# Distributional Effects of CAP Subsidies: Micro Evidence from the EU

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# Distributional Effects of CAP Subsidies: Micro Evidence from the EU[1]

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## Abstract

*In this paper we estimate the income distributional effects of the common agricultural policy (CAP) for farmers and landowners. Using a unique farm level panel data set from the FADN for the period 1995-2007 we employ the fixed effects, the Heckman selection bias and the GMM estimators to estimate income distributional effects of CAP subsidies. The results do not confirm the theoretical hypothesis that landowners benefit a large share of the CAP subsidies. According to our estimates, farmers gain between 60% to 95%, 80% to 178% and 86% to 90% of the total value of coupled crop/animal, coupled RDP and decupled payments, respectively. The CAP subsidies are only marginally capitalised in land rents. Our results suggest that rental rates are more responsive to structural variables and show a strong time dependency, suggesting the presence of rigidities in the EU rental markets, which constraint the adjustment of land rents to market signals and thus reduce landowners' gains from the CAP.*

## 1. Introduction

The EU agricultural sector receives more than 50 billion Euros (ca. 45% of the EU budget) through the CAP subsidies per year. There is an ongoing debate among policy makers and scientific community about the actual beneficiaries of the CAP subsidies (or as referred to "income distributional effects of subsides"). Even though farmers are the primary recipients of the CAP subsidies, various factors may lead to a situation where farmers benefit only part of the subsidies or to a situation where farmers do not benefit from the CAP subsidies at all. Besides farmers, also other agricultural market participants may partly or fully capture the CAP subsidies. Particularly, this might be the case of landowners, consumers, and input suppliers. For example, studies from the US show that landowners capture a substantial share of subsidies (e.g. Goodwin, Mishra and Ortalo-Magné 2005; Kirwan 2005; Lence and Mishra 2003).

Theoretical studies show that depending on the type of subsidies and formal and informal institutions and market distortions, agricultural subsidies may or may not benefit farmers. The theoretical literature has explored how different types of agricultural policies (e.g. decoupled subsidies, export subsidies, price intervention) and other factors (e.g. elasticities, market imperfecttions, market structure) affect the distributional effects of subsidies (e.g. Alston and James 2002; de Gorter and Meilke 1989; Gardner 1983; Guyomard et al 2004; Salhofer 1996; Ciaian and Swinnen 2009).

The empirical evidence on distributional effects of farm subsidies is considerably scarcer. Two types of approaches have been followed in empirical literature. First, econometric studies try to estimate the distributional effects of subsidies. The vast majority of these studies estimate the capitalisation rate of subsidies into land values (i.e. landowners' policy rents) in North America (e.g. Goodwin and Ortalo-Magné 1992; Gardner 2002; Lence and Mishra 2003; Roberts, Kirwan, and Hopkins 2003; Kirwan 2005). There are only few studies on the capitalisation of the CAP in the EU (Duvivier, Gaspart and de Frahan 2005; Patton et al. 2008; Kilian et al. 2008).[2] The other strand of empirical literature applies partial equilibrium (PE) or general equilibrium (CGE) models to simulate the distributional effects of agricultural subsidies (e.g. Dewbre, Anton and Thompson 2001; Gohin and Moschini 2006; Hubbard (1995); OECD 2000; Salhofer and Schmid 2004). Although PE and CGE models can capture complex interlinkages present in the agricultural markets, the simulated effects heavily depend on calibrated or arbitrary assumed elasticities. As a result, the confidence interval of these studies is rather big.

The objective of this study is to assess the distributional effects of the CAP subsidies in the EU. We consider coupled (crop and animal payments, RDP payments) and decoupled payments. These subsidies cover most of the CAP support (around 75% of the total CAP expenditures). Our main contribution to the literature is to empirically estimate how benefits of different types of the CAP subsidies are distributed between farmers and landowners. Employing a unique farm level Farm Accountancy Data Network (FADN) panel data for the period 1995-2007 we are able to empirically estimate the distributional effects by controlling for unobserved heterogeneity.

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[1] The authors are grateful to Microeconomic Analysis Unit L.3 of the European Commission for granting access to the firm-level FADN data. The authors are solely responsible for the content of the paper. The views expressed are purely those of the authors and may not in any circumstances be regarded as stating an official position of the European Commission.

[2] With few exceptions (Dewbre and Mishra 2007; Henningsen, Kumbhakar and Lien 2009), the econometric estimates on farmers' benefits from subsidies are non-existent.

## 2. Theoretical framework

There is extensive theoretical literature on the distributional effects of agricultural subsidies. Most of these studies apply partial equilibrium models either by modelling a representative farm or by considering the supply-demand market interactions (e.g. Floyd 1965; Alston and James 2002; de Gorter and Meilke 1989; Gardner 1983; Guyomard, Mouël, and Gohin 2004; Salhofer 1996; Ciaian and Swinnen 2006, 2009).

In line with the first approach, in this paper we employ a stylised partial equilibrium model with perfect markets, whereby the representative farm's non-increasing to scale production technology, $f(A,Z)$, where, *f*, the quantity of the final product, is assumed to be a function of two inputs (land, $A$, and non-land input, $Z$, (e.g. labour)) with $f_i > 0$, $f_{ii} < 0$, $f_{ij} > 0$,[3] for *i*, *j* = *A* and *Z*. For simplicity, the entire land is assumed to be owned by landowners, which rent it to farms. The representative farm's profits are given as follows:

(1) $\prod = pf(A,Z) - rA - wZ$

where *p* is the price of the final product, *r* is rental price of land, and *w* is price of non-land input.

We analyse two types of CAP subsidies: (i) coupled direct payments and coupled RDP measures, and (ii) decoupled direct payments granted under the CAP. The coupled direct payments and the coupled RDP measures include crop area direct payments, animal direct payments, investment support, LFA payments, and environmental payments. The coupled direct payments are available to farmers in all EU Member States (MS), though they were significantly reduced with the introduction of the SPS in 2005. The decoupled CAP payments consist of the Single Payment Scheme (SPS), and the Single Area Payment Scheme (SAPS). The SPS was introduced by the 2003 CAP reform and is implemented mainly in the Old MS starting from 2005. The SAPS is implemented in the New MS.

*Coupled CAP payments*

The coupled direct payments change farm profit function (1) as follows:

(2) $\prod = (p + s_Q) f(A,Z) - (r - s_A)A - (w - s_Z)Z$

The crop coupled direct payments include payments such as compensatory area payments for cereals, oilseeds and protein crops, area payment to rice, etc. They are directly coupled to land and can be modelled as an area subsidy, $s_A$, linked to land (e.g. Dewbre et al. 2001; Kilian and Salhofer 2008). The coupled animal direct payments include various types of subsidies such as suckler cow premium, beef premium, slaughter premium, ewe premium, etc. These subsidies are either output (animal) type of payments, $s_Q$, (e.g. beef premium, slaughter premium) or subsidies linked to non-land input, $s_Z$, (e.g. suckler cow premium, ewe premium), which particularly affect the stock of breeding livestock.

Besides the crop and animal coupled direct payments, farmers receive also Rural Development Programme (RDP) payments (also known as the "second pillar" CAP policies). We study three types of RDP payments: the investment support, the LFA and environmental payments. Under the investment support programme farmers can obtain a grant to partly finance the costs of capital purchases. The investment support can be modelled as a non-land (capital) input subsidy, $s_Z$, because it reduces the non-land input costs. The LFA is an area based payment to farmers located in less productive regions. Similar to the crop area payments, it can be modelled as an area subsidy, $s_A$. The environmental payments are granted for a range of farm activities aimed at improving environment on the farm. These payments cover additional costs and farm income foregone resulting from these activities. The environmental payments affect in particular farm input use, because they are conditional on the adoption of environmentally friendly production practices, such as input use reduction, organic farming, intensification of livestock, conversion of arable land to grassland, rotation measures, and support of biodiversity (European Commission 2005). These payments can be modelled as land or/and non-land input subsidies, $s_A$, $s_Z$, because they affect all inputs, but may not alter farm production level and/or farm income. For example, if the environmental payments cover exactly the additional costs, then their marginal impact on farm behaviour is zero.[4]

With decoupled subsidies farm and market equilibrium conditions are given as follows:

(3) $(p + s_Q) f_A = r - s_A$ and $(p + s_Q) f_Z = w - s_Z$

(4) $f = D(p)$

(5) $A = S^A(r)$

(6) $Z = S^Z(w)$

[3] $f_i$ and $f_{ij}$, $f_{ii}$ are first and second derivatives of the production function with respect to its arguments, respectively.

[4] Implicitly it follows that the actual value of environmental payments could be positive, zero or negative depending on the size of additional costs induced by the payments.

where $D$ is output demand and $S^A$ and $S^Z$ are supply functions of land and non-land inputs, respectively, with $\partial D/\partial p = D_p \leq 0$, $S_r^A \geq 0$ and $S_w^Z \geq 0$.

Equations (3) are farm marginal equilibrium conditions derived from maximisation of the profit function (2). They determine the farm input demands. Equations (4), (5) and (6) are market clearing conditions for output, land, and non-land input, respectively.

Farm's profit may be altered by subsidies ($d\Pi/ds_i$) for two reasons: first, because farms are recipients of the subsidies; and second, because subsidies may affect agricultural output prices ($dp/ds_i$), and input prices (i.e. land, $dr/ds_i$ and non-land input $dw/ds_i$). Landowner's income is affected if subsidies affect land rental prices ($dr/ds_i$). Totally differentiating the equilibrium conditions (3) – (6) and solving for $dp/ds_i$, $dr/ds_i$, $dw/ds_i$, and $d\Pi/ds_i$ (for $i = A, Z, Q$), respectively, yields comparative static results, which are summarised in Table 1.

The comparative static results reported in Table 1. According to these results, the ranking of income distributional effects between farmers and landowners depends on the type of the CAP payments. However, in well functioning markets, landowners are found to benefit a large share of all types of CAP subsidies through their capitalisation into land rents. This is due to inelastic land supply, which does not allow adjustments in land supply. The only channel of land market adjustment is rental price, when subsidies induce stronger competition for agricultural inputs. In particular, landowners are expected to gain proportionally more from CAP subsidies linked to land (e.g. crop area payments, LFA) than farmers (and other market agents), because land subsidies directly stimulate land market and because of inelastic land supply. Farmers and landowners are expected to share the benefit (losses) from output subsidies and non-land input subsidies (e.g. investment support, environmental payments). However, because of inelastic land supply, landowners may also benefit a substantial share of non-land input and output subsidies.

*Decoupled CAP payments*

The CAP implements two types of decoupled direct payments: the SPS and the SAPS. The SPS was introduced by the 2003 CAP reform mainly in Old MS. The SAPS is implemented in most New MS in 2004.

Theoretically, the decoupled subsidies are expected to have a mixed impact on incomes of landowners and farmers (Kilian and Salhofer 2008; Courleux, et al. 2008; Ciaian, Kancs and Swinnen 2008). They may result in high capitalisation rates leading in such a way to considerable leakage of policy gains to landowners. This is the case of the SAPS and, if entitlements are surplus relative to the eligible area, also the case of the SPS. In this case both the SAPS and the SPS create similar market incentives as land based subsidies. However, as long as the number of eligible area exceeds the number of entitlements, the SPS benefit farmers.

## 2.1. Other factors affecting the income distributional effects of the CAP

In the theoretical analysis above we assumed perfect input and output markets. However, in reality rural markets are affected by many other factors, the two most important of which are accompanying policy measures and land market institutions and regulations.

The income distributional effects of subsidies depend particularly on *accompanying policy measures.* In the real world agricultural support policies are combined in policy programmes involving multiple instruments implemented in the same time, none of which can be considered isolated from the others. For example, both coupled and decoupled CAP payments are conditional on the fulfilment of cross-compliance requirements. Farm failure to respect these conditions can lead to a reduction or a complete termination of the CAP payments. The conditionality of the CAP payments may mitigate their effects on land rents and farm profits due to the fact that the eligibly for subsidy may require farmers to incur certain costs.

The distributional effects of subsidies can be affected also by *market institutions and regulations*. The rental market regulations in the EU include e.g. rental price restrictions (minimum/maximum price) and regulations on the duration of rental contracts (Ciaian, Kancs and Swinnen 2010). The rental price restrictions are in general formal imposed by government, whereas the duration of rental contracts can be regulated through both formal governmental interventions and/or through informal rural market institutions. Of particular importance for the CAP is the maximum price intervention. The potential capitalisation of the CAP into land rents will be reduced in the presence of a rental price ceiling and thus will facilitate higher transfers of the CAP rents toward farms. An important implication for the rental price adjustments has also the duration of rental contracts. *Ceteris paribus*, long-term rental contracts for agricultural land will adjust less to external changes than short-term contracts. According to Ciaian, Kancs and Swinnen (2010), the key determinants of rental contract duration in the EU are social norms (e.g. in Greece), governmental regulations (e.g. there is a minimum of 9 years in Belgium and France, 6 years in the Netherlands and 5 in Spain), and market institutions (e.g. Germany, Italy, Sweden). Moreover, in several countries (e.g. France) even the renewal of rental contracts is regulated. The implications of the rental contract duration on the CAP capitalisation are likely more significant than the rental price regulations, because they are more widespread in the EU (Ciaian, Kancs and Swinnen 2010).

## 3. Econometric specification

Solving the farm maximisation problem (equations (3)-(4)) and accounting for the SPS subsidies, farm income (profit) and land rents depend on the output price (*p*), the non-land input price (*w*), farm output (*f*) and decoupled and coupled subsidies (*e* and $s_i$ for *i*=*Q*, *A*, *Z*) suggesting the following econometric models:

(7) $$r_{jt} = \alpha_0 + \alpha_s s_{ijt} + \alpha_e e_{jt} + \alpha_1 p_{jt} + \alpha_2 w_{jt} + \alpha_3 f_{jt} + \alpha_4 X_{jt} + \eta_{jt}$$

(8) $$\Pi_{jt} = \delta_0 + \delta_s s_{ijt} + \delta_e e_{jt} + \delta_1 p_{jt} + \delta_2 w_{jt} + \delta_3 r\_adj_{jt} + \delta_4 f_{jt} + \delta_5 X_{jt} + \varepsilon_{jt}$$

where subscripts *i, j, t* stand for the type of coupled subsidies (*i*=*Q*, *A*,*Z*), farm and time, respectively; and $X_{jt}$ is a vector of observable covariates such as farm characteristics, regional, and time variables. As usual, $\eta_{jt}$ and $\varepsilon_{jt}$ are the residuals.

The main interest in our study are parameters $\alpha_s$ and $\alpha_e$ in rental equation, and $\delta_s$ and $\delta_e$ in profit equation. These parameters indicate the income distributional effects of subsidies: i.e. the policy rents of landowners ($\alpha_s, \alpha_e$) and farmers ($\delta_s, \delta_e$) per 1 Euro of coupled and decoupled CAP payments.

The estimation of equations (7) and (8) is subject to several econometric issues. We identify three key issues: omitted variable bias, selection bias and endogeneity. Without addressing these issues it is impossible to obtain consistent estimates of the incidence of agricultural subsidies on farmland rental rates. In order, to control for these econometric issues we estimate three econometric models: the fixed effects model, the Heckman selection bias model and the generalised method of moment (GMM) model.

*Omitted variable bias*

Equations (7) and (8) contain the key variables determining the incidence of agricultural subsidies. In addition to these included explanatory variables, there are also unobservable farm characteristics, e.g. farmer ability, which affect land rental price and net farm income, and in the same time are correlated with explanatory variables in equations (7) and (8). Ignoring the unobserved farm heterogeneity would cause omitted variable bias.

The panel structure of the FADN data allows us to control for the omitted variable bias. By employing properties of the panel data, the unobserved heterogeneity component that remains fixed over time can be controlled for thus eliminating or reducing considerably the omitted variable bias. In order to control for unobserved permanent farm-level characteristics, we follow Kirwan (2005) and estimate *fixed effects model*, which yields:

(9) $$r_{jt} = \alpha_0 + b_j + \alpha_s s_{ijt} + \alpha_e e_{jt} + \alpha_1 p_{jt} + \alpha_2 w_{jt} + \alpha_3 f_{jt} + \alpha_4 X_{jt} + \eta_{jt}$$

(10) $$\Pi_{jt} = \delta_0 + d_j + \delta_s s_{ijt} + \delta_e e_{jt} + \delta_1 p_{jt} + \delta_2 w_{jt} + \delta_3 r\_adj_{jt} + \delta_4 f_{jt} + \delta_5 X_{jt} + \varepsilon_{jt}$$

where $b_j$ and $d_j$ are fixed effects for farm $j$, which capture time-unvarying farm-specific characteristics. These fixed effects reflect farm heterogeneity, such as different technologies for different farms, different managerial skills or other unobservable fixed farm specific characteristics.

*Selection bias*

A significant number of farms in the FADN dataset do not rent any land. Because of missing left hand side variables, these farms are excluded from our sample. To control for the selection bias related to farms' rental market participation decisions, we employ the *Heckman's sample selection model* (Heckman 1979).

One may expect that more dynamic farms and/or those with limited own land resources may be more inclined to participate on rental markets compared to less dynamic, part-time and/or subsistence farms. Farms with zero rentals will drop out from equation (7), as their land rental prices do not exist. If the farm rental decision is non-random, then the standard estimation approach would result in biased estimates. To control for the potential sample selection bias, we follow Heckman (1979) and adopt a two stage estimation approach. In the first stage, we examine the determinants of farms' decision to rent agricultural land using a Probit model.[5] In the second stage, we estimate the rental equation (7) in first differences. The selection bias is controlled for through inclusion of the Inverse Mills Ratio (IMR) computed in the first stage.[6] This yields an empirically estimable Heckman's sample selection model, which controls for time-unvarying farm specific effects:

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[5] The dependent variable $h_j$ is a dichotomous (1, 0) variable indicating whether the *j*-th farm rented land or not.

[6] If IMR is significant in the second stage, it suggests there is significant bias in the initial model. However, one potential limitation of the Heckman method is that if the Heckman in the selection model is not well-specified, the IMR may be weaker than expected and the Heckman method may have limited power to detect bias. As a result, a second factor to examine following the addition of the IMR variable into the initial specification models is whether or not there have been significant changes in any of the parameter estimates.

(11) $\Delta r_{jt} = \alpha_s \Delta s_{ijt} + \alpha_e \Delta e_{jt} + \alpha_1 \Delta p_{jt} + \alpha_2 \Delta w_{jt} + \alpha_3 \Delta f_{jt} + \alpha_4 \Delta X_{jt} + \alpha_4 \mathrm{IMR}_{jt} + \Delta \eta_{jt}$

Although, the FADN sampling strategy is representative and methodologically consistent, theoretically, the estimation of equations (7) and (8) could also suffer from attrition bias. The FADN is an unbalanced panel, where every year 5 to 20 percent of farms are dropped from the sample. Farms are excluded either because of the FADN sampling strategy of regular annual replacement of observations and/or because of other reasons (voluntary drop-out, exit from farming). If some groups of farms drop out from the sample more frequently than others, then the standard estimators would yield biased results. Therefore, we test also for the attrition bias. We find no significant impact on the estimated coefficients.[7]

*Endogeneity*

If subsidies were assigned to farms randomly, then parameters $\alpha_s$ and $\alpha_e$ in the rental equation and parameters $\delta_s$ and $\delta_e$ in the profit equation would measure the share of each extra subsidy Euro per hectare reflected in higher rental rates. In reality, however, subsidies are not assigned randomly to farms. For example, the coupled animal and crop subsidies depend on regional and farm level productivities. The coupled subsidies are allocated to each MS based on regional productivities (e.g. regional reference yield). At farm level the size of subsidies depends on the MS subsidy size (i.e. regional productivity) and on the farms' crop choice (e.g. supported versus non-supported crops). Similar holds for the SAPS in the new MS. Although, the SAPS is not based on farm productivities directly, it is nevertheless correlated with the pre-accession average country/regional productivities, because the base for the CAP application in new MS was the average production level and intensity in the pre-accession period. This implies that the SAPS is exogenous at farm level within each new MS but endogenous between the new MS. The decoupled SPS payments depend on the past coupled payments and on the average country/regional productivities, because the value of the SPS was set based on regional productivities or/and farm past level of subsidies. The RDP (investment support, environmental payments) are allocated to farmers based on project submission. Only those farms which submit and have a successful project are granted the support. Hence the RDP is non-random because farms self-select to participate and only those with the best projects (likely the more productive farms) are granted the RDP support. This structure of coupled and decoupled CAP subsidies implies that they are endogenous variables reflecting the characteristics of country/regions' land and farmer's behaviour.

These endogeneity problems may lead to biased estimates. To address this source of endogeneity, we employ the Arellano and Bond (1991) robust two-step GMM estimator. Arellano and Bond (1991) have shown that lagged endogenous variables are valid instrument in panel data setting. This allows us to use lagged levels of the endogenous variables as instruments (additionally to exogenous variables), after the equation has been first-differenced to eliminate the farm specific effects. The GMM estimator is particularly suitable for datasets with a large number of cross-sections and few periods and it requires that there is no autocorrelation. The FADN dataset matches these requirements, because it is a panel data and contains a very large number of farm-level observations relative to the period covered. Given that the robust two-step GMM standard errors can be severely downward biased, we use the Windmeijer (2005) bias-corrected robust variances.

## 4. Data and variable construction

The main source of the data used in the empirical analysis is the Farm Accountancy Data Network (FADN), which is compiled and maintained by the European Commission. The FADN is a European system of sample surveys that take place each year and collect structural and accountancy data on the farms. To our knowledge, the FADN is the only source of micro-economic data that is harmonised (the bookkeeping principles are the same across all EU Member States) and is representative of the commercial agricultural holdings in the whole EU.

The FADN data is a panel dataset, which means that farms that stay in the sample over consecutive years can be traced over time using a unique identifier. In this study we use panel data for 1995-2007 covering all EU MS except Romania and Bulgaria. Romania and Bulgaria were excluded from the sample, because for these countries the data were available only for one year (2007).

The dependent variable in equation (7) ($r_{jt}$) - *land rental price* - is constructed from the FADN data by dividing the total amount of rent paid for farm land and rental charges with the total utilised agricultural area (UAA) rented by the holder under a tenancy agreement for a period of at least one year. The dependent profit variable in equation (8) ($\Pi_{jt}$) – *net farm income* – is calculated by subtracting taxes, variable expenses (intermediate, land, labour) and fixed costs (depreciation and interest payments) from the total farm revenues (output and subsidies). We estimate equation (8) per hectare, which means that we divide the obtained net farm income with the utilised agricultural area.

[7] The results are available upon request from the authors.

Similarly, all subsidy variables (*coupled crop area payments*, *coupled animal payments*, *decoupled payments* (SPS and SAPS), *investment support*, *environmental payments* and *LFA*) (*e* and $s_i$ for *i*=*Q*, *A*, *Z*) are constructed from the FADN data and are calculated on per-hectare basis. Every agricultural producer in the FADN survey is asked to report both the total subsidies received as well as to specify the amount by major subsidy types. To account for taxes and other types of subsidies, we construct variable *other subsidies* by subtracting taxes from rest of the farm payments not included in the above payment categories.

Also the output and input control variables in equations (7) and (8) ($w_{jt}$, $r\_adj_{jt}$, $f_{jt}$) are constructed from the FADN data. To account for the output and input price adjustments we include *market return*, *wage*, *other inputs* and *adjusted rental price* (only for income equation (8)). The market return variable is constructed by dividing the total farm output by the total utilised agricultural area. The wage variable is constructed as a weighted average of the regional mean wage and farm specific wage. The variable other inputs includes crop/animal-specific inputs (seeds and seedlings, fertilisers, crop protection products, feed, other specific costs), overheads, depreciation and interest costs. It is constructed as a weighted average of the sectoral/regional mean and farm specific value and it is divided by the UAA. Similarly, the adjusted rental price is a weighted average of the regional/sectoral rate and farm specific rent. We utilise weighted input costs (i.e. wage, other inputs and rents) of the regional/sectoral mean and farm-specific values in order to control for three factors: regional opportunity values of inputs, measurement error potentially present at farm level data[8] as well as farm specific effects (e.g. labour skill differences, land quality at farm, farm specific technology).

The covariates matrix, $X_{jt}$, includes other explanatory variables, which affect land rents and farm income. We consider the following covariates: land rented ratio, labour own ratio, sharecropped land, farm size, land per capita, irrigated land, area under glass, fallow land, credit and capital availability and sectoral, regional and time dummies.

Variables used in the GMM regressions are structured in endogenous and exogenous and are summarised in Table 2.[9] To reduce the endogeneity problem between various types of subsidies and to reduce the number of instruments, we merge the subsidy types into four main groups: *RDP (investment support*, *environmental payments*, *LFA*), *coupled payments* (*crop area payments*, *animal payments*) *decoupled payments* (*SPS*, *SAPS*), *other subsidies* (the rest of subsidies minus taxes). To account for the dynamic adjustment of rents and farm income, we create lagged dependent (2 lags) and lagged explanatory (0 and 1) variables. For all endogenous variables, we use the first lag as an instrument alongside the exogenous variables and lagged dependent variables. The choice of lags for instruments was selected by checking the validity of different sets of instruments.

## 5. Empirical results

We estimate the incidence of agricultural subsidies on farmland rental rates in three alternative models: the fixed effects model, the Heckman sample selection model and the first difference GMM model. Table 3 reports the fixed effects panel data estimates in levels, where the dependent variables are net farm income (columns 1-3) and land rental price (columns 4-6). Additional to the complete income and rental equation specification in columns 1 and 4, we add lag dependent variable in specifications 3 and 4 and, following Dewbre and Mishra (2007), we exclude variables potentially causing multicollinearity in specification 2 and 5.

Generally, the farm income models yield significantly 'better' estimates than the rental price models. For example, most of the estimated coefficients have the expected sign in the income equation, and market returns have a positive and significant impact on farm income whereas inputs costs reduce farm income (columns 1-3). This is not the case for the rental equation, where input variables are either statistically insignificant or they have a positive sign although, according to our expectations, market returns increase land rents (columns 4-6).

Both the income and land rent coefficients weakly increase with *farm size*, which may reflect the presence of economies of scale. The land abundance variable (*land per capita*) is positive and significant for income equation but not for the rental equation. The *rented land ratio* reduces both income and land rents. Profits are affected because of lower incentive associated with the use of rented land and because of higher costs of farms relying on rented land as opposed to farms owning land. Rental rates might decrease because of lower incentive associated with the use of rented land. *Sharecropped land ratio* has a positive sign but is not statistically significant in most of the estimated models. Own labour (*labour own ratio*) increases farm profits because of cost reducing effect. Contrary to our expectations, own labour reduces land rents as, due to incentive differences between family and hired labour, one would expect the opposite sign (e.g. Pollak 1985; Allen and Lueck 1998). The coefficient associated with the *output livestock ratio* is statistically insignificant. Higher farm own consumption reduces farm income and land rents, which possibly is because of smaller market orientation of farms producing for self-

[8] For example, regional averages were utilised for farms with missing wage, rental price and other costs data (because of zero labour hiring and zero land renting).

[9] The agricultural employment is relatively low in the overall EU employment (around 2-5%) implying that farms are likely price taker on the labour market and hence the wage rate is most likely exogenous for individual farms.

consumption. The *liabilities-to-assets ratio* increase income and land rants, which may indicate the presence of farm credit constraint.

All estimated models suggest that subsidies significantly influence farm income (columns 1-3, Table 3). The estimates are relatively stable across the models except for the coupled crop and animal payments, which suggest their correlation with the excluded variables in specification 2, such as market returns and input prices (column 2 in Table 3). As discussed in the previous section, the regional and farm level productivities represent a strong determinant of coupled CAP subsidies. Our estimates imply that the net farm income increases between 0.77 EUR and 1.65 EUR for each subsidy EUR[10]. Surprisingly, the estimated subsidy coefficients are particularly high for LFA and coupled crop area payments for farm income. According to the theoretical predictions, both should be capitalised into land rents and benefit landowners instead of farmers. As expected the *decoupled payment* estimates (between 0.89 and 0.92) are slightly higher than the estimates for coupled crop/animal payments and the investment support (between 0.60 and 0.90). In contrast, the *environmental payments* generate slightly higher farm income effect (between 0.85 and 1.00) compared to decoupled payments, which is contrary to the theoretical expectations. These results may suggest that they do not induce farm behavioural effects, e.g. additional costs.

Although, the estimates of the income distributional effects of subsidies reported in Table 3 are rather high, they are consistent with other studies. For example, Henningsen, Kumbhakar and Lien (2009) report that the intermediate input subsidies have a negative impact on farmers' income in Norway (i.e. -0.39), while output subsidies and decoupled payments fully benefit farmers (1.02 and 1.00, respectively). The estimates of Dewbre and Mishra (2007) for US range between 0.96 and 0.97 for decoupled payments and between 0.50 and 0.83 for coupled payments.

Regarding the land rental price equation, the estimates of subsidy effects are statistically significant for roughly half of the variables, but their values are relatively low (less than 0.05), implying that subsidies are not an important determinant of land rents (columns 4-6, Table 3). These findings contradict the empirical studies from the US, which find that the capitalisation rate for coupled and decoupled subsidies is between 20-100%.[11] Among the possible explanations behind the relatively low estimates could be strict rental market regulations in the EU, and identification issues. In addition, the rental costs in the FADN data include not only farm land rents, but also rents for buildings and other rental charges. Although, we made an attempt to correct for this data issue,[12] the data may still contain a measurement error bias.

Table 4 reports the Heckman first-difference estimates for rental equation, which controls for the rental market participation bias. The coefficient of the *Inverse Mills Ratio*, which tests the impact of rental market participation bias, fails to be significant and parameter estimates of subsidies are to a large extent consistent with the fixed effects estimates reported in Table 3, which confirms that the CAP subsidies are capitalised into land rents at a low rate.

The GMM estimates are shown in Table 5.[13] As usual, we start with diagnostic tests. We employ the Arellano-Bond statistics to test for serial dependence of errors. The tests indicate strong evidence against the null hypothesis of zero autocorrelation in the first-differenced errors at order 1 but confirm no autocorrelation in the first-differenced errors at order 2 in both the rental and income equations. Serial correlation of order higher than 1 would imply misspecification of the model. The test for the validity of instruments performs better for the income equation than for the rental equation. The Sargan test statistics indicates that we cannot reject the null hypothesis that the over-identifying restrictions are valid for the income equation. However, for the rental price equation, the test rejects the null hypothesis, implying that instruments may be correlated with the residuals and thus fail to fulfil the exogeneity condition. The Sargan test rejection may be also a result of heteroskedasticity. Arellano and Bond (1991) found tendency for this test to be under-rejected in the presence of heteroskedasticity. To account for heteroskedasticity, we follow Windmeijer (2005) and use robust standard errors.

Generally, the GMM results reported in Table 5 are fairly consistent with the fixed effects results reported in Table 3 for the income equation (columns 1 and 2). The consistency is particularly strong in terms of sign for all parameters and of magnitude for parameters corresponding to subsidies, market return and input prices. The rental equation shows significant changes in the sign, magnitude and significance level for all parameters compared to the fixed effects results (columns 3 and 4). These results confirm that the rental equation does not respond well to variables predicted by the theory. The majority of the estimated coefficients corresponding to subsidies, market return and input prices are not significant. A strong determinant of rents appears to be lagged values of rents, indicating the rigidity of rental markets potentially induced by rental price regulations and long durations of rental

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[10] The subsidy farm income effect higher than 1.00 may be caused by the interaction of subsidies with the farm credit constraint leading to productivity upgrade and hence higher farm income (Ciaian and Swinnen 2009).

[11] The empirical findings from the studies show that land capitalisation of both coupled and decoupled subsidies (based on US studies) varies between 20% and (more than) 90% (Goodwin, Mishra and Ortalo-Magné 2003, 2005; Lence and Mishra 2003; Roberts, Kirwan, and Hopkins 2003; Kirwan 2005; Barnard, et al. 1997; Taylor and Brester 2005).

[12] For example by excluding high value rents which may represents rental for buildings.

[13] The variables employed in GMM are summarised in Table 3.

contracts. In the presence of rental price thresholds and long durations of rental contracts, land rents do not adjust to market signals but tend to stay unchanged over time, which may lead to a lagged dependency between rents. Additionally, rents are responsive to control variables such as *farm size*, *land rented ratio*, *output livestock ratio*, indicating that the farm structural differences are strong determinants of rental rates.

According to the results reported in Table 5, a substantial share of the CAP payments benefit farms (columns 1 and 2). Relative to the fixed effects results (Table 3), the *RDP* and *coupled payments* tend to generate higher gains to farmers whereas *decoupled payments* induce slightly lower benefits if lagged effects are not taken into account (model 1). Accounting for the lagged dependencies (model 2), the contemporaneous farm income effect of subsidies is reduced, and the lagged coefficients of subsidies are not statistically significant. The estimates in Table 5 indicate that farmers benefit between 0.81 to 0.95 EUR, 0.81 to 0.86 EUR and more than 1.00 EUR for each payment EUR of coupled, decupled and RDP payments, respectively (columns 1 and 2). For the rental equation most of the coefficients measuring the subsidy capitalisation into land rents are statistically not significant (Table 5, columns 3 and 4).

*Identification issues and limitations*

The estimated results reported in Table 3 to Table 5 show that capitalization of the CAP subsidies into land rents is inconsistent with the theoretical predictions saying that a substantial share of all types of CAP subsidies benefit landowners (see the theoretical section 2). Two issues may yield these results: governmental regulations and rental market institutions, and identification problem.

The extensive governmental regulations and rental market institutions (minimum/maximum price; long-term rental contracts) in the EU may prevent land rents to adjust to policy changes. A study of Ciaian, Kancs and Swinnen (2010) reports the presence of important rental market regulations including rental price restrictions (minimum/maximum price) and the regulations on the duration of rental contracts**.** The rental price restrictions are in general imposed by government whereas the duration of rental contracts can be implemented by both formal governmental interventions and/or through informal rural market institutions. According to Ciaian, Kancs and Swinnen (2010),[14] several MS implement minimum or maximum rental prices such as Belgium, France, Greece and the Netherlands. These price interventions (particularly the maximum price) may reduce the transmission of subsidies into land rents. An even more important implication on the rental price adjustments has the long-term duration of rental contracts because, according to Ciaian, Kancs and Swinnen (2010), they tend to be more widespread than rental price regulations. For example, several countries have the average duration of rental contracts longer than 5 years (Belgium, Finland, France, Germany, Netherlands, and Spain). In Italy the average duration is 2 to 5 years for arable crops and 5 to 10 years for fruit crops (Ciaian, Kancs and Swinnen 2010). The long-term duration of rental contracts makes rental markets stickier and the time lag for the adjustment to policy changes takes a longer time period.

An important shortcoming of the FADN rental data is that it does not contain any information about the farm rental contracts and rental market regulations (e.g. contract type, contract duration, maximum rental price), which would allow to control for the rental market institutions. For example, to control for the rental contract duration, Patton et al. (2008) exclude from their sample in Northern Ireland all farms with the duration of contracts longer than one year and find (contrary to our empirical finding) high coupled subsidy capitalisation into land rents (between 0.40 and 1.20). Similarly, Kilian et al (2008) consider a variable measuring the share of newly signed rental contracts in order to estimate the difference in land capitalisation rate between the SPS and the pervious coupled subsidies in Bavaria (Germany). Their estimates indicate that the SPS is capitalised by additional 15% to 19% above the previous coupled subsidies. However, since Kilian et al (2008) use a cross-section data, they are not able to control for unobserved farm specific effects.

Particularly the rental price estimates may suffer from identification problems. If the law of one (rental) price holds, then the cross-sectional variation in rental price in each region/MS is independent of the subsidy variation at farm level, whereas the time variation in rental price, which may be induced by change in the subsidies, will be captured by regional/time dummies, or other region/country specific variables. This is because the equilibrium market rental price adjustments are determined by overall marginal and not by the farm specific marginal change of subsidies. In other words, the law of one price implies that the variation in land rents is not farm-specific but the rental prices tend to respond to policy or market changes at the same rate for all farms in a given region/MS. For farm income estimates this is less of a problem, because profits are farm specific and are determined by both farm and region specific variables (including subsidies).

## 6. Conclusions

In this paper we estimate the distributional effects of the CAP subsidies between farmers and landowners. We use the FADN farm level panel data for the period 1995-2007. We employ the fixed effects, the Heckman sample selection model and the GMM estimators to estimate the distributional effects of CAP subsidies. The empirical

[14] The study of Ciaian, Kancs and Swinnen (2010) cover 11 MS.

results do not confirm the theoretical predictions, whereby landowners benefit a large proportion of the CAP subsidies. In contrast, our estimates suggest that farmers benefit the major share of all types of CAP subsidies (RDP, coupled and decupled payments). According to our results, farmers gain more than 60% of CAP payments, i.e. they gain 60% to 95%, 86% to 90% and 80% to 178% of coupled, decupled and RDP payments, respectively. Our estimates are relatively robust with respect to different specifications and estimation approaches.

In contrast, landowners are found to benefit only marginally from subsidies; the coefficient estimates are either statistically not significant or their magnitudes are close to zero. These estimates could change, if, for example, improved rental contract data becomes available (e.g. duration of rental contract; presence of new contracts). Further, our results suggest that farmland rental rates are more responsive to structural variables (farm size, farm specialisation, importance of renting) than to variables predicted by the theory (market returns, input prices, subsidies). Additionally, the empirical results confirm a strong time dependency between the land rents (i.e. current rental rates depend on the lagged rents), suggesting that the presence of rigidities on the EU rental markets (rental price regulations and prevalence of long duration of rental contracts) may considerably constrain the rental price adjustments and thus reduce the landowners gains from subsidies relative to farmers. At the same time, the dependency of rental price on structural variables may indicate the identification problem of the farm level variation of subsidies on land rents. This is because, if the law of one (rental) price holds, the cross-sectional and the time variation in rental price in each region/MS is independent of the subsidy variation at farm level but it is likely correlated and captured by the time and/or region/country specific dummy variables.

**References**


Arellano, M. and S. Bond. (1991). “Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations.” *The Review of Economic Studies* 58: 277 – 297.

Ciaian, P. and J.F.M. Swinnen (2009). “Credit Market Imperfections and the Distribution of Policy Rents. “*American Journal of Agricultural Economics* 91(4): 1124-1139.

Ciaian, P. and J.F.M. Swinnen (2006). “Land Market Imperfections and Agricultural Policy Impacts in the New EU Member States: A Partial Equilibrium Analysis.” *American Journal of Agricultural Economics* 88(4): 799-815.

Ciaian, P., D. Kancs and J. Swinnen (2010). *EU Land Markets and the Common Agricultural Policy*. CEPS, Brussels.

Courleux, F., H. Guyomard, F Levert, and L. Piet. 2008. “How the EU Single Farm Payment should be Modelled: Lump-sum Transfers, Area Payments or… what else?” Working Paper SMART – LERECO N°08-01.

de Gorter, H., and K.D. Meilke. 1989. “Efficiency of Alternative Policies for the EC's Common Agricultural Policy.” *American Journal of Agricultural Economics* 71: 592-603.

Desquilbet, M., and H. Guyomard. 2002. “Taxes and Subsidies in Vertically Related Markets.” *American Journal of Agricultural Economics* 84: 1033-1041.

Dewbre, J. and A.K. Mishra (2007). “Impact of Program Payments on Time Allocation and Farm Household Income.” *Journal of Agricultural and Applied Economics* 39(3): 489-505.

Gohin, A. and GC. Moschini. (2006). "Evaluating the Market and Welfare Impacts of Agricultural Policies in Developed Countries: Comparison of Partial and General Equilibrium Measures." *Review of Agricultural Economics* 28(2): 195-211.

Guyomard, H., Le Mouël, C., Gohin, A. (2004). Impacts of alternative agricultural income support schemes on multiple policy goals. *European Review of Agricultural Economics*, 31(2): 125-148.

Heckman, J.J. (1979). Sample Selection Bias as a Specification Error, *Econometrica 47*: 153-161.

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

Kilian, S. and Salhofer, K. (2008). "Single Payments of the CAP: Where Do the Rents Go? *Agricultural Economics Review*, 9(2): 96-106.

Kilian, S., J. Antón, N. Röder and K. Salhofer (2008). "Impacts of 2003 CAP Reform on Land Prices: From Theory to Empirical Results." Paper presented at the 109th EAAE Seminar "The CAP After the Fischler Reform: National Implementations, Impact Assessment and the Agenda for Future Reforms". Viterbo, Italy, 20-21 Nov. 2008.

Kirwan, B. (2005). “The Incidence of U.S. Agricultural Subsidies on Farmland Rental Rates.” Working Paper 05-04. Department of Agricultural and Resource Economics, Univ. of Maryland.

Patton, M., P. Kostov, S.A. McErlean and J. Moss 2008. “Assessing the Influence of Direct Payments on the Rental Value of Agricultural Land.” *Food Policy* 33(5): 397-405.

Salhofer, K. 1996. “Efficient income Redistribution for a Small Country Using Optimal Combined Instruments.” *Agricultural Economics* 13: 191-199.

Salhofer, K., and E. Schmid. 2004. “Distributive Leakages of Agricultural Support: Some Empirical Evidence.” *Agricultural Economics* 30: 51-63.

**Table 1. Transfer efficiency of coupled subsidies**

| | **Output subsidy ( $s_Q$ )** (2) | **Land subsidy ( $s_A$ )** (3) | **Non-land input subsidy ( $s_Z$ )** (4) |
|---|---|---|---|
| $\frac{dr}{ds_i}$ | $\frac{\left[p_s f_{ZZ} f_A - \frac{f_A}{S_w^Z} - f_Z p_s f_{AZ}\right]\frac{D_p}{S_r^A}}{U} > 0$ | $\frac{\left[\frac{f_Z f_Z}{p_s f_{ZZ}} - \frac{D_p}{p_s f_{ZZ} S_w^Z} + D_p\right]\frac{p_s f_{ZZ}}{S_r^A}}{U} > 0$ | $\frac{-\left[\frac{f_Z f_A}{p_s f_{AZ}} + D_p\right]\frac{p_s f_{AZ}}{S_r^A}}{U} <> 0$ |
| $\frac{d\Pi}{ds_i}$ | $\frac{d\Pi}{ds_Q} = f\left[1 + \frac{dp}{ds_Q}\right] - A\frac{dr}{ds_Q} - Z\frac{dw}{ds_Q} > 0$ | $f\frac{dp}{ds_A} + A\left[1 - \frac{dr}{ds_A}\right] - Z\frac{dw}{ds_A} <> 0$ | $f\frac{dp}{ds_Z} - A\frac{dr}{ds_Z} + Z\left[1 - \frac{dw}{ds_Z}\right] <> 0$ |
| $\frac{dp}{ds_i}$ | $\frac{\left[p_s f_{ZZ} - \frac{1}{S_w^Z} - p_s \frac{f_Z}{f_A} f_{AZ}\right] f_A^{\,2}}{U} + \frac{\left[p_s f_{AA} - \frac{1}{S_r^A} - p_s \frac{f_A}{f_Z} f_{ZA}\right] f_Z^{\,2}}{U} < 0$ | $\frac{f_A\left[p_s f_{ZZ} - \frac{1}{S_w^Z}\right] - f_Z p_s f_{ZA}}{U} < 0$ | $\frac{f_Z\left[p_s f_{AA} - \frac{1}{S_r^A}\right] - f_A p_s f_{AZ}}{U} < 0$ |
| $\frac{dw}{ds_i}$ | $\frac{\left[p_s f_{AA} f_Z - \frac{f_Z}{S_r^A} - f_A p_s f_{ZA}\right]\frac{D_p}{S_w^Z}}{U} > 0$ | $\frac{-\left[\frac{f_Z f_A}{p_s f_{ZA}} + D_p\right]\frac{p_s f_{ZA}}{S_w^Z}}{U} <> 0$ | $\frac{\left[\frac{f_A f_A}{p_s f_{AA}} - \frac{D_p}{p_s f_{AA} S_r^A} + D_p\right]\frac{p_s f_{AA}}{S_w^Z}}{U} > 0$ |

Note: $U = D_p\left[f_A \frac{f_Z}{D_p} + p_s f_{AZ}\right]^2 - \left[f_A \frac{f_A}{D_p} + p_s f_{AA} - \frac{1}{S_r^A}\right]\left[f_Z \frac{f_Z}{D_p} - \frac{1}{S_w^Z} + p_s f_{ZZ}\right] D_p$ ; $p_s = p + s_Q$ . For non-increasing return to scale production function it follows that $f_{ZZ} f_{AA} \geq f_{AZ} f_{AZ}$ implying $U_A > 0$ .

## Table 2. Variables used in the GMM estimation

| | Variable name | Lags |
|---|---|---|
| Dependent variable | | |
| | Land rental price | 2 |
| | Net farm income | 2 |
| Endogenous variables | | |
| | RDP | 0 and 1 |
| | Coupled payments | 0 and 1 |
| | Decoupled payments | 0 and 1 |
| | Other subsidies | 0 and 1 |
| | Market return | 0 and 1 |
| | Adjusted rental price | 0 and 1 |
| | Other inputs | 0 and 1 |
| | Building-machinery per ha | 1 |
| | Farm product stock | 0 and 1 |
| | Investment | 1 |
| Exogenous variables | | |
| | Wage, Farm size, Land per capita, Land rented ratio, Sharecropped land ratio, Labour own ratio, Output livestock ratio, Own-consumption ratio, Liabilities-to-assets ratio, and other dummies for sector, country, and their interaction terms. | 0 |

## Table 3. Fixed effects estimates of net farm income and land rental price for EU

| | Net farm income | | | Land rental price | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Investment support | 0.866*** | 0.805*** | 0.861*** | 0.00998** | 0.0113*** | 0.0149*** |
| Environmental payments | 0.969*** | 1.006*** | 0.947*** | 0.00713 | 0.0110** | 0.00655 |
| LFA | 1.213*** | 1.264*** | 1.197*** | 0.0421*** | 0.0497*** | 0.0412*** |
| Coupled crop area payments | 0.912*** | 0.593*** | 0.904*** | 0.00252 | -0.00152 | 0.00163 |
| Coupled animal payments | 0.832*** | 0.773*** | 0.815*** | 0.00787** | 0.00864*** | -0.000149 |
| Decoupled payments | 0.920*** | 0.889*** | 0.908*** | -0.0181*** | -0.0175*** | -0.0161*** |
| Other subsidies | 1.639*** | 1.005*** | 1.567*** | -0.00161 | -0.00605 | -0.00517 |
| Market return | 0.881*** | | 0.879*** | 0.0075*** | | 0.00741*** |
| Wage | -0.00929*** | | -0.00923*** | 0.0005*** | | 0.00029*** |
| Adjusted rental price | -0.0822*** | | -0.0811*** | | | |
| Other inputs | -1.046*** | | -1.031*** | -0.000371 | | 0.000622 |
| Net farm income(-1) | | | -0.0133*** | | | |
| Land rental price(-1) | | | | | | 0.153*** |
| Observations | 675719 | 677501 | 498882 | 434261 | 435393 | 319714 |
| R-squared | 0.834 | 0.032 | 0.840 | 0.046 | 0.039 | 0.074 |
| Number of idn | 177151 | 177262 | 131325 | 114103 | 114177 | 84030 |

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1;
Note: for the sake of conciseness not all variables are reported

## Table 4. Heckman first difference estimates of land rental price for EU

| | Land rental price |
|---|---|
| Investment support | 0.00879*** |
| Environmental payments | 0.00715** |
| LFA | 0.0299*** |
| Coupled crop area payments | 0.00785*** |
| Coupled animal payments | 0.00990*** |
| Decoupled payments | -0.00763*** |
| Other subsidies | -0.000645 |
| Market return | 0.00602*** |
| Wage | 0.000350*** |
| Adjusted rental price | |
| Other inputs | 0.00172*** |
| Observations | 557048 |

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1;
Note: For the sake of conciseness not all variables are reported

## Table 5. Arellano and Bond estimates of farm income and land rental price for EU

| | Net farm income | | Land rental price | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| RDP | 1.782*** | 1.328*** | -0.101** | -0.0577 |
| RDP(-1) | | -0.264 | - | 0.0145 |
| Coupled payments | 0.950*** | 0.815*** | -0.0176 | -0.0212 |
| Coupled payments(-1) | | 0.158 | - | 0.0129 |
| Decoupled payments | 0.864*** | 0.812*** | -0.0131 | -0.0188 |
| Decoupled payments(-1) | | 0.123 | - | 0.0134 |
| Other subsidies | 1.275** | 0.953 | -0.00184 | 0.125 |
| Other subsidies(-1) | | 0.755 | - | 0.0302 |
| Market return | 0.972*** | 0.914*** | -0.00303 | 0.00322 |
| Market return(-1) | - | 0.101 | | -0.00237 |
| Wage | -0.00310*** | -0.00251* | -0.000362* | -0.000264 |
| Wage(-1) | - | -0.00262* | - | 0.000434** |
| Adjusted rental price | -0.0517 | 0.174 | - | - |
| Adjusted rental price(-1) | - | -0.442 | - | - |
| Observations | 116920 | 116431 | 76584 | 76362 |
| Number of idn | 47345 | 47291 | 30347 | 30321 |
| Sargan test (Prob > chi2) | 0.1312 | 0.1880 | 0.0000 | 0.0000 |
| Arellano-Bond autocorrelation test | | | | |
| AR(1) (Prob > z) | 0.0000 | 0.0001 | 0.0000 | 0.0000 |
| AR(2) (Prob > z) | 0.5214 | 0.4949 | 0.1108 | 0.1133 |

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
Note: Estimates are based on the period 2000-2007; For the sake of conciseness not all variables are reported