The OECD PSE database and its use in market model

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1. Introduction

The OECD has been developing a unique database of agricultural support in member countries and some non-member countries (Brazil, China, Russia, South Africa and Ukraine). Producer Support Estimate (PSE) allows analysts to compare the change in the level and composition of domestic support to agriculture over time, making it an important resource in monitoring and evaluating the changes in agricultural policy. Although the database itself can measure policy effort, it cannot estimate the impact of domestic support by itself.

Since 1998, OECD has been developing the Policy Evaluation Model (PEM), which 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. 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. OECD has been using the PEM to simulate the market and welfare effects of policies recorded in the PSE database. The representation of policy in PEM model follows the policy classification made in the PSE database, whose classification method is updated to reflec much more details on the implementation criteria under which support is provided to producers.

This paper consists of two parts. The first discusses the structure and content of the PSE/CSE database which has undergone substantial revisions in recent years. Since 2007 this new classification contains much more detail on the implementation criteria under which support is provided to farmers. Policy measures are classified into seven categories which indentify the transfer basis for the policy. For example it is distinguished whether the payment is based on current or historical parameters and whether production is required or not. In addition, policy measures in each category are further distinguished by labels. For example, the labels contain information on whether a payment to inputs is conditional, whether the payment rates are fixed or variable etc. Such information is indispensable to give an adequate representation of policies that have become increasingly fine-tuned. The second part illustrates the use of the policy support information in the OECDs Policy Evaluation Model. The section discusses in particular the adequate use of PSE data to represent policy support that is relatively decoupled from current production and linked to farm assets, in particular land. It will also explore the representation of payments based on income or revenue and their effects on the variability of farm returns.

2. Structure of the OECD's PSE/CSE database

Since the mid-1980s, the OECD has been measuring the monetary transfers associated with agricultural policies, using a standard method of classification. The methodology on PSE is implemented to measure domestic support to producers based on several conventions. First, the measurement of domestic support includes all policies that generate a transfer which can be explicit or implicit in the form of money, goods or services. Policies measures that result in transfers from producers, such as taxes on inputs or the cost of purchasing tradable permits are not considered. Second, there is no consideration of the nature, objectives or economic impact of a policy measure beyond an "accounting" for transfers. Thirdly, transfers generated by agricultural policies are measured in gross terms. It means that no adjustment is made for costs incurred by producers in order to receive support, *e.g.* the costs of increasing production or meeting compliance conditions attached to certain payments. The only costs taken into consideration are specific contributions that producers make to finance the transfers they are receiving, such as contributions to stockholding, marketing measures or export subsidies.

The PSE/CSE and related indicators provide measures of the level of support, and the degree of protection and market orientation. The analysis of these indicators provides an assessment of the need for, and progress in, policy reform. Although these indicators do not measure, by themselves, the effects or distortions, they provide the necessary data and information for the quantification of such effects.

The most important and central one is the Producer Support Estimate (PSE). The PSE covers all transfers to farmers from consumers and taxpayers that:

- maintain domestic prices for farm goods at levels higher (and occasionally lower) than those at the country's border (market price support, MPS);
- provide payments to farmers, based on criteria such as the quantity of a commodity produced, the amount of inputs used, the number of animals kept, the area farmed, or the revenue or income received

The key point is that support not only comprises budgetary payments that appear in government accounts, but also the price gap for farm goods between domestic and world markets, as measured at a country's border.

To contribute to a better quantitative or qualitative evaluation of policy impacts, the policy measures included in the TSE are grouped according to the conditions under which the associated transfers are provided, *i.e.* to producers (PSE), to consumers (CSE), or to general services provided to agriculture (GSSE). Policy measures within the PSE are classified in terms of how policies providing transfers to farmers are implemented. This composition of support allows a ranking of categories of PSE measures according to their *potential* impacts on production, consumption, trade, income, or the environment. The relative impacts of the different categories of PSE measures on each of these variables are important elements used to evaluate policy developments in OECD countries.

2.1. Classification

The impact of policy measures on variables such as production, consumption, trade, income, employment and the environment depend, among other factors, on the way policy measures are implemented. Therefore, to be helpful for policy analysis, policy measures to be included in the PSE are classified according to implementation criteria. For a given policy measure, the ***implementation criteria*** are defined as *the conditions under which the associated transfers are provided to farmers, or the conditions of eligibility for the payment*. However, these conditions are often multiple. Thus, the criteria used to classify payments to producers are defined in a way that facilitates: the analysis of policies in the light of the —operational criteria defined by OECD Ministers of Agriculture in 1998; the assessment in subsequent analysis of their impacts on production, consumption, income, employment, etc., through, for example, the Policy Evaluation Model (PEM); and the classification of policy measures in a consistent way across countries, policy measures and over time. Major refinements of classification are made in 1999 and 2007 to better capture recent policy movements (e,g., move to more decoupled payments).

The value of price transfers to producers is called Market Price Support (MPS) and is defined as the annual monetary value of gross transfers from consumers and taxpayers to agricultural producers, measured at the farm gate level, arising from policy measures that support agriculture by creating a gap between domestic market prices and border prices of specific agricultural commodities.

While not measuring the effects of policy measures, the classification system recognises that different policy measures will have different impacts. Policy measures are classified into seven categories which identify the transfer basis for the policy, whether the basis is current or non-current, and whether production is required or not. Policy measures in each category are further distinguished according to whether constraints are placed on output levels or input use, whether the payment rate is variable or fixed, and whether the policy transfer is specific or not as to commodities covered or excluded.

The various *categories* have been constructed to identify the implementation criteria that are considered to be the most significant from an economic perspective and which reflect policies applied in OECD countries. . The categories identify:

- the ***transfer basis*** for support: output (Category A), input (Category B), Area/Animal numbers/Receipts/Income (Categories C, D and E), non-commodity criteria (Category F);
- whether the support is based on a ***current*** (Categories A, B, C and F) or ***non-current (historical or fixed***) basis (Categories D and E);
- whether ***commodity production is required*** (Categories A, B, C and D) or ***not*** (Categories E and F).

Table 1 summarized the updated classification in the PSE database.

2.2. Label

The PSE classification has been restructured following the development and changes in policy measures supporting agriculture across the OECD countries. A major refinement of the classification system in 2007 includes the introduction of six labels, which serve as a shorthand for categories not included in the main presentation.

Each policy measure is assigned several labels that provide additional details on policy implementation. The six labels contain information on whether constraints are placed on output and payment levels or input use. They also further specify the basis of transfer, its commodity specificity and variability of payment rates. The alternatives offered by each label are exhaustive so that only one of the available options can be attributed to a given policy measure. However, not all labels are applicable to all PSE categories. For example, the label specifying whether a payment is based on a single, group or all commodities is by definition not applicable to policies for which production is not required (Categories E and F).

Distinction between the terms PSE categories and PSE label is a matter of presentation convention. Table 1 shows that the PSE classification is a matrix of various policy implementation criteria where PSE categories are presented along the vertical axis and PSE labels along the horizontal axis. Labels only represent additional dimensions in which the PSE can be broken down and, like the PSE categories, are defined in terms of implementation criteria rather than policy objectives. Labels could be used as an alternative presentation of policy implementation; they also could theoretically be presented as PSE sub-categories or sub-sub-categories. For example, in PSE category E, the ―with variable or fixed payment rates‖ label is used to create sub-categories E.1 and E.2. However, not all labels are applicable to all PSE categories (A to F). For example, the label specifying whether a payment is based on a single, group or all commodities is not applicable to policies in category *E. Payments based on non-current A/An/R/I*, *production not required*, or *F. Payments based on non-commodity criteria*. A label distinguishing payments based on area, animal numbers, receipts or income is by definition redundant for policies in categories *A. Support based on commodity output* and *B. Payments based on input use*.

Table 1. PSE categories and labels

PSE CATEGORIES	PSE LABELS																Value of transfers, LC million
	Current commodity production and payment limits		Payment rates		Input constraints			Payment eligibility based on							Production exceptions		
												Commodity(ies)					
	Limit	No limit	Fixed	Variable	With (mandatory)	With (voluntary)	Without	Area	Animal number	Receipts	Income	Single	Group	All	With	Without	Year 1... Year n
A. Support based on commodity outputs																	
A1. Market Price Support																	
commodity *n*					na	na	na	na	na	na	na	*	na	na	na	na	
commodity *m*, etc					na	na	na	na	na	na	na	*	na	na	na	na	
A2. Payments based on output																	
commodity *k*								na	na	na	na	*	na	na	na	na	
commodity *l*, etc.								na	na	na	na	*	na	na	na	na	
B. Payments based on input use																	
B1. Variable input use																	
policy measure b_{11}								na	na	na	na				na	na	
policy measure b_{1n}								na	na	na	na				na	na	
B2. Fixed capital formation																	
policy measure b_{21}								na	na	na	na				na	na	
policy measure b_{2n}								na	na	na	na				na	na	
B3. On-farm services																	
policy measure b_{31}								na	na	na	na				na	na	
policy measure b_{3n}								na	na	na	na				na	na	
C. Payments based on current A/An/R/I, production required																	
C1. Based on current receipts/income																	
policy measure c_{11}															na	na	
policy measure c_{1n}															na	na	
C2. Based on current area/animal numbers																	
policy measure c_{21}															na	na	
policy measure c_{2n}															na	na	
D. Payments based on non-current A/An/R/I, production required																	
policy measure d_1															na	na	
policy measure d_n															na	na	
E. Payments based on non-current A/An/R/I, production not required																	
E1. Variable rates																	
policy measure e_{11}												na	na	na			
policy measure e_{1n}												na	na	na			
E2. Fixed rates																	
policy measure e_{21}												na	na	na			
policy measure e_{2n}												na	na	na			
F. Payments based on non-commodity criteria																	
F1. Long-term resource retirement																	
policy measure f_{11}			na	na	na	*	na	na	na	na	na	na	na	na	na	na	
policy measure f_{1n}			na	na	na	*	na	na	na	na	na	na	na	na	na	na	
F2. A specific non-commodity output																	
policy measure f_{21}			na	na	na	*	na	na	na	na	na	na	na	na	na	na	
policy measure f_{2n}			na	na	na	*	na	na	na	na	na	na	na	na	na	na	
F3. Other non-commodity criteria																	
policy measure f_{31}			na	na	na	na	na	na	na	na	na	na	na	na	na	na	
policy measure f_{3n}			na	na	na	na	na	na	na	na	na	na	na	na	na	na	
G. Miscellaneous payments	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	

Symbols: "na" – PSE label not applicable to policy measures in a given category; "*" – PSE label applicable to policy measures in a given category by definition; LC – local currency.

3. The use of PSE data in OECD's Policy Evaluation Model

The PSE indicators do not themselves quantify the impacts of policy measures on such variables as production, consumption, trade, farm income or the environment. Those impacts depend on the ***level of support***, the n***ature of support*** in terms of the way policy measures are implemented, and the Moreover, policy measures are rarely applied in isolation and their impacts depend also on the policy mix or ***composition of support***. The impacts or distortions associated with agricultural support are also the result of different ***rates of support*** among agricultural commodities and between commodity and non-commodity based support. Finally, the extent of such impacts and distortions may be limited through constraints imposed on production, on factors of production or on farming methods and technologies. The quantification of these impacts (distortions) requires economic models.

Since 1998, OECD has been developing the Policy Evaluation Model (PEM), which 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. 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 main purpose of the Policy Evaluation Model (PEM) is to bridge the gap between the PSE information, which categorises and quantifies agricultural support, and the impacts of policies, by providing an analytical instrument to measure the economic effects of support on production, trade, prices, income and welfare. The approach taken is to combine the PSE data with basic information on production technology and assumptions about elasticities of supply and demand, based on an extensive literature review, in order to relate the level of different types of policy transfers as classified in the PSE to the economic effects of interest.

3.1 Policy representations in the PEM model

The PEM is a partial equilibrium model that was specifically developed to simulate the impact of support on economic variables such as production, trade and welfare, by incorporating (inter alia) factor demand and supply equations. The representation of producer support in PEM has been tracking the evolution of the policy classification in the PSE database.

The key advantage of the PEM approach is that it recognises that the initial incidence of the agricultural policies classified in each of the seven PSE categories based on different implementation criteria is in the various factor (input) and output markets. For example, payments based on area planted affect first the land market, and then the rest of the parts of the production system through the interactions that occur between markets. Market price support enters the commodity market first as a differential between the domestic and world price, and then affects factor markets through derived demands and other commodities through cross-elasticities. Policies providing the same level of transfer can have very different effects according to what market they impact first, their so-called initial incidence. The PEM contains representations of markets for several important PSE commodities (wheat, coarse grains, oilseeds, rice, milk, beef), and also representations of factor markets including land, labour, purchased inputs, and farm capital. By creating a model that can properly reflect these initial incidences, the PEM captures the most economically significant differences in implementation that the PSE categories are intended to highlight. The outcome is a model that fits very well the sort of information contained in the PSE database.

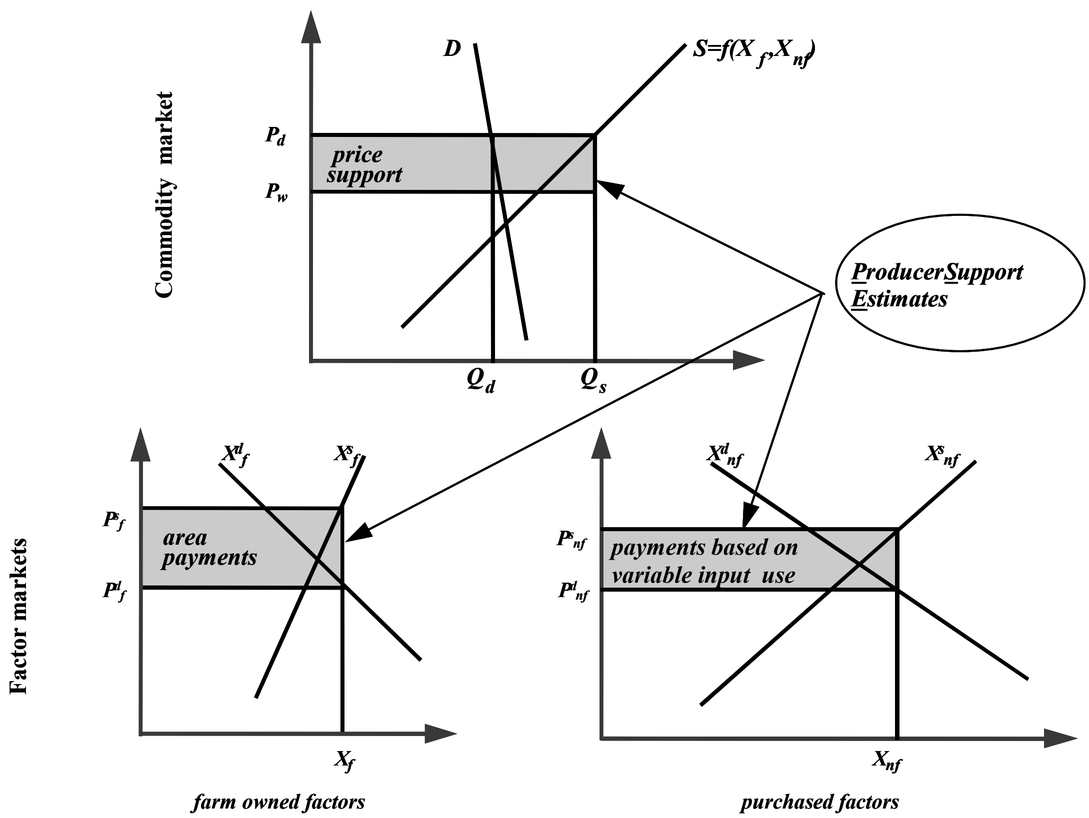
To illustrate how policies are represented in the PEM, imagine a simplified version of the model having just one country, one output and two inputs, the one country being any one of the participant countries. The two inputs are the aggregates: 'farm owned' and 'purchased'. Here, for the sake of simplicity, the former factor consists of land only. Figure 1 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 1 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. [1] The former is represented as a wedge between the effective incentive price 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 1. Policy Evaluation Model



1. 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.

Table 2 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. 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.

Table 2 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 & 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[2] 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 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

2. 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.

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.

The set of equations for a single country is provided in the Annex Table A.1. This set of equations can vary to some degree by country depending on the implementation of particular polices that affect the structure of markets, such as dairy production quotas, administered prices, or other market interventions. Currently, the PEM constructs 8 different policy variables from the PSE database (Table 3).

Table 3. Policy representations in the PEM model

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)

3.2 Policy shocks and scenario design in the PEM model

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 1; 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 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[3]. 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 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.[4]

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

3. 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.

4. 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)

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 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.

4. Conclusion

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. It is proven to be a useful took to assess the policy reform effort in a consistent way across countries and time.

On the other hand, 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. OECD has been developing the Policy Evaluation Model (PEM), which 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. This paper discusses how the OECD's PEM model represents producer support recorded in the PSE database and how the model implements policy shock in the model. In particular, a great deal of efforts is made in PEM to represent of payments based on farm income and non-current area payments in different factor markets.

However, the policy representation in PEM could be further improved, responding to the implementation of more targeted policies in member countries. For example, PEM does not represent the environmental payments which impose input constraints to producers. The representation of geographically targeted payments could be improved though introducing more disaggregated model structure. PEM requires continuous efforts to track the policy development in member countries.

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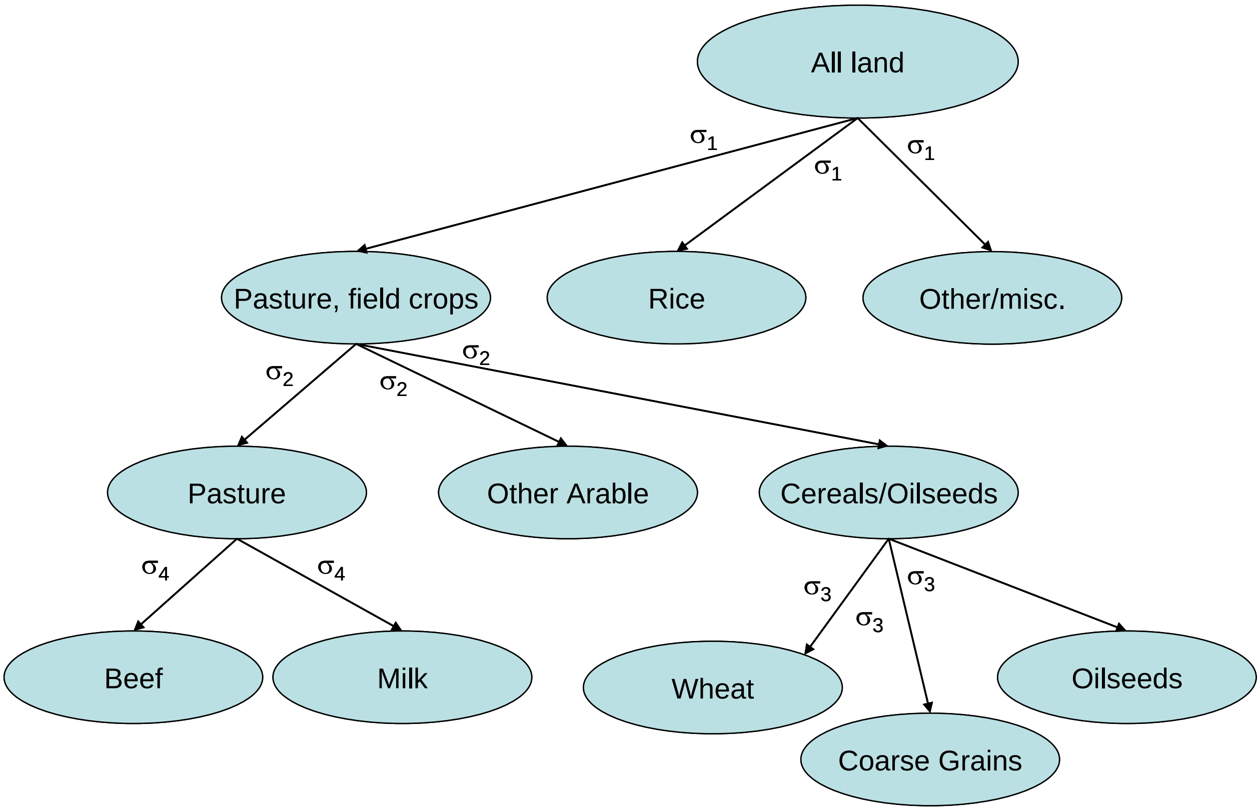
Appendix

1. Representation of land markets in PEM

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 A1).

Figure A.1. 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:

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

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

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

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

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.[5]

2. Stylized definition of market equilibrium conditions PEM

Table A.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
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)

5. 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.

$\dot{r}_n^s = \sum_{j=1}^{z} \frac{sr_j}{sr_n} \cdot \dot{r}_j^s$	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

Equations (dot above variable indicates percentage change)

$\dot{x}_{j,i}^d = \sum_{j=1}^{4} c_{ji} \sigma_{ji} \dot{p}_j^d + \dot{x}_{cfi}^s$	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
$\dot{r}_{cfi}^s = \sum_{j=1}^{z} c_{ji} \dot{p}_j^d$	Zero profit condition in feed market (concentrated feed price equals unit average cost of production)
$x_j^s = x_j^d$	input market clearing
$r_j^s = r_j^d + r_j^{s0}(h + f) + a_j + G1$	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
$r_j^s = r_j^d + r_j^{s0} \cdot f$	Supply price for “farm-owned” input for j=6 commodities
$r_j^s = r_j^d + r_j^{s0} \cdot s_j$	non-land supply price for input j, aggregated over commodities
$p_i^s = p_i^d + o_i$	supply prices for i=1 to 6 commodities
$p_i^d = p_i^w + m_i$	demand prices for i=1 to 6 commodities