td>-0.41%</td>
<td>0.0%</td>
<td>-0.56%</td>
</tr>
</tbody>
</table>

Source: OECD Secretariat

51. Table 3 shows the relative changes from base scenario for each scenario with respect to milk and dairy product consumption and production. The table shows that in the LFP scenario the consumption of manufactured dairy products is the same as in the base scenario reflecting the fact that the prices of manufactured dairy products in this scenario are left at the baseline level. On the other hand the consumption of manufactured dairy products in the LSP scenario increases in response to the reduction of those prices. The reduction of fluid milk price in both scenarios (Table 2) has brought an increase in fluid milk consumption in both cases. The increase is relatively higher in the LFP scenario, which is to be expected given the greater size of the fluid milk price cuts. The reduction of milk production in response to the 0.5% decrease of producer prices is the same in both scenarios by definition and amounts to about 0.12% on average. The decrease in production of dairy products is influenced by the reduction in milk production but also by different increases in fluid milk consumption, which reduces the availability of milk for manufacturing purposes.

\textsuperscript{15} Differences between simulated price changes for fluid versus manufacturing milk reflect differences in the relative importance of these two demand categories in total milk production. Roughly two-thirds of total raw milk production in the US goes into production of manufactured dairy products. It follows that the proportion of milk used for fluid purposes is about one-third. Thus manufacturing milk has a relatively greater weight in calculating the pooled producer price.
Table 3. Production and consumption impacts of reductions in manufacturing milk prices and an assumed fluid milk premium, averages for 2002-2008

<table>
<thead>
<tr>
<th></th>
<th>Consumption impacts</th>
<th>Production impacts</th>
<th>% changes from base scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LFP</td>
<td>LSP</td>
<td>LFP</td>
</tr>
<tr>
<td>Fluid milk</td>
<td>0.189</td>
<td>0.063</td>
<td>0.189</td>
</tr>
<tr>
<td>Raw milk</td>
<td>-0.122</td>
<td>-0.122</td>
<td>-0.122</td>
</tr>
<tr>
<td>Butter</td>
<td>0</td>
<td>0.210</td>
<td>-0.262</td>
</tr>
<tr>
<td>SMP</td>
<td>0</td>
<td>0.336</td>
<td>-0.350</td>
</tr>
<tr>
<td>Cheese</td>
<td>0</td>
<td>0.168</td>
<td>-0.262</td>
</tr>
<tr>
<td>Whey powder</td>
<td>0</td>
<td>0.079</td>
<td>-0.174</td>
</tr>
</tbody>
</table>

Source: OECD Secretariat

52. In both policy scenarios, fluid milk consumption increases and milk production falls. This results in a smaller volume of milk available for manufacturing and a consequent reduction in production of dairy products. These differences are manifested in changes of trade volumes summarised in Figure 2. (Figures A2.1 – A2.4 in Annex 2 depict traded volumes for each dairy product and for each of the seven years in the baseline for the baseline and the two policy scenarios.) Figure 2 indicates that the simulated quantity of net butter imports by the United States is increased in both scenarios. The LSP scenario shows a greater increase in butter net imports when compared to the LFP scenario. The difference is about one thousand tonne (Kt) in absolute terms (42% in relative terms). An even larger increase in net imports is seen for cheese as is apparent from the size of the columns in the diagram. The LSP scenario shows greater increase when compared to LFP scenario by about 5 Kt in absolute terms (30% in relative terms). The last set of columns in the diagram indicates that simulated skimmed milk powder (SMP) net exports have been reduced in both scenarios (in Figure 2 the net SMP exports are presented as negative net imports). The higher reduction is seen in the case of the LSP scenario and the difference when compared to LFP scenario is about 1.5 Kt in absolute terms (44% in relative terms).

53. Results presented in Figure 2 make clear that milk market price support — whether resulting from the fluid milk premium or from higher manufactured dairy product prices, does have impacts on trade. These impacts are quantitatively different. A 0.5% decrease in average producer price achieved by reducing the price of supported manufactured products\(^\text{16}\) (LSP scenario) increases overall consumption (in milk equivalent) by a greater amount than is seen in the scenario which reduces the average producer price by means of reducing the fluid milk premium (LFP scenario). Given the fact that milk production is identical in both scenarios the differences in the fluid and manufacturing milk consumption translate directly into differences in net exports that have immediate consequences for world dairy market prices. The differences in results for simulated world market price impacts are shown in Figure 3 for both scenarios.\(^\text{17}\)

\(^{16}\) This mimics the effects of using just trade measures to accomplish the reduction.

\(^{17}\) The domestic price of whey powder in the United States is used as a proxy for world whey powder price in Aglink, thus no impact on world whey price is reported.
54. Comparing the impact across dairy products indicates that the highest percentage change in a world price is in the cheese market. The higher impact on cheese markets stems from the fact that the majority of manufacturing milk in the United States is used for the production of cheese. In fact, about three-quarters of all manufacturing milk are channelled to cheese production.\(^{18}\) It follows that the reduction in production in absolute terms is significantly higher for cheese than for the other products. The figure also shows that, as for net exports, world market price effects are greater for the LSP scenario.

55. In the earlier discussion of ‘in general’ effects of milk price support measures it was noted that for some specific situations the question of which support measure is most trade distorting could be answered definitively only with reference to the trading status of the country and specific elasticity assumptions. The simulated result obtained here suggests a high degree of similarity in trade effects

\(^{18}\) The allocation of US manufacturing milk in the model is based on regression analysis and historical shares of individual dairy products in the manufacturing milk markets.
between the two with price support due to trade measures slightly more trade distorting than price support due to discriminatory pricing.

**PEM results**

56. The Aglink analysis in the foregoing section focused on illustrating the price and quantity impacts of hypothetical reductions in producer prices achieved by reducing alternately the support prices for manufactured dairy products and the fluid milk premium. The PEM analysis reported in this section of the paper focuses on the effects on trade and welfare of hypothetical changes in the level of market price support provided alternately by those support mechanisms. Moreover, where the Aglink analysis was concerned mainly with supply, demand and price effects for individual manufactured dairy products at the final consumer, here the spotlight will be on aggregate effects measured in milk equivalents at the farm gate. That is, the “consumer” in PEM is the first consumer in the processing chain, who purchases from the dairy farmer. This is consistent with the definition of consumer used in the PSE database. It does prompt a caveat: To the degree that there is imperfect price transmission along the processing chain to the retail market, welfare results for the “consumer” in the model will be an imperfect proxy of the welfare of the final consumer of the dairy product. Specifically, model results will overestimate final consumer welfare gains in response to reduction in producer price support if some of those changes are captured as excess rents by processors or retailers.

**Simulated net trade impacts of alternative market price support measures**

57. The first simulation experiment done using the PEM model was to evaluate the impact of reducing the level of any market price support provided by discriminatory pricing arrangements in Japan and in the United States. Accordingly, the simulated reduction in market price support is achieved by reducing an assumed fluid milk premium without changing trade measures. Consistent with the labelling scheme adopted for the Aglink analysis this simulation is called the “Lower Fluid Premium” (LFP) experiment. The second experiment simulated the impact of reducing the amount of support provided (implicitly) by trade measures applied to manufactured dairy products in the same two countries. Again in keeping with the Aglink labelling this experiment is called the “Lower Support Price” (LSP) experiment. In both experiments the simulated reduction in milk market price support was USD 100 million.

58. Figure 4 shows the simulated impacts on net dairy product trade, converted to milk equivalents. When measured in milk equivalents both Japan and the United States were net importers of dairy products in 2001. (Since, by convention, net trade is measured as production minus consumption so that imports appear, as in Figure 4, as negative numbers.)
Figure 4. Estimated trade impacts of reductions in manufacturing milk prices and an assumed fluid milk premium

(PEM simulated changes in the volume of net milk equivalent exports)

Source: OECD Secretariat

59. PEM results in Figure 4 generally confirm the Aglink results for individual dairy products presented in the previous section: no matter the mechanism, reducing milk market price support increases imports or decreases exports. Likewise, these findings corroborate the earlier proposition, based on analysis with the stylised model, that trade measures will always be more distorting than price-supporting discriminatory pricing if the country in question is a net importer.

The economic costs and benefits of alternative milk market price support measures

60. Table 4 presents and defines the PEM model indicators of the various categories of economic benefits and costs of support for the two categories of milk market price support featuring in the present study. The charts in Figure 5 display simulation results for these indicators comparing the two categories of milk price support. Consistent with the fact that in all the simulation experiments market price support is reduced, note that consumers gain while farm households and input suppliers lose. Estimated transfer efficiency ratios reveal the relative magnitude of these changes.

Table 4. Indicators of economic costs and benefits in the PEM dairy model

<table>
<thead>
<tr>
<th>Economic indicators</th>
<th>Definition of measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taxpayer costs</td>
<td>Total change in costs incurred by government in paying for border measures * and consumer subsidies.</td>
</tr>
<tr>
<td>Consumer surplus</td>
<td>Change in consumer surplus.</td>
</tr>
<tr>
<td>Farm income</td>
<td>Change in return above opportunity costs to farm owned factors including land, cows, forage and silage.</td>
</tr>
<tr>
<td>Input supplier profits</td>
<td>Change in returns above opportunity costs earned by suppliers of purchased factors including purchased feed and hired labour.</td>
</tr>
<tr>
<td>Transfer efficiency</td>
<td>Change in farm income divided by the sum of the changes in taxpayer cost and consumer surplus.</td>
</tr>
</tbody>
</table>

*Export subsidies would lead to positive costs for a net exporter whereas border measure costs would be negative for a net importing country where the government collects the tariff revenues.
Figure 5. Simulated impacts of reductions in manufacturing milk prices and an assumed fluid milk premium on selected indicators of the economic benefits and costs of support

![Diagram showing taxpayer costs, consumer surplus, farm household income, and input suppliers profits for Japan and the United States.](image)

Source: OECD Secretariat.

61. The first diagram in Figure 5 depicts the impact of the two experiments on the taxpayer costs in the United States and Japan. The reduction in taxpayer costs is mainly due to a simulated increase in import tariff revenues in the two countries.¹⁹ (In this context, tariff revenues the government receives from, for example, auctioning rights to import protected dairy products, might helpfully be viewed as negative taxpayer costs.) Note that two factors influence the size of import tariff revenues: 1) the total volume of imports and 2) the price gap between domestically produced manufacturing milk and the world reference price. The results in Figure 5 suggest that the import quantities increase proportionally more than the

¹⁹ Consumer subsidies are also included in taxpayer costs. However, the rates of these subsidies are much smaller than the gap between the manufacturing milk and the world reference prices in the two countries. Accordingly, their relative contribution to the simulated change in total taxpayer costs is negligible.
corresponding reductions in the gap between the manufacturing milk and the world prices in all the experiments.

62. Because consumer prices fall in both experiments, consumer surplus increases in both. However, as shown in Figure 5, the estimated impacts on the two milk markets are different. In the LSP experiments, the consumer prices for both fluid milk and manufacturing milk are reduced, benefiting both fluid milk and manufacturing milk consumers. In the LFP experiment, on the other hand, the fluid milk price is reduced without changing the gap between the manufacturing milk and the world prices confining the gains just to fluid milk consumers. Indeed manufacturing milk consumers lose fractionally. The reason for this is the increase in the world reference price in response to the increase in the import quantity. The increase in the imports reduces supplies in the world dairy market, putting upward pressure on the world reference prices. This automatically increases the domestic manufacturing milk price and decreases consumer surplus of manufacturing milk.

63. While qualitatively similar, there are some differences in the simulated results for the United States as compared to those for Japan. Note first, from Figure 4, that the simulated increase in milk equivalent imports is significantly greater for the United States, largely because the US dairy market is substantially larger. Obviously, in light of these changes in imports, the world market price effects and the associated reduction in surplus for consumers of manufacturing milk is greater in the LFP experiment for the United States simulation than for Japan. Moreover, there are differences in the simulated results that reflect the different characteristics of the milk markets in those countries. The ratio of fluid milk consumption to manufacturing milk consumption is significantly higher in Japan, while the ratio of the demand elasticity for fluid milk to that for manufacturing milk is significantly lower.

64. There is another interesting difference in the results for the United States versus those for Japan. First, recall that in all the simulation experiments, the simulated reduction in milk market price support is the same. For Japan, the simulated increase in consumer surplus (the total for fluid milk and manufacturing milk consumers) due to a reduction in the fluid milk premium is less than the simulated increase in consumer surplus due to lower support prices for tradable dairy products. For the United States, although it is the other way around, consumers benefit just slightly more from the reduction in the fluid milk premium. In general terms, the implications for consumer surplus of discriminatory pricing versus flat price-trade measures based support are, as was the case for trade effects, ambiguous. The empirical result depends on the initial trading status of the country, initial levels of support and elasticities.

65. Transfer efficiency refers to the proportion of total consumer and taxpayer costs of a support measure that translates into increased net income for farm households. Earlier work on the transfer efficiency of alternative support measures (OECD, 2002) reports that market price support is among the least efficient ways of improving incomes of farm households. Findings in that analysis suggested that, on average across the OECD and for all of agriculture, probably no more than twenty-five percent of the total costs paid by consumers and taxpayers under market price support measures can be counted as net gain for farm household income. The rest is lost either in the form of income gains by economic agents who were not the intended beneficiaries of support or in consequence of resources being diverted from other productive uses to the production supported commodities. Previous analyses of transfer efficiency focused on only one category of market price support — implicitly market price support that results from government intervention via trade measures.

66. Notice that the estimated transfer efficiency of milk market price support is slightly higher than that obtained in earlier work considering agriculture in total, OECD-wide. Differences in two key

20  The fluid and manufacturing milk elasticities are –0.3 to –0.5 respectively in Japan, and –0.15 to –0.41 in the United States.
economic parameters explain the results. For milk production, the share of farm owned factors is typically higher and the elasticity of supply of them is lower than for agriculture in total. These results also line up well with earlier findings regarding the trade effects.

67. The estimates of transfer efficiency for support due to discriminatory pricing are higher than for support due to trade measures. Since, by the design of the simulation experiment, the change in farm household income is roughly the same between the two simulation experiments; the difference is explained by differences in simulated impacts on taxpayer costs and consumer surplus. Once again, however, the differences are not large. Moreover, before any strong conclusions could be drawn in this regard some other cost considerations would need to be accounted for — especially potential extra administrative costs of price discrimination schemes as compared to price support arrangements based exclusively on trade interventions.

V. Conclusions

68. This paper has investigated trade and economic effects of milk price support measures. The market price support in this document was segregated into i) support due to trade measures – i.e. support attributable to a package of target prices, product support prices and trade measures and ii) support due to discriminatory pricing. Here, the discriminatory pricing does not refer to a discrimination between domestic and export markets but rather to a practice administered or sanctioned by a government that lead to prices paid for raw milk, for some end uses (typically fresh milk products) that are higher by more than the additional marketing costs than those paid for raw milk for other end uses (typically manufactured milk products) on the domestic market. The additional revenue generated by discriminatory pricing is then transferred back to farmers through a pooled (averaged) price.

69. Although there are market-driven explanations for some of the difference between fluid and manufacturing milk (consumer preferences in terms of quality differences, transportation and marketing costs, and seasonality in milk production was noted), the administered price difference could be sufficiently large to provide an additional price support to producers. It follows, that domestic fluid milk consumers under price discrimination partly support farmers via such a higher set fluid milk premium or set fluid milk price which can enable a government to set support measures for the manufacturing (tradable) milk at a lower level (for the same “target” producer support price) in comparison to a government that does not operate price discrimination and pooling.

70. An analytical framework was set up in this paper to investigate the impact of support due to trade measures and due to discriminatory pricing on dairy markets and trade. The simulation analysis with a mathematical model (based in economic theory) of milk price determination shows that on a dollar for dollar basis it is theoretically possible for milk price support resulting from discriminatory pricing to be as or even more trade distorting than milk price support resulting from explicit trade intervention in dairy product markets.

71. The empirical results of the assumed change in policy parameters obtained from simulations with Aglink and PEM suggest, however, that, as a practical matter, price-supporting discriminatory pricing arrangements could be less trade distorting —but not by much. Moreover, such price-supporting arrangements are by design, unfair, imposing higher costs on one particular group of consumers. Both categories of milk price support cost consumers and taxpayers considerably more than the benefits they deliver in farm household income. It should however be noted that the results of this analysis are simulated model outcomes and thus have to be viewed within the limits of the tools applied and the hypotheses and

21. This is even more so the case in countries where milk production quotas are in place. This may help to explain why reform of milk price support policy is typically a politically difficult matter.
assumptions postulated. The most important assumption is that markets are assumed to be perfectly competitive.

72. In summary, compared to a situation without market price support, market price support whether the consequence of trade interventions in dairy product markets or the consequence of discriminatory pricing arrangements, leads to increased production (unless there are quota restrictions) and reductions in consumption. In most cases this will result in higher exports and lower imports. Market price support due to the flat support price and trade measures regime is deemed to be relatively more distorting than market price support due to discriminatory pricing, however any associated reductions in trade distortion and export subsidies come at the expense of higher costs for fluid milk consumers.

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22 The hypotheses of the analytical framework are laid out the first 5 paragraphs of section III, footnote 7 and Annex 1. The model assumptions are discussed in paragraphs 36-37, Annex 2 and Annex 3.
Box 1. Milk price deregulation in Australia

Market milk regulations were originally introduced to guarantee year round supplies of fresh milk to Australian consumers. The regulations included farm gate and retail price controls on fresh milk sales as well as supply management arrangements, all on a regional basis. The fluid milk prices differed across regions despite the potential for inter-state trade, because an industry agreement ensured that inter-state fresh milk sales were priced to maintain the regulated farm-gate price. Although the farm-gate price of fresh milk varied from state to state, it was always well above the price of manufacturing milk.

In 1995, a regulatory reform process began which stipulated that in each state only farm gate price controls would remain in place by January 1999. In July 1999 the review of market milk regulations in Victoria concluded there was no net public benefit from retaining farm-gate price controls. Victoria is the largest milk producing state in Australia, accounting for nearly two-thirds of total national milk production. Faced with the prospect of complete deregulation of such a large share of national milk production (in a region seen as having comparative advantage in milk production) governments in other producing states concluded that their own market milk regulations would be unsustainable. Accordingly, when the Victorian government announced the state milk marketing regulations would end on 1 July 2000, the individual state dairy industries and governments recognised that national deregulation of dairy industry was inevitable (OECD, 2001).

The policy reform removed simultaneously the Dairy Market Support scheme and fresh milk regulations on 1 July 2000 to allow the market to determine milk prices. At the same time, a structural adjustment package was introduced in the form of the Dairy Industry Adjustment Act 2000 to help producers cope with the adjustment pressures and allow farmers to choose between adjusting to lower market returns versus leaving the industry (Australian Competition and Consumer Commission, 2001). The adjustment package is funded by a levy of 11 cents (USD 6 cents) per litre on all domestic sales of fresh milk. The levy partially replaced the implicit consumer tax inherent in the fresh milk regulations and was set at a level to ensure consumer prices would not rise after deregulation. It will remain in place for approximately eight years until the package is fully funded. The individual adjustment programs are called: Dairy Industry Adjustment Package (DIAP), Dairy Structural Adjustment Program (DSAP), Dairy Exit Program (DEP) and Dairy Regional Assistance Program (DRAP).

Table Box 1: Australian farm gate milk prices (AUS cents per litre)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing</td>
<td>26.0</td>
<td>24.0</td>
<td>23.9</td>
<td>22.5</td>
<td>22.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluid milk</td>
<td>49.9</td>
<td>51.1</td>
<td>52.0</td>
<td>51.5</td>
<td>52.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average farm gate price</td>
<td>31.1</td>
<td>29.6</td>
<td>29.4</td>
<td>28.5</td>
<td>26.2</td>
<td>29.0</td>
<td>30.2</td>
</tr>
</tbody>
</table>

Source: Department of Agriculture, Fisheries & Forestry, Australia (2002).

Table Box 1 illustrates the fluid, manufacturing and average (pooled) milk price received by farmers prior to deregulation (1995-96 until 1999-00) and after the deregulation (after 2000-01). It is apparent from the table that, prior to deregulation, there was a substantial difference between manufacturing and fluid milk market prices. The removal of state government controls of the farm gate supply and pricing of milk introduced an open market for fluid milk in Australia. Thus, after the milk market deregulation in July 2000, market forces removed the differential between ‘market’ and ‘manufacturing’ milk prices that had previously been imposed on markets by government policy. In the four years since deregulation, regional price variation has fallen across Australia, with a smaller change in the overall Australian average prices (ABARE, 2004). Market forces continue to generate prices that differ across regions, but with about half the variation that existed in the last four years of regulation. Farm gate milk prices in individual states both increased and decreased under deregulation (Table Box 2).
Table Box 2. Australian farm gate milk prices by state

<table>
<thead>
<tr>
<th>Year</th>
<th>New South Wales c/L</th>
<th>Victoria c/L</th>
<th>Queens-land c/L</th>
<th>South Australia c/L</th>
<th>Western Australia c/L</th>
<th>Tasmania c/L</th>
<th>Australia c/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996-97</td>
<td>37.5</td>
<td>25.3</td>
<td>38.7</td>
<td>28.7</td>
<td>34.2</td>
<td>22.8</td>
<td>28.5</td>
</tr>
<tr>
<td>1997-98</td>
<td>36.4</td>
<td>24.2</td>
<td>38.4</td>
<td>28.7</td>
<td>35.1</td>
<td>22.6</td>
<td>27.7</td>
</tr>
<tr>
<td>1998-99</td>
<td>35.1</td>
<td>24.4</td>
<td>38.5</td>
<td>29.1</td>
<td>34.1</td>
<td>23.7</td>
<td>27.5</td>
</tr>
<tr>
<td>1999-2000</td>
<td>32.3</td>
<td>22.1</td>
<td>36.8</td>
<td>28</td>
<td>34.2</td>
<td>20.9</td>
<td>25.4</td>
</tr>
<tr>
<td>2000-01</td>
<td>29.1</td>
<td>29.3</td>
<td>30.6</td>
<td>27.7</td>
<td>26.6</td>
<td>25</td>
<td>29</td>
</tr>
<tr>
<td>2001-02</td>
<td>32.5</td>
<td>33.3</td>
<td>34.5</td>
<td>31.5</td>
<td>28.7</td>
<td>32.7</td>
<td>33</td>
</tr>
<tr>
<td>2002-03</td>
<td>32.8</td>
<td>24.8</td>
<td>34.8</td>
<td>30.3</td>
<td>28.2</td>
<td>25.9</td>
<td>27.1</td>
</tr>
</tbody>
</table>

a/ Prior to 2000-01, prices are weighted average of both market and manufacturing prices.
REFERENCES


Lippert, O. (2001), The perfect food in a perfect mess: The cost of milk in Canada, Public Policy Sources, Number 52, The Fraser Institute, Vancouver, B.C., Canada.


OECD (1996), Reforming Dairy Policy, Directorate for Food, Agriculture and Fisheries, Paris


OECD (2002b), OECD Agricultural Outlook 2002-2007, Directorate for Food, Agriculture and Fisheries, Committee for Agriculture, Paris


Annex 1. Algebraic version of graphical model

73. In this annex the expected trade effects of discriminatory pricing arrangements relative to trade measures are examined with a simple mathematical model for a milk market. The analysis employs the same simplifying assumptions underlying the graphical version of the model in Figure 1 of the main text. These are:

- There are only two end-use milk classes, fluid milk and manufacturing milk.
- Fluid milk is produced and consumed domestically (i.e. no trade in fluid milk products).
- Manufacturing milk is used to produce tradable dairy products.
- Trade measures widen the gap between the implicit domestic and border prices of manufacturing milk.
- Discriminatory pricing arrangements constitute the only source of a premium for milk for fluid use over manufacturing use.
- Farmers receive a weighted average of the prices paid for milk destined for fluid uses and the prices paid for milk destined for manufacturing uses.
- The country in question is small enough in world trade to have no or negligible influence on world trade.

74. The supply, demand and price equations for this model are:

\[ Q_s = S(P_s) \]  
\[ Q_f = D_f(P_f) \]  
\[ Q_m = D_m(P_m) \]  
\[ P_s = \frac{P_f Q_f + P_m (Q_s - Q_f)}{Q_s} \]  
\[ X = Q_s - Q_f - Q_m \]

75. The symbol \( Q_s \) stands for quantity produced. \( S(P_s) \) is the milk supply function and \( P_s \) is a milk producer price. \( Q_f \) is the demand for fluid milk, \( D_f(P_f) \) the fluid milk demand function and \( P_f \) the fluid milk demand price. Similarly, \( Q_m \) is the demand for manufacturing milk, \( D_m(P_m) \) the manufacturing milk demand function and \( P_m \) the manufacturing milk demand price. Since \( P_s \) is the weighted average of \( P_f \) and \( P_m \), \( P_s \) can be written as in equation (4). \( X \) is the net exports of dairy products (milk equivalent term) which will be negative in the case of imports. All quantities and prices are considered in liquid units.
76. Writing out the total differentials of equations (1) through (5):

\[ dQ_s = S'(P_s) dP_s = \frac{\epsilon Q_s}{P_s} dP_s \]

(6)

\[ dQ_f = D_f'(P_f) dP_f = \frac{\eta_f Q_f}{P_f} dP_f \]

(7)

\[ dQ_d^m = D_d'(P_m) dP_m = \frac{\eta_m Q_d^m}{P_m} dP_m \]

(8)

\[
\begin{align*}
    dP_s &= \frac{Q_f \left( 1 + \eta_f - \frac{P_m}{P_f} \eta_f \right)}{Q_s \left( 1 + \epsilon - \frac{P_m}{P_s} \epsilon \right)} dP_f + \frac{Q_s - Q_f}{Q_s \left( 1 + \epsilon - \frac{P_m}{P_s} \epsilon \right)} dP_m \\
    dX &= dQ_s - dQ_f - dQ_d^m
\end{align*}
\]

(9)

77. The symbols \( \epsilon \), \( \eta_f \) and \( \eta_m \) stand for the elasticities of milk supply, fluid milk demand and manufacturing milk demand respectively. Substituting equations (6), (7) and (8) in (10) and re-arranging, we have

\[
\frac{dX}{dP_s} = \frac{\epsilon Q_s}{P_s} - \frac{\eta_f Q_f}{P_f dP_s} - \frac{\eta_m Q_d^m}{P_m dP_s}
\]

(11)

78. Equation (11) shows how a change in a milk producer price changes the volume of trade.

79. When a trade measure is used to achieve a given increase in \( P_s \) the price gap between fluid milk and manufacturing milk (fluid milk premium) is assumed to remain at its initial level such that, \( dP_f = dP_m \). This does not rule out the case examined in the previous section where the ‘initial level’ of the fluid milk premium was zero. It does allow though illustrating, as is done subsequently, the important dependence of trade effects on initial relative prices of fluid and manufacturing milk prices. In this case, equation (11) becomes

\[
\frac{dX}{dP_s \bigg|_{dP_f=dP_m}} = \frac{dX}{dP_s \bigg|_{trade}} = \frac{\epsilon Q_s}{P_s} - \left( \frac{dP_f}{dP_s \bigg|_{dP_f=dP_m}} \right) \left( \frac{\eta_f Q_f}{P_f} + \frac{\eta_m Q_d^m}{P_m} \right)
\]
80. Consider now the case where the supposed increase in \( P_s \) is achieved only through an increase in the fluid milk premium without any change in the trade measures, i.e. \( dP_m = 0 \). In this case, equation (11) becomes

\[
\frac{dX}{dP_s}\bigg|_{dP_m=0} = \frac{dX}{dP_s}\bigg|_{DPA} = \frac{\varepsilon Q_s}{P_s} - \left( \frac{dP_f}{dP_s}\bigg|_{dP_m=0} \right) \frac{\eta_f Q_f}{P_f} = \frac{\varepsilon Q_s}{P_s} - \left( \frac{1 + \varepsilon - \frac{P_m}{P_s} \varepsilon}{P_f} \right) \frac{\eta_f Q_f}{P_f} = \frac{\varepsilon Q_s}{P_s} - \left( \frac{1 + \varepsilon - \frac{P_m}{P_s} \varepsilon}{P_f} \right) \frac{\eta_f Q_f}{P_f}
\]

(13)

81. Subtracting equation (13) from (12) and re-arranging, we get the difference in trade impact due to trade measures and that due to discriminatory pricing:

\[
\frac{dX}{dP_s}\bigg|_{\text{trade}} - \frac{dX}{dP_s}\bigg|_{\text{DPA}} = \theta \cdot \left[ 1 - \left( \frac{\eta_m}{\eta_f} \right) \left( \frac{P_f}{P_m} \left( 1 + \eta_f \right) - \eta_f \right) \right] \left( \frac{Q_d^m}{X + Q_d^m} \right)
\]

(14)

where \( \theta \) is defined as

\[
\theta = \frac{\eta_f Q_f}{P_f Q_f} \left( \frac{1 + \varepsilon - \frac{P_m}{P_s} \varepsilon}{P_f} \right) \left( \frac{Q_d^m}{X + Q_d^m} \right)
\]

It is easy to prove that: 0 < \( P_m \leq P_f \) and \( -1 \leq \eta_f < 0 \) \( \Rightarrow \theta < 0 \). Therefore whether trade measures have greater or smaller impact on the volume of trade than discriminatory pricing arrangements depends only on the value in the square bracket in equation (14). That condition can be written as
82. The propositions in (15) are illustrated in Figure A1. The straight line $Q_m^m/(X + Q_m^m) = (\eta_f/\eta_m)/(P_f/P_m)(1 + \eta_f) - \eta_f$ is the border between two critical zones. Any points on the right-hand side of that line correspond to situations where the trade effect of trade measures is greater than the trade effect of discriminatory pricing arrangements. Any points on the left-hand side of that line indicate the situations where the trade effect of discriminatory pricing arrangements is greater than the trade effect of trade measures.

Figure A1. Relative trade effects of milk price support measures

83. Since our assumptions include $(\eta_f/\eta_m) < 1$, i.e. that the elasticity of demand for fluid milk is always less than the elasticity of demand for manufacturing milk, all points must range from zero to one vertically. Horizontally, any points ranging from zero to one indicate net exporters; those exceeding one indicate net importers. Any points in Figure 2 may be divided into three cases based on the following criteria: the relative manufacturing and fluid milk prices; and the status of trade (importers and exporters).

Case 1: $X < 0$

84. This is a case of net importers and the corresponding area in Figure 2 is the right-hand rectangle area of the vertical line BC. The rectangle area is located in the right-hand side area of the border, indicating that the trade effect of trade measures is always greater than the trade effect of discriminatory pricing arrangements in the case of net importers of dairy products (in milk equivalent totals).

---

23. This is the case for major milk producing countries among the OECD, as shown in Table 2.
**Case 2:** $X > 0$ and $P_f = P_m$

85. This is a case of net exporters with no initial price gap between fluid and manufacturing milk (no initial fluid premium). In this case, it is clear that equation (15) can be simplified as

\[
\frac{dX}{DP_S}_{\text{trade}} > \frac{dX}{DP_S}_{\text{DPA}} \iff \left( \frac{\eta_f}{\eta_m} \right) > \frac{Q_d^m}{X + Q_d^m}
\]

(15′)

86. This result means that the trade effect of a trade measure is greater than that for discriminatory pricing arrangements if the ratio $(\eta_f/\eta_m)$ is less than the ratio $(Q_d^m/(X + Q_d^m))$ and vice versa. The corresponding area for the former case in Figure 2 is the area $AOC$, and the area for the latter case is the area $BCO$.

**Case 3:** $X > 0$ and $P_f > P_m$

87. This is a case of net exporters that currently have fluid premium. In this case, since $(P_f/P_m) > 1$, the denominator of the left-hand term in the equation in (15) is greater than one,\(^{24}\) resulting in the value of the left-hand term being less than $(\eta_f/\eta_m)$. Like **Case 2**, the percentage of exportation and the ratio between the two demand elasticities are key to determine the relative magnitude between the trade effect of trade measures and the trade effect of an increase in the fluid milk premium. As noted earlier, there is one other important relationship for this case — the ratio of the initial price of fluid milk to manufacturing milk. The bigger is this ratio, the higher is the possibility that the trade effect of an incremental change in trade measures is greater than the trade effect of an incremental change in the fluid milk premium.

88. The black diamonds in Figure A1 correspond to data points constructed from the milk demand elasticities, milk quantity and price data that form part of OECD’s Aglink and PEM models.\(^{25}\) These particular results correspond to observed situations of seven major milk-producing countries in the OECD in 2001: Australia, Canada, European Union, Japan, Mexico, Switzerland and the United States. Table A1 summarises the ranges of key parameters observed across those seven countries. The ratio of the demand elasticity for fluid milk to that for manufacturing milk ranges in value between 0.30 to 0.78, indicating that, as expected, the demand for fluid milk is relatively price inelastic. The ratios of the demand for manufacturing milk to the total manufacturing milk production illustrate a wide variety in the trading status of dairy products amongst those countries. The minimum value (0.31) corresponds to the situation of a significant net exporter — Australia in this case while the maximum value (2.16) refers to the situation of a major net importer — Japan in this case.

89. Results in Figure A1 reveal that, in general, a given marginal change in price support achieved using trade measures will be more trade distorting than if that increase in support were to be achieved using discriminatory pricing arrangements. However, there is clearly the possibility of the reverse happening. This situation may, as stated above, occur for a country where the share of exportation is big; the elasticities of demand for fluid and manufacturing milk are close to each other; and the initial fluid milk premium is small.

---

\(^{24}\) Substituting 1 from the denominator yields: \[\{(P_f/P_m)(1+\eta_f)-\eta_f\}^{-1}=(1+\eta_f)(P_f/P_m^{-1})\]. Our assumptions in this case make that $(1+\eta_f)(P_f/P_m^{-1})>0$.

\(^{25}\) The procedures used to obtain these data points are somewhat tedious and space does not allow their full documentation. The authors will be glad to share these, however, with interested readers.
Table A1. Ranges of values for key components of formulas determining relative trade effects

<table>
<thead>
<tr>
<th></th>
<th>( \eta_f / \eta_m )</th>
<th>((P_f/P_m)(1+\eta_f)-\eta_f )</th>
<th>((\eta_f / \eta_m)/(P_f/P_m)(1+\eta_f)-\eta_f )</th>
<th>( Q_m^d/(X+Q_m^d) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>minimum</td>
<td>0.30</td>
<td>1.00</td>
<td>0.25</td>
<td>0.31</td>
</tr>
<tr>
<td>maximum</td>
<td>0.78</td>
<td>1.29</td>
<td>0.78</td>
<td>2.16</td>
</tr>
<tr>
<td>average</td>
<td>0.49</td>
<td>1.10</td>
<td>0.45</td>
<td>1.16</td>
</tr>
</tbody>
</table>
90. As noted in the text the US Federal Milk Marketing Orders are not specifically modelled in Aglink and the pooling of revenues from manufacturing and fluid milk markets in the model is represented only at the national level. Thus the implicit fluid milk premium does not correspond to any of the actual fluid milk price premiums observed. The FMMO Class I differentials at principal pricing points are illustrated in table A2.1. Minimum prices (f.o.b. plants) for milk in fluid use are calculated by adding the Class I differentials to a manufacturing milk price. (Actual market-generated prices are typically higher in FMMO markets). The table clearly illustrates that the FMMO Class I differentials vary considerably across the United States depending on the marketing order region. The minimum Class I differentials reflect the spatial price variation as generated by Pratt, et al., which modelled the U.S. dairy industry as of 1995.

91. Aglink baseline uses the manufacturing milk and all-milk prices as reported by USDA\NASS. The Aglink baseline fluid price is calculated implicitly from USDA\NASS manufacturing milk price and all milk price as follows:

\[
\text{Fluid milk price} = \frac{(\text{all milk price} \times \text{all milk quantity} - \text{Manuf milk price} \times \text{Manuf milk quantity})}{\text{fluid milk quantity}}.
\]

Thus, there is only one implicit national fluid milk premium in Aglink. The all milk price is a weighted average f.o.b plant price, and therefore is calculated from market-generated prices, not FMMO minimum prices.
Table A2.1. Federal Milk Order Principal Pricing Points, with Class I Differential

<table>
<thead>
<tr>
<th>Federal Milk Order</th>
<th>Principal Pricing Point</th>
<th>Major City in Principal Pricing Point</th>
<th>Principal Pricing Point differential (USD/100kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northeast</td>
<td>Suffolk Co., MA</td>
<td>Boston</td>
<td>7.2</td>
</tr>
<tr>
<td>Appalachian</td>
<td>Mecklenburg, Co., NC</td>
<td>Charlotte</td>
<td>6.8</td>
</tr>
<tr>
<td>Southeast</td>
<td>Fulton Co., GA</td>
<td>Atlanta</td>
<td>6.8</td>
</tr>
<tr>
<td>Florida</td>
<td>Hillsborough, Co., FL</td>
<td>Tampa</td>
<td>8.8</td>
</tr>
<tr>
<td>Mideast</td>
<td>Cuyahoga Co., OH</td>
<td>Cleveland</td>
<td>4.4</td>
</tr>
<tr>
<td>Upper Midwest</td>
<td>Cook Co., IL</td>
<td>Chicago</td>
<td>4.0</td>
</tr>
<tr>
<td>Central</td>
<td>Jackson Co., MO</td>
<td>Kansas City</td>
<td>4.4</td>
</tr>
<tr>
<td>Southwest</td>
<td>Dallas Co., TX</td>
<td>Dallas</td>
<td>6.6</td>
</tr>
<tr>
<td>Arizona-Las Vegas</td>
<td>Maricopa Co., AZ</td>
<td>Phoenix</td>
<td>5.2</td>
</tr>
<tr>
<td>Western</td>
<td>Salt Lake Co., UT</td>
<td>Salt Lake City</td>
<td>4.2</td>
</tr>
<tr>
<td>Pacific Northwest</td>
<td>King Co., WA</td>
<td>Seattle</td>
<td>4.2</td>
</tr>
</tbody>
</table>


92. The simulations with LFP and LSP scenario prices generated consumption, production and trade levels which were compared to the baseline projections. The results are presented in Table A2.2 and Table A2.3 as percentage difference between each scenario and baseline values for production and consumption of domestic milk and dairy products. Table A2.4 presents the percentage differences between the LFP scenario and the baseline and the LSP scenario and the baseline for the world dairy product prices. The levels of net trade flows are graphically illustrated in Figure A2.1 for butter, in Figure A2.2 for cheese, in Figure A2.3 for SMP and in Figure A2.4 for whey powder. Given the marginal nature of the scenarios, the reported changes are relatively small (never above 1%), nevertheless, they clearly show the difference in the impacts the two price support measures have on the dairy markets.

Table A2.2 Percentage differences between the respective scenarios and the baseline (Consumption)

<table>
<thead>
<tr>
<th>Consumption</th>
<th>Scenario</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluid milk</td>
<td>LFP</td>
<td>0.193</td>
<td>0.189</td>
<td>0.185</td>
<td>0.187</td>
<td>0.188</td>
<td>0.190</td>
<td>0.190</td>
</tr>
<tr>
<td>Fluid milk</td>
<td>LSP</td>
<td>0.066</td>
<td>0.064</td>
<td>0.062</td>
<td>0.062</td>
<td>0.062</td>
<td>0.061</td>
<td>0.061</td>
</tr>
<tr>
<td>Butter</td>
<td>LFP</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Butter</td>
<td>LSP</td>
<td>0.192</td>
<td>0.208</td>
<td>0.205</td>
<td>0.211</td>
<td>0.217</td>
<td>0.219</td>
<td>0.217</td>
</tr>
<tr>
<td>SMP</td>
<td>LFP</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>SMP</td>
<td>LSP</td>
<td>0.308</td>
<td>0.307</td>
<td>0.296</td>
<td>0.339</td>
<td>0.391</td>
<td>0.356</td>
<td>0.354</td>
</tr>
<tr>
<td>Cheese</td>
<td>LFP</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cheese</td>
<td>LSP</td>
<td>0.168</td>
<td>0.178</td>
<td>0.166</td>
<td>0.163</td>
<td>0.165</td>
<td>0.168</td>
<td>0.167</td>
</tr>
<tr>
<td>Whey powder</td>
<td>LFP</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Whey powder</td>
<td>LSP</td>
<td>0.086</td>
<td>0.086</td>
<td>0.081</td>
<td>0.077</td>
<td>0.075</td>
<td>0.073</td>
<td>0.071</td>
</tr>
</tbody>
</table>
Table A2.3 Percentage differences between the respective scenarios and the baseline (Production)

<table>
<thead>
<tr>
<th>Production</th>
<th>Scenario</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk</td>
<td>LFP</td>
<td>-0.012</td>
<td>-0.057</td>
<td>-0.097</td>
<td>-0.131</td>
<td>-0.161</td>
<td>-0.186</td>
<td>-0.208</td>
</tr>
<tr>
<td>Milk</td>
<td>LSP</td>
<td>-0.012</td>
<td>-0.057</td>
<td>-0.097</td>
<td>-0.132</td>
<td>-0.161</td>
<td>-0.186</td>
<td>-0.208</td>
</tr>
<tr>
<td>Butter</td>
<td>LFP</td>
<td>-0.097</td>
<td>-0.167</td>
<td>-0.226</td>
<td>-0.278</td>
<td>-0.321</td>
<td>-0.360</td>
<td>-0.387</td>
</tr>
<tr>
<td>Butter</td>
<td>LSP</td>
<td>-0.049</td>
<td>-0.128</td>
<td>-0.198</td>
<td>-0.261</td>
<td>-0.315</td>
<td>-0.362</td>
<td>-0.398</td>
</tr>
<tr>
<td>SMP</td>
<td>LFP</td>
<td>-0.062</td>
<td>-0.155</td>
<td>-0.261</td>
<td>-0.360</td>
<td>-0.449</td>
<td>-0.539</td>
<td>-0.621</td>
</tr>
<tr>
<td>SMP</td>
<td>LSP</td>
<td>-0.031</td>
<td>-0.109</td>
<td>-0.212</td>
<td>-0.318</td>
<td>-0.418</td>
<td>-0.522</td>
<td>-0.619</td>
</tr>
<tr>
<td>Cheese</td>
<td>LFP</td>
<td>-0.097</td>
<td>-0.167</td>
<td>-0.226</td>
<td>-0.278</td>
<td>-0.321</td>
<td>-0.360</td>
<td>-0.387</td>
</tr>
<tr>
<td>Cheese</td>
<td>LSP</td>
<td>-0.044</td>
<td>-0.114</td>
<td>-0.171</td>
<td>-0.220</td>
<td>-0.261</td>
<td>-0.296</td>
<td>-0.322</td>
</tr>
<tr>
<td>Whey powder</td>
<td>LFP</td>
<td>-0.064</td>
<td>-0.112</td>
<td>-0.152</td>
<td>-0.187</td>
<td>-0.214</td>
<td>-0.237</td>
<td>-0.255</td>
</tr>
<tr>
<td>Whey powder</td>
<td>LSP</td>
<td>-0.029</td>
<td>-0.076</td>
<td>-0.115</td>
<td>-0.148</td>
<td>-0.173</td>
<td>-0.196</td>
<td>-0.212</td>
</tr>
</tbody>
</table>

Table A2.4 Percentage differences between the respective scenarios and the baseline (World dairy prices)

<table>
<thead>
<tr>
<th>World Prices</th>
<th>Scenario</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butter</td>
<td>LFP</td>
<td>0.066</td>
<td>0.105</td>
<td>0.117</td>
<td>0.131</td>
<td>0.137</td>
<td>0.139</td>
<td>0.138</td>
</tr>
<tr>
<td>Butter</td>
<td>LSP</td>
<td>0.167</td>
<td>0.218</td>
<td>0.218</td>
<td>0.233</td>
<td>0.240</td>
<td>0.243</td>
<td>0.241</td>
</tr>
<tr>
<td>SMP</td>
<td>LFP</td>
<td>0.020</td>
<td>0.050</td>
<td>0.072</td>
<td>0.089</td>
<td>0.101</td>
<td>0.112</td>
<td>0.121</td>
</tr>
<tr>
<td>SMP</td>
<td>LSP</td>
<td>0.069</td>
<td>0.102</td>
<td>0.112</td>
<td>0.121</td>
<td>0.130</td>
<td>0.138</td>
<td>0.147</td>
</tr>
<tr>
<td>Cheese</td>
<td>LFP</td>
<td>0.146</td>
<td>0.199</td>
<td>0.277</td>
<td>0.326</td>
<td>0.356</td>
<td>0.387</td>
<td>0.404</td>
</tr>
<tr>
<td>Cheese</td>
<td>LSP</td>
<td>0.326</td>
<td>0.326</td>
<td>0.400</td>
<td>0.435</td>
<td>0.464</td>
<td>0.493</td>
<td>0.506</td>
</tr>
<tr>
<td>WMP</td>
<td>LFP</td>
<td>0.028</td>
<td>0.056</td>
<td>0.073</td>
<td>0.084</td>
<td>0.089</td>
<td>0.093</td>
<td>0.095</td>
</tr>
<tr>
<td>WMP</td>
<td>LSP</td>
<td>0.060</td>
<td>0.108</td>
<td>0.110</td>
<td>0.114</td>
<td>0.117</td>
<td>0.119</td>
<td>0.119</td>
</tr>
</tbody>
</table>
Figure A2.1. Net exports for butter (negative for imports)

Figure A2.2. Net exports for cheese (negative for imports)

Figure A2.3. Net exports for SMP (negative for imports)

Figure A2.4. Net exports for WMP (negative for imports)

Source: OECD Secretariat
Annex 3

A description of the Aglink and PEM models

AGLINK MODEL

93. 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.

94. 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

95. 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.

96. 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.

97. 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.

98. 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, Rappeseed, 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.

99. 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.

100. 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.

101. 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

102. 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.

103. 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).

104. 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.

105. 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.

106. 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.

107. 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.

108. 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.

109. 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**

110. 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\(^{26}\). The PEM allows for a styled 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.

\(^{26}\) 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.
111. 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.

112. 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.

113. 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.

114. 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”.

115. 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.

116. 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 A3.1).

27. 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.
117. 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, $\sigma$, 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.

118. 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. 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.

119. 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”.

120. 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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28. 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.