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Do agricultural subsidies crowd out or stimulate rural credit institutions?

The Case of CAP Payments

ABSTRACT

In this paper we estimate the impact of subsidies from the EU's common agricultural policy on farm bank loans. According to the theoretical results, if subsidies are paid at the beginning of the growing season they may reduce bank loans, whereas if they are paid at the end of the season they increase bank loans, but these results are conditional on whether farms are credit constrained and on the relative cost of internal and external financing. In the empirical analysis, we use farm-level panel data from the Farm Accountancy Data Network to test the theoretical predictions for the period 1995–2007. We employ fixed-effects and generalised method of moment models to estimate the impact of subsidies on farm loans. The results suggest that subsidies influence farm loans and the effects tend to be non-linear and indirect. The results also indicate that both coupled and decoupled subsidies stimulate long-term loans, but the long-term loans of large farms increase more than those of small farms, owing to decoupled subsidies. Furthermore, the results imply that short-term loans are affected only by decoupled subsidies, and they are altered by decoupled subsidies more for small farms than for large farms; however, when controlling for endogeneity, only the decoupled payments affect loans and the relationship is non-linear.

FACTOR MARKETS Working Papers present work being conducted within the FACTOR MARKETS research project, which analyses and compares the functioning of factor markets for agriculture in the member states, candidate countries and the EU as a whole, with a view to stimulating reactions from other experts in the field. See the back cover for more information on the project. Unless otherwise indicated, the views expressed are attributable only to the authors in a personal capacity and not to any institution with which they are associated.

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ISBN-13: 978-94-6138-131-6

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Do agricultural subsidies crowd out or stimulate rural credit institutions?

The Case of CAP Payments

Pavel Ciaian and Jan Pokrivcak*

Factor Markets Working Paper No. 4, September 2011

1. Introduction

Agricultural subsidies have important impacts on agricultural markets. Besides affecting farmers' incomes, studies have shown that agricultural subsidies distort input and output markets and thus alter the rents of other agents active in the agricultural sector (for example, consumers or input suppliers). The impact of agricultural subsidies on income distributional effects depends on their type, the structure of the markets and the existence of market imperfections (Alston and James, 2002; de Gorter and Meilke, 1989; Gardner, 1983; Guyomard, Mouël and Gohin, 2004; Salhofer, 1996; Ciaian and Swinnen, 2009). Studies also evaluate, among other things, the effects of subsidies on the environment and agricultural public goods (e.g. Beers Van Cees and Van Den Bergh, 2001; Khanna, Isik and Zilberman, 2002) as well as productivity and market distortions (e.g. Chau and de Gorter, 2005; Goodwin and Mishra, 2006; Sckokai and Moro, 2006).

With a few exceptions (e.g. Ciaian and Swinnen, 2009), most of these studies investigate the direct impacts of subsidies (on prices, quantities, income, the environment, etc.) by assuming that subsidies do not alter the structure of agricultural markets and do not interact with market institutions. In reality, government policies may have various unintended effects. They can change the structure of the market organisation or crowd out some market institutions. An analysis of such effects goes beyond the focus of the current literature on agricultural policy analysis. Yet these issues are related to the 'crowding-out effects' of other types of government programmes, which are extensively analysed in the literature. For example, the interaction between private transfers and public welfare programmes has attracted considerable attention in academic studies (e.g. Barro, 1974; Lampman and Smeeding, 1983; Roberts, 1984; Maitra and Ray, 2003; Cox, Hansen and Jimenez, 2004).

The objective of this paper is to assess the impact of the EU's common agricultural policy (CAP) on farm bank loans. First, extending the models of Feder (1985), Carter and Wiebe (1990) and Ciaian and Swinnen (2009), we theoretically analyse how subsidies may affect farm loans. Then, employing unique, farm-level panel data from the Farm Accountancy Data Network (FADN) for the period 1995–2007, we empirically estimate the interaction between CAP subsidies and farm loans. To our knowledge, this paper is one of the first attempts to study empirically how agricultural subsidies affect rural credit institutions.

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2. The model

We build the theoretical framework of the present study on the model of Feder (1985), Carter and Wiebe (1990), and Ciaian and Swinnen (2009). Feder (1985) and Carter and Wiebe (1990) analyse farm production behaviour under credit constraints in developing countries, while Ciaian and Swinnen (2009) study how a credit constraint impacts on the income distributional effects of area payments. In this study we extend the three models by analysing how subsidies affect farm demand for bank loans.

We consider a representative profit-maximising farm. The farm output is a function of the fixed amount of land (A), the fixed quantity of family labour (F)¹ and non-land inputs (K), which we refer to as 'fertilizer' but which also captures other capital inputs used by the farm. The production function is represented by a constant returns-to-scale production technology $f(A, K, F)$ with $f_i > 0$, $f_{ii} < 0$, $f_{ij} > 0$, for $i, j = A, K, F$. We assume that all land is owned by the farm. End-of-season profit is $\Pi = pf(A, K, F) - k_c K$, where $k_c = (1 + i_c)k$, p is the price of the final product, k is the per-unit price of fertilizer and i_c is the interest rate. We assume that the economy is small and open, which implies that the fertilizer price, the interest rate and the output price are fixed.

An important issue is the timing of various activities and payments. We assume that fertilizer is paid for at the beginning of the production season, whereas the revenue from the sale of production is collected after harvest at the end of the season. Because of the time lag between the payment for fertilizer (variable inputs) and obtaining revenues from the sale of production, the farm has a demand for short-term credit. The demand for credit can be satisfied either internally (by cash flow, savings and subsidies) or externally (by a bank loan or trade credit). For the sake of simplicity we consider only external financing through a bank loan and later on in the paper also a subsidy.² The demand for credit might not be fully satisfied, which means that the farm could be credit constrained. As in Ciaian and Swinnen (2009), the short-term credit constraint implies that the farm may be constrained with respect to the use of fertilizer, that is, the credit constraint may prevent the farm from using the optimal amount of fertilizer.

2.1 Perfect credit markets

To establish a point of comparison, we first identify the equilibrium without a credit constraint. With perfect credit markets, the farm is not constrained on the quantity of input it uses. The farm chooses the quantity of fertilizer that maximises its profit given by equation 0. This implies the equilibrium condition of

$$pf_K = k_c. \quad (1)$$

In equilibrium, the marginal value product of fertilizer is equal to its price. The condition 0 determines the fertilizer demand function of the farm. Total fertilizer demand is represented by function D_K in Figure 1. Because we assume that both the fertilizer price and the interest rate are fixed, the supply of fertilizer is the horizontal curve, S . The equilibrium quantity of fertilizer with no credit constraint is K^* .

2.2 Imperfect credit markets

It is assumed that the maximum amount of money that the farm can borrow from the bank (C) for fertilizer purchase depends on the farm's collateral (W). Again, for the sake of

¹ The assumption of a fixed amount of land and family labour is not strictly needed to obtain the results. We introduce this assumption to simplify the exposition of the model results.

² This assumption is not strictly needed to obtain the results.

simplicity, we consider that banks accept only assets as collateral.³ That is, $C = C(W)$, where $dC/dW > 0$. The credit constraint is given by

$$kK \leq C(W). \quad (2)$$

With a credit constraint, the farm maximises the end-of-season profit given by equation 0, subject to the credit constraint 0. This amounts to solving the Lagrangean function:

$$\Psi = pf(A, K, F) - k_c K - \lambda_c (kK - C) \quad (3)$$

where λ_c is the shadow price of the credit constraint.

When the credit constraint is binding, $\lambda_c > 0$, the farm cannot use the unconstrained optimal level of fertilizer and the quantity demanded of fertilizer is determined by $K = C(W)/k$. The optimality conditions are the following:

$$pf_k - (1 + i_c + \lambda_c)k = 0 \quad (4)$$

$$kK - C \leq 0. \quad (5)$$

From equation 0 it follows that the marginal value product of fertilizer is higher than the marginal cost of fertilizer k_c : $pf_k > k_c$. By increasing fertilizer use the farm could increase its profit but the credit constraint does not allow it to buy additional fertilizer. The more credit constrained the farm is, the less fertilizer it can use, and hence the lower its productivity level.

In Figure 1, the credit-constraint curve (i.e. fertilizer supply), represented in terms of fertilizer units, is given by the bold line $k_c AS_K$, where $S_K = C/k$. With the credit constraint, the equilibrium use of fertilizer is equal to K_c^* . At K_c^* the fertilizer supply curve is vertical, as determined by the credit-constraint condition 0. Under a credit constraint, the farm uses less fertilizer than it would in a situation of perfect competition, $K_c^* < K^*$.

3. Subsidies and credit constraint

We define DS as the decoupled subsidy that the farm receives irrespective of its level of production. With the subsidy, the objective function of the farm becomes

$$\Pi = pf(A, K, F) - k_c K_c - k_s K_s + DS \quad (6)$$

where $k_s = (1 + i_s)k$, K_c is the fertilizer financed through the bank loan C , K_s is the fertilizer financed by the subsidies DS , i_s represents the farm's opportunity cost of the subsidy (i.e. the return on the most profitable, alternative investment opportunity), and $K = K_c + K_s$. We assume that the cost of the bank loan is higher than the cost of the subsidy, $i_c > i_s$. This

³ Again, this assumption is not strictly needed to obtain the results. In reality, the level of farm credit may depend on farm characteristics (e.g. reputation, owned assets and profitability). In general, the evidence from the literature shows that these factors are important determinants of farm credit (e.g. Benjamin and Phimister, 2002; Petrick and Latruffe, 2003; Latruffe, 2005; Briggeman, Towe and Morehart, 2009). For example, Latruffe (2005) finds in the case of Poland that farmers with more tangible assets and with more owned land were less credit constrained than others. Briggeman, Towe and Morehart (2009) find for farm and non-farm sole proprietorships in the US that the probability of being denied credit is reduced by, among other factors, net worth, income, the value of assets and subsidies.

assumption is reasonable given the information and incentive problems involved in providing a loan to the farm.

Subsidies affect not only the profit function but also the credit constraint. If the farm receives the subsidy at the beginning of the season, it can use it to pay for the fertilizer. Receiving the subsidies at the end of the season also improves the farm's access to credit. Future guaranteed payments of subsidies might serve as collateral for obtaining a loan from the bank (Ciaian and Swinnen, 2009). Therefore, the subsidy may alleviate the credit constraint of the farm irrespective of the timing of the subsidy.

With a subsidy, a credit constraint is given by the following inequalities:

$$kK \leq C[W + (1 - \alpha)DS] + \alpha DS \quad (7)$$

$$kK_s \leq \alpha DS \quad (8)$$

where α is a dummy variable taking the value zero when the farm uses its subsidy to purchase fertilizer directly or one when the subsidy improves access to fertilizer indirectly through the enhanced value of collateral.

Equation 0 thus implies that the farm can use two sources to finance the purchase of fertilizer: subsidy, αDS , and/or the bank loan, $C[W + (1 - \alpha)DS]$. If the subsidy is paid at the beginning of the season, $\alpha = 1$, the farm can use it to alleviate its credit constraint. On the other hand, when the subsidy is paid at the end of the season, $\alpha = 0$, the farm may use it as collateral to obtain a bank loan. In other words, the subsidy increases farm assets, improves its creditworthiness and enhances access to bank loans. Equation 0 states that the use of subsidy for the purchase of fertilizer cannot exceed the total value of subsidies DS .

With subsidies and a credit constraint, the objective function of the farm is represented by the following Lagrangean function:

$$\Psi = pf(A, K, F) - k_c K_c - k_s K_s - \lambda_c \{kK - C[W - (1 - \alpha)DS] - \alpha DS\} - \lambda_s (kK_s - \alpha DS) \quad (9)$$

where λ_s is the shadow price of the subsidy constraint 0.

The optimality conditions are given by

$$pf_K - (1 + i_c + \lambda_c)k = 0 \quad (10)$$

$$pf_K - (1 + i_s + \lambda_s)k = 0 \quad (11)$$

$$kK - C[W - (1 - \alpha)DS] - \alpha DS \leq 0 \quad (12)$$

$$kK_s - \alpha DS \leq 0. \quad (13)$$

3.1 The impact of a decoupled subsidy

First, we consider the impact of a decoupled subsidy on the bank loan under the condition of a perfect credit market. Then we analyse the credit-constraint case. We summarise our results from testing three hypotheses.

Hypothesis 1: *If farms are not credit constrained and if financing through bank loans is more expensive than financing through subsidies, subsidies reduce the amount of farms' bank loans if they are paid at the beginning of the season; otherwise, subsidies do not affect the farm loans.*

If financing through the bank loan is more expensive than financing through the subsidy, $i_c > i_s$ (i.e. $k_c > k_s$), the subsidy can reduce the amount of the bank loan but only in the case

when the subsidy is paid at the beginning of the season. In such a case, the farm can use the subsidy instead of the bank loan to buy fertilizer. This situation is illustrated graphically in Figure 2. With no credit constraint and with no subsidies, the equilibrium fertilizer use is K^* and all fertilizer is financed through the bank loan. The availability of cheaper financing through subsidy DS allows the farm to reduce the amount of bank loans. The farm will use loans less and some of the fertilizer will be financed with the subsidy, equal to K_s^* ($= DS/k$). The remaining portion of fertilizer, $K^* - K_s^*$, will be bought with the bank loan. In welfare terms the farm gains area a in Figure 2. Note that with the subsidy DS , the equilibrium fertilizer use is not affected and remains at K^* . Only if subsidies crowd out all bank loans, which occurs for sufficiently high subsidies (if $DS > kK^*$), does the equilibrium fertilizer use increase.

If the subsidy is paid at the end of the season, the farm cannot use it directly to purchase fertilizer. The subsidy can still be used as collateral, however. We assume that the type of collateral does not affect the interest rate of the bank loan; hence, the subsidy does not alter the equilibrium quantity of loans.⁴

Next we analyse the case in which a farm is credit constrained and its subsidy is paid at the beginning of the season, $\alpha = 1$.

Hypothesis 2: *If farms are credit constrained and if subsidies are paid at the beginning of the season, then a) farms will use the same amount of loans with or without subsidies if the subsidies are sufficiently small, and b) the farm will reduce bank loans if the subsidies are sufficiently high.*

If the subsidy is paid at the beginning of the season, the farm can use it directly to finance the purchase of fertilizer. The impact of the subsidy on the bank loan in a situation of credit constraint is illustrated in Figure 3. The equilibrium quantity of fertilizer with the credit constraint and with no subsidy is K_c^* . First, consider subsidy DS_1 . The subsidy DS_1 shifts the supply of fertilizer from $k_c DS_K$ to $k_s AES_{K1}$, where $S_{K1} = (C + DS_1)/k$. The equilibrium quantity of fertilizer is K_{cs1}^* ($= (C + DS_1)/k$). Some fertilizer is financed directly through the subsidy, K_{s1}^* ($K_{s1}^* = DS_1/k$), and the rest is financed through the bank loan, K_c^* ($= K_{cs1}^* - K_{s1}^* = C/k$). The farm gains area ad when the subsidy is used to purchase fertilizer under a credit constraint. Subsidy DS_1 does not change the quantity of the bank loan: with or without the subsidy the farm purchases the same amount of fertilizer through the bank loan, K_c^* . With subsidy DS_1 , the farm is still credit constrained ($\lambda_c > 0$) – the amount of fertilizer K_{cs1}^* is lower than the amount of fertilizer that would be used in a perfect market K^* , $K_{cs1}^* < K^*$ – and thus it is profitable for the farm to exploit fully all available financing opportunities (subsidies and loans).

Yet if the subsidy is sufficiently high, it can reduce the amount of bank loans. For example, with subsidy DS_2 , where $DS_2 > K^* - K_c^* > DS_1$, the supply of fertilizer shifts to $k_s BFS_{K2}$, where $S_{K2} = (C + DS_2)/k$ (Figure 3). The equilibrium fertilizer use changes to K^* : K_{s2}^* ($= DS_2/k$) is financed with the subsidy and $K^* - K_{s2}^*$ is financed with the bank loan. Now,

⁴ In reality, the type of collateral may affect the cost of the loan. For example, if banks perceive subsidies to be more secure or if they have lower transaction costs for administering them than other types of farm collateral, then the interest rate may be lower for subsidy-backed loans than for loans backed by the other types of collateral. In this case, the effects will be similar as those shown in Figure 2.

the farm uses a smaller amount of loans. The amount of fertilizer financed with the bank loan is $K^* - K_{s2}^*$, which is less than the total amount of fertilizer financed through a bank loan without subsidy K_c^* . Relative to a situation of no subsidy, the farm's gain is the area $abde$. Intuitively, subsidy DS_2 eliminates the credit constraint (i.e. the credit constraint 0 is not binding with DS_2 , $\lambda_c = 0$) and the farm substitutes some of the expensive bank loans with cheaper subsidies. With subsidy DS_2 , the farm is not credit constrained and it uses the same amount of fertilizer as under the perfect market situation, K^* .

Finally, we consider the situation with a binding credit constraint when the subsidy is paid at the end of the season, $\alpha = 0$.

Hypothesis 3: *If farms are credit constrained and if subsidies are paid at the end of the season, the farm increases its bank loans.*

The graphical analysis for this hypothesis is in Figure 4. The fertilizer supply without the subsidy and with the credit constraint is $k_c AS_K$ and the equilibrium fertilizer use is K_c^* . If the credit constraint 0 is binding ($\lambda_c > 0$), it is profitable for the farm to use the subsidy DS paid at the end of the season ($\alpha = 0$) as collateral for obtaining a bank loan for the purchase of fertilizer at the beginning of the season. Hence, because of more collateral, subsidies increase bank loans from $C(W)$ to $C(W + DS)$, where $C(W) < C(W + DS)$. The availability of more loans shifts the fertilizer supply to $k_c BS_{K1}$ and the equilibrium fertilizer use to K_{c1}^* , where $K_{c1}^* > K_c^*$. Relative to the situation with no subsidy, the farm benefits from more loans; the gain is equal to area a . Note that for a sufficiently high level of subsidy, the farm may become credit unconstrained (i.e. $\lambda_c = 0$). For example, this is the case when the subsidy shifts the fertilizer supply to $k_c DS_{K2}$, which increases the equilibrium use to K^* and generates a gain for the farm equal to area ab .

3.2 Extension: Long-term loans

In general, farms use long-term loans to finance long-term investments that generate a multi-annual income stream. The impact of decoupled subsidies on long-term loans is similar to that in the case of short-term loans.⁵ If subsidies are received at the beginning of the season, they may be used to finance farm investments. If subsidies are allocated at the end of the season, they may alter loans only by affecting farm collateral value. Hence, all three hypotheses in the previous section also hold for long-term loans.

Still, expectations about the continuation of the CAP affect the ability of farmers to use subsidies for obtaining long-term loans. If market agents (particularly banks) perceive CAP payments to be unstable and subject to change, this may reduce their incentive to provide loans collateralised by subsidies. Since its inception the CAP has been reformed several times, changing both the type of instrument and the level of support. In this respect, two kinds of policy risks are present: a reduction/change in the level of a given instrument and a change in the type of instrument through which support is allocated to farms. The first element reduces the availability of funds allocated to farmers and thus reduces the possibility to obtain subsidy-collateralised loans. The second one determines the degree of risk and the transaction costs of using subsidies as collateral, because different instruments may have different eligibility costs and may be conditional on predefined farm performance – thereby

⁵ Although the interest rate may differ between the short- and the long-term loans, the intuition is the same for both cases.

potentially requiring the monitoring of farm activities and being susceptible to productivity risk.

4. Econometric specification

Theoretically, the impact of a decoupled subsidy on agricultural loans is ambiguous. Agricultural subsidies paid at the end of the season have no impact on bank loans in perfect markets while they reduce bank loans when paid at the beginning of the season. Under a credit constraint, subsidies paid at the beginning of the season have no impact on bank loans if they are sufficiently small but they reduce bank loans if they are sufficiently high. Furthermore, under a credit constraint, when subsidies are paid at the end of the season they reduce bank loans. The relationship between subsidies and bank loans is therefore an empirical question.

Solving the maximisation problem (equations 0-0), the amount of farm loans depends on a farm's subsidy, profitability and assets. We therefore estimate the following econometric model:

$$loan_{jt} = \beta_0 + \beta_{ds} DS_{jt} + \beta_a assets + \beta_\pi \Pi_{jt} + \beta_x X_{jt} + \varepsilon_{jt} \quad (14)$$

where subscripts j and t represent farm and time, respectively; $loan$ stands for farm bank loans, $assets$ are farm assets and X_{jt} is a vector of observable covariates, such as farm characteristics, regional and time variables. As usual, ε_{jt} is the residual term.⁶

We are especially interested in estimating the parameter β_{ds} , which measures the impact of subsidies on bank loans. A statistically significant and negative value of the coefficient confirms either hypothesis 1 (subsidies paid at the beginning of the season reduce bank loans because farms are not credit constrained) or hypothesis 2(b) (sufficiently high subsidies paid at the beginning of the season eliminate bank loans when farms are credit constrained). A statistically significant and positive coefficient confirms hypothesis 3 (farms are credit constrained and subsidies are paid at the end of the season). Finally, if the coefficient is not statistically significant, then hypothesis 2(a) holds (farms with subsidies remain credit constrained and subsidies have no effect on farm loans).

We expect that data will confirm either hypothesis 2 or 3 because there is overwhelming evidence that farms are credit constrained (Carter, 1988; Blancard et al., 2006; Lee and Chambers, 1986; Färe, Grosskopf and Lee, 1990). In addition, anecdotal evidence indicates that subsidies tend to be paid at the end of the season,⁷ which implies that hypothesis 3 should hold. This is particularly the case for long-term loans, which tend to finance investments with a higher value, than for short-term loans.⁸ Hence, the annual value of farms' subsidies may not cover the full costs of the long-term investments even if they are received at the beginning of the season. Hypothesis 3 is more likely to hold in the case of long-term loans.

The estimation of equation 0 is subject to the omitted variable bias and particularly to endogeneity. There are unobservable characteristics, such as the farmer's ability, that affect bank loans and may be correlated with explanatory variables. Ignoring this unobserved farm heterogeneity would bias the results. We use panel data and estimate a fixed-effects model, which helps us to control for the unobserved heterogeneity component that remains fixed

⁶ The definition of the rest of the variables is the same as in the theoretical section.

⁷ There is no available consistent data on the timing of CAP subsidies.

⁸ In a perfect market situation, the price of an investment good is the present value of the future returns from the investment good, which tends to be higher than the price of a variable input (e.g. fertilizer). The price of a variable input is determined by its annual marginal contribution to the farm's profitability.

over time, thus considerably reducing the problem of omitted variable bias. To control for endogeneity, we estimate the generalised method of moment (GMM) model.

4.1 Fixed-effects model

The following estimation of a fixed-effects model implies the specification,

$$loan_{jt} = \beta_0 + b_j + \beta_{ds} DS_{jt} + \beta_a assets + \beta_\pi \Pi_{jt} + \beta_x X_{jt} + \varepsilon_{jt} \quad (15)$$

where b_j is the fixed effects for farm j , which capture time-unvarying, farm-specific characteristics. These fixed effects represent farm heterogeneity. For example, they could reflect different technologies for different farms, or they could reflect diverse managerial skills or other unobservable, fixed, farm-specific characteristics.

4.2 Endogeneity

Three sources of endogeneity might bias our estimates. If subsidies were assigned to farms randomly, then parameter β_{ds} would measure the impact of subsidies on bank loans. 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 member state based on regional productivities (e.g. the regional reference yield). At the farm level, the amount of the subsidies depends on the size of the member state (i.e. regional productivity) and on the farm's crop choice (e.g. supported versus non-supported crops). A similar situation holds for the Single Area Payment Scheme (SAPS) in the new member states. Although the SAPS is not directly based on farm productivities, it is nevertheless correlated with the pre-accession average country/regional productivities, because the base for the CAP application in new member state was the average production level and intensity in the pre-accession period. This implies that the SAPS is exogenous at the farm level within each new member state but endogenous among the new member states. The decoupled Single Payment Scheme (SPS) payments depend on the previous coupled payments and on the average country/regional productivities, because the value of the SPS was set based on regional productivities or the past level of farm subsidies (or both). The coupled payments of the Rural Development Programme (RDP) are allocated to farmers based on project submission. Only those farms that 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 RDP support. This structure of coupled and decoupled CAP subsidies implies that they are endogenous variables reflecting the characteristics of country/regional land and farmers' behaviour. As such, subsidies are not assigned randomly, which implies that subsidy payments are correlated with the error term. Consequently, the resulting standard estimates of β_{ds} may be biased.

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 instruments in a panel data setting. This allows us to use lagged levels of the endogenous variables as instruments (in addition 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 consists of 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.

5. Data and variable construction

The main source of the data used in the empirical analysis is the 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. In total there is information about 150 variables on farm structure and yield, output, costs, subsidies and taxes, income, balance sheet and financial indicators. Sample sizes vary from country to country (roughly between 500 and 20,000 observations, with those in most countries ranging from 1,500 to 10,000) representing a population of around 5,000,000 farms, covering approximately 90% of the total utilised agricultural area (UAA) and accounting for more than 90% of the total agricultural production. The aggregate FADN data are publicly available. Farm-level data are confidential, however, and for the purposes of this study, accessed under a special agreement.

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 it is representative of the commercial agricultural holdings across the entire EU. Holdings are selected to take part in the survey on the basis of sampling plans established at the level of each region in the EU. The survey does not cover all the agricultural holdings in the Union, but only those that are of a size allowing them to rank as commercial holdings.

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

A description of the variables constructed is presented in Table 1. All variables except for ratios are calculated per hectare of UAA to reduce the potential problem of heteroskedasticity. The dependent variables in equation 0 – *total loans*, *long-term loans* and *short-term loans* – are constructed from the FADN data by dividing the total long-/medium-term and the short-term loans, respectively, by the total utilised agricultural area.

Similarly, all subsidy variables (*sub_total_ha*, *sub_decoupled_ha*, *sub_coupled_ha*) are constructed from the FADN data and are calculated on a per-hectare basis. Every agricultural producer in the FADN survey is asked to report the total subsidies received as well as to specify the amount by major subsidy type. Decoupled subsidies, *sub_decoupled_ha*, include SPS and SAPS payments. Coupled subsidies, *sub_coupled_ha*, include payments linked to farm inputs or outputs, such as crop area payments, animal payments and the RDP. The total subsidies variable, *sub_total_ha*, is the sum of coupled and decoupled CAP subsidies. The independent variables *assets* and *income_ha* represent the value of farm assets and farm cash flow calculated on a per-hectare basis.

The covariates matrix X_{ji} includes other explanatory variables that affect farm loans. The *land rented ratio* and *labour own ratio* are included in the equations to control for potential differences in incentives between own and rented/hired land/labour as well as to account for the higher costs incurred by farms using rented/hired land/labour. A variable capturing the economic size (*farm size*) of the farms is also available from the FADN data. The economic size of farms is expressed in European size units. To account for the various technological, sectoral and regional covariates, we include variables representing effects such as irrigated land, area under glass, fallow land and sectoral, regional and time dummies (for more details see Table 1).

6. Preliminary results

The results are reported in Table 2 for total farm loans (columns 1-3), for long-term farm loans (columns 4-6) and for short-term farm loans (columns 7-9).⁹ In addition to the complete equation specification 0, we add an interaction variable between subsidies and farm size (models 2, 3, 5, 6, 8 and 9) and the square value of subsidies (models 3, 6 and 9) to account for an indirect and non-linear relationship between subsidies and loans.

The model-adjusted R^2 s range from 0.10 to 0.49. The most consistently significant variables ($\text{prob}(t) < 0.10$) across all models are assets (*assets_ha*), the trend variable (*year*), the own labour ratio (*labor_own_ratio*) and the rented land ratio (*land_rented_ratio*).

The estimated results suggest that subsidies influence farm loans but the effects are indirect and non-linear. The coefficient for subsidies in models 1, 4 and 7, where only a linear subsidy term is used, is not statistically significant for all types of loans. When interacting subsidies with farm size (models 2 and 5), however, its coefficient is statistically significant but only for total loans and for long-term loans. At the same time, the coefficient associated with the linear subsidy term *sub_total_ha* (the direct effect) is statistically significant and takes a negative value. This indicates that subsidies stimulate farm loans but only for larger farms, whereas the direct impact of subsidies has a reducing effect on total and long-term loans (models 2 and 5). For the short-term loans (model 8), neither of the coefficients (i.e. for the interaction variable and the linear term *sub_total_ha*) is significant.

Furthermore, the results indicate that the relationship between subsidies and loans is non-linear. A small value of subsidies per hectare reduces bank loans (the coefficient for *sub_total_ha* is negative and significant in models 3 and 6) and as the value of subsidies increases farms use more bank loans (the coefficient for the squared value of subsidies *sub_total_ha_sq* is positive and significant in models 3 and 6). Again, this only holds for total loans and for long-term loans. The short-term loans are not affected by subsidies, which is also the case when the non-linear relationship is considered (model 9).

These results indicate that hypothesis 3 holds for the total and the long-term loans, whereby subsidies increase farm collateral and thus farm loan use. The multi-annual character of the long-term investments allows the use of subsidies by credit-constrained farms to finance investments only through loans. For the short-term loans, the estimated results suggest the validity of hypothesis 2(a). Yet this does not imply that farms are not credit constrained with respect to short-term loans. Farms may still be credit constrained and may use subsidies to finance short-term inputs either because they receive them at the beginning of the growing season or because they may use other informal sources that may be subsidy-collateralised. On the other hand, the difference in the statistical significance between the long-term and the short-term loans may indicate that farms may prefer to use subsidies to finance long-term investments and not short-term ones possibly because of the presence of a greater credit constraint in the former type of investment than in the latter one.

In Table 3 we disaggregate subsidies in coupled (*sub_coupled_ha*) and decoupled (*sub_decoupled_ha*) payments and again estimate their impact on total loans (columns 1-3), long-term loans (columns 4-6) and short-term loans (columns 7-9). The results indicate the important differences these two types of payments have on farm loans. For the long-term loans (models 4-6), the effects are similar to those shown in Table 2 where long-term loans (models 4-6) were regressed over aggregated subsidies. Both coupled and decoupled subsidies have an indirect (by stimulating more loans among large farms than among small ones) and non-linear impact on long-term loans.

For the short-term loans, the effects of disaggregated subsidies (Table 3) differ with respect to the results reported in Table 2. The short-term loans are affected only by decoupled payments. Nevertheless, the direct effect (the coefficient for *sub_decoupled_ha* in model 9)

⁹ We estimate fixed-effects models with heteroskedasticity-consistent standard errors.

is positive and significant, whereas the interaction term (the coefficient for *sub_decoupled_fsize* in model 9) is negative and significant. These results suggest that the decoupled subsidies are used as collateral to increase farm loans, but that this is more important for small farms than for large farms. The coupled payments do not affect the short-term loans: i.e. the coefficients for the variables *sub_coupled_ha*, *sub_coupled_ha_sq* and *sub_coupled_fsize* are not statistically significant in model 9.

The results in Table 3 confirm that hypothesis 3 tends to hold for the long-term loans for both types of CAP payments. For the short-term loans, only the decoupled payments imply the validity of hypothesis 3, whereas the estimated effects for the coupled payments suggest that hypothesis 2(a) may better represent reality.

The GMM estimates are shown in Table 4. Generally, the GMM results indicate different results compared with those reported for the fixed-effects model. When controlling for endogeneity, the importance of subsidies in determining both long-term and short-term loans reduces significantly. Only the decoupled payments affect loans and the relationship is non-linear. A small value of subsidies does not affect the loans (the coefficients for *sub_decoupled_ha* and *sub_coupled_ha* are not significant in models 2 and 3, nor in models 4 and 6) and as the value of subsidies increases farms use more bank loans (the coefficient for the squared value of subsidies *sub_coupled_ha_sq* is positive and significant in models 3 and 6). This holds for both types of loans.

7. Conclusions

In this paper we have estimated the impact the CAP subsidies on farm bank loans. First, we have theoretically analysed the demand for farm loans by farmers under perfect and imperfect credit-market assumptions. In the empirical analysis, we have used farm-level panel data from the FADN to test the theoretical predictions.

According to the theoretical results, subsidies may increase bank loans, reduce them or have no impact on bank loans depending on whether farms are credit constrained, whether subsidies are allocated at the beginning or at the end of the growing season, and on the relative cost of internal and external financing. If the external financing is more expensive than the internal financing, subsidies affect bank loans even if farms are not constrained with respect to external financing. This is the case when subsidies are paid at the beginning of the season and thus allows farms to substitute loans with cheaper subsidies. In the presence of credit constraints, farms have an incentive to expand the internal or external financing (or both) to invest in constrained inputs. If subsidies are paid to farmers at the beginning of the season, farms may use them directly to purchase inputs with no effect on bank loans. If subsidies are substantial, however, they may eliminate the farms' credit constraints and may crowd out more expensive bank loans. On the other hand, if subsidies are received at the end of the season, farms cannot use them directly to finance inputs. Instead, they may use subsidies as collateral to obtain more bank loans, thus increasing the availability of external financing for inputs at the beginning of the season.

We employ the fixed-effects and GMM models to estimate the impact of subsidies on farm loans. The estimated results suggest that subsidies have the following effects on the use of farm loans:

- i) Subsidies influence farm loans and the effects tend to be non-linear and indirect.
- ii) Coupled subsidies affect short- and long-term loans in a different way from decoupled subsidies.
- iii) Both coupled and decoupled subsidies stimulate long-term farm loans. But the long-term loans of large farms increase more than those of small farms, owing to decoupled subsidies.

- iv) Short-term loans are only affected by decoupled subsidies. At the same time, decoupled subsidies increase the short-term loans of small farms more than they do those of large farms.
- v) When controlling for endogeneity, the importance of subsidies in determining both the long- and short-term loans reduces significantly. Only the decoupled payments affect loans and the relationship is non-linear.
- vi) In general, our empirical results indicate that hypothesis 3 holds for the decoupled payments, whereas coupled payments are found not to affect loans.

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Figure 1. Farm fertilizer use with and without a credit constraint

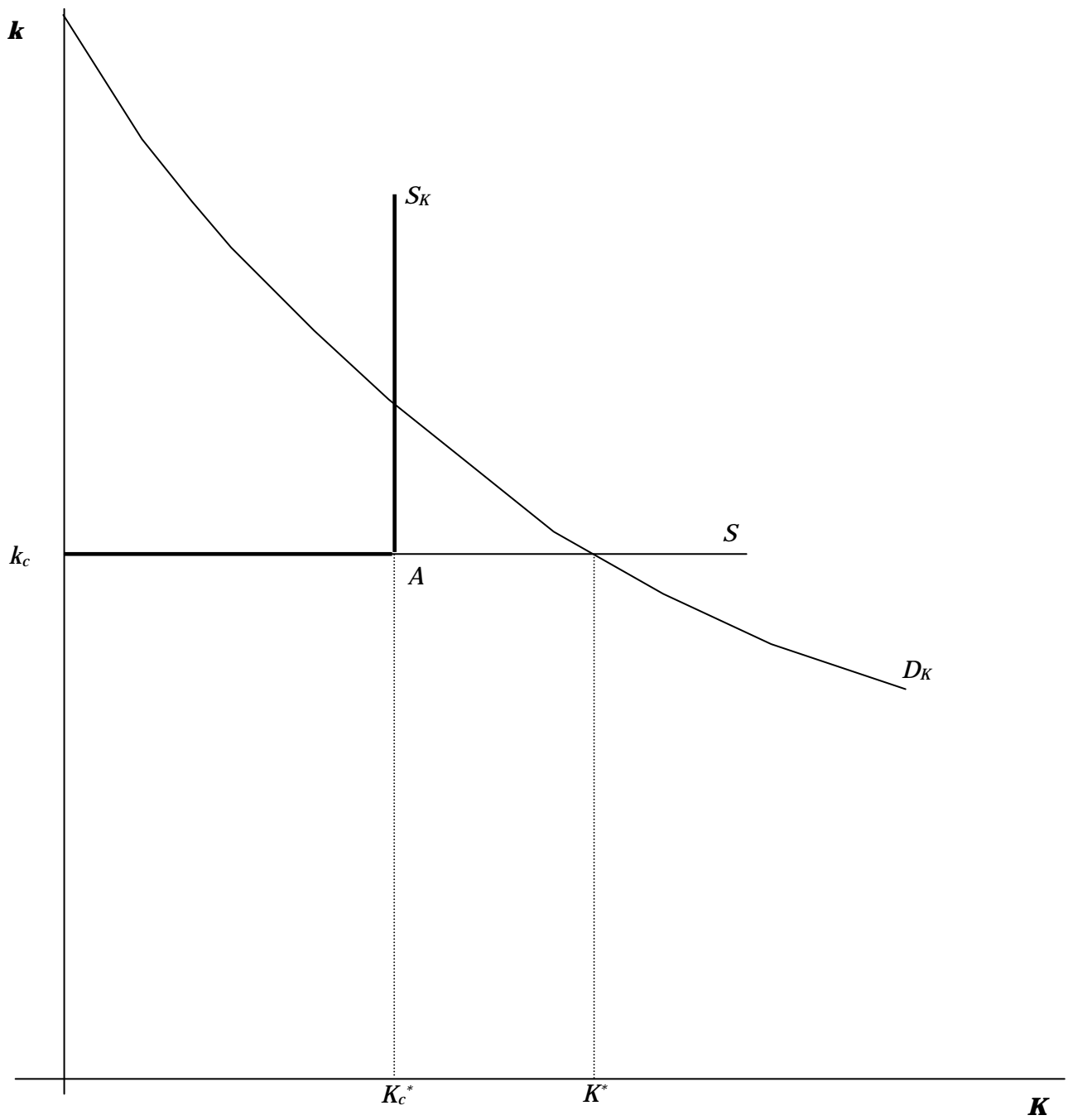


Figure 2. Subsidies and no credit constraint

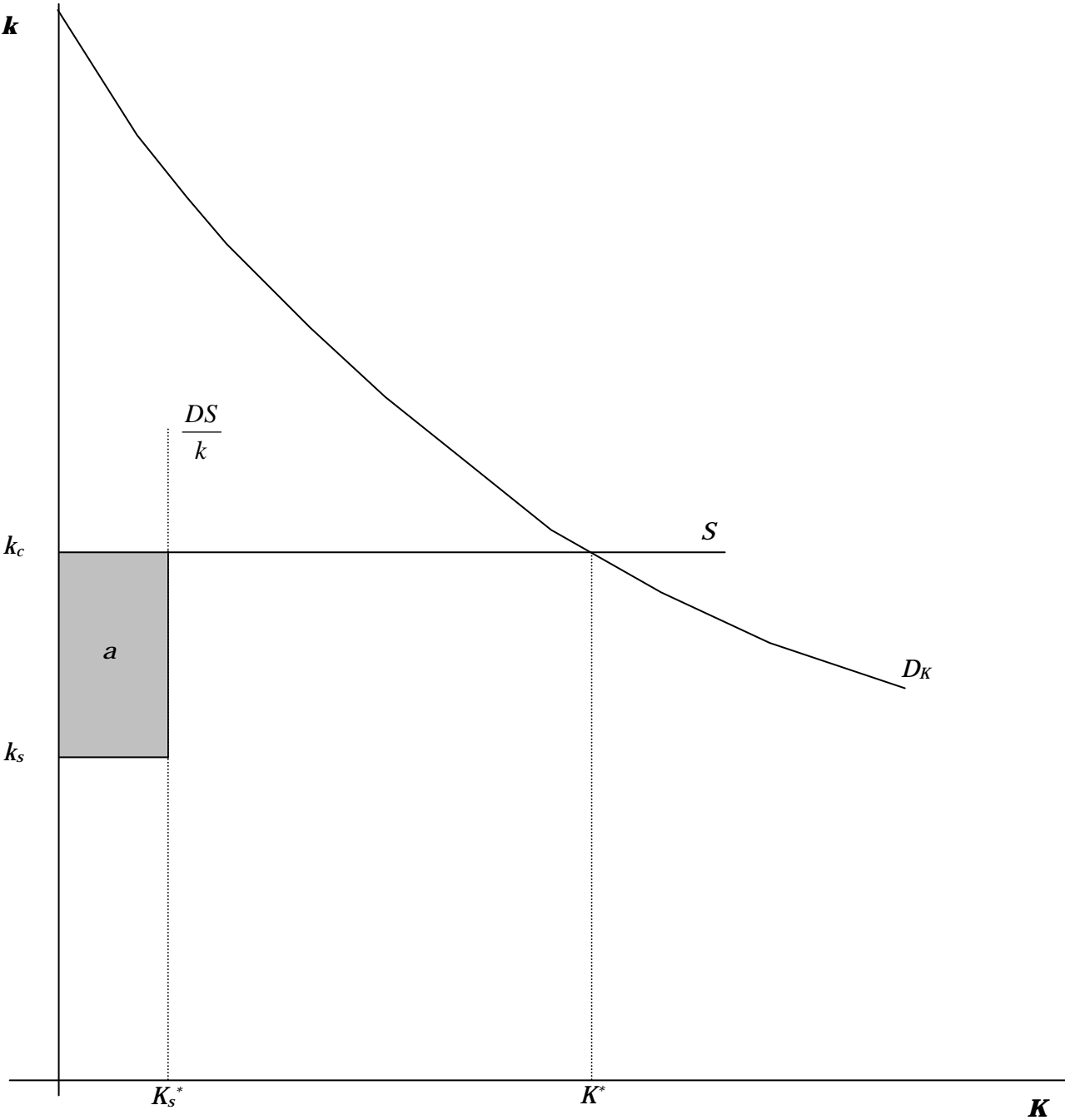


Figure 3. Credit constraint and subsidies with $\alpha = 1$

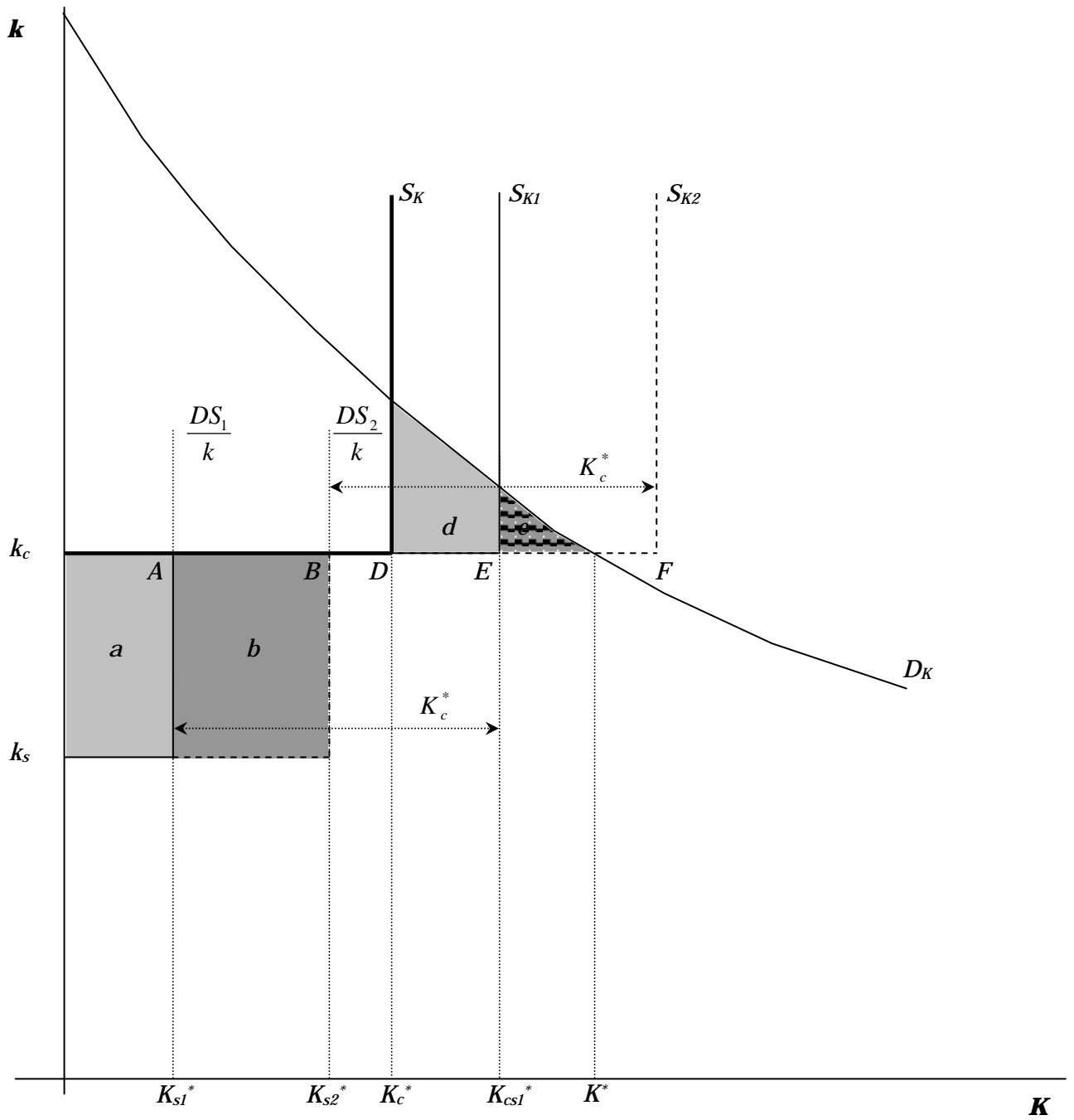


Figure 4. Credit constraint and subsidies with $\alpha = 0$

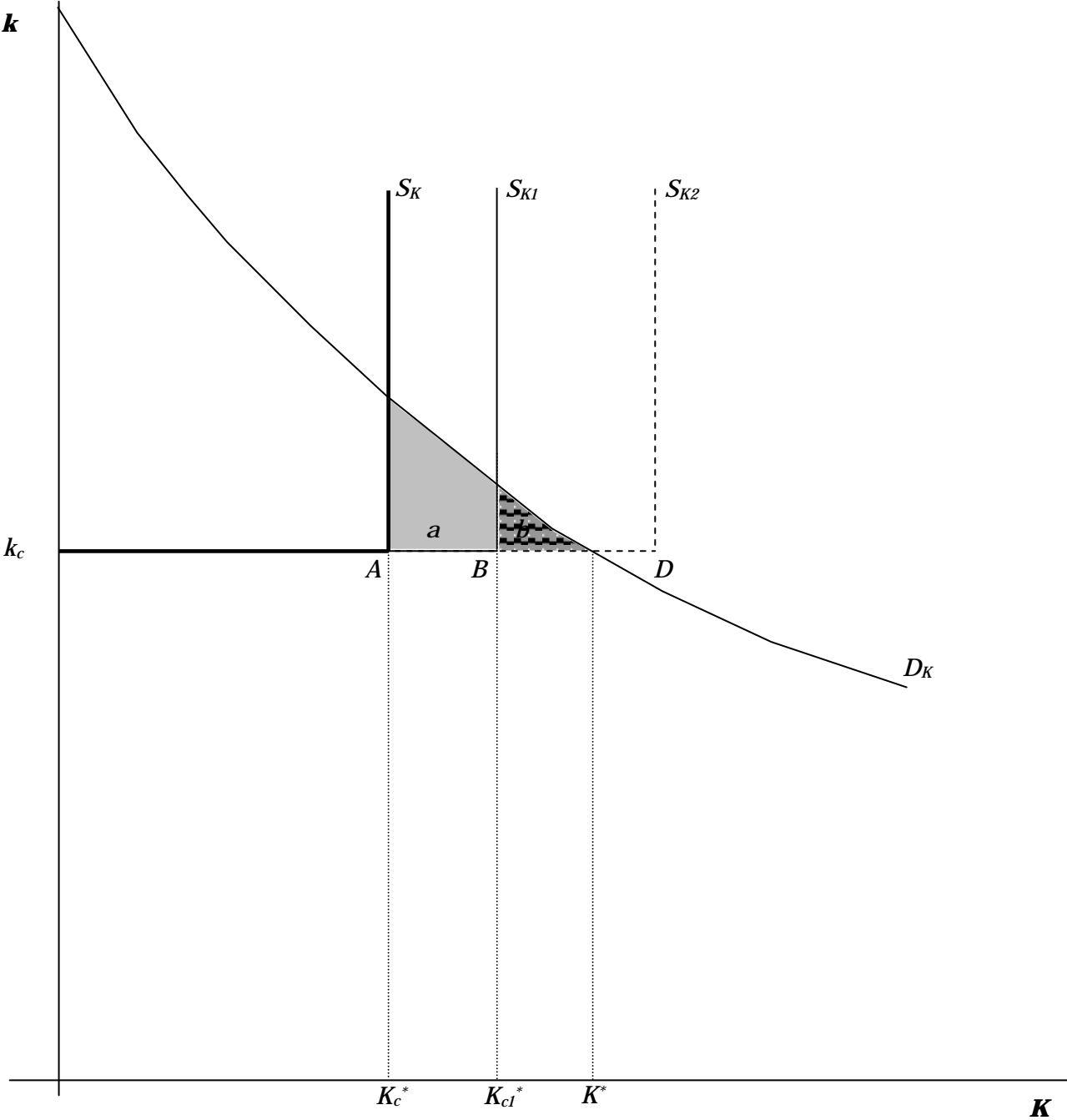


Table 1. Description of variables

Variable name	Description
<i>Dependent variables</i>	
Total loans	Long, medium and short-term loans per UAA
Long-term loans	Long- and medium-term loans per UAA
Short-term loans	Short-term loans per UAA
<i>Explanatory variables</i>	
sub_total_ha	Hectare value of farm subsidies
sub_coupled_ha	Hectare value of all coupled subsidies on crops, livestock and livestock products and RDP
sub_decoupled_ha	Hectare value of SPS and SAPS
sub_total_ha_sq	Square value of subsidies
sub_coupled_ha_sq	Square value of coupled subsidies
sub_decoupled_ha_sq	Square value of decoupled subsidies
sub_total_fsize	Interaction variable between subsidies and total loans (=sub_total_ha * farm size)
sub_coupled_fsize	Interaction variable between coupled subsidies and total loans (=sub_coupled_ha * farm size)
sub_decoupled_fsize	Interaction variable between decoupled subsidies and total loans (=sub_decoupled_ha * farm size)
assets_ha	Hectare value of farm assets
income_net_ha	Cash flow: farm revenues from production sales minus payments for inputs (excluding depreciation and interest costs)
income_net_ha_l	Lagged value of income_net_ha
year	Trend variable
land_rented_ratio	Ratio of rented area to UAA
labor_own_ratio	Ratio of unpaid input to total labour
Farm size	Economic size of holding expressed in European size units (ESU)
irrigated_land	Ratio of irrigated land to UAA
glass_land	Ratio of the area under glass or plastic land to UAA
land_unused_ratio	Ratio of fallow and set-aside land to UAA
land_woodland_ratio	Ratio of woodland area to UAA
output_livestock_ratio	Ratio of total livestock output to total farm output
output_owncons_ratio	Ratio of farmhouse consumption and farm use to total output
lu_ha	Total livestock units per UAA

Note: All variables are calculated from the FADN data.

Source: Authors' compilation.

Table 2. Fixed-effects estimates of loans (total subsidies)

	<i>Total loans</i>			<i>Long-term loans</i>			<i>Short-term loans</i>		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
sub_total_ha	0.0656	-0.995**	-1.075***	0.0762	-1.943***	-1.662***	0.00813	-0.142	-0.142
sub_total_ha_sq	–	–	0.000143**	–	–	0.000164**	–	–	-7.02e-07
sub_total_fsize	–	0.142*	0.0967	–	0.255**	0.158**	–	0.0204	0.0206
assets_ha	0.418***	0.418***	0.419***	0.406***	0.406***	0.407***	0.0522***	0.0521***	0.0521***
income_net_ha	0.246	0.246	0.247	0.301	0.302	0.303	-0.0726*	-0.0726*	-0.0726*
income_net_ha_l	-0.136	-0.136	-0.135	-0.149	-0.148	-0.147	0.000462	0.000466	0.000463
year	24.94**	24.94**	25.59**	19.89**	19.81**	20.66**	-7.654***	-7.664***	-7.667***
farm size	85.82	28.93	48.96	99.07	0.353	40.88	17.50	9.233	9.125
labor_own_ratio	-251.4***	-249.8***	-256.5***	-253.1**	-253.1**	-260.0**	-51.85	-51.54	-51.50
land_rented_ratio	3,780**	3,778**	3,779**	3,258**	3,251**	3,253**	470.0***	470.0***	470.0***
land_unused_ratio	297.1	279.2	279.9	200.5	175.1	179.4	-70.19	-72.55	-72.62
land_woodland_ratio	-2,209***	-2,166***	-2,148***	-2,598**	-2,546**	-2,529**	-179.9*	-173.4	-173.5
output_livestock_ratio	-3.075	-3.078	-2.473	1.655	1.843	2.441	-4.268	-4.270	-4.272
output_owncons_ratio	436.9	436.4	448.5	436.7	439.9	451.7*	-43.92	-44.00	-44.09
irrigated_land	-13.49	-13.45	-13.01	32.17	32.65	39.00	5.168	5.170	5.169
glass_land	28.15	28.16	30.58*	49.48***	50.20***	52.75***	-9.384*	-9.382*	-9.395*
yield_wheat	-0.194**	-0.195**	-0.190**	-0.236***	-0.234***	-0.230***	0.0405**	0.0405**	0.0405**
lu_ha	91.61	91.28	90.70	34.18	33.57	32.81	48.59**	48.57**	48.58**
Constant	-54,495**	-54,088**	-55,396**	-44,250**	-43,310**	-45,192**	15,011***	15,091***	15,098***
Observations	237372	237372	237372	195496	195496	195496	206108	206108	206108
R-squared	0.489	0.489	0.490	0.484	0.484	0.485	0.106	0.106	0.106
Number of idn	60904	60904	60904	51360	51360	51360	54382	54382	54382

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' compilation.

Table 3. Fixed-effects estimates of loans (disaggregated subsidies)

	<i>Total loans</i>			<i>Long-term loans</i>			<i>Short-term loans</i>		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
sub_decoupled_ha	-0.0325	-2.712***	-2.182**	0.131	-6.451***	-5.383***	-0.164***	1.120***	1.183***
sub_decoupled_ha_sq	–	–	-0.000383	–	–	-0.000878*	–	–	-8.10e-05
sub_decoupled_fsize	–	0.339**	0.260	–	0.801***	0.676***	–	-0.153***	-0.155***
sub_coupled_ha	0.0696	-0.945**	-1.046***	0.0740	-1.731**	-1.450***	0.0139	-0.196	-0.198
sub_coupled_ha_sq	–	–	0.000142**	–	–	0.000162**	–	–	-2.63e-06
sub_coupled_fsize	–	0.136*	0.0960	–	0.229**	0.136**	–	0.0282	0.0297
assets_ha	0.418***	0.418***	0.419***	0.406***	0.406***	0.407***	0.0521***	0.0522***	0.0522***
income_net_ha	0.247	0.247	0.247	0.301	0.302	0.303	-0.0718*	-0.0717*	-0.0718*
income_net_ha_l	-0.136	-0.135	-0.135	-0.149	-0.148	-0.147	0.000671	0.000783	0.000758
year	27.46*	28.34*	26.50*	18.55	20.71	18.22	-3.072	-3.549*	-3.809*
farm size	84.51	15.31	38.08	99.77	-26.67	16.71	15.01	17.02	16.87
labor_own_ratio	-252.3***	-243.6***	-251.3***	-252.7**	-232.3**	-239.1**	-54.60	-60.46*	-60.39*
land_rented_ratio	3,779**	3,779**	3,781**	3,258**	3,258**	3,261**	469.0***	468.2***	467.9***
land_unused_ratio	292.3	275.0	276.2	204.1	177.2	185.8	-81.02	-91.46	-91.89
land_woodland_ratio	-2,208***	-2,146**	-2,129**	-2,598**	-2,556**	-2,544**	-176.4*	-190.4*	-191.1*
output_livestock_ratio	-2.842	-2.693	-2.154	1.535	2.463	3.166	-3.852	-4.012	-4.002
output_owncons_ratio	448.2	443.1	445.3	430.9	427.0	426.8	-9.337	-0.244	-1.678
irrigated_land	-13.71	-14.51	-14.00	34.17	25.43	30.25	5.128	5.680	5.685
glass_land	24.32*	25.83*	32.41**	51.57***	55.21***	64.12***	-15.99***	-17.37***	-16.98***
yield_wheat	-0.187**	-0.189**	-0.191**	-0.239***	-0.242***	-0.247***	0.0532***	0.0551***	0.0545***
lu_ha	91.60	91.32	90.68	34.19	33.70	32.86	48.60**	48.46**	48.47**
Constant	-59,533*	-60,790*	-57,152*	-41,584	-44,903	-40,130	5,857	6,794	7,310*
Observations	237372	237372	237372	195496	195496	195496	206108	206108	206108
R-squared	0.489	0.489	0.490	0.484	0.484	0.485	0.106	0.107	0.107
Number of idn	60904	60904	60904	51360	51360	51360	54382	54382	54382

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' compilation.

Table 4. Arellano and Bond estimates of loans (disaggregated subsidies)

	<i>Long-term loans</i>			<i>Short-term loans</i>		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
sub_decoupled_ha	2.434***	-4.792	0.294	0.328	-0.677	-0.415
sub_coupled_ha	2.471***	-1.644	-0.214	0.279	-0.101	-0.189
sub_decoupled_fsize	–	0.861**	–	–	0.118	–
sub_coupled_fsize	–	0.482	–	–	0.0449	–
sub_decoupled_ha_sq	–	–	-0.000630	–	–	0.000792
sub_coupled_ha_sq	–	–	0.000317***	–	–	0.000185***
assets_ha	0.214***	0.216***	0.215***	0.0427***	0.0396***	0.0429***
income_net_ha	0.468***	0.477***	0.431***	0.0628**	0.0511*	0.0489*
investment_ha	0.766***	0.756***	0.747***	-0.0786	-0.0593	-0.0579
L.investment_ha	0.243***	0.242***	0.260***	0.0797***	0.0886***	0.0782***
a26	-82.65***	-292.0**	-83.61***	-13.58	-41.48	-16.61
labor_own_ratio	-90.20	-74.66	-86.22	-54.90	-45.12	-49.75
land_rented_ratio	1,760***	1,690***	1,617***	281.5***	275.8***	294.3***
land_unused_ratio	416.1***	397.7***	210.4*	-75.45	-88.65	-73.07
land_woodland_ratio	-4,758***	-3,836***	-3,190***	-151.6	-131.5	-123.8
output_livestock_ratio	13.87	14.68	14.46	0.304	0.450	-0.0605
output_owncons_ratio	545.7***	441.0***	519.2***	48.86	43.17	60.15
irrigated_land	-192.7	-193.7	-219.0	-17.68	-29.78	-36.60
glass_land	59.32***	60.47***	46.79***	1.185	1.128	0.925
yield_wheat	-0.258***	-0.270***	-0.267***	-0.0196	-0.0228	-0.00653
lu_ha	167.0***	151.3**	175.9***	35.31	41.42	33.86
L.loan_total_ha_adj	–	–	–	–	–	–
L2.loan_total_ha_adj	–	–	–	–	–	–
L.loan_long_run_ha_adj	-0.0368*	-0.0298	-0.0357*	–	–	–
L2.loan_long_run_ha_adj	-0.0407***	-0.0436***	-0.0269*	–	–	–
L.loan_short_run_ha_adj	–	–	–	0.146***	0.160***	0.141***
L2.loan_short_run_ha_adj	–	–	–	-0.0233	-0.0233	-0.0305
Constant	-1,948***	-172.0	-907.7***	-94.81	142.6	72.89
Observations	92328	92328	92328	95448	95448	95448
Number of idn	26792	26792	26792	28380	28380	28380

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' compilation.



Comparative Analysis of Factor Markets for Agriculture across the Member States

245123-FP7-KBBE-2009-3

The Factor Markets project in a nutshell

Title	Comparative Analysis of Factor Markets for Agriculture across the Member States
Funding scheme	Collaborative Project (CP) / Small or medium scale focused research project
Coordinator	CEPS, Prof. Johan F.M. Swinnen
Duration	01/09/2010 – 31/08/2013 (36 months)
Short description	<p>Well functioning factor markets are a crucial condition for the competitiveness and growth of agriculture and for rural development. At the same time, the functioning of the factor markets themselves are influenced by changes in agriculture and the rural economy, and in EU policies. Member state regulations and institutions affecting land, labour, and capital markets may cause important heterogeneity in the factor markets, which may have important effects on the functioning of the factor markets and on the interactions between factor markets and EU policies.</p> <p>The general objective of the FACTOR MARKETS project is to analyse the functioning of factor markets for agriculture in the EU-27, including the Candidate Countries. The FACTOR MARKETS project will compare the different markets, their institutional framework and their impact on agricultural development and structural change, as well as their impact on rural economies, for the Member States, Candidate Countries and the EU as a whole. The FACTOR MARKETS project will focus on capital, labour and land markets. The results of this study will contribute to a better understanding of the fundamental economic factors affecting EU agriculture, thus allowing better targeting of policies to improve the competitiveness of the sector.</p>
Contact e-mail	info@factormarkets.eu
Website	www.factormarkets.eu
Partners	17 (13 countries)
EU funding	1,979,023 €
EC Scientific officer	Dr. Hans-Jörg Lutzeyer

