Do Agricultural Subsidies Crowd-out or Stimulate Rural Credit Market Institutions?: The Case of CAP Payments

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Abstract
In this paper we estimate the impact the CAP subsidies 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 empirical analysis we use the FADN farm level panel data to test the theoretical predictions for period 1995-2007. We employ the fixed effects and GMM models to estimate the impact of subsidies on farm loans. The estimated results suggest that (i) subsidies influence farm loans and the effects tend to be non-linear and indirect; (ii) both coupled and decoupled subsidies stimulate long-term farm loans, but the long-term loans of big farms increase more than those of small farms due to decoupled subsidies; (iii) the 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 (v) when controlling for the endogeneity, only the decoupled payments affect loans and the relationship is non-linear.

Introduction

Agricultural subsidies have important impacts on agricultural markets. Besides affecting farmers' income, studies have shown that agricultural subsidies distort input and output markets and thus alter 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, structure of markets and the existence of market imperfections (Alston and James 2002; de Gorter and Meilke 1989; Gardner

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1983; Guyomard, Mouël, and Gohin 2004; Salhofer 1996; Ciaian and Swinnen 2009). Studies also evaluate, among others, impacts of subsidies on the environment and agricultural public goods (e.g. Beers Van Cees and Van Den Bergh 2001; Khanna, Isik and Zilberman 2002) or productivity and market distortions (e.g. Chau and de Gorter 2005; Goodwin and Mishra 2006; Sckokai and Moro 2006).

With few exceptions (e.g. Ciaian and Swinnen 2009), most of these studies investigate the direct impacts of subsidies (on prices, quantities, income, 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 organization or crowd out some market institutions. An analysis of such effects goes beyond the focus of the current agricultural policy analysis literature. These issues are related to "crowding out effects" of other types of govrement programs extensively analyzed in the literature. For example, the interaction between private transfers and public welfare programs attracted considerable attention from 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 European Union'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 analyze how subsidies may affect farm loans. Then, employing a unique farm level Farm Accountancy Data Network (FADN) panel data 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.

The Model

We build a 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) analyze farm production behaviour under the credit constraint in developing countries while Ciaian and Swinnen (2009) study how the credit constraint affects the income distributional effects of area payments. In this study we extend the three models by analyzing 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), fixed quantity of family labour (F)[5] and non-land inputs (K), which we refer to as "fertilizer" but which captures also 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:

(1) $\prod = pf(A, K, F) - k_c K$

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 sale of production the farm has a demand for the short-term credit. The demand for credit can be satisfied either internally (cash flow, savings, subsidy) or externally (bank loan, or trade credit). For the sake of simplicity we consider only external financing through the bank loan and later on in the paper also subsidy[6]. The demand for credit might not be fully satisfied, which means that the farm can 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, credit constraint may prevent the farm from using the optimal amount of fertilizer.

Perfect Credit Markets

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[5] The assumption of fixed amount of land and family labour is not strictly needed to obtain the results. We introduce this assumption in order to simplify the exposition of the model results.

[6] This assumption is not strictly needed to obtain the results.

To establish a point of comparison, we first identify the equilibrium without 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 maximizes its profit given by equation (1). This implies the equilibrium condition:

(2) $pf_K = k_c$

In equilibrium the marginal value product of fertilizer is equal to its price. The condition (2) determines the farm's fertilizer's demand function. Total fertilizer demand is represented by function D_K in Figure 1. Because we assume that both fertilizer price and the interest rate are fixed, the supply of fertilizer is horizontal curve, S. The equilibrium quantity of fertilizer with no credit constraint is K^*.

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 collateral (W). For the sake of simplicity we consider that banks accept only assets as collator.[7] That is $C = C(W)$ where $dC/dW > 0$. The credit constraint is given by:

(3) $kK \leq C(W)$

With the credit constraint the farm maximizes the end-season profit given by equation (1), subject to the credit constraint (3). This amounts to solving the LaGrangean function:

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

where λ_c is the shadow price of the credit constraint.

[7] 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, 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 US that the probability of being denied credit is reduced, among others, by net worth, income, price of assets, and subsidies.

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:

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

(6) $kK - C \leq 0$.

From equation (5) 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 $k_c A S_K$, 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 (3). Under credit constraint the farm uses less fertilizer than under the perfect competition, $K_c^* < K^*$.

Subsidies and Credit Constraint

We define *DS* as a decoupled subsidy which the farm receives irrespective of its level of production. With subsidy the objective function of the farm becomes:

(7) $\prod = pf(A, K, F) - k_c K_c - k_s K_s + DS$

where $k_s = (1 + i_s)k$, K_c is the fertilizer financed through the bank loan *C*, K_s is the fertilizer financed with subsidies *DS*, i_s represents farm's opportunity cost of subsidy (i.e. the return on the most profitable alternative investment opportunity), and $K = K_c + K_s$. We assume that the cost of bank loan is higher than the cost of subsidy, $i_c > i_s$. This 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 subsidy at the beginning of the season, it can use it for paying for the fertilizer. Receiving the subsidies at the end of the season improves the farm's access to credit too. Future guaranteed payment of subsidy may serve as collateral for obtaining loan from the bank (Ciaian and Swinnen 2009). Therefore subsidy may alleviate the credit constraint of the farm irrespective of the timing of the subsidy.

With subsidy credit constraint is given by the following inequalities:

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

(9) $kK_s \leq \alpha DS$

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

Equation (8) therefore 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 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 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, subsidy increases farm assets, improves its creditworthiness and thus increases access to bank loans. Equation (9) states that the use of subsidy for fertilizer purchase cannot exceed the total value of subsidies *DS*.

With subsidies and credit constraint the objective function of the farm is represented by the following LaGrangean function:

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

where λ_s is the shadow price of the subsidy constraint (9).

The optimality conditions are given by:

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

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

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

(14) $kK_s - \alpha DS \leq 0$.

The Impact of Decoupled Subsidy

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

Hypothesis 1: *If farms are not credit constrained and if financing via 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 via the bank loan is more expensive than financing through the subsidy, $i_c > i_s$ (i.e. $k_c > k_s$), subsidy can reduce amount of 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. The 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. Availability of cheaper financing through subsidy *DS* allows the farm to reduce the amount of bank loans. The farm will use less loan and part of the fertilizer will be financed with subsidy, equal to K_s^* ($= DS/k$). The remaining 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 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 $DS > kK^*$), the equilibrium fertilizer use increases.

If the subsidy is paid at the end of the season, the farm cannot use it directly to purchase fertilizer. However, subsidy can still be used as collateral. We assume that the type of collateral does not affect bank loan interest rate; hence the subsidy does not alter the equilibrium quantity of loans.[8]

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

Next we analyse the case when farm is credit constrained and 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, (a) farms will use the same amount of loans with and without subsidies if subsidies are sufficiently small and (b) the farm will reduce bank loans if 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 subsidy on the bank loan under 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 $k_c D S_K$ to $k_s AE S_{K1}$, where $S_{K1} = (C + DS_1)/k$. The equilibrium quantity of fertilizer is K_{cs1}^* $(= (C + DS_1)/k)$. Some fertilizer is financed directly from 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 subsidy is used to purchase fertilizer under the credit constraint. Subsidy DS_1 does not change the quantity of the bank loan: with and without the subsidy the farm purchases the same amount of fertilizers 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 used under perfect market K^*, $K_{cs1}^* < K^*$ – and thus it is profitable for the farm to exploit fully all available financing opportunities (subsidies and loans).

However, if 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 $k_s BF S_{K2}$, where $S_{K2} = (C + DS_2)/k$ (Figure 3). The equilibrium fertilizer use changes to K^*: K_{s2}^* $(= DS_2/k)$ is financed from subsidy and $K^* - K_{s2}^*$ is financed with the bank loan. Now, the farm uses 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 with bank loan without subsidy K_c^*. Relative to no subsidy situation, the farm's gain is the area *abde*. Intuitively subsidy DS_2 eliminates the credit constraint (i.e. the credit constraint (13) is not binding with DS_2, $\lambda_c = 0$) and farm substitutes part of expensive bank loans with cheaper subsidies. With subsidy DS_2 the farm is not credit constrained and it uses the same level of fertilizer as under the perfect market situation, K^*.

Finally, we consider the situation with binding credit constraint when 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 the season, the farm increases bank loans.*

The graphical analysis is in Figure 4. The fertilizer supply without the subsidy and with the credit constraint is $k_c A S_K$ and the equilibrium fertilizers use is K_c^*. If the credit constraint (8) 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 purchase of fertilizer at the beginning of the season. Hence, because of higher 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 $k_c B S_{K1}$ 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 sufficiently high subsidy, the farm may become credit unconstrained (i.e. $\lambda_c = 0$). For example, this is the case when subsidy shifts the fertilizer supply to $k_c D S_{K2}$ which increases the equilibrium use to K^* and generates a gain for the farm equal to area *ab*.

Extension: Long-term Loans

In general, farms use long-term loans to finance long-term investments which generate multi-annual income stream. The impact of decoupled subsidies on the long-term loans is similar as in the case of the short-term loans.[9] 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 season, they may alter loans only by affecting farm collateral value. Hence, all three hypotheses derived in the previous section hold also in the case of long-term loans.

Econometric specification

Theoretically the impact of decoupled subsidy on agricultural loans is ambiguous. Agricultural subsidies paid at the end of the season have no impact on bank loans under perfect markets while they reduce bank loans when paid at the beginning of the season. Under 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 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 (11)-(14)), the amount of farm loan depends on farm's subsidy, profitability, and assets. We therefore estimate the following econometric model:

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

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.[10]

We are especially interested in estimating the parameter β_{ds} which measures the impact of subsidies on bank loans. Statistically significant 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 2b (sufficiently high subsidies paid at the beginning of the season eliminate bank loans when farms are credit constrained). Statistically significant and positive coefficient confirms hypothesis 3

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

[10] The definition of the rest of the variables is the same as in the theoretical section.

(farms are credit constrained and subsidies are paid at the end of the season). Finally, if the coefficient is not statistically significant, then the hypothesis 2a 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; Fare, Grosskopf and Lee 1990). Further, anecdotal evidence indicates that subsidies tend to be paid at the end of the season[11] which implies that the hypothesis 3 should hold. This is in particular the case of the long-term loans which tend to finance investments with higher value than short-run loans.[12] 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. The hypothesis 3 is more likely to hold in the case of the long-term loans.

The estimation of equation (15) is subject to the omitted variable bias and particularly to the endogeneity. There are unobservable characteristics like farmer's ability that affect bank loans and may be correlated with explanatory variables. Ignoring this unobserved farm heterogeneity bias the results. We use panel data and estimate fixed effects model which helps us to control for the unobserved heterogeneity component that remains fixed over time thus reducing considerably the omitted variable bias problem. In order to control for the endogeneity we estimate the generalised method of moment (GMM) model.

Fixed effects model

The following fixed effects model estimation implies the following specification:

$$loan_{jt} = \beta_0 + b_j + \beta_{ds} DS_{jt} + \beta_a assets + \beta_\pi \Pi_{jt} + \beta_x X_{jt} + \varepsilon_{jt} \quad (16)$$

where b_j is the fixed effect 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 different

[11] There is not available consistent data on the timing of CAP subsidies.

[12] In 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 inputs (e.g. fertilizers). The price of variable inputs is determined by its annual marginal contribution to the farm profitability.

managerial skills or other unobservable fixed farm specific characteristics.

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 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 coupled RDP 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. Hence, subsidies are not assigned randomly, which implies that subsidy payments are correlated with the error term. As a result, 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 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.

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. 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, while most countries have about 1 500-10 000) representing a population of around 5,000,000 farms, covering approximately 90% of the total utilised agricultural area and accounting for more than 90% of the total agricultural production. The aggregate FADN data are publicly available. However, farm-level data are confidential 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 in the whole 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, however, cover all the agricultural holdings in the Union, but only those which 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 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 description of constructed variables is presented in Table 1. All variables except for ratios are calculated per hectare of utilised agricultural area (UAA) in order to reduce the potential problem of heteroskedasiticy. The dependent variables in equation (16) – *total loan, long-term loans, short-term loans* – are constructed from the FADN data by dividing total, long-medium-term and short-term loans, respectively, with 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 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. Decoupled subsidies, *sub_decoupled_ha*, include SPS and SAPS payments. Coupled subsidies, *sub_coupled_ha*, include payments linked to farm inputs or outputs such crop area payments, animal payments and RDP. The total subsidies, *sub_total_ha*, variable 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 per-hectare basis.

The covariates matrix X_{jt} includes other explanatory variables which 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 higher cost level of 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. In order to account for the various technological, sectoral and regional covariates we include variables accounting for effects such as irrigated land, area under glass, fallow land, and sectoral, regional and time dummies (for more details see Table 1).

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).[13] Additional to the

[13] We estimate fixed effects models with heteroscedasticity-consistent standard errors.

complete equation specification (16), 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 indirect and nonlinear relationship between subsidies and loans.

The model-adjusted R^2s ranges from 0.10 to 0.49. The most consistently significant variables (prob(t) < 0.10) across all models are assets (*assets_ha*), trend variable (*year*), own labour ratio (*labor_own_ratio*), and 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, are statistically not significant for all types of loans. However, when interacting subsidies with farm size (models 2 and 5) 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) both coefficients (i.e. for the interaction variable and the linear term *sub_total_ha*) are not significant.

Further, 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 holds only for total loans and for long-term loans. The short-term loans are not affected by subsidies also when the non-linear relationship is considered (model 9).

These results indicate that the hypothesis 3 holds for the total and the long-term loans whereby subsidies increase farm collateral and thus farm loan use. Multi-annuality character of the long-term investments allows the use subsidies by credit constraint farms to finance investments only through loans. For the short-term loans the estimated results suggest the validity of the hypothesis 2a. However, this does not imply that farms are not credit constraint with respect to short-term loans. Farms may still be credit constrained and may use subsidies to finance short-term inputs because either receiving them at the beginning of the growing season or because they may use other informal sources which 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 the long-term investments and not the short-term ones possibly because of stronger credit constraint present 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 important differences the two types of payments have on the farm loans. For the long-tem 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 farm more loans of big farms than of 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. However, the direct effect (the coefficient for *sub_decoupled_ha* in model 9) 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 short-term loans are used as collateral to increase farm loans but this is more important for small farms than for big farms. The coupled payments do not affect the short-term loans: i.e. the coefficients for variable *sub_coupled_ha*, *sub_coupled_ha_sq* and *sub_coupled_fsize* are statistically not significant in model 9.

The results in Table 3 confirm that the hypothesis 3 tend 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 the hypothesis 3, whereas the estimated effects for the coupled payments suggest that the hypothesis 2a may better represent the reality.

The GMM estimates are shown in Table 4. Generally, the GMM results indicate different results as compared to the ones reported for the fixed effect model. When controlling for the endogeneity, the importance of subsidies in determining both the long-term and the 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, 3 and 4, 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.

Conclusions

In this paper we estimate the impact the CAP subsidies on farm bank loans. First, we theoretically analyse the farmers' farm loan demand under perfect and imperfect credit market assumptions. In empirical analysis we use the FADN farm level panel data 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 farm is not constrained with respect to external financing. This is the case when subsidies are paid at the beginning of the season and thus allowing farms to substitute loans by cheaper subsidies. With credit constraint, 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. However, if subsidies are substantial they may eliminate the farms' credit constraint and may crowd out more expensive bank loans. On the other hand, if subsidies are received at the end of the season, farms can not use them directly to finance inputs. Instead they may use subsidies as a collateral to obtain more bank loans thus rising 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 the following impact of subsidies on farm loan use: (i) Subsidies influence farm loans and the effects tend to be non-linear and indirect. (ii) Coupled subsidies affect short and long term loans differently than decoupled subsidies. (iii) Both coupled and decoupled subsidies stimulate long-term farm loans. But long-term loans of big farms increase more than those of small farms due to decoupled subsidies. (iv) Short-term loans are affected only by decoupled subsidies. However, decoupled subsidies increase short-term loans of small farms more than those of large farms. (v) When controlling for the endogeneity, the importance of subsidies in determining both the long-term and the 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 the hypothesis 3 holds for the decoupled payments, whereas coupled payments are found not to affect loans.

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Figure 1. Farm fertilizers use with and without credit constraint

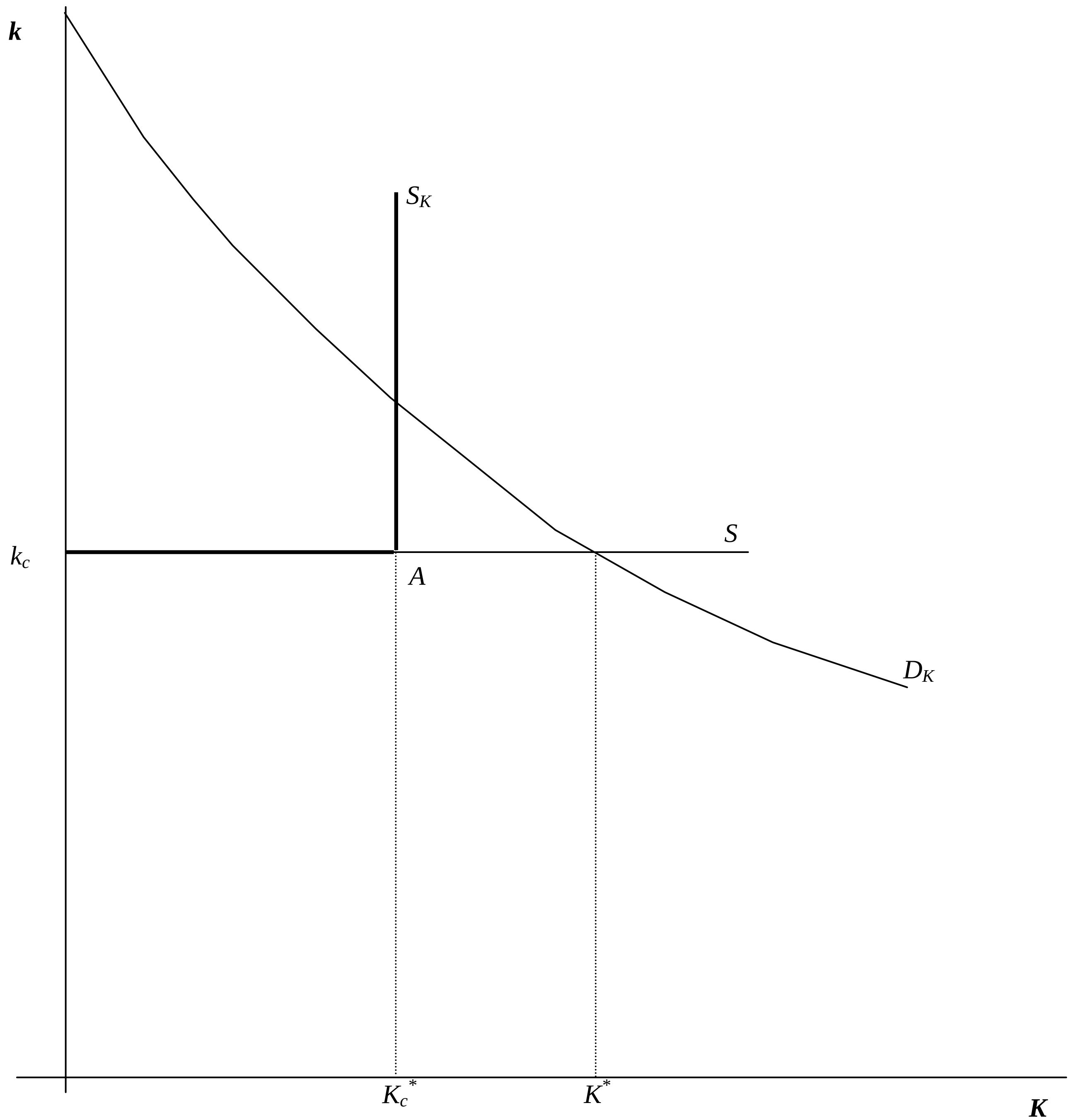

Figure 2. Subsidies and no credit constraint

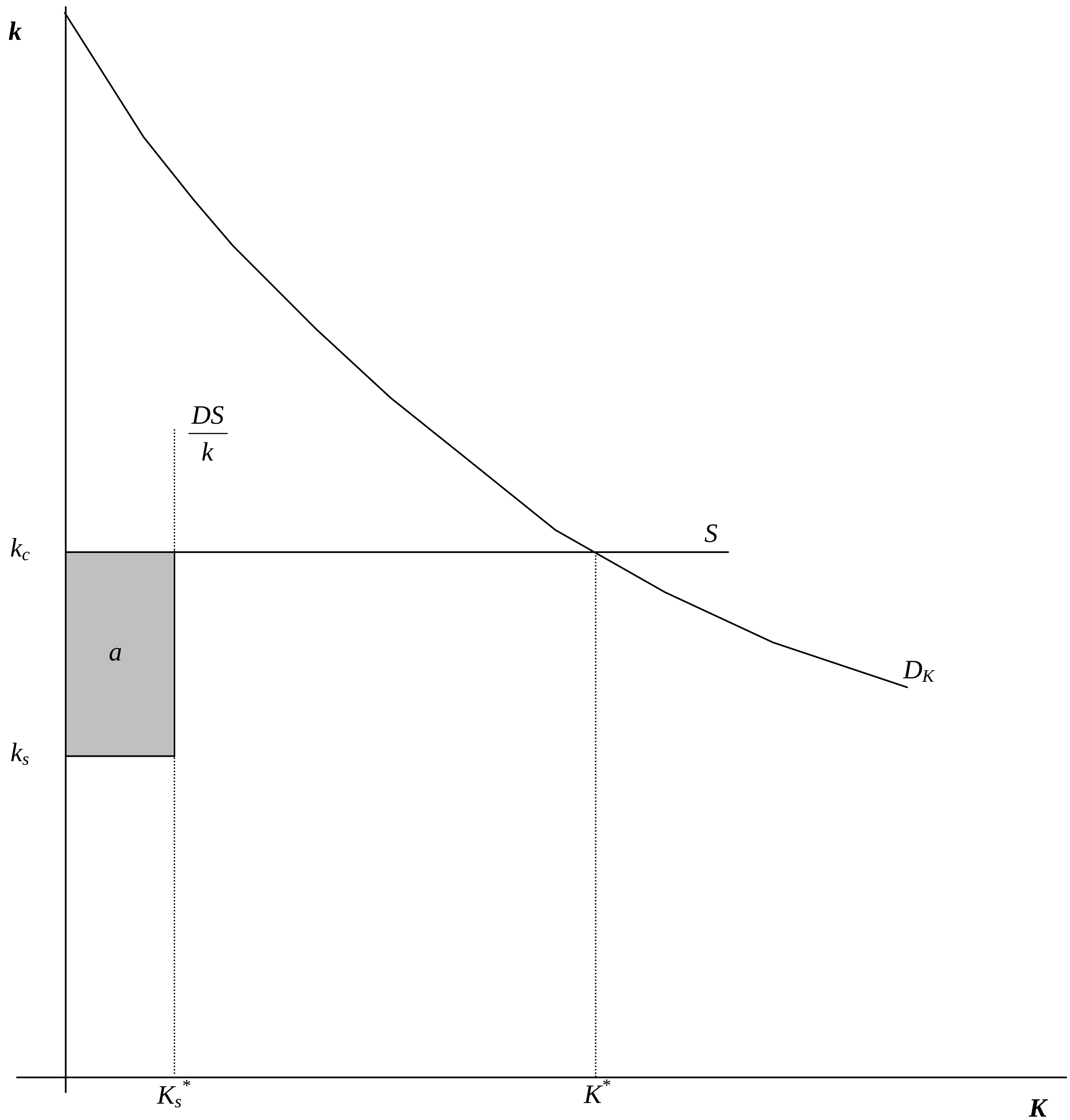

Figure 3. Credit constraint and subsidies with $\alpha = 1$

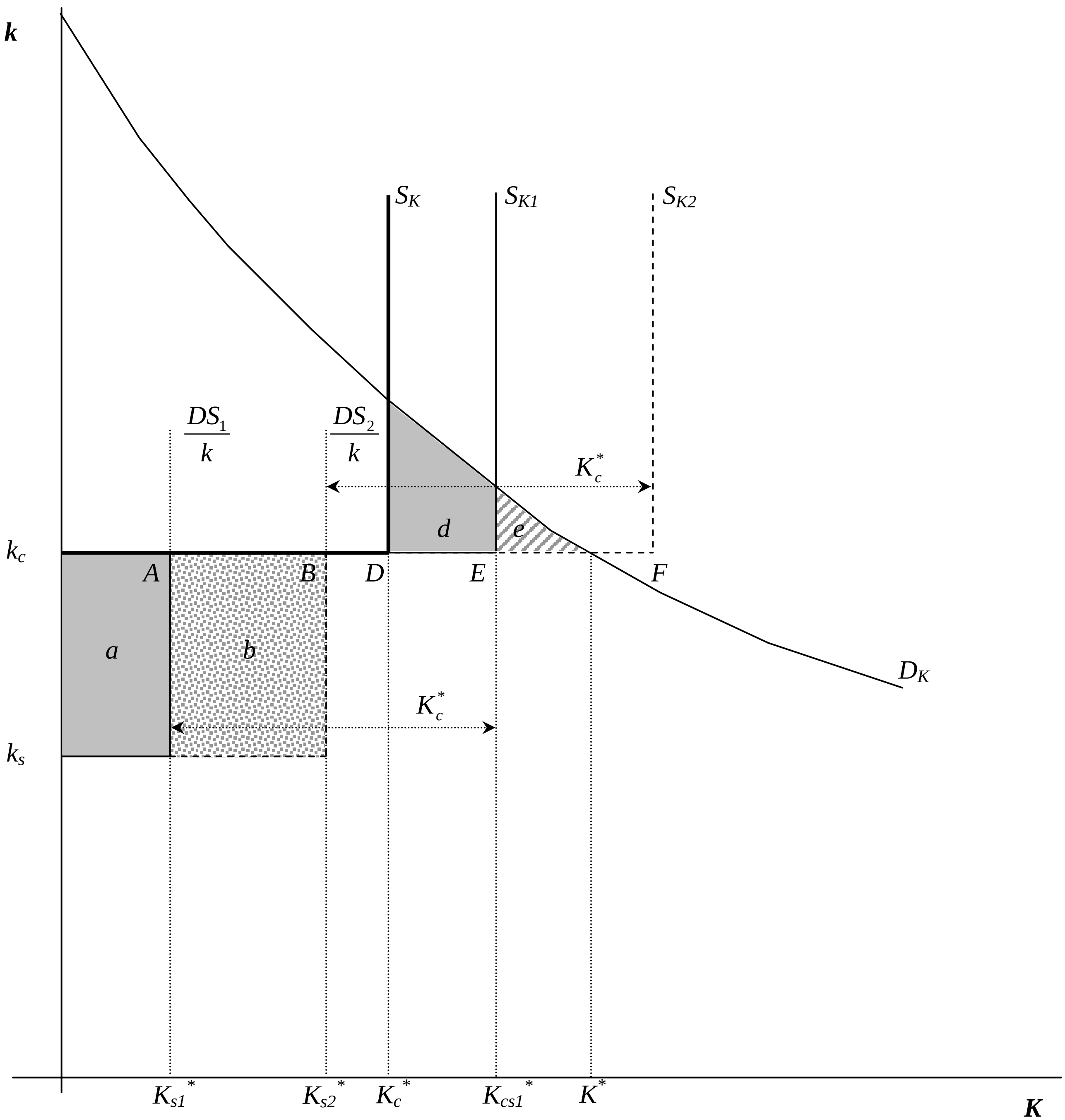

Figure 4. Credit constraint and subsidies with $\alpha = 0$

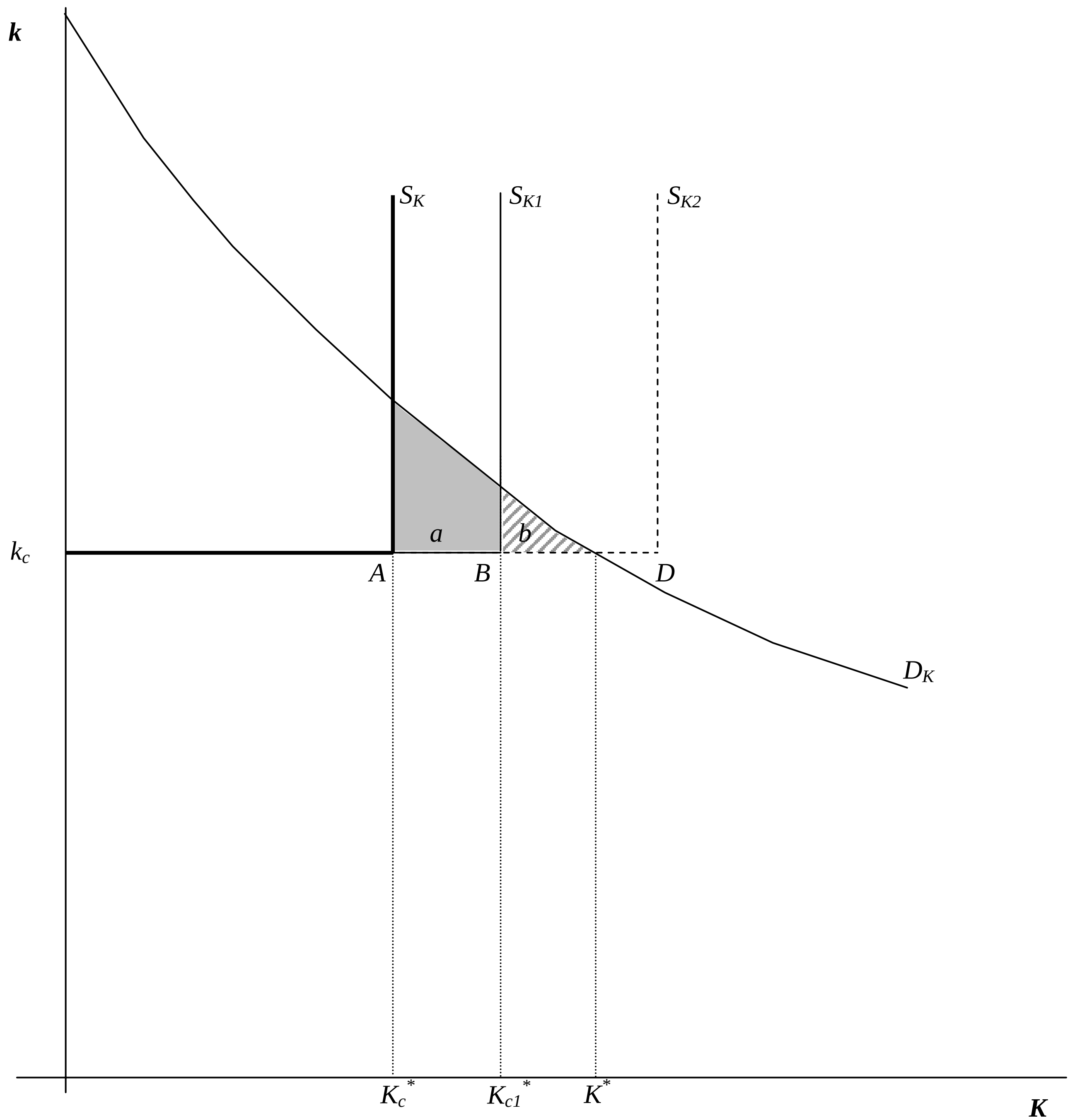

Table 1. Description of variables

Variable name	Description
Dependent variables	
Total loans	Long, medium and short-term loans per UAA
Long run loans	Long & medium-term loans per UAA
Short run loans	Short-term loans per UAA
Explanatory variables	
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)
irigated_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 variable are calculated from the FADN data.

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

	Total loans			*Long-term loans*			*Short-term loans*		
	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
irigated_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

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

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

	Total loans			*Long-term loans*			*Short-term loans*		
	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
irigated_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

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

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

	Long-term loans			*Short-term loans*		
	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
irigated_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

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1