An Ex-Ante Assessment of CAP Income Stabilisation Payments using a Farm Household Model

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Abstract

Common Agricultural Policy (CAP) reforms over the last two decades have increased the sensitivity of EU farm incomes to market fluctuations. Following legal proposals from the European Commission, an income stabilisation tool may be introduced during the 2014-2020 period. From a theoretical perspective, it is not possible to evaluate a priori how farmers will actually respond in terms of input and output allocation to such measures and therefore what the impacts on farm income will be. This paper assesses the potential implementation of these payments using a farm household model calibrated to French cereal farms.

Keywords: *Common Agricultural Policy, income stabilisation payment, price and yield uncertainty.*

JEL codes: *Q12, Q18*

1. Introduction

The Common Agricultural Policy (CAP) has experienced significant changes since the 1992 reform with a manifest shift away from almost exclusive price support towards market decoupled direct payments. As a result of this market orientation of the CAP, farmers across the EU are much more exposed to market fluctuations than in the past. Despite the positive impacts of decoupled payments providing income support, farmers have to cope with increased farm income volatility.

Following legal proposals for the post-2013 CAP, additional instruments are likely to be introduced into the CAP (through Pillar 2), targeting farm income stabilisation. These new tools correspond to a need to maintain income support and to reinforce instruments to better manage risks and respond to crisis situations, in a context of ever increasing pressures on farm incomes (EC, 2011a). One of the tools foreseen is an income stabilisation payment (ISP) which will be granted to a farmer facing exceptional decreases in farm income (defined as the sum of revenues received from the market, including any form of public support, deducting input costs – article 40 of the EC legal proposals on Rural Development). If the farmer experiences a drop of income of more than 30 per cent with respect to an average of the last three years[1], he will receive compensation up to 70 per cent of the income loss. These thresholds are similar to the Green Box criteria of the World Trade Organisation (WTO) and shield ISPs from any limit or reduction as mentioned in the WTO Agreement on Agriculture.

Much international attention has focussed on the fact that EU farm support measures (as well as other WTO members' farm support measures) could generate significant trade distortions through the sheer scale of its direct payment programme. Today, the introduction of an ISP, which implies linkages between price, production and income, could mean shifting back to (indirect) price and production coupled support. Thus, even though the proposed scheme follows WTO criteria, the existence of such payments into Pillar 2 may reinitiate the debate over the distortive aspects of European support among the community of agricultural economists. The aim of this paper is therefore to better understand the impacts of income stabilisation tools by assessing *ex ante* the potential implementation of these payments in French cereal farmers on farm input and output allocation and farm income.

Economic theory has shown that farm payments affect farm input and output decisions through several transmission channels (e.g. Phimister, 1995; Chau and de Gorter, 2000; Vercammen, 2007). Moreover, the timing and nature of payments also matters (Hennessy, 1998; Anton and Le Mouël, 2006; Mary, 2013). However, from a purely analytical perspective, there is no way to evaluate *a priori* how farmers will respond in terms of input and output allocation to such IS measures, mainly because information on farm incomes is not instantaneously available. ISP will then be given to farmers with some delay and may well be pro-cyclical, potentially generating adverse effects. In particular, there is a moral hazard issue, which may induce farmers to take more risk decisions and might partially prevent the fulfilment of their objectives (OECD, 2011)[2].

There is a vast bulk of empirical literature that has analysed the impacts of various farm support instruments (e.g. Sckokai and Moro, 2006; Goodwin and Mishra, 2006; Goodwin, 2009; Serra *et al.*, 2009; Sckokai and Moro, 2009). On the contrary, little research has been done on the impact of ISPs and has focussed on North America. Results show that such payments can be inefficient in stabilising incomes (Anton and Kimura, 2011) and that they

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[1] The legal proposal (Article 40) refers to the average annual income of the individual farmer in the preceding three-year period or a three-year average based on the preceding five-year period excluding the highest and lowest entry (Olympic average).

[2] The existence of partial compensations and thresholds in the programme design implicitly introduces non-linearities which make the analysis even more cumbersome.

may affect input decisions to the extent they could be technically classified as production-distorting (Bhakshi and Gray, 2012). Yet, the proposed European Union's scheme is clearly different from the type of income stabilisation payments, which have been studied in earlier studies. For example, the Canadian AgriStability payment contains three layers linked to the magnitude of income loss[3]; producers are expected to manage less than 15 per cent of margin losses. In contrast, the income stabilisation tool in Europe is designed so that producers have to manage up to 30 per cent of income losses. This main difference additionally justifies the need for a specific assessment of the proposed EU's income stabilisation programme.

From a methodological perspective, such evaluation requires accounting for the influence of price and yield uncertainty on farm behaviour. However, most studies in the literature have ignored the role of expectations and assumed that uncertainty about future prices and yields do not affect farmer's decisions. Yet, several papers have modelled expectations but have traditionally assumed these to be myopic or adaptative (e.g. Sckokai and Moro, 2009). It is clear that in the present EU context of highly increased price volatility, resulting in more volatile farm incomes, the role of expectations on future prices and yields cannot be ignored when assessing the impact of income stabilisation tools. Consequently, here, we develop a dynamic model of a farm household incorporating fully rational expectations on prices and yields. In other words, farmers make their decisions based on current prices and yields but also on their beliefs on the evolution of future prices and yields. While the model includes output price and yield uncertainty, by construction, the model also incorporates payment uncertainty (defined as uncertainty surrounding the fact whether the farmer will receive the ISP or not, and the monetary amount) because ISPs are coupled to actual prices and yields.

The paper is structured as follows. Section 2 describes the model and section 3 explains the parameterisation of the model. Section 4 defines the policy scenario and analyses the results. Section 5 concludes.

2. Model

We draw upon Mary (forthcoming) and consider a stylised model of a farm household using several inputs, namely, farm household labour (*N*), hired labour (*HN*), farm capital (*K*) and farm land (*L*), which is the sum of owned land (L^O)and rented land (L^R), to produce one aggregate good (*F*). Inputs are combined in the production technology with a Cobb-Douglas function and constant returns to scale[4].

The farmer can use his time endowment (*T*) for farm work and/or home time (*H*): $T = N_t + H_t = 1$[5].

Further, the stock of farm capital (which is fully used), evolves according to: $K_{t+1} = K_t(1-\delta) + I_t$ with $I_t \geq 0$, with $\delta \in (0,1)$ denotes the rate of depreciation of capital, *I* denotes gross investment in farm machinery, which is irreversible. The presence of irreversibility acknowledges that the value of capital may not be fully recoverable when resold. This is, for instance, because farm machinery (especially for planting and harvesting) has few other alternative uses besides agriculture.

[3] The program covers 70 per cent of the margin loss between 70 per cent to 85 per cent of the reference margin. This rate of compensation increases to 80 per cent in the tier which covers between 0 to 70 per cent of the reference margin.
[4] The CB function is tested against a Translog functional form and is not rejected using a log-likelihood ratio test. Constant returns to scale are not rejected. Results are available upon request.
[5] We assume there is no off-farm work, partially because there is no information available in the Farm Accountancy Data Network (FADN) dataset.

In face of output price and yield uncertainty, with price ($\tilde{P}$) and yield ($\tilde{Y}$) being negatively correlated, the household maximises its expected intertemporal utility. The farmer is risk averse and his preferences are represented by a CRRA utility function, implying decreasing absolute risk aversion: $U(C,H)=\frac{[C^{\eta}(1-H)^{(1-\eta)}]^{1-\phi}}{1-\phi}$, $\phi \neq 1$ and ϕ is the coefficient of relative risk aversion, C is farm consumption. The infinite horizon allows taking into account the uncertainty that lies on the farmer's end of life.

All decisions relative to investment in machinery, land renting (at a fixed price[6] $\overline{P}_L$), and farm household work (leisure) are flexible. Also, each year the household hires a fixed quantity of labour. The farmer earns income from the sale of its output and from farm decoupled direct payments (E), independent of its current activity. Additional to these farm subsidies, he might receive an additional farm payment, income stabilization payment ($\tilde{G}$), depending on the level of income. There is no restriction on how the farmer uses farm payments; thus, he may simultaneously use the additional income from the provision of farm payments towards increased consumption, renting land or investing in machinery.

The farm household faces the following budget constraint:

$$W_0+\tilde{P}_t.\tilde{Y}_tF_t+E+\tilde{G}=C_t+I_t+\Phi(K_{t+1},K_t)+r\overline{D}+\overline{P}_L L^R{}_{t+1}+\Gamma(L^R{}_{t+1},L^R{}_t)+wL_t$$

The left hand side includes the farm initial wealth (W_0) including the value of owned land, total farm income, which is the product of the output level and stochastic price and yield, and farm payments. The right hand side includes land use costs (wL) (e.g. seeds, fertilisers, plants and crop protection), which are assumed to vary proportionally to the quantity of farm land, as a linear function of w. The household's budget constraint also includes investment adjustment costs (Φ) and land rental transaction costs (Γ). In addition, the farmer faces debt repayments $r\overline{D}$ (with r, the interest rate and the fixed level of debt $\overline{D}$), assuming that the farmer's debt equals his maximum debt obtainable in the short and medium run $\overline{D}$ (Blancard et al., 2006) i.e. $\Delta D=0$.

The farmer does not have perfect foresight. Instead, he has subjective beliefs characterizing the distribution of future prices and yields. Both price and yields expectations are given by a probability transition matrix, whose elements are derived from the joint distribution of prices and yields. By construction, the farmer faces payment uncertainty as ISPs are linked to current yields and prices, which are not known with certainty. Therefore, when the farmer makes fully rational expectations on future prices and yields, he implicitly does so for ISP.

The maximization problem is defined as follows:

$$\max E\sum_t^{\infty}\beta_t U(C_t,H_t)$$

$$s.t.$$

$$W_0+\tilde{P}_t.\tilde{Y}_tF_t+E+\tilde{G}=C_t+I_t+\Phi(K_{t+1},K_t)+r\overline{D}+\overline{P}_L L^R{}_{t+1}+\Gamma(L^R{}_{t+1},L^R{}_t)+wL_t$$

With:

$$F_t=(N_t+\overline{HN})^{\beta^N}K_t^{\beta^K}L_t^{\beta^L}, with \beta^N+\beta^K+\beta^L=1$$

$$\Phi(.)=\varepsilon(K_{t+1}-K_t)^2$$

$$\Gamma(.)=\chi(L^R{}_{t+1}-L^R{}_t)^2$$

[6] It is assumed that the impacts of direct decoupled payments have fully adjusted into land rents. Further, we assume that ISP have no impact on rents in the short-to-medium run and limit our simulations to 5 years.

3. Parameterisation

We use a dynamic stochastic programming approach to solve this maximization problem. We assume the existence of a representative average farm across all farms in our dataset. The calibration of the representative farm household model is performed using FADN dataset for the years 1996-2003. Model specification and parameters are further discussed and can be found in Table 1.

3.1 Data

The FADN data is at farm level with the samples of farms chosen so as to be representative of French agriculture, with detailed data provided on farm output, on farm labour supply, farm investment, assets and debts etc. However, neither consumption data nor off-farm labour information is available in the dataset. As the panel is incomplete, some farms are only present in the database for one, two or three years. The sample consists of all the farms that have been surveyed for at least four years. This rule of thumb ensures that the sample used for this study only includes farms which have provided data for at least half of the period study, and prevents including observations that could come from exceptional events such as weather disasters. Data attrition is explained in Appendix. There are 1529 crops farms, observed for a minimum number of four years, between 1996 and 2003, satisfying these conditions for a total number of 7479 observations.

3.2 Parameterisation

Table 1 reports the parameterisation of the representative model. First of all, we follow Mary (forthcoming) to calibrate several structural parameters of the model, i.e. production elasticities[7], interest rate, depreciation rate, coefficient of risk aversion and capital adjustment cost parameter. The last two parameters are within the traditional range from the empirical literature (e.g. Anton and Le Mouël, 2004; Huttel *et al.*, 2010). The marginal cost of land and the quantity of land owned by the farmer are directly taken from the FADN panel dataset. The wealth of the farmer is set using information from INSEE (2009), which finds that the mean wealth of farmers in France is around 483,100 Euros.

Finally, the value of θ is chosen so that the model matches the observed average proportion of farm work in total time. The land transaction cost parameter (χ) is calibrated so as to closely match the long-run value of land and land transactions observed in the data. As prices and yields are negatively correlated, following Bhaskar and Beghin (2010), we use a copula approach (Frank), in which we assume the yields to follow a beta distribution, and the output price to follow a log normal distribution. The variance of the expected output price is calculated following the methodology used in Lansink (1999) and Chavas and Holt (1990) and parameters of price uncertainty are calibrated so as to reproduce the estimated standard deviation of the expected output price (0.256). As some of the parameters may be surrounded by uncertainty, a Systematic Sensitivity Analysis (SSA) is further implemented and explained in Section 4 to ensure that the values chosen do not dramatically change the main results.

[7] In this paper, elasticities are estimated using two-step system GMM estimation.

Table 1. Model parameters

Elasticity of output with respect to capital	α_K	0.141
Elasticity of output with respect to labour	α_N	0.305
Elasticity of output with respect to land	α_L	0.554
Interest rate	$\boldsymbol{r}$	0.055
Depreciation rate	$\boldsymbol{\delta}$	0.115
Marginal cost of land (per hectare)	$\boldsymbol{w}$	0.28
Correlation between price and yield	ρ	- 0.34
Initial wealth (in thousand Euros)	$\boldsymbol{W_0}$	483.1
Coefficient of risk aversion	γ	2
Capital adjustment cost parameter	ε	2
Parameter for on-farm work	η	0.63
Land transaction cost parameter	χ	0.20
Single Farm Payments (in thousand Euros)	E	37.8

4. Simulations

The purpose of this paper is to assess the impacts of income stabilisation payments as proposed within rural development policy 2014-2020. First, the baseline scenario is the one in which no income stabilisation policy is implemented, but includes Single Farm Payments (SFPs) as decoupled direct payments. The alternative scenario, including the additional introduction of ISP is simulated and compared to the baseline.

4.1 Policy scenarios

The baseline scenario includes the provision of decoupled direct payments, i.e. 37,800 Euros per year[8]. This baseline is designed with a direct reference to the current SFP scheme of the European Union, which do not depend on the current level of production and are time invariant throughout the simulations.

Table 2. Policy scenarios

Scenario	Single Farm Payments	Income Stabilisation Payments
Baseline	YES	NO
Income Stabilisation	YES	YES

The alternative scenario aims at representing the potential introduction of income stabilisation tools following the EC's proposal for the post-2013 CAP. This payment is

[8] We use the average farm Single Farm Payment for cereal French farms in 2009.

granted where the drop of farm income exceeds 30 per cent of the average annual income of the farmer in the preceding three year period or a five-year Olympic average. Income is computed as the sum of farm revenues and public support (here, direct payments), deducting input costs. The ISP compensates for no more than 70 per cent of the income lost.

4.2 Results

A SSA allows taking into account the existence of parametric uncertainty and provides more information on the accuracy of the simulation results. We use a Gaussian Quadrature that approximates the moments of the joint distribution of the parameters using a discrete joint probability distribution evaluated over a finite number of points. We apply the Stroud approach. The variance for each parameter is consistent with the assumption that observed parameter values are drawn from independent uniform distributions with lower and upper bound equal to +/-50 per cent of the mean estimate. For a model with T jointly distributed parameters, there are 2T Stroud points at which the model must be evaluated. In this case, we study the impacts of several parameters (i.e. farm initial wealth, marginal cost of land, coefficient relative risk aversion, adjustment capital costs, land transaction costs, received monetary amount of decoupled direct payments), and the model is solved 12 times. Each time, the model is shocked with 20,000 correlated draws of yield and prices. Simulation results are provided in Table 4 and details of each run can be found in Tables A1 and A2 (appendix).

Table 3 presents the average impacts of an ISP (as proposed by the EC) on farm input and output allocation decisions, over a period of 5 years. The main message is that, despite potentially significant impacts on input and output decisions, ISP would largely reduce farm income volatility in French crop farms. The average impact on farm output is very small (-0.32%). This result might seem to confirm that such a tool is not very distortive on production and tends to justify *ex post* the Green Box criteria established in Annex 2 of WTO Agreement on Agriculture[9]. Yet, given the large size of the associated coefficient of variation (8.044), it is clear that this finding is not robust as there is vast uncertainty linked to the impact of ISP on farm output. Indeed, Figure 1 shows that the final impact on farm output can be negative in a few simulations but significantly positive for other runs.

Furthermore, the average final impact on production masks some significant differences in how the ISP affects input decisions. While there is no impact on farm household labour, an ISP substantially affects both capital and land in the farm decision-making. In our simulations, we find that farm capital decreases by more than 7 per cent and that farm land increases by almost 2 per cent. The result on farm capital may be somewhat counter-intuitive at first. In our modelling framework, this results from an increase in investment volatility, which might potentially jeopardise the objective of farm income stabilisation. In implementing such income stabilisation programmes, there are difficulties for the paying authority to observe accurately and timely information about farm incomes[10]. Therefore it is likely that payments that are triggered by a fall in farm incomes (i.e. designed to be countercyclical) could be given to farmers one (or two) year(s) later. By then, the programme could be creating incentives for farmers to take more risky decisions (OECD, 2011). While this could theoretically mean more future profits, the delayed payment has a counter-productive effect as it perturbs the optimal farm risk level to a level which is higher; in turn,

[9] The Green Box is defined as "support measures for which exemption from the reduction commitments is claimed shall meet the fundamental requirement that they have no, or at most minimal, trade-distorting effects or effects on production".
[10] In our simulations, while we measure the accurate size of the payments, the payment is given to the farmer one year after the fall in farm income, in order to explicitly model delays in paying farmers. Yet, we do not account for the difficulty to obtain accurate information.

this increases uncertainty on the investment decision, which ends up having long-run negative consequences on the capital stock.

Table 3. Average policy impacts, systematic sensitivity analysis, $T = 5$

	Baseline	Income Stabilisation Payments % change
Farm household work (AWU)	1.29	**-0.02** (0.383)
Farm machinery (thousand Euros)	118.42	**-7.77** (0.509)
Farm land (in ha)	143.74	**1.93** (1.827)
Farm output (thousand Euros)	167.44	**-0.32** (8.044)
Farm income (thousand Euros)	133.20	**1.25** (0.988)
Farm income volatility[11] (thousand Euros)	2.66	**-38.99** (0.707)

Notes: Results are over 20,000 price and yield simulations.
Coefficients of variation (in absolute values) over Stroud simulations in parentheses.

More fundamentally, Table 3 suggests that farm income volatility is negatively affected. The calculation of income volatility shows that an ISP play a key role in reducing farm income fluctuations (Table 3) as average income variability is reduced by more than 38 per cent in our simulations. This is despite an increase in investment volatility. In other words, in contrast with Anton and Kimura (2011), we find that income stabilisation payments are efficiently reducing the farmer's exposure to income fluctuations (relative to the situation without ISP). The difference in results may be due to the different types of income stabilisation payments studied and the type of risk these cover, i.e. frequent normal risk – between 15 per cent and 30 per cent income losses – and dramatic risk, i.e. more than 30 per cent). Finally, our results indicate that the impacts of an ISP are likely to vary from a farm to another, depending on farm-specific characteristics. A quick look at Kendall's coefficients of correlation between simulated impacts of the policy scenario on farm output/income and the set of variables used for the SSA give some useful information on the key determinants of such impact patterns. Specifically, results highlight that the wealth of farmers is negatively associated with higher impacts of an ISP on farm output, income and input (capital and land rental) decisions (significant at 5%). On the contrary, the risk aversion is positively associated with the impacts of ISP on the abovementioned farm decisions. All other variables (marginal costs of land, adjustment capital costs, land transaction costs, value of SFPs) are not significantly associated with the impacts of ISP.

[11] Farm income volatility is calculated as the standard deviation of farm income.

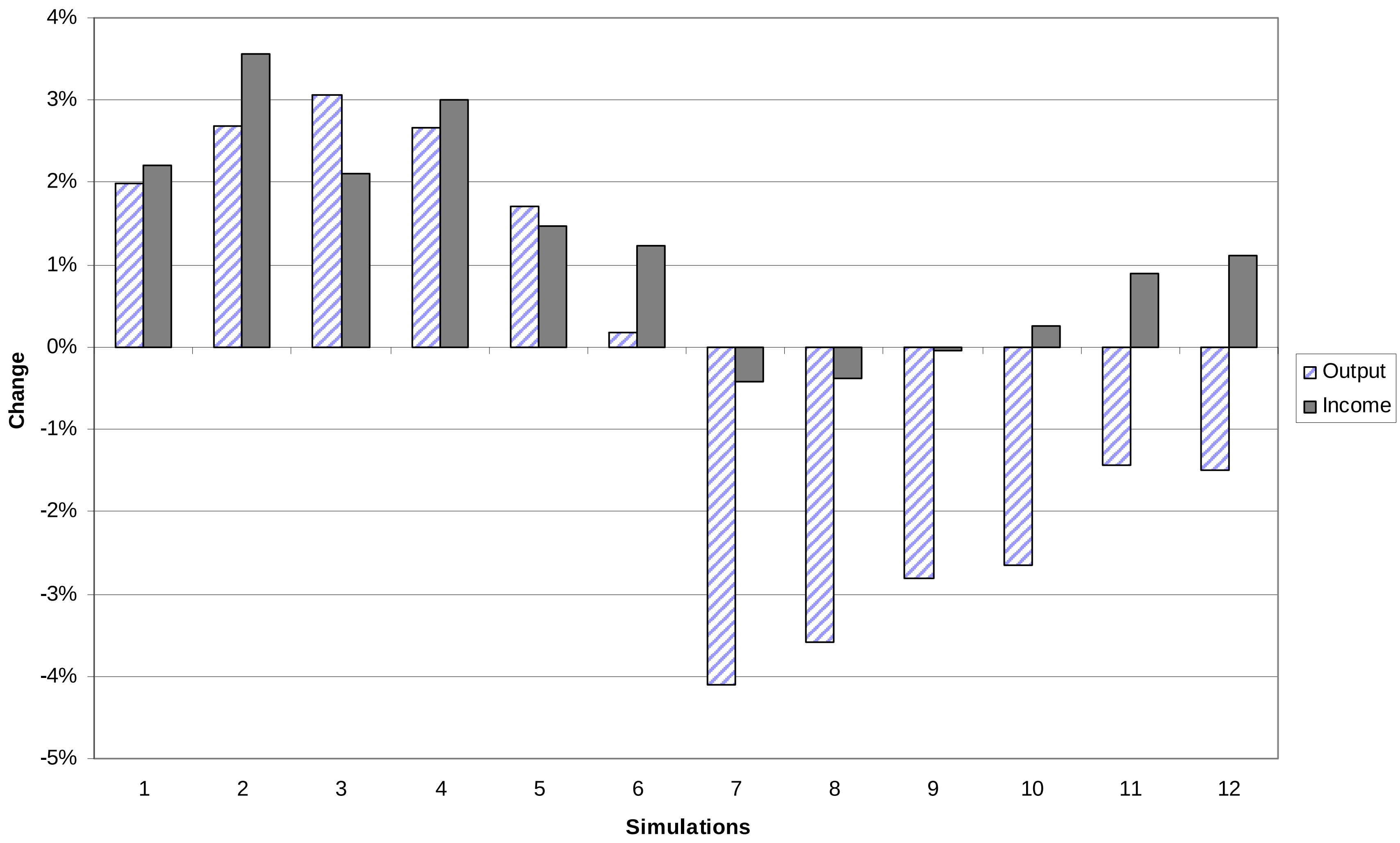

Figure 1. Policy impacts on farm output and income, $T = 5$

5. Conclusions

This paper assesses *ex ante* the impacts of the implementation of an eventual ISP in French cereals farms. Using a dynamic farm household modelling framework with yield and price uncertainty, this paper provides the impacts of such payments on farm input and output, and in turn on farm income and income volatility for a representative French cereal farm.

First, we find that the introduction of such payments (as suggested by the European Commission when preparing the post 2013 CAP) may generate output distortions. However, results extracted from the systematic sensitivity analysis show that the impacts on farm output may vary significantly from a farm to another, as in our analysis they range from about -4 per cent to 3 per cent. The pattern of results on output is driven by multiple and contrary impacts on capital and, at times, on land rental decisions. Furthermore, the paper gives a clear, and this time, robust indication that ISP efficiently fulfil their objective of income stabilisation. In our simulations, we find that income volatility decreases by more than 35 per cent. European farmers have faced increased price volatility over the last years and the trend may continue in the future. Risk management alternatives are a necessary condition for a successful reform of agriculture in the face of on-going structural change in Europe. There are some evidence that income diversification, insurance schemes or the use of modern market instruments (forward contracts, futures and options) facilitate farm holdings to cope with price volatility. In this paper, ISP seem to be efficient. However, other strategies should be encouraged by policies, as the diversification of income sources within and outside the farm holding is a key factor in order to cope with income volatility (OECD, 2009).

In addition to the existence of potential distortions and the fulfilment of its main objective of income stabilisation, there are a few institutional issues related to the insertion of an ISP within pillar 2 of the CAP. First, the optional implementation by European member states will inevitably lead to discordant implementation and economic distortions of this programme within the European market. Therefore, it would add to the existing rural development policy instruments, which are applied with a large degree of subsidiarity across Europe. Second, the cost of a large-scale (EU wide) implementation of such ISP could be huge; at a time of budgetary constraints, this could be at the cost of other CAP or rural development tools. While a back-of-the envelope calculation shows that the costs amount on average to 2,842€ per year for the average French cereal farm in our simulations, the cost of such programme is extremely difficult to estimate at the EU level. The annual cost could amount up to 7 billion Euros, about half the annual Rural Development policy envelope, assuming that about 20% of European famers were compensated for a 30% income loss (European Commission, 2011b). Yet, the uncertainty surrounding the budgetary requirements of such measure may appear hardly compatible with the current multiannual financial framework for European policy funding.

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Appendix

Table A1. Stroud analysis: policy impacts

	1	2	3	4	5	6	7	8	9	10	11	12
Farm household work	-0.02%	-0.02%	-0.03%	-0.02%	-0.03%	-0.02%	-0.02%	-0.01%	-0.04%	-0.01%	-0.02%	-0.01%
Machinery	-3.47%	-2.97%	-2.53%	-3.23%	-6.39%	-7.73%	-11.89%	-13.82%	-13.17%	-11.26%	-9.11%	-7.79%
Land	4.77%	6.16%	6.38%	6.07%	5.12%	2.80%	-3.65%	-2.26%	-0.92%	-1.16%	0.21%	-0.41%
Output	1.99%	2.68%	3.06%	2.67%	1.70%	0.17%	-4.10%	-3.59%	-2.80%	-2.65%	-1.44%	-1.49%
Income	2.20%	3.56%	2.12%	3.01%	1.47%	1.22%	-0.41%	-0.38%	-0.04%	0.25%	0.90%	1.12%
Income volatility	-52.37%	-73.40%	-57.82%	-69.59%	-52.67%	-69.41%	-12.86%	-20.46%	-2.55%	-18.00%	10.57%	-49.28%

Table A2. Stroud analysis: summary statistics

	Mean	Standard deviation	Minimum	Maximum
Farm household work	-0.02%	0.000	-0.04%	-0.01%
Machinery	-7.78%	0.040	-13.82%	-2.53%
Land	1.93%	0.035	-3.65%	6.38%
Output	-0.32%	0.026	-4.10%	3.06%
Income	1.25%	0.012	-0.41%	3.56%
Income volatility	-38.99%	0.276	-73.40%	10.57%