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Assessing the Impacts of Single Farm Payments on Farm Investment and Output in French Arable Farms: a Dynamic Stochastic Farm Household Model with Debt Constraints

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Abstract

The Common Agricultural Policy has radically been reformed in 2003 with the introduction of "decoupled" direct payments. Economic theory suggests that direct payments are expected to have no impact on production in a static deterministic environment with perfect markets for capital and labour. But if factor market imperfections or uncertainty are taken into account, this is no longer true. Taking into account these potential impacts, the empirical literature has studied the impacts of farm payments. However, most studies are based on assumptions such as perfect markets, risk neutrality or static environment. Recent researches have also often neglected the role of debt constraints. The paper develops and numerically solves a dynamic stochastic farm household model with occasionally binding debt constraints and investment adjustment costs. The impacts of direct and counter-cyclical payments are explored and compared to an increase in the intervention price. Results show that both types of payments will positively impact on investment, but the impacts on output will not be as significant as it is with an increase in intervention price. Further, the degree of decoupling of Single Farm Payments in the French crops sector is found to be significantly linked to the degree of capital market imperfections.

Keywords: *Single Farm Payment; farm investment; dynamic stochastic farm household model; debt constraints.*
JEL codes: *Q12, Q18*

1. Introduction

Many developed countries have reformed their farm support policies over the last years. This process has generally marked a move away from intervention pricing and coupled payments towards direct payments. In the European Union, the Mid-Term Review agreed in Luxemburg on June 26th 2003 introduced the Single Farm Payment (SFP).

Despite the fact that this payment is connected to historical subsidy allocations, the SFP is considered to be decoupled from production because it is not linked to current levels of production. This feature is crucial since such a payment is classified in the World Trade Organization's Green Box[1]. Single Farm Payments and in general direct payments pose some conceptual challenges. In fact, the apparent decoupled feature of such payments relies on a definition of decoupling that implicitly assumes a static world with no uncertainty and no market imperfections. Yet, economic theory has shown that direct payments may have output effects through labour market constraints (Benjamin, 1992), binding debt constraints (Phimister, 1995) and risk-related effects (Hennessy, 1998) among other possible channels (see Bhaskhar and Beghin, 2009; Vercammen, 2007).

Taking into account these potential sources for direct payments to affect farm output, research has been undertaken on the issue of decoupling and on the empirical measure of farm payments. However, most studies have assumed either risk neutrality (Baudry, Carpentier and Guyomard, 1996) or a static environment (Lansink, 1999; Moro and Sckokai, 1999). Doing so, the literature has not taken into account the different sources of effects of direct payments and therefore has potentially provided biased estimations of the effects of farm payments. Furthermore, another problem in the literature is the lack of empirical research on the link between investment and direct payments. This is especially relevant as the impact on farm investment may be critical as investment decisions affect current and future levels of production. Recently, Sckokai and Moro (2009) and Serra *et al* (2009) show that direct payments may impact on investment and production based on dynamic methodologies. Nonetheless, as pointed out by Mishra and Goodwin (2004), the role of binding debt constraints has often been neglected in stylized models of expected utility maximization by risk-averse agents. The aim of the paper is to provide an empirical measure of the impacts of Single Farm Payments on investment and output decisions for French crops farmers, using a framework that uses more potential channels than previous studies, by modelling dynamic agricultural production under uncertainty and risk aversion, and by taking explicitly into account the role of binding debt constraints.

While Sckokai and Moro (2009) estimate a structural dynamic model and Serra *et al* (2009) use a reduced form model, we apply another approach to estimate the impacts of farm support policies in a dynamic context. Here, we develop and numerically solve a dynamic stochastic farm household model with occasionally binding debt constraints and investment adjustment costs. The existence of significant credit constraints in French farms (Blancard *et al*, 2006)

[1] Therefore the SFP is not subject to a WTO binding.

requires a model that allows studying simultaneously consumption and production choices (Sadoulet and De Janvry, 1995). Our model based on the framework developed by Phimister (1995) is extended for the infinite-horizon case under uncertainty. Because the model does not have a closed form solution, a numerical approximation technique is required to solve the dynamic stochastic optimization problem linked to our modelling framework. Value function iteration is safe, reliable and compatible with the specificities of the model.

The contribution of this paper is twofold. From a methodological perspective, we present a new approach to estimate the impacts of direct payments in a dynamic modelling framework in which uncertainty and risk aversion are explicitly considered. From an empirical perspective, we provide an assessment of the impacts of SFP on investment and output for a representative French arable crops farm household, and the first assessment of how the degree of decoupling of SFP depends on the farm household's access to credit.

The rest of the paper is as follows. Section 2 sets out the modelling framework. Section 3 describes the data and reviews the calibration. Section 4 presents our empirical results. Section 5 concludes.

2. Modelling framework

2.1 Model

The two period life cycle model developed by Phimister (1995) is extended to an infinite-horizon and stochastic framework. The stochastic dynamic model focuses on the decisions of a representative farm household. Prices for all inputs are normalised to one. Consider the stochastic farm household[2] with preferences described by the following utility function:

$$E_0 \sum_{t=0}^{\infty} \theta_t U(c_t, l_t) \tag{1.1}$$

$$\theta_0 = 1, \tag{1.2}$$

$$\theta_{t+1} = \beta(c_t, l_t)\theta_t \qquad t \geq 0, \tag{1.3}$$

Where $\beta_c < 0$, $\beta_l > 0$. c_t denotes consumption and l_t denotes labour supply. The discount factor ensures stationarity in the modelling framework.

The evolution of next period's debt, d_{t+1}, is given by:

$$d_{t+1} = (1 + r_t)d_t + cf_t, \tag{1.4}$$

Where r_t denotes the interest rate, cf_t the change in farm debt.

[2] Members of the farm household are all identical.

Several types of capital market imperfections are included in the model. Blancard *et al* (2006) find empirical evidence of short-run and long-run credit constraints for a sample of French farms. Main capital market imperfections are introduced through the existence of debt constraints. The farm household faces restrictions on debt.

$$\mathrm{d}_t \le \mathrm{d}^* \tag{1.5}$$

Where d^*, is exogenously determined. The lower bound captures the quantity restrictions which farm households face in the capital market. The farm household also faces a no-Ponzi constraint of the form:

$$\lim_{j\to\infty} E_t \frac{d_{t+j}}{\prod_{s-1}^{j}(1+r_s)} \le 0. \tag{1.6}$$

This constraint prevents the farm household to be able to consume without limit and ensures that the farm household does not hold any debt at the end of his life. Output, y_t, is produced by means of a production function that takes capital, labour and land as inputs. We explicitly model a three-factor production function:

$$y_t = F(k_t, l_t, a_t), \tag{1.7}$$

Where k_t denotes capital and a_t is land. Next, we assume that the farm household only works on-farm so that total labour supply corresponds to total on-farm labour supply. The stock of capital evolves according to:

$$k_{t+1} = i_t + (1-\delta)k_t, \tag{1.8}$$

Where $\delta \in (0,1)$ denotes the rate of depreciation of capital, i_t denotes gross investment in machinery and buildings. The farm household faces the following budget constraint:

$$p_t.y_t + fp_t = c_t + i_t + \Phi(k_{t+1} - k_t) + cf_t \tag{1.9}$$

Where y_t denotes production, p_t is an exogenous stochastic shock, and fp_t denotes a farm payment. The left hand side (LHS) corresponds to the total income of the farm household, which is equal to the sum of farm income and a possible farm payment. Farm income is the product of the level of the production and the price of farm output. Uncertainty is introduced into the farm income. Indeed, the first term of the LHS contains a stochastic shock whose dynamics are defined further.

Another capital market imperfection is introduced into the cash income constraint. Investment adjustment costs prevent farm capital being treated as if it was equivalent to a financial asset, therefore implying more realistic production behaviour. The function Φ (.) is meant to capture these investment adjustment costs and is assumed to satisfy $\Phi(0) = \Phi'(0) = 0$. The restrictions imposed on Φ ensure that in the non-stochastic steady-state adjustment costs are zero.

The model is specified using the following functional forms for preferences and technology. The instantaneous utility function is a Constant Relative Risk Aversion (CRRA) function with γ as the coefficient of relative risk aversion. Previous researches have assumed the same risk aversion function (Phimister, 1993; Sckokai and Moro, 2006). This instantaneous utility function is defined as in Greenwood *et al*. (1988) and satisfies the following conditions:

$$U(c,l) = \frac{[c-\omega^{-1}l^{\omega}]^{1-\gamma}-1}{1-\gamma}, \text{ with: } u(.) < 0,\ u'(.) > 0, \qquad u'(0)=\infty;$$

Where ω is the intertemporal elasticity in labour supply. The discount factor is given by:

$$\beta(c,l) = [1+c-\omega^{-1}l^{\omega}]^{-\psi}$$

Where ψ is the elasticity of the discount factor to the utility. This structure of preferences is known as Stationary Cardinal Utility (Epstein, 1983) and exhibits a time-varying discount factor. While the fixed discount representation of preferences cannot produce stationary stochastic equilibrium dynamics, these preferences ensure the stationarity of the dynamics and determine a well-defined stationary distribution of debt levels in the model. In addition, these functional forms neutralize the wealth effect on labour supply by making the marginal rate of substitution between consumption and labour supply depend on the latter only. This fact is exploited in the numerical simulations.

The farm household produces a good using the following Cobb-Douglas production function:

$$F(k,l,a) = k^{\alpha_k} l^{\alpha_l} a^{1-\alpha_k-\alpha_l}$$

Where $0 < \alpha_k < 1; 0 < \alpha_l < 1; 0 < \alpha_a < 1; \alpha_a = 1-\alpha_k-\alpha_l$.

Despite highly restricted assumptions, the Cobb-Douglas production function provides an effective horse work for this study. Other studies have recourse to such production functions (Adelman and Taylor, 2003). Arguably less restrictive functional forms have not substantially improved previous results (Mundlak, 2000). Constant returns to scale are assumed. This assumption can be considered as strong given that the literature has rarely, if never, displayed such results. However, Mary (2009) argues that previous results in the literature are due to an inadequate estimation process of agricultural production functions.

Investment adjustment costs, defined as a function of net investment, K_{t+1}-K_t, where ϕ>0, are as follows:

$$\Phi(x) = \frac{\phi}{2} x^2; \phi > 0.$$

The interest rate is exogenous:

$$r_t = r_{t+1} = r, \tag{1.10}$$

Similarly to Sckokai and Moro (2009), land is considered to be fixed in the modelling framework. In France the average size of land sale transactions has been fairly stable over the last 15 years at around 3.3 ha. The relative stability in the observed pattern of the average size of farmland sale transactions is likely to be the consequence of rigid sales market regulations in France (Swinnen *et al*, 2008). The importance of land renting is thus higher in such country with strong market regulations[3]. Furthermore, the length of rental contracts is of a minimum of 9 years, which is the highest minimum length of rental contracts in the EU. The renewal (inheritance) of rental contracts is also regulated by the government. Overall, formal rental markets are much stickier in France. Therefore, we consider land, including both owned land and rented land, as a fixed input. Land is normalized to 1:

$$a_t = \bar{a} = 1. \tag{1.11}$$

Farm income is assumed to be uncertain due to the existence of a stochastic process in the equation (1.9). In the literature, two sources of uncertainties have mainly been taken into account, i.e. price and output. Here, we assume that the stochastic shock models price uncertainty and is governed by a Markov chain[4]. Price shocks are assumed to evolve according to equation (1.12):

$$p_{t+1} = p_t^{\rho} \varepsilon_{t+1} \tag{1.12}$$

Where ε_t is an i.i.d. random variable with unit mean and standard deviation σ_ε. This assumption is relatively similar to the one in Lansink (1999). Other studies have used the adaptative expectation hypothesis (Chavas and Holt, 1990; Pope and Just, 1991; Skockai and Moro, 2006).

[3] Indeed, French farms rented 75% of the used agricultural area in 2006.

[4] Tauchen (1986) provides an algorithm to approximate a continued valued $AR(1)$ process using a Markov chain.

The optimization problem is as follows:

$$\max \sum_{t}^{\infty} \theta_t U(c_t, l_t)$$
$$s.t. \begin{cases} p_t . y_t + fp_t = c_t + k_{t+1} - (1-\delta)k_t + \Phi(k_{t+1} - k_t) + d_{t+1} - (1+r)d_t \\ k_{t+1} = i_t + (1-\delta)k_t \\ d_t \leq d^* \\ \lim_{j\to\infty} E_t \dfrac{d_{t+j}}{(1+r)^{j-1}} \leq 0 \end{cases} \qquad (1.13)$$

No closed-form solution to this problem can be found. Nevertheless, the optimal solution can be characterized using dynamic programming. Under several assumptions[5], optimal decision rules that characterize the equilibrium stochastic process of the household can be obtained by solving the functional-equation problem:

$$V(k_t, d_t, p_t) = \max \{U(c_t, l_t) + \theta_t E_t V[(k_{t+1}, d_{t+1}, p_{t+1} \mid p_t)]\} \qquad (1.14)$$

With respect to c_t, k_{t+1} and d_{t+1} and

$$\max \sum_{t}^{\infty} \theta_t U(c_t, l_t)$$
$$s.t. \begin{cases} p_t . y_t + fp_t = c_t + k_{t+1} - (1-\delta)k_t + \Phi(k_{t+1} - k_t) + d_{t+1} - (1+r)d_t \\ k_{t+1} = i_t + (1-\delta)k_t \\ d_t \leq d^* \\ \lim_{j\to\infty} E_t \dfrac{d_{t+j}}{(1+r)^{j-1}} \leq 0 \end{cases} \qquad (1.15)$$

2.2 Solution technique

Due to non-linearities involved in the equations and its stochastic nature, the maximization problem (1.13) cannot be solved analytically. However, even if the exact solution is unobtainable, a numerical approximation of the solution can be found. We consider various numerical techniques and check whether their characteristics are compatible with both our model

[5] The rate of time preference is assumed to be greater then zero. The utility function and the production function are assumed to be twice differentiable, strictly concave and bounded above (Phimister, 1993).

and the aim of this paper, which is to simulate alternative policy scenarios (especially implementing counter-cyclical payments) in a stochastic environment.

First, linear methods imply the certainty equivalence property[6]. This property restricts the range of questions that can be addressed such as alternative policy evaluations (Schmitt-Grohé and Uribe, 2003), especially in a stochastic environment. In particular, linearization solution methods that do not incorporate the effect of higher order moments (and then the effect of risk) may lead to spurious results and incorrect policy interpretations (Kim and Kim, 2002; Benhabib, Schmitt-Grohé and Uribe, 2001). Since the validity of some methods is local, they perform poorly away from the steady state. For instance, perturbation methods are very good for states near the deterministic steady state. Yet their accuracy declines when we consider values for the endogenous variables quite distant from the deterministic state or when the volatility of the shocks is relatively large. Further, our model especially features occasional binding constraints. Solution methods that produce linear decision rules by using linear quadratic approximations or linearizing the first-order conditions in levels or logs cannot handle occasional binding constraints. On the contrary, projection methods as well as value function iteration methods can accommodate for occasional binding constraints. However, projection methods are particularly vulnerable to a change of behaviour in the policy function if the constraint becomes binding (Christiano and Fisher, 2001; Heer and Maussner, 2008). Considering all the elements above, the model is solved via value function iteration method. This solution technique is safe, reliable and rather easy to implement.

3. Data and calibration

3.1 Data

The data are drawn from the French Farm Business Surveys (FADN) for the years 1996-2003 from the data which all national agencies in the EU are obliged to provide the European Commission (EU Commission, 1989). The data are farm level data 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 are available in the dataset. In general, each survey farm remains in the survey for 5 or 6 years. Hence, a panel of farms can be constructed for the period. Only farms which specialise in crop production are studied. The sample is defined according to a set of following criteria. We start with an original sample of 2176 farms observed for 8 years, between 1996 and 2003, for a total number of 8685 observations. The sample consists of all the farms that have been surveyed for at least 4 years. Then all observations where the log difference of the capital stock variable between two consecutive years exceeds 3 in absolute value are dropped. Finally, any observation considered as outliers has been removed.

[6] The certainty equivalence property implies that the optimal solution to the problem with uncertainty is equivalent to the solution of the certainty problem.

There are 1479 crops farms, observed for 8 years, between 1996 and 2003, satisfying these conditions for a total number of 7508 observations.

3.2 Calibration

The model includes a series of parameters that have to be set before any solution technique can be applied to approximate the solution to the problem (1.13). The dynamic model is parameterized to farm level data using a sample of French arable crops farms. Table 1 reports the parameterization.

Table 1
Calibration of dynamic stochastic farm household model

α_K	α_N	α_L	γ	δ	r	ψ	ϕ	ρ	σ_ε	w	$\overline{a}$
0.15	0.62	0.23	0.097	0.2	0.05	0.08	0.5	0.68	0.028	3	1

Farm output elasticities are extracted from Mary (2009) in which a three-factor production function has been estimated for the French crops sector using a hybrid system GMM estimation accounting for variations in utilization rates. Other parameters are calibrated using estimates from the empirical literature and actual data. The risk aversion factor γ is taken from Sckokai and Moro (2009). As pointed out by Cooper and Haltiwanger (2006), estimates of the capital adjustment cost parameter ϕ range over 20 to as low as 3[7]. Nevertheless, estimates of ϕ are subject to a measurement error (upward bias) due to the misspecification of *q*-theory based models (Cooper and Ejarque, 2001). The adjustment cost is set to a relatively low value. The interest rate and the depreciation rate are both estimated using the FADN panel data. The value of *w* (1 plus the inverse of the elasticity in labour supply) is believed to be relevant with a recent literature regarding the econometric estimation of labour supply elasticities (Domeij and Floden, 2001; Felices and Tinley, 2004). Given the other parameters values, θ is determined by the steady-state condition that equates the rate of time preference with the interest rate. This is done by imposing the restriction that the average change in debt ψ is about 8 percent, as observed in the FADN dataset. Price uncertainty is modelled by an $AR(1)$ process. We follow the methodology used in Lansink (1999) and Chavas and Holt (1990) to calibrate the stochastic process modelling price uncertainty.

4. Results

4.1 Simulations

[7] Different methods and datasets explain these various results. Some studies have captured the adjustment costs with only convex costs while some recent works have also taken into account non-convex costs.

The purpose of this paper is to provide a comparative analysis of several farm payments in terms of farm investment and output. First, the baseline scenario is the one in which no farm support policy is implemented. Three alternative scenarios are simulated and compared to the baseline situation.

Table 2
Policy scenarios

Scenarios		Farm support
1.	Baseline	No farm support policy
2.	Intervention pricing (IP)	Increase in price intervention
3.	Direct payment (DP)	Equal-sized direct payment
4.	Counter-cyclical payment (CCP)	Equal-sized CCP

The first alternative scenario models an increase in the intervention price of about 10 per cent, which corresponds to an increase in expected prices of about 1.55 per cent. The existence of intervention prices results in a truncation of the price distribution. In practice, the existence of intervention prices is modelled through the distribution of shocks. This scenario is designed to represent the traditional CAP before major reforms were undertaken in 1990s. The second alternative scenario models the provision of the same monetary amount in the form of direct payments. This scenario is designed with a direct reference to the Single Farm Payment of the European Union. The fixed direct payment is calculated as the average difference between the long-term income of the baseline scenario and the income impact of the intervention price scenario. These direct payments do not depend on the current level of production and are time invariant throughout the simulations. The third scenario models a counter-cyclical payment (CCP) or more precisely, the counter-cyclical provision of equal-sized fixed farm payments. The farm household receives a fixed payment, every period in which the market price falls below a certain level. This scenario represents current CCPs (or previous deficiency payments) in the United States. However, the countercyclical programme of payments in the USA is somewhat different from our simulations. In practice, when market prices fall below a target price, US farmers receive a payment which depends on current market prices and therefore is variable. Although CCPs do not depend on current levels of production and force farmers to look to market prices, not to farm payments, CCPs are believed to have significant impacts on output decisions (Vercammen, 2007). In this scenario, the farm payment acts an insurance scheme. When the market price is above the target level, no payment is made. Therefore, in absolute terms, this last scenario involves a lesser amount of farm payments than the previous two alternative scenarios[8].

[8] The total amount of payments in the scenario implementing the counter-cyclical provision of payments is equivalent to 58% of the total amount of payments in the scenario with direct payments.

For each run, the model is simulated by introducing a set of price shocks. Results are averages over 1,000 simulations, where each simulation consists of 30 periods. Farm payments are time invariant.

4.2 Baseline results

4.2.1 Unconstrained farm household

Table 3 presents the long-run impacts of the simulated policy changes on farm investment and output when the farm household does not face any debt constraints (i.e. unconstrained regime)[9]. The results show that the increase in the intervention price would positively and strongly affect farm investment (+3.36 per cent) and output in the unconstrained regime (+2.43 per cent). If the same monetary amount was provided in the forms of direct payments, it would not significantly impact on investment and therefore on output (0.01 per cent). Direct payments have no impact as if they were truly decoupled for the representative farm household. The alternative scenario regarding the counter-cyclical provision of fixed payments would also have no effect on investment and farm output. These findings, i.e. the absence of impacts, are possibly the consequence of a very low level of risk aversion. Indeed, Hennessy (1998) shows that farm payments may affect output decisions through wealth and insurance effects. However, these effects arise if and only if the farmer is risk averse. We thus hypothesize that the absence of effects is due to the very low risk aversion factor.

4.2.2 Debt-constrained farm household

Economic literature has suggested the relevance of debt constraints as an explaining factor of the potentially coupled nature of direct payments. Access to credit is indeed crucial to finance the demand for capital goods. When this access to credit is limited, the level of farm investment may be affected if the debt constraint is binding or anticipated to be binding. The existence of debt constraints is modelled by assuming that:

$$d_t \leq 0.$$

This constraint is relatively strong in the sense that any investment will have to be financed out of internal resources, while in the unconstrained regime the farm household could finance investment through internal resources and debt. According to the economic literature, direct payments may potentially affect investment decisions when the farm household is debt-constrained.

In the constrained regime the increase in the intervention price would have very similar effects on investment than in the unconstrained case. For example, the impact on output would be 2.43 per cent against 2.34 per cent in the constrained regime. Yet, it seems that the impacts of

[9] In practice, the debt constraint has been calibrated to a extremely low level so that it is as if there were no debt constraint or it would never bind.

intervention pricing would be less in the constrained regime. This is especially noteworthy when comparing the impacts on farm investment (3.36 per cent in the unconstrained regime against 2.73 per cent in the constrained regime). Our result is somewhat compatible with the analytical result found in Phimister (1995) that the effect of a change in the output price on capital stock in the debt constrained regime is always strictly less than the effect in the unconstrained regime.

Table 3
Long-run impacts of farm support policies

	Baseline	Intervention price	Direct payment	Counter-cyclical payment
$\gamma = 0.097$				
Unconstrained regime				
Investment	0.088	0.091	0.088	0.088
per cent Change		3.368	0.084	0.021
Output	0.763	0.781	0.763	0.763
per cent Change		2.436	0.011	0.012
Constrained regime				
Investment	0.083	0.085	0.083	0.084
per cent Change		2.736	0.287	1.028
Output	0.755	0.773	0.756	0.756
per cent Change		2.344	0.023	0.136

Direct payments would seem to impact a little on investment (0.28 per cent). However, this very small increase in farm investment would not translate into a significantly higher level of output (+0.02 per cent). Furthermore, results show that CCPs would affect farm investment in the constrained regime while they would not in the unconstrained regime. In the unconstrained regime, CCPs would increase farm investment by 1.02 per cent. Nonetheless, this increase in investment would not affect farm output as much (0.13 per cent).

Overall, direct and counter-cyclical payments would impact farm investment in the constrained regime. However, these small impacts on investment would not lead to a significantly higher level of production. These results may be linked to the calibration of the dynamic model. In particular, the coefficient of risk aversion is very low. Last, but not least, these findings suggest that the existence of debt constraints would affect the extent to which farm policies impact on investment and output decisions in the French crops sector.

4.3 Farm payments and risk aversion

The risk aversion parameter used in the calibration is in the lower range of values found in the literature. In this section, we proceed to the same analysis as presented in the precedent section across higher levels of risk aversion. Tables 4 and 5 present the long-term impacts of the simulated scenarios on farm investment and output across higher levels of relative risk aversion.

Table 4
Long-run impacts of farm payments and higher risk aversion: unconstrained regime

	Baseline	Price intervention	Direct payment	Counter-cyclical payment
$\gamma = 0.5$				
Investment	0.088	0.092	0.088	0.088
per cent Change		4.196	0.132	0.125
Output	0.763	0.783	0.763	0.763
per cent Change		2.602	0.019	0.027
$\gamma = 0.75$				
Investment	0.087	0.092	0.087	0.088
per cent Change		6.192	0.118	0.300
Output	0.761	0.783	0.762	0.762
per cent Change		2.889	0.015	0.047

4.3.1 Unconstrained farm household

First, the scenario modelling the increase in intervention price would significantly affect investment and so farm output in the unconstrained regime. This result is found for all degrees of risk aversion. For instance, when the coefficient of relative risk aversion is equal to 0.5, the price intervention scenario would increase farm investment by 4.19 per cent and farm output by 2.60 per cent.

More importantly, the magnitude of these positive effects seems to be affected by the level of risk aversion: the impacts on investment and output become greater with a higher coefficient of relative risk aversion. For respective values of γ equal to 0.097, 0.5 and 0.75, a 10 per cent increase in the intervention price would then increase farm investment by 3.36 per cent, 4.19 per cent and 6.19 per cent. These higher levels of investment would lead to respective increases in farm output of 2.34 per cent, 2.60 per cent and 2.88 per cent.

On the contrary, support-equivalent direct payments would have no significant effect on output in the unconstrained regime. This result holds for higher levels of risk aversion. This result can be explained by the fact that direct payments would have no effect or very minimal effects on investment. With respect to the scenario simulating the counter-cyclical provision of fixed farm payments, farm output would not be significantly affected.

Overall, when the farm household is in the unconstrained regime, we find that the increase in the intervention price would increase output while direct and counter-cyclical payments would have no impact on farm output. We present below the same analysis in the constrained situation.

4.3.2 Debt-constrained farm household

Results show that in the constrained regime the intervention pricing scenario would lead to very similar effects on investment than in the unconstrained case. Because the investment effects would be pretty similar as in the unconstrained regime, the output impacts would be alike too. For instance, when $\gamma = 0.75$, the output impact of the first alternative scenario would be 2.88 per cent in the unconstrained regime against 2.23 per cent in the constrained regime.

Table 5

Long-run impacts of farm payments and higher risk aversion: constrained regime

	Baseline	Price intervention	Direct payment	Counter-cyclical payment
$\gamma = 0.5$				
Investment	0.082	0.084	0.083	0.083
per cent Change		2.040	0.580	1.216
Output	0.755	0.722	0.756	0.756
per cent Change		2.253	0.134	0.231
$\gamma = 0.75$				
Investment	0.083	0.084	0.083	0.084
per cent Change		1.975	0.749	1.229
Output	0.755	0.772	0.756	0.757
per cent Change		2.236	0.152	0.244

Furthermore, we confirm the previous finding that the intervention pricing support instrument would have lesser impacts on farm investment and output in the constrained regime than in the unconstrained regime. With higher values of risk aversion, direct payments would significantly impact on farm investment. In the constrained regime, the investment effect of the scenario with direct payments would be +0.58 per cent and +0.74 per cent for respective values of risk aversion of 0.5 and 0.75. Despite these investment impacts, the impacts of direct payments on farm output would remain very small. Finally, CCPs would have much larger positive effects on investment than in the unconstrained regime. For example, for a risk aversion parameter of 0.5, the investment impact would be +1.21 per cent, leading up to an output effect of +0.23 per cent. CCPs would seem to have larger impacts than direct payments in the constrained regime. These findings may suggest the relative greater amplitude of insurance and wealth effects when the risk aversion is higher.

4.4 Production ratios and degree of decoupling

To compare the degree of decoupling of both direct payments and CCPs, we calculate the average production ratios as defined in OECD (2001). The effects on production of the direct payment and the CCP scenarios are compared with the effects of an increase in the intervention price. The production ratios compare the production change due to the intervention pricing with those generated by direct payments and CCPs. Ratios very close to zero imply effective full decoupling whereas a ratio of 1 indicates a fully coupled policy.

Table 6
Average production ratios for the representative farm household

	Unconstrained regime		Constrained regime	
	DP[2] /IP[1]	CCP[3] /IP	DP/IP	CCP/IP
$\gamma = 0.097$	0.004	0.005	0.009	0.057
$\gamma = 0.5$	0.000	0.010	0.059	0.102
$\gamma = 0.75$	0.005	0.016	0.068	0.109

[1] IP: 10 per cent increase in intervention price (1.55 per cent increase in expected price)

[2] DP: support-equivalent in the Single Farm Payment

[3] CCP: support-equivalent in the Counter-cyclical Payment

Table 6 confirms that direct payments are decoupled in the unconstrained regime. The signs of the output changes are positive but practically equal to zero for all risk aversion parameters. The production ratios for the scenario with CCPs are similar to those with direct payments, except for $\gamma = 0.75$ to some extent. The production ratios in the constrained regime indicate that direct payments are not decoupled anymore, except for the lowest risk aversion coefficient that is almost a situation of risk neutrality. However, the degree of coupling generally remains very small. It is also noteworthy that the degree of coupling of direct payments increases with the coefficient of relative risk aversion, suggesting the relative greater amplitude of insurance and wealth effects. Further, the degree of coupling for counter-cyclical payments also increases with respect to the unconstrained regime. For $\gamma = 0.097$, the computed production ratio is 0.057 in the constrained regime (against 0.005 in the unconstrained regime). When increasing the factor of relative risk aversion, the production ratios of CCPs increase as well. For $\gamma = 0.75$, the production ratio is 0.109. Results thus confirm the partially coupled nature of these payments.

In our simulations, the direct payment is modelled so as to represent the Single Farm Payment. The main conclusion from Table 6 is that the Single Farm Payment is not totally decoupled when the farm household faces significant debt restrictions. However, given the very low production ratios obtained across risk aversion parameters and financial regimes, the assumption of an effective decoupling of the SFP is reasonable in the French arable crops sector.

Finally, we can also compare the direct payment to the counter-cyclical payment. For all levels of relative risk aversion, the production ratio of CCPs is larger than of direct payments. In particular, the relative larger magnitude of CCPs in terms of output impacts is striking in the debt-constrained regime. This is quite an important result as the counter-cyclical scenario, which was designed to represent previous deficiency payments and current CCPs in the United States, implies a much lesser amount of subsidies to the farm household, making of CCPs a much more efficient, but also more trade-distorting, instrument to support farmers than Single Farm Payments.

5. Conclusions

This paper assesses the impacts of farm policies on investment and output of a sample of French arable crops farms observed from 1996 and 2003. Our empirical analysis is based on the framework developed by Phimister (1995), which is extended to an infinite horizon and stochastic framework. The model presented here contributes to the existing literature by applying a different approach to those of Sckokai and Moro (2009) and Serra *et al* (2009) to represent dynamic agricultural production under uncertainty and risk aversion.

A dynamic stochastic farm household model with occasionally binding debt constraints and investment adjustment costs is developed, calibrated to farm level data and numerically solved to explore the impacts of an increase in the intervention price as well as the effects of Single Farm Payments and Counter-cyclical Payments in French crops farms.

Results show that an increase in the intervention price would significantly impact farm investment and output decisions in the unconstrained and debt-constrained regimes. On the contrary, SFPs would only affect investment decisions in the debt-constrained regime. More importantly, these impacts on farm investment would increase with the degree of risk aversion. In all cases, they would remain too little so that output decisions would not be significantly affected. Finally, CCPs would have no or minimal effects on investment and output if the farm household was not debt-constrained. But, if the farm household was debt-constrained, CCPs would affect farm investment and to a lesser extent output decisions much more than SFPs.

Although SFPs are found to potentially affect investment and output decisions, given the relatively low degree of coupling of Single Farm Payments, it is reasonable to consider that the Single Farm Payment is “empirically” decoupled in this French FADN sample of arable crops farms. This result is consistent with Sckokai and Moro (2009), whose findings confirm the relatively decoupled nature of the Single Farm Payment using an Italian FADN sample of arable crops farmers. Further, our findings highlight that the degree of decoupling of farm payments is strongly linked to the existence of significant debt constraints and to the degree of risk aversion and confirm that these two factors are key variables to incorporate when assessing the impacts on farm support policies.

A number of caveats to the work need to be emphasized. The main limitation of this study is that our results rely on the choice of parameters. Specifically, our results are subject to the Lucas critique to the similar extent that Sckokai and Moro (2009) and Serra et al (2009) are. The parameterization represents the behaviour of French crops farms between 1996 and 2003, i.e. to data referring to the pre-reform period. Therefore, our results are based on the assumption that changes in farm support policies would not alter the farm household decisions. In addition, a few parameters have, to some extent, been arbitrarily chosen. For example, more research is needed in the econometric estimation of adjustments costs and risk aversion parameters. For these reasons, our findings should be treated with caution. Another caveat relates to the modelling framework. The current version of the model ignores off-farm work. Further extensions of the model could take into account the possibility that part of the household's time is allocated to off-farm work. This may modify the simulation results since off-farm activities may be rather important for investment decisions (Sckokai and Moro, 2009).

References

Benjamin, D. "Household composition, labour markets and labour demand: testing for separation in agricultural households models", *Econometrica*, volume 60, no. 2 (1992).

Blancard, S., Boussemart, J.-P., Briec, W., and Kerstens K. "Short- and long-run credit constraints in French agriculture: A directional distance function framework using expenditure-constrained profit functions", *American Journal of Agricultural Economics* 88 (2), (2006) pp. 351-364.

Bhaskhar ,A., and Beghin ,J.C. "How coupled are decoupled farm payments? A review of the evidence", *Journal of Agricultural and Resource Economics* 34 (1), (2009) pp. 130-153.

Chavas, J.-P. and Holt M. T. "Acreage Decisions Under Risk: The Case of Corn and Soybeans", *American Journal of Agricultural Economics*, volume 72, no. 3, (1990) pp. 529-538.

Christiano L.J. and Fisher J.D.M.. "Algprtihms for solving dynamic models with occasionally binding constraints", October 1997, Working paper 9711 NBER.

Heer B. and Maussner A., "Value function iteration as a Solution Method for the Ramsey Model", CESIFO WP n. 2278, (2008).

Henessy, D. "The production effects of agricultural income support policies under uncertainty", February 1998, *American Agricultural Economics Association*, volume 80, no. 1 (1998).

Lansink, A. O., "Area Allocation Under Price Uncertainty on Dutch Arable Farms", *Journal of Agricultural Economics*, Volume 50, Number 1, January (1999), pages 93-105.

Mary S. "The system is not enough: Agricultural production functions and GMM estimation", Working paper, University of Aberdeen Business School (2009).

Moro D. and Sckokai P. "Modelling the CAP arable crop regime in Italy: degree of decoupling and impact of Agenda 2000". *Cahiers d'Economie et Sociologie Rurales 53*, (1999) pp 49-73.

Mundlak Y. *Agriculture and Economic Growth, Theory and Measurement*, Harvard University Press, (2000).

Phimister E. "Farm household production in the presence of restrictions on debt: theory and policy implications", *Journal of Agricultural economics*, volume 46, no. 3. September (1995).

Sadoulet E. and De Janvry A. *Quantitative Development Policy Analysis*, The John Hopkins University Press, (1995).

Sckokai P. and Moro D. "Modelling the reforms of the Common Agricultural Policy for arable crops under uncertainty", *American Journal of Agricultural Economics* 88 (1), February (2006) pp. 43-56.

Sckokai P. and Moro D. . "Modelling the impacts of the CAP Single Farm Payment on farm investment and output", *European Review of Agricultural Economics* 36 (3), (2009) pp. 395-423.

Serra T., Stefanou S., Gil J.M. and Featherstone A., "Investment rigidity and policy measures", *European Review of Agricultural Economics* 36 (1), (2009) pp. 103-120.

Swinnen J., Ciaian P. and d'Artis K. "Study on the Functioning of land markets in the EU member states under the influence of measures applied under the CAP", Brussels: Center for European Policy Studies (2008).

Vercammen J. "Farm bankruptcy risk, direct payments and agricultural investment", *European Review of Agricultural Economics* 34, (2007) pp. 479-500.