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Long Term Trends in Agricultural Policy Impacts

Roger Martini

OECD

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Abstract

LONG TERM TRENDS IN AGRICULTURAL POLICY IMPACTS

by
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Agricultural policies have undergone reforms in most OECD countries, each choosing a different path to replace policies historically based on market price support with other forms of support deemed superior in achieving differing policy objectives. This report looks at the results of this reform in six OECD regions and concludes that while every region has seen progress, results have been uneven. The key to reform that delivers effective results is keeping the focus on reducing market price support. Reforms moving from one form of land-based payment to another offer relatively little scope for improving the impact of the overall policy set. Recent reductions in market price support are at risk of reversal if the current trend towards higher commodity prices does not continue, as much of recent progress reflects market developments and not underlying policy change.

Keywords: Agricultural policy, policy reform, indicators, protection, trade

JEL Classification: Q14, Q17, Q18

Table of contents

Tables

Figures

Boxes

Executive Summary

Traditionally, agricultural policies have been dominated by measures supporting domestic producers through market price support (MPS). The negative impacts of this approach are well known—such policies promote trade friction, distort incentives, and in many cases have proven ineffective at reaching their goals. As a result, many OECD countries have put in place reforms that change the way support is targeted and delivered, moving to a broader range of policy tools in which payments based on land in various forms have grown in importance.

How effective has this re-instrumentation of support been at improving the effectiveness and reducing the negative effects of agricultural policy? Since 1986, the OECD has measured and classified agricultural support according to an agreed set of implementation criteria in the form of the Producer Support Estimate (PSE). The PSE is an important resource in monitoring and evaluating the changes in agricultural policy over time, but by itself can measure only policy effort, not impact.

Using a new set of indicators developed on the basis of the PSE, the evidence presented in this paper demonstrates that good progress has been made in improving the efficiency and effectiveness of support and reducing its negative market impacts. With few exceptions, this progress can be seen in countries that provide a high level of support to their agricultural sectors as well as those who have historically provided less support, measured with respect to the size of their agricultural sectors.

The greatest benefits from reform come from moving from market price support to other forms of support. This is most evident in Switzerland, where a gradual process of reinstrumentation of policy away from MPS to payments not requiring production has significantly reduced the production and trade distorting impacts of agricultural policy. The same is true in the European Union, where the same swing away from MPS to payments not requiring production has taken place.

It is because the rates of MPS were high and dominating the composition of the PSE for Switzerland and the European Union that reform yields such evident benefits—there were large efficiency gains to be had. This does not mean that there was not progress in other countries where MPS was always less important. The United States and Canada show similar degrees of progress as Switzerland and the European Union when differences in the scale of support are taken into account. Mexico has made progress in improving the composition of support, but exchange rate movements during the study period complicate an overall view of the result. Korea and Japan have made the least progress in reducing the importance of MPS in overall support, with changes in those countries reflecting the evolution of the size of their agricultural sectors, exchange rates and world prices more than reforms to the way support is delivered.

While the trends in support and its effects over time are clear, there is considerable short-term variability. This is mainly due to the impact of prices and exchange rates on MPS and price-based budgetary payments. This is particularly evident in the United

States, where many important budgetary policies depend in part on prices. World prices for commodities trended higher in 2008, reducing the implicit support provided by MPS in many countries. Should world prices fall, and many have already retreated from their 2008 highs, some of the measured progress may prove temporary as calculated MPS rises.

While the objectives of agricultural policies are diverse and not always focussed on farm income, the results of this study show that it is possible to reduce the level of support and the amount of market distortions it provokes without reducing the amount of income transferred to producers. Achieving this re-instrumentation in practice requires substantial changes in the composition of support. In particular, substantially reducing the importance of MPS seems to be a necessary part of the reform process if significant gains are to be realised.

Introduction

Agricultural policies, their objectives, rationale and implementation in OECD countries have undergone significant change in the past two decades. While falling relative to the size of the agricultural sector, the support provided by these policies continues to have an important impact on production, trade and farm income in most OECD countries and can influence the decision-making and well-being of farmers in a number of different ways. The OECD Producer Support Estimate (PSE) has been tracking in level and composition changes in support since 1986. But the PSE is not by itself an indicator of the distortions imposed by policies, or their impact on the well-being of the various actors in the agricultural economy.

For the evaluation of policy to be effective and useful requires some means by which policies may be measured and compared among countries and over time. In addition to the Producer Support Estimate, the OECD produces many derivative indicators that while not in themselves indicators of market distortion are useful in tracking agricultural policy developments over time and making comparisons among countries. Two of the most relevant are the Nominal Assistance Coefficient (NAC) and the Nominal Protection Coefficient (NPC). The NAC is the ratio of total farm revenues, inclusive of support, to the total farm revenue obtained with the same farm output valued at reference prices at the border. The Nominal Protection Coefficient (NPC) is the ratio of the average producer price and the corresponding reference price. The main distinction between these two indicators is that the NAC reflects all financial transfers from consumers and taxpayers to producers while the NPC reflects only those transfers from consumers and taxpayers that directly increase the producer price.

Discussing how to improve measures of support, Josling (1993) points out the inevitability of using economic models (implicitly or explicitly) in evaluating agricultural policy. He argues however, that models are most effective in analyses that begin by clearly defining the indicators of the specific policy effects, e.g. trade, income, environment, etc., which one wishes to measure. By emphasising definitions first, the focus is shifted from the technique used to generate an indicator to that which the indicator is intended to measure. Starting with indicators of policy effects that have a clear and widely agreed upon interpretation leads to more productive discussion and debate about which methods of calculation or models are best suited to the job of measuring them. This is compared with measures that may have a well-known and agreed upon method of calculation but allow for many interpretations of what they mean. In Josling’s view uniformity of approach to measuring an indicator is seen to be much less important than being specific and clear as to its meaning.

Anderson and Neary (1996) have proposed an indicator, the Trade Restrictiveness Index (TRI), defined as the uniform tariff that is equivalent in welfare terms to the protection provided by a given set of varying trade policies. The TRI is an example of a Josling type “fixed definition” indicator, being explicitly a measure of a welfare-equivalent uniform tariff, a measure for which there are clearly alternative means of calculation. Anderson and others have used the TRI and its variations as an alternative to average tariff measures as well as a means of indexing domestic taxes and subsidies. Key virtues of the TRI are the clarity of its interpretation—a welfare-equivalent uniform tariff—and its respectability owing to its firm basis in welfare theory.

One of the difficulties in using the TRI in practice is the requirement for a general equilibrium model calibrated over a long time series and covering a range of interesting countries in order to carry out the analysis. Few studies cover simultaneously a large number of countries (Kee, Nicita and Olarreaga, 2008) and a large number of years (Anderson, Bannister and Neary 1995). To deal with this, Lloyd, Croser and Anderson (2009) describe an approach that uses simplifying assumptions on supply and demand elasticities to derive a TRI that can be calculated as mean of order two of average producer and consumer price distortions, eliminating the need for a model[1]. This approach is a step beyond simple average tariffs, but the restrictiveness of the assumptions behind its calculation limits its usefulness. In particular, it does not account for varying supply responses emanating from changes in the structure of protection. This report overcomes these shortcomings by applying a model allowing a complex system of supply and demand as well as providing results for a significant time series and for many countries.

The analysis in this paper applies Josling's principle of fixed-definition measures, using the basic approach of the TRI, but adding several different indicators of policy effects. It takes advantage of the detailed PSE data classified into different support categories according to the way the associated policy is implemented. The analysis is undertaken using the OECD's Policy Evaluation Model (PEM), a partial equilibrium model of selected agricultural markets, designed to take into account both the level of transfers to producers and their composition in terms of policy categories (OECD, 2001). Using the PEM allows the development of model-based indices covering the 23-year period between 1986 and 2008, for six OECD countries plus the European Union. Three different choices for the construction of a fixed-definition measure using a TRI-like approach are explored: 1) producing equal increase in farm income 2) resulting in the same production level and 3) resulting in the same volume of net trade. The results for each are then compared with the PSE, the %PSE, the NAC and the NPC.

Model-based approaches are by nature simplifications of reality. The role of the model is to estimate the effect of the current policy mix in selected OECD countries and selected commodities on incentive prices in the relevant output and input markets. As such, it does not reflect the other ways by which agricultural policies may affect producer decisions. This is not a criticism; it is simply drawing attention to the fact that the indicators developed here measure a certain scope and type of effect of policies and no more.

The analysis shows that the approach taken here can provide improved measurement of the effects of support compared with other OECD indicators. All of the countries studied show progress in reducing the impact of their policies on markets. The European Union and Switzerland in particular have put in place reforms that improve market openness without reducing the amount of income transferred to farmers by agricultural policies.

1. A mean of order two is defined as $\overline{X} = \left[\sum_n w_i x_i^{\,2} \right]^{1/2}$ where w_i is an appropriate weight (such as 1/n).

OECD measures of support to agriculture

Since the mid-1980s, measuring support provided by farm policies has been one of the flagship activities of OECD work on agriculture. The analytical backbone of this OECD activity is the PSE. The PSE can be expressed in monetary terms (PSE**)**; as a ratio of the value of total gross farm receipts, measured by the value of total production (at farm-gate prices), plus budgetary support (%PSE**)**; a ratio between the value of total gross farm receipts including support, and production valued at world market prices without support (Nominal Assistance Coefficient, or NAC); or a ratio of the average price received by producers, including support based on commodity output, and the border price (Nominal Protection Coefficient, or NPC).

While the %PSE and the NAC are complementary measures that always move in the same direction, the %PSE is relatively sensitive to changes in support levels when support is low relative to receipts, whereas the NAC is relatively sensitive to changes in market receipts when support is high. Using both can be helpful in understanding changes in policy support over a broad range of support levels.

The %PSE is the share of the PSE in total receipts, and so measures the ratio of the PSE to total receipts, including support:

$$\%PSE = \frac{PSE}{Q \cdot P_b + PSE} \qquad (1)$$

where Pb is the border (reference) price. The PSE includes Market Price Support (MPS). The %PSE approaches the value of 1 as the PSE gets large relative to receipts. When the PSE is large relative to market receipts, changes in the PSE will move the %PSE by a relatively small amount as the change in PSE impacts both the numerator and denominator of the ratio that defines the %PSE. As a result, the %PSE is relatively insensitive to PSE changes when the PSE is significantly larger than market receipts. For example, a %PSE value of 75% indicates a situation where the PSE is three times the level of market receipts. This was approximately the case in Switzerland in the 1986-88 period. To reduce the %PSE from 75% to 66%, nine percentage points, which reflects the situation for Switzerland in 2004-06, either the PSE has to reduce by half, or market receipts must increase by 50%.

The NAC is the extent to which receipts come from the marketplace and so measures the ratio of total receipts to market receipts:[2]

$$NAC = \frac{Q \cdot P_b + PSE}{Q \cdot P_b} \qquad (2)$$

The NAC approaches a value of 1 as the PSE grows small relative to market receipts. When the PSE is large relative to Y, changes in the PSE will affect the NAC approximately linearly, but changes in market receipts can affect the NAC asymptotically (consider the denominator of the equation to see why this is so). For example, for the same situation described above where the PSE is three times the level of market receipts (%PSE=75%), the NAC has a value of 4, reflecting a situation where total receipts are 400% the market receipts. Increasing market receipts by 50% would reduce the NAC to 3, a reduction of 100 percentage points and 25% of the value of the indicator.

2. The NAC can also be expressed as 1/(1-%PSE).

When the producer NAC is equal to one, gross farm receipts are entirely derived from the market. The higher is the producer NAC, the lower the share of gross farm receipts derived from the market This can be seen as an indicator of market orientation, i.e. the degree of influence of market signals (relative to those from government intervention) on agricultural production decisions. In the case of the NPC:

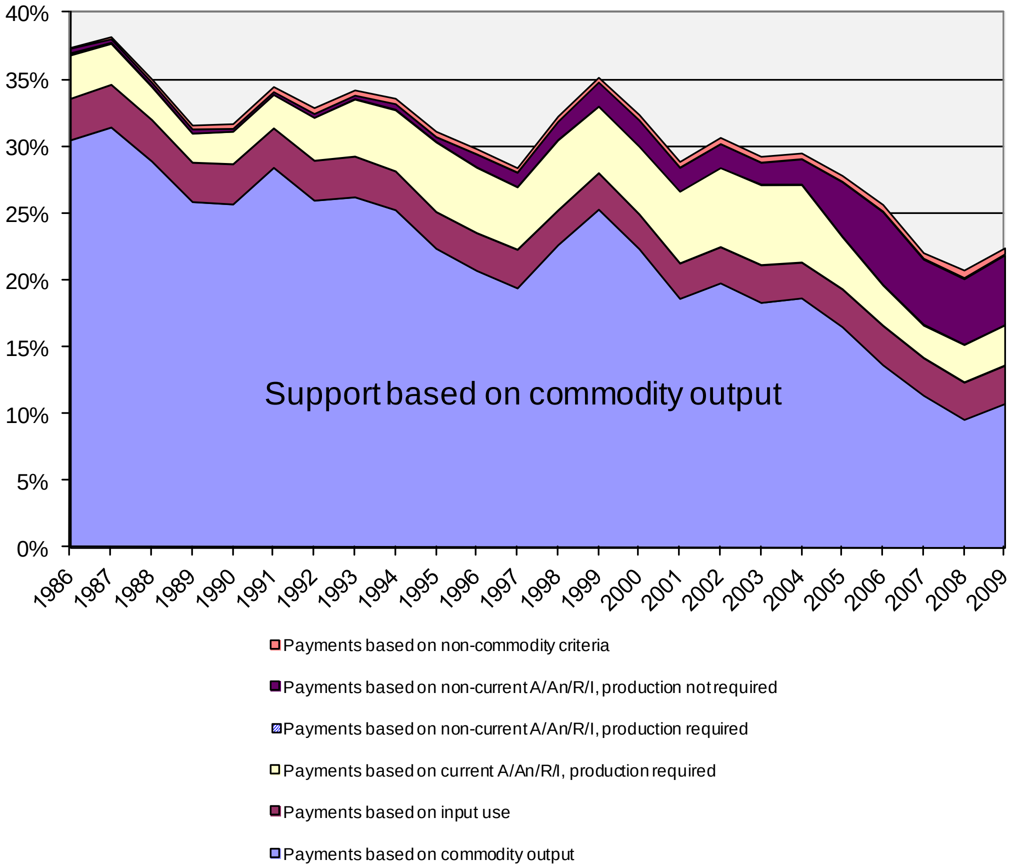
$$NPC = \frac{P_p + PO/tonne}{P_b} = \frac{(P_p - P_b) + PO/tonne}{P_b} + 1 \qquad (3)$$

where PO is payments based on commodity output, a value of 2 would show that the price received by farmers is twice the border price. The NPC can be seen, therefore, as an estimate of the nominal rate of market protection for producers. The NAC includes all forms of support, while the NPC only those forms that influence the price received by the producer.

It has been argued that the PSE does not properly reflect changes in agricultural policies and in particular their effects on production and trade. In this context, concern has been expressed in countries that have engaged in reforms of their agricultural policies, by changing the nature of the instruments used, that the PSE as a measure of total transfers to agriculture does not take the market and trade effects of such reforms of the policy mix sufficiently into account. To respond to this, the OECD has over time increasingly emphasized the composition of the PSE according to its various policy categories, and any changes that may have taken place in that composition. The resulting categorization of support shows the changes that have taken place over time (Figure 1). Support based on commodity output has declined greatly as a share of the total PSE as other forms of support have grown in importance. This change in composition is as important to understanding the potential impact of support on markets as is the level of the PSE.

Figure 1. Composition of support in the OECD

in per cent of gross farm receipts



A/An/R/I= Area, Animal Numbers, Receipts, or Income.

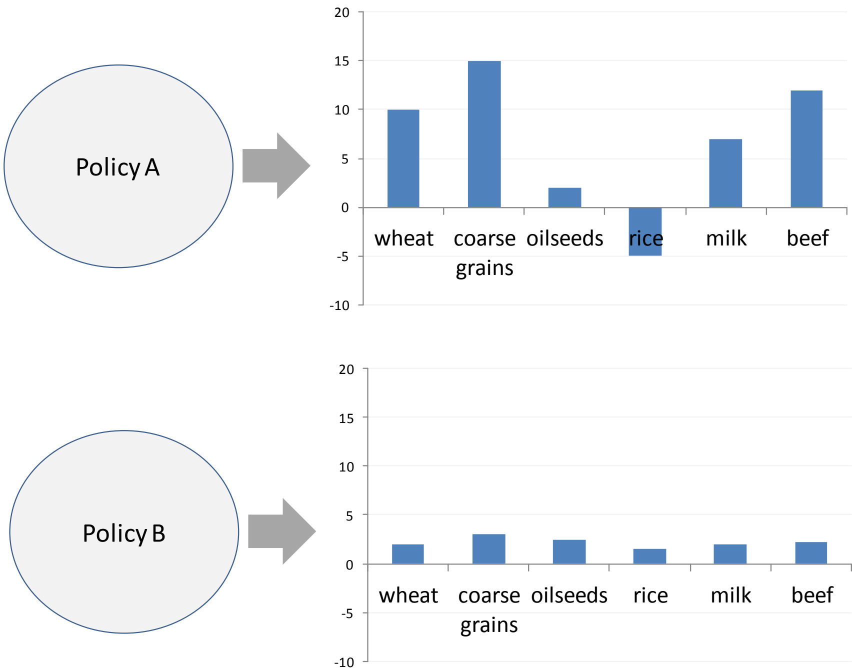
Source: OECD, PSE/CSE database 2010

Combining the information contained in the composition of the PSE with that contained in the level of the PSE to produce a "composition-adjusted" PSE would enable a clearer understanding and analysis of the evolution of support over time. Existing measures such as the NAC tell us something about the level of support but do not and are not intended to indicate the impact of support. As the effect of support is the usually of greater interest than its level, the lack of precision in the interpretation of the NAC increases the potential for its misuse. The method developed in this paper produces a "composition-adjusted" PSE, which may be used to derive indicators similar to the NAC and NPC but with an improved ability to measure the effect of policies on production, trade and welfare.

Method

Consider two policies, A and B, which have different impacts on production as estimated by the model (Figure 2). The different impacts will have to do with the level of support provided by each policy and how they are implemented. For example, Policy A may be deficiency payments offered to different commodities at different rates. Policy B may be a broad payment to all farms, perhaps not requiring production. How do we compare the effects of these two polices? Policy A has a generally larger impact, but not always, and in some cases may have a negative impact. Policy B has a generally smaller but more uniform impact.

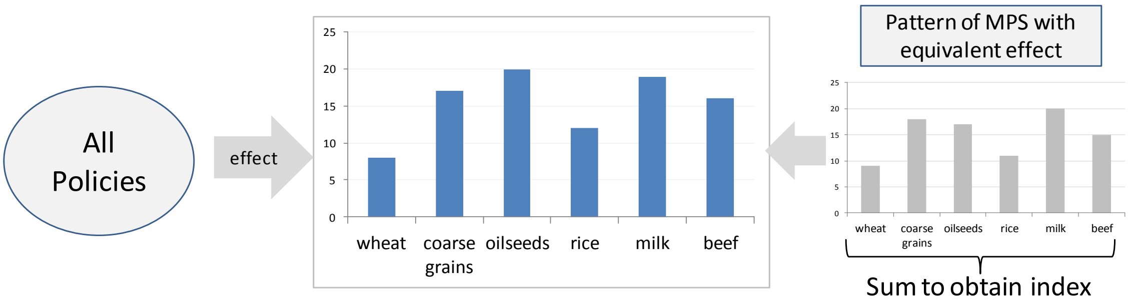
Figure 2. Hypothetical impacts of two policies



Formal comparison requires a way to describe the patterns of impact shown in Figure 2 in a way that is consistent for all years and all countries. The approach taken here is to choose another policy to become a yardstick for comparison, and determine how that policy must be applied to reproduce the same pattern of impact as for Policy A (or B). For example, the amount of MPS can be found that, when applied to wheat will have the same production impact on wheat as does Policy A, the amount of MPS for coarse grains, and so on. This yields a quantity of MPS for each commodity such that, when applied in the model, results in the same pattern of production as was the case for Policy A. Importantly, this does not change how Policy A is represented in the model nor its effect—it is simply a means to characterise the outcome of the policy. If this process is repeated for Policy B, then the amount of MPS required to reproduce its impact versus that for Policy A becomes a way of comparing the two policies. That is, the greater is the amount of MPS required to replicate the effects of the policy, the larger is the estimated effect of the policy.

Now imagine that Policy A, instead of being a single policy, represents the entire policy set in the country, and the impacts shown in Figure 2 show the net impact of all the policies operating together. In this case, the overall effect is a function of both the *level* and *composition* of support as it is not made up of a single policy. The exact same procedure may be done, finding the level of MPS for each commodity such that the same overall result is obtained (Figure 3). Simply summing up the amount of MPS for each commodity yields a total level of MPS that serves as a measure of the impact of the policy set. In this case, the level of MPS is not measuring individual policies, but the effect of the whole policy set including the interactions that take place between them. This approach allows for the ex-post assessment of policies on a comparable basis over time and across countries.

Figure 3. Hypothetical policy set



This allows the key analytical questions motivating this analysis to be tackled—*"how have policies changed over time?"* and *"what has been the effect of these changes?"* First, however, the "policy effect" that is to be measured must be identified. The example above discussed the production impact, but one could choose as well trade, welfare or other possible impacts. In each case, the pattern and size of impact will be different, and therefore so will the level of MPS that reproduces it.

Since there is no level of MPS that can replicate all the different impacts of the policy set at the same time, each type impact must be calculated separately. In this paper, three indices are produced, one based on net trade, one on production and one on farm income, called respectively: *trade-impact index*, *production-impact index* and *income-impact index*.

How is the value of this index calculated in practice? The objective is to find the amount of MPS that has the same effect as the overall policy set for a particular outcome. To do this in the model, that outcome (the level or production, trade, or farm income) is held fixed. Then, all policies are simultaneously eliminated (the level of support offered by each policy is set to zero). Because a policy outcome in the model is not allowed to change in response to this policy change, the level of MPS, acting as the reference policy, must adjust so that the model remains in equilibrium at the level of production, trade, or income that was held constant. That is, as all support is removed, the level of MPS in the model adjusts to hold fixed the policy outcome of interest. How much MPS is required to do so serves as the measure of the effect of the policy set.[3]

3. In the case of production and trade, the pattern of production and trade for each commodity must be the same before and after the policy shock. Farm income in the model accrues from returns to several different inputs that are owned by the household. In order to hold constant

An advantage of this approach is that the resulting indicator is a measure of the net, joint impact of all policies in the policy set. It is not built with individual conversion factors between specific policies and MPS, and its calculation requires no change in how a policy is implemented in the model or how its impacts are interpreted. As it is calculated simultaneously, and not on a commodity-by-commodity or policy-by policy basis, it takes into account all of the interactions between policies and markets that are represented in the model. MPS is a useful numeraire because it is flexible, easily measurable, and already dominates overall support (Box 1).

Box 1. MPS as the numeraire policy

The approach being applied in calculating these indices is to replicate the effect of the full set of policies in a country through one single policy. This matches an existing PSE composed of multiple policies with a PSE composed of a single policy that has the same effect on a specific policy outcome. This second PSE is easily comparable across countries and years.

In principle, any policy may serve in calculating this second PSE. In practice, MPS has a number of advantages.

- MPS can easily replicate the pattern of impact of a policy set, not just its total impact. There is a level of MPS associated with each commodity, so the pattern of impact of the policy set across commodities can be easily reproduced by varying these rates individually.
- MPS is directly connected to outputs, and has a strong, linear impact on production. Thus it offers more robust estimates of impact than would more decoupled policies such as payments based on land, even if those were associated with particular commodities and would work in principle (see the above point).
- MPS as used in this exercise has a clear interpretation as a simple price wedge between domestic and world prices, even if MPS as actually applied in specific cases may be more complicated.
- MPS already forms the majority of support in all countries. Using MPS as the reference policy makes the results less sensitive to model parameters (as a large part of support is essentially unchanged in the process) and therefore more accurate.

As part of the PSE, MPS is calculated as a function of domestic and world prices plus adjustments, and can vary with changes in world price even absent an explicit policy change. This is relevant for the measured PSE that forms the basis of the analysis, and its implications are well known (see The PSE Manual (OECD 2009) for examples). But this does not affect the development of the indicators in this paper, as MPS here is an endogenous calculation of a price wedge using the model.

farm income, equations representing the change in producer surplus for all these elements are introduced, and their total for each commodity is held constant. Thus the distribution of overall farm income by commodity is maintained, but the distribution of the various *sources* of income may change.

Formally, the production-impact index is the amount of MPS, MPS^*, that solves the implicit equation:

$$Q_i^s(MPS, BP \mid \phi) = Q_i^s(MPS^*, 0 \mid \phi) \quad (4)$$

where Q_i^s is the quantity supplied of commodity *i*, *BP* is budgetary payments, and ϕ is a vector of other elements in the model that influence Q_i^s. In the case of the trade-impact index, the net volume of trade in the model is defined as:

$$T_i = \left(Q_i^s(MPS, BP \mid \phi) - Q_i^d(MPS, BP \mid \gamma)\right), \quad (5)$$

where quantity demanded, Q_i^d, is defined similarly to quantity supplied in equation 1. The trade-impact index is defined as the amount MPS^* such that

$$T_i = \left(Q_i^s\left(MPS_i^*, 0 \mid \phi\right) - Q_i^d\left(MPS_i^*, 0 \mid \gamma\right)\right), \quad (6)$$

holding T_i constant.

The income-impact index is the amount MPS^* that holds total producer surplus accruing from farm-owned inputs (plus quota rent) constant:

$$\sum_j PS_j(MPS, BP \mid \phi) = \sum_j PS_j(MPS^*, 0 \mid \phi) \quad (7)$$

All commodities have a "farm owned" input, all use land, which is assumed here to be owned by the farmer, the animal herd is a farm-owned input in the production of beef and milk, and milk also has quota as an element of welfare in the form of quota rent[4].

Results

As discussed above, the PSE is used to calculate a number of different indicators, each of which serving a particular purpose in presenting the data contained in the PSE. These same transformations may be made to the indices developed here, which in their basic form are essentially the same as the PSE. That is, it may be converted to different proportional measures similar to the NPC, NAC and %PSE to aid in the interpretation of results.

For example, the measure with the closest interpretation to the trade-impact index is the NPC, which measures the degree of market openness. For a group of commodities, an alternative calculation of the NPC may be obtained by dividing the value of production at domestic prices by the value of production at border prices for each commodity. This can be expressed as:

$$NPC = \frac{\sum_i Q_i P_i + MPS_i + PO_i}{\sum_i Q_i P_i} \quad (8)$$

4. The assumption that land is owned by farmers is a simplifying one that aids comparisons across countries. In some countries, virtually all land is owned by farmers, while in others, rental of land forms a significant share. What is uncertain is 1) whether landowners are targets of policy or not, and 2) of the land that is rented, what proportion of the landowners are themselves farmers or others that are targets of agricultural policies?

for any aggregate of commodities, where P_i is the border price, Q_i is the level of production, and MPS_i and PO_i are transfers due to market price support and commodity output support, respectively. The trade-impact index can be converted into a comparable measure by expressing it in *ad valorem* form (that is, as a percentage of the value of production):

$$\text{trade-impact ad-valorem index} = \frac{\sum_i Q_i P_i + MPS^*_i}{\sum_i Q_i P_i} \qquad (9)$$

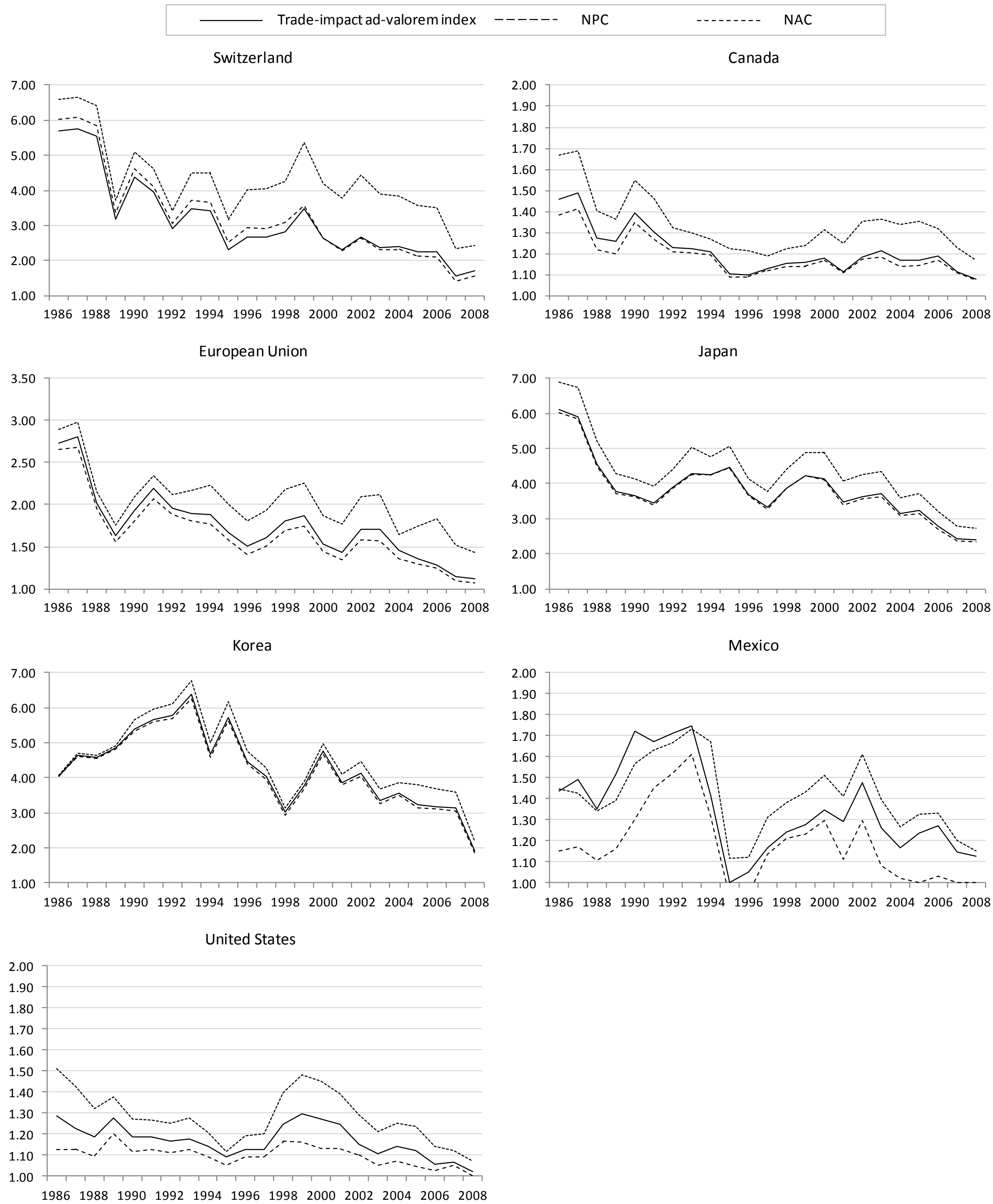
The resulting measures are shown along with the NPC and NAC, which have a similar *ad valorem* interpretation (Figure 4). The trade-impact index in *ad valorem* form is expected to fall between the NAC and the NPC. Why? The NPC includes only those policies which directly influence producer price. The NAC includes all policies, weighting them all equally, see equation (2). The trade-impact index includes all policies, but with an adjustment that expresses the result in terms of MPS, one of the most distorting forms of support. Therefore, the trade-impact *ad valorem* index should in most cases lie above the NPC as it contains additional policies that do have some impact on producer price (and therefore trade), and it should lie below the NAC because it weights these policies according to the degree to which they affect prices and trade.

Think of the distance between the NAC and the NPC as the measure of uncertainty of the effect of domestic budgetary policies on trade. If domestic policies do not affect trade at all, the NPC is a complete measure of trade impact of policies. If domestic policies impact trade in the same manner as MPS, then the NAC measures the trade impact of policies. The trade-impact *ad valorem* index resolves this uncertainty by identifying the point of equivalency of MPS and other domestic policies, showing whether domestic policy is more or less equivalent to MPS, and how that changes over time as the policy mix changes.

The PEM contains representations of major cereal and oilseed crops, milk and beef only. Support to other commodities not mentioned is not included, and in some cases this can have an impact on the results. In addition, it omits some categories of policies in the PSE, such as those based on non-commodity outputs, or some payments with associated input constraints. The “Modelled PSE” contains Single Commodity Transfers (SCT) for included commodities, Group Commodity Transfers (GCT) to grains, all crops, and livestock (GCT1, GCT3 and GCT8), and All Commodity Transfers (ACT). This omits for example SCT for pork, poultry, eggs and sugar. The Annexes contain more detail on this element of the PEM.

Omitting policies from the PEM because they have associated input constraints or similar complications is justified because the net effects of these policies cannot be deduced simply through the price wedges in markets that are used in the model. Leaving these policies out of the model is analogous to assuming that these policies have no impact on production, trade, or welfare. Omitting these policies could impart an under-estimation in the results; that is, the impact of the whole policy set is greater than reported here. In contrast, it could also be the case that there is an over-estimation in the results, for example when policies included in the model have cross-compliance restrictions that place constraints on producers. In particular, the EU Single Payment Scheme has certain cross-compliance restrictions that have the effect of reducing the impact of the policy.

Figure 4. Trade-impact *ad valorem* index, NPC and NAC, 1986-2008



Each chart in this figure has a different scale for the vertical axis. While this improves the visibility of changes over time for each country, it can make comparisons of absolute magnitude across countries difficult. In particular, note that Canada, the United States and Mexico are on the same (low) scale with values between one and two, while Switzerland, Japan, and Korea are on the same (high) scale, with values between one and seven. The European Union is on a scale in between these two.

Source: OECD Policy Evaluation Model.

The trade-impact index is trending downward for all countries studied. This reflects reforms reducing the overall trade distortiveness of the policy set (in particular in Switzerland and the European Union[5]), and lower overall support relative to the size of the sector. The trade-impact *ad valorem* index tracks the NPC more closely than the NAC in most cases. An exception is the United States, where budgetary payments are relatively important, in particular around the year 2000, and which pull the trade-impact index upward in those years[6]. Overall for the United States, the trade-impact *ad valorem* index rests approximately one third of the distance between the NPC and the NAC until 2006, after which it approaches more closely the NPC. Lower Loan Rate payments seem to be behind this shift as higher prices reduce the impact of this program.

The trade-impact *ad valorem* index for Switzerland and Canada is low relative to the NPC, and lies below it in many years. In these countries, several facts taken together help to explain this result. Support in both countries is dominated by MPS for milk (this is more strongly the case for Canada), meaning that what happens in the milk sector strongly influences the results. Both countries have milk quota systems in place for most of the study period (Switzerland has been reforming its quota system over time). Quota systems limit production (and in Canada are maintained through a binding import tariff-rate quota (TRQ)), such that higher levels of MPS will not induce increased production (Box 2).

The trade-impact index replicates the trade impact of all policies, including quota restrictions, with MPS. Quota restrictions reduce the trade distortions normally associated with MPS, leading to a lower reported trade impact for the overall policy set, which may even lie below the NPC. The NPC, which measures price protection, provides an incomplete view of the trade impact of policies as it cannot take into account other market interventions such as quota systems.[7]

How important is the effect of quota in reducing trade distortion of the associated MPS? Comparing the trade-impact index calculated either including or excluding the effect of the quota system can help answer this question. The impact of dairy quotas on the trade impact of the policy set is most dramatic in Canada, reducing the trade-impact index by an average of almost 20% (Figure 5). The quota system has a less dramatic impact in Switzerland and the European Union, where milk forms a smaller share in total support.

5. For consistency over the time period, policies unique to the new member states (EU-12) are not included in the analysis. In practice, this makes little difference in the results.

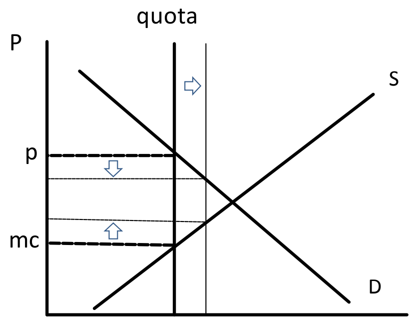
6. What would cause the trade-impact *ad valorem* index to be closer to the NAC? High levels of deficiency payments or payments based on variable input use would be more distorting and therefore “weight” higher in the calculation of the trade-impact index, raising its value and bringing it closer to the NAC. Other kinds of market distortions such as production-restricting quotas can have large impacts but do not have direct budgetary impacts. These policies can influence the index, to the point where it could lie outside the range defined by the NPC and the NAC.

7. This is not to conclude that quota policies are a good idea. Quotas enable high levels of price support by reducing the need for export subsidies and ensuring compliance with trade rules. The cost of this is a deeply distorted market where price does not equal cost and the difference becomes built up in quota rents. Quotas may reduce production and trade effects, but at the cost of highly inefficient markets. See OECD (2005) *Dairy Policy Reform and Trade Liberalisation*.

The production-impact index in most cases looks very similar to the trade-impact index. This is because the difference between the production and trade impact of a given policy depends mainly on the way they impact domestic consumption. If two policies are equally production distorting, any difference in how they affect trade will come down to how they impact domestic consumption. In particular, MPS and payments based on commodity output have the same impact on producer prices and production, but MPS has the additional effect of increasing domestic prices paid by the consumer, and so dampens domestic consumption. As a result MPS is more trade-distorting than payments based on commodity output, though a given level of support provided by the two policies will have similar production effects.

Box 2. Milk quota in PEM

Quota systems specify an allowable production level that, to be relevant, must be less than the desired level of production at the prevailing price (see box figure). If production is below the desired equilibrium level, the marginal cost of production must be less than the market price. Increasing the production limit will lead to increased production at a lower market price and higher marginal cost, eroding the difference between price and cost (quota rent). At the point where the price and marginal cost are equal, the quota level is no longer relevant as producers no longer wish to increase production and the market is in equilibrium.



The equations that deal with this for the European Union and Switzerland in the PEM is a simple logical condition that tests whether the market is in equilibrium or not:

IF Price > marginal cost, THEN Production = Quota level, OTHERWISE Price=marginal cost

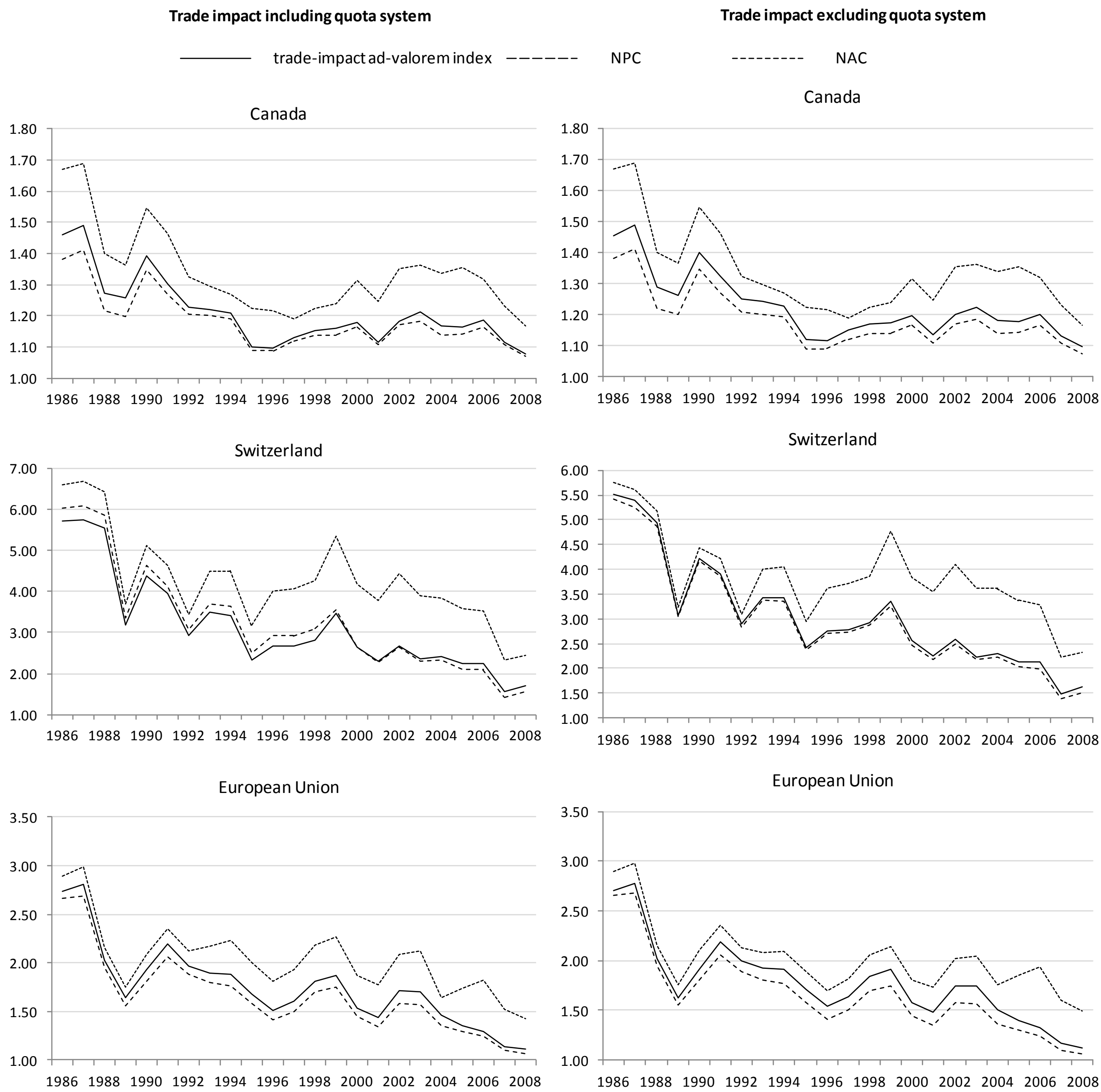
The model is initially calibrated such that price exceeds marginal cost according to a quota rent parameter and the quota level is a policy variable to be set. If price is greater than marginal cost, quota is binding and the quota level determines production. If price equals marginal cost, quota is not binding and the P=MC equilibrium condition determines the production level. In the case of Canada, quota is associated with binding TRQ levels so the full set of conditions are:

IF Price > marginal cost, THEN Production = Quota Level, Trade = TRQ level, producer price = fixed value (no price transmission), OTHERWISE P=MC, Trade=QP-QC, P=WP+MPS.

In calculating the Index, the condition P=MC is forced to hold everywhere, eliminating the relevance of the quota and allowing a full market equilibrium to hold.

The production-impact *ad valorem* index should lie above the trade-impact *ad valorem* index in most cases, and it should not correspond to the NPC quite as well as did the trade-impact *ad valorem* index (Figure 6). The production-distortiveness of policy in Switzerland has declined more rapidly than has trade distortiveness. In other countries, the difference between the two indices is not large. This lends support to the idea that the distinction between production or trade "Market distortion" does not add much to the policy debate.

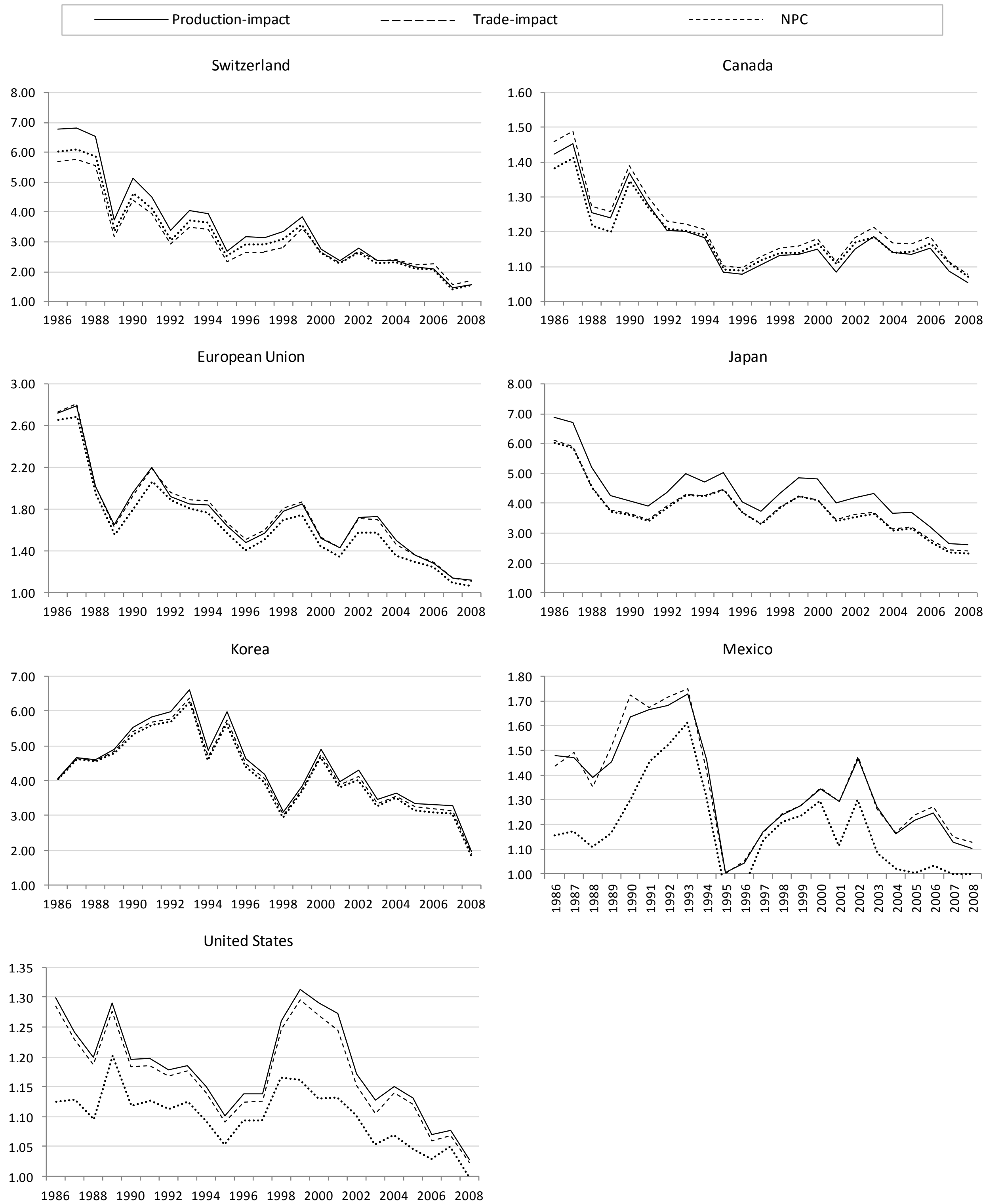
Figure 5. Effect of quota restrictions on trade



Source: OECD PEM model.

Figure 6. Production-impact, trade-impact and NPC, 1986-2008

Ad valorem index



Source: OECD Policy Evaluation Model.

The PSE measures transfers to producers from consumers and taxpayers, recognising that such transfers are not equally nor entirely effective at increasing the income of farm households.[8] Suppliers can capture most of the benefits accruing from subsidies to inputs such as fuel or fertiliser, and in general the greater the production distortion caused by a policy, the less efficient is that policy in transferring income to producers. Previous work using the PEM model has indicated that this difference in efficiency can exceed a factor of two for commonly used agricultural policies, and in particular MPS (the policy that is the basis of the measure developed here) does a poor job at generating income for producers (OECD 2005).

Putting the income-impact index into *ad valorem* form allows comparison again with the NPC and NAC. As long as payments based on input use do not form a significant portion of total support, the income-impact tariff-equivalent should lie above both the NPC and the NAC. This is again due to the fact that MPS, upon which the index is based, is generally less efficient at transferring income, and so a greater amount is required to obtain the same level of income as the existing policy package.

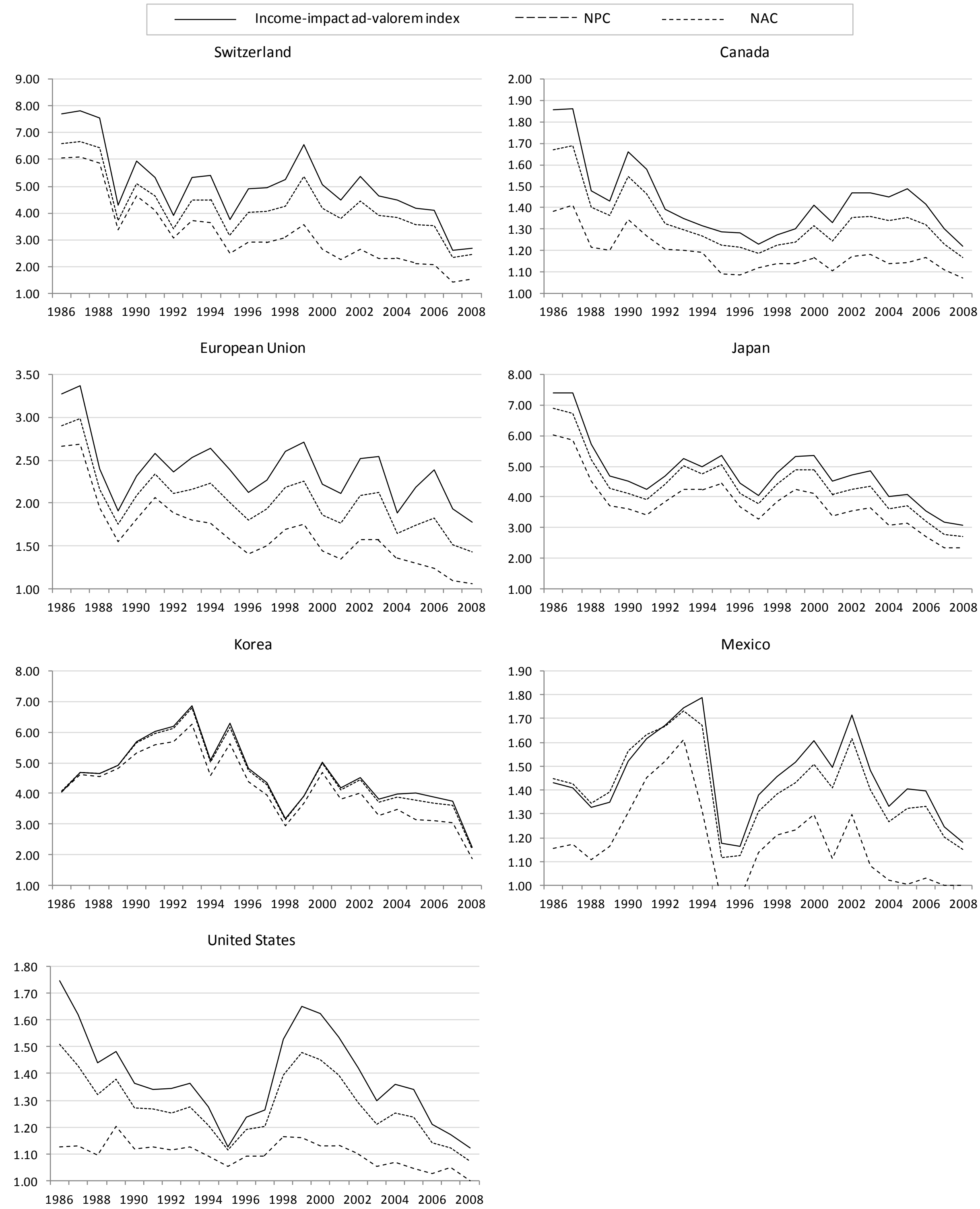
The income-impact *ad valorem* index measures the implicit transfer efficiency of the policy set by measuring its impact on farm household income. Where the trade-impact *ad valorem* index was compared with the NPC, the NAC is a more natural basis of comparison for the income-impact *ad valorem* index. It will typically exceed the NAC, and the extent to which it does so is a function of the transfer-efficiency of the policy set. As a limit case, the income-impact *ad valorem* index will coincide with the NAC when the transfer efficiency of the policy set is equal to the transfer efficiency of MPS. Similarly, when comparing the income-impact index with the PSE, it should in general exceed the PSE, and a greater divergence indicates greater transfer efficiency of the existing package of support measures. In this way improvements in the transfer efficiency of policies over time can be evaluated.

There is some evidence that re-instrumentation of policies have improved their effectiveness in improving farm incomes. In the European Union, the income-impact *ad valorem* index has been stable over most of the study period, having value in 2008 essentially the same as for 1989, even though the NAC has declined significantly, from 1.75 in 1989 to 1.5 in 2008, or 25 percentage points. In all the other study regions, the index has declined to varying degrees (and with much variability) over the study period. In the United States, disaster payments made in the early 2000s raise the income-impact *ad valorem* index, and to a greater extent than the increase in the NAC as these payments are highly transfer efficient and formed a significant share of support in those years. The same occurred in Canada, where a series of disaster payments made between 2002 and 2005 drive up the index.

In Korea and Japan, MPS makes up a large share of support, so the index tracks the NAC quite closely. This is also true in Switzerland, where the share of MPS in support has been declining and headage payments (a relatively distorting form of support) to livestock are relatively important. Results for Mexico are strongly influenced by changes in MPS driven by movements in the exchange rate.

8. Nor is it always the point of agricultural policies to do so. Nevertheless, understanding what proportion of transfers is turned into farm income is an important part of policy evaluation.

Figure 7. Income-impact *ad valorem* index, 1986-2008



Source: OECD Policy Evaluation Model.

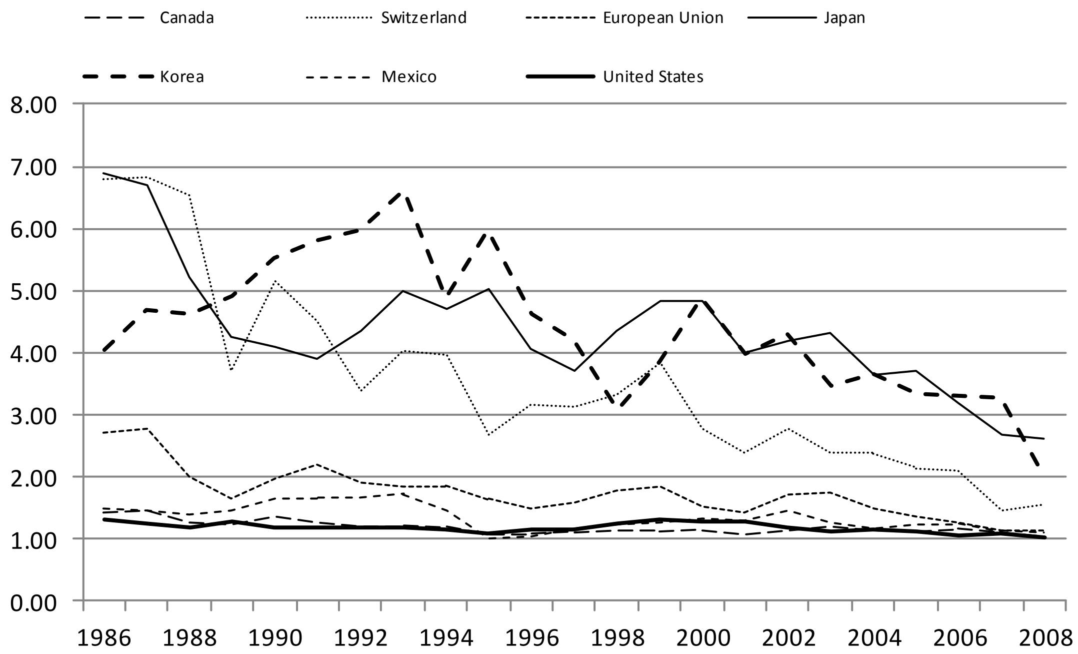
Although market price support is generally seen to be more production distorting and less transfer efficient than other forms of support this is not always the case in every year. Simulated results for Mexico illustrate this point. The income-impact index and PSE for the commodities represented in the model for Mexico reflect the fact that support to crop producers in Mexico in the early 1990s was dominated by input support, and for that period the income-impact index lies below the NAC (Figure 7). Policy reforms in 1994 that introduced the PROCAMPO program altered the composition of support with payments based on non-current area not requiring production becoming the dominant component of the PSE, increasing the efficiency of the total policy package in transferring income, and resulting in an income-impact index greater than the NAC after 1994. The large trough in support centred on 1996 reflects the impact of the devaluation of the Peso on the level of support provided by MPS policies.[9] The continued importance of MPS in total support to agricultural producers in Mexico is reflected in the degree to which the two measures of support track each other.

Comparing the production-impact indices for all seven PEM regions shows a noticeable degree of convergence, even though differences between high- and less-supporting countries remain (Figure 8). The measured production distortion of polices in the European Union has decreased to an amount comparable with the United States, Canada, and Mexico, which are grouped together, having generally lower levels of measured distortion. Switzerland, Japan, and Korea have also reduced the overall impact of their policy sets on production, though Switzerland seems to have made more progress in this regard, having improved the composition of support to a greater degree than have Japan or Korea, whose declines have more to do with lower overall PSE levels.

Taking a look by comparison at the income-impact indices, the evolution of policies becomes a bit more clear (Figure 9). While the amount of production distortion induced by policy has been reducing, the amount of income transferred has been much more stable, in particular for the European Union and Switzerland. This suggests that these countries have been successful in restructuring their agricultural policies to be less production distorting without sacrificing the objective of supporting farm income.

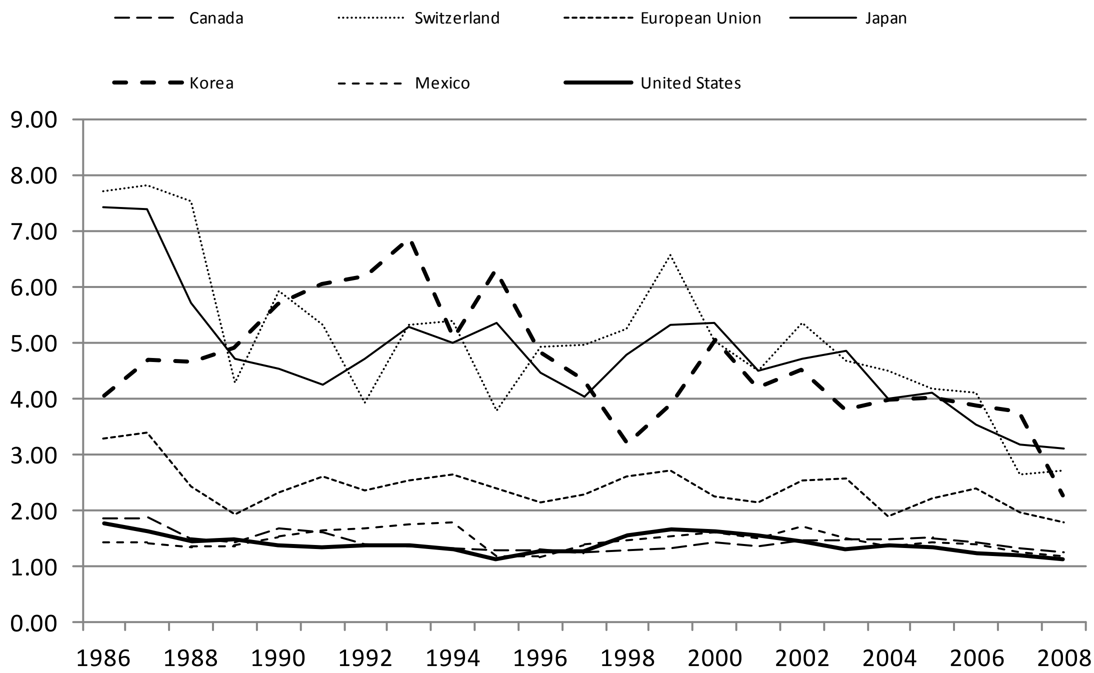
9. In fact, devaluation caused MPS for several commodities in Mexico to be negative in 1996. The PSE remained positive as it also includes budgetary polices.

Figure 8. Production-impact *ad valorem* index by country, 1986-2008



Source: OECD Policy Evaluation Model.

Figure 9. Income-impact *ad valorem* index by country, 1986-2008



Source: OECD Policy Evaluation Model.

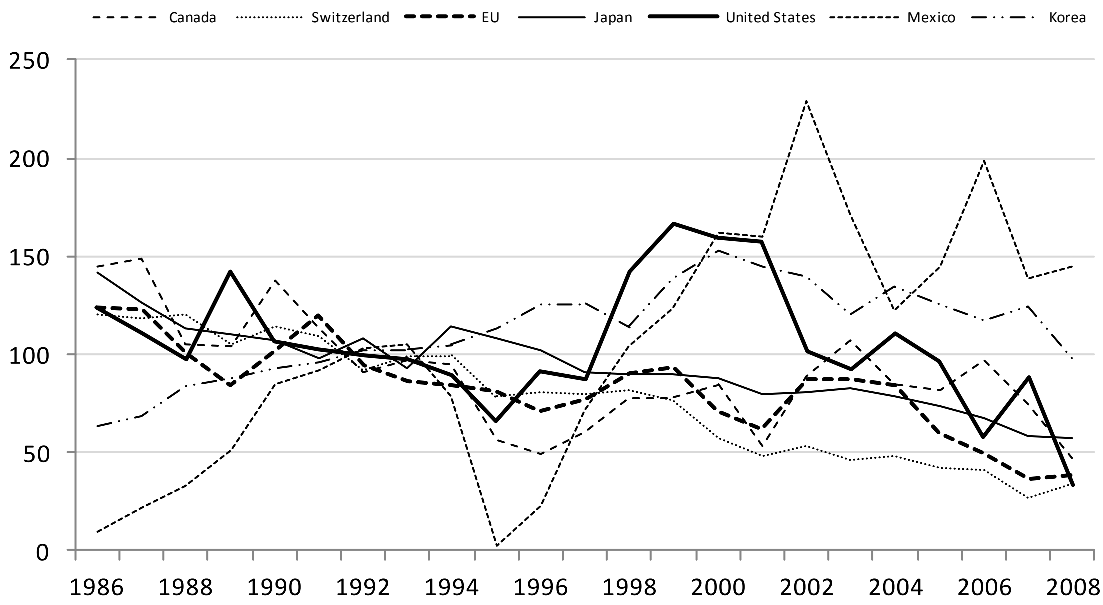
The trend in the income-impact indices does not say very much about the trend in producer income, just the impact of policies on farm income. For example, for Korea the income-impact *ad valorem* index drops significantly in 2008 as a result of higher world prices for rice lowering measured MPS. So the proportion of income received by producers from the marketplace likely increased as transfers from policy decreased.

Figures 8 and 9 compare the different scale of impact between countries; as *ad valorem* indices they relate the size of the production or income impact to the size of the sector. Since the scales of impact are so different across countries, it is difficult to compare the progress in policy reform in each country relative to each country's initial situation. Such an internal measure of progress in policy reform can be constructed by rescaling the indices such that a base period = 100. This index expresses only relative changes with no size component and is best suited to assess reform progress over time. This was done for the production-impact index using the (average of the) period 1991-1993 as the base period.

The results indicate that, relative to the situation in the base period, most countries have made fairly similar and consistent progress in reducing the production impact of support (Figure 10)[10]. In this view, the production effect of the policy set in the United States in 2008 was only 33% that of the early 1990s base period, the lowest of all countries studied. The rate of reduction in production impact between the United States and Switzerland is very similar, even though the magnitudes of support as shown in Figure 8 are quite different.

Figure 10. Production-impact index by country, 1986-2008

1991-93=100



10. A note of caution: 2008 was a year of particularly high prices for commodities globally, the effect of which was to reduce measured MPS considerably relative to previous years. Since then, prices have moderated and the sharp declines between 2007 and 2008 are expected to reverse somewhat in 2009, which is outside the study period.

Results for Mexico and Korea are significantly affected by exchange rate movements over the study period that makes drawing conclusions about the overall trend difficult.

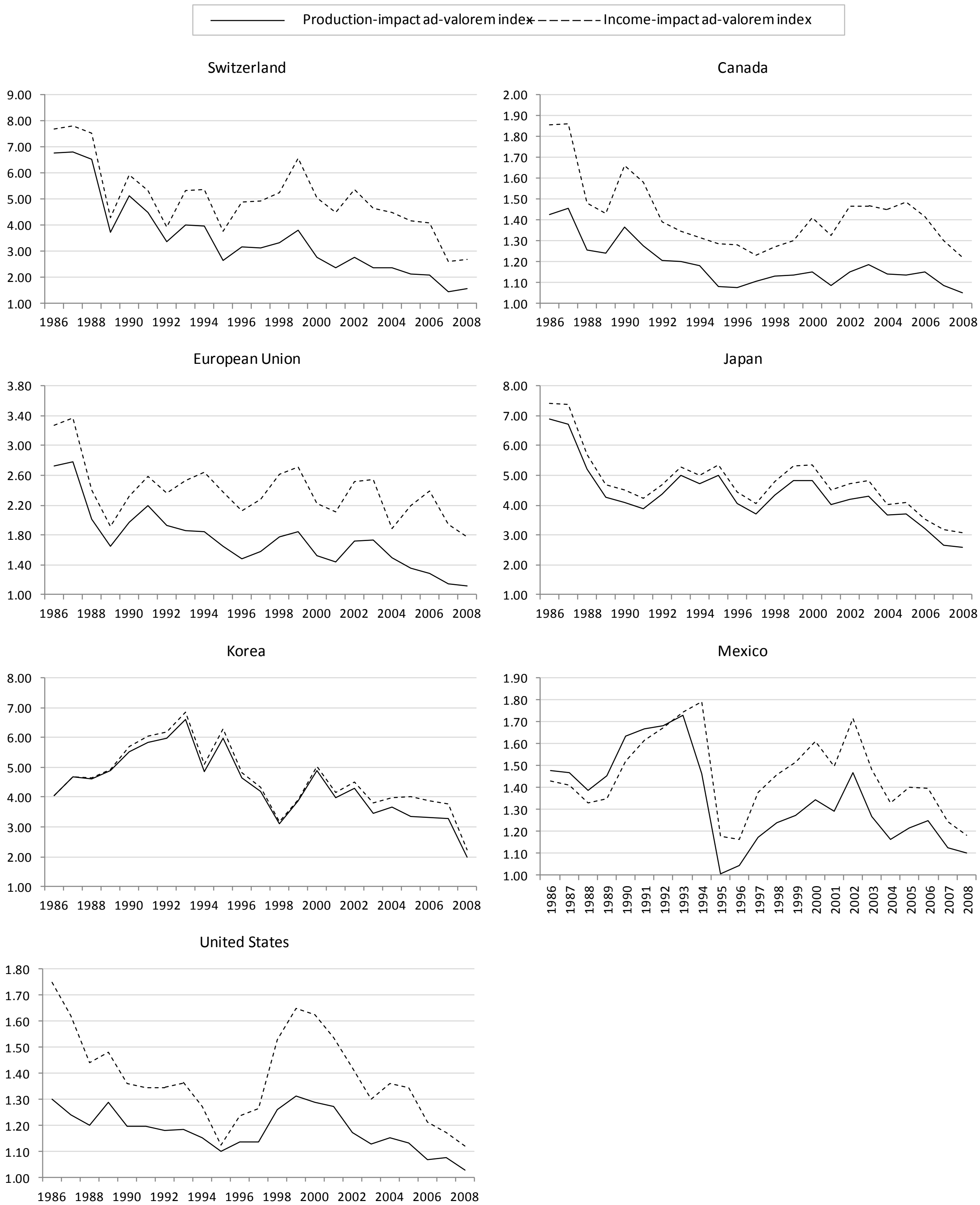
Source: OECD PEM

The United States, and to a lesser extent Canada, show considerable variability around the trend in Figure 10. Counter-cyclical programs that make payments depending on prices or revenue are behind this factor. In every country, there is a certain amount of variability provoked by changes in border prices and their effect on MPS. When budgetary payments are also contingent on prices, as is the case where counter-cyclical policies are in place, this variation in MPS can be reinforced by changes in budgetary payments. This is behind the large bump in the index for the United States in 2000-2002, for example.

The levels of the production-impact and income-impact indices cannot be directly compared due to their different definitions; the fact that the income-impact index has a higher value than the production-impact index has no meaning. However, differences in their trends over time provide an important indication of how the policy set is evolving. A faster rate of decline in the production-impact index compared with the income-impact index may be seen as progress; it indicates that, relative to previous years, the policy set is provoking less market distortion per unit of income transferred. This may be seen graphically by comparing the income-impact and production-impact *ad valorem* indices for each country (Figure 11). For Switzerland and the European Union, some divergence after the mid 1990s is apparent. For other countries, the result is less obvious.

Significant reduction in the production-distorting effects of policies while maintaining the level of income transferred by programs is a key challenge of policy reform. Significant progress seems to require meaningful reductions in the share of MPS in overall support. In Switzerland, for example, a steady decline in the amount of MPS is combined with an increase in payments based on non-current area (Figure 12). The reduction in the importance of MPS reduces market distortions, while the area payments increase the transfer efficiency of the policy set. The reduction in MPS has come about as a result of changes in the dairy sector, where high MPS and production quotas have been gradually replaced with payments based on commodity output. Payments based on current area have increased since 1992, first with payments for integrated production of crops (1992-1998) and complementary direct payments (1993-1998). These payments were replaced by an area payment not requiring production in 1998 that now represents about half of all budgetary payments. At least some of the decline in MPS has been replaced by increased output support payments (milk supplement for cheese production), including payments based on animal numbers (payments for roughage-eating animals or livestock in difficult conditions), which for beef animals is considered in the model as equivalent to output support.

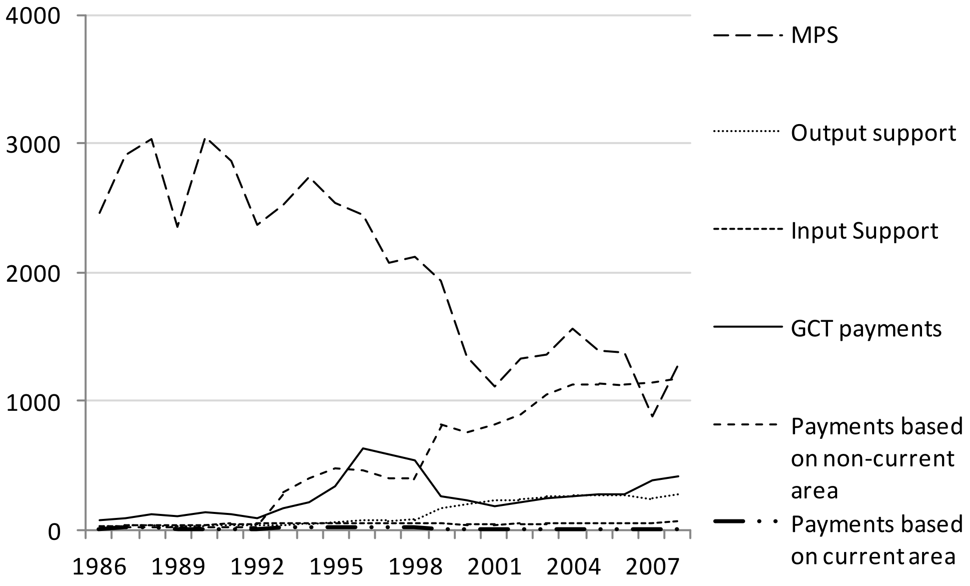
Figure 11. income-impact and production-impact *ad valorem* indices by country, 1986-2008



Source: OECD Policy Evaluation Model.

Figure 12. Evolution of support in Switzerland, 1986-2008

USD Millions



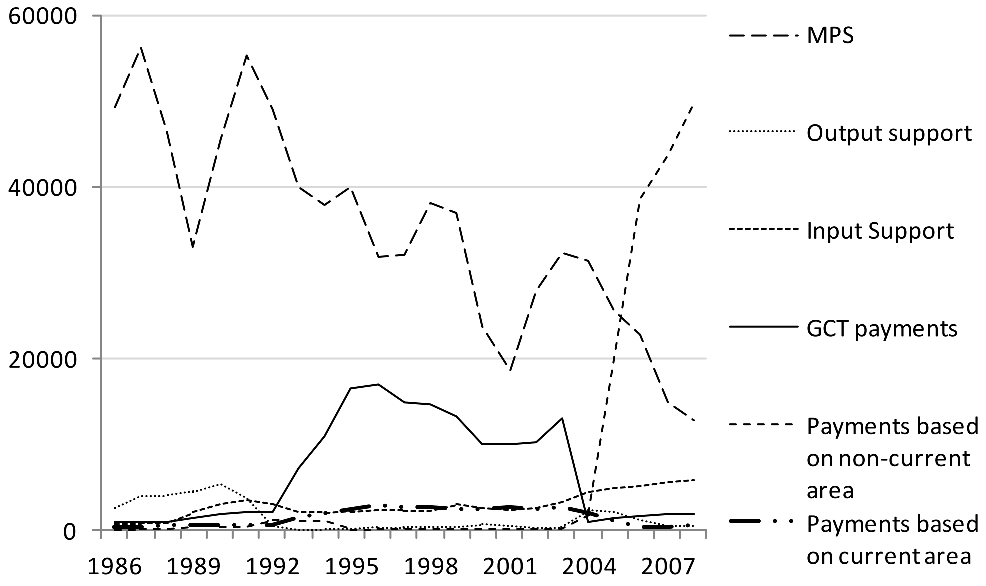
Figures do not match PSE as data represents only those polices modelled in PEM.

Source: OECD Policy Evaluation Model.

For the case of the European Union, MPS began its downward trend after the MacSharry reforms of 1992 introduced area payments in the CAP. Those reforms introduced new payments, which appear in the model as area payments for oilseeds, and GCT payments for cereals (Figure 13). While these payments were less than the reduction in measured MPS, their increased transfer efficiency leads to a flat income-impact index over this period (see Figure 11, for example). The CAP reform of 2003 introduced the Single Payment Scheme which prompted a dramatic change in the composition of support to payments not requiring production. The effect of this change is not more evident in the income-impact index because during this period price-driven changes in MPS along with changes to dairy intervention prices that erode quota rents in the model reduce the value of the income-impact index in 2007 and 2008. Had prices stayed at the 2006 level, the income-impact index would have been higher; much of the variability in the income-impact index has to do with the effect of border price changes on MPS and quota rents to dairy producers rather than explicit changes in policies.

Figure 13. Evolution of support in the European Union, 1986-2008

USD Millions

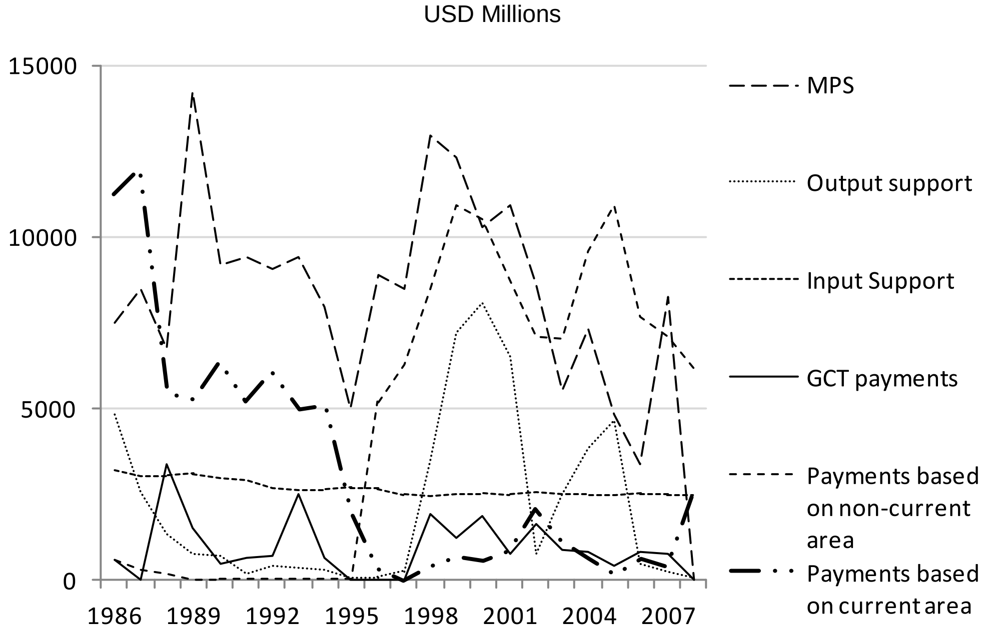


Figures do not match PSE as data represents only those polices modelled in PEM.

Source: OECD Policy Evaluation Model.

In the United States, MPS was never as dominant a share of overall support as was the case for Switzerland or the EU. In addition, forms of support considered less distorting of production make up a significant share of the total in every year of the study period, even if the way it was delivered changed (moving from area-based payments to payments based on non-current production in the mid-1990s) (Figure 14). Overall levels of support are also lower. Taken together, this leaves much less room for significant movement in the relative sizes of the different impact indices. Milk policy very strongly influences the results—MPS for milk makes up 80% of the total MPS until 1995, and 100% thereafter. While MPS fluctuates over the period, it trends downward only in the very last years of the study period, when world prices for dairy products increased significantly. Most budgetary support is for crop production—the important trend here is the movement from area-based deficiency payments to direct payments in 1995—and while direct payments are less distorting, than area payments, the difference in efficiency is not dramatic when compared with a move from MPS to direct payments. The increase in output support (loan rate payments) between 1999 and 2001 explains the large increase in the value of the indices in that period, and in general the US results show the counter-cyclical nature of payments with respect to prices.

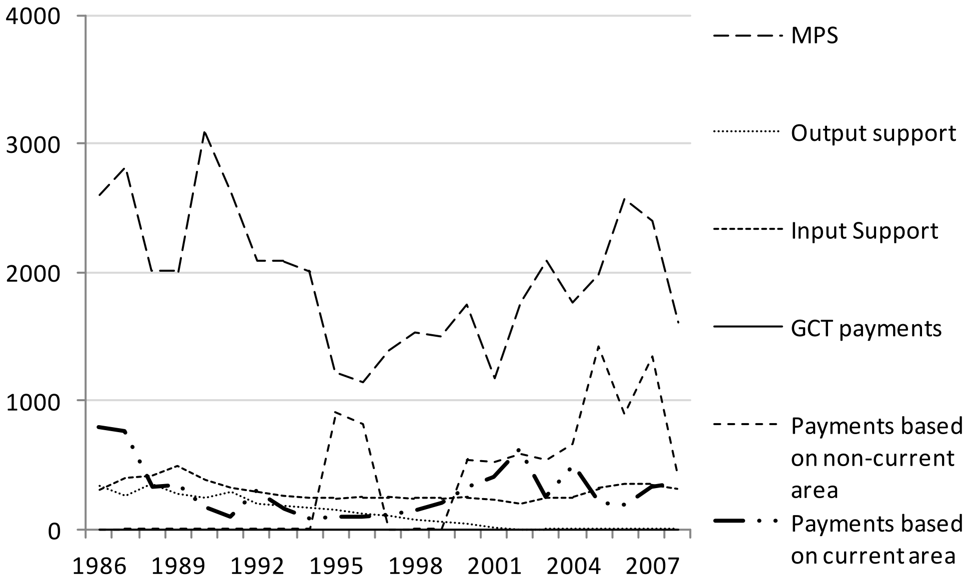
Figure 14. Evolution of support in the United States, 1986-2008



Source: OECD PEM model.

In Canada, as in the United States, MPS is essentially related to milk, with MPS for other commodities effectively ending by 1996. MPS shows some variation related to changes in world prices, but does not have a strong trend, which is to be expected as the support system for milk in Canada has not changed significantly over the study period (Figure 15). As was the case in the United States, higher world milk prices in 2008 significantly reduced MPS in that year. Other forms of support are small relative to MPS and have no obvious trend, with the exception of payments based on non-current production which grew in importance after the year 2000 in the form of a series of one-time disaster payments responding to various events in the sector (BSE, drought).

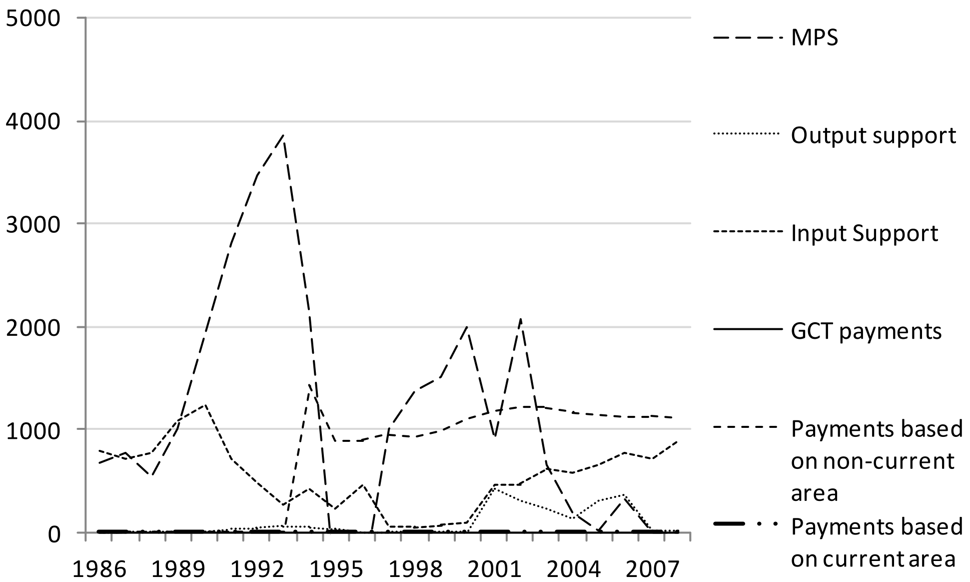
Figure 15. Evolution of support in Canada, 1986-2008



Source: OECD PEM model.

In Mexico, there was a significant re-instrumentation of support away from MPS towards payments based on non-current area (Figure 16). Input support is also significant, and has been rising after a period of significant decline in the 1990s. The re-instrumentation of support is visible in the results, but the effect of exchange rate movements complicates the overall picture.

Figure 16. Evolution of Support in Mexico, 1986-2008



Source: OECD PEM model.

Korea is still in the early stages of reform, with MPS dominating total support and other forms of support coming into use only in recent years (Figure 17). Fluctuations in overall support are due mainly to world price movements' impact on MPS. The same is true for Japan, though a broader range of policy instruments is in use there (Figure 18).

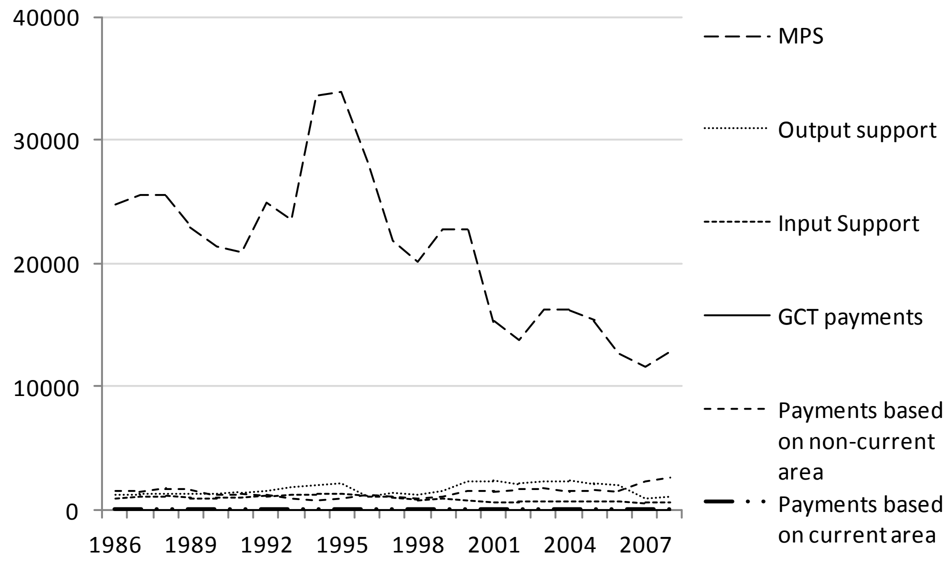
Figure 17. Evolution of support in Korea, 1986-2008

USD Millions

Source: OECD PEM model.

Figure 18. Evolution of support in Japan, 1986-2008

USD millions



Source: OECD PEM model.

Conclusion

A set of three indicators based on the “fixed definition” approach defined by Josling (1993) were developed using the OECD Policy Evaluation Model. These indices are designed to combine in a single measure the effect of both the level and composition of support on production, farm income, and exports. These indicators were compared to the NAC and NPC, which are existing measures of the scale of current policies and the amount of protection they provide.

The NPC was seen to closely correspond to the trade-impact *ad valorem* index, as effective protection measured by the NPC and the impact of policies on trade is closely related. The NPC was unable to capture the impact of structural policies such as production quotas and the impact of different forms of support on trade, but the dominant effect of MPS on trade was clear. The NAC as a measure of overall support to the sector was seen as more closely corresponding to the income-impact *ad valorem* index. The three indices go beyond the NAC and NPC to reflect more closely the impact of the changes in the composition of the PSE. In particular, the trade-impact *ad valorem* index was interpreted as bridging the gap between the NPC and NAC by including the effects of several different domestic policies on trade.

The degree to which the NPC, NAC, and these new indices track each other is mainly a function of the share of MPS in total support. When MPS remains a large share of support, as is the case for many OECD countries, little additional information is available from different indicators. The value of the indices developed here becomes clear when countries undergo significant re-instrumentation of support. Changes in the composition of support were particularly notable in Switzerland and the European Union and the indices were able to capture these changes and help to explain their impacts on production, trade and income. In particular, the introduction of the Single Payment Scheme in the European Union was seen to have brought about drastic improvements in the effect of support on production, trade, and income.

The conditions that characterise the change in support in Switzerland and the European Union are not present in every country. Countries like the United States, where MPS formed a smaller share of support, support is overall lower in level, and many less-distorting forms of support have been in use for a long time will naturally show a different scale of results. To keep matters in perspective, while Switzerland has shown the most dramatic progress, the indices of the impact of support remain higher than those of the US in every year, and support in Switzerland remains above the OECD average. When progress in each country is looked at relative to the level of support in that country (by using an index the average value in the 1991-1993 period set equal to 100), all countries studied show progress in reducing the production and trade distorting effects of their policies and the indices developed here offer an improved means to measure and evaluate that progress.

While the trends in support and its effects over time are clear, there is considerable short-term variability. This is mainly due to the impact of prices and exchange rates on MPS and price-based budgetary payments. This is particularly evident in the United States, where many important budgetary policies depend in part on prices. World prices for commodities trended higher in 2008, reducing the implicit support provided by MPS in many countries. Should world prices fall, and many have already retreated from their 2008 highs, some of the measured progress may prove temporary as calculated MPS rises.

While the objectives of agricultural policies are diverse and not always focussed on farm income, the results of this study show that it is possible to reduce the level of support and the amount of market distortions it provokes without reducing the amount of income transferred to producers. Achieving this re-instrumentation in practice requires substantial changes in the composition of support. In particular, substantially reducing the importance of MPS seems to be a necessary part of the reform process if significant gains are to be realised.

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Annex 1.

Tables

This annex contains tables of results of the impact index calculations reported in terms of domestic currency, national currency, and conversions of both to pure indices with 1986=100. The model operates with data in US dollars, so indices reported in national currency reflect results that are multiplied ex-post by the exchange rate.

These tables also report the results of a sensitivity analysis on the impact index calculations. This was done using monte-carlo simulation, varying the parameters of the models on a uniform distribution in the ranges specified in the consultant reports. This is essentially the same approach as was taken in “The Six-Commodity PEM Model: Preliminary Results” (OECD internal document). Results of the sensitivity analysis are reported as standard deviations from the value of the index obtained using the base parameter values of the model.

The sensitivity analysis provides a standard deviation for the index that quantifies the possible range of values the index may take depending on the parameterization of the model. Values for some years in some countries are missing due to technical problems solving the model in those cases. However, enough data points are available for the robustness of the index results to be evaluated. The standard deviation is a measure of variability around a mean estimate. A 95% confidence interval can be constructed by taking the mean estimate and adding and subtracting twice the standard deviation to establish upper and lower bounds. The true value of the index world fall within this bound with a 95% probability.

Table A1.1 Production-impact index by country, 1986-2008

USD Millions, ***standard deviation***

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Switzerland	2 825	3 341	3 463	2 705	3 482	3 223	2 748	2 835	3 062	2 805	2 748	2 320	2 377	2 146	1 442	1 213	1 431	1 437	1 636	1 421	1 387	941	1 313
	80.6	95.2	99.3	71.6	89.7	67.5	69.2	79.9	85.3	80.2	98.9	82.0	81.1	65.9	34.4	29.4	34.6	30.4	29.0	27.0	25.5	38.5	37.1
Canada	2 901	3 112	2 360	2 430	3 280	2 735	2 079	2 078	1 937	1 128	1 000	1 215	1 452	1 451	1 583	948	1 562	2 111	1 802	1 875	2 378	1 937	1 213
	120.3	118.7	62.1	61.9	48.8	43.1	56.5	33.7	18.4	31.5	27.0	23.3	39.5	55.7	69.6	79.9	118.5	94.7	130.3	84.6	77.6	77.9	92.1
EU	51 304	59 765	49 776	39 115	54 195	62 243	51 144	42 498	41 773	44 576	37 633	36 766	42 291	41 848	27 544	23 368	34 582	41 471	44 054	31 113	26 213	20 686	23 347
	278.4	305.9	303.3	296.0	440.4	281.2	392.2	557.8	784.1	1155.6	1184.1	1095.8	1000.2	917.0	1148.5	1376.8	1246.3	1536.9	1467.4	1166.6	1321.2	1354.3	1305.2
Japan	29 007	30 168	30 576	27 582	25 384	25 219	29 457	28 922	38 499	39 620	32 210	25 987	23 567	27 092	27 946	22 670	22 073	24 685	25 101	23 140	19 890	17 097	19 156
	83.6	99.2	98.8	86.4	83.3	101.7	101.9	56.4	124.3	108.7	113.4	102.6	100.6	99.1	88.0	87.3	99.5	112.7	145.3	109.1	107.2	106.1	114.6
Korea	5 689	6 664	9 196	10 516	10 451	10 439	10 389	10 171	10 365	11 658	12 478	10 542	6 501	9 327	10 774	8 949	8 891	8 061	9 358	9 800	9 789	10 685	7 090
	1.5	3.4	9.9	3.0	52.3	60.1	60.7	57.8	74.9	94.3	83.0	58.6	27.0	16.4	38.8	27.5	28.2	35.4	32.1	96.5		55.9	61.1
Mexico	2 084	2 087	1 957	2 804	4 047	4 123	4 526	4 596	3 165	50	406	1 230	1 547	1 754	2 325	2 322	3 227	2 155	1 470	1 806	2 471	1 727	1 767
	33.7	32.8	39.6	77.0	77.2	41.1	15.8	12.7	22.3	7.6	25.8	17.4	9.7	14.7	17.8	29.5	33.9	26.9	29.4	35.2		30.8	34.4
United States	17 825	15 917	13 963	20 469	15 253	14 707	14 286	14 052	12 848	9 413	13 114	12 529	20 375	23 860	22 892	22 606	14 587	13 261	15 916	13 830	8 232	12 660	4 733
	1 618.5	1 782.7	628.2	675.6	771.5	621.0	766.5	589.9	661.2	242.3	109.4	114.8	110.4	153.6	147.1	196.3	324.4	236.0	142.9	87.3	99.5	79.5	349.2

Domestic currency, millions, ***standard deviation***

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Switzerland	5 081	4 981	5 067	4 424	4 835	4 621	3 863	4 188	4 185	3 316	3 396	3 365	3 446	3 225	2 434	2 045	2 228	1 933	2 033	1 771	1 738	1 129	1 423
	144.9	141.9	145.3	117.1	124.6	96.7	97.3	118.0	116.5	94.8	122.3	118.8	117.6	99.0	58.0	49.6	53.8	40.9	36.1	33.6	32.0	46.3	40.2
Canada	4 030	4 127	2 906	2 877	3 828	3 135	2 513	2 681	2 645	1 549	1 363	1 683	2 153	2 156	2 351	1 467	2 453	2 961	2 345	2 273	2 697	2 081	1 295
	167.1	157.4	76.5	73.3	57.0	49.4	68.3	43.5	25.1	43.2	36.8	32.3	58.7	82.8	103.4	123.7	186.0	132.9	169.5	102.6	88.1	83.7	98.3
EU	52 280	51 850	42 124	35 527	42 690	50 358	39 518	36 282	35 218	34 098	29 647	32 442	37 813	39 276	29 888	26 092	36 693	36 709	35 458	25 034	20 884	15 111	15 969
	283.7	265.4	256.7	268.9	346.9	227.5	303.0	476.2	661.1	884.0	932.8	966.9	894.3	860.7	1246.2	1537.3	1322.4	1360.4	1181.1	938.7	1052.6	989.3	892.7
Japan[1]	4 888	4 363	3 918	3 806	3 676	3 392	3 731	3 215	3 936	3 727	3 505	3 144	3 085	3 085	3 014	2 754	2 765	2 863	2 715	2 548	2 314	2 013	1 981
	14.1	14.4	12.7	11.9	12.1	13.7	12.9	6.3	12.7	10.2	12.3	12.4	13.2	11.3	9.5	10.6	12.5	13.1	15.7	12.0	12.5	12.5	11.9
Korea[1]	5 012	5 498	6 713	7 037	7 399	7 654	8 104	8 162	8 336	8 993	10 037	10 020	9 105	11 068	12 181	11 548	11 123	9 589	10 717	10 038	9 317	9 932	7 805
	1.3	2.8	7.2	2.0	37.1	44.1	47.4	46.4	60.3	72.7	66.7	55.7	37.8	19.5	43.9	35.5	35.3	42.1	36.8	98.9		51.9	67.3
Mexico	1 332	2 958	4 465	6 997	11 498	12 460	14 008	14 318	10 726	319	3 090	9 745	14 157	16 757	21 980	21 695	31 170	23 251	16 579	19 671	26 938	18 879	19 709
	21.5	46.5	90.3	192.2	219.4	124.3	48.9	39.5	75.7	48.6	196.2	138.2	89.1	140.1	168.3	276.1	327.1	290.2	331.5	383.1		336.9	383.4
United States	17 825	15 917	13 963	20 469	15 253	14 707	14 286	14 052	12 848	9 413	13 114	12 529	20 375	23 860	22 892	22 606	14 587	13 261	15 916	13 830	8 232	12 660	4 733
	1 618.5	1 782.7	628.2	675.6	771.5	621.0	766.5	589.9	661.2	242.3	109.4	114.8	110.4	153.6	147.1	196.3	324.4	236.0	142.9	87.3	99.5	79.5	349.2

[1] national currency in billions

Source: OECD PEM model.

Table A1.2 Production-impact index by country, 1986-2008 (1991-93=100)

index 1991-93=100, national currency

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Switzerland	120	118	120	105	114	109	91	99	99	79	80	80	82	76	58	48	53	46	48	42	41	27	34
Canada	145	149	105	104	138	113	91	97	95	56	49	61	78	78	85	53	88	107	84	82	97	75	47
EU	124	123	100	84	102	120	94	86	84	81	70	77	90	93	71	62	87	87	84	60	50	36	38
Japan	142	127	114	110	107	98	108	93	114	108	102	91	90	90	87	80	80	83	79	74	67	58	57
Korea	63	69	84	88	93	96	102	102	105	113	126	126	114	139	153	145	140	120	134	126	117	125	98
Mexico	10	22	33	51	85	92	103	105	79	2	23	72	104	123	162	160	229	171	122	145	198	139	145
United States	124	111	97	143	106	102	100	98	90	66	91	87	142	166	160	158	102	92	111	96	57	88	33

index 1991-93=100, USD

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Switzerland	96	114	118	92	119	110	94	97	104	96	94	79	81	73	49	41	49	49	56	48	47	32	45
Canada	126	135	103	106	143	119	90	90	84	49	44	53	63	63	69	41	68	92	78	82	104	84	53
EU	99	115	96	75	104	120	98	82	80	86	72	71	81	81	53	45	67	80	85	60	50	40	45
Japan	104	108	110	99	91	91	106	104	138	142	116	93	85	97	100	81	79	89	90	83	71	61	69
Korea	55	64	89	102	101	101	101	98	100	113	121	102	63	90	104	87	86	78	91	95	95	103	69
Mexico	47	47	44	64	92	93	103	104	72	1	9	28	35	40	53	53	73	49	33	41	56	39	40
United States	124	111	97	143	106	102	100	98	90	66	91	87	142	166	160	158	102	92	111	96	57	88	33

Source: OECD PEM model.

Table A1.3. Trade-impact index by country, 1986-2008

USD Millions, ***standard deviation***

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Switzerland	2 295	2 724	2 840	2 179	2 849	2 713	2 204	2 325	2 508	2 217	2 107	1 796	1 853	1 866	1 343	1 135	1 350	1 427	1 681	1 542	1 585	1 165	1 648
	0.1	***0.2***	***0.2***	***0.2***	***0.2***	***0.3***	***0.3***	***0.3***	***0.3***	***0.4***	***0.3***	***0.2***	***0.3***	***0.2***	***0.2***	***0.1***		***0.2***	***0.2***	***0.2***	***0.2***	***0.1***	***0.2***
Canada	3 140	3 351	2 510	2 618	3 488	2 954	2 323	2 296	2 180	1 371	1 255	1 487	1 714	1 718	1 908	1 263	1 903	2 430	2 155	2 304	2 899	2 542	1 750
	149.4	***148.4***	***74.1***	***83.1***	***65.0***	***65.8***	***82.5***	***60.0***	***63.2***	***78.7***	***71.5***	***73.9***	***85.2***	***91.8***	***120.8***	***125.0***	***166.2***	***134.4***	***179.4***	***137.2***	***159.8***	***191.0***	***187.5***
EU	51 637	60 604	50 164	37 989	52 426	61 891	53 266	44 479	43 770	46 876	39 521	38 505	44 082	43 104	28 027	23 516	33 971	39 710	40 410	30 821	27 082	20 873	21 984
	246.9	***317.7***	***313.5***	***282.8***	***324.4***	***240.4***	***246.3***	***392.9***	***580.3***	***909.2***	***895.4***	***857.7***	***768.8***	***693.3***	***850.1***	***1033.3***	***909.0***	***1091.8***	***1137.8***	***1017.8***	***1305.3***	***1147.6***	***1187.7***
Japan	25 213	25 930	25 791	23 481	21 869	21 252	25 365	23 719	33 767	34 200	28 421	22 215	20 220	22 853	22 836	18 521	18 187	20 131	20 157	19 096	16 044	14 647	16 600
																		62.9		***82.2***	***85.5***	***89.8***	***96.7***
Korea	5 670	6 601	9 123	10 369	10 141	10 089	9 964	9 727	9 867	11 096	11 926	10 072	6 236	8 999	10 426	8 620	8 449	7 632	9 004	9 326	9 262	10 020	6 631
	2.5	***7.8***	***8.4***	***18.4***	***28.2***	***26.5***	***29.7***	***32.6***	***41.1***	***39.0***	***45.4***	***47.3***	***32.7***	***37.0***	***36.1***	***35.7***	***56.2***	***49.6***	***48.4***	***39.7***	***35.5***	***58.5***	
Mexico	1 910	2 180	1 771	3 205	4 601	4 173	4 744	4 718	2 841	25	453	1 203	1 564	1 772	2 349	2 351	3 286	2 103	1 527	1 986	2 716	2 019	2 217
	56.8	***56.4***	***58.2***	***83.6***	***99.3***	***57.8***	***38.2***	***20.8***	***34.2***	***20.6***	***42.1***	***9.9***	***6.2***	***9.2***	***11.0***	***54.3***	***48.9***	***53.8***	***42.9***	***52.5***		***51.4***	***69.2***
United States	16 981	15 074	13 138	19 524	14 303	13 810	13 464	13 298	11 991	8 435	11 902	11 476	19 282	22 481	21 322	20 342	12 828	10 960	14 687	12 754	7 022	11 445	3 981
	1 157.9	***1 432.9***	***506.3***	***562.8***	***654.7***	***518.0***	***677.0***	***496.6***	***570.1***	***186.8***	***123.2***	***143.7***	***131.4***	***211.0***	***234.3***	***239.0***	***271.1***	***239.6***	***134.5***	***138.8***	***104.6***	***90.5***	***262.3***

Domestic currency, millions, ***standard deviation***

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Switzerland	4 128	4 060	4 156	3 563	3 957	3 890	3 098	3 435	3 428	2 621	2 605	2 604	2 687	2 803	2 267	1 915	2 102	1 919	2 088	1 922	1 987	1 398	1 786
	0.2	***0.3***	***0.3***	***0.3***	***0.3***	***0.4***	***0.4***	***0.4***	***0.4***	***0.4***	***0.4***	***0.3***	***0.4***	***0.3***	***0.3***	***0.2***		***0.2***	***0.2***	***0.2***	***0.2***	***0.2***	***0.2***
Canada	4 363	4 444	3 090	3 100	4 071	3 385	2 808	2 963	2 977	1 882	1 712	2 060	2 543	2 552	2 833	1 956	2 988	3 408	2 804	2 792	3 288	2 731	1 868
	207.6	***196.8***	***91.2***	***98.4***	***75.9***	***75.4***	***99.7***	***77.4***	***86.3***	***108.0***	***97.5***	***102.3***	***126.4***	***136.4***	***179.5***	***193.6***	***261.0***	***188.4***	***233.5***	***166.2***	***181.3***	***205.2***	***200.1***
EU	52 620	52 578	42 453	34 504	41 297	50 073	41 158	37 974	36 902	35 858	31 134	33 976	39 414	40 455	30 412	26 258	36 045	35 150	32 524	24 799	21 576	15 248	15 036
	251.6	***275.6***	***265.3***	***256.8***	***255.5***	***194.5***	***190.3***	***335.4***	***489.2***	***695.5***	***705.4***	***756.8***	***687.4***	***650.7***	***922.5***	***1153.8***	***964.5***	***966.4***	***915.7***	***818.9***	***1039.9***	***838.3***	***812.4***
Japan[1]	4 249	3 750	3 305	3 240	3 167	2 858	3 213	2 637	3 452	3 217	3 093	2 688	2 647	2 603	2 463	2 250	2 278	2 335	2 180	2 102	1 867	1 725	1 716
																				9.1	***10.0***	***10.6***	***10.0***
Korea[1]	4 996	5 446	6 660	6 939	7 179	7 397	7 772	7 805	7 936	8 560	9 594	9 573	8 733	10 679	11 788	11 123	10 571	9 079	10 312	9 552	8 815	9 313	7 300
	2.2	***6.4***	***6.1***	***12.3***	***20.0***	***19.4***	***23.2***	***26.1***	***33.1***	***30.1***	***36.6***	***45.0***	***45.9***	***43.9***	***40.8***	***46.1***	***70.3***	***59.0***	***55.4***	***40.7***	***33.8***	***54.4***	
Mexico	1 221	3 090	4 039	7 997	13 070	12 613	14 682	14 698	9 628	159	3 444	9 534	14 314	16 924	22 203	21 964	31 747	22 691	17 227	21 624	29 612	22 068	24 732
	36.3	***79.9***	***132.7***	***208.5***	***282.1***	***174.7***	***118.2***	***64.7***	***115.8***	***132.4***	***320.3***	***78.6***	***57.0***	***87.6***	***103.7***	***507.7***	***472.7***	***580.2***	***484.2***	***571.6***		***561.9***	***771.4***
United States	16 981	15 074	13 138	19 524	14 303	13 810	13 464	13 298	11 991	8 435	11 902	11 476	19 282	22 481	21 322	20 342	12 828	10 960	14 687	12 754	7 022	11 445	3 981
	1 157.9	***1 432.9***	***506.3***	***562.8***	***654.7***	***518.0***	***677.0***	***496.6***	***570.1***	***186.8***	***123.2***	***143.7***	***131.4***	***211.0***	***234.3***	***239.0***	***271.1***	***239.6***	***134.5***	***138.8***	***104.6***	***90.5***	***262.3***

[1] national currency in billions

Source: OECD PEM model.

Table A1.4. Trade-impact index by country, 1986-2008 (1991-93=100)

index 1991-93=100, national currency

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Switzerland	119	117	120	103	114	112	89	99	99	75	75	75	77	81	65	55	61	55	60	55	57	40	51
Canada	143	146	101	102	133	111	92	97	98	62	56	67	83	84	93	64	98	112	92	91	108	89	61
EU	122	122	99	80	96	116	96	88	86	83	72	79	92	94	71	61	84	82	76	58	50	35	35
Japan	146	129	114	112	109	98	111	91	119	111	107	93	91	90	85	78	78	80	75	72	64	59	59
Korea	65	71	87	91	94	97	101	102	104	112	125	125	114	139	154	145	138	119	135	125	115	122	95
Mexico	9	22	29	57	93	90	105	105	69	1	25	68	102	121	159	157	227	162	123	154	212	158	177
United States	126	111	97	144	106	102	100	98	89	62	88	85	143	166	158	150	95	81	109	94	52	85	29

index 1991-93=100, USD

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Switzerland	95	113	118	90	118	112	91	96	104	92	87	74	77	77	56	47	56	59	70	64	66	48	68
Canada	124	133	99	104	138	117	92	91	86	54	50	59	68	68	76	50	75	96	85	91	115	101	69
EU	97	114	94	71	99	116	100	84	82	88	74	72	83	81	53	44	64	75	76	58	51	39	41
Japan	108	111	110	100	93	91	108	101	144	146	121	95	86	97	97	79	78	86	86	81	68	62	71
Korea	57	66	92	104	102	102	100	98	99	112	120	101	63	91	105	87	85	77	91	94	93	101	67
Mexico	42	48	39	71	101	92	104	104	63	1	10	26	34	39	52	52	72	46	34	44	60	44	49
United States	126	111	97	144	106	102	100	98	89	62	88	85	143	166	158	150	95	81	109	94	52	85	29

Source: OECD PEM model.

Table A1.5. Income-impact index by country, 1986-2008

USD Millions, ***standard deviation***

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Switzerland	3 273	3 904	4 083	3 273	4 141	3 982	3 362	4 038	4 552	4 623	4 954	4 276	4 322	4 207	3 308	3 073	3 511	3 815	4 165	3 956	3 939	3 389	3 915
	107.4	130.8	131.9	97.7	130.9	120.0	113.2	166.6	194.5	211.9	265.2	236.4	236.2	206.0	161.2	156.4	177.6	190.1	193.7	184.5	171.8	145.2	142.2
Canada	5 841	5 901	4 428	4 361	5 910	5 685	3 944	3 612	3 329	3 891	3 613	2 650	3 027	3 242	4 367	3 639	4 838	5 312	5 734	6 787	6 478	6 654	4 959
	395.9	357.6	199.2	183.3	272.0	297.7	183.6	150.2	148.1	234.4	222.0	138.9	150.3	171.0	277.5	254.1	351.6	310.6	397.8	482.3		418.7	309.8
EU	67 473	79 126	68 597	54 613	74 022	82 315	75 354	76 173	81 118	96 054	87 115	81 528	87 575	84 426	64 226	60 258	73 020	87 042	78 528	102 576	131 204	138 006	149 614
	2577.4	3012.4	2849.3	2370.0	3166.9	3228.8	3566.2	3514.0	3597.2	4787.9	4121.4	4083.9	4222.2	4183.8	4219.8	4440.1	4596.8	5160.5	6293.6	10667.5	16272.0	15016.5	12147.2
Japan	31 640	33 731	34 232	31 242	28 824	28 256	32 433	30 852	41 417	43 053	36 278	29 036	26 723	30 424	31 723	26 376	25 611	28 630	28 344	26 525	22 871	22 227	25 026
	478.0	494.7	531.5	501.0	383.4	351.4	332.5	287.8	247.8	336.4	409.2	344.1	323.0	382.7	501.6	478.5	491.1	558.6	485.9	503.7	452.3	701.8	798.0
Korea	5 700	6 689	9 268	10 536	10 840	10 872	10 821	10 592	10 952	12 400	13 116	11 015	6 762	9 505	11 162	9 497	9 481	9 142	10 478	12 550	12 221	12 936	9 068
	1.3	2.8	8.8	1.5	49.1	55.5	55.8	53.5	68.8	90.0	76.1	54.2	28.3	18.0	43.7	59.4	57.6	119.3	127.6	334.5		256.1	206.9
Mexico	1 877	1 824	1 653	2 171	3 321	3 801	4 452	4 697	5 390	1 325	1 465	2 704	2 975	3 301	4 118	3 955	4 923	3 866	3 006	3 366	3 942	3 370	3 098
	45.0	47.0	50.4	96.6	124.5	57.9	19.3	6.8	200.7	110.9	72.2	122.7	119.7	131.9	164.2	139.0	149.2	152.5	126.6	132.1		129.5	103.2
United States	44 540	40 918	30 771	33 987	28 039	25 435	27 554	27 418	23 381	11 626	22 684	23 968	41 505	49 430	49 257	44 367	35 539	31 181	37 858	36 014	25 078	28 362	20 666
	6 060.8	5 461.6			2 783.4		3 015.6	2 627.4	2 321.8	384.9	1 174.7	1 388.6	3 076.0	3 711.3	3 883.8	2 998.3	3 156.0	2 433.0	3 028.1	2 953.1	2 208.2	1 884.3	2 097.7

Domestic currency, millions, ***standard deviation***

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Switzerland	5 887	5 820	5 973	5 352	5 751	5 709	4 726	5 965	6 223	5 464	6 124	6 201	6 266	6 322	5 583	5 183	5 466	5 131	5 176	4 929	4 936	4 067	4 242
	193.2	195.0	193.0	159.8	181.8	172.1	159.2	246.1	265.9	250.4	327.8	342.8	342.4	309.5	272.1	263.9	276.5	255.7	240.7	229.8	215.3	174.2	154.1
Canada	8 115	7 826	5 452	5 164	6 897	6 516	4 768	4 660	4 547	5 341	4 927	3 671	4 491	4 816	6 486	5 634	7 595	7 451	7 460	8 224	7 348	7 149	5 294
	550.0	474.3	245.2	217.1	317.5	341.3	221.9	193.8	202.3	321.8	302.7	192.4	223.0	254.0	412.2	393.5	552.0	435.6	517.6	584.4		449.8	330.7
EU	68 757	68 647	58 053	49 603	58 309	66 597	58 225	65 032	68 388	73 477	68 629	71 939	78 302	79 237	69 692	67 284	77 479	77 047	63 204	82 535	104 530	100 812	102 334
	2626.5	2613.4	2411.3	2152.6	2494.6	2612.3	2755.5	3000.0	3032.7	3662.5	3246.8	3603.6	3775.2	3926.6	4578.9	4957.8	4877.5	4567.9	5065.5	8583.3	12963.9	10969.4	8308.4
Japan[1]	5 332	4 878	4 386	4 311	4 174	3 800	4 108	3 430	4 234	4 050	3 948	3 513	3 498	3 465	3 421	3 204	3 208	3 321	3 065	2 920	2 661	2 617	2 587
	80.5	71.5	68.1	69.1	55.5	47.3	42.1	32.0	25.3	31.6	44.5	41.6	42.3	43.6	54.1	58.1	61.5	64.8	52.5	55.5	52.6	82.6	82.5
Korea[1]	5 022	5 519	6 766	7 050	7 675	7 972	8 440	8 499	8 808	9 565	10 551	10 470	9 470	11 280	12 620	12 255	11 862	10 875	11 999	12 854	11 632	12 023	9 983
	1.1	2.3	6.4	1.0	34.8	40.7	43.5	42.9	55.3	69.4	61.2	51.5	39.6	21.4	49.4	76.6	72.1	141.9	146.1	342.6		238.1	227.7
Mexico	1 200	2 585	3 771	5 416	9 434	11 488	13 779	14 632	18 265	8 511	11 138	21 426	27 232	31 534	38 928	36 953	47 554	41 714	33 914	36 650	42 985	36 835	34 557
	28.8	66.6	115.0	241.0	353.8	175.1	59.7	21.2	680.2	711.8	548.8	972.4	1095.8	1259.9	1552.4	1298.7	1441.3	1645.9	1427.7	1438.9		1415.0	1151.3
United States	44 540	40 918	30 771	33 987	28 039	25 435	27 554	27 418	23 381	11 626	22 684	23 968	41 505	49 430	49 257	44 367	35 539	31 181	37 858	36 014	25 078	28 362	20 666
	6 060.8	5 461.6			2 783.4		3 015.6	2 627.4	2 321.8	384.9	1 174.7	1 388.6	3 076.0	3 711.3	3 883.8	2 998.3	3 156.0	2 433.0	3 028.1	2 953.1	2 208.2	1 884.3	2 097.7

[1] national currency in billions

Source: OECD PEM model.

Table A1.6. Income-impact index by country, 1986-2008 (1991-93=100)

index 1991-93=100, national currency

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Switzerland	108	106	109	98	105	104	86	109	114	100	112	113	115	116	102	95	100	94	95	90	90	74	78
Canada	153	147	103	97	130	123	90	88	86	100	93	69	85	91	122	106	143	140	140	155	138	135	100
EU	109	108	92	78	92	105	92	103	108	116	108	114	124	125	110	106	122	122	100	130	165	159	162
Japan	141	129	116	114	110	101	109	91	112	107	104	93	93	92	91	85	85	88	81	77	70	69	68
Korea	60	66	81	85	92	96	102	102	106	115	127	126	114	136	152	148	143	131	145	155	140	145	120
Mexico	9	19	28	41	71	86	104	110	137	64	84	161	205	237	293	278	358	314	255	276	323	277	260
United States	166	153	115	127	105	95	103	102	87	43	85	89	155	184	184	166	133	116	141	134	94	106	77

index 1991-93=100, USD

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Switzerland	86	103	108	86	109	105	89	106	120	122	131	113	114	111	87	81	93	101	110	104	104	89	103
Canada	132	134	100	99	134	129	89	82	75	88	82	60	69	73	99	82	110	120	130	154	147	151	112
EU	87	102	88	70	95	106	97	98	104	123	112	105	112	108	82	77	94	112	101	132	168	177	192
Japan	104	111	112	102	94	93	106	101	136	141	119	95	88	100	104	86	84	94	93	87	75	73	82
Korea	53	62	86	98	101	101	101	98	102	115	122	102	63	88	104	88	88	85	97	117	114	120	84
Mexico	43	42	38	50	77	88	103	109	125	31	34	63	69	76	95	92	114	90	70	78	91	78	72
United States	166	153	115	127	105	95	103	102	87	43	85	89	155	184	184	166	133	116	141	134	94	106	77

Source: OECD PEM model.

Annex 2.

The Policy Evaluation Model

The OECD began development of the PEM in 1998 when it undertook a pilot study to investigate the feasibility of developing a "Policy Evaluation Matrix", a table for comparing the impacts of various kinds of market and budgetary support given to producers against selected indicators of policy effects using an approach first elaborated by Gardner (1987) and following most closely the applications by Gunter *et al.* (1996) and Hertel (1989). The pilot study was carried out by a working group including representatives from the OECD Secretariat and representatives from each included region as well as other interested member countries. This working group made use of consultants who provided estimates of important model parameters through a systematic review of relevant studies available in the academic literature.[11] This working group also relied on important contributions from the authorities of participating countries, who provided significant information and analysis in all parts of the model development process.

The final report of the PEM pilot study was presented to the Working Party on Agricultural Policies and Markets in 2000 and main results from the model were presented in the document "Market Effects of Crop Support Measures" (OECD, 2001a). That document used a crops-only version of the model to produce a set of "decoupling indicators" relating the relative production, trade, and welfare effects of different PSE categories of support with that of market price support (MPS). The model was updated to include milk and beef production in a mixed crop-livestock model, and updated results for decoupling indicators were presented in the document "The Six-Commodity PEM Model: Preliminary Results" (OECD internal document).

Development of the PEM after the conclusion of the pilot study in 2000 has taken place within the OECD secretariat with less formal interaction with member countries. Experts meetings were held in 2004, 2006 and 2009 to report on progress and solicit advice for ongoing PEM development. This work has resulted in the addition of Korea to the model, accounting for the enlargement of the European Union in 2005, inclusion of the risk effects of policy measures, an elaboration of the representation of land supply, a feed market connecting crops and livestock, a revision of the representation of some policies including adding coverage of payments based on farm income, and numerous updates to model parameters and supporting data. This Annex describes the modifications made to the model since "The Six-Commodity PEM Model: Preliminary Results" (OECD internal document), including those modifications made specifically for country studies (see *Evaluation of Agricultural Policy Reforms In Korea* (OECD 2008), *Evaluation of Agricultural Policy Reforms in Japan* (OECD 2009), *Evaluation of Agricultural Policy Reforms in the United States* [TAD/CA/APM/WP(2009)22/FINAL]).

11. David Abler (2000) *Elasticities of substitution and factor supply in Canadian, Mexican, and US agriculture* and Klaus Salhofer (2000) *Elasticities of substitution and factor supply elasticities in European Agriculture: a review of past studies*.

1. General characteristics of the PEM framework

The Policy Evaluation Model (PEM) provides a stylised version of existing and hypothetical policies in the participant countries. The sensitivity of the results to assumptions about the elasticity values or price responsiveness of supply and demand for inputs have been analysed in detail and also provide important information for policy makers. The purpose of the PEM is to provide a closer connection between measurement of support as done using the Producer Support Estimate (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 market of primary incidence of support measures. 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.

A partial equilibrium model of the farm sector elaborated in Gardner (1987) provided the basic analytical structure for the PEM. First developed by Hicks to study issues in labour economics, the model has been widely applied in general economic policy analysis. An important precedent to its application in agricultural policy analysis was in an analysis of housing and urban land economics by Muth. The development of the model for analysis of agricultural price supports is generally credited to Floyd. Its application for the PEM follows most closely applications found in Atwood and Helmers (1998), Gunter *et al.* (1996), and Hertel (1989).

The type of analysis undertaken using this modelling framework has become known more generally as 'equilibrium displacement modelling' (Salhofer and Sinabell (1999), Piggott (1992), Cahill (1997)). In this framework, commodity supply is usually represented in terms of an aggregate production function and the associated factor demand and factor supply functions. Commodity demand and supply equations typically relate quantities and prices at the farm level, although several of the applications in the literature involve modelling sector-wide policy and market linkages (Alston 1991). Normally, the functional relationships in the model are approximated with equations linear in elasticities and percentage changes in quantities and prices (as was done for this analysis).

In doing policy analysis, supply and demand behavioural relationships are combined with the equilibrium requirements that supply must equal demand to simultaneously clear all markets. This system of equations is calibrated to replicate a given market situation -- actual prices and quantities observed in a particular 'base year'. A small change in the value of some exogenous policy parameter, such as an administered price, an area payment or an input subsidy, is then introduced and the model used to calculate a new set of equilibrium values for all endogenous prices and quantities. This procedure is termed a 'policy experiment' or 'policy simulation experiment'.

Policy simulation experiments usually involve relatively small changes in policy variables because of concern about whether model estimates of policy effects will be valid for large changes (e.g. complete elimination of government support programs for agriculture). The concern arises first because demand and supply relationships in the model are derived from theory applied to evaluation of small 'marginal' changes in variables and, secondly, because all the supply and demand relations in the model are *approximated* with constant elasticity linear equations.[12] The validity of the constant elasticity assumption can be brought into question when applying the model to evaluation of large changes in policy. Further, there is no way of knowing whether the elasticities of supply and demand appropriate for evaluating larger changes should be higher or lower than those appropriate for evaluating small changes. Concerns about the robustness of simulation results to large changes are not unique to the PEM model. They apply equally to any and all policy analyses based on numerical simulations of economic models, partial and general equilibrium alike.

What, in practical terms, is "too large" a change in a policy variable? Gardner (pp.132) cautions, "*Strictly speaking, the [experimental] changes imposed must be infinitesimal, since the equations are generated from differentials; small finite changes yield approximations. The approximations will usually be not as good for larger changes,* ***like 30%***." Piggott (pp. 133) notes, *'The procedure [of equilibrium displacement modelling] is also valuable in allowing headway to be made in measuring the displacement effects of small (****say, in the order of 10% or less****) finite changes in exogenous variables*.

Note that it is not the size of the change in the support measure *per se* that matters in this context, but rather the size of the induced changes in prices and quantities along producer and consumer demand schedules. Very large changes in support, even complete elimination of support – that is to say, a 100% change – need not have large effects on prices or quantities, depending on the policy in question and the degree to which such changes are made across multiple commodities and regions. Furthermore, so long as the movement from parameter "accuracy" to "inaccuracy" as price changes get large is a smooth one, sensitivity analysis is able to accommodate these changes in parameter values by demonstrating model results over a range of plausible parameter values.

2. PEM model structure

The PEM model provides a stylized representation of production, consumption, and trade of aggregates of major cereal and oilseeds crops, milk, and beef production in seven OECD countries or regions: Canada, the European Union[13], Japan, Korea, Mexico, Switzerland, and the United States (Table A2.1). The commodity modules of the PEM model were all developed according to a common structure, with some specifics added to deal with dairy quota, pricing systems or other policies that impact market structure where they exist. Policy experiments are 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, where supply functions are directly specified, there are equations representing demand and supply responses for at least four categories of inputs used to

12. These types of equations provide log-linear approximations to the "true" functional forms of the underlying production function, the associated factor demand equations and the equations of factor supply and commodity demand. The approximations would be better, especially for evaluating relatively large changes, if the underlying true production functions were of the constant elasticity of substitution, and the factor supply and commodity demand equations were truly log linear (Gardner, 1987).

13. The European Union is treated in the model as a single region for commodity markets with two separate regions supplying into commodity markets—the EU-15 and the EU-12 representing new member states.

produce these commodities in the study countries. The factor demand equations reflect the usual assumptions of profit maximisation constrained by the production relationship. Thus, the commodity supply for the seven OECD countries or regions are embedded in the equations that determine equilibria in these input markets. Supply response corresponding to a medium term adjustment horizon of three to 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.

No factor is assumed to be completely fixed in production, but land and 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. (Abler, 2000 and Salhofer, 2000). Both reviews were commissioned by the Secretariat to obtain objectively plausible values of the parameters (and ranges of them) for carrying out sensitivity analysis. [Technical documentation and tables containing numerical values for all the parameters used, by country will be provided in the next version of the document][14].

Factor coverage differs from one country to another (to be described in forthcoming technical documentation). Each of the country modules has three farm-owned factors: land, cows, and a residual "other farm owned factors". The representation of the land market allows simulating payments based on area, payments based on non-current areas, and farm income. The set of purchased factors covered in each country includes, at the least, fertiliser and a residual "other purchased factors" and often many more (Table A2.1).

Table A2.1 Commodity and Factor Coverage in PEM

Wheat	**Coarse Grains**	**Oilseeds**	**Rice**	**Milk**	**Beef**
Common Wheat	Maize	Soybeans	All Rice	Fluid	All Beef
Durum Wheat	Barley	Rapeseed		Manufacturing	
	Oats	Sunflower			
	Sorguhm				
	Farm-owned factors	**Substitutable across commodities?**	**Purchased Factors**	**Substitutable across commodities?**	
	Land	Yes (imperfect)	Chemicals	Yes	
	Cows	No	Energy	Yes	
	other farm owned	No	Fertiliser	Yes	
			Hired Labour	Yes	
			Concentrate Feed	No	
			Interest	Yes	
			Irrigation	Yes	
			Insurance	Yes	
			Mach. & Equipment	Yes (crops only)[1]	
			Other Inputs	Yes (crops only)	

1. Machinery and Equipment and other purchased inputs are assumed perfectly transferable across crop uses, but specialized to dairy or beef production.
Source: OECD PEM model.

14. 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.

Table A2.2. Representative country module in PEM

Endogenous variable symbol	***Stands for***
q_i^d, q_i^s, q_i^t	Demand, supply and trade quantities
p_i^d, p_i^s, p_i^w	Domestic demand, supply and world price of commodities
x_j^d, x_j^s	Input demand and supply quantities
r_j^d, r_j^s	Input demand and supply prices
Policy variable symbol	***Stands for rate of***
m_i	Market price support
o_i	Payments based on commodity output
a_i	Payments based on current area
h	Payments based on non-current A/An/R/I, percent of land value
s_j	Payments based on variable input use, percent of purchased input value
f	Payments based on current revenue or income, percent of farm owned input and land value
G1	Payments based on current area paid to all crops (GCT 1)
G3	Payments based on current area paid to cereals (GCT 3)
G8	Payments based on current animal numbers paid to all livestock (GCT 8)
Parameter symbol	***Stands for***
n_{ij}	Elasticity of demand for crop i with respect to price of commodity j
c_{ji}	Cost share of input j used in producing commodity i
e_j	Elasticity of supply for input j
$\sigma^S{}_{ij}$	Elasticity of substitution between factor i and j
$\sigma^T{}_{ij}$	Elasticity of transformation between land use i and j
Equations (dot above variable indicates percentage change)	
$\dot{q}_i^d = \sum_{j=1}^{4} n_{ij} \dot{p}_i^d$	Domestic consumption demands for i=1 to 6 commodities
$\dot{x}_{j,i}^d = \sum_{j=1}^{m} c_{ji} \sigma_{ji} \dot{r}_j^d + \dot{q}_i^s$	Input demands for j=1 to m inputs, i=1 to 6 commodities
$p_i^s \cdot q^s{}_i = \sum_{j=1}^{m} x^d{}_{ij} r_j^d$	Zero profit conditions for i=1 to 6 commodities (input cost exhausts revenue)
$\dot{r}_n^s = \sum_{j=1}^{z} \frac{sr_j}{sr_n} \cdot \dot{r}_j^s$	Land price for land nest n containing z land sub-types, n=pasture & cropland, pasture land, cereal and oilseed land
$\dot{x}_i^s = \sum_{j=1}^{z} \sigma_n \frac{sr_j}{sr_n} \cdot \dot{r}_j^s$	Demand for land producing commodity i in nest n. z=number of land uses in subgroup and may include aggregate land groupings.
$\dot{x}_j^s = e_j \dot{r}_j^s$	Non-land input supplies for non-land inputs

Table A2.2. Representative country module in PEM (*cont.*)

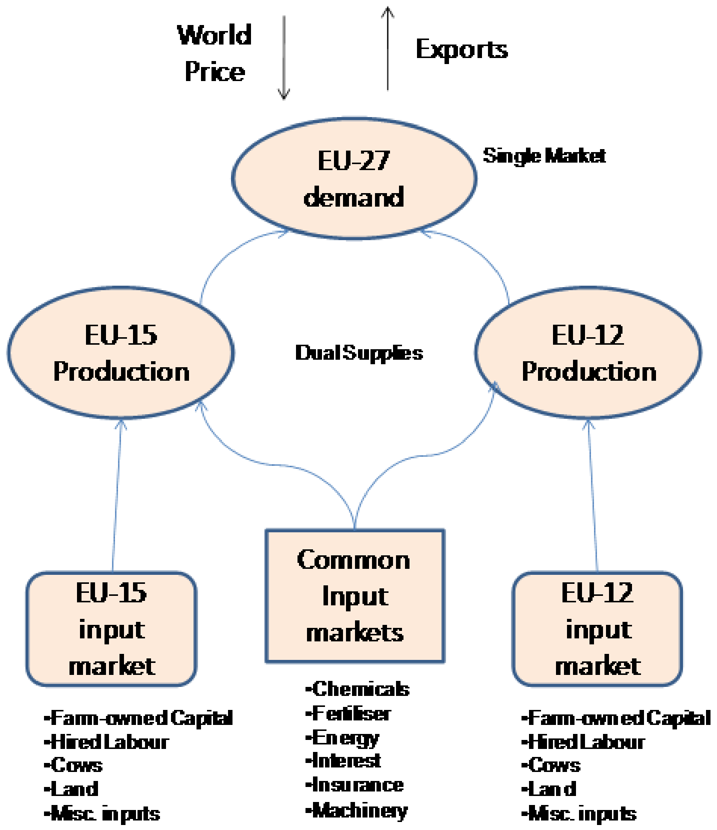
Equations (dot above variable indicates percentage change)	
$\dot{x}^d_{j,i} = \sum_{j=1}^{4} c_{ji}\sigma_{ji}\dot{p}^d_j + \dot{x}^s_{cfi}$	Demand for grains, oilseeds, and capital in production of concentrated feed, i=milk, beef; c_{ji}=cost share of input j in production of feed for livestock production i; p_j^d =consumer price of grains or oilseeds or cost of capital in feed production
$\dot{r}^s_{cfi} = \sum_{j=1}^{z} c_{ji}\dot{p}^d_j$	Zero profit condition in feed market (concentrated feed price equals unit average cost of production)
$x^s_j = x^d_j$	Input market clearing
$r^s_j = r^d_j + r_j^{s0}(h + f) + a_j + G1$	Land supply prices for j=1 to 7 categories of land. A_j=0 for beef pasture, *G1*=0 for dairy and beef pasture and “other arable” land, *f*=0 for “other arable” land
$r^s_j = r^d_j + r_j^{s0} \cdot f$	Supply price for “farm-owned” input for j=6 commodities
$r^s_j = r^d_j + r_j^{s0} \cdot s_j$	Non-land supply price for input j, aggregated over commodities
$p^s_i = p^d_i + o_i$	Supply prices for i=1 to 6 commodities
$p^d_i = p^w_i + m_i$	Demand prices for i=1 to 6 commodities

Structure of the European Union in PEM

The member states of the European Union are represented in two aggregate units: The EU-15 composed of countries that were members before 2005, and the EU-12, representing new members since that date. The addition of the EU-12 into the PEM took into account the principles of the Common Agricultural Polices which are market unity, community preference and financial solidarity. Extending the representation of the EU-15 towards an EU-27 in the PEM depended on where the same policies and same support prices apply to all producers and consumers within this region. The approach taken also needed to reflect some fundamental differences in the farm size structure, in the pattern of agricultural supply, in the ownership structure and in the macro-economic relevance between agriculture in the EU-15 and in the EU-12

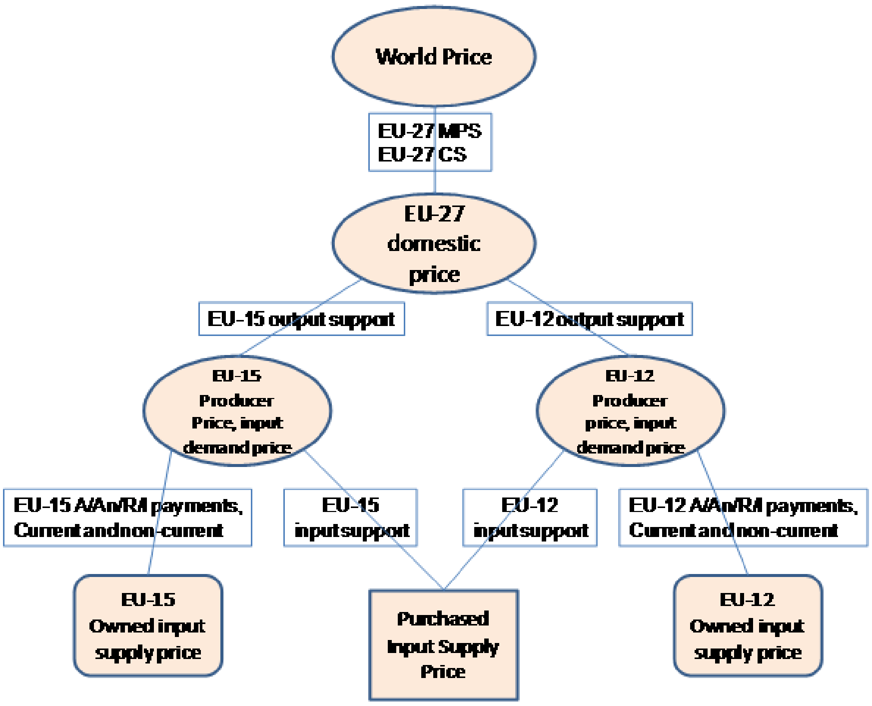
The final result is a model where for many of the markets in the EU-27, including output commodity markets and input markets, a single market is taken to hold. There are some exceptions to this rule, namely for the market for fluid milk, whose transportability over long distances is limited, and some factors of production such as hired labour where it is assumed that some restrictions still exist. Within these single markets are two separate production systems representing separately the EU-15 and the EU-12. This allows for differences in production technology and factor use between the two regions (Figure A2.1).

Figure A2.1. EU-27 Structure in PEM



Policy representation in the model is differentiated between the EU-15 and EU-12 for all policy categories except for payments in category A1, Market Price Support, and consumer subsidies in the CSE. The integrated market structure of the model prohibits the separation of these forms of support by region. Other policies are represented separately between the regions to take into account differences due to sub-national payment levels and the existence of interim policies such as SAPS. Thus, for commodity markets there is a single domestic price that holds for the EU-27, but separate EU-15 and EU-12 producer prices that differ according to the level of payments in category A2, payments based on commodity output. For markets for purchased inputs, there is a common EU-27 supply price, and demand prices for factors of production differ between EU-15 and EU-12 according to the level of payments in B1: Payments based on variable input use. For land, both the supply and demand is differentiated between the EU-15 and EU-12, as land is not a tradable good. Policies that affect land are those in category C with the label based on "area", Payments based on non-current A/An/R/I, production either required (category D) or not (category E). Payments in category C that are based on revenue or income affect both the land market and the market for farm-owned capital (Figure A2.2).

Figure A2.2. First incidence of policies in PEM, by PSE category



The consultant also provided a set of elasticity parameters and related model data to help complete the representation of the EU-12. Most of this data is adapted from the European Simulation Model (ESIM) and pre-existing PEM data. A particular problem was the lack of econometric estimates from the EU-12 to underlie these parameters. This problem can be traced to the profound structural changes that these countries have undergone in the period of transition. Such structural change precludes estimation using time series data. Expert review of this data was made in a session of the OECD Regional Meeting on Agricultural Policy Reform that was held in Bucharest on 24-25 September 2007. At this session the lack of sound empirical data was underlined by the participants. The weak empirical foundations of the representation of the EU-12 in PEM will have to be kept in mind; applications of the model will be limited to uses that are not critically dependent on the precise elasticity choice. As well, sensitivity analysis will be a useful adjunct to the model output to mitigate the effect of parameter uncertainty.

Modelling support to producers

The main purpose of the PEM pilot project was to bridge the gap between the PSE information, which categorises and quantifies agricultural support in OECD countries, by providing an analytical instrument to measure the effects of that support on production, trade, prices, etc. The analytical instrument developed to measure policy effects is the PEM. Given its partial equilibrium and static nature, it is an appropriate instrument to capture relative price effects of different kinds of support policies. It is not expected to specifically capture other non-price effects of policies such as income effects under constraints, externalities, expectations or other dynamic effects. However, part of these effects could be implicitly captured in the parameter values, thinking of the PEM as a reduced form of a more sophisticated model.

The starting point is the PSE classification, which is based on implementation criteria. Each of the main kinds of support defined in this classification appears in the model with a specific initial incidence on producer and consumer incentive prices. As in any economic model of policy effects, it is difficult to represent the mechanisms of policy implementation and therefore their incidence in complete detail.

The PEM does not represent in a fully comprehensive manner the specifics of support programs applying to each individual crop 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.[15] 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. Where policies exist in specific countries that fundamentally limit the production or pricing in that country, such details are often included in the model. Specifically, dairy quota limits on production and premium pricing for fluid milk are built into the commodity modules where they exist.

To illustrate how policies are represented in the PEM, imagine a simplified version of the model having just one country, one output and two inputs, the one country being any one of the participant countries. The two inputs are the aggregates: “farm owned” and “purchased.” Here, for the sake of simplicity, the former factor consists of land only. Figure A2.3 contains supply and demand diagrams illustrating the basic components of this representative model. The upper panel shows *commodity* supply and demand curves and the lower two panels show supply and demand curves for the two aggregated factors of production.

Figure A2.3 shows how price wedges corresponding to unit MPS, payments based on current area and payments based on variable input use (reduction in input costs) were represented in the PEM model. The MPS wedge separates prices paid by domestic consumers to domestic producers, P_d, from the corresponding price on world markets, P_w. No consideration is given to the specific trade or domestic policy instruments actually creating the price wedge.

Similarly, payments based on current area are modelled as wedges between the price a farmer earns from using his land and other owned factors in production, $P^s_{f,}$ and the return, $P^d_{f,}$ those factors would earn in some alternative use. Finally, subsidies to purchased inputs are assumed to create a wedge between the price suppliers receive, $P^s_{nf,}$ and the price farmers pay for them, P^d_{nf}. Purchased input markets in the PEM model are not commodity specific. That means any purchased inputs price wedge that is applied is the same across all commodities.

There are two other categories of the PSE that are captured with price wedges in the PEM model: payments based on commodity output and payments based on non-current A/An/R/I.[16] The former is represented as a wedge between the effective incentive price

15. See *OECD’s Producer Support Estimate and Related Indicators of Agricultural Support: Concepts, calculations, Interpretation and Use (The PSE Manual)* (OECD 2008) for a definition of all categories of support in the PSEs.

16. Examples of payments based on non-current area are Direct Payments and Counter-cyclical payments in the United States, the Single Payment Scheme in the European Union, and PROCAMPO payments in Mexico.

received by the producer and the price paid by the consumer. The total of payments within this category is equal to this price wedge times production. The payments based on non-current A/An/R/I are modelled as a price wedge between the supply and the demand price of land analogous to that for the payments based on current area. However, this gap is modelled as not altering relative land prices for land categories affected by the payment (all six commodity uses plus "other arable"); this reduces the effect of these payments in area allocation compared to those of payments based on current area.

Figure A2.3. Policy Evaluation Model

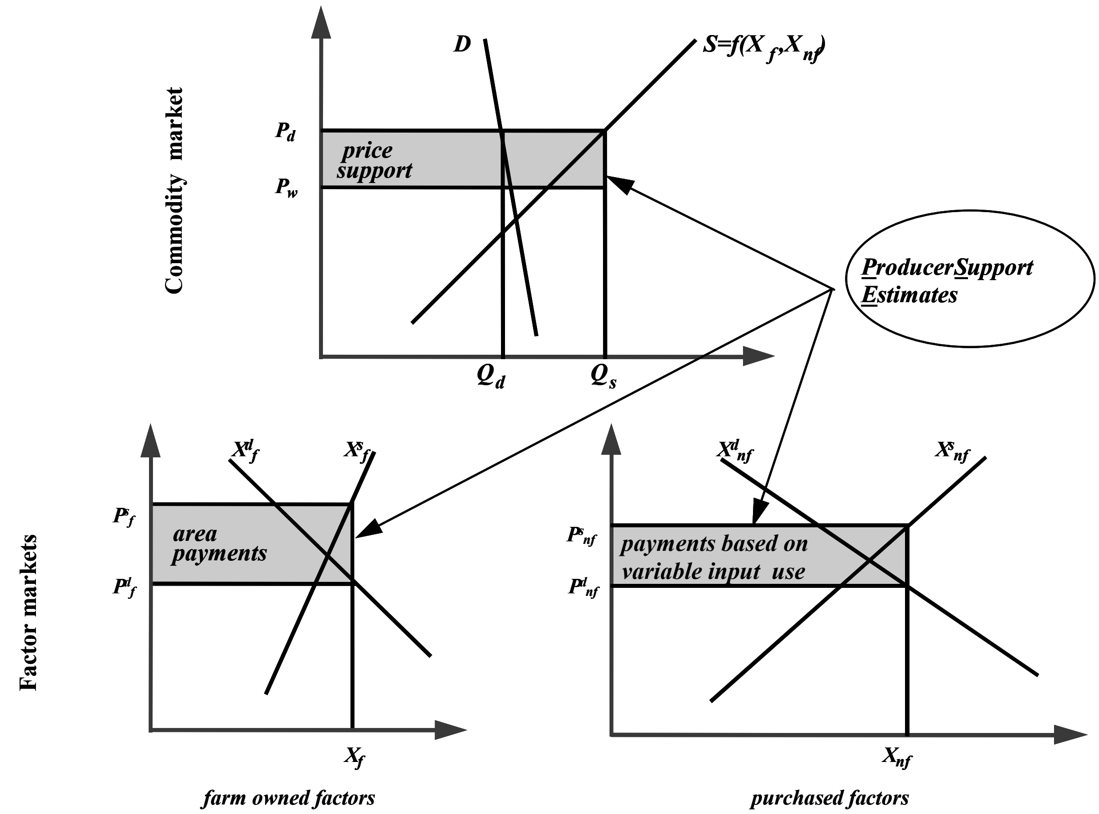


Table A2.3 summarises the first incidence of different categories of support in the PEM. The impact of a marginal change in support within a given category depends critically on the pre-existing level of support within that same category.[17] In general, the greater the pre-existing levels of support the smaller the effects of incremental changes. This is an important source of non-linearity using the PEM model.

17. The effects of a change in support provided by a particular support measure may also be different depending on the existing level of support provided by other support measures. This difference arises because the induced changes in input and output depend on factor shares and elasticities. The values of these parameters, however, might be different under circumstances of high pre-existing support levels as compared to low pre-existing support levels. The current PEM model assumes constant factor share and elasticity values and does not capture these interactions.

Table A2.3 How different categories of the PSE are represented in the PEM

PSE classification	First incidence of support in price wedge (between)
A1. Market price support (MPS)	Domestic (producer and consumer) and the world price
A2. Payments based on commodity output	Domestic producer and domestic consumer prices
B1. Payments based on variable input use (without input constraints0	Domestic supply price and demand price - not specific to any one commodity. Applies equally to all purchased inputs except fertiliser and hired labour.
B2. Payments based on fixed input use	Supply and demand price for farm-owned inputs, rent per hectare received by land owners and rent per hectare paid by land users; not specific to any one commodity
C. Payments based on current area, animal numbers, Receipts or income (A/An/R/I), without input constraints.	Area--Rent per hectare received (by landowners) and rent per hectare paid (by land users) - this wedge may be the same for different crops, or it may be different**
	Animal numbers — supply and demand price for cows (milk) or domestic producer and domestic consumer price (beef).
	Reciepts or Income -- Supply and demand price for farm-owned inputs, rent per hectare received by land owners and rent per hectare paid by land users; not specific to any one commodity
D. Payments based on non current A/An/R/I, production required	Rent per hectare received by land owners and rent per hectare paid by land users - not specific to any one commodity Applies to all land uses based on “production exceptions” label.
E. Payments based on non current A/An/R/I, production not required	Rent per hectare received by land owners and rent per hectare paid by land users - not specific to any one commodity. Applies to all land uses based on “production exceptions” label.

* The primary distinction between this type of payment and area-based payments is the number of categories of land in the model to which the payment applies.

** In the model, landowners are distinguished from land users to provide a basis for distributing the economic effects of policy changes. Of course, in reality, not all cropland is rented. The per hectare rent for land not rented needs to be interpreted as a shadow price reflecting the opportunity costs of using land in one or another of the crops under study here in some other use.

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. Most input prices are defined as an index with initial value of 100. Input quantities are subsequently derived from cost shares and revenue, using the zero-profit condition. Exceptions are for concentrated feeds and cow herd sizes, where quantity data, taken from various sources, are used and for which the cost shares and zero-profit condition then imply the price. As of this writing, the model is calibrated for all years between 1986 and 2008 inclusive, and any of these years may be used for a simulation experiment.

Measuring the impacts of support

Table A2.4 lists the main indicators of policy effects used in measuring the effects of policy changes. These indicators are measured in the standard way of economic models using the functional specification of the PEM crop model. After any assumed quantitative change in support, the model adjusts the entire set of factor and commodity prices to obtain a new equilibrium. Calculating the change in the value of the various indicators between the initial and the final equilibrium gives the estimated policy effects of interest.

Table A2.4. PEM indicators of policy effects

Indicator	Definition of measure
Taxpayer costs	Total change in government costs/receipts for: payments based on current area, input subsidies, export subsidies and tariffs.
Consumer impacts	Change in consumer surplus.
Farm welfare[18]	Change in returns above opportunity costs to land, cows, other farm owned factors, and dairy quota (net household income from farming).
Input suppliers effects	Change in returns above opportunity costs earned by suppliers of purchased factors.
Transfer efficiency	Farm welfare / (Taxpayers + Consumers costs)
Production	Change in volume of crop production.
Consumption	Change in volume of crop consumption
Net trade	Change in volume of net trade.

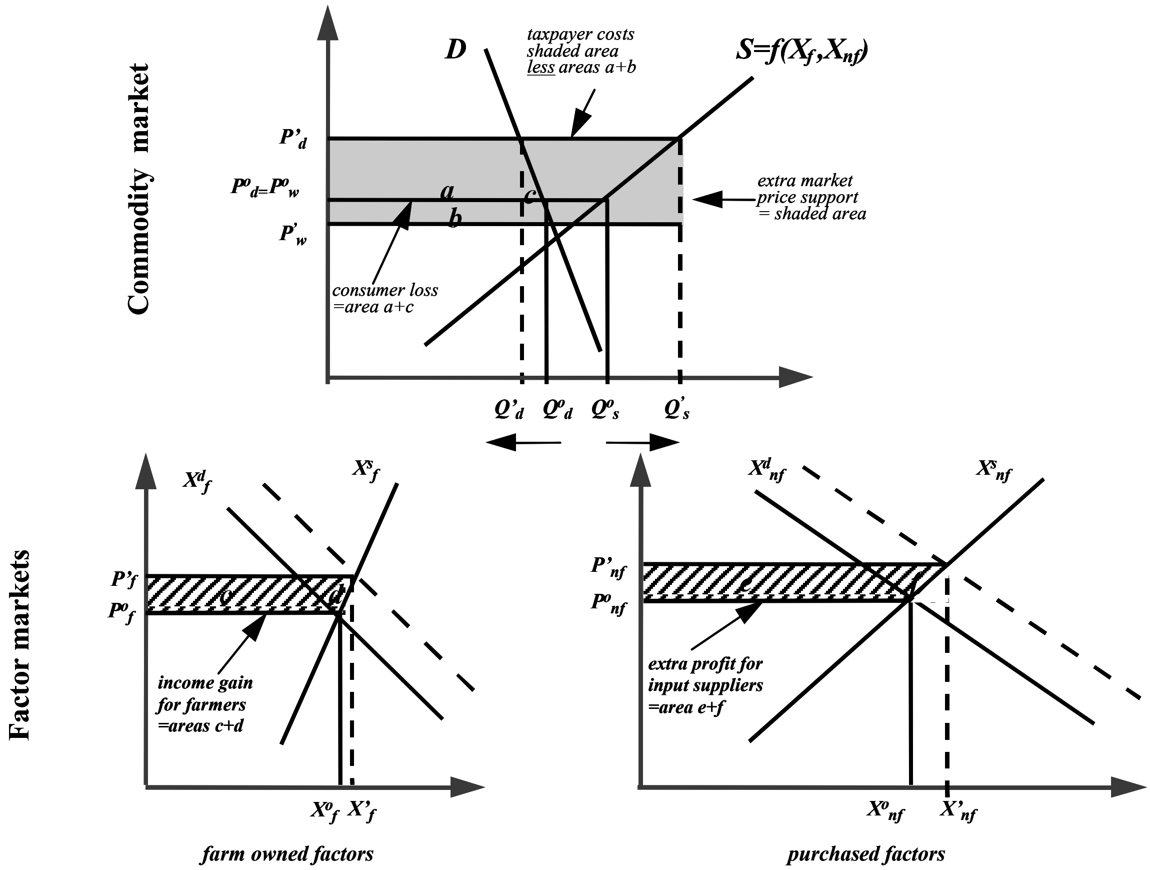
The main features of a policy simulation experiment aimed at obtaining the desired estimates of policy effects can be illustrated in a graph. Figure A2.4 contains a simplified representation of market equilibria “before and after” a hypothetical policy change. The example used is a hypothetical increase in MPS. Figure A2.4 is the same as Figure A2.1 except, for expositional convenience, we assume that support is increased in a situation where there was no support before.

Observe the upper panel of the figure showing commodity market impacts. For this illustration, assume a situation in which domestic price, P^0_d, and world price, P^0_w, are initially equal. Then, suppose a change in some market support instrument results in a price wedge, P'_d- P'_w, and an accompanying level of MPS of some given amount as indicated by the shaded area in the top part of Figure A2.4. There are two price impacts of the increased MPS: the induced *increase* in the domestic price from P^0_d to P'_d, and the

18. As indicated in the table, in calculating economic costs and benefits of changes in support, farm welfare was measured as returns above opportunity costs for the two farm owned factors in the model: farmland and the aggregate other farm owned. However, farm households do not own all farmland. Some of it they rent from people who do not farm. This would mean simulated changes in farm welfare due to hypothetical changes in support measures would be overstated.

induced *decrease* in the world price, from P^0_w to P'_w. The relative magnitudes of these two price changes will depend on the size of the country in production and trade of the commodity in question.

Figure A2.4 Trade and Income Effects of Market Price Support



The increase in crop production induced by the increased support is $Q_s' - Q_s^o$. The associated reduction in consumption is $Q^0_d - Q'_d$, with effects on net trade equals the difference between the implied quantity of exports after the change in support, $Q'_s - Q'_d$, less the implied quantity of exports[19] before the policy change $Q^0_s - Q^0_d$. The increase in support is represented in the figure by the 'PSE rectangle' whose base is Q_s', and whose height is $P'_d - P'_w$. The area marked *a* and *c* shows the induced increase in consumer costs (reduction in consumer surplus). The induced increase in taxpayer costs to cover export subsidies is shown by the rectangle whose base is $Q'_s - Q'_d$ and whose height is $P'_d - P'_w$.

19. This illustration assumes the country in question is an exporter both before and after the policy change. Illustrating the effects of market support for an importing country involves a straightforward adaptation of Figure 2.2. Except, in the case of an importing country, the consumer costs of a given increase in MPS are relatively much greater. Depending on the policy regime, such higher costs for consumers may be partially offset by an increase in tariff revenues.

The sum of taxpayer and consumer costs equals the whole of the shaded area measuring the change in support less the area marked *b*.

Observe now the bottom part of Figure A2.4 showing associated factor market effects. The hypothesised increase in the producer price due to increased MPS translates into outward shifts in demand for both farm owned and purchased factors of production as shown by the dashed lines to the right of the demand curves labelled Xdf and Xdnf. This causes the quantities and prices of both factors to rise, the degree to which clearly depends on relative elasticities (slopes) of the factor supply schedules.

The areas marked c and d in the lower left hand panel of Figure A2.4 represent the impact of the supposed change in MPS on net incomes of farm households supplying the farm owned factors of production. Correspondingly, areas marked e and f in the lower right hand panel show increased profits for suppliers of purchased inputs. Which of these is the greater will depend on the elasticities of factor supply and substitution as well as on the relative importance of the factor bundles in crop production.

The price increases will always be the greater for the factors (or factor bundle) exhibiting the lowest supply elasticity, in this case the farm-owned factor. However, this does not guarantee that the largest share of total benefits of support go to this factor since this depends on factor shares as well as elasticities. The essential point is that there will be some sharing of the economic benefits of increased support among these two groups of economic agents.

Analogous exercises could be done for any other of the PSE category of payments that are modelled in the PEM model. Payments based on commodity output would also have their first incidence in the output markets. However, payments based on current area, current revenue or income, non-current A/An/R/I and variable input use have their first incidence in some of the factor markets.

Peculiarities of the representation of milk production

The representation of raw milk production in the PEM is structurally similar to that for crop and beef production; that is, a constant elasticity of substitution supply function is implicit in a set of factor demand and supply functions combined with a zero-profit condition. Factors are either purchased or owned by the farmer, and are substitutable with each other according to a matrix of own and cross elasticities of substitution. Quantity levels of all factors other than land or feed used in the model are derived from total expenditures on that factor and its price index. Where the representations differ is that milk consumption (not production) is differentiated into fluid and industrial demand. Of the two, only industrial milk is considered to be a tradable commodity.

The PEM provides a stylized representation of the most important dairy policies in the regions included. Specifically, the model allows for premia to milk for fluid use (hereafter referred to as a blend price system), direct payments to milk production, subsides for either fluid or industrial milk consumers, MPS, border measures restricting trade, and production-limiting quotas.

The model will operate differently in each region, depending on whether the region in question uses a blend price system, applies a quota on milk production, or both – or neither. In some regions (the European Union, Switzerland) a quota system is in place that limits production response to prices over a certain range. In other regions (Japan, the United States) there are domestic pricing arrangements that maintain separate prices for fluid and industrial milk. Canada uniquely has a dual-quota system that sets separate quotas endogenously with domestic prices in both the fluid and industrial markets, and Mexico has neither quota nor domestic pricing arrangements in the market for milk. The following sections describe the model structure for milk production for each of the different possible policy environments.

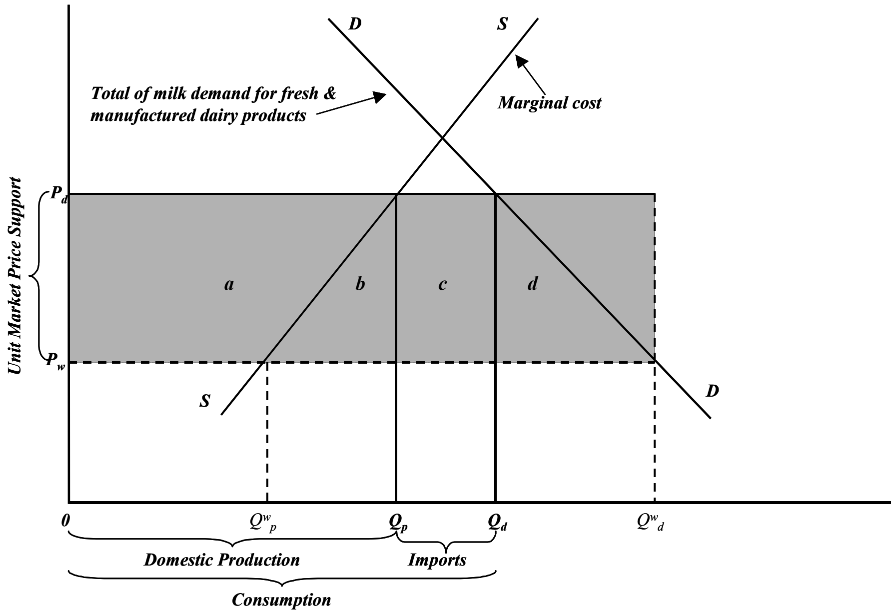
No blend price system, no quota

Although this specific version of the model was used to model the effects of MPS only in the case of Mexico, it constitutes the basic framework upon which the other versions are built. Figure A2.5 illustrates the model representation for Mexico, a net importer of dairy products. Raw milk demand, denoted by line *DD*, comprises the sum of demands for the production of manufactured and fresh dairy products. In the regions represented in the model manufactured dairy products typically comprise 60 to 70% of total demand for dairy products in raw milk equivalent terms, although in Japan this proportion is reversed.

In the PEM, each of these two categories of aggregate demand for raw milk has its own equation and price elasticity. Demand for fresh dairy products is generally less responsive to price, that is to say it has a lower price elasticity of demand, than is the demand for manufactured products. This is an important consideration for the blend price version, discussed below. Demand elasticities for all countries and commodities are provided in Annex 3. The price elasticities of aggregated demand for fresh dairy products average around -0.25, while those for the aggregated demand for manufactured dairy products average around -0.50. Most come from the Aglink model.

Supply of raw milk is represented in Figure A2.5 by the line SS. Notice that this line is also labelled marginal cost. For a competitive industry the market supply function is obtained by aggregating the marginal cost functions of individual producers and is sometimes labelled the industry marginal cost function. As will become clear, the distinction is an important one for the quota version of the model.

Figure A2.5. Basic milk model



In the model this market supply/industry marginal cost relationship is based on a raw milk production function and the underlying supply and demand equations for inputs used in milk production: family and hired labour, cows, forage, concentrated feed and other purchased inputs. Accordingly, the elasticity of raw milk supply, which would be reflected in the slope of the curve *SS*, depends on the cost shares and the elasticities of factor substitution and supply. The estimates of these parameters, as well as the calculated resulting supply elasticity are reported for each country in Annex 3.

The horizontal axis of Figure 2.3 shows the equilibrium quantities of production Q_p, consumption Q_d, and imports (Q_d - Q_p), at the prevailing domestic price P_d. The dashed lines terminating on the horizontal axis at the points $Q^w{}_p$ and $Q^w{}_d$ indicate the lower level of production and the higher level of consumption and imports ($Q^w{}_d$ - $Q^w{}_p$) that might be expected if producers and consumers received/paid the lower world market price P_w.

The shaded rectangle in the figure comprising areas *a*, *b* and *c* traces out the total of the monetary transfers from consumers resulting from MPS (the Consumer Support Estimate). Each of the sub-areas within that shaded area corresponds to the economic impact of support on one or another of the economic agents concerned (Table A2.5). The sum of areas *a*, *b*, *c* and *d* indicates the economic costs to consumers. Area *a* corresponds to the economic gains that accrue to milk producers and input suppliers from that support. These cannot be identified separately in the Figure, but are reported separately in the policy simulation analysis.

Net economic losses attributable to milk price support, the dead-weight losses, comprise the sum of areas *b* and *d* and, sometimes, area *c*. The ambiguity about area *c* arises because it corresponds to the *potential* tariff revenues on imports. Some governments, Mexico for example, auction the entitlements to import dairy product in order to capture these rents. In other countries, such as the United States, these import licenses are allocated without charge to private individuals, allowing them to capture any rents.

Table A2.5 Economic costs and benefits of milk price support

Cost or benefit to economic agent	Area(s) in Figure 2.3
Taxpayer gains (from tariff revenues)	*c* (in some cases)
Consumer losses	*a* + *b* + *c* + *d*
Farm welfare + input supplier gains	*a*
Dead-weight losses	*b* + *d* (and, in some cases *c*)

The policy effects illustrated by the price, quantity and area comparisons in the Figure A2.5 *indicate* the direction of changes that might be expected with changes in milk support levels, but do not tell the whole story. This is because the position and slopes of the demand and supply curves, and the world market price will also change with changes in support levels.

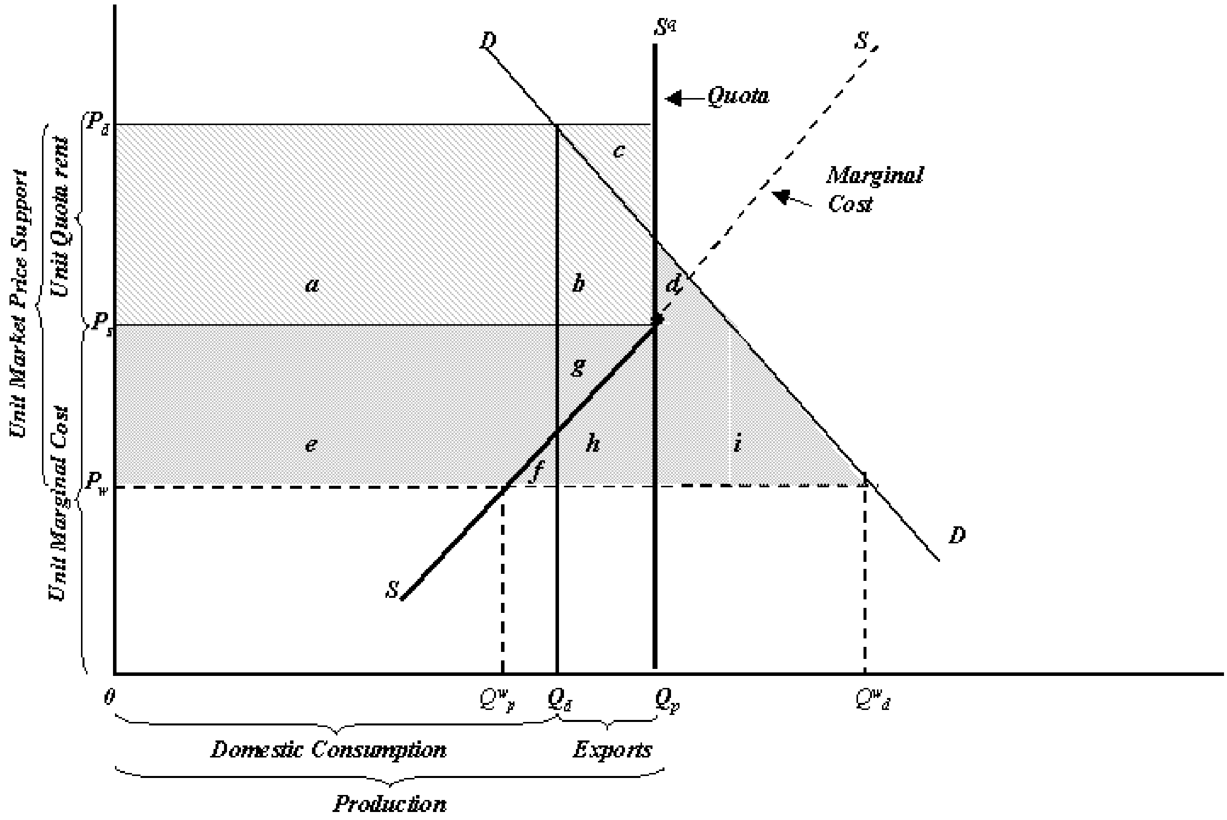
Quota system only

This version of the model is used to analyse the effects of market support in the European Union and Switzerland. This version differs from the more basic one above in the addition of an exogenous variable representing the production quota, to be set, independently of market outcomes by policy makers. This exogenous quota level sets an upper limit to supply response in the model. Producer prices remain endogenous and determined by the rate of MPS and world market prices (Table A2.4).

The effects of market support in the presence of quotas depend critically on where the quota is set relative to domestic consumption. The European Union and Switzerland are both net exporters of dairy products (in milk equivalent terms).[20] The locations of the supply and demand curves in Figure A2.6 correspond to the case of a net exporting country that in the absence of price support (that is, if production and consumption occurred at world market prices) would be a net importer.

20. Recent reforms in Switzerland that have taken place over the last several years have eliminated quota restrictions over time. The amount of quota rent in the model has been reduced from 25% in 2002 to 1% in 2008.

Figure A2.6. Quota version of Milk Model



Supply of raw milk is represented by the kinked line SS^q. The line *SS* corresponds to the industry marginal cost curve. These are the same only for that portion of the line below the intersection with the line designating the quota. Above this point they diverge. The point on the price axis at that point of intersection, P_s, has a particular interpretation. It is the so-called shadow price of the quota. It is that price which would, in the absence of the quota, bring forth exactly the quota level of production. Equivalently, it is the unit marginal cost of production at the quota.

In theory, changes in the producer price above this shadow price have no effect on production. The difference between the price the producer receives and the shadow price (P_p-P_s) measures the quota rent. Assuming that production quotas can be freely traded this rent reflects the price a producer would be willing to pay to purchase or rent one additional unit of quota. The *initial* value of this quota rent is a key parameter in the analysis. The estimated values for these parameters used in the simulation model are presented for each country in Annex 3. Notice that the unit quota rent will change with changes in either the producer price or in the marginal cost. Changes in the producer price above the shadow price result from changes in the trade or domestic policy measures responsible for creating the MPS gap. Changes in unit marginal costs result from both changes in the quota (movements along the curve SS^q) and changes in the costs of milk production (shifts in the curve *SS*).

The shaded areas in Figure A2.6 trace out the total of the monetary transfers from consumers resulting from MPS in the same sense as in Figure A2.5. However, the package of economic effects is somewhat different. The most important difference is the quota rent represented by the sum of the lightly shaded areas *a*, *b* and *c*. These rents are often assumed to accrue to milk producers, but are more properly regarded as returns to quota owners, whether they also happen to produce milk or not (Table A2.6).

Table A2.6 Economic costs and benefits of milk price support in the presence of quotas

Cost or benefit to economic agent	Area(s) in Figure 2.6
Taxpayer cost (to pay export subsidies)	*b+c+g+h*
Consumer losses	*a+b+d+e+f+g+h+i*
Quota rents	*a+b+c*
Farm welfare + input supplier gains	*e+g*
Dead-weight losses	*b+d+f+g+2h+i*

The effect of a change in quota on rents

An important policy question is the impact on producer welfare of changes in the level of the production quota. This change is composed of the change in quota rents (assuming for the moment that quota holders are in fact farm households, and the change in the producer surplus of the farm owned inputs. As noted above, this surplus cannot be identified in a supply demand chart, as the producer surplus in this space is the sum of that for farm households and input suppliers.

Increasing quota has three influences on the total quota rent. The increased quantity produced increases the rent by the change in quantity times the excess of price over marginal cost (area *d* in Figure 2.5). However, the increase in production causes marginal cost to increase along the supply function, eroding quota rents by this change (a loss equal to area *c*). At the same time, the producer surplus shared by farm households and input suppliers does increase by the amount above the supply curve and below the shadow price (area *c*+*e*).

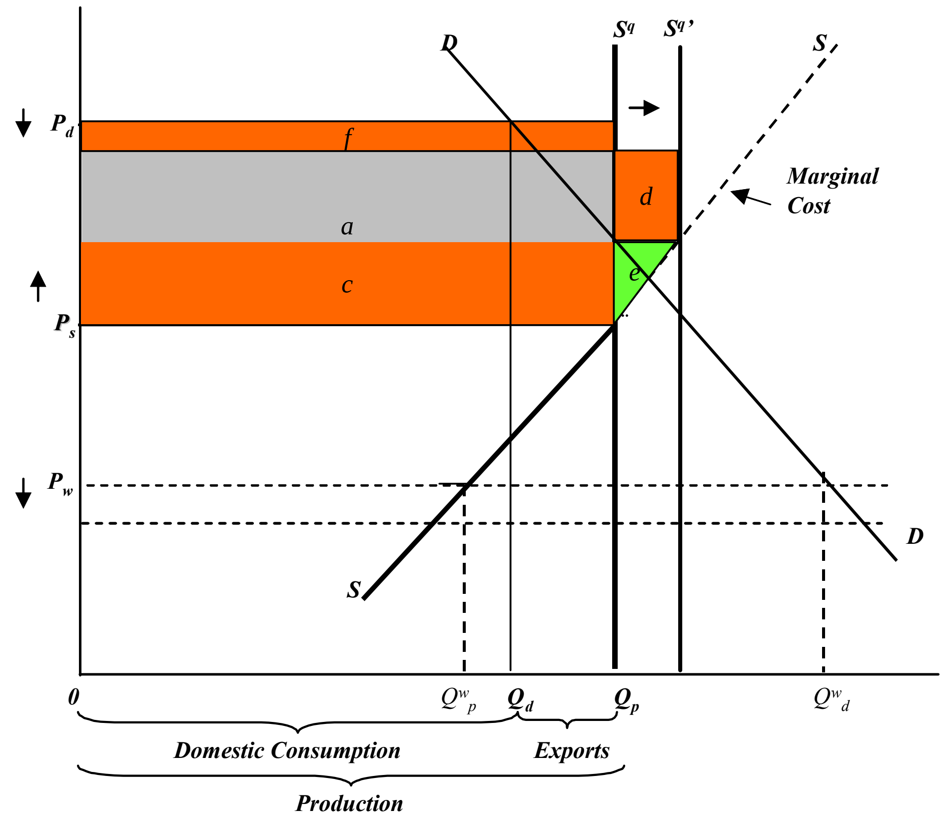
If the country in question is large enough to not be a price-taker on world markets, the increase in production and exports brought about by the quota increase will result in a decrease in world prices. This will reduce quota rents through a corresponding decline in domestic prices (assuming a constant tariff rate), shown as area *f* in Figure A2.7.

Table A2.7 Changes in benefits to farm households and quota owners from a quota increase

Cost or benefit to economic agent	Area(s) in Figure 2.5
Quota rents	*d – c – f*
Farm welfare + input supplier gains	*c + e*

As the areas *c* and *e* represent surplus and rents that are shared between farm households and input suppliers according to their relative factor intensity in production, it is impossible to be definitive on the basis of this graph. However, again assuming that quota holders are farm households, the move of area *c* from quota rents to surpluses must entail a net loss for farm households. Thus, for a quota increase to increase farm household welfare, $(1\text{-}fhh)*c\text{-}f < fhh*e+d$ where *fhh* is the share of producer surplus that accrues to farm households, a condition which would seem to depend primarily on the initial price support level, the slope of the supply function, and the degree to which the country is a price-taker on world markets.

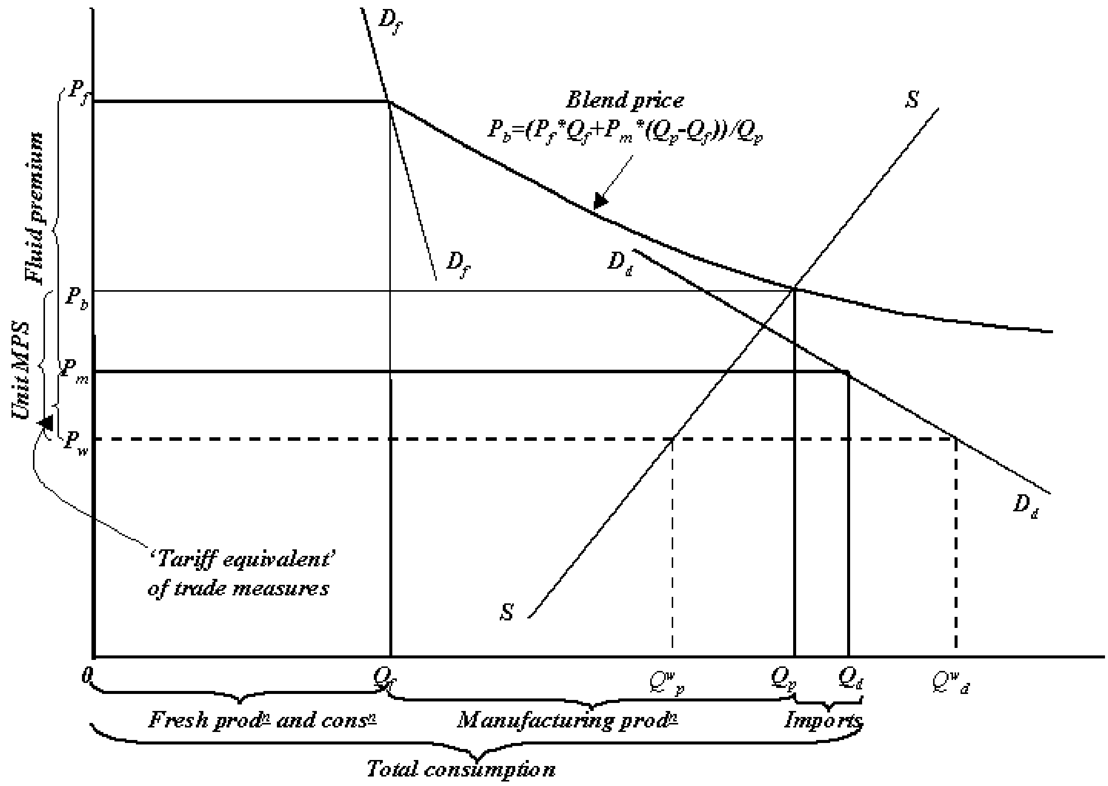
Figure A2.7. Change in Quota



Blend price system only

In the case of a blend price system, a policy-determined premium applies to the price charged consumers of fresh milk products. This representation is used for the United States[21], a net importer of dairy products in raw milk equivalent terms (Figure A2.8).

Figure A2.8. Blend price version of milk model



21. In the United States, the pricing scheme is implemented by a policy requiring milk handlers to pay producers a minimum premium for milk used for fluid consumption. The observed premium can be greater than the minimum premium due to other market factors. The policy cannot determine the blend price level but can act as a price discrimination scheme where a higher price is charged to the less elastic market. By doing so, it can enhance producer income without raising prices of the traded dairy products. More importantly, unlike other domestic market support policies, this policy can operate effectively without the help of border protection.

Supply of raw milk is represented by the line *SS* (also the industry marginal cost curve in this case). The supply-inducing price in this version of the model, the effective demand curve facing the industry, is the blend price P_b. (This is sometimes referred to as the pool price.) It is a weighted average of the consumer prices of two aggregated classes of milk demand: that for fresh dairy products (P_f) and that for manufactured dairy products (P_m). The weights are the respective quantities of milk used in each of the two end-uses. The difference between the price of milk used for fresh dairy products and that of milk used for manufactured dairy products is the policy-determined premium.

As the quantities of milk consumed and produced increases, the blend price declines gradually (asymptotically) toward the manufacturing milk price. The equilibrium level of milk production is determined by the intersection of the blend price with the milk supply curve. This is the point at which the producer's marginal cost equals the marginal price they receive. Notice that at that point on the demand curve *DD* consumers pay a lower price (the consumer price for manufacturing milk). This discrepancy between the marginal valuations by producers and consumers is an important source of economic distortion for blend price support systems.

The line *DD* corresponds to the total (the horizontal summation of) demands for fresh and manufactured dairy products. The equilibrium level of demand for fresh dairy products is denoted on the horizontal axis as Q_f, that of total demand by Q_d with difference equal to the demand for manufactured dairy products.

In calculating the unit rate of MPS the blend price is compared to the associated world market reference price for milk. The resulting price gap will be higher the higher the level of the tariff equivalent of trade measures used in a country and the higher the policy determined premium attached to the price of fresh dairy products. For purposes of the analysis the MPS gap obtained from the PSE data is partitioned between the tariff-equivalent measure and the price premium on fresh dairy products using data measuring the price of manufacturing milk in the countries concerned.

Comparing the equilibrium level of imports (Q_d-Q_p) with potential imports at world market prices ($Q^w{}_d$-$Q^w{}_p$) gives some indication of the degree to which the *combination* of these two instruments distorts trade volumes. A key question for the policy simulation analysis is how different are the production, consumption and trade effects of these two support measures.[22]

The graphical representation of the blend price model contained in Figure A2.7 illustrates the main price and quantity effects of support provided with one or the other of the two support measures in the model. However, the need to deal with two categories of consumer demand, each with its own price, in a single supply-demand diagram makes it

22. Although tariff-equivalent trade measures and blend price schemes may have similar effects, their policy targets may be entirely different. In the US case, for example, the two-price scheme is not a substitute for border support, nor can it be used effectively as a national milk support program. In reality, there is not a "national blend" price in the United States. Rather, there are regional blend prices designated by the Federal Milk Marketing Order System. This blend price policy redistributes producer income from one region to another. The greater the premium the more it raises income for producers located in areas where there is high utilisation of fluid milk, but lowers income of producers where there is low fluid utilisation. Changes in this pricing system are politically sensitive because of disputes between regions.

impossible to illustrate all the economic impacts by designating various geometric areas as done in the other figures.

Combined blend price and quota systems

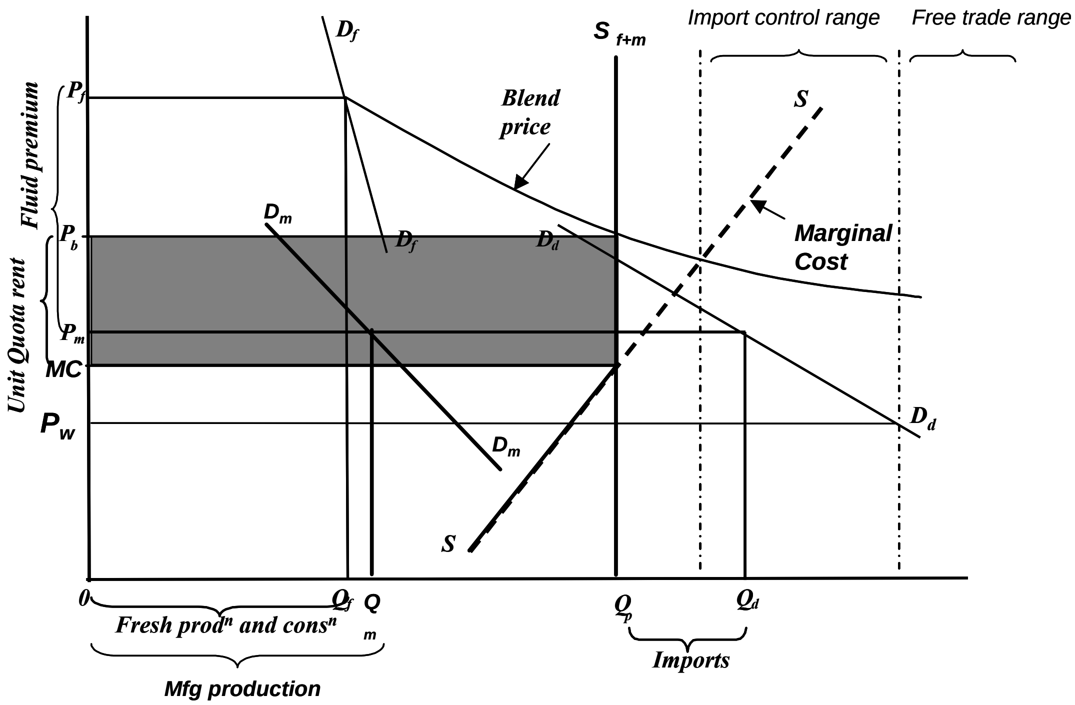
The Canadian version of the model treats quotas as endogenous and specifies a separate fluid and manufacturing milk quota. That is, domestic fluid and manufacturing milk prices are chosen by the policy maker, and then quotas in each market are set sufficient to clear each market, taking into account a fixed level of net imports of dairy products in raw milk equivalent. Because prices and imports are chosen through a policy process, there is no price transmission into the domestic market so long as the quotas continue to bind.[23] Producers own quota rights for industrial milk, and are allocated fluid production rights in a manner that is specific to each province, but nevertheless receive a blend price for their output.

Figure A2.8 illustrates this version of the model. Here, the policy choice of imports is handled implicitly as part of the way quotas are set as follows: In the range where total quota level lies to the left of the intersection of marginal cost and the blend price curve, the quota is binding on production. Changes in quota levels will be met by domestic production changes and imports will remain fixed. Quota levels set in the intermediate range to the right of the marginal cost-blend price intersection but before the blend price equals world price result in a situation where the quota is not binding on domestic producers (their marginal cost would be above the blend price in this range), but if domestic consumption were restricted to the quota level some restriction on imports would still be required. Therefore, scenarios with quota in this range can be considered to be representative of a non-binding domestic quota combined with some restrictions on total imports.[24] Beyond this point, quotas set in the "free trade range" in Figure A2.9, are completely unrestrictive, affecting neither domestic production nor level of imports.

23. In Canada, manufacturing milk is regulated at the federal level, while provincial marketing boards are responsible for fluid market regulation. Revenue from milk production is put into two pools, one for the western and one for the eastern provinces and farmers receive a common pool price for their milk on this basis.

24. It is actually even more complicated than this, since so many different combinations of levels of the two quotas are possible. Further, this is difficult to represent graphically, since Pm and Pf change endogenously with changes in the quota levels. The representation in Figure A2.8 is not exactly accurate, as shifts in the quota levels will shift the position of the blend price curve.

Figure A2.9. Two-quota version of milk model



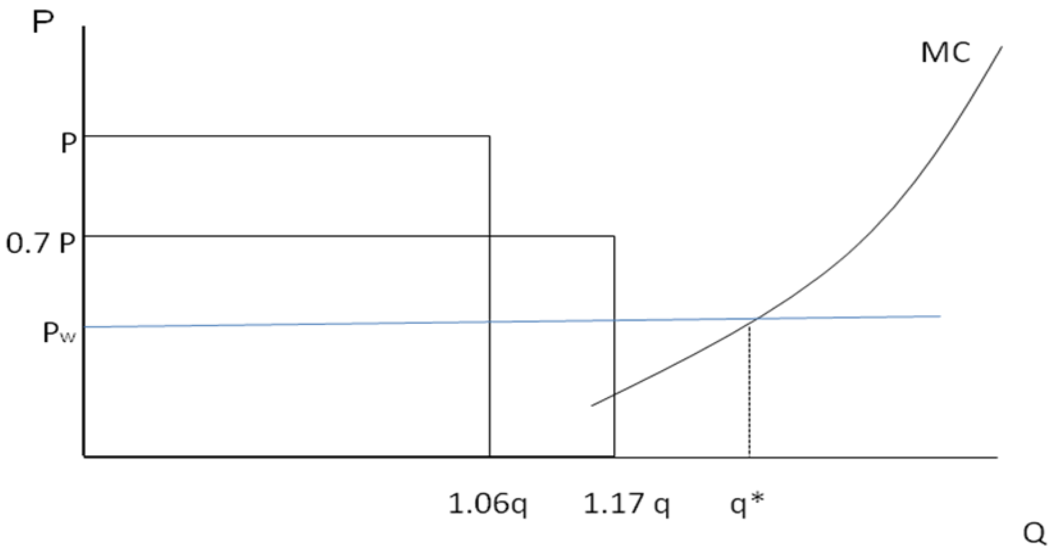
Milk market structure in Korea

The current dairy policy in Korea was instituted in 2002 with the creation of the KDC, the Korean Dairy Commission, which was put in place to handle the marketing of milk between producers and processors. Producers of milk were assigned a quota for milk production based on their production in a base period. Deliveries within 106% of the quota amount receive an in-quota price, with production between 106% and 117% of quota receiving 70% of the in-quota price. Deliveries over 117% of quota receive a price close to the import (world) price (Figure A2.10).

Currently, only 27% of milk deliveries are made through the KDC, with the rest being made through a number of different marketing organizations. These other marketing groups typically have a pricing structure that is similar in nature to that of the KDC (though usually without the intermediate quota price and quantity, and an over-quota price that may be below the world price) and the KDC operates as a price leader in the market. The KDC price and quota structure cannot be used directly in the PEM as it is valid for only about one quarter of domestic milk deliveries, but the idea of a high in-quota price and low out-of-quota price holds in general for the Korean milk sector, and this structure is adopted in the PEM representation of the Korean milk market.

Most milk produced is intended for the domestic fluid milk market, with domestic production in excess of domestic demand used for processing into manufactured milk products. Domestic milk processors are also able to import milk products from the world market under a modest tariff, which leaves the raw-milk equivalent price of imported milk for manufacturing well below the domestic price received by producers. To make up the difference, a subsidy is paid to processors using domestic milk.

Figure A2.10. Price and quota structure of KDC System

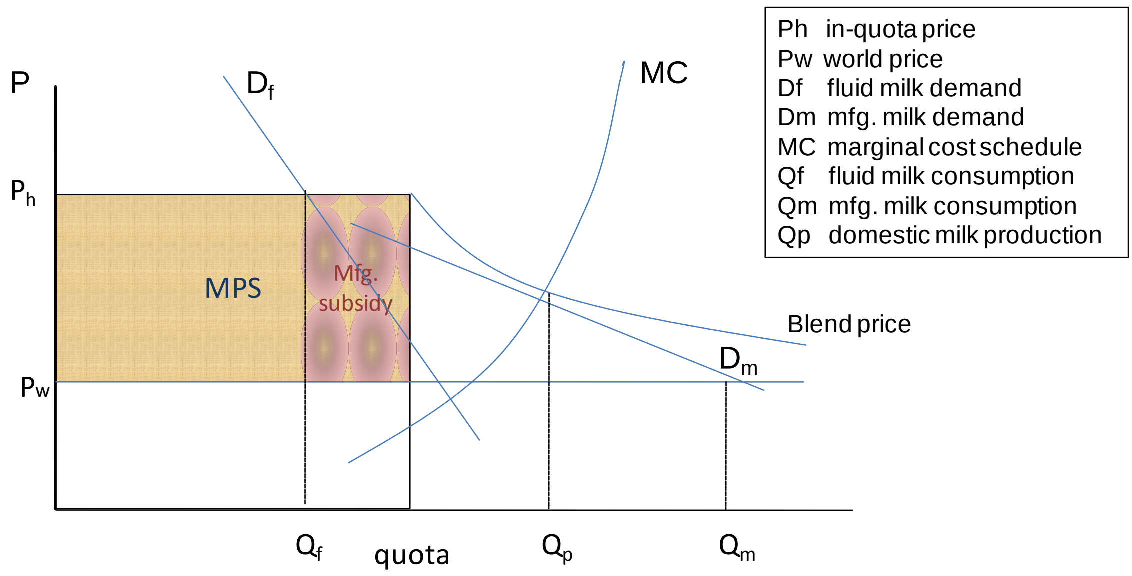


Source: Adapted from Song, Joo-Ho, Min-Kook Jeong, Hyun-Joong Kim, Hyun-Ok Lee, and Byeong-Il Ahn (2005).

The price differential between the domestic and import (world) price is measured in the PSE as market price support. The subsidy paid for domestic milk used for processing is not currently in the PSE and is added using Korean data. The PEM model reconciles this data with the milk market structure by solving for the quota amount and in-quota price that exhausts both the MPS level and manufacturing subsidy level given total milk production and fluid milk deliveries. That is, using the definitions for MPS and the manufacturing subsidy, P_d and Q can be uniquely solved for, thereby calibrating the model.[25] The final structure of the model defines MPS as the difference between the world price and the domestic price, multiplied by the quota level. The manufacturing subsidy is the excess of domestic milk production over fluid use, also multiplied by the difference between domestic and world price (Figure A2.11). Producers are assumed to respond to the blend price received for milk.

25. Total MPS defines the area of the square labelled "MPS" in Figure A2.10, defined by the difference between P (the domestic in-quota price) and Pw (the world price), and the origin and the quota level, labelled "quota". The manufacturing subsidy is defined by a square of the same height (P-Pw), and width defined by the difference between quota production and fluid milk consumption. Pw and the quantity consumed as fluid milk is known, as are the level of MPS and manufacturing subsidy, which taken together imply unique values of P and "quota" by solving a system of two equations (the definitions of MPS and subsidy levels) and two unknowns (the in-quota price and quota level).

Figure A2.11. Korea milk market representation in PEM



Representation of counter-cyclical programs in the United States

A version of the model taking into account the effects of risk-reducing policies in the United States on producer choice was developed for the study "Evaluation of Agricultural Policy Reform in the United States" [TAD/CA/APM(2009)/22/REV3]. The impact of the group of related policies commonly termed "Loan Rate" and the counter-cyclical payment on the variability of farm returns is calculated, and this impact is translated into model outcomes under the assumption of a certain level of risk-aversion on the part of the producer. This approach will eventually be expanded to cover risk-reducing policies in other countries represented in PEM.

Risk-reduction is a objective of agricultural policy in many countries and provides benefits to risk-averse producers by making payments when prices are low, thus reducing the net effects of negative price shocks. Such payments can be made either according to current production, as for the loan rate (LR) programs, or on the basis of historical production, as is the case for the Counter Cyclical Payment (CCP), paid on the basis of base acres according to current prices.

The approach taken is to consider the effect of the two main risk-reducing programs, LR and CCP, on the profit-maximising decision of a producer of multiple commodities, potentially possessing base acres in each. It is assumed that producers are risk averse with a utility function compatible with constant absolute risk aversion (CARA) preferences, which exclude the complicating factor of wealth effects of risk. Wealth effects have been shown to be small relative to the insurance effect (OECD 2002). This approach builds on that used in OECD 2002, a primary difference being the multi-commodity approach taken here.

Begin by considering the profit function of a representative farm:

$$\tilde{Y} = \sum_{i=i}^{n} [\tilde{P}_i Q_i - C(Q_i)] + \sum_{i=1}^{n} LR_i(\tilde{P}_i) Q_i + \sum_{i=1}^{n} CCP_i(\tilde{P}_i) Q_i^0 + \theta \tag{1}$$

where Y is farm income, P_i, Q_i and $C(Q_i)$ are the price, quantity produced and cost of production of commodity i, respectively and the tilde indicates a random variable. The LR payment is defined for each commodity and paid on the basis of current price per unit of current output. The CCP payment is defined for each commodity as a function of the current price of commodity i and paid on the basis of base area of commodity i, Q_i^0. The additional term θ represents other sources of income. For simplicity it is assumed that the only source of risk is price risk, such that the price of the commodity is a random variable but the quantity produced is not. A utility function with CARA preferences defined by parameter α may be expressed as a mean-variance utility function as follows:

$$\breve{Y} = \bar{Y} - \frac{1}{2}\alpha V(\tilde{Y}) \tag{2}$$

that is to say, certainty-equivalent income equals expected income minus the variance of income times one half the CARA parameter. The variance of income is derived by application of the law of sums and products of random variables to the variance of (1), and involves several covariance terms between the different commodity prices, the loan rate and the CCP:

$$\begin{aligned} V(\tilde{Y}) = {} & \sum_i Q_i^2 V(\tilde{P}_i) + \sum_i Q_i^{0^2} V(CCP_i(\tilde{P}_i)) + \sum_i Q_i^2 V(LR_i(\tilde{P}_i)) \\ & + \sum_i \sum_{j \neq i} Q_i Q_j COV(\tilde{P}_i, \tilde{P}_j) + \sum_i \sum_{j \neq i} Q_i Q_j COV\left(LR_i(\tilde{P}_i), LR_j(\tilde{P}_j)\right) \\ & + \sum_i \sum_{j \neq i} Q_i^0 Q_j^0 COV\left(CCP_i(\tilde{P}_i), CCP_j(\tilde{P}_j)\right) + 2\sum_i \sum_j Q_i Q_j COV(\tilde{P}_i, LR(\tilde{P}_j)) \\ & + 2\sum_i \sum_j Q_i^0 Q_j COV\left(CCP_i(\tilde{P}_i), LR_i(\tilde{P}_i)\right) \; 2\sum_i \sum_j Q_i Q_j^0 COV(\tilde{P}_i, CCP(\tilde{P}_j)) \end{aligned} \tag{3}$$

With the variance defined, the first order condition with respect to Q_i is found by taking the derivative of the certainty-equivalent utility function (2) after substituting (3) and cleaning up terms:

$$\frac{\partial \breve{Y}}{\partial Q_i} = P_i - C'(Q_i) \underbrace{- \alpha \left[\sum_j \{ Q_j [COV(\tilde{P}_i, \tilde{P}_j) + COV(LR_i, LR_j) + COV(\tilde{P}_i, LR_j)] + Q_j^0 [COV(\tilde{P}_i, CCP_j) + COV(CCP_i, LR_j)] \} \right]}_{\phi} \tag{4}$$

The risk effects can be characterised as an add wedge in the risk-free price=marginal cost condition. The amount ϕ contains all the relevant variance and covariance terms multiplied by the CARA parameter.

Taking a closer look at the components of ϕ indicates that a higher covariance in prices, indicating higher variability of market revenue, reduces optimal quantity produced. The loan rate potentially adds to that variability by adding a revenue stream with its own covariance, Cov(LR,LR), that is counteracted by the negative—by design—covariance of the loan rate with prices, Cov(P,LR). Similarly with the CCP, its negative covariance with prices reduces overall variability, while the covariance term Cov(CCP,LR) is potentially positive. Covariance terms involving the CCP are multiplied by base area, while other terms are multiplied by the current output of the commodity with respect to which the covariance is taken. The producer responds to lower overall variability with greater production. This is the essence of risk aversion—lower variability is equivalent to a higher price. In general for a risk averse firm under price uncertainty $C'(Q)>E(P)$ and output is less than in the case of certain prices.

Treating the risk effects ϕ as a simple price premium related to price variability provides a straightforward means of including these effects in the PEM. By calculating the variance and covariance terms to determine an explicit value for ϕ, the model can be recalibrated to include this element as part of the initial market equilibrium. In policy simulations, changes in the covariance terms that result from changes in policies will affect the incentive price for producers. Equation (4) yields a premium that may be calculated for each commodity in the model. The zero-profit condition in the model connects quantity supplied and price and is the natural insertion point for ϕ by simply using the incentive price implied by (4):

$$Q * (P - \phi) - \sum_{i} r_i X_i = 0 \qquad (5)$$

The risk premium appears only in the supply side of the model—it does not impact consumer price.

To calculate ϕ an estimate of the value of the CARA parameter α is required. This parameter defines the relative importance of income and variance of income in the utility function, serving to scale the impact of risk according to the degree of risk aversion and the magnitude of income variation. Risk aversion can be quantified by the specification of a risk premium (the amount a risk-averse individual is willing to pay to avoid a fair gamble) or a probability premium (the amount above the actuarially fair amount the probability of winning a gamble must be to make the risk-averse individual indifferent between taking the gamble or not). The CARA parameter is a function of these measures of risk aversion (expressed in percent) and the standard deviation of returns—essentially the magnitude of the risk taken. Babcock, Choi and Feinerman (1993) provide the following relationship between the risk premium θ, the CARA parameter α, and the standard deviation of returns σ:

$$\theta = \frac{\ln\left[\frac{1}{2}\left(e^{-\alpha\sigma} + e^{a\sigma}\right)\right]}{\alpha\sigma} \qquad (6)$$

This equation has to be solved implicitly for α; results for some typical values are shown in Table A2.8. Notice that the CARA parameter increases exponentially with the value of the risk premium—higher risk premiums means the variance of income is relatively more important in (2).

The CARA parameter α for the utility function in (2) can be estimated based on the variation of returns to all the commodities in PEM and a chosen value of θ. In order to get a time series for the CARA parameter, the variation of returns for the previous 8 years was used to determine that year's CARA parameter (requiring revenue data back to 1979 for early years in the study period).

Table A2.8. CARA parameters for 1% risk premium (□=0.01, 1986-2008)

	CARA Parameter α	Standard Deviation of Revenue σ
1986	0.00000378	5287.0
1987	0.00000380	5270.1
1988	0.00000434	4605.7
1989	0.00000413	4838.7
1990	0.00000367	5449.8
1991	0.00000364	5489.2
1992	0.00000309	6475.1
1993	0.00000319	6275.2
1994	0.00000356	5622.8
1995	0.00000335	5971.1
1996	0.00000287	6959.1
1997	0.00000278	7190.2
1998	0.00000290	6908.1
1999	0.00000347	5765.3
2000	0.00000371	5384.3
2001	0.00000584	3422.1
2002	0.00000599	3339.0
2003	0.00000323	6200.3
2004	0.00000231	8642.4
2005	0.00000203	9851.6
2006	0.00000178	11237.1
2007	0.00000078	25533.1
2008	0.00000066	30476.4

Source: OECD PSE database, own calculations.

The second component of ϕ that needs to be calculated is the set of covariances identified in (4). The covariances of prices are calculated on the basis of the prior eight years observations, while covariances between the LR, CCP, and prices are calculated using the observed distribution of prices and the specified loan rates and target prices for each commodity. That is, using the observed mean and standard deviation of prices for each year, and assuming a normal distribution, a series of 3 000 prices were drawn, and the implied LR and CCP payments calculated.[26] The covariances between these payments and prices are then calculated using these 3 000 synthetic observations.

Observed prices and payment rates are not used in this calculation as for many commodities and years, no CCP payments have been made, so a calculation based on observed values would yield a covariance of zero, indicating the program has no impact on producers. This does not correspond with the fact that the payment has a risk-reducing effect that provides a value to producers. Consider farmers with base in wheat; while they

26. The standard deviation of prices was calculated using the previous eight year's data, but the mean price was calculated using the past three year's data, under the assumption that farmers do not use prices in the far past to form expectations.

have never received a CCP payment on the basis of wheat price, they would not be indifferent to the elimination of the CCP. The insurance effect of the program remains valuable to them. The model therefore relies on expected values for the program, rather than observed values that are contingent on the particular price draws observed by history.

Table A2.9. Covariance Matrices, 2008

Cov(Pi,Pj)	Wheat	Coarse grains	Oilseeds	Rice	Milk	Beef
Wheat	3133	1875	3771	4749	2393	12389
Coarse Grains	1875	1199	2348	2782	1279	7137
Oilseeds	3771	2348	5296	5899	2734	17834
Rice	4749	2782	5899	8322	3589	25567
Milk	2393	1279	2734	3589	3310	12388
Beef	12389	7137	17834	25567	12388	112193

Cov(LRi,LRj)	Wheat	Coarse grains	Oilseeds	Rice	Milk	Beef
Wheat	0.8	0.6	1.1	2.5	0	0
Coarse Grains	0.6	1.4	2.5	2.3	0	0
Oilseeds	1.1	2.5	19.5	15.2	0	0
Rice	2.5	2.3	15.2	73.9	0	0
Milk	0	0	0	0	0	0
Beef	0	0	0	0	0	0

Cov(Pi,LRj)	Wheat	Coarse Grains	Oilseeds	Rice	Milk	Beef
Wheat	-11.1	-14	-69.9	-180.4	0	0
Coarse Grains	-6.6	-10	-45.9	-104.0	0	0
Oilseeds	-12.6	-18	-107.3	-223.9	0	0
Rice	-15.7	-19	-107.7	-330.3	0	0
Milk	-8.1	-8	-45.3	-131.5	0	0
Beef	-35.2	-43	-335.9	-1040.5	0	0

Cov(LRj,CCPi)	Wheat	Coarse Grains	Oilseeds	Rice	Milk	Beef
Wheat	2.1	1.1	0.8	2.8	0	0
Coarse Grains	2.4	1.7	1.2	3.4	0	0
Oilseeds	9.5	7.5	8.3	18.2	0	0
Rice	22.0	11.3	11.8	57.5	0	0
Milk	0	0	0	0	0	0
Beef	0	0	0	0	0	0

Cov(Pi,CCPj)	Wheat	Coarse Grains	Oilseeds	Rice	Milk	Beef
Wheat	-102.5	-72.3	-62.5	-333.1	0	0
Coarse Grains	-61.7	-47.7	-40.1	-195.4	0	0
Oilseeds	-121.7	-92.2	-92.1	-412.0	0	0
Rice	-152.8	-104.8	-96.5	-578.3	0	0
Milk	-77.6	-46.8	-41.9	-254.6	0	0
Beef	-384.0	-256.7	-287.8	-1767.1	0	0

Cov(CCPi,CCPj)	Wheat	Coarse Grains	Oilseeds	Rice	Milk	Beef
Wheat	16.7	9.2	6.4	26.7	0	0
Coarse Grains	9.2	8.0	5.1	16.8	0	0
Oilseeds	6.4	5.1	7.3	14.6	0	0
Rice	26.7	16.8	14.6	103.7	0	0
Milk	0	0	0	0	0	0
Beef	0	0	0	0	0	0

Source: OECD PSE/CSE database, own calculations.

Milk and beef do not receive CCP or LR payments, so the covariance of these programs with respect to these commodities is zero. These covariances and the estimate of α, combined with information on base acres and production are sufficient to calculate ϕ and calibrate the model using (5). Values for ϕ can be negative when there exists a natural hedge between commodity prices that have negative covariances (Table A2.9). This is true for milk and beef for some years in the study period, as livestock prices can move in the opposite direction from crop prices. The prices of the crops in PEM tend to move strongly together. The major component of ϕ comes from the covariance of prices—the covariances introduced by the loan rate and CCP are relatively small and make up a correspondingly small part of ϕ.

3. The feed market and other interactions between commodities

On the demand side of the model, estimates of own- and cross-price elasticities of demand were generated using the 2005 version of the Aglink model and baseline (*Agricultural Situation and Outlook*, OECD, 2005c). This provided a matrix of elasticities for all six PEM commodities, and allows price changes for any commodity to affect the demand for any other. That said, many of the cross-price elasticities are small, and were truncated to zero if they were measured as being below 0.001 in absolute value.

Concentrated feeds represent a significant percentage of total demand for crops, especially for coarse grains and oilseeds (in the form of oilseed meal). A change in this demand is the main driver of cross-commodity effects between livestock and crop production. The other source of cross-commodity effects on the supply side of the model come from the substitutability in input use in the production of different commodities. As mentioned above, different inputs have different degrees of substitutability across commodity uses. In the production of each commodity there is assumed to be an input, termed *Other farm-owned inputs* that is perfectly specialised in the production of that commodity and for which no substitution across commodities is possible. For most purchased inputs, the assumption is that they are perfectly substitutable across commodities. That is, a single supply price prevails for these inputs and it is possible to represent these inputs as having a single source of supply that is demanded by all commodity uses. These are termed common, or allocatable, inputs. Exceptions to this are the inputs *Machinery and Equipment*, and *Other Purchased Inputs*, which are assumed common to all crop uses but specialised to milk and beef production. Cows and Concentrated Feeds are specialised to milk and beef, and are not used in crop production. Land is the only input with a cross-price elasticity of supply between 0 and infinity. How this cross-elasticity is determined will be discussed in the following section.

The crop, milk and beef sectors (indeed all agricultural uses) share a common land base, with total agricultural land substitutable between pasture for animals and land used for the production of grains, oilseeds or other crops.[27] Land is a factor of particular interest, as it is one of those inputs assumed owned by farmers[28], and one in which value of government programs is thought to be capitalized.

In the model, concentrated feed is produced using crops as an input, plus capital specific to the production of feed. This demand for wheat, coarse grains and oilseeds used in the production of milk is a component of total demand for these outputs and so forms part of their consumer demand functions. Specifically, changes in demand for feed grains and oilseed meal are additive to the consumer demand function. This recognises that the consumption data used in the model correspond already to total demand, including that for feed production, and essentially separates the demand function for crops into two parts—demand for feed use, and demand for non-feed use.[29]

Production of concentrated feed is much like a mini version of any other PEM commodity module. It uses a linearised CES function with four inputs—capital, wheat, coarse grains, and oilseeds—to produce the concentrated feed output used by milk and beef producers. The crop component of the model provides the supply side of the feed factor markets, as described in the preceding paragraph. Capital input into the feed market has a supply function of the usual form, and the amount of capital required is determined via the zero-profit condition for the feed market. That is, the value of output of concentrated feed is known from the input expenditures in milk and beef production. The expenditure on crop inputs into feed production is known from the crop prices endogenous in the model and the initial demands from the base data. The difference between expenditure on concentrated feeds and expenditures on crop inputs into feed production must be the value added in concentrated feed production, equal to the value of the feed capital input. This calibrates the feed market.

27. No distinction is made between land that is foraged by animals directly or mown for hay or silage.

28. This assumption is made recognising that some farm land is rented from non-farmers, the difference being important only for allocating estimates of welfare changes.

29. This structure is taken into account in generating the demand elasticities using Aglink. That is, the elasticities taken from Aglink represent consumption demand for all uses other than that for feed consumption by milk or beef animals.

To complete representation of the feed market a supply elasticity of the value-added factor as well as elasticities of substitution for different grain and oilseed inputs is required. The values of these elasticities are the same for each country (Table A2.10). The supply elasticity of value added (capital) is taken to be the same as farm-owned factors (0.5), and inputs are assumed to be poorly substitutable with the exception of wheat and coarse grains, which are highly substitutable. This is because wheat and coarse grains are both energy feeds, while oilseed meal is a protein feed. Own-elasticities are determined by the homogeneity condition and are not reported.

Table A2.10 Concentrated Feed Production Parameters

Supply elasticity of capital	0.5			
Elasticity of substitution	**Capital**	**Wheat**	**Coarse Grains**	**Oilseeds**
Capital	-	0.1	0.1	0.1
Wheat	0.1	-	0.9	0.1
Coarse Grains	0.1	0.9	-	0.1
Oilseeds	0.1	0.1	0.1	-

Source: OECD PEM model.

The milk and beef sectors interact in the model not just through competition for inputs, including concentrated feeds, but also through the production of beef as a by-product of dairy production, in the form of calves and cull cows. The model currently assumes that 25% of the dairy herd is culled and enters the beef market in any given year (that is, a dairy cow has a four-year useful lifespan). Culls, measured in animals, are converted to tonnes using a carcass weight parameter. Production from beef-only enterprises is calculated as the total beef production quantity in the PSE database minus the size of the dairy herd multiplied by the cull rate and carcass weight conversion factor. Dairy calves are not currently included, but can be an important component of beef supply in some regions.

Land used in the production of milk or beef represents generally any land used to produce forage for dairy animals, including either land used for the production of silage, or pasture land, differentiated between milk or beef use. Other elements of the land supply structure are arable land used for other crops, and miscellaneous or "all other" land, comprising mainly land for production of fruit and vegetables. While most other input factors are represented as indexes in the model, demand for land is represented in hectares. Land prices are determined by dividing the value of land as an input by the area used in each category.[30] For other arable land, for which the model provides no information on value, the price is assumed equal to the average price for land used in the production of wheat, coarse grains, and oilseeds. Miscellaneous land is assumed to have a price double this amount.

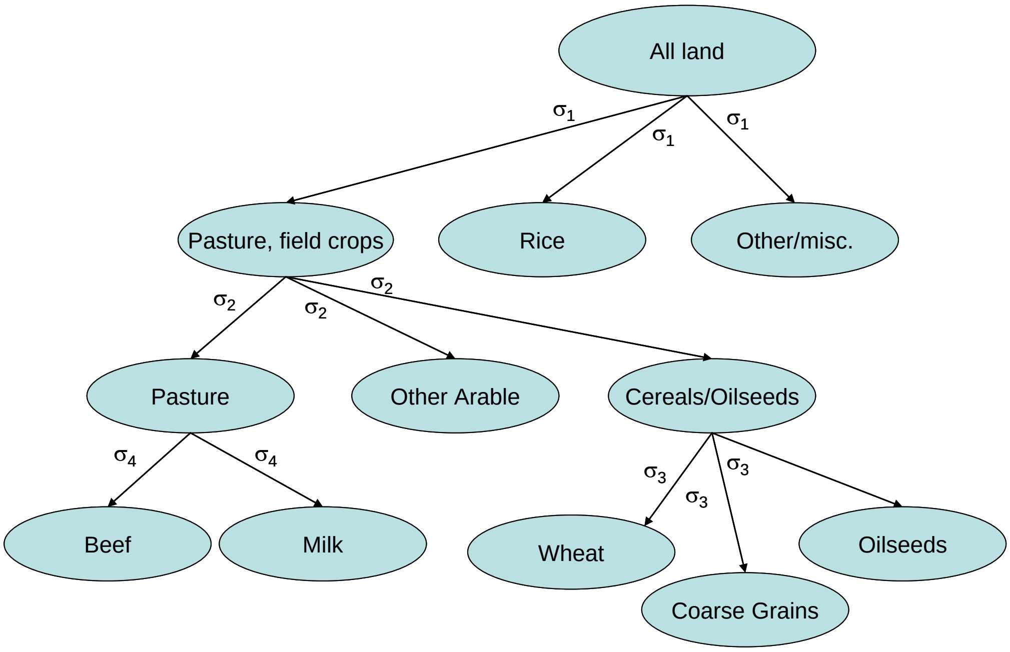
30. Factor quantities are normally defined as *Factor quantity=(Revenue*factor share)/price*. Factor prices are normally set arbitrarily at 100, leaving the factor share as the key piece of information. Since quantity of land in hectares is known, this equation is inverted to determine the price of land.

4. Land allocation

In the PEM, land is assumed to be 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 pasture, beef pasture and other agricultural uses) according to a transformation function.

This 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, pasture is allocated between milk and beef, and the cereals and oilseeds group is allocated between wheat, coarse grains, and oilseeds (Figure A2.12).

Figure A2.12. Land allocation structure



At each of these stages a constant elasticity of transformation (CET) function is used to describe how uses may be allocated. That is, at each level in this decision-making process the transformability of land is the same, but this rate differs between levels. The parameter of the CET function, σ, determines the mobility of land between uses at each stage. As we move downward through this land allocation framework, land becomes more similar in use and therefore more easily fungible between uses. We expect $[\sigma_3, \sigma_4]>\sigma_2>\sigma_1$ in general. We term this a **nested CET framework**, and refer to the land groupings in each stage as **nests**, the top being nest 1 and the lowest nest 3.

In the case of the PEM, information regarding the transformability of land between one use and another is contained in the two consultant reports produced for this purpose during the pilot phase of the model development. These reports provided best estimates and acceptable ranges of estimates of own- and cross-price elasticities of demand for land based on a review of the literature. These elasticities are straightforward functions of the transformation parameters in each nest and the share of land for each use. As land use shares are known constants, this leaves the choice of the three CET parameters as the determinant of the matrix of own and cross-price elasticities for land. The conversion is as follows. For rice land, a member of nest 1 (the highest), its own-price elasticity is

$$\varepsilon_{rr} = \sigma_1 \cdot (1 - sr_r),$$

where sr_r represents the value share of rice in all land. As this is the highest level CET function, this equation is the same as for any single CET function; the own elasticity is equal to the transformation parameter times one minus the share. The cross-price elasticity is defined as

$$\varepsilon_{rw} = -\sigma_1 \cdot sr_w,$$

the negative of share of wheat land times the transformation parameter for nest 1.

For wheat land, a member of nest 3 (the lowest, and similarly for milk or beef land), its own-price elasticity is

$$\varepsilon_{ww} = \sigma_3 \cdot \left(1 - \frac{sr_w}{sr_{n3}}\right) + \frac{sr_w}{sr_{n3}} \cdot \sigma_2 \cdot \left(1 - \frac{sr_{n3}}{sr_{n2}}\right) + \frac{sr_w}{sr_{n2}} \cdot \sigma_1 \cdot (1 - sr_{n2}),$$

where sr_w is the value share of wheat in all land, sr_{n3} is the value share of the lowest nest in all land, and sr_{n2} is the value share of the second nest in all land. The ratio sr_w/sr_{n3} is therefore the proportion of value of wheat in nest 3. This can be seen as an extension of the result for a single CET function, where to the single function formula is added a share of the impact of all the higher nests. That is, a change in the price of wheat will bring an adjustment of land for wheat within not only its nest, but between nests as well.

The cross-price elasticities for wheat land, with respect to price of coarse grains land (same nest), price of pasture (prior nest), and price of rice land (top nest) are as follows

$$\varepsilon_{wc} = -\sigma_3 \cdot \frac{sr_c}{sr_{n3}} + \frac{sr_c}{sr_{n3}} \cdot \sigma_2 \cdot \left(1 - \frac{sr_{n3}}{sr_{n2}}\right) + \frac{sr_c}{sr_{n2}} \cdot \sigma_1 \cdot (1 - sr_{n2}),$$

$$\varepsilon_{wp} = -\sigma_2 \cdot \frac{sr_p}{sr_{n3}} + \frac{sr_p}{sr_{n3}} \cdot \sigma_1 \cdot (1 - sr_{n2}),$$

$$\varepsilon_{wr} = -\sigma_1 \cdot sr_r$$

Having only three degrees of freedom means that it is practically impossible to recover exactly the original elasticity matrix. A decision rule was used where σ_1, σ_2, and σ_3 were chosen to produce an average value of the own- and cross-price elasticities for all wheat, coarse grains, and oilseeds and the own-price elasticity for rice equal to the average values for these parameters specified in the consultant reports. Beef and dairy land are assumed to have the same own-price elasticity as crops, thus determining σ_4. This approach leaves free all other elasticities, for which estimates were not included in the consultant reports, and also allows in some cases specific own- or cross-price elasticities to fall outside of the range specified in these reports. This deviation from a strict application of values given in their reports is a necessary trade-off for having the more formalized structure of land allocation. This rule results in the following equations for the CET parameters σ_1, σ_2, σ_3, and σ_4:

$$\sigma_1 = \frac{\varepsilon_{rr}}{(1 - sr_r)},$$

$$\sigma_2 = \frac{\bar{\varepsilon}_{ii} + 2\bar{\varepsilon}_{ij} - \frac{\varepsilon_{rr}}{(1 - sr_r)} \cdot \left(\frac{sr_{n3}}{sr_{n2}} - sr_{n3} \right)}{1 - \frac{sr_{n3}}{sr_{n2}}},$$

$$\sigma_3 = \bar{\varepsilon}_{ii} - \bar{\varepsilon}_{ij},$$

$$\sigma_4 = \bar{\varepsilon}_{kk} - \bar{\varepsilon}_{ij},$$

where the bar above the elasticity indicates an average value. The own-price elasticity for livestock uses is denoted ε_{kk}.

This approach to choosing the values for the σ's has the virtue of being true to the estimates provided in the consultants' reports, but is not an unambiguously best choice. In particular, it makes no attempt to set reasonable limits on the net elasticity of important land groupings. These net elasticities can be major determinants of the production impacts of some policies.[31]

5. Policy shocks and scenario design

How policy shocks enter the model was discussed in a general way in an earlier section of the paper. This section returns to this topic and goes into some further detail to describe the manner that policy changes enter the PEM model, and how the choices regarding this manner can affect the results the model produces.

Every policy included in the model requires two pieces of information: The total level of support and the rate of support that acts as a price wedge in one or more markets. Initial calibration of the model involves using the levels of support in the PSE database and deriving the appropriate rate of support that, over all the affected markets, adds up to and implies that initial level. For commodity-specific policy categories, this is a simple process. The rate of support is equal to the level of support divided by the quantity produced. This yields a rate of support appropriate for use in the following formulation of supply and demand prices:

$$P^i{}_s = P^i{}_d + r^i$$

This is the standard approach shown in Figure A2.3; supply price for commodity or input *i* (P^i_s) equals the demand price (P^i_d) plus rate of support (r^i). This solves the initial calibration problem and, for commodity-specific shocks, leads to a simple method of generating policy scenarios: add or subtract the desired amount from the total level of

31. The value of σ_1 is of particular importance in determining the net elasticity, and so a variation in the rule for choosing this parameter could modify this net elasticity. The other main factor in determining this net elasticity is the value of miscellaneous land (essentially fruits and vegetables). For this reason, policy analysis is often conducted on the basis of stochastic simulations (with varying parameter values) and, as regards future research, obtaining an accurate price for this category is important, and may merit special consideration.

support, and recalculate the rate, leaving the quantity as endogenous. However, for more general policy scenarios, there are still some decisions to be made. For example, if one wishes to model a general increase or decrease in deficiency payments applied to several commodities, how might one choose to allocate support changes across commodities? One obvious choice is to provide each affected commodity with the same level of shock, thus evenly spreading the value of the policy change across commodities. However, this may be unrealistic for cases where a country has traditionally supported one commodity but not others. An alternative then would be to allocate the level of support according to the pattern that exists in the base data. This would mimic an expansion or contraction of the current policy landscape, but can hardly be called a "general" increase if it means that the support change predominantly affects a single commodity.

In the PEM, the choice was taken to use the latter approach, a uniform expansion of the current payment pattern, to reflect broadly-based changes in support. Where there is no support provided in the base year for a given category of support, equal level changes across commodities are used. This requires one to be alert to the resulting pattern of support when considering such results. This decision affects MPS, payments based on commodity output, payments based on current area, and consumer subsidies, as these are the commodity-specific policies in the model.

Payments based on variable input use present a different challenge. These payments are not made to a specific commodity or input[32]. Moreover, some inputs are common to all commodity uses, while others are common to crops but are specific to milk and beef (such as machinery and equipment). The assumption for such payments is that they affect all purchased factors except hired labour, concentrated feed, and fertiliser. This reflects the observation that while it is uncertain to which inputs these payments are directed, it is unlikely to be at these three. Farm-owned inputs (Cows, land, other farm owned inputs) are assumed not to receive input support payments.

An input support rate must be found that, when applied to up to seven different inputs and for six different commodities, exhausts the total level of input support provided to all commodities. These payments are not considered commodity-specific, so it is assumed that such payments do not distort the relative price levels of affected inputs, so the mix of inputs will be unchanged even though the total inputs purchased will be higher. That is, relative supply prices of supported inputs must be preserved. This requires the support rate to be proportional to the supply price; an *ad valorem* amount. In this case rather than dividing the level of support by the quantity, it must be divided by the amount of factor expenditures, price times quantity. In fact, the level must be divided by the total value of all affected input markets, for all commodities, in order to determine the common *ad valorem* rate.

This broaches the topic of how support may affect relative prices. Changes in relative prices essentially drive the model, so the distinction between policies that affect relative prices and those that do not is important. In general, it is assumed that payments that are non-current or non-commodity specific do not alter the relative prices between affected markets. This is a change from the original crops version of the model. This formulation means that the important relative price change from such a policy shock is between the *set* of affected markets and the set of other markets. The larger the set of affected

32. It is likely that in some cases, payments based on input use may be tied to their use in the production of a particular commodity. The approach chosen here is considered generic to the PSE category.

markets, the less impact a program is likely to have. This is because there are a greater number of prices that are not changing in relative terms, and because the total level of support is being spread across more markets, thus reducing the rate of support, all else equal. It is always the case that a policy that does not directly influence production decisions within its scope also does not directly affect relative prices in that same scope of application; these are equivalent statements. This is true regardless of the initial basis or distribution of such a payment.

Payments based on non-current A/An/R/I are assumed to be capitalized in the value of land (the most fixed input in production). These payments will affect land prices as a result, but should not alter the land allocation decision except where conditions or restrictions on how land receiving the payment may be used. That is, such a payment would discourage land from being converted to orchards or golf courses if by doing so eligibility for the payment is eliminated. Therefore, such restrictions define the scope of the policy impact and the set of land markets affected by the payment. Again, relative prices of land within this set should not change, and so the rate of support will be calculated on an *ad valorem* basis.[33]

Finding this *ad valorem* rate is more complicated for payments based on non-current A/An/R/I than for payments based on variable input use. With payments based on variable input use, the supply price can be assigned an arbitrary index value as a starting point for the calculation. In the case of land, the quantity is given in the data, and the demand price implied by this quantity and the level of factor payments (from the factor share and zero profit condition). This means that the rate of support must be determined simultaneously with the supply price for land. Specifically, the rate of support is equal to the level of support divided by the sum of supply price times supply quantities for each affected land market. Those supply prices in turn are a function of the rate of support. The analytical solution for this is not easily obtained, but the result can be obtained numerically for the set of simultaneous equations that define the problem, and that is what is done for the model calibration in this case.

Payments based on current farm receipts or income are assumed to increase the returns to farm-owned factors generally. This means that such payments will have their first incidence in the markets for land, cows, and other farm-owned factors, but again will not alter the relative prices of these inputs. In the model, dairy quota is also a source of farm welfare, but is not assumed to be affected by these payments. There is no factor return to quota as such, and the value of quota is determined by the quota rent and level. The main distinction between payments based on non-current A/An/R/I (HE in the equation notation below) and the representation of payments based on current farm receipts or income is that payments based on current farm receipts or income affect cows and other farm-owned factors in addition to land, but do not affect the "other arable" land category as do payments based on non-current A/An/R/I.

Calculating the rate of this support is done in the same manner as was the case for payments based on non-current A/An/R/I, and for the same reason having to do with the endogeneity of the land supply price. In fact, these two rates of support, those based on payments based on non-current A/An/R/I and payments based on current farm receipts or

33. Creating a truly generic version of a payment based on non-current A/An/R/I is a challenging task; there are many conceivable ways to do this, each with its weaknesses. Where a stylised approach is inappropriate for a specific research problem, a more customized approach may be fruitful, as was done for the publication *Analysis of the 2003 CAP Reform* (OECD 2004)

income, must be determined simultaneously as they both affect the land supply price. The system of equations that must be solved for support rates and supply prices is:

$$r_{fi} = L_{fi} \Big/ \left(\sum P_S{}^l Q_S{}^l + \sum P_S{}^k Q_S{}^k + \sum P_S{}^c Q_S{}^c \right)$$

$$r_{he} = L_{he} \Big/ \sum P_S{}^l Q_S{}^l$$

$$P_{Si}{}^l = \left(P_{Di}{}^l + r_{ap} \right) \Big/ \left(1 - r_{fi} - r_{he} \right) \quad \forall\ i = land\ categories$$

$$P_{Si}{}^j = P_{Di}{}^j \Big/ \left(1 - r_{fi} \right) \qquad j = \{cows, capital\}$$

where L is the level of support, r is the rate. The *he* and *fi* subscripts denote payments based on non-current A/An/R/I and payments based on current farm receipts or income, the *ap* subscript for payments based on current area. The superscripts l, k, and c denote inputs land, capital, and cows, respectively. The S subscript refers to supply price and quantity, D for demand.

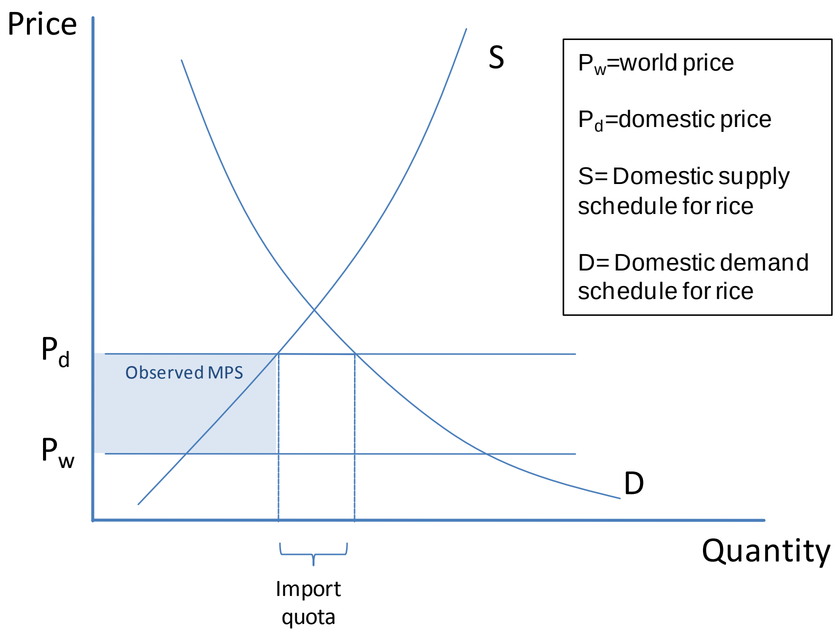
Policy implementation in Korea

The PEM representation of Korean trade measures for rice involves quantitative restrictions that specify the allowable level of imports. This border measure effectively isolates the domestic market from the world market such that the domestic market price for rice is determined internally. Thus, there is no price transmission from world markets to the Korean domestic market for rice. The domestic price is determined by a market clearing condition that states that domestic production plus allowed imports must equal the quantity consumed (Figure A2.13). In this manner, the domestic price is fully endogenous to the model and cannot be controlled as a matter of policy without leading to a surplus or deficit in the domestic market. The level of market price support is observed as an outcome of a policy scenario, but cannot be the subject of a policy shock. This is only the case for rice; for coarse grains, oilseeds, and beef, full transmission of world prices to the domestic market is assumed. The milk market has special pricing arrangements discussed below.

To alter the level of MPS in a policy scenario in the Korean model requires changing the level of imports, which is an exogenous policy variable. Increasing allowed imports would lower the domestic price to allow the domestic market to clear the increased supply of rice. This would lower domestic production and increase consumption. The reduction of the domestic price relative to the world price would indicate a reduction in MPS support to rice.

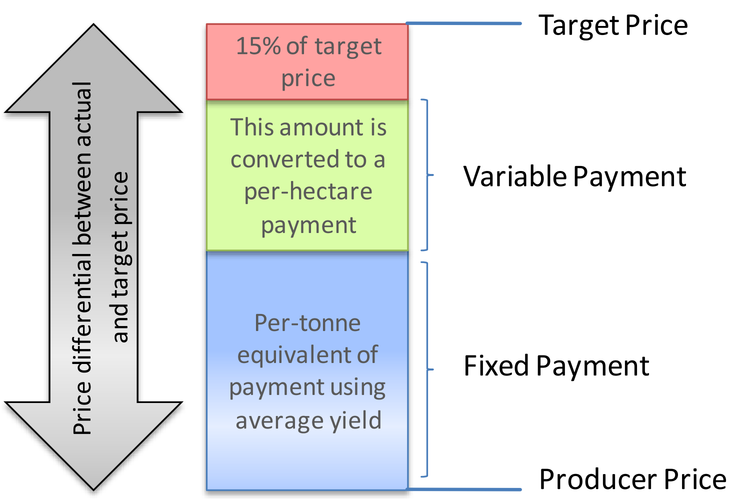
This representation of MPS in Korea swaps the role of the MPS level and the level of imports in the model. An *ad valorem* tariff in the model takes the level of MPS as exogenous (from the PSE) and the level of imports is endogenous, varying when a policy shock changes the MPS level. Here, the level of MPS is endogenous (calibrated to initially equal the amount in the PSE) and the level of imports is an exogenous variable that can be altered by a policy shock, leading to a new level of observed MPS.

Figure A2.13. PEM rice market structure



Another policy affecting the rice market in Korea is the variable payment for paddy rice. This payment offers rice producers protection against reductions in the price of rice. As there is no system of control over the domestic rice price beyond the import quota, the domestic price varies according to the size of the rice harvest and the level of demand. In order to protect producers against price fluctuations, the variable payment offers a payment equal to the difference between 85% of a target price and the market price, minus the per-kg equivalent of the fixed payment calculated using an average yield (Figure A2.14). This price differential is converted to an area payment based on a standard yield and provided to rice producers according to their planted area of rice. This payment is made on the basis of area planted, but is connected to the current price of rice.

Figure A2.14. Calculation of variable payment for paddy rice



The variable payment to paddy rice is endogenised in the model such that changes in the domestic price affect the variable payment for paddy rice according to the program formula described above. This requires calibration of a target price such that the observed payments made under this program in 2005 and 2006 correspond to a gap between the producer price and the hypothetical target price. To do this, the rate of payment per hectare for the variable payment is converted to a rate per tonne using the observed yield in the model (total rice production divided by total paddy rice area). This rate must be equal to the difference between the producer price of rice and 85% of the target price, minus the per-kg equivalent of the fixed payment for paddy rice. For 2006, this calculation implies a target price of KRW 181 000 per 80 kg of rice, very close to the actual target price of KRW 175 000/80 kg. In the base year 2006, where a variable payment for paddy rice was made, this means that any scenario where the producer price is reduced below its 2006 level will result in an increase in the variable payment, as the condition for triggering the variable payment has already been met.[34]

Rice policy in Japan

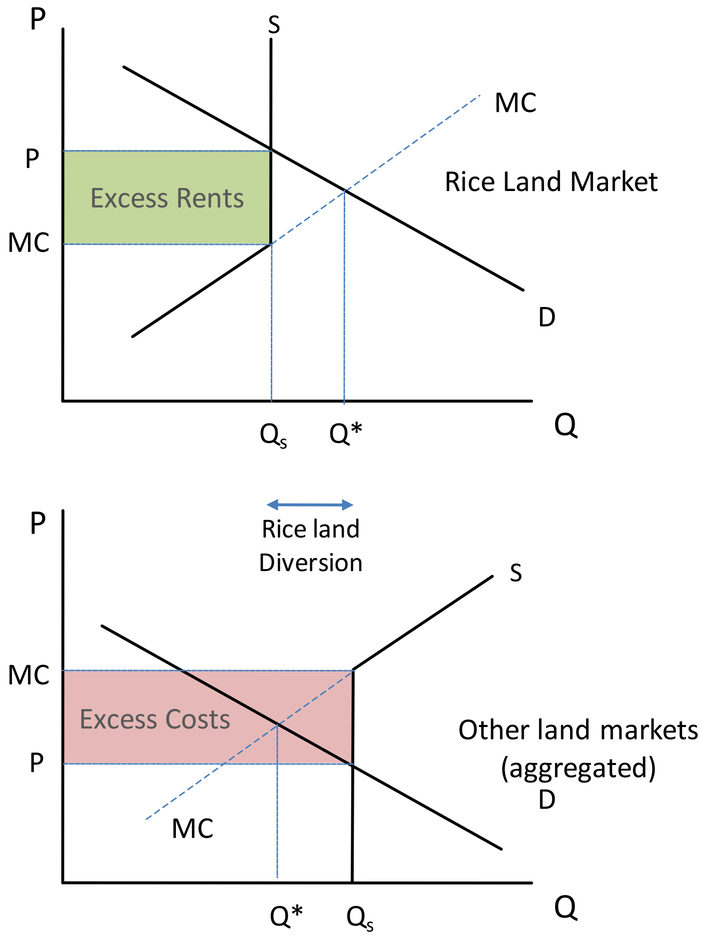
The rice production adjustment program in Japan is a means of influencing the domestic price for rice by controlling the total domestic supply. Border controls include a TRQ for rice with a prohibitive out-of-quota tariff level that leaves imports essentially fixed at the TRQ limit. As for Korea, this essentially disconnects domestic price formation for rice from the influence of world markets. The production adjustment program made possible by this border policy in the same way as are dairy production quotas, and operates in much the same fashion.

The production adjustment program is represented in the model as a reduction in allowable land used for rice production, defined with respect to the equilibrium land quantity. This reduction is matched with an increase in land used for other uses by the same quantity above the equilibrium amount in those land markets (Figure A2.14). This reflects the view that the program moves land from rice production to other uses, and that without the diversion program, some land would optimally be moved from other uses into rice production. The amount of land diverted from rice production therefore enters the model as an exogenous policy variable, and as a consequence there is no endogenous responsiveness either in the amount of rice land or the aggregate total of other land uses. More specifically, the amount of land used in rice (or other uses) will not adjust to changes in prices in the model so long as the price of land exceeds its marginal cost. In the base calibration of the model, price exceeds marginal cost in the rice land market because the quantity is kept below the equilibrium amount. In the same manner, marginal cost exceeds the land rental price in other land uses as land is diverted unprofitably into alternative uses (producers receive a payment under the program to compensate them for this cost).[35]

34. The model is defined with respect to aggregate commodities and average annual prices which will always differ slightly from observed prices for specific markets. Part of the process of calibrating the model is ensuring internal consistency, which can lead to the values of some model variables differing from their real-world analogues. This does not in general affect the quality of the results.

35. This payment is classified in the PSE in category E, as production is not required to receive the payment. It therefore appears in the model in the same manner as any payment made on a non-current area.

Figure A2.15. Land markets under the Production Adjustment Programme



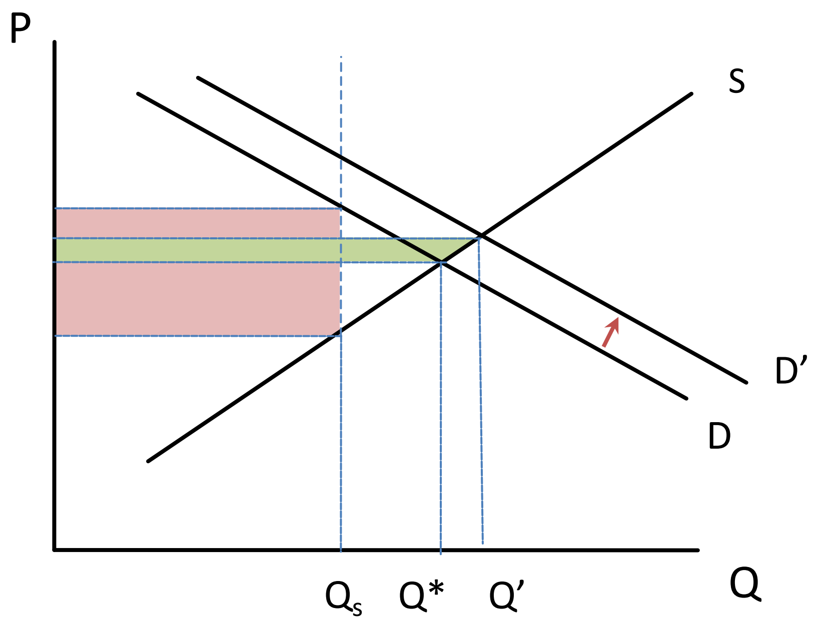
The quantities P and Q_s in each market are identified using the basic model data. These are the "observed" market price and quantity supplied. The marginal cost of production is not observable and must be specified in order to locate the underlying supply function. This is done using the slope of the supply/marginal cost function, determined by the supply elasticity parameter, and the difference between actual supply Q_s, and the equilibrium supply level $Q*$.

The difference between Q_s and $Q*$ is challenging to identify. It is not simply the amount of land diverted under the program, because not all diverted land is expected to return to rice production were the production adjustment program to be eliminated. Some is likely to remain in an alternative use, but a portion may also be expected to become or remain idle absent the program. MAFF estimates that of the 710 000 ha of paddy area diverted in 2006, about 330 000 ha may be expected to return to rice production. We take this estimate of 330 000 ha "effectively" diverted paddy land to be the difference between Q_s and $Q*$. Thus, if in the model the production adjustment program is removed and no other policy shock is introduced, the amount of land used in the production of rice would increase by 330 000 hectares and the amount of land in other uses would decrease by a similar amount.

Reducing the amount of land diverted under the production adjustment program effects producer welfare by reducing the amount of excess rent earned in the rice land market, and at the same time reducing the excess cost of land diverted into other uses. These need not be exactly offsetting as it depends on the value of Q_s as well as the elasticities of supply and demand in each market. In general, the larger the share of land rental costs in the total cost of producing rice (factor cost share), the greater the amount of excess rent earned in the land market

In addition to the erosion of rents that takes place from expanding rice production, there is also the possibility of generating additional producer surplus if endogenous changes in the model lead to a shift in the demand function for land (Figure A2.16). Thinking about a shift in the restriction in the supply of land (Qs) leftward, the excess rent in the rice land market is eroded until point *Q** is reached, where excess rents are completely exhausted. At this point, the change in farmers' welfare is equal to the negative of the initial level of excess rents, shown as the red area in Figure A2.16. If the supply continues to expand beyond Q*, say as a result of a shift in demand for land provoked by an increase in the price of rice, farmers would begin to accumulate an increase in producer surplus, shown as the green area in Figure A2.15. The same is true for a leftward shift in the demand function.

Figure A2.16. Welfare changes in the market for land for rice production



To calculate the change in producer surplus, changes in the price and quantity of land must be evaluated with respect to the equilibrium point Q*. Q* is an intermediate point that does not form part of the model solution, but its value and associated price are retained from the initial calibration of the supply function. This value will change according to alternative values of factor cost shares and must be recalculated for each alternative.

Annex 3.

Data

The Secretariat commissioned two consultant reports to review the empirical literature on the main coefficients determining the adjustment in factor markets (factor supply elasticities and elasticities of substitution). David Abler reviewed the relevant literature for United States, Canada and Mexico; Klaus Salhofer reviewed the relevant literature for the European Union. It was decided to use for the Swiss module the same set of parameters as in the EU module. An informal review on Japan was made by the Japanese experts in the PEM working group. The consultants were asked to present a tabulation of the estimations of the different parameters, a recommended base value for each parameter and a reasonable range of plausible values to allow for sensitivity analysis. The two consultant papers use different statistical procedures to summarise the information from the different studies in the literature in the form of base values and ranges. All this information was used to select the base values for all the parameters in the PEM crop model. With few exceptions, the base values proposed by the consultant were taken on board.

Demand and supply in the world market

The PEM crop model represents the aggregate of the rest of the world, defined as all non-participating countries, with a set of aggregate demand and supply for each crop. The adjustment in demand and supply in countries which are not covered by the PEM crop model is calculated from Aglink simulations and were last updated in 2005 (Tables A3.1 and A3.2).

Table A3.1 Elasticity of Demand in Rest of World

Change in quantity ↓	*Change in price →*	**Wheat**	**Coarse Grains**	**Oilseeds**	**Rice**	**Milk**	**Beef**
	Wheat	**-0.22**	0.07	0.01	0.03	0.00	0.00
	Coarse Grains	0.05	**-0.22**	-0.02	0.02	0.00	0.00
	Oilseeds	0.02	0.01	**-0.25**	0.00	0.00	0.00
	Rice	0.01	0.00	0.00	**-0.11**	0.00	0.00
	Milk	0.00	0.00	0.00	0.00	**-0.15**	0.00
	Beef	0.00	0.00	0.00	0.00	0.00	**-0.11**

Source: OECD Aglink model.

Table A3.2 Elasticity of Supply in Rest of World

Change in quantity ↓	*Change in price* →	**Wheat**	**Coarse Grains**	**Oilseeds**	**Rice**	**Milk**	**Beef**
	Wheat	**0.33**	-0.11	-0.03	-0.11	0.00	0.00
	Coarse Grains	-0.15	**0.37**	-0.09	0.37	0.00	0.00
	Oilseeds	-0.02	-0.08	**0.79**	-0.08	0.00	0.00
	Rice	-0.02	-0.01	-0.03	**-0.01**	0.00	0.00
	Milk	0.00	0.00	0.00	0.00	**0.70**	0.00
	Beef	0.00	0.00	0.00	0.00	0.00	**0.39**

Source: OECD Aglink model.

Factor Coverage

The number of factors covered in each country is dependent on the availability of data. Where factor coverage is less complete, the assumption is that these factors are subsumed in the *other purchased inputs* factor. Factor shares are updated periodically. The most recent updates were for Japan and Korea in 2009 (Table A3.3).

Table A3.3 Factor Coverage by Country

	Canada	**European Union**	**Japan**	**Korea**	**Mexico**	**Switzerland**	**United States**
Farm Owned	c,m,b[1]	c,m,b	c,m,b	c,m,b	c,m,b	c,m,b	c,m,b
Land	c,m,b	c,m,b	c,m,b	c,m,b	c,m,b	c,m,b	c,m,b
Cows	m,b	m,b	m,b	m,b	m,b	m,b	m,b
Hired Labour	c,m,b	c,m,b	c,m,b	c,m,b	b,m	c,m,b	c,m,b
Other Purchased	c,m,b	c,m,b	c,m,b	c,m,b	c,m,b	c,m,b	c,m,b
Concentrated Feeds	m,b	m,b	m,b	m,b	m,b	m,b	m,b
Chemicals	c	c,m,b	c	c		c	c
Energy	c,m,b	c,m,b	b	b	b	c,m,b	c,m,b
Fertiliser	c	c	c	c	c	c	c
Insurance	c	c				c	c,m
Irrigation		c[2]					c
Interest	c,m,b	c	c,m,b	c		c	c,m,b
Machinery and Equipment	c,m,b	c,m,b	c,m,b	c,m,b		c,m,b	m,b

1. Letters designate the presence of the factor; c = crops, m=milk, b=beef.

2. Except wheat.

Source: OECD PEM model.

Structural Data

The following tables report data on physical characteristics of the agricultural sectors in each region.

Table A3.4. Beef and Dairy Herd Size by country, 19986-2008

million head

Beef herd

Million head	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Switzerland	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Canada	6.1	6.1	6.2	6.4	6.3	6.8	6.7	6.8	7.2	7.8	7.8	7.8	7.7	7.6	7.9	8.0	7.6	8.5	8.6	8.4	8.2	7.9	7.5
EU-15	65.3	64.4	64.4	62.4	62.3	62.2	62.1	62.0	62.0	62.0	62.1	62.1	61.6	61.2	60.8	60.1	59.5	58.8	58.4	57.9	57.8	57.7	57.2
EU-12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.1	7.0	7.2	7.4	7.3
Japan	2.6	2.7	2.7	2.7	2.8	2.9	3.0	3.0	3.0	2.9	2.9	2.9	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.7	2.8	2.8	2.9
Korea	2.8	2.4	2.0	2.1	2.1	2.3	2.5	2.8	2.9	3.1	3.4	3.3	2.9	2.5	2.1	2.0	2.0	2.0	2.2	2.3	2.5	2.7	3.2
Mexico	35.2	34.6	33.8	33.1	32.1	32.8	31.2	32.0	31.8	29.6	28.6	29.1	29.2	28.3	28.4	28.5	29.2	29.3	29.0	28.8	28.9	29.0	28.9
United States	102.1	99.6	96.7	95.8	96.4	97.6	99.2	101.0	102.8	103.5	101.7	99.7	99.1	98.2	97.3	96.7	96.1	94.9	95.4	96.7	97.0	96.7	96.2

Dairy herd

Million head	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Switzerland	1.5	1.5	1.5	1.6	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.3	1.3	1.2	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Canada	1.4	1.4	1.4	1.4	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.0	1.0	1.0	1.0	1.0
EU-15	30.3	28.9	28.1	27.8	24.9	24.6	23.5	23.2	23.1	22.5	22.1	21.7	21.4	21.0	19.9	20.0	19.6	19.3	18.8	18.4	18.0	17.9	17.8
EU-12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.5	6.5	6.3	6.3	6.2
Japan	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1
Korea	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Mexico	1.9	2.0	2.0	2.0	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
United States	10.5	10.3	10.1	10.0	10.0	9.7	9.7	9.5	9.5	9.4	9.4	9.3	9.2	9.2	9.2	9.1	9.1	9.1	9.0	9.0	9.1	9.2	9.3

Source: OECD AGLINK database

Table A3.5. Carcase weight of beef animals by country, 1986-2008

Kilograms per head

kg/animal	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Switzerland	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280
Canada	251	257	265	263	268	275	278	283	294	295	290	300	315	321	329	332	337	337	337	333	350	355	360
EU-15	255	257	260	268	277	277	272	273	273	277	283	279	280	282	280	284	283	285	287	284	291	292	293
EU-12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	287	284	291	292	293
Japan	360	375	390	394	395	397	397	393	392	399	399	397	401	403	414	410	433	401	410	406	419	421	423
Korea	191	207	207	220	230	242	324	297	275	283	292	300	293	313	307	319	333	322	338	353	361	369	377
Mexico	198	215	235	210	210	200	210	217	210	205	206	212	213	216	215	216	206	209	206	210	210	210	210
United States	275	281	287	293	297	307	308	305	314	311	305	307	318	322	327	328	336	328	334	339	342	345	348

Source: FAOSTAT

Table A3.6. Volume of milk used in the manufacture of processed milk products by country, 1986-2008

million tonnes

million tonnes	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Switzerland	2.5	2.5	2.5	2.6	2.5	2.5	2.5	2.5	2.6	2.5	2.5	3.0	3.1	3.1	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.4
Canada	4.7	4.7	4.7	4.6	4.5	4.3	4.1	4.3	4.4	4.4	4.3	4.4	4.5	4.5	4.6	4.6	4.6	4.8	4.9	4.8	4.8	5.0	5.1
EU-15	95.1	90.0	86.8	86.4	86.5	84.6	82.5	82.4	79.1	83.8	84.1	84.6	84.6	85.1	83.0	83.5	82.6	82.6	81.2	80.9	79.5	79.6	79.8
EU-12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0	3.0	3.0	6.0	6.0
Japan	3.0	2.6	2.7	3.0	3.0	3.0	3.3	3.5	3.0	3.1	3.4	3.4	3.4	3.4	3.4	3.3	3.3	3.3	3.3	3.4	3.4	3.4	3.4
Korea	0.3	0.3	0.4	0.6	0.5	0.5	0.5	0.6	0.5	0.7	0.7	0.5	0.8	1.1	0.8	0.9	1.2	1.0	0.9	0.9	0.8	0.8	0.8
Mexico	2.1	2.3	2.3	2.3	2.4	2.3	2.6	2.5	3.1	2.8	2.7	2.7	2.8	3.1	3.3	3.3	3.3	3.3	3.6	3.6	3.8	3.9	3.8
United States	39.2	39.0	40.3	39.4	41.1	40.9	43.2	43.3	44.4	45.3	44.4	44.8	45.4	47.7	50.0	49.1	51.1	51.3	51.4	54.1	55.9	57.6	59.5

Source: OECD AGLINK database

Table A3.7. Concentrated feed use by beef animals by country, 1986-2008

Thousand tonnes

	thousand tonnes	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Switzerland	wheat	12	9	11	10	17	18	13	15	13	18	24	20	18	18	13	4	10	5	9	11	12	18	9
	coarse grains	39	38	52	60	56	57	54	56	54	51	52	49	51	43	46	43	41	29	40	40	35	35	35
	oilseeds	-																						
Canada	wheat	113	113	115	118	117	126	124	126	133	144	144	145	142	141	146	149	141	157	159	155	151	147	139
	coarse grains	3 297	3 295	3 370	3 445	3 432	3 676	3 638	3 682	3 901	4 210	4 215	4 227	4 148	4 136	4 281	4 344	4 137	4 587	4 652	4 538	4 409	4 289	4 072
	oilseeds	270	270	276	283	282	302	298	302	320	345	346	347	340	339	351	356	339	376	382	372	362	352	334
EU-15	wheat	1 154	1 060	1 046	997	992	1 166	1 104	968	1 255	1 476	1 577	1 616	1 661	1 820	1 733	2 002	1 940	2 190	1 427	1 960	2 171	2 061	2 259
	coarse grains	3 534	3 410	3 272	3 316	3 268	3 191	3 237	3 028	3 124	3 289	3 419	3 678	3 885	3 958	3 918	3 960	4 248	4 146	4 045	4 269	4 094	4 421	4 335
	oilseeds	6 871	6 631	6 362	6 447	6 355	6 204	6 293	5 888	6 074	6 396	6 648	7 150	7 554	7 695	7 618	7 699	8 259	8 062	7 864	8 301	7 960	8 595	8 428
EU-12	wheat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	371	370	509	454
	coarse grains	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	871	884	1 576	1 264
	oilseeds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	645	655	1 169	937
Japan	wheat	33	33	33	33	35	36	36	37	37	36	36	35	35	35	35	35	35	35	34	34	34	35	36
	coarse grains	2 003	2 007	2 007	2 046	2 124	2 194	2 238	2 250	2 245	2 197	2 197	2 159	2 156	2 152	2 137	2 125	2 149	2 124	2 111	2 080	2 086	2 125	2 188
	oilseeds	313	313	313	319	332	343	350	351	351	343	343	337	337	336	334	332	336	332	330	325	326	332	342
Korea	wheat	35	29	25	25	26	28	31	35	36	39	42	40	36	31	26	24	24	25	27	28	31	33	39
	coarse grains	2 126	1 807	1 544	1 553	1 609	1 718	1 914	2 131	2 230	2 383	2 571	2 483	2 212	1 883	1 616	1 480	1 479	1 514	1 638	1 740	1 880	2 010	2 421
	oilseeds	332	282	241	243	251	268	299	333	348	372	401	388	345	294	252	231	231	236	256	272	294	314	378
Mexico	wheat	13	13	13	13	13	15	16	49	32	4	33	33	33	68	73	71	72	76	78	80	81	83	87
	coarse grains	208	277	294	265	294	239	246	139	183	337	383	335	368	688	752	801	680	872	925	795	803	874	896
	oilseeds	31	40	45	52	57	57	67	52	56	63	72	67	76	165	186	189	170	182	188	172	168	176	168
United States	wheat	3 236	1 642	1 011	2 086	3 497	1 735	1 113	2 741	2 048	1 743	2 191	2 490	1 769	2 550	1 723	987	1 774	1 152	1 348	767	1 299	1 152	1 099
	coarse grains	41 418	42 350	33 329	37 335	39 666	38 527	43 341	39 930	42 997	37 869	43 620	43 773	41 809	44 926	45 628	44 705	40 722	43 559	45 827	45 966	41 885	43 900	38 159
	oilseeds	5 838	6 515	5 814	6 465	7 010	6 886	7 291	7 671	7 937	8 131	8 366	8 828	8 953	9 340	9 620	9 844	9 171	9 379	9 966	10 094	10 344	9 849	8 741

Source: OECD PSE database, Japan feed manual, Statistics Canada

Table A3.8. Concentrated feed use by dairy animals by country, 1986-2008

Thousand tonnes

	thousand tonnes	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Switzerland	wheat	41	30	39	34	58	62	43	51	45	63	82	67	61	61	46	15	36	19	30	36	40	62	31
	coarse grains	162	158	219	251	235	238	225	233	224	213	217	206	213	181	191	180	171	123	169	167	147	148	144
	oilseeds	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Canada	wheat	152	149	147	145	140	136	129	129	132	131	130	125	122	117	115	115	113	112	110	108	106	104	104
	coarse grains	3 743	3 679	3 642	3 588	3 470	3 351	3 194	3 197	3 253	3 233	3 217	3 094	3 022	2 883	2 851	2 832	2 784	2 756	2 721	2 663	2 625	2 572	2 567
	oilseeds	617	606	600	591	572	552	526	527	536	532	530	510	498	475	469	466	459	454	448	439	432	424	423
EU-15	wheat	4 855	4 463	4 402	4 197	4 174	4 907	4 645	4 073	5 279	6 214	6 639	6 799	6 988	7 659	7 294	8 425	8 164	9 216	6 003	8 247	9 137	8 675	9 508
	coarse grains	11 667	11 259	10 803	10 948	10 791	10 536	10 687	9 998	10 315	10 861	11 290	12 142	12 828	13 067	12 937	13 073	14 024	13 689	13 354	14 096	13 516	14 595	14 312
	oilseeds	7 258	7 005	6 721	6 811	6 713	6 554	6 648	6 220	6 417	6 757	7 023	7 554	7 980	8 129	8 048	8 133	8 725	8 516	8 308	8 769	8 409	9 080	8 904
EU-12	wheat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1 561	1 556	2 140	1 909
	coarse grains	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2 875	2 918	5 205	4 172
	oilseeds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1 298	1 318	2 350	1 884
Japan	wheat	30	30	31	31	31	31	30	29	29	29	29	28	28	27	26	26	26	26	25	24	24	24	23
	coarse grains	1 608	1 621	1 654	1 639	1 644	1 642	1 605	1 556	1 556	1 547	1 530	1 508	1 483	1 450	1 414	1 413	1 403	1 368	1 328	1 310	1 311	1 266	1 240
	oilseeds	757	763	779	771	774	773	755	732	732	728	720	710	698	683	666	665	660	644	625	617	617	596	584
Korea	wheat	5	6	6	6	6	6	7	7	7	7	7	7	7	7	7	7	7	6	6	7	6	6	6
	coarse grains	289	309	320	346	338	341	350	371	366	369	366	359	357	354	362	368	358	342	348	351	308	299	296
	oilseeds	136	145	151	163	159	160	165	175	172	173	172	169	168	167	170	173	168	161	164	165	145	141	139
Mexico	wheat	60	60	60	60	60	57	76	197	133	23	177	177	177	149	146	139	139	143	141	136	148	140	142
	coarse grains	487	1 254	1 137	1 063	1 389	931	1 158	562	761	1 834	2 049	1 792	1 971	1 513	1 499	1 563	1 314	1 645	1 668	1 345	1 464	1 476	1 461
	oilseeds	72	179	174	208	271	220	316	209	233	343	386	360	409	363	371	368	329	344	340	291	307	293	267
United States	wheat	1 769	853	535	1 082	1 676	852	512	1 219	940	767	947	1 030	747	1 030	691	402	758	466	547	306	513	457	466
	coarse grains	22 643	21 987	17 654	19 363	19 004	18 927	19 959	17 761	19 727	16 656	18 848	18 107	17 649	18 147	18 287	18 200	17 404	17 626	18 580	18 333	16 543	17 404	16 181
	oilseeds	3 191	3 382	3 080	3 353	3 359	3 383	3 357	3 412	3 642	3 576	3 615	3 652	3 779	3 773	3 855	4 007	3 919	3 795	4 040	4 026	4 086	3 905	3 706

Source: OECD PSE database, Japan feed manual, Statistics Canada

Table A3.9. Land use, Switzerland and Canada, 1986-2008

Million hectares

Switzerland

million hectares	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Beef	0.23	0.22	0.20	0.21	0.20	0.19	0.20	0.21	0.22	0.23	0.23	0.23	0.29	0.24	0.25	0.26	0.27	0.28	0.29	0.29	0.30	0.30	0.33
Milk	1.04	1.02	1.02	0.98	0.97	0.97	0.94	0.94	0.93	0.93	0.93	0.92	0.87	0.91	0.90	0.89	0.87	0.86	0.85	0.84	0.83	0.84	0.81
Wheat	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.11	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.09	0.09	0.09	0.08	0.08	0.08
Coarse Grains	0.09	0.09	0.10	0.11	0.11	0.11	0.10	0.10	0.10	0.10	0.09	0.08	0.09	0.08	0.08	0.08	0.08	0.08	0.07	0.08	0.09	0.08	0.07
Oilseeds	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03
Rice	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Arable	0.09	0.09	0.09	0.08	0.08	0.09	0.09	0.09	0.08	0.09	0.09	0.10	0.09	0.09	0.09	0.09	0.09	0.09	0.10	0.09	0.09	0.10	0.10
Other land	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.10	0.10	0.10	0.11	0.10	0.10

Canada

million hectares	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Beef	12.68	12.77	12.90	13.03	13.15	13.43	13.45	13.41	13.43	13.53	13.48	13.52	13.49	13.53	13.57	13.56	13.52	13.71	13.75	13.76	13.75	13.74	13.74
Milk	2.98	2.95	2.89	2.81	2.75	2.53	2.44	2.41	2.32	2.15	2.13	2.05	2.03	1.95	1.87	1.83	1.88	1.70	1.67	1.67	1.69	1.71	1.71
Wheat	14.23	13.46	12.94	13.72	14.10	14.16	13.83	12.37	10.77	11.12	12.26	11.42	10.68	10.38	10.85	10.61	8.71	10.21	9.39	9.40	9.68	8.64	10.03
Coarse Grains	7.10	7.25	6.54	7.34	6.71	6.16	5.89	6.52	6.56	6.58	7.66	7.25	6.98	6.62	6.88	6.66	6.00	7.04	6.15	5.99	5.82	7.18	6.12
Oilseeds	3.01	3.08	4.25	3.46	3.01	3.74	3.67	4.87	6.58	6.10	4.31	5.93	6.41	6.57	5.92	4.85	4.65	5.74	6.04	6.34	6.44	7.45	7.69
Rice	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Arable	20.90	21.53	21.64	20.92	21.68	21.51	22.17	21.79	21.64	21.74	21.29	21.01	21.60	22.17	22.16	23.77	26.36	22.58	23.84	23.53	23.17	21.83	0.83
Other land	6.93	6.79	6.64	6.50	6.36	6.22	6.36	6.50	6.64	6.78	6.91	6.78	6.64	6.50	6.37	6.23	6.39	6.55	6.71	6.87	7.03	7.05	7.05

Land for milk and beef is an aggregation of land for pasture and land for all other fodder crops.

Source: OECD Aglink Database and FAOSTAT.

Table A3.10. Land use, EU-15 and EU-12, 1986-2008

Million hectares

EU-15

million hectares	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Beef	45.06	45.10	45.44	44.91	45.76	44.18	44.32	44.23	44.72	45.02	44.96	44.67	44.95	45.15	44.79	45.51	45.57	47.83	47.86	48.24	48.54	48.57	48.57
Milk	14.65	14.33	14.06	14.55	13.35	12.52	12.28	12.25	12.20	11.93	11.76	11.66	11.67	11.55	11.24	15.14	14.98	15.67	15.44	15.35	15.09	15.06	15.06
Wheat	17.27	17.41	16.85	17.72	17.35	17.38	17.34	15.82	15.87	16.62	16.95	17.32	17.25	17.09	17.99	16.59	17.95	17.10	17.81	17.55	13.87	13.80	14.76
Coarse Grains	24.46	23.51	23.84	23.12	22.01	21.56	20.73	19.32	18.93	19.08	19.95	20.77	20.24	19.18	19.45	17.07	16.79	16.85	16.70	15.91	15.94	15.84	16.58
Oilseeds	4.07	5.21	4.96	4.94	5.77	5.59	5.77	6.03	6.07	5.67	5.38	5.48	5.79	5.95	5.26	5.12	4.73	4.83	4.91	4.83	4.65	4.84	5.51
Rice	0.33	0.33	0.35	0.33	0.38	0.37	0.36	0.34	0.38	0.37	0.43	0.43	0.41	0.40	0.40	0.40	0.40	0.41	0.42	0.41	0.41	0.40	0.40
Other Arable	32.82	32.50	32.56	32.34	32.81	32.68	32.98	35.14	34.86	33.34	32.93	31.56	31.39	32.05	31.04	33.97	33.16	33.40	32.96	33.65	37.15	36.61	36.61
Other land	11.65	11.58	11.55	11.49	11.49	11.28	11.11	10.98	10.96	10.80	10.80	10.90	11.04	11.13	11.19	11.15	10.93	10.87	10.79	10.78	10.69	10.59	10.59

EU-12

million hectares	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Beef																				8.36	8.14	8.22	8.22
Milk																				7.84	7.19	6.97	6.97
Wheat																				8.83	11.08	11.01	11.68
Coarse Grains																				6.15	6.38	5.95	6.31
Oilseeds																				3.98	4.29	4.52	4.67
Rice																				0.01	0.01	0.01	0.01
Other Arable																				19.15	16.48	16.46	16.46
Other land																				3.21	3.14	3.14	3.14

Land for milk and beef is an aggregation of land for pasture and land for all other fodder crops.

Source: OECD Aglink Database and FAOSTAT.

Table A3.11. Land use, Japan and Korea, 1986-2008

Million hectares

Japan

million hectares	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Beef	0.33	0.33	0.33	0.30	0.30	0.30	0.31	0.31	0.31	0.28	0.28	0.28	0.28	0.28	0.30	0.45	0.45	0.45	0.45	0.45	0.44	0.45	0.45
Milk	0.17	0.17	0.17	0.15	0.15	0.15	0.14	0.14	0.14	0.13	0.13	0.13	0.13	0.12	0.13	0.19	0.19	0.19	0.18	0.18	0.18	0.17	0.17
Wheat	0.25	0.27	0.28	0.28	0.26	0.24	0.21	0.18	0.15	0.15	0.16	0.16	0.16	0.17	0.18	0.20	0.21	0.21	0.21	0.21	0.22	0.21	0.21
Coarse Grains	0.12	0.13	0.13	0.12	0.12	0.11	0.09	0.08	0.07	0.07	0.06	0.07	0.06	0.06	0.06	0.07	0.07	0.08	0.07	0.06	0.06	0.06	0.06
Oilseeds	0.14	0.16	0.16	0.15	0.15	0.14	0.11	0.09	0.06	0.07	0.08	0.08	0.11	0.11	0.12	0.14	0.15	0.15	0.14	0.13	0.14	0.14	0.14
Rice	2.30	2.15	2.11	2.10	2.07	2.05	2.11	2.14	2.21	2.12	1.98	1.95	1.80	1.79	1.77	1.71	1.69	1.67	1.70	1.71	1.69	1.67	1.67
Other Arable	2.01	2.11	2.12	2.13	2.17	2.20	2.19	2.19	2.16	2.22	2.32	2.31	2.40	2.38	2.34	2.33	2.30	2.29	2.26	2.24	2.23	2.24	2.24
Other land	0.54	0.53	0.51	0.49	0.48	0.46	0.45	0.44	0.42	0.41	0.39	0.38	0.37	0.36	0.36	0.35	0.34	0.34	0.34	0.33	0.33	0.32	0.32

Korea

million hectares	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Beef	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Milk	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Wheat	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coarse Grains	0.22	0.24	0.22	0.21	0.19	0.15	0.13	0.14	0.11	0.11	0.11	0.09	0.11	0.10	0.09	0.11	0.10	0.09	0.09	0.08	0.09	0.09	0.08
Oilseeds	0.14	0.16	0.15	0.16	0.16	0.12	0.11	0.12	0.12	0.11	0.10	0.10	0.10	0.09	0.09	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.09
Rice	1.23	1.26	1.26	1.26	1.24	1.27	1.16	1.14	1.10	1.06	1.05	1.05	1.06	1.07	1.07	1.08	1.05	1.02	1.00	0.98	0.96	0.95	0.94
Other Arable	0.41	0.35	0.37	0.35	0.36	0.38	0.50	0.48	0.51	0.50	0.48	0.47	0.44	0.44	0.47	0.42	0.43	0.47	0.48	0.49	0.49	0.47	0.47
Other land	0.14	0.14	0.14	0.15	0.16	0.16	0.17	0.18	0.19	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.19	0.19	0.18	0.18	0.18	0.19	0.19

Land for milk and beef is an aggregation of land for pasture and land for all other fodder crops.

Source: OECD AGLINK database and FAOSTAT.

Table A3.12. Land use, Mexico and the United States, 1986-2008

Million hectares

Mexico

million hectares	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Beef	71.66	71.80	72.24	72.56	72.83	73.38	73.59	74.17	74.61	74.69	74.51	74.55	74.50	74.26	74.21	74.21	74.35	74.39	74.19	74.23	74.20	74.24	74.24
Milk	3.84	4.20	4.26	4.44	4.67	4.62	4.91	4.83	4.89	5.21	5.39	5.35	5.40	5.64	5.69	5.69	5.55	5.51	5.71	5.67	5.70	5.66	5.66
Wheat	1.20	0.99	0.91	1.14	0.93	0.98	0.92	0.88	0.96	0.93	0.81	0.77	0.77	0.65	0.71	0.69	0.63	0.60	0.52	0.63	0.65	0.69	0.80
Coarse Grains	6.68	7.09	6.75	6.73	7.60	7.23	7.51	7.66	8.31	8.27	8.33	7.65	8.14	7.39	7.42	8.12	7.40	7.89	8.02	6.91	7.61	7.62	8.04
Oilseeds	0.38	0.47	0.14	0.49	0.29	0.34	0.32	0.24	0.29	0.14	0.05	0.12	0.10	0.08	0.08	0.07	0.06	0.07	0.09	0.10	0.06	0.07	0.08
Rice	0.13	0.15	0.12	0.14	0.08	0.07	0.07	0.06	0.09	0.08	0.09	0.11	0.10	0.08	0.08	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.08
Other Arable	15.11	15.00	15.97	15.59	15.40	15.82	15.78	15.96	15.25	15.69	15.72	16.34	15.99	16.90	16.81	16.16	16.96	16.48	16.41	17.30	16.11	16.05	16.05
Other land	2.00	2.00	2.00	2.00	2.00	2.05	2.10	2.10	2.20	2.20	2.30	2.30	2.30	2.30	2.30	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40

United States

million hectares	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Beef	219.1	216.7	216.5	216.5	216.8	217.5	218.0	217.5	217.0	216.3	215.2	214.9	215.4	215.7	215.9	216.4	239.6	216.7	217.2	217.4	217.4	217.4	217.4
Milk	22.5	22.4	22.7	22.6	22.4	21.7	21.2	20.5	20.0	19.7	19.8	19.9	19.9	20.1	20.4	20.4	22.8	20.8	20.5	20.3	20.4	20.6	20.6
Wheat	24.6	22.6	21.5	25.2	28.0	23.4	25.4	25.4	25.0	24.6	25.4	25.4	23.9	21.8	21.5	19.6	18.5	21.5	20.2	20.3	18.9	20.6	22.5
Coarse Grains	38.4	32.4	30.3	34.0	33.8	35.2	37.0	31.8	35.8	32.2	36.9	35.7	34.9	33.9	34.6	33.1	32.7	33.8	34.0	34.0	31.8	39.2	36.3
Oilseeds	23.6	21.1	23.2	24.1	22.9	23.5	23.6	23.3	24.7	25.1	25.8	28.2	28.9	29.7	29.9	30.1	29.8	29.8	30.3	29.6	30.6	26.4	30.6
Rice	1.0	0.9	1.2	1.1	1.1	1.1	1.3	1.1	1.3	1.3	1.1	1.3	1.3	1.4	1.2	1.3	1.3	1.2	1.3	1.4	1.1	1.1	1.2
Other Arable	100.3	108.7	109.5	101.3	99.8	102.4	96.8	101.1	95.0	98.6	89.8	87.0	87.8	88.6	88.2	91.3	93.7	90.4	88.3	87.2	88.1	83.1	83.1
Other land	2.0	2.0	2.0	2.1	2.1	2.1	2.1	2.2	2.2	2.3	2.3	2.5	2.5	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7

Land for milk and beef is an aggregation of land for pasture and land for all other fodder crops.

Source: OECD AGLINK database and FAOSTAT.

Parameter Data

The following sections describe the parameters for each country.

Elasticities of demand

Elasticities of demand used in the final demand functions of the model represent demand for the commodities for all uses other than that which are already represented in the model. That is, as demand for crops for production of concentrated feed used by milk and beef is part of the model structure, the demand elasticities for each crop were determined using the Aglink model with this component of total feed demand held exogenous. Elasticities of demand are generated using the OECD Aglink model based on the 2004 baseline, and observing adjustment at the fifth year of the projection that model generates.

Table A3.13. Demand Elasticities for Switzerland

		Change in price →						
		Wheat	**Coarse Grains**	**Oilseeds**	**Rice**	**Fluid Milk**	**Mfg. Milk**	**Beef**
Change in quantity ↓	**Wheat**	**-0.400**	0.500	0.100	-0.257	0	0	0
	Coarse Grains	0.580	**-1.000**	0.100	0	0	0	0
	Oilseeds	0.010	0.100	**-1.000**	0	0	0	0
	Rice	0	0	0.004	**-0.240**	0	0	0
	Fluid Milk	0	0	0	0	**-0.100**	0	0
	Mfg. Milk	0	0	0	0	0	**-0.275**	0
	Beef	0	0	0	0	0	0	**-1.000**

Source: OECD Aglink model

Table A3.14. Demand Elasticities for Canada

		Change in price →						
		Wheat	**Coarse Grains**	**Oilseeds**	**Rice**	**Fluid Milk**	**Mfg. Milk**	**Beef**
Change in quantity ↓	**Wheat**	**-0.546**	0.325	0.191	-0.001	0.017	0.003	0.110
	Coarse Grains	0.073	**-0.103**	-0.021	-0.001	0.028	0.006	0.178
	Oilseeds	0.100	-0.071	**-0.078**	-0.001	0.018	0.025	0.116
	Rice	0	0	0	**-0.048**	0	0	0
	Fluid Milk	0	0	0	0	**-0.273**	0	0
	Mfg. Milk	0	0	0.011	0	-0.040	**-0.465**	0.019
	Beef	0.017	0.098	0.054	0	0	0.001	**-0.212**

Source: OECD Aglink model

Table A3.15. Demand Elasticities for the European Union

Change in quantity ↓		Wheat	Coarse Grains	Oilseeds	Rice	Fluid Milk	Mfg. Milk	Beef
		Change in price →						
	Wheat	**-0.294**	0.311	-0.098	0	0	0	0.038
	Coarse Grains	0.177	**-0.300**	0.030	0	0	0	0.071
	Oilseeds	-0.153	0.116	**-0.161**	0	-0.003	0	0.054
	Rice	0	0	0	**-0.197**	0	0	0
	Fluid Milk	0	0	0	0	**-0.374**	0	0
	Mfg. Milk	0	0	0	0	0	**-0.457**	0.002
	Beef	0.031	0.066	0.042	0	0	0	**-0.237**

Source: OECD Aglink model

Table A3.16. Demand Elasticities for Japan

Change in quantity ↓		Wheat	Coarse Grains	Oilseeds	Rice	Fluid Milk	Mfg. Milk	Beef
		Change in price →						
	Wheat	**-0.136**	0.017	0.018	0.056	0	0	0.002
	Coarse Grains	0.013	**-0.174**	0.063	0	0	0	0.026
	Oilseeds	0.019	0.055	**-0.174**	0	0	0.021	0.021
	Rice	0	0	0	**-0.558**	0	0	0
	Fluid Milk	0	0	0	0	**-0.259**	0	0
	Mfg. Milk	0	0	0	0	0	**-0.558**	0
	Beef	0.002	0.031	0.022	0	0	0	**-0.433**

Source: OECD Aglink model

Table A3.17. Demand Elasticities for Korea

Demand Elasticities for Korea

Change in quantity ↓		Wheat	Coarse Grains	Oilseeds	Rice	Fluid Milk	Mfg. Milk	Beef
		Change in price →						
	Wheat	**-0.184**	0	0	0	0	0	0
	Coarse Grains	0	**-0.409**	0	0	0	0	0
	Oilseeds	0	0	**-0.347**	0	0	0	0.0
	Rice	0	0	0	**-0.789**	0	0	0
	Fluid Milk	0	0	0	0	**-0.939**	0	0
	Mfg. Milk	0	0	0	0	0	**-1.170**	0
	Beef	0	0	0	0	0	0	**-0.523**

Source: Various models, Korean Ministry of Agriculture and Forestry.

Table A3.18. Demand Elasticities for Mexico

		Change in price →						
		Wheat	**Coarse Grains**	**Oilseeds**	**Rice**	**Fluid Milk**	**Mfg. Milk**	**Beef**
Change in quantity ↓	**Wheat**	**-0.620**	0.388	-0.004	0	0	0	0.010
	Coarse Grains	0.078	**-0.163**	0.007	0	0	0	0.019
	Oilseeds	0.001	0.054	**-0.493**	0	0	0	0.055
	Rice	0.029	0	0	**-0.040**	0	0	0
	Fluid Milk	0	0.099	0	0	**-0.095**	0	0
	Mfg. Milk	0.002	0.035	0.016	0	-0.189	**-0.265**	0.047
	Beef	0.005	0.131	0.030	0	0	0	**-0.452**

Source: OECD Aglink model.

Table A3.19 Demand Elasticities for the United States

		Change in price →						
		Wheat	**Coarse Grains**	**Oilseeds**	**Rice**	**Fluid Milk**	**Mfg. Milk**	**Beef**
Change in quantity ↓	**Wheat**	**-0.363**	0.276	0.072	0	0	0	0.020
	Coarse Grains	0.061	**-0.163**	-0.022	0	0	0	0.070
	Oilseeds	0.054	0.010	**-0.289**	0	0	0	0.082
	Rice	0	0	0	**-0.002**	0	0	0
	Fluid Milk	0	0	0	0	**-0.142**	0	0
	Mfg. Milk	0	0	0.040	0	0	**-0.353**	0
	Beef	0.005	0.090	0.070	0	0	0	**-0.420**

Source: OECD Aglink model.

Factor cost shares

Factor cost shares are calculated using cost of production data from national sources and are expressed as a percentage of revenue.

Table A3.20 Factor Cost Shares for Switzerland

	Wheat	Coarse Grains	Oilseeds	Milk	Beef
Farm-owned Capital	0.25	0.20	0.44	0.33	0.35
Land	0.13	0.13	0.09	0.07	0.10
Cows	0	0	0	0.14	0.04
Hired Labour	0.04	0.04	0.03	0.07	0.02
Other Purchased Inputs	0.23	0.24	0.15	0.17	0.16
Concentrated Feeds	0	0	0	0.07	0.24
Chemicals	0.02	0.04	0.02	0	0
Energy	0.02	0.03	0.03	0.03	0.03
Fertiliser	0.05	0.04	0.04	0	0
Insurance	0.03	0.04	0.03	0	0
Irrigation	0	0	0	0	0
Interest	0.04	0.05	0.03	0	0
Machinery and Equipment	0.19	0.20	0.14	0.12	0.06

Source: OECD PEM model.

Table A3.21 Factor Cost Shares for Canada

	Wheat	Coarse Grains	Oilseeds	Milk	Beef
Farm-owned Capital	0.27	0.22	0.36	0.44	0.15
Land	0.16	0.17	0.12	0.05	0.11
Cows	0	0	0	0.03	0.02
Hired Labour	0.00	0.01	0.00	0.05	0.02
Other Purchased Inputs	0.11	0.13	0.13	0.15	0.12
Concentrated Feeds	0	0	0	0.18	0.38
Chemicals	0.12	0.10	0.10	0	0
Energy	0.03	0.05	0.02	0	0.06
Fertiliser	0.15	0.16	0.12	0	0
Insurance	0.03	0.02	0.03	0	0
Irrigation	0	0	0	0	0
Interest	0.05	0.06	0.05	0.09	0.07
Machinery and Equipment	0.08	0.09	0.06	0.02	0.06

Source: OECD PEM model.

Table A3.22 Factor Cost Shares for the European Union

	Wheat	Coarse Grains	Oilseeds	Rice	Milk	Beef
Farm-owned Capital	0.32	0.43	0.43	0.39	0.32	0.35
Land	0.14	0.11	0.11	0.12	0.08	0.10
Cows	0	0	0	0	0.03	0.04
Hired Labour	0.04	0.03	0.03	0.05	0.04	0.02
Other Purchased Inputs	0.17	0.14	0.14	0.13	0.19	0.16
Concentrated Feeds	0	0	0	0	0.24	0.24
Chemicals	0.09	0.04	0.04	0.09	0	0
Energy	0.05	0.06	0.06	0.06	0.04	0.03
Fertiliser	0.09	0.10	0.10	0.07	0	0
Insurance	0.02	0.02	0.02	0.02	0	0
Irrigation	0	0.01	0.01	0.04	0	0
Interest	0.01	0.01	0.01	0	0	0
Machinery and Equipment	0.07	0.05	0.05	0.03	0.07	0.06

Source: OECD PEM model.

Table A3.23 Factor Cost Shares for Japan

	Wheat	Coarse Grains	Oilseeds	Rice	Milk	Beef
Farm-owned Capital	0.30	0.30	0.30	0.30	0.31	0.17
Land	0.20	0.20	0.20	0.20	0.11	0.06
Cows	0	0	0	0	0.15	0.04
Hired Labour	0	0	0	0	0	0
Other Purchased Inputs	0.45	0.45	0.45	0.45	0.13	0.05
Concentrated Feeds	0	0	0	0	0.31	0.64
Chemicals	0	0	0	0	0	0
Energy	0	0	0	0	0	0.02
Fertiliser	0.05	0.05	0.05	0.05	0	0
Insurance	0	0	0	0	0	0
Irrigation	0	0	0	0	0	0
Interest	0	0	0	0	0	0
Machinery and Equipment	0	0	0	0	0	0.03

Source: OECD PEM model.

Table A3.24. Factor Cost Shares for Korea

	Factor Cost shares for Korea					
	Wheat	**Coarse Grains**	**Oilseeds**	**Rice**	**Milk**	**Beef**
Farm-owned Capital		0.26	0.45	0.24	0.20	0.24
Land		0.27	0.05	0.42	0.01	0.002
Cows		0	0	0	0.20	0.04
Hired Labour		0.03	0	0.03	0.02	0.01
Other Purchased Inputs		0.06	0.41	0.04	0.06	0.05
Concentrated Feeds		0	0	0	0.38	0.53
Chemicals		0.01	0	0.04	0	0
Energy		0.01	0	0	0.02	0.01
Fertiliser		0.17	0.09	0.04	0	0
Insurance		0	0	0	0	0
Irrigation		0	0	0	0	0
Interest		0.07	0	0.05	0.02	0.02
Machinery and Equipment		0.11	0	0.15	0.09	0.09

Source: KREI.

Table A3.25. Factor Cost Shares for Mexico

	Wheat	**Coarse Grains**	**Oilseeds**	**Rice**	**Milk**	**Beef**
Farm-owned Capital	0.13	0.17	0.09	0.28	0.18	0.21
Land	0.24	0.27	0.30	0.20	0.18	0.47
Cows	0	0	0	0	0.08	0.13
Hired Labour	0	0	0	0	0.06	0.02
Other Purchased Inputs	0.55	0.40	0.60	0.45	0.09	0.06
Concentrated Feeds	0	0	0	0	0.41	0.08
Chemicals	0	0	0	0	0	0.02
Energy	0	0	0	0	0	0.01
Fertiliser	0.09	0.16	0.02	0.08	0	0
Insurance	0	0	0	0	0	0
Irrigation	0	0	0	0	0	0
Interest	0	0	0	0	0	0
Machinery and Equipment	0	0	0	0	0	0

Source: OECD PEM model.

Table A3.26 Factor Cost Shares for the United States

	Wheat	Coarse Grains	Oilseeds	Rice	Milk	Beef
Farm-owned Capital	0.23	0.21	0.23	0.14	0.20	0.15
Land	0.21	0.21	0.27	0.19	0.14	0.11
Cows	0	0	0	0	0.05	0.02
Hired Labour	0.04	0.02	0.03	0.05	0.07	0.02
Other Purchased Inputs	0.17	0.14	0.12	0.24	0.05	0.12
Concentrated Feeds	0	0	0	0	0.24	0.38
Chemicals	0.06	0.07	0.11	0.10	0	0
Energy	0.08	0.06	0.04	0.10	0.03	0.06
Fertiliser	0.11	0.15	0.05	0.08	0	0
Insurance	0.05	0.07	0.09	0.05	0.01	0
Irrigation	0.01	0.002	0.00	0.02	0	0
Interest	0.05	0.06	0.07	0.04	0.003	0.07
Machinery and Equipment	0	0	0	0	0.22	0.06

Source: OECD PEM model.

Elasticities of Factor Substitution

The Allen elasticities of substitution that enter the factor demand equations for crops are obtained from the consultant papers. Ranges of values for sensitivity analysis are taken to be between half and double this value. Elasticities of factor supply are 2.0 for all purchased inputs and 0.5 for other farm-owned factors and cows

Table A3.27 Elasticities of factor substitution for Switzerland

		Among purchased inputs	Between land and other farm owned factors	Between land and purchased inputs	Between purchased and other farm owned	Between land and feed
Crops	Base	**0.5**	**0.4**	**0.5**	**0.9**	-
	Minimum	0.0	0.0	0.0	0.0	-
	Maximum	1.0	0.8	1.0	1.8	-
Milk and beef	Base	**0.15**	**0.15**	**0.15**	**0.15**	**0.5**
	Minimum	0.075	0.075	0.075	0.075	0.25
	Maximum	0.3	0.3	0.3	0.3	1.0

Source: OECD PEM model.

Table A3.28 Elasticities of factor substitution for Canada

		Among purchased inputs	between land and other farm owned factors	between land and purchased inputs	between purchased and other farm owned	between land and feed
	Base	**0.1**	**0.1**	**0.5**	**0.9**	**-**
Crops	min	0.0	0.0	0.0	0.0	-
	max	0.2	0.2	1.0	1.8	-
	Base	**0.15**	**0.15**	**0.15**	**0.15**	**0.5**
Milk & beef	min	0.075	0.075	0.075	0.075	0.25
	max	0.3	0.3	0.3	0.3	1.0

Source: OECD PEM model.

Table A3.29. Elasticities of factor substitution for the European Union

		Among purchased inputs	between land and other farm owned factors	between land and purchased inputs	between purchased and other farm owned	between land and feed
	Base	**0.5**	**0.4**	**0.5**	**0.9**	**-**
Crops	min	0.0	0.0	0.0	0.0	-
	max	1.0	0.8	1.0	1.8	-
	Base	**0.15**	**0.15**	**0.15**	**0.15**	**0.5**
Milk & beef	min	0.075	0.075	0.075	0.075	0.25
	max	0.3	0.3	0.3	0.3	1.0

Source: OECD PEM model.

Table A3.30 Elasticities of factor substitution for Japan and Korea

		Among purchased inputs	between land and other farm owned factors	between land and purchased inputs	between purchased and other farm owned	between land and feed
	Base	**0.3**	**0.3**	**0.6**	**0.4**	**-**
Crops	min	0.0	0.0	0.0	0.0	-
	max	0.6	0.6	1.2	0.8	-
	Base	**0.15**	**0.15**	**0.15**	**0.15**	**0.5**
Milk & beef	min	0.075	0.075	0.075	0.075	0.25
	max	0.3	0.3	0.3	0.3	1.0

Source: OECD PEM model.

Table A3.31 Elasticities of factor substitution for Mexico

		Among purchased inputs	between land and other farm owned factors	between land and purchased inputs	between purchased and other farm owned	between land and feed
	Base	**0.15**	**0.5**	**0.5**	**0.5**	**-**
Crops	min	0.0	0.0	0.0	0.0	-
	max	0.3	1.0	1.0	1.0	-
	Base	**0.15**	**0.15**	**0.15**	**0.15**	**0.5**
Milk & beef	min	0.075	0.075	0.075	0.075	0.25
	max	0.3	0.3	0.3	0.3	1.0

Source: OECD PEM model.

Table A3.32 Elasticities of factor substitution for the United States

		Among purchased inputs	between land and other farm owned factors	between land and purchased inputs	between purchased and other farm owned	between land and feed
	Base	**0.15**	**0.3**	**0.5**	**0.8**	**-**
Crops	min	0.0	0.0	0.0	0.0	-
	max	0.3	0.6	1.0	1.6	-
	Base	**0.15**	**0.15**	**0.15**	**0.15**	**0.5**
Milk & beef	min	0.075	0.075	0.075	0.075	0.25
	max	0.3	0.3	0.3	0.3	1.0

Source: OECD PEM model.