Modelling the impact of post-2006 agricultural policy scenarios on farm behaviour: The case of arable farms in France and Italy

Davide Viaggi [a], Meri Raggi [a], Sergio Gomez y Paloma [b], Laure Latruffe [c,d], Yann Desjeux [c,d]

[a] University of Bologna, Viale Fanin, 50, 40127 Bologna
[b] IPTS, c/ Inca Garcilaso, s/n. E-41092 Seville
[c] INRA, UMR1302 SMART, F-35000 Rennes
[d] Agrocampus, UMR1302 SMART, F-35000 Rennes

Corresponding author
Laure Latruffe, INRA, UMR SMART, 4 allée Bobierre, CS61103, 35011 Rennes Cedex
(Laure.Latruffe@rennes.inra.fr)

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Abstract
The objective of the paper is to model the effects of several policy and price scenarios between 2006 and 2021 on a few French and Italian arable farm households. It uses a multi-criteria dynamic programming model of farm households, calibrated on primary data from a survey of single farms through a questionnaire. Simulation results show that, as expected, reducing or cutting payments from 2013 onwards (Scenarios 3) have a stronger negative impact on farming activities than maintaining the payments does (Scenarios 2). However, a reduction in payments has a less pronounced impact on income from farming than a decrease in prices does. But a combination of price decrease and payment reduction may lead to abandonment by some farms. Results also highlight that adaptation of farm activities is more important than investment as a reaction to both policy and price changes.

Keywords
Common Agricultural Policy, scenarios, mathematical programming, arable farms, France, Italy

JEL classification
Q18; C61

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1. Introduction and objectives

The Common Agricultural Policy (CAP) in the European Union (EU) has been subject to continuous changes since the 80es. The CAP reforms accelerated since 1992 with the introduction of a degree of decoupling between CAP subsidies and production, this degree increasing over the past three reforms: the 1992 MacSharry reform, the Agenda 2000 reform, and the 2003 Luxemburg reform which saw the introduction of a new instrument, the Single Farm Payment (SFP). The future of the CAP is still unsure post 2013, with a Health Check currently undertaken by the Commission. Several scenarios may be envisaged, such as a continuation of decoupling, a reduction in the level of payments, a shift from production subsidies towards rural development subsidies, or even a total cut in the payments received by farmers.

Research is constantly undertaken about the impact of several policy scenarios on the European agriculture, in order to support decision-making regarding the policy adjustments. However, past simulations generally stopped at the 2013 horizon when the CAP is supposed to be reformed again. By contrast, this paper considers a longer time horizon, 2021. The objective of this study is to assess how French and Italian arable farmers may react to various long-term policy scenarios from 2006 onwards, comparing with a hypothetical continuation of Agenda 2000. The scenarios introduce different policy parameters but also different assumptions on price development.

Arable farms have been chosen in this study because previous research has commonly shown that the crop sector is the most affected by continuous reforms of the CAP. France and Italy are interesting case studies to compare because their agricultural conditions are different, but their policies are similar: both countries opted for a similar SFP scheme within the 2003 Luxemburg reform, namely a SFP based on a reference period (the historical model), and the maintenance of partial coupling for several aids. The paper simulates the effect of different scenarios with a multi-criteria dynamic programme, calibrated for eight farms based on data collected from a questionnaire.

The paper is structured as follows. The next section, Section 2, presents the literature review for the two countries studied. In section 3 the methodology is explained, while the description of the farms used in the modelling exercise is given in Section 4. Section 5 explains the results, while Section 6 concludes.

2. Previous forecast studies in France and in Italy

At the sectoral level

In the frame of the FP6 IDEMA project, Balkhausen and Banse (2007) apply a partial equilibrium analysis (ESIM model) in several European Union (EU) countries over the period 2004-2013 under three scenarios: a continuation of Agenda 2000, the actual implementation of

the 2003 CAP reform, a full decoupling of SFP (removal of partial coupled premiums), and a bond scheme (decoupled payments not linked to land but to farmer). In France and Italy, compared to a hypothetical continuation of Agenda 2000, the actual 2003 CAP implementation reduces cereal, oilseed and sheep production, but increases fodder and pasture areas (and beef production for France). A full decoupling scenario has similar effects, but stronger; the exception is a decrease of beef production under this scenario in France and a weaker negative effect for livestock in Italy. Finally, regarding the bond scheme as compared to the 2003 CAP implementation, there is a strong negative effect on all productions, except for livestock in Italy.

The INRA foresight study "Agriculture 2013" apply three scenarios, based on CAP characteristics and world conditions, in France for the period 2006-2013 (Guyomard et al., 2008). The scenarios include either the maintenance of the CAP as implemented after the 2003 reform or a further reform including a reduction by 35% in first-pillar aids combined with full decoupling. This is associated with alternative hypotheses concerning economic growth, biofuel issues and international trade regulations. Maintenance of the CAP combined with a slowdown of economic growth (the "walk" scenario) penalise most dairy, beef, lamb, cereal, oilseed and sugar sectors (in terms of production, price and income). However, the negative consequences are attenuated for crop productions in the case of biofuel development. A further CAP reform associated with maintenance of economic growth (the "trot" scenario) negatively affects farm income in all sectors, but negatively affects production of sugar and meat. Again, biofuel development mitigates production reduction in the crop sectors. Finally, when a further CAP reform is associated with the acceleration of economic growth and the development of biofuels (the "gallop" scenario), crop productions increase, while dairy production stagnates and meat production decreases, and only income in the cereal and oilseed sector is positively affected. The main conclusion of the analysis is that agriculture as a whole is positively affected by world economic growth, cereal and oilseed production is positively impacted by biofuel development, and animal production is negatively affected by a further CAP reform. In addition, the analysis underlines the importance of subsidies in equilibrating the European market for sugar and dairy products.

At the regional level

Lobianco and Esposti (2006) and Sahrbacher et al. (2007), in the frame of the FP6 IDEMA project, apply an agent-based dynamic model (AgriPoliS model) to several regions in Europe, the western region Brittany in France, the central Italian region Colli Esini, and the southern Italian region Piana di Sibari. The scenarios applied over the period 2004-2013 are: a continuing Agenda 2000, the 2003 CAP reform as implemented in each region, a full decoupling of SFP (removal of all partially coupled premiums), and a bond scheme. All scenarios except the continuing Agenda 2000 assume an increase of prices depending on the productions (between 3 and 9%). In Brittany, compared to a hypothetical continuation of Agenda 2000, the implementation of the 2003 CAP reform as well as a scenario of full decoupling of SFP attenuates the decrease in the number of farms and the increase in the average farm size; they also enable a higher farm profit (Sahrbacher et al., 2007). By contrast, a bond scheme scenario has a stronger negative impact on the number of farms, but keeps similar farm profits (compared to 2003 CAP reform). In Italy, the same slightly decreasing trend is observed for the number of farms under continuing Agenda 2000 and actual 2003 CAP implementation, while the bond scheme scenario results in a sharp decrease (Lobianco and Esposti, 2006). As for farm profit, it

decreases more strongly under the 2003 CAP reform than under continuing Agenda 2000, and even more sharply under the bond scheme scenario.

Blanco et al. (2008) analyse the impact of the 2003 CAP reform at the level of irrigation board, in an area of Central Italy. A comparison of the actual crop mix before and after the reform highlights a sharp reduction of common and durum wheat, accompanied by a shift towards more water intensive crops, such as vegetables. When coming to simulations, however, the paper emphasises also the (sometimes strongly) different results across different modelling approaches.

At the farm level

Chatellier and Delattre (2005) predict that the effect of the 2003 CAP reform for French farms would be a mitigation of land abandonment in mountainous areas due to the maintenance of partial coupling. The authors surveyed ten farmers in the French Alps, whose intentions corroborated the scenario results.

Within the IDEMA project, a survey to farmers was additionally undertaken (Douarin et al., 2007), in several EU countries including France. Respondents in this country declared that they did not intend to change their behaviour during the period 2005-2010 under the actual 2003 CAP reform and under full SFP decoupling, compared to hypothetical continuing Agenda 2000. They intended to exit the farming sector or enlarge their farm area as they would have done without the CAP reform. They, however, intended to reduce their crop production.

Bougherara and Latruffe (2007) carry out an intentions survey to landowners, operating land or not, in 2006 in France to investigate whether the 2003 CAP reform provides incentives to French landowners to idle land previously under production and to maintain it in Good Agricultural and Environmental Condition (GAEC) in order to receive the SFP. Both landowners operating land and non-operator landowners were shown to be equally uninterested in GAEC.

Arfini et al. (2008) propose a simulation of the effects of the 2003 CAP reform on a sample of farms in Northern Italy, using a Positive Mathematical Programming (PMP) approach. The research emphasises the differentiation of the results across farms with different characteristics, as well as the importance of product chain relationships as both determinant of farm reaction and vehicle for transmission of policy effects downstream.

Summary

In general, all studies tend to show that continuous reforms of the CAP may lead to a reduction of the crop production, to a reduction of the reliance on subsidies and thus an increase or decrease of farm welfare depending on the world conditions (economic growth, prices), but to small structural adjustments. Additionally, analyses show differentiated responses between France and Italy, for example Italian farmers being more affected in terms of profit.

3. Methodology

3.1 The mathematical programming model

The scenarios

In this study six scenarios have been designed, differentiated on the basis of three variables: i) the amount of public payments; ii) the mechanism of payments (coupled vs. decoupled); iii) the market prices of agricultural products. The time horizon of the model is 2021. The six scenarios implemented in the model are described in Table 1.

Table 1 – Description of the six scenarios used in the modelling

Scenarios		*Description*	
Code	*Name*	*CAP*	*Prices*
1.	Baseline 1	Agenda 2000	Current prices [a]
2.1	Decoupling 1	2003 reform	Current prices [a]
2.2	Decoupling 2	2003 reform	Lower prices (-20%, WTO scenario)
3.1	Payment cut 1	2003 reform up to 2013 No payments after 2013	Current prices [a]
3.2	Payment cut 2	2003 reform up to 2013 Gradual reduction of the payments after 2013	Current prices [a]
3.3	Payment cut 3	2003 reform up to 2013 Gradual reduction of the payments after 2013	Lower prices (-20%, WTO scenario)

[a] Current prices means prices prevailing at the time of the survey, that is to say in 2006.

Scenario 1 represents the baseline used as a reference to assess the impact of decoupling and alternative scenarios. It represents the hypothesis of maintaining the Agenda 2000 conditions (last year of application) up to the end of the time horizon (i.e. in 2030). Nevertheless, it is supposed that payments have been reduced by 10% starting in 2006 due to financial discipline. Prices are assumed to be the ones at the time of the survey (i.e. in 2006) and to undergo no change till the end of the time horizon.

Scenario 2.1 is meant to capture the impact of decoupling: it assumes the present decoupled policy in France following the 2003 CAP reform, keeping it up to the end of the time horizon. In both countries the reform introduces decoupled payments, the SFP, that can be activated with eligible areas but without the obligation to produce. Farmers may receive them by simply keeping their land under GAEC. In France, besides SFP farmers may still receive coupled aids, for crops (25% coupling), beef livestock (100% coupling for suckler cows and calves slaughter premium, 40% for cow, bull and heifer slaughter premium) and other livestock (50% for sheep and goat). In Italy, crops were 100% decoupled, but coupled payments remained for livestock (like in France) and durum wheat (40%). Scenario 2.2 illustrates the impact of the decoupling policy as described in Scenario 2.1, but associated with possible lower prices of agricultural products due to WTO negotiations. In the absence of more accurate estimates, the price reduction has been set to 20%, assumed to be a reasonable range of change during the time horizon.

The three scenarios described above assume for the period 2013-2021 the continuation of payments as they were before 2013 (either area based as in scenario 1, or decoupled as in scenarios 2). By contrast, scenarios 3.1, 3.2 and 3.3 formulate different hypotheses on what will happen after 2013. Scenario 3.1 considers the extreme hypothesis that there will be no more direct payments or support, while scenario 3.2 assumes a gradual reduction of payments. This latter hypothesis is associated with lower market prices in scenario 3.3. The proposed gradual reduction of payments after 2013 is calculated as a linear reduction that reaches zero in 2020. This is consistent with the duration of current reforms and it ends the payments at a date that has been used in other modelling exercises (e.g. Scenar, 2020).
All other policy parameters (set-aside prescriptions, production quotas, rural development policies, rules for eligibility to SFP) are assumed to be constant across scenarios. Local conditions (e.g. labour opportunities and costs, other factor prices) are also kept constant across scenarios, as well as technology. We consider real prices only (i.e. no inflation is accounted for).

The model

The model used is a multi-criteria dynamic programming model of the farm household. The choice was motivated by the following considerations.
- An optimization (programming) model was preferred to the econometric approach, because it enables to simulate future farm behaviour, as well as to accommodate farm activities, farm resources and financial constraints with great detail and technical connections.
- A dynamic model is necessary in order to account for investment. A non-linear specification of the model is preferable to prevent the model from generating extreme unrealistic solutions and to allow for greater flexibility.
- We consider that farm households take into account several criteria in their decision making, and not only simple profit maximization. For this reason we use an approach that can accommodate multiple criteria (e.g. consumption, household worth). As stressed by several authors, farmers pursue various objectives, and thus, modelling farmers' decision-making with pure economic rationality may give good aggregate results but may hide the variability of individual responses (e.g. Gasson, 1973; Harper and Eastman, 1980; Shucksmith and Herrmann, 2002). Despite this, relatively few papers use multi-criteria analysis in combination with multi-period planning (e.g. Romero and Rehman 1983; Wallace and Moss 2002).

The underlying theoretical model is a multi-criteria household-level decision-making model. The farm household is considered to maximize a utility function defined as a combination of multiple criteria, each defined as a function of a set of decision variables. The maximization is subject to constraints on decision variables, represented by the feasible set and by non-negativity constraints. The general structure of the model is given by equations (1) to (3).

$$\text{Max } Z(x) = F\left[z_1(x), z_2(x), ..., z_q(x), ..., z_Q(x)\right] \quad (1)$$

subject to

$$x \in X \quad (2)$$

$$x > 0 \quad (3)$$

where Z is the objective function; z_q is the value of the objective q; X is the feasible set; x is a vector of decision variables.

Empirically, a simple multi-criteria objective function is used, as in Romero and Rehman (2003):

$$\text{Max } Z = \sum_{q=1}^{Q} \omega_q z_q \quad (4)$$

where Z is the objective function; z_q is the value of the objective q; ω_q is the weight of the objective q.

Constraints deal with capital (accumulation, depreciation, investment), liquidity (credit, savings, consumption), labour (external, on-farm by the household, off-farm by the household) and payments. To avoid unrealistic increases of farms' size, the possibility of expansion of the farm is allowed only when land purchase was already planned by the farmers (information collected through the survey). Household labour has been attributed a different opportunity cost across respondents, depending on the off-farming salary stated by the respondents. This is a widely used solution in linear programming models (e.g. Hazell and Norton, 1986; Hillier and Lieberman, 2005).

The MPM used here is a recursive dynamic multi-objective model. It is firstly solved as fully dynamic model for a "short" time horizon (n = 8 years). Then, the choices for year 1 are kept fixed and the model is solved again for the horizon from time 1+1 to n+1. The procedure continues in the same way, moving ahead 1 year at each step, and keeping fixed, after each run, the results of the initial year of that planning period. The procedure continues until the initial time is equal to m, which is the number of years for which one wants to generate results from the model. In our case the model is run till m = 18, i.e. 2023, with final year 2030. This period appears to be long enough to assess the profitability of most investments. Results will be given as averages of two shorter periods: 2006-2013 (the present programming period of the CAP) and 2014-2021.

3.2 The survey

The model was applied to a few farms, whose data were collected during an extensive survey in summer-autumn 2006. The French case-study area is around the town Chartres in the French NUTS3 region "Eure-et-Loir" (in the NUTS2 region "Centre"), located on the southern-west border of Paris. This area is very agricultural-based: the share of utilised agricultural area in the total area of this NUTS3 region is 76.5%, compared to about 57% in France. The geographical name of the area is "Beauce", and it is nicknamed the "wheat loft of France". This is due to its favourable climatic and geographical conditions that make it an ideal area for cereal production, in particular soft wheat. Beauce is a flat, fertile, treeless limestone plain that is planted mainly with wheat and sugar beets. 59% of the arable area of the NUTS3 region is allocated to cereals, 36% being for soft wheat. The Italian case study is the NUTS2 Region "Emilia Romagna". It is a complex region, covering more than 22 thousand square kilometres (around 7.3% of Italian national surface), among which 60% is used for agricultural activities. The southern part of the region is characterised by hills and mountains, while the northern part is totally plain, placed on the southern side of the River Po. Most of the plain is characterised by high fertility and important agricultural potentialities. The hilly and mountain area is very relevant as a place for recreational use of land. Among the 9 NUTS3 regions (Provinces) of "Emilia Romagna", farms are from three of them: "Bologna", "Ferrara" and "Ravenna". Arable crop production in the area is mixed with fruit and vegetables. In addition, there is a strong interaction of agricultural areas with urban areas.

A questionnaire was designed to collect data about the farm and the household, their perspectives, their intended investment behaviour and their intended reaction to policy changes. It was also aimed at collecting technical and economic information on production processes, in order to feed the models. The structure of the questionnaire included the following chapters: 1) Location and contact details; 2) Farm structure (legal type, owned land, specialisation, etc); 3) Household structure and labour management; 4) Farm activities and production; 5) Farm organisation, constraints and connections (crop rotations, main constraints to the activities, production contracts, indebtedness, etc); 6) Policy and decoupling; 7) Farm household assets and past investments/disinvestments; 8) Vision of the future and expectations (regarding policies, prices, etc); 9) Household wealth status and objectives; 10) Foreseen household and farm developments; 11) Activity-related details (yield, use of fertiliser and pesticides, cost of production, etc).
Chapter 6) on policy and decoupling collected information about the household's reaction to decoupling, in particular the number and amount of the SFP received and its use, the type and amount of other payments received (e.g. rural development payments, national or local subsidies) and their use, and what were the current or expected changes in the farm/household as a reaction to the introduction of the SFP.
The household objectives necessary for the multi-criteria function of the model have been collected through the questionnaire's chapter 9). A list of potential household objectives (e.g. consumption level, leisure, household wealth) was proposed. The weights used in the model are then derived from the ranking of objectives given by the household, using the rank reciprocal formula (Wallace and Moss, 2002).

Secondary data were used when necessary, coming from several sources. In France, data about production cost were provided by the Cost of Production Model at the French Ministry of Agriculture, and labour uses depending on the type of production were estimated based on agricultural science books and expert opinions. In Italy, FADN was the main source of economic data (revenues, costs) and were complemented with labour coefficients available from the local technical literature (e.g. published reports on production costs).

4. Case study farms

Four farms in each country were used for modelling. Table 2 gives some descriptive characteristics for the eight farms, all of them family-run. Within both countries there are large differences in terms of size, ranging from 40 (FR 3) to 240 hectares (FR 2) in France, and from 24 (IT 3) to 324 hectares (IT 4) in Italy. In France, the three large farms have a very strong reliance on subsidies with an SFP to income ratio of more than 140 percent, while the smallest farm has less than one third of its income stemming from subsidies (ratio of 30 percent). In Italy, for all farms the figures are in the range of 30 to 60 percent. The debt to asset ratio was high for one of the French farms (FR 4), while information on it could not be obtained for the other cases. For the purposes of the modelling exercise, this has been assumed to be zero. The smallest French (FR 3) and Italian (IT 3) farms do not use external labour; in all farms but one (the smallest Italian farm) at least one member of the household works off farm.

Table 2 – Summary statistics of the farms modelled

France	Farm FR 1	Farm FR 2	Farm FR 3	Farm FR 4
Number of household members	5	5	5	3
Head farmer's age	47	55	54	37
Total land (ha)	116	240	40	153
Share of rented land (%)	88	100	55	93
Use of external labour	Yes	Yes	no	Yes
Some member working off farm	Yes	Yes	Yes	Yes
Household's debt to asset ratio (%)	n.k.	n.k.	n.k.	45
Total household income (euros/ha) [a]	1,047	2,262	1,102	1,536
Share of income from farming (%) [a]	92	93	88	95
Total SFP amount (euros)	36,731	81,400	11,964	44,034
SFP to household income ratio	184	407	30	147
Number of SFP rights	116	220	39	142
Italy	Farm IT 1	Farm IT 2	Farm IT 3	Farm IT 4
Number of household members	3	5	3	2
Head farmer's age	44	45	47	61
Total land (ha)	123	110	24	324
Share of rented land (%)	86	41	100	0
Use of external labour	Yes	Yes	No	Yes
Some member working off farm	Yes	Yes	No	Yes
Household's debt to asset ratio (%)	10	3	17	1
Total household income (euros/ha) [a]	346	1,395	866	676
Share of income from farming (%) [a]	68	77	95	89
Total SFP amount (euros)	17,000	28,500	11,500	58,000
SFP to household income ratio	57	29	36	n.k.
Number of SFP rights	33	101	40	176

n.k.: not known.

[a] Figures used for the first period of the baseline scenario (Scenario 1).

French respondents indicated two main constraints to their farming activity: the little availability of land and the shortage of liquidity mainly due to high cost and low prices. This shortage constrains farmers in their credit reimbursement. The pressure on land is a major issue in the region surveyed, in particular because of expanding infrastructures. Farmers reported losing several hectares of their farm area every couple of years, and although expropriation is well financially compensated, this reduces their farm size. As for the household objectives, they clearly reveal different behaviours. FR 3 intends to provide for the needs of the household and to allow some leisure time. By contrast, FR 4's main objective is to keep a substantial household net worth by investing, while FR 2 and FR 3 have ranked first the issue of income certainty.

Italian respondents emphasized constraints due to poor market trends for agricultural products (they were just at the end of two years of low prices at the time of the survey). In addition, they highlighted labour and land availability constraints. The pressure for land is a key driver in the area as it is the case in the French case study area. All households chose the reduction of income uncertainty as first objective, meaning increasing the average income from farming and reducing uncertainty about future trends of the sector. Household worth is normally the second objective, except from Farm IT 3 that expressed the aim to reduce the farm's debt to asset ratio.

5. Simulation results

This section shows the simulation results brought by the multi-objective programming of the five scenarios on four indicators: income from farming, total household income, investment (in farm and non-farm assets), farm labour use. In addition, simulated changes in the main farming activities are discussed. The results for the scenarios in terms of income from farming (gross margin) and total household income are firstly reported in Table 3 and Table 4 respectively.

Decoupling as implemented by the 2003 CAP reform (Scenario 2.1) generally brings a reduction in income from farming, with the exception of farms FR 2 (the largest French), IT 1 and IT 3 (the smallest Italian) whose income increased (Table 3). A reduction in prices by 20% (Scenario 2.2) leads to a reduction in income from farming in the range of 20-30% for all farms. A total cut in payments in the period 2014-2021 (Scenario 3.1) leads to a sharp drop in income from farming during this period, up to -48% in France (FR 1 and FR 3) and to abandonment (i.e. -100% of farming income) for an Italian farm (IT 4, the largest Italian farm with the oldest farmer). This negative effect is attenuated in the case of a gradual reduction (Scenario 3.2). The concurrent reduction of prices and payments (Scenario 3.3) between 2014 and 2021, while bringing roughly no change in the first period as compared to a reduction of prices only (Scenario 2.2), leads to the worst effects for all farms in the second period. In general, a reduction in payments (e.g. Scenario 3.2 vs. 2.1) has a less pronounced impact on income from farming than a decrease in prices by 20% (e.g. Scenario 2.2 vs. 2.1). Regarding the effect on total household income, in France it is similar to the effect on income from farming, due to the low relevance of non-farming income, in spite of the fact that all households have some member working off farm (Table 4). In Italy, by contrast, the consequences of the scenarios are less pronounced on total income than on income from farming due to the reliance on off-farm work, except for IT 3 where no members work off-farm and for which the effects are similar.

Table 3 – Impact of the scenarios on income from farming of the farms modelled

	Farms	Scenario 2.1	Scenario 2.2	Scenario 3.1	Scenario 3.2	Scenario 3.3
France						
2006-2013	FR 1	-4%	-25%	-4%	-4%	-25%
	FR 2	1%	-21%	2%	2%	-22%
	FR 3	-9%	-30%	-9%	-9%	-30%
	FR 4	-7%	-30%	-8%	-7%	-30%
2014-2021	FR 1	2%	-20%	-48%	-30%	-52%
	FR 2	2%	-21%	-16%	-9%	-33%
	FR 3	-9%	-30%	-48%	-33%	-54%
	FR 4	-7%	-30%	-28%	-21%	-43%
Italy						
2006-2013	IT 1	22%	-20%	22%	22%	-45%
	IT 2	-12%	-37%	-12%	-12%	-37%
	IT 3	10%	-21%	10%	20%	-21%
	IT 4	-15%	-34%	-16%	-15%	-34%
2014-2013	IT 1	22%	-20%	-31%	-11%	-82%
	IT 2	-20%	-43%	-37%	-31%	-53%
	IT 3	13%	-20%	-8%	7%	-33%
	IT 4	-17%	-36%	-100%	-39%	-100%

Note: See Table 1 for a description of the scenarios 2.1 to 3.3. The reference scenario is continuing Agenda 2000.

Table 4 – Impact of the scenarios on total household income of the farms modelled

	Farms	Scenario 2.1	Scenario 2.2	Scenario 3.1	Scenario 3.2	Scenario 3.3
France						
2006-2013	FR 1	-4%	-25%	-4%	-5%	-25%
	FR 2	1%	-21%	1%	2%	-23%
	FR 3	-8%	-28%	-8%	-8%	-28%
	FR 4	-8%	-31%	-8%	-8%	-31%
2014-2021	FR 1	0%	-23%	-44%	-28%	-50%
	FR 2	2%	-21%	-14%	-8%	-33%
	FR 3	-9%	-30%	-43%	-30%	-51%
	FR 4	-8%	-31%	-26%	-19%	-43%
Italy						
2006-2013	IT 1	16%	-14%	16%	16%	-20%
	IT 2	-5%	-25%	-5%	-5%	-25%
	IT 3	10%	-21%	10%	19%	-21%
	IT 4	-3%	-19%	-4%	-3%	-20%
2014-2013	IT 1	17%	-14%	-18%	-4%	-41%
	IT 2	-9%	-30%	-22%	-17%	-38%
	IT 3	14%	-22%	-6%	7%	-34%
	IT 4	-3%	-19%	-47%	-20%	-49%

Note: See Table 1 for a description of the scenarios 2.1 to 3.3. The reference scenario is continuing Agenda 2000.

As presented in Table 5, in the first period the scenarios generally lead to no relevant changes in investment for French farms with the exception of a decrease in investment by FR 2, the largest and positively indebted farm. In the second period (2014-2021), not only FR 2 but also FR 1 are negatively affected, though for both at least one price reduction scenario (Scenario 2.2 or Scenario 3.3) leads to an increase in investment. This is to be interpreted as a situation in which farms need to adapt asset endowment in order to minimise losses in the adverse situation (and not, of course, as driven by increased profitability). In Italy, farm IT 4 (the largest in Italy but with the oldest farmer) is the most affected by all scenarios in terms of investment, while farm IT 3 manages to increase its investment in the second period under all scenarios.

Table 6 displays the effect of the scenarios on labour use on the farms. In France labour is stable, with the exception of FR 3 (which uses no external labour) on which it decreases slightly, and FR 1 which showed an increase in the second period. Changes are more visible for Italian farms. They generally follow the downwards trends of income from farming, with abandonment by farm IT 4 (i.e. -100% in labour use) in the case of total payment cut, or reduction of payments accompanied by lower prices (Scenarios 3.1 and 3.3).

Table 5 – Impact of the scenarios on total investment of the farms modelled

	Farms	Scenario 2.1	Scenario 2.2	Scenario 3.1	Scenario 3.2	Scenario 3.3
France						
2006-2013	FR 1	0%	0%	0%	-6%	-6%
	FR 2	-17%	-26%	-21%	-33%	-799%
	FR 3	0%	0%	0%	0%	0%
	FR 4	0%	0%	0%	0%	0%
2014-2021	FR 1	-378%	-378%	-378%	-368%	25%
	FR 2	-11%	6%	-16%	-10%	-303%
	FR 3	0%	0%	0%	0%	0%
	FR 4	0%	-2%	-2%	-2%	-2%
Italy						
2006-2013	IT 1	0%	2%	0%	0%	1,154%
	IT 2	-127%	-127%	-127%	-127%	-127%
	IT 3	0%	-2%	-4%	-120%	0%
	IT 4	-3,533%	-4,423%	-15,191%	-3,675%	-15,237%
2014-2013	IT 1	0%	-15%	0%	0%	-114%
	IT 2	-40%	-40%	-40%	-40%	-40%
	IT 3	96%	38%	93%	66%	42%
	IT 4	-112%	28%	-114%	-119%	-100%

Note: See Table 1 for a description of the scenarios 2.1 to 3.3. The reference scenario is continuing Agenda 2000.

Table 6 – Impact of the scenarios on labour use by the farms modelled

	Farms	Scenario 2.1	Scenario 2.2	Scenario 3.1	Scenario 3.2	Scenario 3.3
France						
2006-2013	FR 1	0%	0%	0%	0%	0%
	FR 2	0%	0%	0%	0%	-3%
	FR 3	0%	-2%	0%	0%	-2%
	FR 4	0%	0%	0%	0%	0%
2014-2021	FR 1	14%	14%	10%	10%	0%
	FR 2	0%	0%	0%	0%	-5%
	FR 3	0%	-2%	0%	0%	-2%
	FR 4	0%	0%	0%	0%	0%
Italy						
2006-2013	IT 1	1%	-70%	1%	1%	-70%
	IT 2	-15%	-15%	-15%	-15%	-15%
	IT 3	-6%	-11%	-4%	-4%	-11%
	IT 4	-26%	-29%	-27%	-26%	-29%
2014-2013	IT 1	1%	-70%	1%	1%	-81%
	IT 2	-24%	-24%	-24%	-24%	-24%
	IT 3	-2%	-10%	-1%	0%	-10%
	IT 4	-29%	-33%	-100%	-29%	-100%

Note: See Table 1 for a description of the scenarios 2.1 to 3.3. The reference scenario is continuing Agenda 2000.

Changes in the production mix of the farms under the various scenarios are reported in Table 7. Regarding French farms, decoupling (Scenario 2.1) brings no short-run change in the production carried on by the farms. The changes due to other scenarios appear negligible, except for the increase of maize and the decrease of rapeseed when all prices decrease by 20% (Scenarios 2.2 and 3.3). It seems that French farms do not have major alternatives in terms of crop choices, and the present crop mix already responded to a reasonable differentiation. The main adjustment

could be the adoption of some voluntary set-aside, though in practice this may be uncommon: all four French respondents indicated that they did not intend to follow this adjustment in the future. In Italy decoupling brings an increase in alfalfa and forage and a reduction in wheat (Scenario 2.1). A price reduction decreases further wheat but also causes a drop in alfalfa and forage products (Scenarios 2.2 and 3.3). Set-aside is a more frequent option for the Italian farms than for the French farms, except in the scenarios with a price decrease.

Table 7 – Impact of the scenarios on selected productions on the farms modelled

	Productions	Scenario 2.1	Scenario 2.2	Scenario 3.1	Scenario 3.2	Scenario 3.3
France						
2006-2013	Maize	0%	47%	0%	0%	47%
	Rapeseed	0%	-15%	-1%	0%	-15%
	Set-aside	0%	0%	0%	0%	0%
	Sugar beet	0%	0%	0%	0%	0%
	Wheat (durum)	0%	0%	0%	0%	0%
	Wheat (soft)	0%	0%	0%	0%	0%
2014-2021	Maize	0%	52%	0%	0%	52%
	Rapeseed	4%	-12%	4%	4%	-16%
	Set-aside	-25%	-25%	-25%	-25%	-26%
	Sugar beet	0%	0%	0%	0%	0%
	Wheat (durum)	0%	0%	0%	0%	0%
	Wheat (soft)	1%	1%	0%	0%	0%
Italy						
2006-2013	Alfalfa	34%	-27%	43%	39%	-27%
	Forage	60%	-49%	68%	60%	-49%
	Maize	0%	0%	0%	0%	0%
	Set-aside	12%	-44%	12%	12%	-44%
	Sugar beet	0%	0%	0%	0%	0%
	Wheat	-43%	-52%	-44%	-45%	-52%
2014-2013	Alfalfa	59%	-22%	55%	54%	-33%
	Forage	83%	-40%	70%	60%	-62%
	Maize	0%	0%	0%	0%	0%
	Sugar beet	0%	0%	0%	0%	0%
	Wheat	-46%	-59%	-49%	-53%	-62%

Note: See Table 1 for a description of the scenarios 2.1 to 3.3. The reference scenario is continuing Agenda 2000.

6. Conclusion

This paper used a multi-criteria dynamic programming model of farm households, calibrated on primary data from a survey of single farms through a questionnaire. The objective was to model the effects of different policy and price scenarios between 2006 and 2021 on a few French and Italian arable farm households. Although only eight models were built, related each to an individual farm, the results give valuable insights into farms' adjustment capacity to changes. In fact, given the number of farms considered, average results cannot be expected to be statistically representative of whole areas. However, results for individual farm-households allow a deeper understanding of the mechanisms of change and allow to account for the variability of effects across different farms.

Simulation results show that decoupling produces minor changes in this already very payment-dependent farming systems. As expected, reducing or cutting payments from 2013 onwards (Scenarios 3) have a stronger negative impact on farming activities than maintaining the payments does (Scenarios 2). However, a reduction in payments has a less pronounced impact on income from farming than a decrease in prices does. A combination of price decrease and payment reduction would produce the most serious impact and may lead to abandonment by some farms.

The scenarios' results show that CAP is important for the sustainability of farming systems, but prices appeared to be more important than policy (at least with the present levels of payments and prices). The findings also highlight that adaptation of farm activities is more pronounced than investment as a reaction to both policy and price changes. This is confirmed by the results from the survey attached to the data collection for modelling, where farmers stated that they were rather indifferent to the continuous decoupling, but placed more importance on input and output prices.

The study also allows underline that the impact of policy changes is highly differentiated depending on several farm parameters, such as off-farm employment, the use of external labour or indebtedness, and, what is more important, in relation to the general strategic orientation of the farm. This point is emphasised by the fact that decoupling can have opposite income effects in different farms. Such aspects thus need to be taken into account when designing new policies. In particular, further decoupling of residual coupled payments, regionalisation or, more important, shifting of funds from the first to the second pillar would be non-neutral with respect to different farm types, even within the same farming system.

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