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Effects of policy instruments on farm investments and production decisions in the Spanish COP sector

Zein KALLAS; Teresa SERRA; José M. GIL

Center for Agro-food Economy and Development

&

Polytechnic University of Cataluña

(CREDA)- UPC - IRTA

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1. INTRODUCTION

Farm household assets can be classified into 2 main different types:

Off-farm investments

- Not directly related to farming activities.
- Are based on non-farming assets such as financial assets.
- Are used to effectively stabilize the financial performance of their farm income and to reduce risk in their economic results.

On-farm investments

- Directed toward farming activities.
- To support agricultural practices and to ensure a regular flow of goods and services.
- Involve assets such as farm machinery, farm buildings, land improvements, etc.

1. INTRODUCTION

Among the economic factors, agricultural policy support has been shown to play a relevant role in investment decisions (Sckokai, 2005; Coyle, 2005 and Cahill, 2005).

Findings from previous research allow to classify variables that usually influence farmers' investment decisions into:

non-economic factors

- **Farmer characteristics:** age, gender, education...
- **Farmer attitudes and opinions:** risk behaviours, information source...
- **Agronomic characteristics:** soil fertility, animal welfare...

economic factors

- **Farm management issues:** input use, labour, costs, farm income, debt level, productivity and efficiency...
- **Exogenous factors:** market size, policy support, input and output prices, interest rate...

1. INTRODUCTION

- This economic factor (policy support) is particularly relevant in the Cereal, Oilseed and Protein (COP) crops sector, which has received considerable attention within the EU agricultural policy.

- Over the last years, the Common Agricultural Policy (CAP) applied to the COP sector has undergone an important reform process characterized by a reduction in price supports, where area payment has been introduced and considered as partially decupled payment (PD) by several studies.

- The CAP reform process culminated with the 2003 reform that introduced the single farm payment, defined as a fully decoupled measure (FD)

2. OBJETIVE

🌐 **Our paper focuses on analysing the IMPACT OF PD PAYMENTS ON "ON-FARM" INVESTMENT decisions in the SPANISH COP sector:**

▪ **The statistical data to analyze the effects of FD payments are not yet available, since these payments were first applied in the 2006-2007 marketing year.**

▪ **Previous research assessing the impacts of CAP PD payments has mainly focused on variable input use and land allocation, and few papers have analyzed their impacts on investment decisions.**

3. COP sector and CAP Reforms

🌐 **The EU-27 is the third world's largest producer of cereals with 12.12% of global production, behind the USA (15.60%) and China (20.05%), and is the first worldwide producer of barley (40.5%) and wheat (20.8%).**

🌐 **The EU-27 COP sector represents 76.5% of total utilized agricultural area (UAA) and 37.2% of total crop production.**

🌐 **In 2006, the most important cereal producers within the EU-27 were France and Germany, representing 23.27% and 14.76% of total EU production, respectively, followed by Italy, Poland, Spain and the United Kingdom**

🌐 **The Spanish COP sector occupies 59.0% of the Spanish UAA and represents 30.2% of the Spanish total crop production**

3. COP sector and CAP Reforms

The COP area and production in Spain within the period study

	Cereals		Oilseeds		Protein crops		Total COP	
	1,000 ha (%)[a]	1,000 t (%)[b]	1,000 ha (%)[a]	1,000 t (%)[b]	1,000 ha (%)[a]	1,000 t (%)[b]	1,000 ha (%)	1,000 t (%)
2000	6,802.49 (78.3)	24,555.67 (80.9)	894.06 (10.3)	992.47 (3.3)	996.61 (11.5)	4,811.40 (15.8)	8,693.16 (100)	30,359.54 (100)
2004	6,597.28 (76.5)	24,808.86 (78.5)	763.99 (8.9)	837.35 (2.6)	1,266.92 (14.7)	5970.80 (18.9)	8,628.19 (100)	31,617.00 (100)

[a] Percentage over total COP area

[b] Percentage over total COP production

3. COP sector and CAP Reforms

⬛ <u>**1992 reform**</u>: **a) Oilseed and protein crop guaranteed prices were abolished, b) cereal prices were ⬇ by one third, c) area payment & set aside established.**

⬛ <u>**Agenda 2000**</u>: **a) Guaranteed price for cereals was ⬇ by 15% and the direct payment ⬆ by the same proportion, b) Direct payments to oilseed crops were ⬇ to the cereals' payment level and c) Direct payments to protein crops were also ⬇ but kept above the cereal and oilseed payments.**

⬛ <u>**Mid Term Review 2003**</u>: **single farm payment was introduced as a key element in the new farm support system. For the COP sector, 25 % of support remain as coupled payment.**

⬛ **Of the European Agricultural Guidance and Guarantee Fund (EAGGF) expenditure, 25.1% is devoted to COP**

4. Theoretical and econometric frameworks

🔹 **Our model is based on a reduced-form application of the dual model of investment under uncertainty developed by Sckokai (2005).**

🔹 **The conceptual foundations of this model rely on the duality theory results from McLaren and Cooper (1980) and Epstein (1981).**

🔹 **Under the assumptions that farmers <u>produce a single output</u>, are <u>not risk neutral</u> and take their decisions to <u>maximize discounted utility</u> over an infinite horizon, the <u>value of the firm </u> can be represented as follow:**

4. Theoretical and econometric frameworks

$$J(.) = \max \int_0^\infty e^{-rt} u(A, \sigma_A^2) \qquad \text{s.t.} \quad \dot{k} = (1 - \eta k)$$

- where *u* function is the expected utility of wealth assumed to depend on:
  - The expected farm's wealth (*A*) and the variance of wealth (σ^2_A).
- $\dot{k}$ is the time derivative of the capital path, η represents the capital depreciation rate and k are the units of capital.

- The expected farm's wealth is given by: $A = A_0 + \overline{p}y - wx - ck + S + S_r$
  - Where A_0 is a farm's initial wealth;
  - $\overline{P}$ is the expected market output price;
  - *y* is the farm output production function; $\longrightarrow$ $y = f(x, k, I; b) + e$
  - *w* is input price;
    - *I* is the gross investment in capital;
  - *x* is variable input;
    - *b* is labor;
  - *c* is the capital rental price;
  - *S includes the CAP direct payments to COP crops*;
  - S_r is the rural development subsidies.

The Hamilton-Jacobi-Bellman dynamic programming is used to obtain the optimal output and input demand equations:

$$
\begin{cases}
\dot{k}(r, A_0, \overline{P}, w, c, b, S, S_r, \sigma_A^2, k) \\
y(r, A_0, \overline{P}, w, c, b, S, S_r, \sigma_A^2, k) \\
x(r, A_0, \overline{P}, w, c, b, S, S_r, \sigma_A^2, k)
\end{cases}
$$

Since not every farm invests in every asset nor produces each crop considered, a <u>CENSORING ISSUE</u> underlies the empirical model.

To handle this issue, we use the Shonkwiler and Yen (1999) estimation procedure:

4. Theoretical and econometric frameworks

- Let $F_i, i = 1, \ldots, n$ represent a censored decision variable

- and $H_j, j = n+1, \ldots, m$ a non-censored one,

- and $\mathbf{X} = (r, A_0, \overline{P}, w, c, b, S, S_r, \sigma_A^2, k)$ the vector of explanatory variables

- The output and input demand equations can be alternatively expressed as:

$$\begin{cases} \mathbf{F}_t = f(\mathbf{X}_t, \boldsymbol{\beta}) \\ \mathbf{H}_t = f(\mathbf{X}_t, \boldsymbol{\gamma}) \end{cases}$$

- where **F** and **H** are vectors containing the <u>CENSORED AND NON-CENSORED VARIABLES RESPECTIVELY,</u> β and δ are vectors of parameters and *t* denotes each observation.

4. Theoretical and econometric frameworks

🌐 **For estimation we follow the two-step procedure outlined by Shonkwiler and Yen (1999).**

🌐 **FIRST STEP, the discrete variable indicating a non-censored observation of $\mathbf{F}_t = d(\mathbf{F}_t > 0)$ is evaluated through a Probit model of the form.**

🌐 **SECOND STEP, the normal cumulative distribution function $\Phi(\mathbf{Z}_t, \alpha)$ and the normal probability density function $\phi(\mathbf{Z}_t, \alpha)$ derived from the probit model are used to construct correction terms in the censored equations system.**

4. Theoretical and econometric frameworks

- **Thus, the resulting system can be rewritten as:**

$$\begin{cases} \mathbf{F}_t = \Phi(\mathbf{Z}_t, \boldsymbol{\alpha}) f(\mathbf{X}_t, \boldsymbol{\beta}) + \delta \phi(\mathbf{Z}_t, \boldsymbol{\alpha}) + \boldsymbol{\xi}_t^{\mathrm{F}} \\ \mathbf{H}_t = f(\mathbf{X}_t, \boldsymbol{\gamma}) + \boldsymbol{\xi}_t^{\mathrm{H}} \end{cases}$$

- **Where $\boldsymbol{\xi}_t^{\mathrm{F}}$ and $\boldsymbol{\xi}_t^{\mathrm{H}}$ are vectors of error terms.**

- **The equations system is estimated by Seemingly Unrelated Regression (SUR) Procedure.**

4. Theoretical and econometric frameworks

🌐 **It should be noted that parameter estimates derived from the two-step method might disguise the actual effects of the variables.**

🌐**This would be especially true when a common explanatory variable is used in the first and second stages of the estimation process.**

🌐 **In order to solve this problem, we <u>COMPUTE THE MARGINAL EFFECTS</u> and <u>RELY ON THEM FOR THE INTERPRETATION OF RESULTS OF THE CENSORED EQUATIONS</u>**

$$\frac{\partial E\left[\mathbf{F}_t \middle/ \mathbf{X}_t, \mathbf{Z}_t\right]}{\partial X_{zt}} = \Phi(\mathbf{Z'}_t\alpha)\beta_z + \mathbf{X'}_t\beta\,\phi(\mathbf{Z'}_t\alpha)\alpha_z - \delta_z(\mathbf{Z'}_t\alpha)\phi(\mathbf{Z'}_t\alpha)\alpha_z$$

5. Empirical Implementation

Farm-level data for a sample of Spanish farms specialized in the production of COP crops are utilized. Data are taken from the Farm Accounting Data Network (FADN) for the period 2000-2004, a period during which the Agenda 2000 reforms were effective.

Country-level nominal market inflation rates and interest rates have been taken from the official statistics published by EUROSTAT (2007) and OECD (2007), respectively.

In our empirical application, the model presented in (2) is generalized to consider a multi-output firm, as well as the investment in different types of assets. We distinguish between two output types: 1) cereals and 2) oilseeds and protein crops.

5. Empirical Implementation

DEPENDENT VARIABLES

🔹 Two quasi-fixed inputs representing <u>THE GROSS FARM INVESTMENT IN MACHINERY AND EQUIPMENT</u>, and the <u>GROSS INVESTMENT IN FARM BUILDINGS AND LAND IMPROVEMENTS</u>.

🔹 Assuming constant returns to scale, output can be approximated by land. Thus, the third and fourth decision variables represent <u>LAND ALLOCATED TO CEREALS AND TO OILSEED AND PROTEIN CROPS</u>, respectively.

🔹 The last decision variable represents <u>CROP-SPECIFIC VARIABLE INPUTS</u> variable input costs. This variable includes such as seeds and seedlings, fertilizers, crop protection products and other specific crop costs.

5. Empirical Implementation

🔵 **Almost 90% of our farms <u>do not invest in machinery and equipment</u>, while more than 95% have zero investment <u>in farm buildings and land improvements</u>. As a result, <u>BOTH VARIABLES ARE CONSIDERED AS CENSORED</u>.**

🔵 **Almost 64% of the farms <u>did not plant oilseed or protein crops</u>. Therefore this variable was <u>CONSIDERED AS CENSORED</u>. Conversely, only less than 1% of the farms did not plant cereals and thus the variable <u>WAS NOT CONSIDERED A CENSORED ONE</u>.**

🔵 **This specific crop costs variable <u>WAS TREATED AS NON-CENSORED</u> since only a 0.04% of observations are null.**

5. Empirical Implementation

EXPLANATORY VARIABLES

🔹 The lagged agricultural area is used as an indicator of a farms' wealth

🔹 Expected output prices are defined for cereals and oilseed and protein crops.

🔹 Variable input prices are approximated through the lagged price index for plant protection products and pesticides and fertilizers and soil improvers.

🔹 The rental price for capital is defined for both types of investment considered and is calculated as: $c_i = \left(r + \eta_i \right) z_i, \ i = 1, 2$

where **r** is the annual market interest rate, η_i is the capital depreciation rate, and z_i is the capital price index.

5. Empirical Implementation

- Total labor of the holding is expressed in annual working units and includes both family and rented labor.

- CAP subsidies received by COP producers and rural development subsidies are included.

- Farm's wealth variability is approximated by the coefficient of variation of lagged COP sales on a per hectare basis.

- The lagged value of machinery and equipment and, building and land improvement are included.

- The age of the manager.

- Producers' risk preferences captured using a dummy variable that takes the value 1 if the farm insures its crops and zero, otherwise

5. Results

Censored equations

Non-Censored equations

Variables	Parameter Estimates and summary statistics					Marginal Effects and summary statistics for censored equations		
	Machinery	Building & land improvement	Oilseeds & Protein	Cereals	Variable inputs	Machinery	Building & land improvement	Oilseeds & Protein
Intercept	1507.03	10009.81	-29.15	11.84	132.53	241.94	360.02	-27.43
Total Agricultural Area of holding	0.22	-1.46	0.09	0.45	0.17	-1.00E-3	-0.03	0.03
Expected oilseed and protein crop price.	0.21	4.24	0.11	-0.09	-0.05	0.02	0.13	0.07
Expected cereal price.	0.74	-5.00	5.00E-3	-0.03	-0.07	0.06	-0.13	-2.00E-3
Lagged input price index for plant protection products and pesticides.	746.90	-7849.08	12.09	2.27	-162.83	-116.56	-262.84	11.57
Lagged input price index for fertilizers and soil improvers.	-1019.89	-2490.73	12.54	-15.08	42.78	-155.18	-84.53	9.41

5. Results

	Parameter Estimates and summary statistics					Marginal Effects and summary statistics for censored equations		
Variables	Machinery	Building & land improvement	Oilseeds & Protein	Cereals	Variable inputs	Machinery	Building & land improvement	Oilseeds & Protein
Rental price of Machinery and equipment	-29.30	55.54	0.06	-0.03	-0.36	-3.09	1.95	0.01
Rental price of Building and land improvement.	-73.43	-751.32	-2.08	0.88	-1.51	-12.32	-25.00	-0.64
Total labor input of holding.	-12.86	-141.63	4.84	3.67	47.71	-4.32	-3.70	1.41
Area payments and set aside premiums.	2.00E-3	0.02	2.00E-4	1.00E-3	4.00E-3	4.00E-4	4.00E-4	9.00E-5
Subsidies for environmental and rural development.	0.02	7.00E-3	3.00E-4	-1.00E-3	-1.00E-3	2.00E-3	7.00E-5	2.00E-4
Coefficient of variation of lagged sales by hectares	-1.05	-5.64	0.02	0.01	-0.22	-0.16	-0.148	6.00E-3

	Parameter Estimates and summary statistics					Marginal Effects and summary statistics for censored equations		
Variables	Machinery	Building & land improvement	Oilseeds & Protein	Cereals	Variable inputs	Machinery	Building & land improvement	Oilseeds & Protein
Lagged Building and land improvement capital.	-8.00E-4	4.00E-3	-1.00E-4	2.00E-4	8.00E-5	-1.00E-5	8.00E-5	-3.00E-5
Lagged machinery and equipment capital.	3.00E-4	-2.00E-3	-1.00E-4	7.00E-5	2.00E-4	1.00E-5	-4.00E-4	-3.00E-5
Unpaid manger age.	5.44	12.83	5.00E-3	-0.08	-0.06	0.76	0.33	3.00e-3
Proportion of rented land	147.66	-64.06	-9.38	1.68	16.46	21.35	-2.49	-2.51
Dummy variable: 1 for insurance cost,	85.80	272.95	-5.52	0.41	14.12	12.45	7.22	-1.67
PDF	372.03	2008.73	0.71	-	-			
R2	0.114	0.032	0.570	0.948	0.796			
Objective value	4.9591	Nº observation	5023					

5. Results

■ **Subsidy parameter estimates suggest that an increase in PD payments increases the investment in building and land improvement.**

■ **Both PD payments and rural development subsidies, have a positive impact on machinery and equipment investment. Since farm output is a function of different inputs including the level of capital, which depends on past decisions on investments, the impact of PD subsidies on investment demand will have long-lasting (dynamic) impacts on production.**

■ **PD payments further stimulate production by motivating an increase in the use of variable inputs.**

5. Results

🔷 **PD payments are found to influence land allocation by stimulating an increase in the area devoted to cereals, the predominant crop within the Spanish COP sector.**

🔷 **Results demonstrate that an increase in farm's wealth causes an increase in the area devoted to cereal crops as well as an increase in variable input use.**

🔷 **wealthier farmers, in being less risk averse, are likely to be more prone to expand their business size. These results together with the subsidy parameter estimates suggest that agricultural subsidies can have relevant wealth effects, leading to an increase in output supply and input demand.**

5. Results

Our results show that those farms with a higher proportion of rented area are more prone to invest in machinery and use more variable inputs. They are also more likely to devote more land to grow cereals to the detriment of land allocated to oilseed and protein crops. These results suggested that direct costs of land rentals may create stronger incentives to work the land more intensively, relative to the opportunity costs borne by owned fields

Results demonstrate that an increase in the age (farmer's experience) leads to an increase in investment demand. These results suggest that the more experienced the farmers are, the more likely they are to invest. It is also true that older farmers are less likely to be credit constrained relative to their younger counterparts, which facilitates investment.

5. Results

■ **Farmers who have signed up for an insurance contract tend to invest more and use more variable inputs than farmers who do not insure. To the extent that farmers are not risk neutral, insurance will reduce their aversion to risk and stimulate production**

■ **The parameter estimate representing risk (i.e., the coefficient of variation of lagged sales per hectare) suggests that an increase in risk levels is accompanied by a decrease in both types of investments. Moreover, farmers also try to minimize variable input use when uncertainty increases.**

■ **An increase in input index price for plant protection products and pesticides yields a decrease in both investment and the demand for variable inputs and an increase in oilseed and protein crop prices is found to motivate investment in buildings and land improvements**

6. Concluding remarks

🔹 **PD payments are found to increase short-run production by increasing variable input use.**

🔹 **An increase in PD area payments is also found to generate a statically significant increase in the investment in farm assets.**

🔹 **In this context, the results demonstrate that this support scheme is found to increase long-run production.**

🔹 **Results also show the importance of assessing the effects of PD payments in a dynamic framework as the one applied in this paper.**

6. Concluding remarks

🔹 **Moreover, PD payments are shown, in some cases, to be more relevant than market prices in influencing investment demand.**

🔹 **Apart from PD payments, other variables are found to influence investment decisions. These include crop insurance contracting, tenure regime of land, farmers' age, input and output prices, as well as risk.**

🔹 **Results demonstrate that farmers' land allocation decisions mainly depend on market prices for both inputs and outputs. Also subsidies, labor input use and farmer age are shown to be important variables in explaining production decisions.**