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Jesus Anton, Chantal Le Mouël, . Unité d'Economie Et Sociologie Ruralestoulouse

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Jesús Antón and Chantal Le Mouël[1]
Directorate for food, Agriculture and Fisheries
OECD, 2 Rue André Pascal 75 775 PARIS cedex 16
Contact: jesus.anton@oecd.org or chantal.lemouel@oecd.org

Abstract

This paper utilises the OECD database on Producer Support Estimates (PSEs) and the partial equilibrium PEM crop model developed by the OECD to study the impacts on production of different types of support in selected OECD countries. The time series dimension of the database is exploited to estimate the contribution of each category of support to reducing farm revenue variability. The PEM model has been expanded to include risk-related effects by introducing appropriate risk premiums derived from the maximisation of a mean-variance utility function. The model has been used to simulate policy changes and to estimate, using parameters from the empirical literature, the production impacts of different support categories when including also their effects on reducing revenue variability. This methodology allows the relative magnitude of the risk-related effects (insurance and wealth effects) to be estimated and compared with the standard relative price effects for each considered category of support.

Keywords: Decoupling, risk, Producer Support Estimate (PSE), modelling.

1. Introduction

Decoupling has become one of the key issues in agricultural policy, both at the national and international level. This issue dominated much of the debate leading to the Uruguay Round Agreement on Agriculture in 1994. In the latter, policies deemed to have no or minimal effects on production and trade were classified in the so-called "green box" and thus exempted from all disciplines. As a result, green box policies have been providing a growing and important share of total support to agriculture. The extent to which exempted policies really are production and trade neutral has attracted increasing scrutiny, including in the context of the new WTO agricultural trade negotiations launched in 2000.

There are several mechanisms through which policies affect production and trade. In addition to standard static relative price effects, one may distinguish three main channels through which policy measures may affect farmers' production decisions: i) static effects that may arise whenever market work imperfectly or farmers make decisions under binding constraints; ii) dynamic effects that may occur when current investment decisions and/or farmers' expectations on future policies affect

1. The views expressed in this paper are those of the authors and not those of the OECD.

production decisions in the following years; iii) risk-related effects that may be observed in a uncertain world when farmers are risk averse.[2]

The ranking of these three types of effects as well as their respective magnitude relative to the static price effects is an empirical issue. There is little empirical evidence on the ranking of all these possible effects. However several recent studies focusing on the above mentioned risk-related effects provide assessments of their magnitude and of their relative importance as compared to static price effects. Hennessy (1998) first proposes a theoretical framework that allows for analysing the production effects of agricultural income support policies under uncertainty. Comparative static results allow emphasising two kinds of effects that would not arise in a certain world. The wealth effect is the change in production caused by the additional wealth created by the support measure. Hennessy shows that if farmers' risk aversion decreases with wealth, support measures resulting in increased wealth will make farmers willing to assume more risk and produce more. The insurance effect is the change in production caused by the reduction in the farm income variability attributable to the support measure. Then, applying his model to a US Midwestern corn farm, Hennesy provides an assessment of both these effects and the standard relative price effects of US deficiency payments. Obtained results suggest that while wealth effects remain small insurance effects are substantial and higher than relative price effects. In the same vein, using data of Kansas wheat production, Mullen (2001) and Mullen *et al.* (2001) have attempted to measure the relative magnitude of wealth, insurance and price effects of the various US payments in force for crops. Results are similar to those of Hennessy. They find that wealth effects are quite small while insurance effects are substantially higher than price effects.

This paper is in line with above presented studies. It focuses on production effects of agricultural policies under uncertainty and aims at assessing and comparing their wealth, price and insurance effects. However, the proposed analysis enlarges previous studies in two directions. First of all it considers not only the US but several OECD countries. Secondly it involves several categories of support.

The analysis is centred on crop and uses the PSE (Producer Support Estimate) database as well as the crop version of the Policy Evaluation Matrix (i.e., the PEM crop model).[3] Hence, countries covered are those taken into account individually in the PEM crop model (i.e., Canada, the European Union, Japan, Mexico, Switzerland and the United States). The analysis proceeds in three steps. In the first step, we attempt to measure the reduction in farmers' revenue variability associated with each category of support as classified in the PSE. This first step aims at providing empirical evidence of the risk reducing impact of these various categories of support. The second step is concerned with the assessment of the production and trade impacts of support categories when including risk-related effects. For that purpose the PEM crop model was modified to include risk effects in farmers' decisions and then used to simulate scenarios allowing to isolate, measure and compare wealth, insurance and price effects of the various considered categories of support. The third step provides a sensitivity analysis of results to the new parameters included in the PEM model, related to both wealth and insurance effects.

The paper is organised as follows. Section 2 is centred on step one. Section 3 focuses on the PEM modelling framework. Particularly, it describes how the model was re-designed and re-calibrated in

2. There is an extensive literature focusing on one or another of these three types of effects. One may find a synthesis of existing literature as well as a detailed description of such these effects in, e.g., OECD (2001*c*) and Gohin *et al.* (2001).

3. The PEM crop model is an equilibrium displacement model developed by the OECD in co-operation with some Member countries. See OECD (2001*b*) and Dewbre *et al.* (2001) for a detailed description.

order to take into account revenue risk faced by farmers. Section 4 is concerned with steps two and three. Finally, section 5 concludes.

2. The risk reducing impact of policy measures: Empirical evidence

The OECD has, since 1987, measured support to agriculture using the Producer Support Estimate (PSE). To be helpful for policy analysis, policy measures to be included in the PSE are classified according to implementation criteria. Hence the PSE is composed of various PSE categories, that correspond to different types of policy measures. The considered PSE categories are the following: market price support (MPS), payments based on output, payments based on area planted/animal numbers, payments based on historical entitlements, payments based on input used, payments based on input constraints, payments based on overall farming income and miscellaneous payments.[4] Data required to calculate PSEs, by commodity and by country, is available for the period 1986-2000 in the PSE database.

The objective of this section is to examine, using the information available in the PSE database, to what extent the different PSE categories affect not only the average revenue of crop producers but also its variability. Data over the period 1986-2000, provided by the PSE database, are used to measure the revenue variability across these years. That is, the time series dimension of the database is exploited to analyse not only the amount of the various types of payments in each year, but also how this amount is correlated with market revenue. The variability of revenue is used as an objective measurement of farming risk.

The analysis focuses on the commodities and the countries that are taken into account in the PEM crop model, i.e., wheat, coarse grains, oilseeds and rice for the commodities and Canada, the European Union, Japan, Mexico, Switzerland and the United States for the countries. The method used consists of a statistical analysis of a group of time series related to the revenue received by producers of each commodity in each country. Since the PSE database has no information about costs or non-farm income, the analysis is limited to farm receipts. We have not found a source of information on non-farm income for the whole time series. Therefore, the results refer to farm revenue and not to the total income of the farm households. The extent to which the results can be extrapolated to income depends on the correlation between farm revenue and farm income.

The series used for each commodity and country are calculated farm revenue from different sources as classified in the PSE database: i) the revenue that farmers would have obtained if they had sold their crop at prevailing world prices (revenue from world prices); ii) the revenue that the farmer actually earns from selling the crop at the domestic producer price (revenue from world prices plus revenue from market price support); iii) the revenue from world prices plus payments based on output; iv) the revenue from world prices plus payments based on area; v) the revenue from world prices plus payments based on historical entitlements; vi) the revenue from world prices plus payments based on inputs; vii) the revenue from world prices plus payments based on input constraints, payments based on overall farm income and miscellaneous payments and viii) the total revenue from the market and from government support, that is the revenue from world prices plus total PSE.

All these series were expressed originally in national currency in nominal terms. In order to make comparisons across countries and across time all the series were converted into constant USD values. For that purpose the methodology defined by Bureau and Butault (OECD, 2000) and by Butault (OECD, 2001*a*) was applied. Basically, the series were deflated using both the PPP

4. For more details about the PSE classification and the PSE categories, see OECD (2001).

(Purchasing Power Parity) index and the inflation rate in the United States using data from the OECD databases.

For each deflated series a linear trend was estimated using ordinary least squares (OLS) estimation. In cases in where a change in trend was observed during the period, the deflated series was divided into two samples using standard hypothesis testing.[5] Based on these calculated trends a variability index was calculated for each series according to the following expression (Tangermann, 1992):

$$\text{Index of Variation} = \sqrt{\frac{1}{15} * \sum_{t=1986}^{2000} \left(\frac{y_t - \hat{y}_t}{\hat{y}_t} \right)^2}$$

with $\hat{y}_t = \hat{a} + \hat{b} * t$ being the estimated trend value. This index of variation[6] represents the square root of the mean of the squared per cent deviations from the trend. It is conceptually equivalent to Pearson's Coefficient of Variation for a trended (non-constant mean) variable.

For each crop, the mean revenue, including each type of support, is compared to the mean revenue from world market prices. The same comparison is made for variability, using the index of variation defined above. The results of these comparisons of variability are summarised in Table 1. The figures in this table represent the increase or decrease in variability induced by each type of support expressed as a per cent of the variability of market revenue at world prices.

[Insert Table 1]

Most of the figures in Table 1 are negative, meaning that for almost all countries and crops, almost all PSE categories of support reduce the variability of farm revenues. The last column of each panel in Table 1 shows that the overall package of government support contributes to reduce the variability of farm revenues for all commodities in all countries, but rice in the European Union. The reduction in the variability of revenue due to support measures was as large as 72% in the case of wheat in the EU.

In most countries and for most commodities the total reduction in revenue variability is explained mainly by market price support. This is the category of support most generally used by governments to smooth the variability of world prices. There is not a single case in Table 1 for which market price support increases revenue variability. For instance market price support alone explains the whole reduction in revenue variability in all crops in Japan and Mexico, and in the European Union

5. Only changes in trend that occurred between 1990 and 1996 are considered to allow enough observations to estimate the trend in each sub-sample. The Student t test was used to determine the significance of the slope and the constant term in each estimation. The Chow test was used to identify the structural change in the trend. On the basis of the results of these tests, the two-periods trend estimation method was used in the following cases with the breaking years in parenthesis: wheat in Japan (1994-95), rice in the European Union (1993-94) and Mexico (1993-94), and oilseeds in Australia (1991-92), Canada (1993-94), the European Union (1991-92) and Japan (1993-94). The details of these estimated trends are not presented in this paper but can be provided if requested.

6. The coefficient of variation of a trended series captures the distance between the trend and the average as variability, which obscures the variability with respect to the trend. That is why, in the index of variation, instead of comparing the observed value with the mean it was compared with the value in the estimated trend. Other alternative indexes were used with similar results:

$$STDm = \sqrt{\frac{1}{T} \sum_{t} (y_t - \hat{y}_t)^2}, \qquad VI = \frac{\sqrt{\frac{1}{T} \sum_{T} (y_t - \hat{y}_t)^2}}{\bar{y}}$$

for cereals. The reduction in revenue variability from market price support is a measure of the lack of price transmission between world markets and domestic markets. This lack of transmission is potentially due to some explicit border mechanisms reducing price transmission -like the European Union's variable export levies or subsidies in most of the sample years- or to tariff rate quotas for which the out-of quota tariff is not the binding instrument, or just prohibitive tariffs. Other factors such as exchange rate adjustments and natural barriers also sometimes play a role in price transmission.

In a few countries, other categories of support have contributed significantly to reduce farm revenue variability. This is the case for Canada for example where payments based on output and area payments have reduced farm revenue variability. However, even in this case, market price support remains an important instrument for reducing farm revenue variability. On the contrary, the United States is the only country that has not used market price support as its main instrument for farm revenue stabilisation in the crop sector. In this country payments based on output, area payments and payments based on historical entitlements have all played a very significant role in reducing farm revenue variability. This fact is easy to explain for the three categories of support. The deficiency payment mechanism under "payments based on output" is explicitly a mechanism to truncate the lower part of the distribution of producer receipts per unit. Most emergency payments in the United States are classified under "payments based on area" and, therefore, the support delivered by this mechanism is negatively correlated with farm revenue. Finally, the Production Flexibility Contract (PFC) payments based on historical entitlements in the last four years have been supplemented with the so-called market loss payments in years of low revenue. In the United States the "package" of support measures for wheat works in a way that reduces revenue variability much more than any one measure on its own.

3. Including risk in the PEM modelling framework

3.1. The PEM crop model

The Policy Evaluation Matrix or PEM model has been developed by the OECD Secretariat to support ongoing monitoring and evaluation of Member country's agricultural policies using the PSE. The PEM crop model is a partial equilibrium model of the world market for crops.[7] It comprises six individual country modules (Canada, European Union (treated as one country), Japan, Mexico, Switzerland and the United States) and one for the rest of the world. The adopted framework was the model of the farm sector elaborated in Gardner (1987) and in Hertel (1989). Our version and application closely follow that developed in Gunter at al. (1996). The basic equation structure of each of the country modules is that shown in Table 2. In the rest-of-the-world module, crop demand is modelled in the same way as in the individual country modules but crop supply is represented using simple aggregate supply equations.

[Insert Table 2]

In each country module, there are four crops (wheat, coarse grains, oilseeds and rice) and three types of factors of production (land, non-land owned factors and non-land purchased factors). A representative non-joint production function for each crop is assumed. Hence, the inter-linkage between crops occurs in the factor markets where scarce factors of production have to be allocated among commodities. An important consideration in modelling the demand and supply of factors is the assumed degree of mobility of these factors across crops. The aggregated factor "other farm owned" (comprising mostly farm household labour and management) is assumed to be completely

7. The PEM crop Model is described in details in OECD (2001*b*).

crop-specific. Conversely, we assume a perfect substitutability in the use of purchased factors amongst crops.[8] In modelling demand and supply of cropland, we defined a unique category of land for each crop in the same way as the "other farm owned" aggregate. However, we assumed that the supply of land to each crop depends not only on the rental rate for that category of cropland but on the rental rates for all other categories of land use as well (including the four study crops plus a residual category: other arable land). Hence, we implicitly assumed that some land is better suited for one crop than for another so that there can be only imperfect substitution amongst uses in response to changes in land rental rates.

Parameters of the PEM model (i.e., crop demand elasticities and factor supply and demand elasticities) were not estimated. They were calibrated on the basis of existing estimates available in the literature and taking into account all theoretical restrictions resulting from assumed well-behaved cost and utility functions. A particular attention was paid to the factor supply and demand elasticities. The elasticities of factor supply and substitution were all based on two reviews of published empirical studies of agricultural supply response, one covering studies focusing on NAFTA countries (Abler, 2001) and the other covering studies centred on European countries (Salhofer, 2001). Required factor cost shares were estimated in collaboration with the various Member country experts who participated in the pilot study of the PEM project. The cost share estimates are based on results from surveys of costs of production done in study countries.[9]

One of the main features of the PEM model is its close relationship with the PSE database. This latter covers the period 1986-2000. For each year and each considered commodity and country, it provides supply and demand quantities as well as domestic and border prices. These basic data are used to calibrate the model for a reference year.[10]

Available information regarding agricultural policies comprise output price gaps, used to calculate the market price support (MPS) component of the PSE, and budgetary transfers induced by applied support measures. As already mentioned, in the PSE database support measures are classified according to implementation criteria. This classification guided the modelling of incidence of policy measures in the PEM model. As shown in Table 3, we model the first incidence of support measures through price wedges, concerned prices depending on the considered category of measures.

[Insert Table 3]

3.2. Including risk in the PEM crop model

In the PEM model, production functions are assumed to be commodity specific. Thus, we may adopt the framework of a representative single-commodity competitive producer. Following Sandmo (1971), Newbery and Stiglitz (1981), Hennessy (1998) and many others, we adopt the commonly used framework of this representative producer maximising the expected utility of his risky income. We define total income of the representative producer (farm household income) as:

$$\tilde{Y} = \tilde{R} - \sum_{j} x_j * w_j + \tilde{B} + O \quad \text{with} \quad \tilde{R} = \tilde{P} * Q \qquad (1)$$

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8. The list of purchased factors is different for each country. Fertiliser is distinguished in all individual countries, and hired labour in all but Mexico and Japan.

9. This step of cost share estimation also provided required domestic prices of the various considered factors of production.

10. For this analysis we retained 1998 as the base year.

where $\tilde{R}$ is the total market receipts of the farmer (with $E(\tilde{R})=\overline{R}$), $\tilde{P}$ is the uncertain price of the output (with $E(\tilde{P})=\overline{P}$), Q the quantity produced, x_j the quantity used of input j and w_j the corresponding price, $\tilde{B}$ the amount of budgetary payments received by the farmer and O the off-farm income of all kinds.

There are two main implicit assumptions in this modelling framework. First of all, it is assumed that the costs of the inputs as well as the production process are not sources of uncertainty.[11] Secondly, off-farm income is a certain exogenous variable in the model. Then the expected value and the variance of the farm household income is:

$$E[\tilde{Y}]=\overline{Y}=\overline{R}-\sum_j x_j * w_j + \overline{B}+O$$
$$V[\tilde{Y}]=V[\tilde{R}+\tilde{B}]=[\overline{R}+\overline{B}]^2 * \left(CV[\tilde{R}+\tilde{B}]\right)^2 \qquad (2)$$

where $CV[\tilde{R}+\tilde{B}]=\sqrt{V[\tilde{R}+\tilde{B}]}/(E[\tilde{R}+\tilde{B}])=\sqrt{V[\tilde{R}+\tilde{B}]}/(\overline{R}+\overline{B})$ is the coefficient of variation of $[\tilde{R}+\tilde{B}]$.

In the following, we assume that this coefficient of variation does not depend on the farmer's decisions (i.e., $CV[\tilde{R}+\tilde{B}]=CV$). This is of course a restrictive assumption but, at this stage, we were forced to adopt this assumption for being able to obtain tractable analytical results that are consistent and can be easily introduced in the current structure of the PEM model.

Using the mean-variance approach to expected utility[12] (e.g., Newbery and Stiglitz 1981; Coyle 1992 and 1999; Mullen 2001; Mullen *et al.* 2001a and 2001b) we can derive a "certainty equivalent" income as:

$$\breve{Y}=\overline{Y}-\frac{1}{2}\alpha * V[\tilde{Y}]$$
$$\breve{Y}=\overline{Y}-\frac{1}{2}\frac{\rho}{\overline{Y}} * V[\tilde{Y}] \qquad (3)$$

where α and ρ are the Arrow-Pratt, respectively, absolute and relative risk aversion coefficients (Arrow, 1971; Pratt, 1965) corresponding to two utility functions commonly used to describe risk preferences: the constant absolute risk aversion (CARA) utility function and the constant relative risk aversion (CRRA) utility function also known as the decreasing absolute risk aversion (DARA) utility function.

Thus the objective of the representative farmer is to maximise this certainty equivalent income when deciding the inputs to be used in production. Deriving expressions (3) with respect to each input quantity x_j, we obtain the corresponding first order conditions (FOCs):

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11. This assumption avoids congruence problems in supply and demand determined from duality as shown in Pope and Just (2002).

12. This approach can be derived from a Taylor series quadratic approximation of the true expected utility function as shown in Chapter 6 of Newbery and Stiglitz (1981).

$$\overline{P} * \left[1 - \alpha\left(\overline{R} + \overline{B}\right) * CV^2\right] \frac{\partial Q}{\partial x_j} = w_j \qquad \text{under CARA}$$

$$\overline{P} * \left[1 - \frac{\dfrac{\overline{R} + \overline{B}}{\overline{Y}}}{\dfrac{1}{2} + \dfrac{1}{\rho * CV^2}}\right] \frac{\partial Q}{\partial x_j} = w_j \qquad \text{under DARA} \qquad (4)$$

In fact these first order conditions are very similar to the standard ones in a non-stochastic model, except for the existence of the following proportional risk premium to be applied to the output price:

$$\theta = \alpha\left(\overline{R} + \overline{B}\right) * CV^2 \qquad \text{under CARA}$$

$$\theta = \frac{\dfrac{\overline{R} + \overline{B}}{\overline{Y}}}{\dfrac{1}{2} + \dfrac{1}{\rho * CV^2}} \qquad \text{under DARA} \qquad (5)$$

Given the structure of the PEM model, above endogenous premiums may be introduced in the corresponding supply equations and the whole model recalibrated. Both CARA and DARA specifications are introduced into the model, the choice of one specification becoming part of the definition of scenarios to be simulated.

The calibration of the new version of the model including risk premiums requires additional information, specifically:

- total farming receipts, related coefficients of variation and an estimate of α in the case of CARA;

- total farming receipts, related coefficients of variation, total farm household income and an estimate of ρ in the case of DARA.

The total farming receipts $\left(\overline{R} + \overline{B}\right)$ for each commodity and country is available in the PSE database and the corresponding coefficients of variation CV have been calculated in section 1. When simulating a policy change we will assume that both farming receipts and the coefficients of variation can be exogenously affected by support measures.

Required information about farm household income is taken from the OECD structural database. This latter provides the ratio "gross output/total income", which is equivalent to our ratio "farming receipts/total farm income" (i.e., $\left(\overline{R} + \overline{B}\right)/\overline{Y}$). Provided ratios are not sufficiently detailed since: required information is missing for some individual PEM countries in the structural database; "gross output/total income" ratios are not calculated for each year of our 1986-2000 study period but only for some specific years; the structural database provides these ratios for all farms and not for crop farms which would be more appropriate for the PEM crop modelling framework. Nevertheless, ratios provided by the OECD structural database are consistent among countries. "Farming receipts/total farm income" ratios adopted for Japan, Switzerland and the US are respectively: 0.57, 2.99 and 1.53. They correspond to all farms average ratios provided by the structural database for the year 1994 in the case of Japan, 1995 in the case of Switzerland and 1996 for the US. Since the database does not provide ratios for Mexico and Canada, the US ratio of 1.53 is used as a first approximation for both countries. For the EU, the all farms average ratio for

Denmark, calculated for the year 1996/97, is used. The sensitivity analysis reported in section 4 and in Appendix considers a range of values for these ratios in the different PEM countries.[13]

The available information about the risk aversion coefficients is even scarcer. There are a lot of applied studies aimed at estimating absolute and/or relative risk aversion coefficients, most of them being centred on US farmers (see Table 4 where selected studies are reported). Provided estimates are nevertheless used to calibrate our α and ρ coefficients for all individual PEM countries. Table 4 reports the range of the coefficient of relative risk aversion obtained by various existing studies. This coefficient does not depend on the specific units used to measure prices, quantities and income, so that it is comparable across studies.

[Insert Table 4]

Most of reported studies reject the hypotheses of risk neutrality and CARA, concluding that farmers' preferences are DARA. The range for relative risk aversion shown in Table 4 is quite wide from 1.4 to 18.8. In this study a conservative decision was adopted in order to avoid an overestimation of the risk-related effects of policy measures. The baseline value was defined as a relative risk aversion of 2.[14] The sensitivity analysis reported in section 4 and in Appendix considers a relative risk aversion coefficient ranging from zero (risk neutrality) to 5.[15]

4. Measuring the production impacts of PSE measures when including risk-related effects

The purpose of this section is to estimate the production impacts of different categories of support in different countries when including risk-related effects. The objective is to calculate the relative importance of price, insurance and wealth effects, and the degree of decoupling of different PSE categories.

4.1. Definitions of simulated scenarios

Section 1 provides empirical evidence of the impact of each PSE category in terms of increasing the average revenue of farmers and decreasing its variability during the period 1986-2000, for each crop and in each country covered by the PEM crop model. This section aims at evaluating the impact of these changes in both the average and the variability of farmers' revenue, as induced by PSE categories, on domestic production and trade. For that purpose a basic scenario is defined involving, for each PSE category, a 10% increase in the corresponding support expenditure (representing an increase in the average revenue) and a 10% decrease in the corresponding coefficient of variation (representing a decrease in the revenue variability) with respect to their observed level in the base year situation.[16]

13. The OECD structural database provides the "gross output/total income" ratios for all farms but also for the smallest (first quartile, based on gross sales) and the biggest (fourth quartile) ones. These data are used to define the lower and the upper bounds of the "farming receipts/total farm income" ratios used for each country in the sensitivity analysis.

14. The value of the coefficient of absolute aversion was derived from the assumed value of the coefficient of relative risk aversion using data on farm income calculated from the ratios "farming receipts/total farm income" issued from the OECD structural database and the data on farming receipts available in the PSE database.

15. Saha *et al* (1994) estimate a larger risk aversion coefficient for larger farms. However, their estimates are not significantly different from each other at 95%.

16. The range of 10% increase in support expenditure and 10% decrease in coefficients of variation has been chosen for avoiding shocks that are so big as to be outside the appropriate range of the model.

We know that this proportionality between support expenditure and reduction in revenue variability is very unlikely. For instance, some agricultural programs -such as the Marketing Loan Program in the United States- have an explicit or implicit triggering mechanism which reduces the variability of the distribution of revenue by truncating the lower tail of the distribution. For these kinds of programs it can be shown that the first dollars spent have a much larger impact on revenue variability. The decreasing impact of support expenditure on revenue variability is illustrated in Figure 1 using the methodology developed by Chavas and Holt (1990). This decreasing marginal insurance effect would reinforce the decreasing marginal price effects that are discussed in OECD (2001*b*). However, in our simulation analysis we use stylised policies whose mechanism for reducing revenue variability is not explicitly modelled. Therefore, we make a proportional change of both the mean and the coefficient of variation of revenue.

[Insert Figure 1]

In order to isolate price, insurance and wealth effects of PSE categories, a set of nine different scenarios was defined. The nine scenarios rely on the basic scenario but are differentiated according to the retained risk preference assumption (i.e., CARA or DARA) and to the retained applied shock(s) (i.e., shock on the mean revenue only, shock on the coefficient of variation only, or both at the same time). Some scenarios may also involve a lump-sum payment that is equal to the estimated increase in farm income, and which purpose is to isolate the wealth effect. The nine scenarios are presented in Table 5.

[Insert Table 5]

These scenarios are simulated for each PSE category and for each country. They provide, in particular, the impact of each PSE category on the production of the main crop in each country. Then, by comparing production impacts resulting from these nine scenarios, one may isolate the price effect, the insurance effect and the wealth effect of each policy measure.[17] More precisely, the production impacts in scenario "A", under risk neutrality, correspond to the standard relative price effects. Scenario "C", under CARA assumption, isolates the insurance effects of policy measures by applying a shock on the coefficient of variation only. Production impacts in scenario "D", under CARA assumption, include both the relative price and the insurance effects. Production impacts in scenario "E", under DARA assumption, include the relative price, the insurance and the wealth effects. Scenario "F", under DARA assumption, isolates the wealth effects of policy measures by considering a theoretical lump-sum payment that affects only the overall income of the representative farmer.[18]

4.2. Analysis of simulation results

Results obtained from the simulations of the nine scenarios performed for the four retained PSE categories, the six countries considered individually in the PEM model and for the three latest year of the sample (1998, 1999, 2000) are summarised in Tables 6A and 6B in the form of three types of indicators:

- ***Total Production ratios***. Those ratios measure the degree of "coupling" with respect to production: one minus the ratio is usually referred to as the "degree of decoupling" (Cahill,

17. This is the same kind of method that is used in Hennessy (1998) and Mullen *et al.* (2001) to isolate price, insurance and wealth effects.

18. Of course, there are a number of other combinations between scenarios allowing to calculate insurance and wealth effects. For example, insurance effects of policy measures may be calculated as the differences between production effects resulting from scenarios "D" and "A". In the same way, wealth effects may be calculated as the difference between production effects resulting from scenarios "E" and "D".

1997; Moro and Sckokai, 1999; OECD, 2001*c*). It is defined as the ratio of the impact on production per dollar of support in a given PSE category, to the impact per dollar of market price support[19] given in the form of a single *ad valorem* non-prohibitive tariff. This kind of market price support allows for price transmission since it does not modify the variability of revenue measured by the coefficient of variation. Therefore, market price support with perfect price transmission is used as the reference for comparison and referred to as MPS in the rest of the section. This method permits production ratios for market price support to be calculated. These ratios can vary depending on the instruments used to support the domestic prices and they will be equal to one under risk neutrality.

- ***Production Ratios by type of effect***. These ratios compare the relative importance of each kind of effect between a given PSE category and market price support. That is, we measure the production impact per dollar through - for example - insurance effects of some PSE categories, and then calculate their respective ratios to the impact through insurance effects of market price support.

- ***Shares of price, insurance and wealth effects in total production impacts***. These shares can differ from one PSE category to another and from one country to another. If a measure is applied in a way that significantly reduces revenue variability, insurance effects will have a larger share in total impacts. If a measure is very efficient in transferring income to farmers, it will have a larger share of wealth effects[20].

[Insert Table 6A]

[Insert Table 6B]

The total production ratio for market price support in the United States is 1.18 when all three effects are considered (price, insurance and wealth effects under DARA). This means that the way price support was provided, it reduced price variability and induced additional production 18% higher than if no such effects existed. The share of price effects is 82% as a result, compared to 17% of insurance effects and 1% of wealth effects. Total production ratios of price support are similar in other countries (1.18 in Canada, 1.14 in the European Union, 1.20 in Mexico, 1.12 in Switzerland) except Japan where it is only 1.03. This lower figure in Japan can be explained by the level of price support, which is so large that the modelled variability reduction per dollar is very small. Insurance effects in Japan are only 5% of the total. Wealth effects of market price support tend to be very small due to the low transfer efficiency of this kind of support (OECD 2001*d*). They are more significant in Canada due to higher transfer efficiency determined by lower levels of support and its "small country" condition.

The total production ratio for payments based on output is more sensitive to the insurance effects, increasing from 1.09 to 1.54 in the United States when including the risk effects. This means that the payments based on output have an impact on production that is 54% higher than the reference MPS. The corresponding figure is 94% higher in the case of Japan. When output support is provided in a risk-reducing manner, it can have an impact on production that is much larger than the price support used as a reference. The production ratios by type of effect show how output payments have a price effect, which is similar to that of MPS in the United States (1.09) and a bit higher in Japan (1.52). But output payments have an insurance effect which is 2.4 times higher that

19. The market price support used as reference does not include wealth effects neither. However those are negligible for this form of support given its low transfer efficiency.

20. See OECD (2001*d*) for an analysis of transfer efficiency of different PSE measures.

of market price support in the United States and 9.1 times higher in Japan. The share of insurance effects for output support is 31% in the United States and 24% in Japan. As expected, wealth effects of output payments are not very significant.

Payments based on area were found to have significantly lower impacts on production than market price support when measuring only relative price effects as in OECD (2001*b*). However, including the risk-related effects can reduce the difference in the production impacts of area payments and market price support. This is the case in the United States and Canada where the programs classified as area payments have a clear counter-cyclical design. The production ratios of area payments when including risk-related effects are 0.61 in the United States and 0.74 in Canada. On the contrary, in the European Union the payments based on area have no counter-cyclical component and, therefore, the total production ratio hardly changes when risk effects are included. Area payments in Switzerland are found to slightly increase revenue variability and have a negative insurance effect. The production ratios by type of effect show that both price and insurance effects on production are larger for market price support than for area payments. However, wealth effects of area payments are, on average, twice as large as for market price support due to their higher transfer efficiency. This is specially the case in Switzerland where the ratio farming receipts / farm household income is higher than in other countries.

The most significant change in the estimated total production ratio when including risk effects is found for payments based on historical entitlements in the United States. The ratio for price effects only is 0.03, but when risk effects are included it becomes 0.39. This is mainly due to the high insurance effects, which represent 83% of the total production impacts. The counter-cyclical nature of these payments in recent years is at the origin of these results. On the other hand, the historical entitlement payments in Mexico have no counter-cyclical element, creating negligible insurance effects but very significant wealth effects that represent 29% of the total production impacts.

4.3. Sensitivity analysis of the production impacts

Previous results show that, according to the simulations carried out with the PEM crop model, the effects associated with risk can be significant. Table 7 compares these results with other results in the literature for the deficiency payments in the United States. Our estimates of the share of the insurance and wealth effects are the smallest out of the three studies found. This can be explained by the choice of the risk-related parameters: the coefficient of relative risk aversion of 2 considered in this paper is low compared to what is used in the other studies (cf. Table 4). The selected ratio between farming receipts and farm household income may also affect this result. Finally, the fact that this study calculates average impacts in reducing revenue variability instead of marginal impacts may reduce the share of risk-related effects.

[Insert Table 7]

Are these results sensitive to the assumptions about the risk-related parameters? How do our results change with these assumptions? In order to answer these questions systematic sensitivity analysis was carried out for the risk-related parameters in the PEM crop model following the methodology developed in Davis and Espinoza (1998) and Griffiths and Zhao (2000) and already used in OECD (2001*b*). This kind of sensitivity analysis is very resource intensive and, therefore, is carried out only for the United States. The two parameters under study are the relative risk aversion coefficient and the ratio between farming receipts and farm household income. Given the limited information and empirical evidence available, we assume simple uniform and independent distributions for each of the parameters.

In order to select the upper and lower bound of each distribution, a conservative criterion was adopted to avoid overestimating risk-related effects. For the relative risk aversion coefficient, an interval between zero (no risk aversion) and five was imposed on the uniform distribution. This interval is in the lower range of values in Table 4. For the ratio between farming receipts and farm household income, an interval between the value of the ratio for the first quartile and the ratio for the fourth quartile of US farms was chosen using the OECD structural database. That is an interval (0.06, 3.61). This choice is also conservative given the larger impact on production of the farms in the fourth quartile. Even if we assign equal probability to any value in the two intervals, the true values are more likely to fall in the upper part of each range. All the values in the intervals seem to be plausible and, therefore, the values of the indicators in each simulation should also be interpreted as plausible.

For each parameter, a sample of hundred stochastic values was drawn. For each PSE category and each scenario "A" to "F", a set of a hundred simulations -one for each value of the stochastic parameters- was carried out. The sensitivity analysis was divided into three phases. Phase 1 undertakes the sensitivity analysis with respect to the relative risk aversion coefficient, the rest of the parameters being constant at their base value. Phase 2 concentrates on the ratio "farming receipts/farm household income", the rest of the parameters being held constant. And phase 3 deals with the sensitivity with respect to both parameters at the same time. The results of this sensitivity analysis are presented in the figures in Appendix.[21]

The sensitivity analysis as regards to the relative risk aversion coefficient shows that the insurance effects of all policies are very sensitive to the value of this parameter. As shown in Figure A.1 in Appendix, the relative price effects on production are not affected by the risk aversion parameter. However the insurance effects are very sensitive to this parameter, whatever the considered PSE category. In fact, Figure A.1 shows that the relationship between the risk coefficient and the insurance effects is almost linear. The insurance effect of market price support varies from zero (since zero risk aversion is the lower bound) to more than half the price effects. Insurance effects may even become larger than price effects for PSE categories that are counter-cyclical (for instance, payments based on output or deficiency payments), or specially in categories that also have lower price impacts (for instance, payments based on historical entitlements). For these latter payments, the insurance effect is dominant even when the risk aversion coefficient is very small. The minimum share of insurance effects for payments based on historical entitlements is 24%.

Wealth effects are larger the larger the risk coefficient, but they remain very small (below 3% of the total impact) for the less transfer efficient PSE categories, that is, market price support and payments based on output. However they may be as significant as 10% of the total impact of payments based on historical entitlements because these payments are more transfer efficient.

The sensitivity analysis of the ratio farm receipts/farm household income (the income parameter) provides some insight into the sensitivity of risk-related effects with respect to off-farm income. The ratio is used in the model to determine the level of off-farm income and, therefore, the relative importance of the reduction in revenue variability induced by the PSE measures. The higher the value of the income parameter, the higher the importance of farming revenue in farmers' income and the larger the relative impact of policy in reducing variability. This positive relationship between the income parameter and the risk-related effects is shown in Figure A2 in Appendix. In fact, Figure A.2 is very similar to Figure A.1. That is, the production effects of each PSE category have the same degree of sensitivity with respect to the intervals chosen for both the parameters. For farmers who have no off-farm income (high-income parameter) the insurance effects of payments

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21. A hundred stochastic parameter values, with six types of simulations for each of the four PSE measures considered and the 3 phases of the sensitivity analysis, generated a total of 7 200 simulations.

based on output may be larger than the price effects of these payments. Insurance effects dominate the production effects of historical entitlement even for farmers with high off-farm income.

As expected, wealth effects are more sensitive to the income parameter than to the risk aversion parameter. That is why the share of wealth effects of the most transfer efficient payments can become as large as 21% in the case of payments based on historical entitlements and 18% for area payments. Furthermore, Figure A.2 shows that the increase in wealth effects with the income parameter is not linear so that the share of wealth effects could be significantly higher for values above the upper limit of the interval.

The sensitivity analysis with respect to both risk-related parameters at the same time provides a wider degree of variability of the production impacts. When a low value of the risk aversion parameter is combined with a low value of the income parameter, the result is smaller insurance and wealth effects. On the contrary when both parameters have high values, insurance and wealth effects are larger. Therefore, the range of all indicators widens as compared to the sensitivity analysis of each parameter separately.[22]

According to obtained results, it is plausible therefore that payments based on area have a production ratio up to 1.63, that is 63% higher than the reference market price support. The highest production ratio for the payments based on historical entitlements is 1.52. These high ratios are due to the greater importance of insurance and wealth effects. However, those effects also operate, to a lesser extent, for market price support. Therefore, the differences in the production impacts of PSE measures are smaller than when price effects only are considered. However, these differences are still significant as shown in Figure 2. The distributions of production ratios are highly asymmetric since they have a lower bound or minimum value determined by the value of the ratio when no risk effects are considered (a straight vertical line shows these values in Figure 2). The modes of these distributions, represented by the peaks in the figure, seem to move in parallel. However, the means of the distributions show that the ratios for payments based on historical entitlements are significantly larger, relative to market price support, when risk-related effects are included.

Furthermore, these distributions show that for plausible values of the parameters the production impacts of all categories of support can be higher than the reference market price support. That is insurance and wealth effects for policy measures may — in some cases — be as large as the relative price effects.

[Insert Figure 2]

5. Concluding comments

Using standard statistical methodologies to analyse the variability of the PSE time series for the period 1986-2000 shows that most PSE categories for most crops and considered countries reduce the risk faced by farmers. This means that in those countries, most forms of agricultural support are provided in a counter-cyclical manner, due to explicit, implicit or *ad hoc* mechanisms of agricultural policy design. Countries with low levels of support have also very low levels of risk reduction.

The PSE category that is most generally used to reduce risk is market price support, which often reduces the variability of farming revenue by half. If market price support was provided through simple and binding *ad valorem* tariffs, one could expect perfect price transmission to occur and no reduction in revenue variability. The fact that sometimes market price support is, or has been,

22. Due to space limitation, the tables reporting the results of the sensitivity analysis in terms of production ratios are not provided in this paper. They are available from the authors upon request.

provided through variable measures, tariff rate quotas or prohibitive tariffs, or that it is accompanied by some intervention in the domestic markets, can facilitate the smoothing of farm revenue through price support measures.

However, other PSE measures have also been used to reduce the variability of farming revenue. In countries such as Canada and the United States, both output and area payments have had a significant impact in reducing farming revenue variability. However, the risk reducing impact of the different PSE categories cannot be generalised across countries. For instance the area payments in the European Union have no counter-cyclical design and, therefore, have a small impact in reducing revenue variability. That is, the specific manner in which the payments are decided is crucial for the risk reduction impacts of the different PSE categories.

A new version of the PEM crop model that incorporates risk premiums and the impact of risk reducing policies has been used to measure the production impacts associated with risk reduction. The results of these simulations show that for some countries the risk-related effects of PSE measures are far from being marginal or irrelevant. Using plausible, conservative values for the risk-related parameters, it is found that the insurance effects associated with market price support represent 20% of the total effects in most countries. The share of the insurance effects of counter-cyclical payments based on output is about 30% of the total impact on production. Finally, for payments with very small price effects, the insurance effects dominate the production impacts: 83% of the production impacts of historical entitlements in the United States are due to risk reduction.

Wealth effects are found to be insignificant for support categories with low levels of transfer efficiency like market price support and payments based on output. However these wealth effects can become relevant for more transfer efficient forms of support such as area payments or payments based on historical entitlements. For instance, wealth effects are estimated to represent 29% of the total production impacts of payments based on historical entitlements in Mexico. Nevertheless total effects of this category of support are found to be smaller than those of market price support.

Since most PSE categories of support reduce farming revenue variability, the risk-related effects exist for all types of support. Relative production impacts of all forms of support are larger when farmers are risk averse than when they are not. However there seems to be evidence of differences in the relative importance of these effects across categories of support and across countries. The categories of support that are used with clear counter-cyclical design or with large transfer efficiency have much larger relative impacts.

The systematic sensitivity analysis carried out using Montecarlo simulations, further emphasises the fact that the risk-related effects of PSE measures could be very significant. Insurance effects can dominate the total production impacts in some cases under plausible assumptions about the parameter values. Full time and more risk averse farmers have larger insurance and wealth effects than farmers whose main income is from an off-farm source and who are risk neutral. The ordering of the production impacts of different PSE measures found in OECD (2001*b*) is not modified in the simulations incorporating risk. However, the differences in the production impacts of the various policy measures can be much narrower when risk effects are included.

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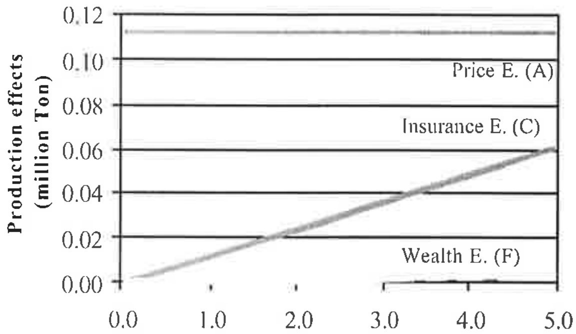
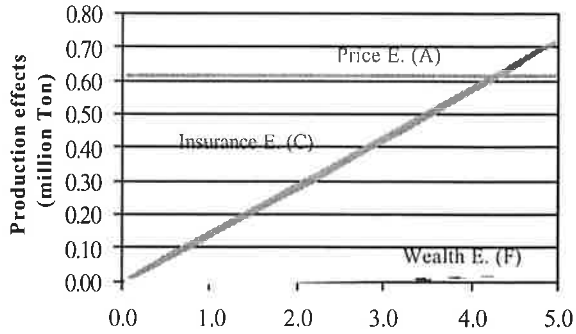
APPENDIX

Figure A.1: Sensitivity analysis of production effects in the United-States (1998)
Relative Risk Aversion coefficient

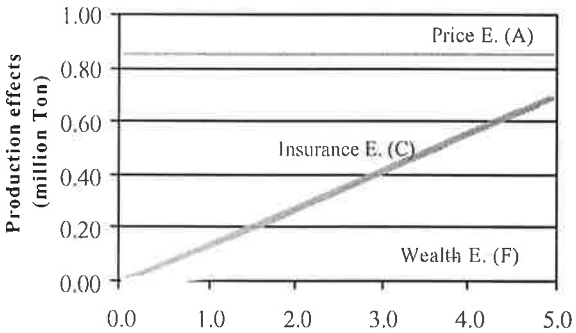
Market Price Support



Payments based on output



Payments based on area planted



Payments based on historical entitlements

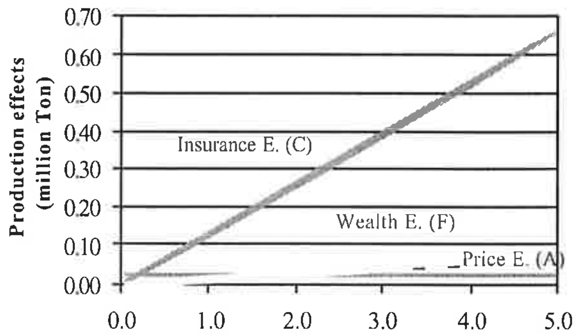


Figure A.2: Sensitivity analysis of production effects in the United-States (1998)
Ratios Farming receipts Farm Income

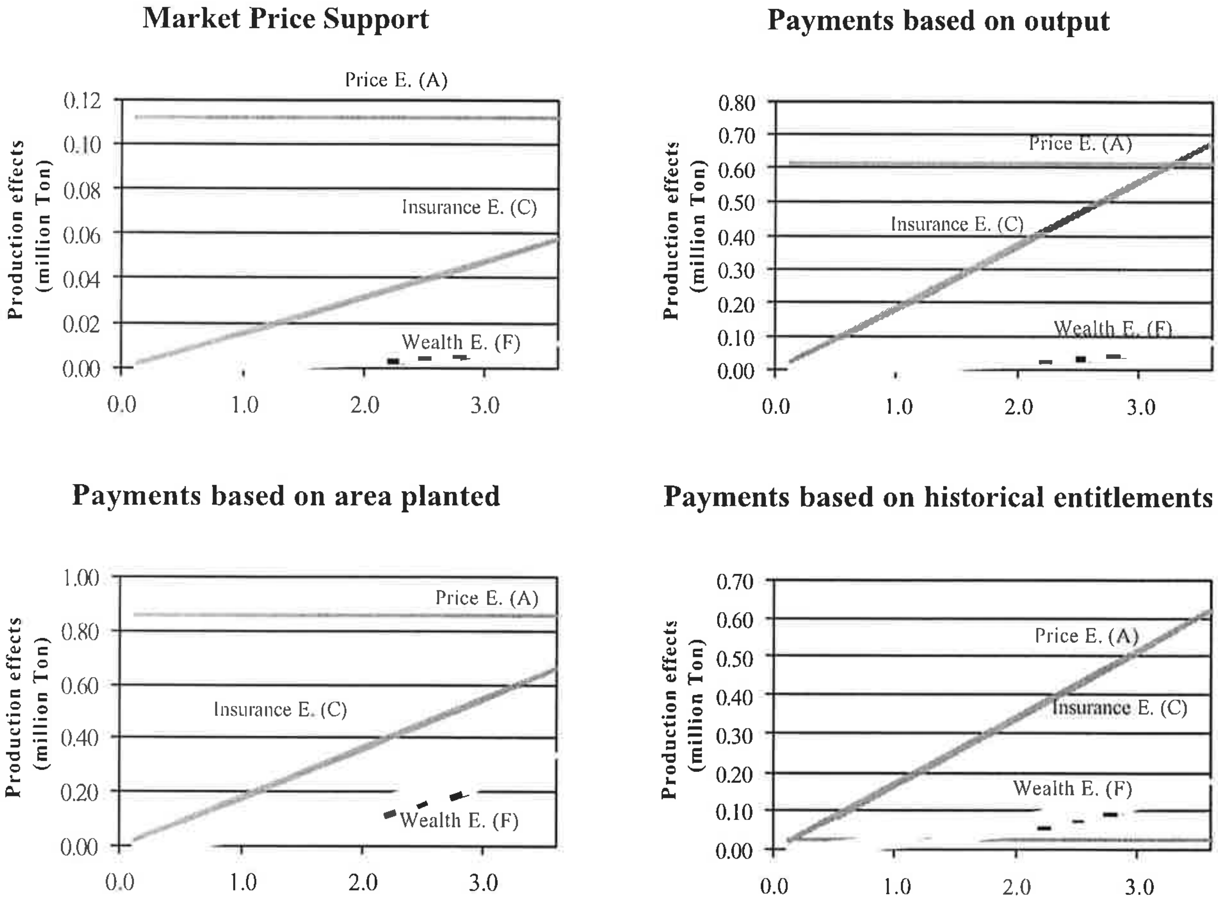


Table 1. Percentage Increase in Revenue Variability (compared to that from world prices) 1986-2000, by commodity, by PSE Category

WHEAT				Source of revenue			
Country	Market Price Support	Payments on Output	Payments on Area	Payments on Hist. Entitle.	Payments on Inputs	Other Payments	Total Revenue
Canada	-15	-2	-8	15	-3	-4	-13
European Union	-72	0	-6	0	-4	-5	-72
Japan	-54	..	..	..	-25	-6	-54
Mexico	-35	..	0	2	-1	0	-33
Switzerland	-38	..	7	-19	-8	-13	-44
United States	-19	-16	-37	-17	-2	-1	-67

COARSE GRAINS				Source of revenue			
Country	Market Price Support	Payments on Output	Payments on Area	Payments on Hist. Entitle.	Payments on Inputs	Other Payments	Total Revenue
Canada	-15	-7	-18	7	-1	-2	-24
European Union	-64	0	-5	0	-4	-4	-63
Japan	-15	-11	..	..	-17	13	-11
Mexico	-46	-1	0	0	-1	0	-48
Switzerland	-26	..	0	-14	-7	-11	-35
United States	-2	-24	-24	-22	-2	0	-37

OILSEEDS				Source of revenue			
Country	Market Price Support	Payments on Output	Payments on Area	Payments on Hist. Entitle.	Payments on Inputs	Other Payments	Total Revenue
Canada	-3	-2	-13	-2	-2	-4	-23
European Union	..	-10	8	0	-4	-5	-15
Japan	..	-26	..	..	-3	-17	-32
Mexico	-65	..	-5	-68	-28	-2	-64
Switzerland	-13	..	57	-11	-15	-11	-46
United States	..	-27	-7	..	-1	-2	-33

RICE				Source of revenue			
Country	Market Price Support	Payments on Output	Payments on Area	Payments on Hist. Entitle.	Payments on Inputs	Other Payments	Total Revenue
Canada	..	..	..	..	..	..	..
European Union	-13	44	-5	..	2	0	4
Japan	-45	-20	..	..	-17	-3	-50
Mexico	-38	-8	0	-5	4	0	-43
Switzerland	..	..	..	..	..	..	..
United States	-1	-69	-17	-8	-1	-69	-68

Table 2. Representative country module of the PEM crop model: definitions and equations*

one output and two inputs	
Price and quantities:	Stands for:
q^d, q^s	Percentage change in crop demand and supply quantities
p^d, p^s, p^w	Percentage change in domestic demand and supply prices and in world price of crop
x_j^d, x_j^s	Percentage change in input demand and supply quantities, j=f,p, for farm owned and purchased inputs
r_j^d, r_j^s	Percentage change in input demand and supply prices
q_r^d, q_r^s	Percentage changes in crop demand and supply quantities in the rest of the world
Q^d, Q^s, Q_r^d, Q_r^s	Levels of domestic crop demand and supply and level of demand and supply in the rest of the world, in the initial equilibrium
Policy variable symbol:	Stands for:
m	Percentage change in rate of Market price support
o	Percentage change in rate of Output price support
a	Percentage change in rate of Area payment
s	Percentage change in rate of Subsidy to purchased inputs
M, O, A, S	Initial level in the rates of the four kinds of support, all assumed to be non-negative
First incidence of policy:	Price gap between:
$p^d = p^w + m$	Crop demand price and world price
$p^s = p^d + o$	Crop supply and demand prices
$r_f^s = r_f^d + a$	Farm owned input (land) supply and demand prices
$r_p^s = r_p^d + s$	Purchased input supply and demand prices
Parameter symbol:	Stands for:
ε_d	Elasticity of demand for the crop in the domestic country, assumed negative
k_j	Cost share of input j used in producing the crop, with j=f,p
σ	Elasticity of substitution between factor f and p, assumed to be positive
η_d, η_s	Elasticity of demand and supply for the crop in the rest of the world
ε_j	Elasticity of supply of input j=f,p , assumed to be positive
Structural equations:	Explanation
$q^d = \varepsilon_d p^d$	Domestic crop demand
$x_j^d = -k_i \sigma r_j^d + k_i \sigma r_i^d + q^s$	Input demands for j,i=f,p and $i \neq j$
$x_j^s = e_j r_j^s$	Input supplies for j=f,p

$q_r^d = \eta_d p_w$; $q_r^s = \eta_s p_w$	Crop demand and supply in the rest of the world
Equilibrium equations:	Economic meaning
$p^s = \sum_{j=f,p} k_j r_j^d$	Zero profit conditions (crop supply price equals unit average cost of production)
$x_j^s = x_j^d$	Input market clearing for $j=f,p$
$Q^s q^s - Q^d q^d = Q_r^d q_r^d - Q_r^s q_r^s$	World market equilibrium

* For simplicity, in order to reduce the number of subscripts, the module considered here is a one crop, two inputs (farm owned, including land, and purchased inputs) case.

Table 3. How the various PSE categories are represented in the PEM crop model

PSE classification	First incidence of support in price wedge between:
Market price support	Domestic (producer and consumer) prices and the world price
Payments based on output	Domestic producer price and domestic consumer price
Payments based on area planted	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[a]
Payments based on historical entitlements	Rent per hectare received by landowners and rent per hectare paid by land users, not specific to any one crop[b]
Payments based on input use	Domestic supply price and demand price of the concerned input, not specific to any one crop

Notes: a. In the model, landowners are distinguished from land users to provide a basis for distributing the economic effects of policy changes. In reality, not all cropland is rented. The per hectare "rent" for land not rented needs to be interpreted as a sort of shadow price reflecting the opportunity cost of using land in one or another of the crops under study here as opposed to some other use. *b.* In the simulation analysis, this (same) wedge is also introduced as a difference between rental rates paid and received for an aggregate of all other arable land.

Table 4. A Selection of Empirical Studies on farmers' risk aversion

Study	Year	Type of study / Data	Coefficient of Relative Risk Aversion
Love and Buccola[a]	1991	Econometric estimation for Iowa Corn production.	2.4 - 18.8
Chavas and Holt[a]	1993	Econometric estimation for Corn and Soybean in US	1.4 - 6.8
Saha, Shumway and Talpaz	1994	Econometric estimation for Kansas wheat farmers	3.7 - 5.4
Henessy[b]	1999	Parameterisation and simulation for a corn producer in Iowa	4.7
Mullen *et al.*	2001	Calibration and simulation for Kansas wheat farmers	2.1

a. The risk coefficients estimated in these studies are all reported in Saha *et al.* (1994).
b. The coefficient of relative risk aversion in this study has been calculated from the data provided in the study, but was not reported by the author.

Table 5. Set of simulated scenarios

Scenarios	A	B	C	D	E	F	G	H	I
Included shocks									
Mean	+ Mean	+ Mean		+ Mean	+ Mean		+ Mean		+ Mean
CV			- CV	- CV	- CV			- CV	- CV
Lump-sum compensation*						+ LS	- LS	- LS	- LS
Risk preferences	Risk Neutral	CARA	CARA	CARA	DARA	DARA	DARA	DARA	DARA

* Lump-sum compensation is equal to the farm income increased obtained in simulation E

Table 6A. Production Ratios and Isolated Insurance and Wealth Effects (average 1998/2000)

	Market Price Support	Payments based on Output	Payments based on Area	Payments based on Historical Entitelments
THE UNITED STATES (Coarse grains)				
Total Production Ratios				
Under no Risk Aversion	1.00	1.09	0.47	0.03
Under CARA	1.17	1.53	0.59	0.37
Under DARA	1.18	1.54	0.61	0.39
Production Ratios by type of effect				
Price	1.00	1.09	0.47	0.03
Insurance	1.00	2.39	0.71	1.61
Wealth	1.00	1.31	2.52	3.26
Share in total production impacts				
Price effect	0.82	0.68	0.72	0.09
Insurance effect	0.17	0.31	0.23	0.83
Wealth effect	0.01	0.01	0.04	0.09
CANADA (Wheat)				
Total Production Ratios				
Under no Risk Aversion	1.00	n.c.	0.55	n.c.
Under CARA	0.99	n.c.	0.51	n.c.
Under DARA	1.18	n.c.	0.74	n.c.
Production Ratios by type of effect				
Price	1.00	n.c.	0.55	n.c.
Insurance	1.00	n.c.	0.70	n.c.
Wealth	1.00	n.c.	1.21	n.c.
Share in total production impacts				
Price effect	0.63	n.c.	0.50	n.c.
Insurance effect	0.21	n.c.	0.22	n.c.
Wealth effect	0.16	n.c.	0.28	n.c.
THE EUROPEAN UNION (Wheat)				
Total Production Ratios				
Under no Risk Aversion	1.00	n.c.	0.23	n.c.
Under CARA	1.13	n.c.	0.24	n.c.
Under DARA	1.14	n.c.	0.26	n.c.
Production Ratios by type of effect				
Price	1.00	n.c.	0.23	n.c.
Insurance	1.00	n.c.	0.11	n.c.
Wealth	1.00	n.c.	1.81	n.c.
Share in total production impacts				
Price effect	0.79	n.c.	0.83	n.c.
Insurance effect	0.21	n.c.	0.10	n.c.
Wealth effect	0.01	n.c.	0.06	n.c.

Table 6B. Production ratios and isolated insurance and wealth effects (average 1998/2000)

	Market Price Support	Payments based on Output	Payments based on Area	Payments based on Historical Entitelments
MEXICO (Coarse grains)				
Total Production Ratios				
Under no Risk Aversion	1.00	n.c.	n.c.	0.23
Under CARA	1.15	n.c.	n.c.	0.22
Under DARA	1.20	n.c.	n.c.	0.30
Production Ratios by type of effect				
Price	1.00	n.c.	n.c.	0.23
Insurance	1.00	n.c.	n.c.	0.02
Wealth	1.00	n.c.	n.c.	1.34
Share in total production impacts				
Price effect	0.75	n.c.	n.c.	0.69
Insurance effect	0.19	n.c.	n.c.	0.02
Wealth effect	0.05	n.c.	n.c.	0.29
JAPAN (Rice)				
Total Production Ratios				
Under no Risk Aversion	1.00	1.52	n.c.	n.c.
Under CARA	1.02	1.94	n.c.	n.c.
Under DARA	1.03	1.94	n.c.	n.c.
Production Ratios by type of effect				
Price	1.00	1.52	n.c.	n.c.
Insurance	1.00	9.05	n.c.	n.c.
Wealth	1.00	1.87	n.c.	n.c.
Share in total production impacts				
Price effect	0.95	0.76	n.c.	n.c.
Insurance effect	0.05	0.24	n.c.	n.c.
Wealth effect	0.00	0.00	n.c.	n.c.
SWITZERLAND (Wheat)				
Total Production Ratios				
Under no Risk Aversion	1.00	n.c.	0.39	n.c.
Under CARA	1.05	n.c.	-0.11	n.c.
Under DARA	1.12	n.c.	0.07	n.c.
Production Ratios by type of effect				
Price	1.00	n.c.	0.39	n.c.
Insurance	1.00	n.c.	-1.98	n.c.
Wealth	1.00	n.c.	1.51	n.c.
Share in total production impacts				
Price effect	0.77	n.c.	2.10	n.c.
Insurance effect	0.15	n.c.	-2.07	n.c.
Wealth effect	0.09	n.c.	0.97	n.c.

Table 7. Shares of risk-related effects of US deficiency payments according to different studies

	Price	Insurance	Wealth
Hennessy (1998) [1]	21%	66%	14%
Mullen *et al.* (2001) [1]	26%	65%	9%
This study	68%	31%	1%

1. Calculated from the results presented in each

Figure 1. Expenditure and reduction of uncertainty under "truncating" programmes

An example using Chavas and Holt methodology assuming a normal distribution and CV=0.1

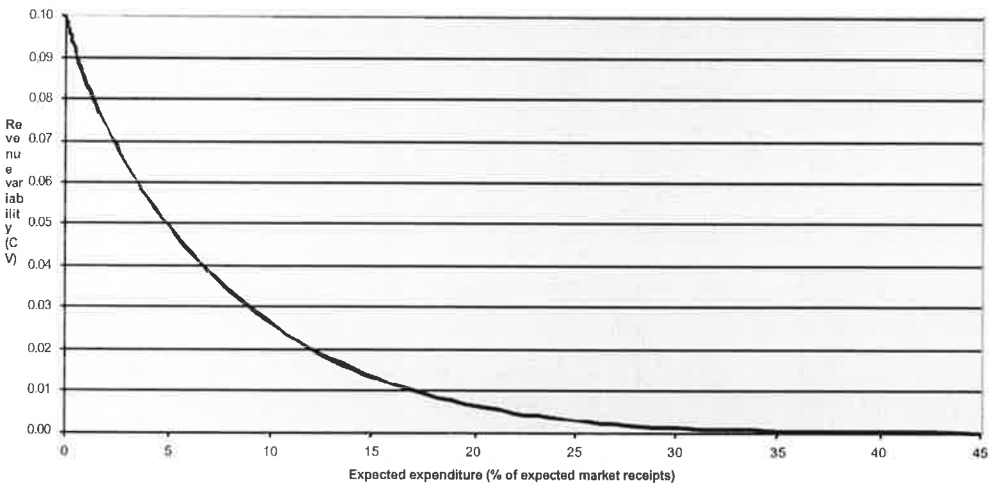


Figure 2: Sensitivity Analysis : Distribution of Total Production Ratios for different PSE categories in the United States (1998)

Result after 100 simulations for each category with stochastic values for the risk-related parameters