The impact of the Single Farm Payments on the Expenditure on Fertilizers and crop protection inputs: a comparative study of the Italian agriculture

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The Health Check (*HC*) *of the European Common Agricultural Policy in 2003 sped up the process of policy reforms toward decoupled payments in order to urge agricultural production to respond to market signals. However, since decoupled payments could generate "coupled" effects on production, it remains questionable how single farm payment* (*SFP*) *alters agricultural intensification. Therefore, through a comparative statistical analysis applied on Italian FADN regional data, this paper aims at evaluating whether the HC reform had positive impacts on the aggregate expenditure on fertilizers and crop production inputs. From the results, it is observed that the expansion of profitable crops like vegetables, flowers and vineyards, along with the receipt of SFP increased the expenditure of fertilizers and crop protection inputs. Such findings suggest that the HC reform has been so far effective in terms of aligning agricultural production to markets' signals, but with the unintended consequence of higher intensification. We deduce that farmers may allocate higher proportions of SFP to purchase fertilizers and crop protection inputs whenever the opportunity of higher profits is found in those cropping activities requiring a higher intensive use of production' factors.*

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Introduction

In 2003 the European Union finalized the reform process of the Common Agricultural Policy (CAP), started in 1992 with the MacSharry reform, by eliminating the supports coupled to production as the primary source of subsidies for farmers. The Health Check (HC) reform approved in 2003 established the introduction of the Single Farm Payment (SFP) which represents a policy solution for accomplishing the external objective of compliance to WTO rules and the internal objectives of economic and environmental sustainability of the agricultural sector along with the reduction of the CAP budget. SFP is a form of income support that is decoupled from production, such that farmers are encouraged to adjust their production decisions according to markets' signals.

As such, the SFP falls within the policy measures categorized by the WTO as "green box" and allows the European Union to comply with international trade agreements. However, payments unlinked to production can potentially generate some allocative or "coupled" effects determined by preexisting conditions in the agricultural sector (Bhaskar and Beghin, 2007). For instance, SFP can reduce the risk aversion of farmers, by the wealth and revenue insurance effects, and increase liquidity to credit-constrained farmers; SFP can be capitalized by increasing both land and rent values; it can remarkably affect on- and off-farm labor allocation, production expectations and investment decisions (Bhaskar and Beghin, 2007). Therefore, doubts still remain about to what extent the introduction of SFP represents a net separation from the previous

system of direct supports, especially for Italy in which the SFP has been implemented according to the reference (historical) method[2](Picchi, 2005).

Recent studies on this topic have mainly focused on the effects of the introduction of decoupled payments on acreage allocation across crops, land values and off- versus on-farm labor allocation. Minor attention, instead, has been given to the potential effect that the introduction of the SFP might have on the use of external inputs of production and the eventual impact on agricultural intensification, that is, the excessive use of fertilizers and crop protection inputs applied to maximize agricultural production.

Based on Picchi (2005), we suppose that the post-reform SFP scheme and the pre-reform support system will have coherent effects on the agricultural intensification in Italy.

To test such hypothesis, we analyze the impacts of the 2003 HC reform on agricultural intensification using regional data from the Italian Farm Accounting Data Network (FADN). The analysis is performed by comparing the effects of coupled payments during the pre-reform period (2000-2002) to the effects of SFP during the post-reform period (2005-2007) on the expenditure on fertilizers and crop protection inputs, taking into account the realized changes in land use and farms' size implied by the alignment of agricultural production to market signals.

Policy background

Member States had the choice to implement the SFP within the period 2005-2007 according to three different methods, that is, the reference (historical), the regional (flat rates) or the mixed (hybrid) method, depending on the specific needs of the agricultural sector in each country.

[2] See the chapter on policy background for detail information about the implementation choices.

However, if State governments considered the implementation of the SFP scheme too risky for their farmers or for the agricultural sector, they had the option to maintain a certain level of coupled direct supports for specific agricultural activities. Such option is called partial decoupling and the reasons to opt for it can be found in the high instability of specific markets or in the risk of abandonment of agricultural land. The implementation of the SFP along with partial decoupling delineates different and uncertain scenarios with regard to the effectiveness of the HC reform across the European Union (Comegna, 2005).

In Italy the implementation of the new policy regime has been processed according to the reference (historical) method without partial decoupling. The reference (historical) method grants farmers a SFP equal to the amount of coupled subsidies received on average during 2000-2002 and, hence, it is likely to represent an extension of the previous system of direct supports (Picchi, 2005). Farmers subject to the reference (historical) method are allowed to grow all crops, including previously unsupported crops, except fruit, vegetables and ware potatoes.

The implementation through the reference method implies the preservation of pronounced regional differences across Italy in terms of both receipt of supports and production potentials (Kroll, 2008), which in turn can lead more profitable farms to respond better to market signals (Giacomini, 2005). In such a context, where the variability of farm income is reduced and the expectations about future production induces land allocation toward more remunerative crops (Frascarelli, 2005), there is the potential to observe in the future a higher level of agricultural intensification.

Literature Review

Although there is agreement on the realization of the desired shift toward a production responsive to market signals, the presented literature highlights that the empirical findings about the potential effects of the introduction of SFP on the level of agricultural intensification are not consistent.

Relevant findings about the "coupled" effects of decoupled payments on input use are exposed in Sierra *et al.* (2005) and Sierra *et al.* (2006). In a study conducted in 2005 on cereal, oilseed and protein crop (COP), Sierra *et al.* (2005) simulated that a policy shift of the CAP toward SFP would produce a reduction in the use of crop protection inputs (mainly pest control) by 11%, implied by a decrease in the acreage of cereals and by an increase in the acreage of oilseeds and protein crops. In a successive study on COP, Sierra *et al.* (2006) analyzed the effects of decoupled payments on the demand for fertilizers and crop protection inputs through the "coupled" wealth effect. Their findings show that the decoupled payments elasticity on both inputs was positive, but not statistically significant. Similar findings are presented by Henningsen *et al.* (2009) who analyzed the effects of both coupled and decoupled subsidies simultaneously by developing a theoretical microeconomic model that accounted for the endogeneity of production inputs. They showed that the direct effects of decoupled payments on the variability of production inputs (land, capital, fertilizers and crop protection) are null for grain producers in Norway.

Viaggi *et al.* (2009) evaluated the effects of the introduction of SFP on farm investments behavior, using survey data collected in Germany, Poland and Italy, by applying a correlation study between the elicited use of SFP and several categories of investments and expenditure on

external inputs. They found that large, more efficient and market oriented farms perceive the receipt of SFP as an opportunity to increase on-farm investments and agricultural intensification, while in small, less efficient and poorer farms the receipt of SFP is seen more as an opportunity for agricultural extensification, by adopting less intensive agricultural practices.

Along with "coupled" effects, the SFP implemented with the reference (historical) method can potentially be detrimental with respect to the income distribution across Italian farm households, by increasing the income inequality (Rocchi, 2009). The presence of such effects are supported by empirical studies affirming that, although facing a greater risk exposure to price variability, farmers received benefits from the insurance effects of direct decoupled payments, which provide a reduction in variability of income (Hennessy, 1998; Sckokai and Moro, 2006). Therefore, the entitlement to receive SFP will tend to favor more competitive farms which can readily respond to market signals and easily adjust the level of agricultural intensification accordingly.

Methodology

The purpose of the paper is to evaluate the impacts of the Health Check reform of 2003 on the level of agricultural intensification induced by changes in fertilizers and crop protection inputs' use, accounting for the observed land use and farms' size redistribution in Italy. Given that the period since the implementation of the SFP could be insufficient to fully capture the impacts of the policy reform (OECD, 2008), a comparison analysis between the pre-reform (2000-02) and post-reform (2005-07) periods will be conducted to determine the change of the effects of the two different support schemes on the expenditure on fertilizers and crop protection inputs.

Differently from previous studies, we employed two sets of statistical models to estimate the effects of SFP on expenditures on fertilizers and crop protection inputs. The first set involves a comparative OLS analysis between estimates of the pre-reform period and estimates of the post-reform period, based on year averages of the respective selected variables: $y_{pk} = \beta_p x_p + e$, where y and x are year averages for the pre-reform period when $p = 1$ and for the post-reform period when $p = 2$, while $k = 1$ represents expenditures on fertilizers and $k = 2$ expenditure on crop protection. The second set aims at comparing OLS estimates for each of the post-reform years to the OLS estimates of the pre-reform period: $y_{pk} = \beta_p x_p + e$, where p = 2005, 2006 and 2007 respectively. The regressions are performed separately on two dependent variables: expenditure on fertilizers and expenditure on crop protection inputs.

The regressors include two sets of control variables: the first set is employed to control for size, on-farm labor and expenditure on seeds and plants, while the second controls for changes in land allocation across crops. Accounting for changes in land use and farm size is essential in order to isolate the direct effects of SFP on agricultural intensification through input use. In fact, Frascarelli (2005), in discussing about the immediate impacts of the 2003 HC reform, highlighted how seeding intents have undergone remarkable changes from 2004 to 2005, especially in favor of crops that did not benefit or benefited in a limited proportion from previous direct payments. At the same time, Giacomini (2005) hypothesized a scenario of farming operational size and land redistribution according to which small farms would have exited the agricultural sector because of limited competitiveness. Moreover, Giacomini (2005) argued that the SFP entitled to small farms might not be even sufficient to keep their land idle, but that it would be more profitable for small farmers to rent their land out.

The key explanatory variables include coupled supports to production in the pre-reform models replaced by SFP in the post-reform models. The variable environmental payments is used in both models to account for cross-compliance. Indeed, all farmers entitled to receive SFP are subject to cross-compliance, which became compulsory in the aftermath of the HC reform in 2003. The cross-compliance requirement of the SFP program includes, beyond the respect of good agricultural and environmental conditions, new requirements about public, animal and plant health and about animal welfare.

The estimates of the post-reform models are then tested to check the statistical difference with respect to the pre-reform regression estimates. The same test is then performed to check the statistical difference between the estimates of the regressions for each of the post-reform years, such to perform an indirect test on the effects of modulation across years. In fact, the financial resources devoted to the SFP program have been reduced according to a "modulation" mechanism. Such reduction amounted to 3 % in 2005, 4 % in 2006 and 5 % from 2007 onwards and the resulting financial resources have been devoted to rural development measures.

Data and Models specification

In order to assess the impacts of the Health Check reform of the European CAP on the use of fertilizers and crop protection inputs in Italy, we used data from the European Farm Accountancy Data Network (FADN). In each Member State of the European Union the data are collected through annual surveys of representative farms. The sampling procedure of farms is planned at regional level and selection is based on the size of agricultural holdings such that the selected representative farms can be considered as commercial. The collected information is then harmonized in order to make the data from each region comparable to other regions within the

Union. Although the FADN consists of data at farm level, in this study we use representative data aggregated at regional level since they are directly available through the FADN website.

The sample includes data from 1999 to 2007 and the observation unit is a representative farm belonging to a class of European Size Unit[3] (ESU) for each of the 21 agricultural Italian regions. Therefore, considering that there are six classes of ESU, the sample potentially contains up to 126 observations for each year.

Since the analysis is focused on cropping activities, the sample excludes the regions Valle d'Aosta, Alto-Adige and Sardegna because of the high incidence of livestock activities on the representative farms in such regions. For the same reason, the sample does not include representative farms having more than 75% of total agricultural area utilized for forage cropping in the remaining regions. Prior to the HC reform, livestock farms were subject to a different and more complex system of supports whose effects on the expenditure on fertilizers and crop protection inputs are not the subject of our analyses. Therefore, the actual number of observations in our sample across years is less than 100. In addition, because of the wide heterogeneity of farms' size distribution across Italy, the number of observations can be even smaller because, for instance, some regions do not display representative farms of 1 ESU, while some others do not display representative farms of 6 ESU, and such heterogeneity can vary as well within each region across years.

Data on expenditure on fertilizers and crop protection inputs are used as dependent variables in the statistical analyses and are collected as part of the external cost section of the FADN surveys.

[3] Economic Size Unit refers to the measurement unit of the agricultural holdings' economic size: total standard gross margin expressed in ECU/EURO.

The variable *fertilizers* is defined as "purchased fertilizers and soil improvers (excluded those used for forests)", measured in current Euro. The variable *crop protection* accounts for expenditures on "Plant protection products, traps and baits, antihail shells, frost protection, etc. (excluding those used for forests)", measured in current Euro. To account for inflation, those variables are corrected by their respective domestic price indexes provided by the Economic Statistic database of the European Union (Table 1). The summary statistics, reported in Table 2, show that the average expenditure of fertilizers changed from €2791 (2000-02) to €3385 (2005-07) – an increase of 17% – and that the expenditure on crop protection inputs changed from €2186 (2000-02) to €3142 (2005-07) – an increase of 30%.

In order to quantify the magnitude of the changes in the expenditure of fertilizers and crop protection inputs due to the policy reform, the statistical models need to include explanatory variables that account for the potential shift toward market orientation, as expected by the introduction of the SFP scheme, as well as for the distortions induced by the coupled subsidies during the period 2000-02. For these reasons, two groups of variables have been selected: one group controls for the changes in cropping operational size, while the other accounts for changes in land use across the main cropping activities.

Based on Giacomini (2005), Sierra *et al.* (2005) and Viaggi *et al.* (2009), we assume that the observed changes in cropping operational size and land use are not a direct effect of the introduction of SFP, but rather they are the direct consequence of the elimination of the previous support system coupled to production. Such assumptions exclude from the model the issue of simultaneity between SFP and land allocation and allow for the estimation of the direct effects of

SFP on the expenditure on fertilizers and crop protection inputs which, based on the hypothesis of Picchi (2005), are expected to be positive.

In order to have a reliable control for size of cropping activities, the models include the explanatory variables *total crop production*, *total labor units* and *seeds and plants*. The variable *total crop production* is computed as the ratio of total crop production, in thousand of Euro, to total utilized agricultural area and it is measured in 000€/Ha. *total labor unit* is defined as "Total labor input of holding expressed in annual work units" and represents a measure of full-time person equivalents. The variable *seeds and plants* is defined as "expenditure on seeds and plants of agricultural and horticultural crops" and is measured in current Euro. From the summary statistics in Table 2 it is observed that, on average, during the period 2005-07 the total crop production per hectare has increased by 13%, total labor by 20% and expenditure on seeds and plants by 40% relative to the period 2000-02. Such statistics highlight a tendency toward the expansion of the operational size of the farms with the consequent potential increment in agricultural intensification. Therefore, we expect the variables controlling for operational size of cropping activities to have positive effects on the expenditure on fertilizers and crop protection inputs, especially *seeds and plants* which is the direct cause of the use of such inputs.

The variables selected to control for land use involve the shares of total utilized agricultural area, expressed in percentage, on *cereals* (wheat, barley, maize, etc.), *other field crops* (potatoes, sugar beets, industrial crops, etc.), *vegetables and flowers* (fresh vegetables, flowers and ornamental plants, etc.), *vineyards* (including young plantations) and *permanent crops* (fruits, berries and citrus orchards, olives, etc.). Major changes from the pre-reform period are observed in the share of land used for *other field crops*, in line with Frascarelli (2005) and Giacomini (2005), which,

because of the drastic reduction of the relative couple subsidies, dropped by almost 41% during 2005-07. Such reduction has been partially compensated by the shares of land used for *vegetable and flowers* and *vineyards*, which together account for an increase of about 20% in 2005-07. Although partially affected by the policy regimes, the share of land use for *permanent crops* dropped in the period 2005-07 by 13%[4]. Lastly, the share of land devoted to *cereals*, still highly subsidized during 2000-02 with respect to the other crops, has been reduced by 5%. However cereals still remain the group of the most cultivated among the considered crops in the selected regions, with an average share of 32% during 2005-07.

Although the selected variables on land use are assumed to be exogenous (shifters), deducing results' expectation from the models' specification is not possible. However, by the insights of Picchi (2005) and Giacomini (2005) some general expectations can be formulated, that is, that increased land shares devoted to more intensive crops could produce increments in expenditure on fertilizers and crop protection inputs.

The variables chosen for the direct assessment of the effects due to the policy reform are the receipts of coupled subsidies (on *crop production*) during the pre-reform period and the receipts of *single farm payment* during the post-reform period. Since during 2000-02 the participation in the agro-environmental program was voluntary and required the conformity to cross-compliance for five years, but during 2005-07 the receipt of the SFP is conditional on mandatory environmental cross-compliance, the models are controlled by the receipts of *environmental* subsidies in both pre- and post-reform periods. The average amount of SFP received by eligible

[4] Farmers growing vegetables and fruits crops during the new policy regime are not entitled to receive SFP. However, if the expected profitability of those crops offsets the loss of the SFP, farmers could decide to renounce to the entitlement.

farmers during 2005-07 (€8257) is slightly lower than the average amount of coupled payments during 2000-05 (€8457) as expected by the presence of the modulation mechanism, which implies a reduction of subsidies larger than €5000 per farm. According to the models' assumptions, it is expected for both coupled subsidies and SFP to show positive effects on the expenditure on fertilizers and crop protection inputs. The *environmental* subsidies enter the models with a one year lag in order to assess the impact on the expenditure on fertilizers and crop protection inputs should farmers exited the agro-environmental program, at least during 2000-02. Therefore, it is expected that the effects of *environmental* subsidies on the expenditure on fertilizers and crop production inputs are negative in the pre-policy period. Moreover, given the large reduction of about 40% in the amount of environmental payments received during 2005-07 and the obligation of environmental cross-compliance for preserving the entitlement to receive the SFP, it is expected that *environmental* subsidies lose effectiveness during the post-reform period in reducing the expenditure on fertilizers and crop protection inputs.

Results

The statistical comparison between the analyses on pre-reform period (2000-02) and the post-reform period (2005-07) highlights the changes in the impacts of the major subsidies on the expenditures on fertilizers and crop protection inputs, at aggregate regional level in Italy. The OLS analyses include control variables for size of cropping activities, labor, expenditures on seeds and plants and the percentage of land devoted to different cropping activities. The estimated changes are then discussed in more details by comparing the OLS analysis on year averages for the pre-reform period to OLS analyses for each single year in the post-reform period. Given the control variables, the results discussion focuses on the comparison between the

effects of coupled subsidies in the pre-reform period and the effects of decoupled SFP in the post-reform period.

Comparison of the OLS analyses on year averages

The statistical analyses on year averages reported in table 3 show that, with respect to the pre-reform period, *total crop production*, *total labor units* and *seeds and plants* have positive but lower effects on the expenditure on both fertilizers and crop protection inputs. Given the statistical difference between the coefficient estimates in the two periods, there is statistical evidence of a tendency toward the reduction of intensive cropping practices at the aggregate level. However, the redistribution of farmland across different crops over the two periods can potentially lead to more detailed and pronounced changes of the effects of each group of crops. In fact, given a slight reduction over time in their respective average shares of land use across regions, the statistical analyses show that the impacts of *cereals*, *other field crops* and *permanent crops* on the expenditure on fertilizers and crop protection inputs remain on average unchanged. Further, an increase is observed in the effects of land shares of *vegetables and flowers* and *vineyard* on the expenditure of both fertilizers and crop protection inputs. This can be explained by the average increase over time of their respective land use across regions, especially for flowers, and by their requirement of intensive practices, as expected.

The *environmental* payments are estimated to be on average effective in reducing the use of both fertilizers and crop protection inputs only during the pre-reform period, while their effects seem to vanish during the post-reform period, as expected. However, more information about the participation rates, locations and payments on environmental programs would help in improving

the model specification and the explanatory power of the environmental payments on the expenditure on fertilizers and crop protection inputs in both periods.

As expected, the effects of *crop production* subsidies on the expenditure on both fertilizers and crop protection inputs are positive in the pre-reform period. This is a further confirmation of the markets and trade distortive impacts of such coupled payments on crop production as well as of the higher level of intensification. The SFP in Italy is provided according to the reference (historical) method which assures a continuation of supports to those farmers that were highly subsidized during 2000-02 and keeps the distortive impacts potentially effective (Picchi, 2005). In fact, the SFP scheme does not contribute to farmers' income redistribution (Rocchi, 2009) rather it could potentially accentuate the incentive to augment intensification whenever farmers decide to grow more remunerative crops, like vineyards and flowers. Indeed, the statistical analysis shows that in the post-reform period the SFP has positive effects on the expenditure on both fertilizers and crop protection inputs and that they are statistically higher in magnitude than the effects of coupled crop production subsidies in the period 2000-02.

Detailed OLS analyses for post-reform years

The OLS statistical analyses for each year of the post-reform period, reported in Tables 4 and 5, can give information about the consistency of the results of the previous analyses on year averages, but also information at aggregate level about the adjustment rates of farming intensive practices, if any, relative to the new policy scenarios and market opportunities.

The estimated coefficients of *total crop production*, *total labor units* and *seeds and plants* are statistically different for each of the post-reform years but their effects are consistent with the

estimated effects in the post-reform analysis on year averages. In particular, *total crop production* and *total labor units* present diminishing effects from 2005 to 2007 on the expenditure on fertilizers and crop protection inputs. The coefficient estimates for *seeds and plants*, instead, show a positive trend of the effects on expenditure on fertilizers and crop protection inputs from 2005 to 2007.

Although there are no significant changes in the post-reform analysis on year averages, the effects of land shares for *cereals* on expenditures on both fertilizers and crop protection inputs are positive and stronger only in 2007. The same condition is found for the effects of *other field crops* which are negative and statistically stronger only in the year 2007 on the expenditures on both fertilizers and crop protection inputs. Consistent with the results from the post-policy analysis on year averages, the effects of land shares of *permanent crops* on expenditures on both fertilizers and crop protection inputs remain unchanged over the whole period from 2005 to 2007.

The estimated coefficients of land shares of *vegetables and flowers* and *vineyards* show from 2005 to 2007 increasing effects on expenditures on both fertilizers and crop protection inputs and they are significantly stronger especially in 2006 and 2007.

The statistical analyses show that the *environmental* subsidies have no significant effects on the expenditure on both fertilizers and crop protection inputs from 2005 to 2007, although there is an exception in 2007 where their impact on the expenditures on fertilizers are significantly negative.

From 2005 to 2007 the effects of SFP on the expenditure on fertilizers are not the same over the years. In particular, although still positive those impacts significantly decrease from 2005 to

2006, but increase remarkably from 2006 to 2007. With regard to the effects on expenditure on crop protection inputs, SFP subsidies have positive and significantly strong impacts especially in 2007.

Conclusions

Using FADN regional data for Italy, this study analyzed the impacts of the 2003 Health Check reform of the CAP on the level of agricultural intensification through production inputs use. Given that the implementation of the SFP in Italy occurred according to the reference (historical) method, there is the suspect that the new decoupled payment scheme might present some allocative or "coupled" effects (Bhaskar and Beghin, 2007), contribute to further income inequality (Rocchi, 2009) as well as induce cropping operational size and land use redistribution (Giacomini, 2005). The specification of the statistical OLS models is inspired by the studies of Giacomini (2005), Sierra *et al.* (2005) and Viaggi *et al.* (2009) and it is assumed that the observed changes in cropping operational size and land use are not a direct effect of the introduction of SFP, but rather they are the direct consequence of the elimination of the previous supports coupled to production. In such a way it is possible to estimate the direct effect of SFP on the expenditures on fertilizers and crop protection inputs.

The findings can provide further evidence that, at aggregate level, cropping farms adopted less intensive practices during the post-policy period as observed by Sierra *et al.* (2005), but there are however several factors that seem to increase expenditures on fertilizers and crop protection inputs, with the highest peak in 2007. Moreover, these results statistically suggest that 15% of each additional Euro received through SFP is spent on fertilizer and crop protection inputs.

There is enough evidence of a significant change toward the cultivation of more remunerative crops, like vegetables, flowers and vineyards, which require a higher intensive use of production' factors. Therefore, if, on one hand, the new policy incentives are actually working well by changing farming activities according to market signals, on the other side the opportunity of higher profits is found in cropping activities that require a more intensive use of production inputs. Therefore, we imply that farmers may allocate higher proportions of SFP to purchase fertilizers and crop protection inputs whenever the opportunity of higher profits is found in those cropping activities requiring a higher intensive use of production' factors.

However, such analyses cannot fully clarify whether such changes are driven by the new policy regime *per se* or by the elimination of the previous coupled subsidies, especially because it does not address the issue from a farmer decision making perspective. In fact, in order to assess how farmers' incentives have changed with the elimination of coupled supports and the introduction of SFP, it would be more appropriate to employ theoretical and empirical dynamic models of profit maximization performed on farm level data. In order to isolate the impacts of the HC reform, such models would need to account for time and commodities' price effects as well as changes in farmers' risk aversions.

References

Bhaskar A. and Beghin C. J. (2007) "How coupled are decoupled farm payments? A review of coupling mechanisms and the evidence.", WP 07021, *Department of Economics, Working Paper Series, Iowa State University*

Comegna, E. (2005) "La complessità e l'incertezza dopo la riforma Fischler", *Agriregioneuropa* 1,1: 9–10

Frascarelli, A. (2005) "Cosa succede nelle aziende agricole dopo il disaccoppiamento?", *Agriregioneuropa* 1,0: 12–14

Giacomini, C. (2005) "L'agricoltura che vorremmo dopo la riforma della PAC", *Agriregioneuropa* 1,1:7–8

Henningsen A., Kumbhakar S. and Lien G. (2009) "Econometric Analysis of the Effects of Subsidies on Farm: Production in Case of Endogenous Input Quantities", Selected Paper prepared for presentation at the Agricultural & Applied Economics Association 2009, AAEA & ACCI Joint Annual Meeting, Milwaukee, Wisconsin, July 26-29, 2009

Hennessy, D. (1998) "The production effects of agricultural income support policies under uncertainty", *American Journal of Agricultural Economics* 80(1): 46–57.

Kroll, J. C. (2008) " The implementation of Single Farm Payment schemes in European Union Countries", Selected paper prepared for the 109th EAAE Seminar " The CAP after the Fischler reform: national implementation, impact assessments and the Agenda for future reforms". Viterbo, Italy, November 20-21st

OECD (2008): *Agricultural Policy Design and Implementation – A synthesis*, Working Party on Agricultural Policies and Markets.

Picchi, A. (2005) "La nuova PAC: dall'Italia norme di attuazione riduttive", *Agriregioneuropa* 1,1: 10–11

Rocchi, B. (2009) “The CAP reform between targeting and equity: a structural policy analysis for Italy”, *European Review of Agricultural Economics* 36,2:175–201

Sckokai, P. and Moro, D. (2006) “Modelling the reforms of the Common Agricultural Policy for arable crops under uncertainty”, *American Journal of Agricultural Economics* 88(1): 43–56.

Serra, T., Zilberman, D., Goodwin, B., and Hyvonen, K. (2005) “Replacement of agricultural price supports by area payments in the European Union and the effects on pesticide use”, *American Journal of Agricultural Economics* 87(4): 870–884.

Serra, T., Zilberman, D., Goodwin, B., and Featherstone, A. (2006) “Effects of decoupling on the mean and variability of output”, *European Review of Agricultural Economics* 33(3): 269–288.

Viaggi, D., Raggi, M. and Gomez y Paloma, S. (2009) “Facing decoupling: use of payments and investment reaction to decoupling in the EU”, Contributed Paper prepared for presentation at the International Association of Agricultural Economists Conference, Beijing, China, August 16-22

Table 1: Variables Description

Variables name	Variables label
Fertilizers (€)	Expenditure on Fertilizers (€) corrected by the price index
Crop Protection (€)	Expenditure on Crop Protection (€)corrected by the price index
Controls for operational size	
Seeds and Plants (€)	Expenditures on Seeds and Plants (€)
Total Crop Production (000€/Ha)	Total Crop production / Total Utilized Agric Area (000€/Ha)
Total Labor Units	Total labor input measured as full-time unit equivalents
Controls for land use	
Cereals	% of Total Agricultural Area devoted to Cereals
Other Field Crops	% of Total Agricultural Area devoted to Other field crops (dry pulses, sugar, tobacco, potatoes,…)
Vegetables and Flowers	% of Total Agricultural Area devoted to Vegetables and Flowers
Vineyards	% of Total Agricultural Area devoted to Vineyards
Permanent Crops	% of Total Agricultural Area devoted to Permanent crops
Subsidies	
Crop Production	Total Subsidies on Crop Production (€)
Lag(1) Environmental	1 Lag - Environmental subsidies (€)
Single Farm Payment	Single Farm Payment (€)

Table 2: Average values of the selected variables

Variable	2000-2002	2005-2007	change
Fertilizers (€)	2791.53	3385.64	17.55%
	(3489.92)	(4097.94)	
Crop Protection (€)	2186.45	3142.67	30.43%
	(3194.78)	(4308.07)	
Total Crop Production (000 €/Ha)	3.14	3.63	13.51%
	(12.61)	(7.02)	
Total Labor Units	1.71	2.15	20.45%
	(1.17)	(1.74)	
Seeds and Plants (€)	3120.72	5192.84	39.90%
	(5003.43)	(7667.11)	
Percentage of land use for enterprises			
Cereals	33.79	32.05	-5.45%
	(14.44)	(14.83)	
Other Field Crops	8.37	5.96	-40.53%
	(6.01)	(4.94)	
Vegetables and Flowers	3.47	4.01	13.43%
	(10.84)	(10.26)	
Vineyards	6.13	6.54	6.24%
	(4.58)	(5.72)	
Permanent Crops	14.27	12.62	-13.05%
	(12.96)	(11.11)	
Subsidies (€)			
Crop Production	8457.81	-	
	(16828.72)		-2.43%
Single Farm Payment	-	8257.53	
		(11154.84)	
Lag(1) Environmental	1570.05	1128.82	-39.09%
	(2640.18)	(1780.79)	
Observations	95	89	

Note: Standard deviations are in parenthesis.
Source: FADN data

Table 3: OLS analyses on year averages

	2000-2002				2005-2007			
	Expenditures on Fertilizers (€)		Expenditures on Crop Protection (€)		Expenditures on Fertilizers (€)		Expenditures on Crop Protection (€)	
Total Crop Production (000€/Ha)	107.34		262.02	***	-135.41	*†	-150.12	†
Tot Labor Units	1756.62	***	2354.61	***	537.89	***†	894.40	***†
Seeds and Plants (€)	0.3798	***	0.35	***	0.2492	***†	0.2141	***†
Percentage of land use for enterprises								
Cereals	29.59	***	9.72		28.962	**	13.81	
Other Field Crops	20.09		33.20		-16.214	†	18.28	†
Vegetables and Flowers	-79.31	*	-234.82	***	125.92	**†	118.38	†
Vineyards	12.11		-1.25		74.896	**†	108.16	**†
Permanent Crops	3.286		-3.00		10.785	†	5.936	†
Subsidies (€)								
Lag(1) Environmental	-0.1928	**	-0.71	***	0.0853	†	-0.1462	†
Crop Production	0.0277	***	0.02	*	-		-	
Single Farm Payment	-		-		0.1178	***†	0.0957	***†
Constant	-2574.53	***	-2445.72	***	-1599.98	***	-1761.02	
Observations	91		91		89		89	
R^2	0.946		0.888		0.920		0.802	

Note: *, ** and *** represent statistical significance at 10, 5 and 1% level, respectively

† represents less than 5% level statistical difference from coefficients estimated in the 2000-2002 model

single farm payment estimates are compared to total crop production subsidies

Table 4: OLS estimation on Expenditures on Fertilizers (€)

	2005		2006		2007	
Total Crop Production (000€/Ha)	1.98	†	-117.85	*†5	-389.49	***†56
Tot Labor Units	933.08	***†	507.35	**†5	284.76	*†56
Seeds and Plants (€)	0.1777	***†	0.2394	***†5	0.3062	***†56
Percentage of land use for enterprises						
Cereals	18.92	†	28.42	**5	37.99	***†56
Other Field Crops	26.69		-3.317	†5	-90.32	**†56
Vegetables and Flowers	41.64	†	109.03	**†5	292.26	***†56
Vineyards	60.37	**†	72.50	**†5	98.84	**†56
Permanent Crops	9.59	†	15.29	†	2.12	56
Subsidies (€)						
Lag(1) Environmental	0.0739	†	0.1317	†5	-0.1618	*†56
Single Farm Payment	0.1377	***†	0.0976	***†5	0.1529	***†56
Constant	-2088.10	***	-1582.28	**	-919.38	
Observations	87		88		87	
R^2	0.9210		0.893		0.901	

Note: *, ** and *** represent statistical significance at 10, 5 and 1% level.

† represents less than 5% level statistical difference from coefficients estimated in the 2000-2002 model

single farm payment estimates are compared to total crop production subsidies

5 and 6 represent less than 1% level statistical difference from coefficient estimates in year 2005 and 2006 respectively

Table 5: OLS estimation on Expenditures on Crop Protection (€)

	2005		2006		2007	
Total Crop Production (000€/Ha)	-20.76	†	-141.53	†5	-600.82	***†56
Tot Labor Units	1280.39	***†	1108.56	***†5	-106.31	†56
Seeds and Plants (€)	0.1947	***†	0.1616	***†5	0.3095	***†56
Percentage of land use for enterprises						
Cereals	10.07		14.52		34.38	**†56
Other Field Crops	53.39	†	25.77	5	-95.45	*†56
Vegetables and Flowers	21.09	†	116.91	†5	454.95	***†56
Vineyards	80.57	†	107.41	**†5	196.61	***†56
Permanent Crops	-5.50		15.36	5	-4.05	6
Subsidies (€)						
Lag(1) Environmental	-0.2877	†	0.1190	†5	-0.1217	†56
Single Farm Payment	0.0880	*†	0.0750	***†	0.1533	***†56
Constant	-2116.77		-2217.02	**	-807.45	
Observations	87		88		87	
R^2	0.786		0.807		0.859	

Note: *, ** and *** represent statistical significance at 10, 5 and 1% level

† represents less than 5% level statistical difference from coefficients estimated in the 2000-2002 model

single farm payment estimates are compared to total crop production subsidies

5 and 6 represent less than 1% level statistical difference from coefficient estimates in year 2005 and 2006 respectively