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The Capitalisation of CAP Payments into Land Rental Prices: A Panel Sample Selection Approach

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Abstract

The empirical literature suggests that farmland prices and rents capitalise agricultural subsidies and that the 2003 reform of the EU Common Agricultural Policy, which decoupled subsidies from production and attached them to land, may have increased the extent of the phenomenon. Employing a farm-level dataset, the Farm Accountancy Data Network (FADN) for Italy, we investigate this issue while accounting for selectivity, endogeneity and unobserved individual heterogeneity. To understand the impact of the reform we compare the estimates of capitalisation rate for decoupled payments with those for coupled payments. After correcting for unobserved individual heterogeneity and selectivity, our results reveal no capitalisation of coupled payments and only limited capitalisation of decoupled area payments into farmland rents in Italy.

Keywords: *Common Agricultural Policy (CAP)*; *land rents*; *panel data econometrics*; *sample selection*; *subsidy capitalisation*.

JEL classifications: *Q18, C33, H22, Q12, Q15*.

1. Introduction

In 2012, land, including permanent crops and quotas, accounted for 65% of total farm fixed assets in the 27 states of the European Union (EU), and the figure rises to 80% when only specialised arable crop farms are considered (European Commission - EU FADN, 2015). Variations in farmland prices therefore have substantial implications for the farm balance sheets (for those farms which own land) and their income generating capacity (for those which rent land) and, accordingly, the theoretical and

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empirical literature on the determinants of agricultural land prices has received much attention.

Following the implementation of the 2003 Common Agricultural Policy (CAP) reform, agricultural subsidies are decoupled from production levels and linked to land through an entitlement mechanism, thus reinforcing the possibility that payments designed to support farmers' income capitalise into farmland prices through higher land rents (Ciaian and Swinnen, 2006). Econometric studies of the capitalisation effects of farm support payments have traditionally focused on the US (Barnard *et al*., 1997; Weersink *et al*., 1999; Goodwin *et al*., 2003; Lence and Mishra, 2003; Roberts *et al*., 2003; Kirwan, 2009*)*. More recently, some contributions have appeared focusing on the EU or its Member States (MS) (Patton *et al*., 2008; Breustedt and Habermann, 2011; Ciaian and Kancs, 2012; Kilian *et al*., 2012; van Herck *et al*., 2013; O'Neill and Hanrahan, 2013; Guastella *et al*., 2014; Michalek *et al*., 2014; Klaiber *et al*., 2017). With the exception of Guastella *et al*. (2014), Kilian *et al*. (2012) and van Herck *et al*. (2013), who use data aggregated respectively at the regional, municipality and country level, all the studies employ farm-level data for the empirical analysis finding robust evidence of capitalisation.

At the farm level, the consistent estimation of the land price equation parameters is subject to several specification issues. One significant problem, often present in micro-level econometrics, is unobserved heterogeneity, which arises because the dataset does not record some individual characteristics of the farmer or of the farm that are likely to have an impact on both the decision to rent land and the rents paid. Second, there is a potential selection issue, since we only observe the farmland rent for renting farms. A problem with sample selection arises whenever the probability of observing a renting farm in the sample is non-random and, more specifically, is determined by the variables that also explain the farmland price. This may be especially the case for decoupled payments. Farmers who own more payment entitlements than eligible hectares may be encouraged to rent more land simply because of the payments. The third problem is related to the endogeneity of returns and, possibly, of the payments. Farmers, in fact, bargain the amount to pay for the rented land based on the expected returns and the expected level of payments, but the econometrician only observes the respective realisations, and any deviation of the observed from the expected values adds to the residuals. Accordingly, the expectation error may violate the standard assumptions about the zero correlation between the covariates and the disturbances.[2]

The previous EU-based literature has approached these problems in different ways, usually because of circumstances related to the nature of the data. For instance, Breustedt and Habermann (2011) base their results on a sample of German renting farms only and use instrumental variable cross-section estimation, thus considering endogeneity but not heterogeneity and selectivity,[3] finding that 38 cents per euro of (coupled) per hectare payment is capitalised; Ciaian and Kancs (2012) apply a two-step sample selection approach to first differenced data of the EU New Member States

[2]Some other problems related to the estimation of the capitalisation effect involve the dynamic nature of rental prices (O'Neill and Hanrahan, 2013) and the geographical dimension of the problem (Breustedt and Habermann, 2011). We are not able to consider these problems for reasons strictly related to our data, i.e. the absence of historical information on the one hand, and the absence of information on the geographical location of the farms on the other.

[3]In Breustedt and Habermann (2011) the use of spatial econometric techniques is likely to mitigate the heterogeneity bias.

(NMS) farms, controlling for endogeneity, individual heterogeneity and, to some extent, also for selectivity[4] and find that between 18 and 20 cents per euro are capitalised; Klaiber *et al*. (2017) use a panel of Bavarian farms to estimate the capitalisation of SFP accounting for selectivity and heterogeneity but not endogeneity and report that, since 2005, farmland prices capitalised 38 cents of any additional euro, and the figure rose to 57 cents in 2012; O'Neill and Hanrahan (2013) apply a dynamic Generalized Method of Moments (GMM) estimator which corrects for endogeneity and heterogeneity but not for selectivity, and report, for Ireland, that farmland prices capitalise between 7 and 25 cents (21 and 53 in the long-run) of decoupled subsidies; similarly, Patton *et al*. (2008) use panel GMM techniques but exclude farms which do not rent land. Hence, their estimate of 41/42 pence for each pound in Irish farms in the years 1994–2002 account for heterogeneity and endogeneity but potentially not for selectivity; finally Michalek *et al*. (2014) estimate an average capitalisation rate of 6% using a sample of EU-15 farms in the period 2004–2007 by applying a Generalized Propensity Score matching approach that considers the endogeneity and the selectivity of subsidies, also accounting for the general equilibrium effects.

We contribute to the existing empirical literature on the capitalisation effect by providing farm-level econometric evidence based on panel data sample-selection approaches for models with endogenous variables. Econometric estimators exist that simultaneously account for selectivity and individual heterogeneity in unbalanced panels (Wooldridge, 1995; Kyriazidou, 1997; Rochina-Barrachina, 1999), but their use in applied econometrics has been rather limited (Dustmann and Rochina-Barrachina, 2007). More recently, Semykina and Wooldridge (2010) extended the Wooldridge (1995) estimator to consider the endogeneity of some covariates. The empirical analysis is conducted for both the periods before (2000–2004) and after the implementation of the 2003 CAP reform in Italy (2005–2008). Although the focus of the paper is on decoupled subsidies, the comparison with the period preceding the reform helps to shed light on the effect of the decoupling of payments on subsidy capitalisation. Our use of Italian data is also a contribution to the existing empirical literature. Except for the work by Viaggi *et al*. (2013), which focuses on the impacts of the 2013 CAP reform introducing the regionalisation of the payments, none of the existing studies has empirically addressed the issue of capitalisation of CAP support in Italy so far. Finally, this paper sheds new light on the relationship between the abundance of entitlements and the capitalisation of decoupled subsidies.

The remainder of the paper is organised as follows. The next section discusses the theory behind the capitalisation of support, with a focus on the EU's decoupled payments in relation to the method chosen by Member States (MSs) to implement the reform. The third section introduces the econometric strategy adopted to estimate the model accounting for the diverse sources of bias. Data used in the empirical model are described in the fourth section. Econometric results are presented in the fifth section and a discussion of evidence concludes the paper.

[4]Ciaian and Kancs (2012) actually apply cross-section selectivity methods using in the estimation sample farms renting for the two consecutive years only, with the consequence that a) farms not observed in the two years, or observed in the two years but renting in one only, are excluded from the estimation sample, and b) individual heterogeneity in the equation for the decision to rent land (selection equation) is not considered.

2. Farmland Rents and Agricultural Payments

Following the MacSharry reform in 1992 and the Agenda 2000 reform in 1999, the CAP was based on (partially) coupled instruments. For arable crops two main policy tools were in place: the intervention price (for cereals) and the area payments. The intervention price acted as a minimum guaranteed price for all cereal crops, while the area payments, calculated regionally, were largely crop-specific[5] and awarded to all farmers declaring the area cultivated with cereals, oilseeds and protein crops. Analogously, in the animal sector, payments were made to farmers on a livestock-unit base.

The 2003 Fischler CAP reform, implemented in Italy starting from 2005, redesigned the majority of payments schemes replacing crop area and headage payments with Single Farm Payments – (SFP). Farmers receive entitlements to the SFPs, provided that they keep farmland in good environmental and agricultural condition (GAEC). The implementation of the SFP scheme required Member States (MS) to adopt either the 'regional model', consisting of a flat per-hectare payment for all farms in a region, or the 'historical model', granting farmers entitlements based on the value of the payments received during a reference period. A third option, the 'hybrid model', was a combination of the regional and historical models. This choice implied some significant consequences on the distribution of payments across farms in each MS, reflecting the distribution of payments prior to the reform, typically favouring arable crop and livestock farmers as compared to other sectors. Thus, the regional model has virtually cancelled such differences in the per hectare level of support, while the historical model has maintained them over time. In 2015, a new reform entered into force and the SFP was converted into a Basic Payment Scheme, conditional on specific 'greening measures' (European Commission, 2013).

The SFP reform, more completely decoupled subsidies from production, relating the amount of support intrinsically to land and apparently increasing the likelihood of capitalisation. As a consequence, a theoretical and empirical literature flourished evaluating the impact of this reform on farmland prices and studying the extent of and the mechanisms for capitalisation of support (Patton *et al*., 2008; Breustedt and Habermann, 2011; Ciaian and Kancs, 2012; Kilian *et al*., 2012; van Herck *et al*., 2013; O'Neill and Hanrahan, 2013; Guastella *et al*., 2014; Michalek *et al*., 2014; Klaiber *et al*., 2017).

Ciaian and Swinnen (2006), Ciaian *et al*. (2008), Kilian and Salhofer (2008) and Kilian *et al*. (2012) all conclude that the introduction of decoupled payments will end up increasing farmland prices in theory, but that the extent of capitalisation also depends on a variety of factors. Specifically, Ciaian and Swinnen (2006) discuss the impact of market imperfections. Ciaian *et al*. (2008) focus on the abundance of entitlements compared to eligible hectares, a condition that favours full capitalisation. Kilian and Salhofer (2008) discuss this relationship between entitlements and eligible hectares in the context of the implementation model chosen by each MS. They argue that the farmland price does not capitalise the subsidy with an abundance of eligible hectares, meaning that the historical model will lead to partial capitalisation and the regional model to full capitalisation with abundance of entitlements. Kilian *et al*. (2012) provide empirical evidence for this hypothesis. Hence, from a theoretical

[5]The MacSharry reform distinguished between 'professional producers', for whom the payments were crop-specific, and 'small producers', for whom payments were not crop-specific; further, the professional producer scheme required to divert a fixed percentage of the land from production to fulfill the compulsory set-aside obligation.

perspective, we expect that farmland price capitalises the subsidy in a more significant manner in the case of the regional model (Ciaian *et al.*, 2014).

In support of these theoretical arguments, the existing empirical literature shows that the capitalisation of the decoupled per hectare payments estimated in the NMS (Ciaian and Kancs, 2012), where the regionalised payment has been implemented, is higher than the rate estimated in the EU-15 (Michalek *et al.*, 2014), where all the MS but Malta and Slovenia adopted either the historical or the hybrid model. Furthermore, evidence in Klaiber *et al.* (2017) indicates that the degree of capitalisation increases when the payment system gradually moves from the historical/hybrid model to the regional base. Viaggi *et al.* (2013), based on simulation results, reach a similar conclusion.

In Italy, the historical model has been adopted. Thus, Italian farmers obtained entitlements valued at approximately 85% the average amount of per hectare payments they individually received in the 2000–2002 reference period.[6] These values were extremely heterogeneous among farms, and such heterogeneity has been maintained through the 10 years of application of the SFP regime. In addition, when the reform entered into force (2005), the eligible hectares were exclusively those used for crops for which a payment was due in the previous regime. Thus, some specific products, extremely important for Italian agriculture, such as wine or fruits and vegetables, were not eligible for the SFP. After the 'Health Check' reform of the CAP (2008), this constraint was removed and virtually all agricultural uses of land became eligible for the SFP, with only the exclusion of forests. Thus, given the peculiar structure of Italian agriculture, this created a typical situation of abundance of eligible hectares with respect to entitlements.[7]

3. Model Specification and Estimation

The starting point of the empirical analysis is a reduced form equation for land demand in which farmland price for farm i at time t (r_{it}) depends on the expected returns and the expected payments. Measuring the expected payments as the sum of the per hectare amounts expected for each crop multiplied by the number of hectares planted with the crop, the land price equation becomes:

$$r_{it} = \alpha_i + \tau_t + \beta_1 \cdot RET_{it} + \beta_2 \cdot \frac{1}{A_{it}} \sum_{k=1}^{K} E\left(g_t^k A_{it}^k\right) + \gamma W_{it} + \varepsilon_{it}. \quad (1)$$

In equation (1) RET is the (per hectare) total return computed as the values of sales and use of products plus the changes in stocks, A_{it} is the area utilised by the farm for total production; g_t^k is the per hectare amount of subsidy disbursed at time t for production k; A_{it}^k is the number of hectares planted for crop k by farm i at time t; W represents a set of individual and environmental controls; a_i are the individual, time-

[6]The approximate 15% cut in the reference amount is due to several specific provisions that accompanied the 2003 reform, such as financing the 'national envelopes' (i.e. supplementary payments targeting specific sectors) and the 'national reserve' of entitlements, targeted to new entrants.

[7]Table 2 in Ciaian *et al.* (2014) reports the values of the ratio between the 'activated area' (area for which the SFP has been claimed) and the total Utilised Agricultural Area (UAA) for 17 EU MSs in the 2007–2011 period. The figures for Italy range between 0.56 and 0.66 and are the lowest in the EU. This is a clear signal of abundance of eligible hectares with respect to entitlements.

invariant effects; τ_t are the time effects that control for common trends in farmland prices; β_1, β_2, and γ are the parameters; ε_{it} is a stochastic disturbance. The equation represents the equilibrium condition with crop-specific coupled payments (i.e. g varying among crops), the total amount received being a function of the planted hectares A^k. The 2003 CAP reform introduced decoupled area payments, whose amount g^D is fixed and does not depend on the crop planted ($g^D = g^1 = g^2 = \ldots = g^K$), although it may vary across farms in case the MS has implemented the historical or the hybrid model; furthermore, the number of entitlement hectares EN, not the planted hectares, determine the amount of the payment. Accordingly, substituting $g_{it}EN_{it}$ to $\sum_{k=1}^{K} E(g_t^k A_{it}^k)$ in equation (1) provides the reduced form in the case of decoupled payments.

Farmers received a per hectare payment different for each crop production until 2004. With this payment scheme, farmers know that an additional hectare of rented land gives the right to receive an additional payment, the amount of which depends on the planted crop. With perfect information and absence of transaction costs, the landlord can fully capitalise the payment, leading to an estimate of β_2 equal to one. In the real-world transaction costs are different from zero, and there is not perfect information. In particular, the farmer and the landlord bargain the land price at the beginning of the contract, which may last for years, and the owner cannot make educated expectations about the crop mix and eventually about the amount of the payment. The consequence is that the landlord may not be able to capitalise the subsidy, leading to an estimate of β_2 which is closer to zero.

The 2003 CAP reform introduced decoupled payments and the mechanism based on the entitlements. In Italy, the value of the entitlements is different among farmers and reflects the historical per-hectare payments but, to receive the payment, the farmer needs to attach a hectare of eligible land to each entitlement. The reform also allowed trade in entitlements without land. Farmers with an excess of entitlements over eligible area have an incentive to rent additional land and even to pay a premium, which reflects the extent of capitalisation. In this case the expected value of β_2 is larger than zero, but still lower than one. In the opposite case, when the farmer owns fewer entitlements than eligible area, there is no incentive to pay a premium rent for the additional area. Contrary to the case of coupled subsidies, this situation does not translate into an extra payment, so the expected value of β_2 is equal to zero.

Consistent and efficient estimation of the parameters β_1 and β_2 in equation (1) is subject to many specification issues. First, individual time-invariant heterogeneity (a_i) characterises the right-hand side of the equation. Survey data do not include relevant information about the tenant (education, age, years of experience), the land parcel (quality of land, presence of buildings and other structures) and tenure characteristics (duration of the plot tenure, rent bargained at the beginning of the season and paid in cash or through a sharecropping agreement at the end of the season), and other characteristics that influence the price of land. Therefore, a large part of the variation in rental price across farms may depend on factors which are in fact unobserved. Second, some farms may not use rented land and for these farms the dependent variable (r_{it}) cannot be observed. If the decision to rent is somehow correlated to the variables on the right-hand side of the model, the issue of selectivity can be taken into account by estimating a first stage probabilistic model to explain the decision to rent land, which should also include fixed effects. In the case of the rental price equation, such

correlation is expected between the rental choice and the productivity and payment levels. In the particular case of decoupled subsidies, the decision to rent land may depend on owning more entitlements than eligible areas, a condition that also affects the price of land through capitalisation.

Finally, the potential difference between the expected and the realised values of the market returns and subsidy variables makes OLS estimates inconsistent and requires the instrumental variable approach. However, since the year 2000 and until the implementation of decoupling, EU farmers knew the value of the crop-specific per hectare amount with sufficient certainty (EC, 2000), such that we can exclude endogeneity caused by expectation errors for coupled payments after the year 2000. We can also exclude endogeneity for decoupled payments, since the per hectare value of the entitlements was fixed and exactly known after their initial calculation. Thus, endogeneity remains relevant for market return expectations, but not for payment expectations.

The econometric framework we propose attempts to consider these specification issues simultaneously. Wooldridge (1995) (from now on W95) suggested a procedure to evaluate the extent of and correct for the presence of selectivity in panel data models where individual time-invariant heterogeneity is present in both the selection and the main equations. The methodology builds on the Heckman (1979) two-step procedure. Semykina and Wooldridge (2010) (from now on SW10) extend the W95 approach allowing testing and correction for selectivity in the presence of endogeneity bias due to the non-zero correlation between explanatory variables and idiosyncratic errors. To explore the potential advantage of accounting simultaneously for these specification issues, we use a standard Pooled OLS, Heckman two-step approach on pooled data, Fixed Effects (FE), and Instrumental Variable Fixed Effects (IVFE) approaches alongside the W95 and SW10 approaches.

In detail, letting r_{it} be the rental price defined in the equation (1) and s_{it} the indicator variable for renting, X the K-dimensional vector of covariates and β the associated vector of parameters, Z the L-dimensional vector of covariates in X plus the variables used in the probability equation only (exclusion restrictions) and δ the associated vector, and ε idiosyncratic disturbances, the W95 panel sample selection model is:

$$\begin{aligned} \Pr(s_{it} = 1) &= \Phi(Z_{it}\delta_t + Z_i\xi_t) \\ r_{it} &= X_{it}\beta + X_i\eta + \rho\hat{\lambda}_{it} + \varepsilon_{it} \end{aligned} . \tag{2}$$

Notice that both the selection and the main equations contain individual time-invariant effects, in both cases modelled through the Chamberlain (1982)-Mundlak (1978) device as a function of time averages of variables. In practice T probit models of s on Z and the time averages of Z, one for each year, are estimated and, using the probit estimates, the vector with the Inverse Mills' Ratios (IMRs) for each year is computed. Then, all the vectors are stacked by year to a $N \times T$ vector $\left(\hat{\lambda}\right)$. In the main equation, a regression of r on X, the time averages of X, and $\left(\hat{\lambda}\right)$, the interactions of $\hat{\lambda}$ with the $T-1$ dummy variables can be included to account for the fact that the IMRs result from yearly probit estimates. The joint significance of the coefficients associated with $\hat{\lambda}$ and its interactions rejects the null hypothesis of no selectivity bias. For the purpose of identification, it is sufficient that $X = Z$ (no exclusion restrictions) but it must be the case that all the variables in X are also part of Z.[8]

[8]For this reason, we could not include the share of rented area, which is likely relevant information to explain the rental price, in the main equation.

If one or more variables in X are endogenous, the SW10 approach estimates the main equation with a two-step instrumental variable approach, while the probit equation is estimated as in W95. Here, a) the Z matrix includes appropriate instruments for the endogenous variables, and b) only the time averages of the exogenous variables and instruments are included in the IV second stage (equation (3)). In the IV first stage, the exogenous variables and the instruments, including the respective means, and the IMR are used to explain the endogenous variable. Once again, the joint significance of the coefficients associated with the IMRs and the interactions rejects the hypothesis of absence of selectivity. The test for endogeneity is instead conducted plugging the IV first stage residuals into the IV second stage equation and testing the significance of the associated coefficients.[9]

$$\begin{aligned} \Pr(s_{it} = 1) &= \Phi(Z_{it}\delta_t + Z_i\xi_t) \\ r_{it} &= X_{it}\beta + Z_i\eta + \rho\hat{\lambda}_{it} + \varepsilon_{it}. \end{aligned} \tag{3}$$

SW10 also suggests using a subset of Z in the first stage of the IV estimation in a way that the selection equation contains some elements that do not enter the reduced form of the main equation. Although this does not have a direct effect on the estimates, such a procedure increases the finite-sample performance of the test. Related to this, we find that none of the variables in our database are eligible as an exclusion restriction, that is, the renting decision is affected but not the rental price.

4. Data

The database employed for the empirical estimation is the EU Farm Accounting Data Network (FADN) database for Italy from which we select farms specialised in arable crops (Specialist cereals, general field-cropping and mixed cropping in the FADN definition).[10] For the years 2000–2008, there are 42,573 records in the dataset. We perform some preliminary checks against possible inconsistencies in the data.[11] Finally, considering the main variables of interest, farmland rent and subsidies, we perform a 'data cleaning', excluding observations that report a value of any of these variables beyond the range defined by plus/minus twice the standard deviation from the mean. Overall, the incidence of cleaning on sample size is about 24% and the final estimation sample includes 30,918 observations, 19,084 of which pertain to the period in which payments were coupled to specific outputs (2000–2004) and 11,834 to the period in

[9]The test is a standard Hausman test and is performed assuming absence of selectivity.

[10]The FADN defines as 'specialised arable crop farms' those farms obtaining at least two thirds of their Standard Gross Margin from arable crops.

[11]We exclude 423 observations reporting zero crop production and 1,338 observations in which a positive value of production in the arable crops (cereals, maize, oilseeds, protein crops and other crops) was recorded against zero hectares for that production and *vice versa*. We also excluded 20 observations reporting a value of coupled payments received for production whose value is zero. Although it is plausible that certain farms might have received a late payment such that the amount has been accounted for in a year different from that in which the right was accrued, this is deemed an inconsistency for the purpose of estimation and the observations are dropped from the estimation sample. Focusing on specialised field-cropping farms means also excluding farms reporting a share of livestock production greater than one third of total output. This is the case for some observations because we consider the areas for grass and fodder and the related outputs as part of the livestock production and hence not strictly field-cropping.

which farmers received decoupled payments (2005–2008). The real dimension of the sample size, however, varies across the estimation methods. In general, we exclude farms observed for only one year to avoid any problem in the estimation with fixed effects, leading to a maximum sample size of 14,425 and 9,401 in the two periods, respectively. Both panels are strongly unbalanced, the average permanence of a farm in the survey being 1.8 and 2.1 years in the two periods, respectively. Table 1 describes the variables used for estimation and provides some descriptive statistics related to the two periods. The dependent variable, the per hectare rental price of land, is measured as the total monetary value of rent paid by the farmer over the total number of rented hectares (*RENT*). This value includes also the rent paid for buildings and other structures present on land, if any, and excludes the rent paid for all other rights and quotas which are not attached to land.

Following the theoretical model and the empirical literature discussed in the previous sections, the main explanatory variable of the rental price is the market returns per hectare (*RETURNS*). Returns are deflated using the Eurostat GDP deflator for Italy. As discussed above, the variable is tested for being endogenous in the empirical specification of the farmland rent model.

Besides the value of production, the level of the payments is also included in the rental price equation. In the period 2000–2004, this corresponds to the total deflated[12] value of payments received for the five arable crop categories and animal payments divided by the total number of eligible hectares in these output categories (*SUB*). In the 2005–2008 period, the variable equals the total deflated amount of decoupled payments received divided by the total number of eligible hectares (*SFP*).[13]

For the 2005–2008 years only, one additional dummy variable is included related to the mechanism of decoupled payments. The variable indicates whether the farm has a number of entitlements greater or at least equal to the eligible hectares (*ENT*), thus capturing the case in which the farmer had a strong incentive to rent extra land. In this situation, we expect a stronger capitalisation effect. Otherwise, we expect weaker or no capitalisation of the decoupled payments. In practice, however, we are not able to estimate the model with both the *SFP* variable and its interaction with the *ENT* dummy variable for two reasons. The first is that the inclusion of both variables generates collinearity problems, as the majority of renting farms in fact rented additional land to end up with sufficient eligible area to get the full payment based on the entitlements. The second is that the interaction is a perfect predictor of the decision to rent land (and that strengthens our hypothesis about the link between capitalisation and the mechanism of decoupling), causing problems in the estimation of the probit equations. Accordingly, we estimate the model only with the interaction term.[14]

The additional covariates included in the model are selected following the most recent empirical studies (Ciaian and Kancs, 2012; Kilian *et al*., 2012; Michalek *et al*., 2014). We include: farm size (*SIZE*) measured as total hectares, expected to have a

[12]The same GDP deflator is used in this case.

[13]The variable actually also includes animal payments, which is necessary to maintain a consistent measure of per hectare payments in the two periods. Since Italy adopted the historical model, the value of entitlements reflects all the previous payments the farmer received including previous animal payments, if any. The choice does not affect the magnitude of coefficient estimates in all models, nor does it influence the results of the statistical tests.

[14]Results using only the *SFP* variable are available upon request.

Table 1
Summary statistics

	2000–2004			2005–2008		
	Mean (SD)	Min	Max	Mean (SD)	Min	Max
Dependent variables						
Rental rate per hectare (euro/ha)	217.91 (144.19)	0.01	590.61	205.94 (147.73)	0.01	589.56
Dummy (=1) if the farm rents land	0.47 (0.50)	0.00	1.00	0.47 (0.50)	0.00	1.00
Explanatory variables						
(RETURNS) Total output per hectare (euro/ha)	2,885.37 (17,129.75)	6.88	1,441,715.00	3,586.03 (16,204.46)	11.54	719,587.50
(SUB) Average coupled payment rate including animal payments (euro/ha)	285.96 (169.10)	0.00	1,509.18			
(SPF) Average decoupled payment rate (euro/ha)				292.97 (153.66)	0.00	748.50
(SIZE) Total farm size (ha)	35.47 (86.59)	0.37	3,493.81	45.26 (96.75)	0.50	3,433.96
(LS) Share of livestock and livestock products in total farm output	0.03 (0.07)	0.00	0.33	0.04 (0.08)	0.00	0.33
(WAGE) Average regional wage per hour worked (euro/ha)	7.42 (2.21)	3.76	14.00	8.24 (2.05)	4.59	12.42
(ADENS) Average number of livestock equivalent units per hectares (#/ha)	0.11 (0.10)	0.00	1.38	0.06 (0.05)	0.00	0.48
(LANDTR) Share of farms reporting the purchase of new land	0.01 (0.01)	0.00	1.00	0.00 (0.01)	0.00	0.03
(LABOUR) Share of family labour in total labour	0.91 (0.20)	0.00	1.00	0.86 (0.25)	0.00	1.00
(CAPITAL) Asset (buildings, equipment and machinery) value per ha (euro/ha)	44.92 (100.15)	0.00	4,376.13	51.14 (133.26)	0.00	4,206.05

negative effect on per hectare rent, as larger farms may have relatively more power in bargaining the rent to pay with landlords and the output share of non-crop activities such as livestock production (*LS*), reflecting the possible effect of specific production choice. We also include two variables reflecting the structure of the farm family-to-total labour ratio (*LABOUR*), measured in terms of number of worked hours; and capital intensity (*CAPITAL*), measured as the value of buildings, machinery and equipment per hectare. These variables are expected to affect the rent and also the decision to rent land.

Three other factors influencing the variability of farmland rents are measured at the regional (NUTS-2) level: animal density (*ADENS*), measured by the total livestock equivalent number of animals per hectare); the average wage (*WAGE*), as measured by the salary per hour of hired labour; the proportion of farms which have increased their owned land area (*LANDTR*). *ADENS* reflects both necessary compliance with the EU nitrate directive (Council Directive 91/676/EEC), requiring additional land for manure spreading in fragile areas which might increase demand for land and hence rents, and also reflect lower soil and land quality for field-crops. *WAGE* is included as our only proxy for other costs of farming, which would be expected to reduce rents, *ceteris paribus*. *LANDTR* is a proxy for the possibility to buy, rather than rent, additional land and relatively higher rents can be expected where such a proportion is low.

Following Lence and Mishra (2003) and Patton *et al.* (2008), we employ lagged values (one and two years) of the endogenous variable as instruments for the current values. Since the panel is strongly unbalanced, whenever the lagged value of observation is not available, we replace it with the corresponding regional (NUTS-2) mean for that year. This helps to save in the estimation sample almost 60% of the observations.

5. Results

5.1. 2000–2004

Table 2 presents the estimation results for the years 2000–2004, using different estimators. The Pooled Ordinary Least Squares (POLS), the Heckman sample selection on pooled data (Heckman), and the Fixed Effects (FE) estimators represent the baseline models in this analysis since most studies rely on these methods to estimate the capitalisation effect. According to POLS (Heckman, FE) estimates, an increase in farm per hectare returns of 100 euros translates into an increase in per hectare paid rent of about 0.7 (0.4, 0.3) euros. Even though the estimated coefficients are statistically different from zero at least in the first two models, their size suggests that, in Italy, returns are not a main determinant of agricultural rental prices. Evidence suggests a substantial role of farms' structural characteristics such as the average size and the use of hired labour, which, yet, turns insignificant in the FE model. Concerning the other variables at both the firm and the regional level, most of them are significant in the POLS and the Heckman models and insignificant in the FE model.

Turning the attention to subsidies, findings using the POLS model suggest a capitalisation rate of 7.6 cents per euro of subsidy, an estimate that is lower than the average capitalisation rate found in other studies. We consider this downward bias a structural element of the Italian context, since we study the rental price of farms specialised in arable crops, and the standard duration of tenancy agreements for these farms is very long, about ten years, making it difficult for landlords to predict the value of future payments. Accounting for selectivity in a cross-section framework, the Heckman

Table 2

Rental price equation, Italy, 2000–2004

	POLS	HECKMAN	FE	IVFE	W95	SW10
RETURNS	0.007*** (0.000)	0.004*** (0.001)	0.003*** (0.001)	–0.029* (0.015)	0.002 (0.001)	–0.006 (0.012)
SUB	0.076*** (0.011)	0.237*** (0.020)	0.013 (0.016)	–0.013 (0.022)	–0.022 (0.025)	–0.031 (0.028)
SIZE	−0.084*** (0.026)	0.048 (0.040)	–0.242 (0.154)	–0.450** (0.194)	–0.070 (0.323)	–0.100 (0.328)
LS	–266.080*** (21.502)	–78.935*** (25.056)	–0.403 (32.651)	–20.494 (39.165)	0.062 (30.823)	5.185 (35.619)
WAGE	14.616*** (0.891)	13.430*** (1.075)	–2.420 (1.564)	–1.413 (1.765)	–1.096 (2.509)	–4.183 (2.652)
ADENS	–47.290*** (17.595)	125.657*** (20.522)	–1.871 (23.089)	37.599 (31.176)	–68.833*** (29.043)	–38.153 (33.923)
LANDTR	–536.741*** (94.869)	426.921*** (168.435)	205.554 (164.617)	630.110*** (242.776)	81.077 (255.295)	1177.134*** (341.385)
LABOUR	–101.719*** (10.187)	–15.224 (16.117)	–10.358 (22.025)	–92.339* (48.089)	–5.640 (31.396)	–26.222 (46.745)
CAPITAL	0.147*** (0.039)	–0.420*** (0.071)	0.222*** (0.079)	0.003*** (0.001)	0.001 (0.001)	0.001 (0.002)
λ					78.217*** (17.971)	65.821*** (21.910)
λ_{2001}					9.503 (14.651)	12.441 (18.211)
λ_{2002}					37.162* (19.908)	34.451 (24.614)
λ_{2003}					81.259*** (25.793)	132.915*** (29.262)
λ_{2004}					19.164 (25.643)	37.090 (27.890)
Intercept	176.792*** (11.155)	–144.231*** (14.963)	234.883*** (26.195)	378.384*** (79.421)	54.561* (30.188)	55.032 (35.101)
Selectivity test $\rho = \rho_t = 0$					F (5,2734) = 10.28 P = 0.000	F (5,2635) = 9.78 P = 0.000
CRE test $\eta = 0$					F (9,2734) = 16.74 P = 0.000	F (9,2635) = 17.76 P = 0.000
Endogeneity test				F (1,3502) = 5.259 P = 0.022		
N obs	6,665	6,665	6,665	6,148	6,665	6,148
N Farms	2,735	2,735	2,735	2,636	2,735	2,636

Notes: Robust standard errors in parenthesis, corrected for first stage estimations when necessary. ***significant at 1% level; **significant at 5% level; *significant at 10% level. Selectivity test refers to either the W95 or the SW10 test for selectivity bias. CRE test is a test on the null hypothesis that all the coefficients of the time means of variables are jointly insignificant. Endogeneity test is the auxiliary regression based Hausman test.

model results suggest that as much as 24 cents per euro capitalise into the land rents. When estimated with the FE model, however, the coefficient for subsidies turns insignificant. We consider this an important indication for the model specification because the use of fixed effects clearly captures much of the (already low) variation in rental prices. Following the results of the Durbin-Wu-Hausman endogeneity test (Davidson and MacKinnon, 1993), which supports the endogeneity of returns, we perform IVFE estimation finding that most of the coefficients remain insignificant following the inclusion of fixed effects in the model.

We do not find any evidence of capitalisation also when estimating the model that accounts for selectivity, and both the W95 and the SW10 selectivity tests confirm the presence of selection bias. Since the baseline models link the absence of capitalisation effect to the inclusion of fixed effects in the estimation, we test the null hypothesis that individual effects can be excluded from the model specification (Correlated Random Effects - CRE test) and, in both the W95 and the SW10 cases we find that the hypothesis is rejected. The FE Probit estimates (see Table A1 in the online Appendix), obtained modelling fixed effects in a pooled probit using the Mundlak-Chamberlain device, suggest that the selection process primarily relates to the unobservable individual characteristics. In fact, many FE Probit coefficients are not statistically different from zero, but the coefficients of the time average of variables ($-M$) indicate that it is the correlation between the unobservable individual effects and many variables that produce this result.

5.2. 2005–2008

Table 3 summarises the results for the period of decoupled payments. Regarding model specification, the subsidy variable results from the interaction between the per hectare SFP payment and a dummy indicating whether (1) or not (0) the farmer owns more entitlements than eligible area. The general evidence, perhaps based on the POLS model, points to a larger capitalisation of decoupled payments (11.4 cents per euro) compared to coupled area payments (7.6 cents per euro).

Similarly to the results in Table 2, the capitalisation effect remains significant after accounting for selectivity in a cross-section framework (Heckman) and does not disappear accounting for individual heterogeneity in the estimation (FE). There is evidence of endogeneity of productivity, as the test does reject the null hypothesis of no endogeneity.

Findings using both the W95 and SW10 approaches suggest a positive capitalisation effect. The result, however, holds only in the case that the farmer owns more entitlements than eligible area, being the estimated coefficient not statistically different from zero when removing the interaction term.[15] Such an effect is estimated at 8.2 and 8.6 cents per euro using, respectively, the W95 and the SW10 estimators, hence very low compared to other studies on the capitalisation of the EU decoupled subsidies, but still significantly different from zero. Based on this result, we conclude that accounting for selectivity is crucial for correctly estimating the coefficients, although the selection bias exhibits only a limited impact on the estimate of the capitalisation effect.

[15]Results not shown and available upon request.

Table 3

Rental price equation, Italy, 2005–2008

	POLS	HECKMAN	FE	IVFE	W95	SW10
RETURNS	0.008*** (0.001)	0.003** (0.001)	0.005*** (0.001)	–0.009 (0.007)	0.006*** (0.002)	0.019 (0.021)
*SPS*ENT*	0.114*** (0.015)	0.160*** (0.019)	0.024 (0.016)	0.024 (0.017)	0.082*** (0.024)	0.086*** (0.024)
SIZE	–0.029 (0.026)	0.111* (0.064)	–0.446*** (0.147)	–0.530*** (0.156)	–0.209 (0.219)	–0.124 (0.245)
LS	–239.889*** (27.238)	–32.445 (60.102)	–28.638 (36.857)	–35.246 (38.320)	–42.933 (38.881)	–34.990 (37.547)
WAGE	11.910*** (1.117)	27.928*** (4.238)	–2.776** (1.234)	–3.414*** (1.305)	1.977 (1.790)	1.791 (1.884)
ADENS	313.473*** (54.576)	497.734*** (76.169)	279.373*** (53.954)	217.765*** (64.587)	16.246 (98.463)	66.882 (139.163)
LANDTR	–1,435.538*** (329.799)	18.679 (486.196)	770.564** (301.299)	856.853*** (311.838)	–616.417 (380.465)	–670.778* (383.817)
LABOUR	–47.538*** (10.535)	10.547 (20.972)	–30.148* (17.483)	–52.494** (21.007)	–22.608 (21.207)	–2.422 (36.994)
CAPITAL	–0.079** (0.037)	–0.002*** (0.001)	0.000 (0.001)	0.001 (0.001)	–0.001 (0.001)	–0.001 (0.001)
λ					46.255** (22.763)	52.363** (24.114)
λ_{2006}					–40.514*** (15.612)	–38.400** (16.095)
λ_{2007}					–7.298 (18.184)	–2.219 (19.461)
λ_{2008}					8.741 (28.122)	–0.104 (34.656)
Intercept	91.897*** (13.644)	–319.110*** (99.927)	240.739*** (22.797)	306.873*** (39.329)	–23.663 (49.271)	–41.154 (51.389)
Selectivity test $\rho = \rho_t = 0$					$F(4,1545) = 3.61$ $P = 0.006$	$F(4,1542) = 3.69$ $P = 0.005$
CRE test $\eta = 0$					$F(9,1545) = 12.03$ $P = 0.000$	$F(9,1542) = 11.57$ $P = 0.000$
Endogeneity test				$F(1,2664) = 4.698$ $P = 0.030$		
N obs	4,260	4,260	4,260	4,217	4,260	4,217
N Farms	1,546	1,546	1,546	1,543	1,546	1,543

Notes: Robust standard errors in parentheses, corrected for first stage estimations when necessary. ***significant at 1% level; **significant at 5% level; *significant at 10% level. Selectivity test refers to either the W95 or the SW10 test for selectivity bias. CRE test is a test on the null hypothesis that all the coefficients of the time means of variables are jointly insignificant. Endogeneity test is the auxiliary regression based Hausman test.

6. Conclusion

Extensive academic and policy discussions accompanied the introduction of agricultural payments decoupled from production, debating the extent to which these payments, being attached to land only, capitalise into agricultural land prices. In Italy, the implementation of the CAP decoupled payment regime followed the historical model, linking the number and value of entitlements to the historical payments. Two consequences of this choice are especially worth noting: the first is that the share of activated area is substantially below one, a condition theoretical models predict as leading to low capitalisation; the second is that some farmers that rented land in the reference period and received subsidies for these hectares may now have more entitlements than eligible area. We examine how these specific conditions affect the capitalisation of decoupled subsidies, compared with the case of coupled subsidies. For this purpose, we study the relationship between rents and subsidies in a sample of Italian farms specialised in arable crops, observed during the years 2000–2008, and split the sample into two periods, the period before the introduction of decoupled payments (2000–2004) and that immediately after (2005–2008).

The first important conclusion of the paper is that we find substantially lower capitalisation effects compared to the previous literature. This is, admittedly, a limitation of this study for the combination of the characteristics of the data and of the institutional and geographical context, which pose severe identification issues with relevant implications for the estimation of the capitalisation effect. The dataset does not provide information on the characteristics of the farmer nor on those of the rental agreement but, benefiting from the panel nature of the dataset, it is possible to consider these effects as fixed over time. The peculiarity of the institutional setting in Italy, on the other hand, is the long contract duration that causes average rents to vary little over time and hence the fixed effects to hide the role of the covariates and, among them, the role of subsidy capitalisation. In fact, we find that accounting for the heterogeneity bias related to the unobservable characteristics of the individual and of the rental agreement weakens the evidence of capitalisation in the period pre-decoupling. However, the evidence proves robust in the period post-decoupling, even though the estimated effect is substantially lower than other estimates in the literature.

A second conclusion of the paper concerns the likely mechanism behind capitalisation. With the coupled payment scheme in use in the years 2000–2004, the farmer received a per hectare amount, broadly known to both the tenant and the landlord, and different for each crop. Given contract duration of about ten years, and since the final per-hectare payment depended on the yearly crop-mix decision, landlords were uncertain about the future payments, and this decreased the likelihood of capitalisation. This explanation justifies, in part, the evidence that coupled subsidies did not capitalise into farmland prices according to our estimates, although this is specific for the arable crop farms, which often rent land for longer periods compared to farms specialised in other crops, and does not generalise to the whole agricultural sector. With the decoupled payments scheme, the farmer needs to attach a hectare of land to each entitlement to receive the payment. If the farmer owns more eligible area than entitlements, an additional hectare of rented land will not give the right to an additional payment, and the likelihood of capitalisation is low. On the other hand, for farmers with more entitlements than eligible hectares, the additional land rented will give the right to an additional payment, and the farmer may be willing to pay a premium for that land. Our findings support this theoretical prediction, suggesting that

the capitalisation of decoupled payments occurs only if the farmer owns more entitlements than hectares.

Supporting Information

Additional Supporting Information may be found in the online version of this article:
Table A1. FE probit model estimates.

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