Credit Market Imperfections and the Distribution of Policy Rents

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Abstract— **This article shows that credit market imperfections have important implications for the distribution of policy rents. In a model with land as fixed factor and credit market imperfections, when an area payment is given, land rents go up by more than the subsidy. On aggregate farms may lose from the subsidy. The results depend on the extent to which subsidies have direct and indirect effects on the credit constraints, on whether farms rent or own land, and on farm heterogeneity.**

Keywords— **Agricultural policy, imperfect credit markets, policy rents.**

I. INTRODUCTION

There is an extensive literature on the distributional effects of agricultural policy, or what Alston and James (2002) refer to as the "incidence of agricultural policy".[1] An influential study by the OECD came to the conclusions that only 20% of all market and price support in OECD countries resulted in net farm surplus gains; the rest was dissipated to others, including owners of production factors (OECD, 2001b). Studies have analyzed how these effects differ among polices (Alston and James, 2002; de Gorter and Meilke, 1989; Dewbre, Anton and Thompson, 2001; Gardner 1983; Guyomard, Mouel and Gohin, 2004), or how the results change if one includes more agents along the vertical chain (Desquilbet and Guyomard, 2002; Sheldon, Pick, and McCorriston, 2001).

The distribution of policy rents is also influenced by imperfections in policies and markets. Two types of imperfections have been studied: imperfect competition and imperfect implementation. Among others, McCorriston and Sheldon (1991) and Salhofer and Schmid (2004) have analyzed how imperfect competition in up- or downstream sectors affect the distribution of policy rents. Others, including OECD (2007), de Gorter (1992), Munk (1994), and Vatn (2001) have analyzed the implications of transaction costs and constraints in the implementation of the polices.

However, little attention has been paid to constraints in factor markets in this literature. The reason is probably that this literature has strongly focused on OECD countries. In contrast, studies analyzing effects of agricultural polices in developing or transition countries, often include market imperfections as key feature of their models (e.g. Bellemare and Barrett 2006; Bhattacharyya, Bhattacharyya, and Kumbhakar, 1996; Fafchamps and Hill 2005; de Janvry, Fafchamps, and Sadoulet, 1991; Rizov and Swinnen, 2004; Sadoulet, de Janvry, and Benjamin, 1998). However the focus of these studies is how market imperfections affect reactions of agents to policy changes and not the distribution of policy rents.

A first attempt to address this shortcoming was by Ciaian and Swinnen (2006) who analyze how imperfections in land markets affect the distributional effects of agricultural polices in Central and Eastern European countries.

Nobody, to our knowledge, has analyzed the impact of credit market imperfections on the incidence of agricultural polices. This is somewhat remarkable given the prevalence of credit market imperfections in agriculture. It is well known that rural credit market imperfections are widespread in developing and transition countries (eg. Carter, 1988; Swinnen and Gow, 1997).[2] However, studies show that also in the US and the EU, farms' access to credit is constrained. In an empirical study of French farmers, Blancard et al (2006) find that two-thirds of the farmers in their sample are credit constraint in the short run and all of them are credit constrained in the long run. Lee and Chambers (1986) and Färe, Grosskopf, and Lee (1990) find that at least part of the US farms in their study are credit constrained.

The objective of the present paper is to analyze how credit constraints affect the distributional effects of subsidy programs. The policy on which this paper focuses is an area payment (subsidies per unit of agricultural land). Area payments are an important form of agricultural subsidies. In

[1] These issues are different from but related to analyses of distortions caused by policies which have received renewed attention in the current WTO negotiations and policy reforms leading up to it. For example, an important issue is whether "decoupled policies" are truly decoupled (e.g. Chau and de Gorter 2005; de Gorter 2007; Goodwin and Mishra, 2006; Hennessy, 1998; OECD, 2001a; Serra et al, 2005; Sckokai and Moro, 2006).

[2] There is a vast theoretical and empirical literature on imperfections in rural credit markets, including the seminal work of Stiglitz and Weiss (1981).

2007, the EU alone spent 30 billion euros on area payments. The importance of area payments as policy instrument is reflected in the fact that several recent studies have analyzed their effect, including Alston (2007), Kirwan (2005), OECD (2005). However none of these studies considers the effect of imperfect credit markets.

The paper is organized as follows. We first explain the basic model and derive the equilibrium without credit constraints. Then we introduce credit constraints and show how the equilibrium changes. Next, we analyze the effect of area payments, and we use a simulation exercise to illustrate the impact of several variables. The final section concludes.

II. THE MODEL

Consider an agricultural economy with *n* identical farms. The output of each farm is a function of the amount of land (A) 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 $f(A,K)$ with $f_i > 0$, $f_{ii} < 0$, $f_{ij} > 0$, for *i*, *j* = *A* and *K*. Total land available is assumed to be fixed, A^T. End of the season profits are:

$$\Pi = pf(A,K) - rA - kK(1+i) \quad (1)$$

where *p* is the price of the final product, *r* is the price of land, k is the per unit price of fertilizers and i is interest rate. We assume that the economy is small and open, which implies that the fertilizer price and the output price are fixed. Similarly, we assume that agriculture is small in terms of the credit use and agricultural loans will therefore not affect interest rates.

An important issue is the timing of the various activities and payments throughout the season. We assume that fertilizers have to be paid at the start of the season while payment of land rents to owners and farms' revenues from selling the harvest occur at the end of the season, after harvest.[3] Other inputs, i.e. fertilizer *K*, need to be financed at the start of the season. This can be done through internal finance (savings or cash flow) and /or through credit.

A. Perfect Credit Market

To establish a point of comparison let us first identify the equilibrium without credit market constraints. With perfect credit markets, farms are not constrained on the quantity of inputs they use. Farms will choose the quantity of land and fertilizer that will maximize their profits given by equation (1). This implies the following equilibrium conditions (for notational simplicity the interest rate *i* is set equal to zero ($i = 0$)): [4]

$$pf_A - r = 0 \quad (2)$$

$$pf_K - k = 0 \quad (3)$$

$$A = A^T \quad (4)$$

Conditions (2) – (4) determine the farm's input demand functions. Total land demand is the aggregate of all *n* farms land demand functions and represented by function *D* in figure 1. For illustrative purposes we use linear functions in the figures. The results which we illustrate hold in general, as proven by the mathematical derivations. In figure 1, with fixed land supply A^T and land demand *D*, the equilibrium rent is r^*.

The distribution of policy rents resulting from area payments in this case are well known. When there is one input fixed in supply and with fixed prices of other inputs and fixed output price, farmers will not benefit from subsidies and all benefits will go to the suppliers of the inelastic input, land in this case (see e.g. Alston and James, 2002; Alston, 2007; Gardner, 1983; Just, Hueth, and Schmitz 2004).

However, this conclusion assumes that credit markets work perfectly (or, in other words, that there are no constraints on the supply of other inputs (fertilizers)). In the next section we will show that these results change when access to credit is constrained.

B. Imperfect Credit Market

To model the imperfect credit market, we use the approach of Feder (1985) and Carter and Wiebe (1990) by introducing a farm credit constraint.[5] It is assumed that the

[3] Although there are no systematic data on this, our inquiries indicate that these assumptions are consistent with reality. When land rents are paid in kind or through sharecropping this obviously implies that they are paid after the harvest; but also cash payments tend to be paid at the end of the year/season.

[4] While this may appear at first sight as a strange assumption in an analysis of credit market imperfections, this assumption does not affect the results because credit market imperfections in this paper are modelled as constraints on the amount of credit rather then its cost, as is standard in the literature (see further). Hence setting *i*=0 merely simplifies the notation, but does not affect the results.

[5] See also Carter (1988) for a credit rationing model for the farm sector in the context of developing countries and Barry and

maximum amount of credit available to a farm (S) depends on farm characteristics (W) such as reputation, farm size and wealth. That is $S = S(W)$ with $S_W > 0$. The credit constraint is given by:

(5) $kK \leq S(W)$

With a credit constraint the decision-making problem of the farms is the maximization of the end-season profit functions, as given by equation (1), subject to credit constraint (5), as represented by the LaGrangean function:

(6) $\Psi = pf(A,K) - rA - kK - \lambda(kK - S)$

where λ is the shadow price of the credit constraint.

When the credit constraint is binding farms cannot use the unconstrained optimal level of fertilizers and fertilizer use is determined by $K = \frac{S(W)}{k}$. Farms then choose their land allocation to maximize profits, treating fertilizer use as fixed.[6]

The optimal conditions with binding credit constraints ($\lambda > 0$) are given by (4) as well as by:

(7) $pf_A + r = 0$

(8) $pf_K - k(1+\lambda) = 0$

(9) $kK - S = 0$.

From equation (8) it follows that the marginal value product of fertilizers is higher than the marginal cost of fertilizers k: $pf_K > k$. By increasing fertilizer use the farm could increase its profit but it cannot use more fertilizer because of the credit constraint. From the characteristics of the production function ($f_{AK} > 0$) it also follows that credit constraints affect the land market. Ceteris paribus, the more credit constrained farms are, the less fertilizers they can use, the lower their productivity, and hence the lower their land demand.

The effect of credit constraints on the land market is illustrated in figure 1. As explained before, the aggregate land demand curve without credit constraints is D. The equilibrium rent without credit constraints is r^*. When credit is constrained, farm land demand shifts to D_c. At low levels of output (and thus land use) the credit constraint is not binding, and the constrained demand curve D_c coincides with the unconstrained demand curve D. This is up to the point x where the credit constraint becomes binding and the constrained demand curve shifts below the unconstrained demand curve. The gap between D and D_c increases for higher levels of land as the reduction in productivity caused by the credit constraint increases. With the credit constraint binding, and reflected in D_c, the new equilibrium land rent is r_c^*. The equilibrium rent declines to $r_c^* < r^*$.

Notice that while land demand is affected, land use is not affected in figure 1. The functions, as drawn, assume that even with credit constraints the marginal value products of all the land available (A^T) is positive (as the land demand function still lies above the vertical axis at A^T). Hence, if this is the case, all the adjustments in the land market occur through price adjustments while in the fertilizer market they occur through quantity adjustments with fixed prices.

III. IMPACT OF AREA PAYMENTS

Define s as the subsidy (area payment) per unit of land, and assume that all land in the analysis qualifies for the subsidies.[7] The representative farm objective function then changes to

(10) $\prod = pf(A,K) - (r-s)A - kK$.

However, not only the objective function will change; also the credit constraint is affected. The payments will alleviate the credit constraint of the farm. In reality farms may receive the subsidies at the beginning or at the end of the season. It may be at the end because of administrative delays or because of administrative controls to check the eligibility of the farms which need to take place during the growing season.[8]

If the farm receives the subsidies at the beginning of the season, farm can use the funds directly to pay for the

Robinson (2001) for a more elaborate discussion of credit markets in agriculture.

[6] In similar context Just, Hueth, and Schmitz (2004) analyze the welfare measurement with constrained input use due to policy intervention. The difference here is that we consider the input constraint caused by insufficient credit and its interaction with area payments.

[7] In reality, policies may impose restrictions on which land can receive payments. Restrictions may relate to crop choice, set-aside requirements, cross-compliance, etc. These restrictions may affect the distributional effects. Here we analyze the case when all land does qualify for subsidies.

[8] For example, the EU has so-called cross-compliance conditions for subsidies which require good agricultural practices, implying, among other things, that environmental criteria have to be satisfied.

fertilizer. However, even if farms receive subsidies at the end of the season, this can still improve their access to credit. If farms and potential lenders know that subsidies will be paid at the end of the season, then farmers may be able to use these future (guaranteed) payments to obtain credit from credit institutions at the beginning of the season. For example, our own research in Eastern Europe showed that the provision of area payments under the EU's CAP had a major effect on farms' access to credit. We found from field interviews that banks and other lenders are more willing to provide credit to farms when they know that such subsidies will be paid. In a sense, (the promise of) subsidies are used as collateral for credit. For example, banks in Slovakia provide credit to farms up to 100% of their area payments in 2007, so the farms can use the funds to finance expenses at the start of the growing season. To obtain such loans, the farms need to have an account at the bank where the area payments will be deposited later by the official paying agency, and the banks have control over the account in order to recuperate the pre-financing.

In our analysis, we allow for subsidies to arrive either at the start of the season or after harvest. With area payments the credit constraint is given as follows:

(11) $kK \leq S(W) + \alpha s A$,

where $0 \leq \alpha \leq 1$, and α measures the extent to which the farm can use subsidies to alleviate its credit constraint. If the farm receives subsidies at the beginning of the season, the farm can use all subsidies to alleviate the credit constraint: in this case $\alpha = 1$. However, if the farm receives the subsidy at the end of the season, it may obtain an amount of credit equivalent to the size of the subsidy or less, depending on the farm's ability to borrow. In this case $0 \leq \alpha \leq 1$.

Proposition 1: *When farms are credit constrained it holds that with the introduction of area payments (and with $\alpha > 0$) land rents increase by more than the subsidy.*
Proof: the proof can be obtained from authors.

Land rents will increase with area payments, but contrary to when there are no credit constraints, the increase in rent is higher than the allocated subsidy, *s*. This is because the payments have two effects on land rents, a direct and an indirect one. This is illustrated in figure 2. The initial equilibrium rent with credit constraints is r_c^*. The first, direct, effect is the standard effect of subsidies with a fixed production factor (land): because farms are granted subsidies per hectare they rent, this increases marginal returns to land, and increases farms' willingness to pay a higher rent equivalent to the size of the subsidy *s*. This effect is reflected in the upward parallel shift of land demand D_c to $D_c + s$. This effect alone would result in land market rent, r_{cs}^s. The increase in rent is equal to the size of the subsidy *s*: $r_{cs}^s - r_c^* = s$.

The second, indirect, effect is that the subsidies relax farms' credit constraints which allows farms to purchase more fertilizer. This increases the marginal value product of land if farms are credit constrained and further increases farms' land demand, thereby inducing a higher rent, reinforcing the first, direct, effect. This second effect results in a further shift of land demand from $D_c + s$ to D_{cs}. The equilibrium rent is r_{cs}^*. It is clear from figure 2 that the rent rises by more than the subsidy, $r_{cs}^* - r_c^* > s$.

The size of this second effect depends on the impact of the subsidy on the credit constraint. In figure 2 we assume that the subsidy reduces the credit constraint but does not fully remove it over the domain $0 - A^T$. More specifically, the subsidy causes the credit constraint to be no longer binding over the interval $A^c - A^s$, and to constrain the land productivity less over the domain $A^s - A^T$. Beyond A^c, the vertical distance between D_c. and D_{cs} increases with land renting. Graphically this is reflected in the fact that over this domain the land demand function without subsidy (D_c) is not parallel with the land demand with subsidy (D_{cs}).

In drawing D_{cs} we assumed that the credit constraint is still binding over the area $A^s - A^T$. If the subsidy effect would be so strong to remove the constraint over the whole $0 - A^T$ domain, the land demand function would shift to D^s and the resulting land rent would be r_s^*. However, it is important to realize that even if the second effect has only a small impact on the land demand, the combined effect will be that the land rent goes up by more than the subsidy *s*.

Proposition 2: *When farms are homogenous and are credit constrained, it holds that with the introduction of area payments (and with $\alpha > 0$) all farms lose.*
Proof: the proof can be obtained from authors.

The graphical analysis is in figure 2. To simplify the graph and the discussion, we consider the extreme case when the subsidies fully solve the credit constraint (the formal analysis hold for the general case). The subsidy shifts demand to D_s and land rent to r_s^*. Farms gain from subsidies and from improved productivity with reduced credit constraints; they lose from the increase in land rents. First, the farms' gains from subsidies equal area *ABCE* and this is identical to the losses from the "direct" effect of the subsidies on land rents (also area *ABCE*). So these two effects exactly offset each other. Second, the farms' gains from improved productivity with reduced credit constraints equal area *CFG*. The farms' losses from the "indirect" effect on land prices is represented by area *CGHJ*. The net effect is always negative: the net losses to farms equal area *CFHJ*, which is the difference between area *CGHJ*, which is equivalent to area *CGKE* (indirect loss), and area *CFG* (productivity gains).[9]

The intuition behind this result is as follows. While the subsidy is the same for all land, this is not the case for the effect of the credit constraint. If the farms would use land up to A^c, there would be no additional effect of the credit constraint reduction on land rents. Beyond A^c, the effect of the credit constraint on farm productivity ($f_{AK} > 0$) increases with land renting. The productivity loss is represented by the distance between the *D* and D_c functions, which increases with land use. The gap is highest at A^T.

Reducing the credit constraint has the strongest effect at the margin, where the credit constraint is strongest, and where the land rent is determined. At the margin the increase in productivity with reduced credit constraints equals the additional increase in land rents. However for the rest of the land this is not the case. As a consequence the gains in land productivity are lower than the increase of the land rent for all the land except for the unit at the margin.

Proposition 3: *When farms are credit constrained it holds that with the introduction of area payments (and with* $\alpha > 0$*) total welfare increases.*
Proof: the proof can be obtained from authors.

The welfare effects are also illustrated in figure 2. Landowners gain from the higher rental price. Their gains are equal to area *ABGK*. Area *ABCE* is the size of the total subsidy, which equals the taxpayers' cost. The net losses to farms equal area *CFHJ*. From the assumption of a small and open economy, with fixed prices for fertilizer, output, and fixed interest rates, it follows that the welfare of fertilizer suppliers, credit suppliers and consumers will not be affected by the subsidies. Hence, the total welfare effect is positive and equals area *CFG*. Total welfare increases because the subsidies solve the credit market imperfection and thereby increase productivity, and total production. Notice that in this specific case there are no deadweight costs because the land supply is assumed fixed and all land receives subsidies. Hence, there are no distortions in land allocation.

A. Heterogeneous farms

The analysis so far assumed that farms were identical. We will now relax this assumption. For simplicity we consider the situation when there are two farms who differ in their credit constraints.[10]

The effect of differences in credit constraints on the land allocation and the land rent is illustrated in figure 3. The land demand curves of farm 1 and farm 2 without credit constraints are D^1 and D^2 and their land use is A^1 and A^2, respectively, with $A^2 = A^T - A^1$. The equilibrium without credit constraint is (A^*, r^*). When credit is constrained, the land demand curves of farm 1 and farm 2 shift to D_c^1 and D_c^2, respectively. The new equilibrium shifts to (A_c^*, r_c^*). The land market rent declines, $r_c^* < r^*$. The change in land allocation between farms depends on the farms' relative credit constraints. In the case illustrated in figure 3, farm 2 is assumed to be more credit constrained than farm 1. As a result, farm 2 renting is lower by $A_c^* - A^*$, compared to the unconstrained equilibrium.

Proposition 4: *When farms differ in their credit constraints, it holds that with the introduction of area payments (and*

[9] Note that these changes incorporate adjustments in fertilizers use and that the welfare change represented by area *CFHJ* in figure 2 is an accurate representation of farm profit change induced by the subsidy. (see Just, Hueth, and Schmitz 2004 for a general discussion and applications to different issues).

[10] Empirical evidence shows important differences among farms in their credit constraints. For example, Bierlen and Featherstone (1998) find in the US that a farms' debt levels are the strongest determinant of credit constraints, while asset size and age are less important. Benjamin and Phimister (2002) find that differences in the structure of agricultural credit markets alter farm credit constraints. They find that in the case of the UK where non-specialized commercial banks dominate and with little government interventions, farms with less collateral were more credit constrained, while in France with dominant specialized agricultural cooperative bank and with extensive government interventions, farm credit is less dependent on collateral. Closer relationships between the cooperative bank and farms in France address better information asymmetry and reduce the reliance on collateral. Bezemer (2003) finds in the case of the Czech Republic that long-established and larger corporate farms have better access to credit than small individual farms. Latruffe (2005) finds in the case of Poland that farmers with more assets were less credit constrained than others. This may differ from the situation in more developed market economies.

with $\alpha^i > 0$), the farms that are less credit constrained will loose and farms that are more credit constrained may gain.
Proof: the proof can be obtained from authors.

With area payment s, farm 2 land demand shifts upwards, from D_c^2 to D_{cs}^2. Farm 1 demand shifts from D_c^1 to D_{cs}^1 (figure 3). As explained earlier, we have two effects. First, farm 1 and 2 land demand shift to D_{cs1}^1 and to D_{cs1}^2, respectively, because of the direct subsidy effect which increase marginal returns to land. This results in a higher land market rent, r_{cs}^s. The increase in rent is equal to the size of the subsidy s (r_{cs}^s - r_c^* = s) and affects both farms simultaneously. Second, because farms can use subsidies to buy more fertilizers, this increases the marginal productivity of land and thus land demand. This indirect effect results in a further shift of farm 1 land demand from D_{cs1}^1 to D_{cs}^1, and for farm 2 from D_{cs1}^2 to D_{cs}^2. The equilibrium is (A_{cs}^*, r_{cs}^*). It is clear from figure 3 that the rent rises by more than the subsidy (r_{cs}^* - r_c^* > s) as in the case with homogenous farms.

However now the impact differs between the two farms. While both farms see their credit constraint reduced and will increase fertilizer use and thereby increase their productivity, this effect is stronger (at the margin) for the farm which has the strongest marginal productivity losses due to credit constraints. The farm which is most credit constrained before receiving the subsidy, i.e. farm 2, will increase its land use because it benefits most from the reduction in its credit constraint, leading to higher land marginal productivity gains. The farm which is less credit constrained, i.e. farm 1, definitely loses because its increase in land rental costs $(r_{cs}^* - r_c^*)$ is higher than the increase in marginal return of land for every hectare it rents (the distance between D_{cs}^1 and D_c^1 is smaller than $(r_{cs}^* - r_c^*)$ for land renting equal to or smaller than A_{cs}^*). Its total losses are equal to area *JKL* minus area *CEGK* (*<0*). The farm which is most credit constrained, i.e. farm 2 in figure 3, may gain or may lose, depending on whether the increase in returns to land (the distance between D_{cs}^2 and D_c^2 for land renting smaller than $A^T - A_{cs}^*$) are larger or smaller than the increase in land rent $(r_{cs}^* - r_c^*)$. In figure 3 it is unclear whether area *LMON* minus area *EFHM* is positive or negative – and this result holds in general.

If the differences in credit constraints are small, both farms will lose. As an illustration of this, notice that in the extreme when differences are small, we end up with the case of homogenous farms. As we have shown before, all farms will lose from area payments in this case (see propositions 1 and 2). However, if there is a sufficiently large difference in credit constraints, and hence a sufficiently strong productivity effect at the margin for the most constrained farm (farm 2), farm 2 may gain. Moreover, while farm 1 will always lose, under specific conditions it is possible that the aggregate impact on farms is positive, i.e. that the sum of area *JKL* and area *LMON* is larger than the sum of area *CEGK* and area *EFHM*. This may occur in the case when farms that are less credit constrained have very elastic land demand and farms that are more credit constrained have a relatively high increase in productivity induced by more fertilizer use. In this case the indirect effect of subsidies on the equilibrium land rent is small while credit constrained farms have high productivity gains (see Ciaian and Swinnen (2007) for a formal analysis). In other cases farms are likely to lose on aggregate.

IV. SENSITIVITY ANALYSES AND HOUSEHOLD EFFECTS

To analyze the sensitivity of our findings to some of our assumptions, we use a simple simulation exercise. We simulate the model with homogenous farms, using a Cobb-Douglas production function, $Q = BA^{\beta_1}K^{\beta_2}$, where B is a constant and β_1 and β_2 are input parameters.

Data for France were used to calibrate the model. We use average data for 2003 and 2004 (sources are European Commission and Eurostat). Total agricultural output was used as proxy for Q, non-land costs were used as proxy for K, and utilized agricultural area was used as proxy for A. The cost share of land in total costs of agricultural production β_1 was calculated from the Farm Accountancy Data Network (FADN) and equals approximately 0.1. This is lower than the value which Alston (2007) used (land cost share equal to 0.2) in a simulation model for the US. However, other studies also use lower land cost shares for the EU than for the US. OECD (2000) estimates the land cost share for different crops in the EU between 0.14 and 0.18, and in the US between 0.21 and 0.27. The GTAP model for grains uses a land cost share of 0.12 for the EU and 0.2 for North America (van Meijl and F. van Tongeren, 1999). Given the fact that France is relatively land abundant within the EU, its land cost share can be expected to be even smaller than the EU average. We use 0.1, but will vary this parameter to asses the sensitivity of the results. With a Cobb-Douglas production function, the cost share of non-land inputs in total costs of agricultural production β_2 was

0.9. To account for the credit constraint, we used estimations of Blancard et. al (2006) to set the shadow price of the credit constraint equal to 1.35. We also vary this parameter.

Consistent with the theoretical model our base simulation model has a fixed land supply and infinitely elastic output demand and fertilizer supply. We then relax these assumptions with simulations using different elasticities of land supply, output demand and fertilizer supply. Following Alston (2007) we use land supply elasticities of 0.1 and 0.2. The most commonly used values of output demand elasticities in the literature are between -0.1 and -0.7 (e.g. Floyd 1965; Hertel, 1989; Tiffin and Tiffin, 1999; de Crombrugghe et. al, 1997; Van Driel, Nadall, and Zeelenberg, 1997; OECD, 2000; FAPRI). We use variations in output demand elasticities of -0.3, -0.7 and infinity. Supply elasticities of non-land inputs in the literature vary widely: between 0.1 and 3 (Balcombe and Prakash, 2000; Floyd 1965; OECD, 2000; Ryan and Duncan, 1974; Thijssen, 1988), because it covers a wide range of inputs (e.g. fertilizers, fuel, labour) which have various reactions to prices. It also depends whether inputs are farm supplied or purchased. Purchased inputs tend to be more elastic than farm supplied inputs. In our simulations we will use 0.5, and 1.5, and infinity.

The results are summarized in table 1. The numbers represent losses or benefits from the introduction of area subsidies measured as a share of total subsidies. The results are consistent with the theory. The basic simulation shows that farms loose (-12%), while landowners gain more than the subsidy (178%) with a fixed land supply and with infinitely elastic output demand and fertilizers supply. Total welfare increases by 67% of the subsidy amount.

Models 2 and 3 show that with lower elasticity of non-land input supply non-land input producers (i.e. capital input suppliers) get part of the rents (20% to 33%). As a result, slightly less policy rents are transferred to landowners but farms lose even more (-53% to -81%). Also welfare increases less (+20% to +40%).

A similar effect occurs with less elastic output demand. Now consumers also benefit from the subsidy (+165 to +381%) while most of these consumer benefits come from strong decreases in farm surplus (-160% to -355%), and less effects on landowners and total welfare.

With more elastic land supply (model 6 and 7) farms gain, but only limited: from 1% to 13%. These gains come from landowners whose gains are lower.

A higher α implies higher losses to farms (-18) because the "indirect" productivity effect increases with α. Landowners benefit more: +217% in model 9.[11] A higher β_1 (hence lower β_2) (model 10) also implies larger losses to farms (-24%) and higher gains to landowners (+190%). Benefits from policy to landowners increase with the importance of land in the production. On the other hand, with credit constraint, the increase in productivity (and increase in land prices) caused by the alleviation of credit constraint decreases with lower β_2. In the simulation in table 2 the former effect is stronger then the latter effect.

Finally, from a policy perspective it is obviously important when interpreting these distributional effects whether "farms" and "landowners" are the same persons (or households), or not. These structural conditions differ strongly around the world (Swinnen, Stanley, and Vranken, 2006). For example, farms rent more than 65% of their land in EU countries like Slovakia, the Czech Republic, Belgium and France. Many landowners are living in urban areas. In contrast, in countries such as Ireland, Poland, Latvia, and Italy, on aggregate farms own more than 70% of their land. The situation in the US is in between both groups of countries.

To measure the implications, table 2 presents simulations results for three scenarios: farms own 25%, 50%, or 75% of their land, respectively. The results in table 2 show that land-owning-farms gain from area payments except (a) when they own relatively little land (25%) and the supply of non-land inputs is inelastic and (b) when demand is inelastic. The latter is an important result since this applies to most developed countries, and farming households even lose when they own most of their land (75%).

V. CONCLUSIONS

In this article we have shown that imperfections in rural credit markets may strongly affect the incidence of agricultural policy. When farms are credit constrained, the introduction of area payments will lead to even larger gains for landowners as land rents will increase by more than the subsidy. This is because the subsidies will reduce farms' credit constraints and thereby increase marginal productivity of land and thus land demand. This will increase land prices in addition to the direct subsidy effect. The effect of area payments on farm profits with homogenous farms is negative. Farms gain directly from the subsidy and indirectly from the increase in productivity.

[11] Notice that with $\alpha = 0$ all policy benefits go to landowners. In this case farms cannot use subsidies to alleviate their credit constraint; and the results are identical to the case when there are no credit constraints. .

However they lose from the increase in land rents. The land rent increase is larger than their gains, causing a negative net impact. If farms are heterogeneous, the most credit constrained farms (ex ante) and those which are most effective in using the subsidies for the reduction of their credit constraints may gain.

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REFERENCES

1. Alston, J. M. 2007. "Benefits and Beneficiaries from U.S. Farm Subsidies." AEI Agricultural Policy Series: The 2007 Farm Bill and Beyond. American Enterprise Institute. http://www.aei.org/farmbill.
2. Alston, J. M. and J. S. James. 2002. "The Incidence of Agricultural Policy." In: Gardner B. L. and G. C. Rausser (ed.), *Handbook of Agricultural Economics*, Volume 2B, pp. 1689-1749 Elsevier.
3. Balcombe, K. and A. Prakash. 2000. "Estimating the Long-run Supply and Demand for Agricultural Labour in the UK." *European Review of Agricultural Economics* 27: 153-166.
4. Barry, P. J. and L. J. Robinson. 2001. "Agricultural Finance: Credit, Credit Constraints and Consequences." In Gardner, B. and G. Rausser, (eds.) *Handbook of Agricultural Economics*, Vol. 1A: 513-571. Amesderdam: Elsevier.
5. Bellemare, M. F. and C. B. Barrett. 2006. "An Ordered Tobit Model of Market Participation: Evidence from Kenya and Ethiopia" *American Journal of Agricultural Economics* 88(2): 324-37.
6. Benjamin, C. and E. Phimister. 2002. "Does Capital Market Structure Affect Farm Investment? A Comparison Using French and British Farm-Level Panel Data." *American Journal of Agricultural Economics* 84(4): 1115–1129.
7. Bezemer, D.J. 2003. "Credit Allocation and Farm Structures in the Czech Republic, 1993-1997." *Comparative Economic Studies* 45:25-43.
8. Bhattacharyya, A., A. Bhattacharyya, and S. Kumbhakar. 1996. "Governmental Interventions, Market Imperfections, and Technical Inefficiency in a Mixed Economy: A Case Study of Indian Agriculture." *Journal of Comparative Economics* 22:219–41.
9. Bierlen, R. and A. M. Featherstone. 1998. "Fundamental q, Cash Flow, and Investment: Evidence from Farm Panel Data." *Review of Economics and Statistics* 80: 427–435.
10. Blancard, S., J. P. Boussemart, W. Briec, and K. Kerstens. 2006. "Short- and Long-Run Credit Constraints in French Agriculture: A Directional Distance Function Framework Using Expenditure-Constrained Profit Functions." *American Journal of Agricultural Economics* 88(2): 351–364.
11. Carter, M. R. 1988. "Equilibrium Credit Rationing of Small Farm Agriculture." *Journal of Development Economics* 28: 83-103.
12. Carter, M. R. and K.D. Wiebe. 1990. "Access to Capital and its Impact on Agrarian Structure and Productivity in Kenya." *American Journal of Agricultural Economics* 72 (5): 1146-1150.
13. Chau, N. H. and H. de Gorter. 2005. "Disentangling the Consequences of Direct Payment Schemes in Agriculture on Fixed Costs, Exit Decisions, and Output." *American Journal of Agricultural Economics*. 87: 1174-1181.
14. Ciaian, P. and J.F.M. Swinnen. 2006. "Land Market Imperfections and Agricultural Policy Impacts in the New EU Member States: A Partial Equilibrium Analysis." *American Journal of Agricultural Economics* 88(4): 799-815.
15. Ciaian, P. and J.F.M. Swinnen. 2007. "Credit Market Imperfections and the Distribution of Policy Rents: The Common Agricultural Policy in the New EU Member States." LICOS Discussion Paper 183/2007.
16. de Crombrugghe, D., F. C. Palm, and J. P. Urbain. 1997. "Statistical Demand Functions for Food in the USA and The Netherlands." *Journal of Applied Econometrics* 12: 615-645.
17. de Gorter, H. and K. D. Meilke. 1989. "Efficiency of Alternative Policies for the EC's Common Agricultural Policy." *American Journal of Agricultural Economics* 71: 592-603.
18. de Gorter, H. 1992. "Assessing the Transfer Efficiency of Agricultural Support Policies." Report to OECD, Paris: OECD.
19. de Gorter, H. 2007. " The potential Benefits to Developing Countries from Domestic Support Reductions in Development Countries." In Morrison, J. and Sarris, A. (eds.) WTO Rules for Agriculture compatible with development Rome: FAO, pp. 241-261.
20. de Janvry, A., M. Fafchamps, and S. Sadoulet. 1991. "Peasant Household Behaviour with Missing Markets: Some Paradoxes Explained." *Economic Journal* 101 (409): 1400-1417.
21. Desquilbet, M. and H. Guyomard. 2002. "Taxes and Subsidies in Vertically Related Markets." *American Journal of Agricultural Economics* 84(4): 1033-1041.
22. Dewbre J., J. Anton, and W. Thompson. 2001. "The Transfer Efficiency and Trade Effects of Direct Payments" *American Journal of Agricultural Economics* 83(5): 1204-1214.
23. Fafchamps, M. and R. V. Hill. 2005. "Selling at the Farmgate or Traveling To Market." *American Journal of Agricultural Economics* 87(3): 717–734.
24. Feder, G. (1985). "The Relation between Farm Size and Farm Productivity - The Role of Family Labour, Supervision and Credit Constraints." *Journal of Development Economics*, 18 (2-3): 297-313 1985.
25. Färe, R., S. Grosskopf, and H. Lee. 1990. " A Nonparametric Approach to Expenditure-Constrained Profit Maximization." *American Journal of Agricultural Economics* 72: 574-581.
26. Floyd, J. E. 1965. "The Effects of Farm Price Supports on the Return to Land Labour in Agriculture" *Journal of Political Economy* 73: 148-158.
27. Gardner, B. 1983. "Efficient Redistribution through Commodity Markets." *American Journal of Agricultural Economics* 65(2): 225-234.
28. Goodwin, B. K. and A. K. Mishra. 2006. "Are "Decoupled" Farm Program Payments Really Decoupled? An Empirical Evaluation." *American Journal of Agricultural Economics* 88: 73-89.
29. Guyomard, H., C. L. Mouel and A. Gohin. 2004. "Impacts of Alternative Agricultural Income Support Schemes on Multiple Policy Goals." *European Review of Agricultural Economics* 31(2): 125-148.
30. Hennessy, D.A. 1998. "The Production Effects of Agricultural Income Support Policies Under Uncertainty." *American Journal of Agricultural Economics* 80 pp. 46-57.
31. Hertel, T. W. 1989. "Negotiating Reductions in Agricultural Support: Implications of Technology and Factor Mobility." *American Journal of Agricultural Economics* 71: 559-573.
32. Just, R, D. L. Hueth, and A. Schmitz. 2004. *The Welfare Economics of Public Policy" A Practical Approach to Project and Policy Evaluation.* Edward Elgar Publishing, Cheltenham and Northampton.

33. Kirwan, B. 2005. "The Incidence of U.S. Agricultural Subsidies on Farmland Rental Rates." Working Paper 05-04. Department of Agricultural and Resource Economics, University of Maryland.
34. Latruffe, L. 2005. "The Impact of Credit Market Imperfections on Farm Investment in Poland." *Post-Communist Economies* 17(3): 349-362.
35. Lee, H. and R. G. Chambers. 1986. "Expenditure Constraints and Profit Maximization in US Agriculture." *American Journal of Agricultural Economics* 68(4): 857-865.
36. McCorriston, S. and I. M. Sheldon. 1991. "Government Intervention in Imperfectly Competitive Agricultural Input Markets." *American Journal of Agricultural Economics* 73: 621-632.
37. Munk, K. 1994. EC agricultural policy for the 21st century. *European economy*. *Reports and studies* 4, European Commission. Directorate-general for Economic and Financial Affairs, Luxembourg.
38. OECD. 2007. *The Implementation Costs of Agricultural Policies*. Paris: OECD.
39. Rizov, M. and J. F. M. Swinnen. 2004. "Human Capital, Market Imperfections, and Labor Reallocation in Transition." Journal of Comparative Economics 32(4): 745-774.
40. Ryan, J.G. and R.C. Duncan. 1974. "Effects on Farm Incomes and Rural Labour of a Relative Increase in Wages." *Australian Journal of Agricultural Economics* 18(3): 193 – 207.
41. Sadoulet, E., A. de Janvry, and C. Benjamin. 1998. "Household Behavior with Imperfect Labor Markets." *Industrial Relations* 37(1): 85-108.
42. Salhofer, K. and E. Schmid. 2004. "Distributive Leakages of Agricultural Support: Some Empirical Evidence." *Agricultural Economics* 30(1): 51-63.
43. Sckokai, P. and D. Moro. 2006. "Modeling the Reforms of the Common Agricultural Policy for Arable Crops under Uncertainty." *American Journal of Agricultural Economics* 88(1): 43–56.
44. Serra, T., D. Zilberman, B. K. Goodwin, and A. M. Featherstone. 2005. "Decoupling Farm Policies: How Does this Affect Production?" Paper presented at the American Agricultural Economics Association Annual Meeting, Providence, Rhode Island, July 24-27, 2005.
45. Sheldon, I. M., D. H. Pick, and S. McCorriston. 2001. "Export Subsidies and Profit-Shifting in Vertical Markets." *Journal of Agricultural and Resource Economics* 26(1):125-141.
46. Stiglitz, J.E. and A. Weiss. 1981. "Credit Rationing in Markets with Imperfect Information." *American Economic Review*, 71(3): 393–410.
47. Swinnen, J., Dries, L., and K. Macours. 2005. "Transition and Agricultural Labour." *Agricultural Economics* 32(1): 15-34.
48. Swinnen, J. F. M. and H. R. Gow. 1999. "Agricultural Credit Problems and Polices During the Transition to a Market Economy in Central and Eastern Europe." *Food Policy* 24: 21-47.
49. Swinnen, J., V. Stanley, and L. Vranken (2006), "Agricultural Land Rental Markets in Europe and Central Asia. Developments, Constraints, and Implications", World Bank Report.
50. Thijssen, G. 1988. "Estimating a Labour Supply Function of Farm Households." *European Review of agricultural Economics* 15: 67-78.
51. Tiffin, A and R. Tiffin. 1999. "Estimates of Food Demand Elasticities for Great Britain: 1972-1994." *Journal of Agricultural Economics* 50(1): 140-147.
52. Van Driel, H., V. Nadall, and K. Zeelenberg. 1997. "The Demand for Food in the United States and the Netherlands: A Systems Approach with the CBS Model." *Journal of Applied Econometrics* (12): 509-532.
53. Vatn, A. 2001. "Transaction Costs and Multifunctionality." Contributed Paper at the OECD Workshop on Multifunctionality, Paris, France, 2-3 July, 2001.

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Table 1 Simulation results

Model	**α**	**β1**	**Non-land input supply elasticity**	**Land supply elasticity**	**Output demand elasticity**	**Surplus change as a share of subsidy expenditure [*X*/(*s***A*^{T})] (%)**				
						Farms	Non-land input suppliers	Landowners	Consumers	Welfare gain
1	0.5	0.1	∞	0	-∞	-12	0	178	0	67
2	0.5	0.1	1.5	0	-∞	-53	20	173	0	40
3	0.5	0.1	0.5	0	-∞	-81	33	170	0	22
4	0.5	0.1	∞	0	-0.7	-160	0	161	165	66
5	0.5	0.1	∞	0	-0.3	-355	0	138	381	65
6	0.5	0.1	∞	0.1	-∞	1	0	163	0	66
7	0.5	0.1	∞	0.2	-∞	13	0	151	0	65
8	0	0.1	∞	0	-∞	0	0	100	0	0
9	0.75	0.1	∞	0	-∞	-18	0	217	0	100
10	0.50	0.2	∞	0	-∞	-24	0	190	0	67

Source: own calculations

Table 2**.** Farm household surplus change (as share of subsidy expenditures) under different assumptions of household land ownership

Model	**α**	**β1**	**Non-land input supply elasticity**	**Land supply elasticity**	**Output demand elasticity**	**Change in farm household surplus with different share of farm land ownership**		
						25%	50%	75%
1	0.5	0.1	∞	0	-∞	32	77	121
2	0.5	0.1	1.5	0	-∞	-10	33	77
3	0.5	0.1	0.5	0	-∞	-39	4	46
4	0.5	0.1	∞	0	-0.7	-120	-80	-40
5	0.5	0.1	∞	0	-0.3	-320	-286	-251
6	0.5	0.1	∞	0.1	-∞	42	83	124
7	0.5	0.1	∞	0.2	-∞	51	88	126
8	0	0.1	∞	0	-∞	25	50	75
9	0.75	0.1	∞	0	-∞	36	90	145
10	0.50	0.2	∞	0	-∞	23	71	118

Source: own calculations

Figure 1. Equilibria in the land market with credit constraint

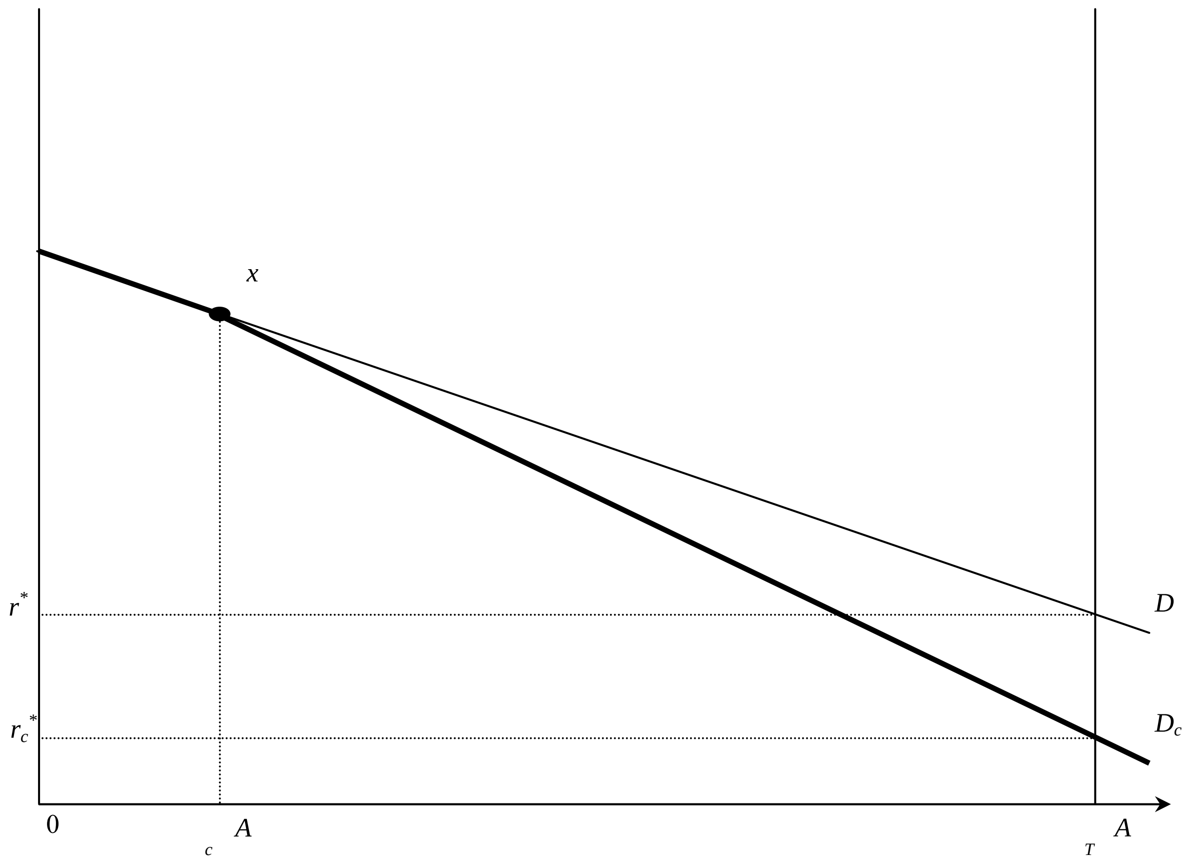

Figure 2. Equilibria in the land market with credit constraint and with area payments

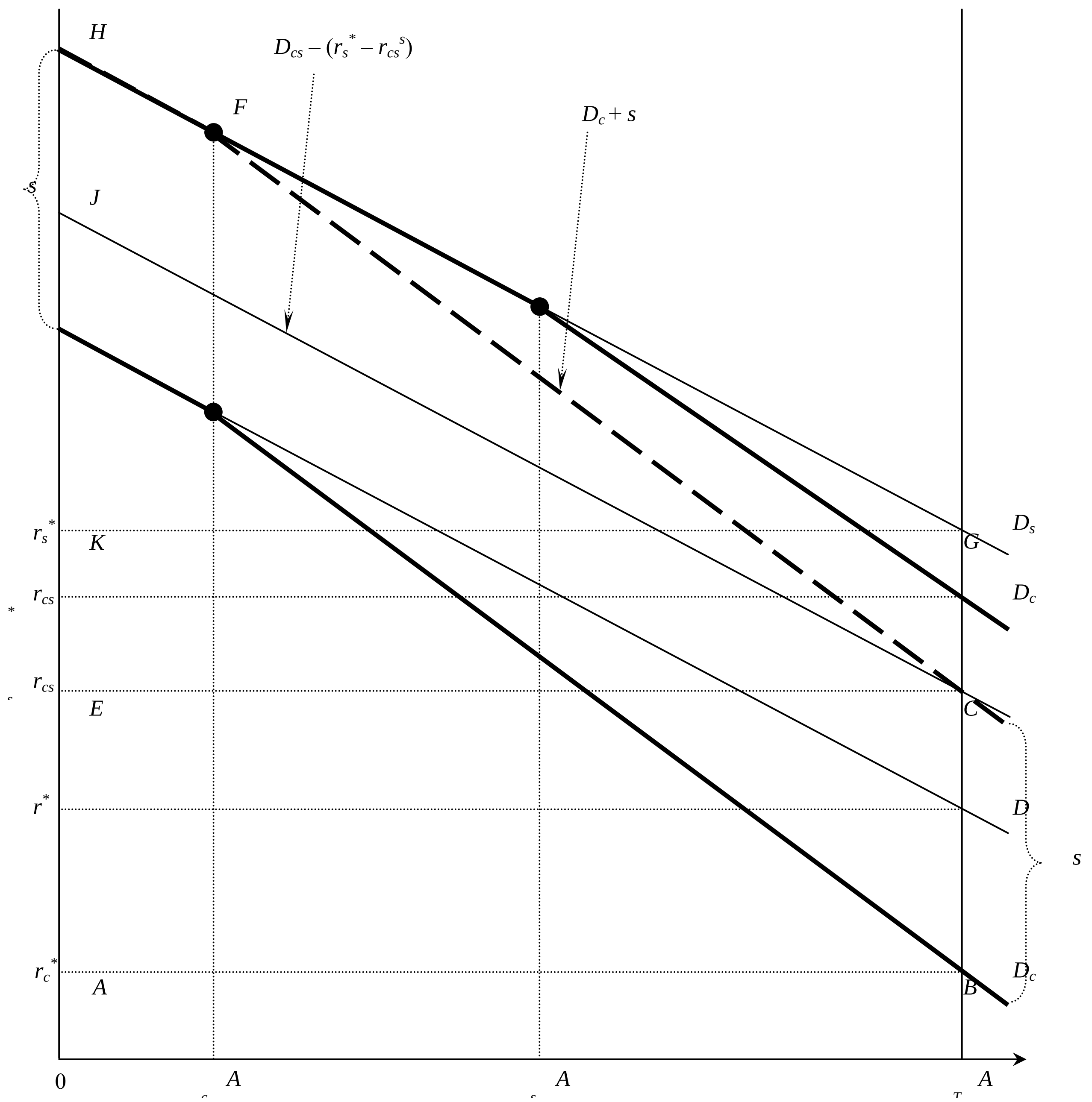

Figure 3. Equilibria in the land market with credit constraints, with area payments, and with heterogeneous farms