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Working Paper

Credit Market Imperfections and the Distribution of Policy Rents: The Common Agricultural Policy in the New EU Member States

LICOS Discussion Paper, No. 183

Provided in Cooperation with:

LICOS Centre for Institutions and Economic Performance, KU Leuven

Suggested Citation: Ciaian, Pavel; Swinnen, Johan F. M. (2007) : Credit Market Imperfections and the Distribution of Policy Rents: The Common Agricultural Policy in the New EU Member States, LICOS Discussion Paper, No. 183, Katholieke Universiteit Leuven, LICOS Centre for Institutions and Economic Performance, Leuven

This Version is available at:

<https://hdl.handle.net/10419/74873>

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LICOS

Centre for Institutions and Economic Performance

LICOS Discussion Papers

Discussion Paper 183/2007

**“Credit Market Imperfections and the Distribution of Policy Rents: The
Common Agricultural Policy in the New EU Member States”**

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Credit Market Imperfections and the Distribution of Policy Rents :
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Version: May 24, 2007

Abstract

This article analyses how credit market imperfections affect the impacts of subsidies by analyzing the effects of agricultural subsidies in the new Eastern Member States of the European Union with a partial equilibrium model which integrates credit and land market imperfections. We show that credit constraints have important implications for the distribution of policy rents. Credit market imperfections may induce very different effects of direct payments and lump-sum transfers.

Key words: agricultural policy, imperfect credit markets, land market, policy rents.

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Credit Market Imperfections and the Distribution of Policy Rents : The Common Agricultural Policy in the New EU Member States

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Introduction

The distortions caused by farm policies and their policy effects on farm incomes has received renewed attention in the current WTO negotiations and policy reforms leading up to it. An important issue is whether “decoupled policies” are truly decoupled (e.g. Chau and de Gorter 2005; de Gorter 2007; Goodwin and Mitra, 2006; Hennessy, 1998; OECD, 2001a; Serra et al, 2005). This not only holds for the impact of policies on production, and hence trade, but also on the distribution of the policy rents. 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). Other studies also identified important differences among policy instruments in their costs and benefits (de Gorter and Meilke, 1989; Dewbre, Anton, and Thompson, 2001; Giannakas and Fulton, 2000; Salhofer and Schmid, 2004). There is considerable discussion on whether the standard policy and trade models are sufficiently complex to capture all the effects, and hence to yield accurate conclusions.

The accession of ten Central and Eastern European countries (CEECs) to the European Union (EU) presents an interesting case to analyze some of these issues. Agricultural issues have played a prominent role in the enlargement debate. Crucial issues were whether a reform of the Common Agricultural Policy (CAP) was needed to avoid conflicts with budgetary and WTO constraints when the CAP would be extended to CEECs and whether CEEC farmers would get access to the same subsidies as EU-15 farmers (Hartell and Swinnen 2000; Tangermann and Banse

2000). In fact, the final days before this historic event were spent mostly on intense negotiations on agricultural subsidies and production quotas.

While several studies estimated the impact of EU enlargement in agriculture on EU expenditures, protection levels, commodity markets, trade and WTO (Banse, Münch, and Tangermann 2000; European Commission 2002, 2007; Frohberg et al. 1998; Hertel, Brockmeier, and Swaminathan 1997; Münch 2002), these studies generally ignored imperfections in factor markets and paid relatively little attention to the income distribution effects within the CEEC economies. These were important limitations since much of the policy debate centered on how the implementation of the CAP would affect rural incomes in CEECs, and since rural factor markets in new EU member states (NEMS) were characterized by major imperfections (Rizov and Swinnen 2004; World Bank 2001). The first attempt to address these shortcomings was by Ciaian and Swinnen (2006) who analyzed how imperfections in land markets – an important problem in CEECs – affect the efficiency implications and the distributional effects of these payments.

However, also rural credit markets were characterized by major imperfections. Credit constraints were a major problem for growth and restructuring during transition (Swinnen and Gow, 1999) and were still considered an important problem at the time of accession in several of the NEMS (Bezemer, 2003; Latruffe, 2005; Petrick, 2004; Petrick and Latruffe, 2003; World Bank, 2001).

The objective of this paper is to analyze explicitly how these credit market

imperfections affect the welfare effects of introducing the CAP in the NEMS. In this article we develop a theoretical framework and use a model of the rural credit and land market to analyze how the income and efficiency effects of the implementation of CAP payments are affected by rural credit market constraints in the NEMS. We analyze the effect of both direct (area) payments and of decoupled single farm payments. The first are currently implemented in NEMS and the second will be implemented later in the decade.

We find that credit market imperfections have major implications for the distribution of policy rents. More specifically, we find that when credit constraints are important, farms benefit from the subsidy directly and indirectly as they induce a reduction of the credit constraints. However, this also causes an increase in the land demand, and consequently an increase in land prices. As a consequence, the dissipation of the policy rents to land owners will be larger with farm credit market constraints, and the benefits for farms will be smaller in most cases. We identify situations in which farms may not only gain less, but even lose, from the introduction of subsidies. This may occur both with coupled payments and decoupled payments.

The article is organized as follows. The next section develops a model of the NEMS land market taking into account imperfections in the credit market. The third and fourth section analyses how CAP subsidies affects the land allocation and surplus distribution. The final section concludes.

*The Model*¹

The current production structure in the NEMS is heavily influenced by the

¹ The basic structure of our model builds on Ciaian and Swinnen (2006), but since the prime focus of the present paper is the credit market imperfections, we focus primarily on these and not on land market imperfections. For example, we include land transaction costs, but not imperfect competition, in the land market. This has no significant implications for our findings.

transition process of the 1990s. Before transition, production decisions, factor allocations and property rights in CEECs were largely controlled by the state. Land was used by large-scale state and collective farms.² Land reform in the early 1990s reallocated most land property rights to individual households in CEECs. We will refer to them as “*landowners*”.³ More or less simultaneous with the land reform, important farm restructuring took place. Farm restructuring included a privatization of the farms and a restructuring of the management structure. This restructuring included a reorganization of collective and state farms into private cooperatives and farming companies. We will refer to them as “*corporate farms*” (CF), which are typically large-scale. The most dramatic restructuring was the break-up of collective and state farms into household plots and family farms. We will refer to these as “*individual farms*” (IF).

Production is assumed to depend on the amount of land (A^i) and on non-land inputs (K^i) which we refer to as “fertilizer” but which captures also other inputs, $f^i(A^i, K^i)$ with $f_j^i > 0$, $f_{jj}^i < 0$, $f_{jn}^i > 0$, for $i = I$ and C , and for $j, n = A$ and K . The end season profits of IF and CF are, respectively:

$$(1) \quad \Pi^I = pf^I(A^I, K^I) - [(r+t)A^I + kK^I](1+i)$$

$$(2) \quad \Pi^C = pf^C(A^C, K^C) - [rA^C + kK^C](1+i)$$

² The exceptions to this rule were Poland and the countries of former Yugoslavia, where land use and ownership remained in small private farms during the Communist system.

³ Land reform took several forms. The main form in CEECs was restitution of land to former owners (Lerman, Csaki, and Feder 2004; Rozelle and Swinnen 2004). The land reform created a class of new, often absentee, landowners while land is used by a mixture of smaller individual farms and large-scale corporate farms. Large scale corporate farms continue to use large parts of the land because of a variety of reasons. These corporate farms are mostly successor organizations from the former collective and state farms after farm privatization and land reform. They are, on average, between 300 and 1000 hectares, and their share of land use is around 85% in Slovakia, 70% in the Czech Republic, 50% in Bulgaria, 40% in Hungary, and more than 30% in Romania and Estonia (table 1). In many countries they use a more than proportionate share of the best agricultural areas, which are especially affected by CAP payments.

where p is the price of the final product, r is the price of land, t are transaction costs in the land market, k is the per unit price of fertilisers and i is interest rate.

To keep the analysis tractable we model the land market in a stylized way, following the approach of Ciaian and Swinnen (2006). We start from a situation where all the land is owned by individual households, but still used by the corporate farms⁴ and assume that land transactions take place exclusively through rental agreements. This is consistent with the majority of land transactions in NEMS.⁵ Landowners receive a rent r for each unit of land that they rent to corporate farms. Several households, landowners or not, consider starting up an individual farm for which they need land. They can either withdraw land from corporate farms or rent from landowners who currently rent their land to corporate farms. In both cases the price they have to pay per unit of land is the sum of the rent paid by the corporate farms, r , (explicitly for rented land or implicitly as opportunity costs) and the transaction costs, t , involved in withdrawing the land from the corporate farms.⁶

An important issue is the timing of the various activities and payments throughout the season. In this paper 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

⁴ This reflects a situation where the land reform is formally completed, and the farms have been privatized, but no restructuring to individual farms has occurred.

⁵ The share of rented land in total agricultural land is more than 90% in Slovakia and the Czech Republic, and around 60% in Estonia, Hungary, Lithuania and Bulgaria. Moreover, corporate farms in NEMS usually rent more than 90% of their land (Swinnen and Vranken, 2007a).

⁶ Land markets in the NEMS were characterized by important transaction costs constraining efficiency enhancing land exchanges (Dale and Baldwin 2000; Lerman, Csaki, and Feder 2004; Swinnen and Vranken 2005; World Bank 1999). An important reason for the continued large share of large scale corporate farms in the land market is that historically, the large-scale farms were the users of the land and that new owners of the land face significant transaction costs if they want to withdraw their land from the farms and reallocate it. Transaction costs include costs involved in bargaining with the farm management, in obtaining information on land and tenure regulations, in implementing the delineation of the land and dealing with inheritance and co-owners (Mathijs and Swinnen 1998; Prosterman and Rolfes 2000). See Ciaian and Swinnen (2006) for a more extensive discussion on how to model land transaction costs.

selling the harvest occur at the end of the season, after harvest. According to our information, these assumptions are consistent with reality in the NEMS. Land rents are generally paid at the end of the season.⁷ In several NEMS land rents are sometimes paid in kind or through sharecropping – effectively implying that they are paid after the harvest.⁸ Hence, credit is needed to finance other inputs, i.e. fertilizer K, at the start of the season.

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 fertilisers that will maximise their profits given by equations (1) and (2), respectively. This implies the following equilibrium conditions (for notational simplicity the interest rate i is set equal to zero ($i = 0$)): ⁹

$$(3) \quad pf_A^I - (r + t) = 0$$

$$(4) \quad pf_K^I - k = 0$$

$$(5) \quad pf_A^C - r = 0$$

$$(6) \quad pf_K^C - k = 0$$

$$(7) \quad A^I + A^C = A^T$$

⁷ We have analyzed how the results change when land rents also have to be paid at the start of the season. We did not include these because of space constraints (given that this assumption is less realistic), but the derivations and analysis can be obtained from the authors.

⁸ Survey evidence shows that payment in kind varies among NEMS but in general CF are more likely to pay in kind than IF (Swinnen and Vranken, 2007a)

⁹ 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 than its cost, as is standard in the literature (see further). Hence setting $i=0$ merely simplifies the notation, but does not affect the results.

Farms increase the quantity of land and fertilisers until marginal value products are equal to economic costs for both inputs. The conditions (3) – (6) also determine farms input demands. As illustrated in figure 1, IF and CF land demands with zero transaction costs ($t = 0$) are given by D^I and D^C , respectively. The equilibrium is (A^*, r^*) . With transaction costs ($t > 0$) IF land demand shifts downwards to D_t^I . The new equilibrium is (A_t^*, r_t^*) . Land rents are lower and IF use less land with transaction costs.¹⁰

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. It is assumed that the maximum amount of credit available to farm i , S^i , depends on farm characteristics (W^i) such as reputation, farm size and wealth. That is $S^i = S^i(W^i)$ with $S_w^i > 0$, for $i = I, C$. Larger farms and farms with better reputation have access to more credit.¹¹ The IF and CF credit constraints, respectively, are then given by:

$$(8) \quad kK^I \leq S^I(W^I)$$

$$(9) \quad kK^C \leq S^C(W^C)$$

¹⁰ This follows from the fact that $f_{jj}^i < 0$, $f_{jn}^i > 0$, for $i = I$ and C , and for $j, n = A$ and K .

¹¹ Empirical evidence generally supports this assumption in the NEMS. Bezemer (2003) finds in the case of the Czech Republic that long-established and larger CF have better access to credit than small IF. 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. 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.

With credit constraints the decision-making problem of IF and CF is the maximization of the end-season profit functions, as given by equations (1) and (2), respectively, subject to credit constraints (8) and (9), respectively, as represented by the LaGrangean function:

$$(10) \quad \Psi^i = pf^i(A^i, K^i) - r^i A^i - kK^i - \lambda^i (kK^i - S^i)$$

for $i = I$ and C , where $r^I = r + t$, $r^C = r$, and λ^i the shadow price of the credit constraint.

When the credit constraints are binding farms cannot use the unconstrained optimal level of fertilisers and fertiliser use is determined by, respectively, i.e.

$$K^I = \frac{S^I(W^I)}{k} \quad \text{and} \quad K^C = \frac{S^C(W^C)}{k}. \quad \text{Farms then choose their land allocation to}$$

maximize profits, treating fertiliser use as fixed.

The optimal conditions with binding credit constraints ($\lambda^i > 0$) are given by (7) as well as by:

$$(11) \quad pf_A^i + r^i = 0$$

$$(12) \quad pf_K^i - k(1 + \lambda^i) = 0$$

$$(13) \quad kK^i - S^i = 0.$$

From equation (12) it follows that the marginal value product of fertilizers is higher than the economic cost of fertilizers k , $pf_K^i > k$: by increasing fertilizer use farms may increase their profits but credit constraints do not allow them to do so. From characteristics of production function $f_{AK}^i > 0$ it also follows that the equilibrium rent declines relative to the equilibrium rent without credit constraints. Further the more credit constrained farms are, the less fertilizers they use and the lower their land demand, *ceteris paribus*.

The effect of credit constraints on the land allocation and the land market rent is illustrated in figure 1. As explained before, the IF and CF land demand curves without credit constraints are D_t^I and D^C . The equilibrium without credit constraint is (A_t^*, r_t^*) . When credit is constrained, IF and CF land demands shift to D_c^I and D_c^C , respectively. The new equilibrium shifts to (A_c^*, r_c^*) . The land market rent declines, $r_c^* < r_t^*$. The change in land allocation depends on the relative farms credit constraints. In the case shown in figure 1, IFs are assumed to be more credit constrained than CFs. As a result, IF renting declines by $A_c^* - A_t^*$.

At low levels of output (and thus land use) the credit constraint is not binding, and the constrained demand curves D_c^I and D_c^C coincide with the unconstrained demand curves D_t^I and D^C . This is up to the points x^i ($i= I,C$) where the constraint becomes binding and the constrained demand curve shifts below the unconstrained demand curves. In the figure we assume that the credit constraints are more important for the (smaller) individual farms than for the (larger) corporate farms.

Impact of CAP payments

Since the 1992 MacSharry reform and the Agenda 2000 reforms, the vast majority of CAP subsidies are so-called direct payments (DPs). These CAP subsidies were a hotly disputed issue in EU enlargement, as the NEMS insisted on getting full access to these direct payments (DPs), while EU-15 member states only wanted to give partial DPs. The ultimate agreement, reached in Copenhagen in 2002, allowed for DPs to be partially introduced from the date of accession and then gradually

increased, from maximum 55% in 2004 to 100% in 2010.¹²

In 2006 34.8 billion Euros were spent in the EU on DPs alone (European Commission, 2006). They make up around two-thirds of the CAP budget and include both per hectare payments for crops and payments per animal for livestock activities, and single farm payments. The latter result from the decision in 2003 to decouple CAP subsidies such that subsidies will be given as a fixed set of payments per farm, so-called single farm payments (SFP). The implementation of the SFP started in 2005 in the EU-15 (the pre-2004 member states), and later in the NEMS. By 2011 all EU countries, including the NEMS, must have shifted their direct payments to single farm payments. We first analyze the impact of the DPs as they have been introduced in the NEMS and afterwards we analyze the effect of SFPs which will be implemented in the future.

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. The objective function of the IF then changes to

$$(14) \quad \Pi^I = pf^I(A^I, K^I) - (r + t - s)A^I - kK^I.$$

The objective function for the CF changes analogously.

However, not only the objective function will change; also the credit constraints are affected. The payments will alleviate the credit constraints of the farms. If farms receive the subsidies at the beginning of the season, they can use the

¹² The EU budget only pays for 25% in 2004 and gradually increases to reach 100% in 2013. However, NEMS governments are allowed to add subsidies from their own budget (the so-called “top-ups”) to a combined maximum of 55% in 2004, gradually increasing to 100% by 2010. Also, NEMS have an option to combine the total direct payments envelope and grant it on a per hectare bases, instead of separating for animals and crops.

funds directly to pay for the fertilizer. However, in reality farms seem to receive the subsidies most often at the end of the season because of administrative reasons needed to check the eligibility as well as to enforce policy objectives (eg cross compliance). For example, in February 2005 the media reported demonstrations by angry Hungarian farmers who were angry that the government was not following up on earlier promises to pay the direct payments in advance (Czech Radio International Services, 25 February, 2005).

Still, if farms receive subsidies at the end of the season, this can also improve their 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. In fact, banks in Slovakia provide credit to farms to pre-finance up to 100% of their direct payments in 2007, so they can use the funds to finance expenses at the start of the growing season. The farms need to have an account at the bank where the direct payments will be deposited later by the official paying agency, and where the banks have control over to recuperate the pre-financing with interest.

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

$$(15) \quad kK^I \leq S^I(W^I) + \alpha^I sA^I,$$

$$(16) \quad kK^C \leq S^C(W^C) + \alpha^C sA^C.$$

where $0 \leq \alpha^i \leq 1$ (for $i = I$ and C), and α^i measures to what extent farmers can use subsidies to alleviate their credit constraints. If farmers receive subsidies at the beginning of the season, farmers can use all subsidies to alleviate their credit constraints. In this case $\alpha^i = 1$. However, if farms receive subsidies at the end of the

season, they may obtain an amount of credit equivalent to the size of subsidies or less, depending on the farms' ability to borrow. In this case $0 \leq \alpha^i \leq 1$.

In their analysis of NEMS land market imperfections, Ciaian and Swinnen (2006) found that, with and without land market imperfections, all the benefits of area payments go to landowners. However, with credit constraints this is no longer the case. The effects differ both in terms of rent distribution and land allocation. The results are summarised in proposition 1.

Proposition 1: *When farms are credit constrained it holds that with the introduction of area payments (and with $\alpha^i > 0$):*

- a. Landowners gain disproportionately since land rents go up more than the subsidy.*
- b. On aggregate farms may gain or loose.*
- c. Some farms will loose and some farms may gain, depending on their relative credit constraint and α^i .*

Proof: see Appendix A1.

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. First, 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 . Second, the land market rent increases because the subsidies relax farms' credit constraints which allows them to use more fertiliser.

This increases the farms' marginal land value product which further induces farms to hire more land, thereby inducing a higher rent, reinforcing the first effect.

With credit constraints, area payments may change the land allocation in either direction, depending on the relative importance of the credit constraints and on the ability of farmers to use subsidies to alleviate credit constraints. If all farms are equally credit constrained and/or if all farms can use an equivalent amount of subsidy to buy additional fertilisers then there is no change in land allocation. However, if some of them are more constrained and/or if some can use more subsidies for credit alleviation, then the land allocation changes.

These effects are illustrated in figure 2 where it is again assumed that IF are more credit constrained than CF and that farms can use all subsidies to alleviate their credit constraints: $\alpha^I = \alpha^C = 1$. The initial equilibrium with credit constraints is (A_c^*, r_c^*) . With area payment s , the IF land demand shifts upwards, from D_c^I to D_{cs}^I . The CF demand shifts from D_c^C to D_{cs}^C . First, the direct subsidy effect shifts the demands of IF and CF to D_{cs}^I and to D_{cs}^C , respectively, because of subsidies which increase marginal returns to land. This results in higher land market rent, r_{cs}^s . The increase in rent is equal to the size of subsidy s , $r_{cs}^s - r_c^* = s$. Second, because farms can use subsidies to buy more fertilisers, this increases land marginal productivity and increases farms' willingness to pay a higher rent. This indirect effect results in a further shift of IF land demand from D_{cs}^I to D_{cs}^I , and for CF from D_{cs}^C to D_{cs}^C . The equilibrium is (A_{cs}^*, r_{cs}^*) . It is clear from figure 2 that the rent rises by more than the subsidy, $r_{cs}^* - r_c^* > s$. Moreover, the farms which are most credit constrained before receiving the subsidy, i.e. the IF, will use more land because they benefit most from increased fertiliser use and higher land marginal productivity.

Landowners gain from higher rental price equal to area $ABCD$. Their gains are larger than the total amount of subsidies given. The farms which are less credit constrained, i.e. the CF, loose because their land rental costs increase $(r_{cs}^* - r_c^*)$ by more than the increase in marginal return of land (the distance between D_{cs}^C and D_c^C). Their total losses are equal to area $E - A (<0)$.¹³ The farms which are most credit constrained, i.e. the IF in figure 2, may gain or lose, depending on whether the increase in returns to land (the distance between D_{cs}^I and D_c^I) are larger or smaller than the increase in land rents $(r_{cs}^* - r_c^*)$. In figure 2 it is unclear whether $F-D$ is positive or negative – and this result holds in general (see proof in Appendix A1).

Whether more credit constrained farms lose depends on the heterogeneity of the farms in terms of credit constraints and on the elasticities of their land demand. We will illustrate these conclusions graphically in figures 3 and 4.

First, if there is no variation in credit constraints among farms then all farms will lose from area payments. This result is illustrated in figure 3, which is a similar analysis as figure 2, but where farms are equally credit constrained and for $\alpha^I = \alpha^C = 1$. In this case the land allocation does not change with subsidies. The initial equilibrium is (A_c^*, r_c^*) . With subsidies the equilibrium shifts to (A_{cs}^*, r_{cs}^*) . Landowners again gain proportionally more than the size of subsidies (area $ABCDG$)

¹³ Note that D_c^C is parallel with D_{cs}^C . While, D_c^C is not parallel with the demand with subsidies and with credit constraint D_{cs}^C . The more CF rent land, the more scares (more voluble) fertilizers become relative to land. This implies that when using subsidies to buy more fertilizers land marginal productivity increases more when renting more land than when renting less land. Hence, farmers are willing to increase the rent more when renting more land than when renting less land. This implies that the vertical distance between D_c^C and D_{cs}^C increases with land renting, and D_{cs}^C shifts closer to the CF land demand with no credit constraint and with subsidies D_s^C . The same holds for IF.

As illustrated in figure 1 then it follows that CF loose from subsidies, because in equilibrium the rent increases by more than it is the increase in the CF marginal land return (subsidies plus productivity rise due to more fertilizer use) for every hectare that CF rent: the distance between D_{cs}^C and D_c^C is smaller than the rent increase $r_{cs}^* - r_c^*$ for every rented hectare up to A_{cs}^* . IF may gain because for some hectares that IF rent, the rent increases by less than is the increase in IF marginal land return (subsidies plus productivity rise due to more fertilizer use): for some hectares in the interval $A_{cs}^* - A^T$, the distance between D_{cs}^I and D_c^I is larger than the rent increase $r_{cs}^* - r_c^*$.

because the rent rises by more than the s , $r_{cs}^* - r_c^* > s$. However now all farms loose because for all the increase in the land rent is higher than the farms' increase in marginal return of land for every hectare that they rent. IF losses equal to area $F - D$ (<0) and CF losses equal to area $E - A$ (<0).¹⁴

When farms are heterogeneous, the most credit constrained are more likely to gain, but even then it is not certain since it depends on the land demand elasticities. Consider figures 4 and 5 which present a case where some farms (IF) have important credit constraints and other (CF) have no credit constraints. In figure 4 the demand elasticity of the CF is high and in figure 5 it is low. The results are very different. With high CF demand elasticity, the impact of IF productivity gains on land rents is small and their net gains in productivity (area BF) are larger than the net losses in higher land rents (area D). The opposite is the case when the CF land demand elasticity is low (figure 5). Then the growth in IF productivity causes a stronger increase in land rents, making it more likely that the net increase in costs (area D) is larger than the net productivity gains (area BF).

Impact of single farm payments

As explained above, the EU decided in 2003 to decouple CAP subsidies such that subsidies will be given as a fixed set of payments per farm, the so-called single farm payments (SFP). The SFP for a specific farm equals the support the farm received in the previous “reference” period. The SFP is an entitlement, but future SFP payments depend on the farm operating an amount of “eligible hectares”, equivalent to the size of the entitlement.

To model this, define E^C as the total payment for the corporate farm after

¹⁴ As long as there is no change in land allocation with s , this result holds for all cases with equal or unequal farms credit constraint or α^i , for $\alpha^I > 0$ or/and $\alpha^C > 0$.

CAP reform, and A_E^C as the amount of eligible area for payments. Assuming that E^C equals the total subsidies the corporate farm received with the area payment system, and that all the land it used qualifies as eligible land, we have $E^C = sA_E^C$, which is equal to area B , with $A_E^C = A_c^*$ in figure 3. Making similar assumptions for the individual farms, $E^I = sA_E^I$, where $A_E^I = A^T - A_c^*$, which equals area G in figure 3. Hence, payments per eligible hectare, e , are equal in this case: $e = e^C = e^I$.

The policy reform has important impacts on the distribution of policy rents. Without credit constraints, Ciaian and Swinnen (2006) find that policy rents shift entirely from landowners to farms with the new CAP support system. However, as we will show below, this will no longer be the case when farms are credit constrained. The results are summarized in Proposition 2.

Proposition 2: *When farmers are credit constrained it holds that with the introduction of SFP (and with $\alpha^i > 0$):*

- a. *Landowners gain.*
- b. *Farm gains may be smaller than the SFP and some farms may even loose.*

Proof: see Appendix A2.

The provision of SFP affects the credit constraints of the farms in the following way:

$$(17) \quad kK^I \leq S^I(W^I) + \alpha^I eA_{FP}^I,$$

$$(18) \quad kK^C \leq S^C(W^C) + \alpha^C eA_{FP}^C.$$

where A_{FP}^i ($i=I,C$) is the amount of eligible land effectively used by the farm.¹⁵ When credit constrained farms receive SFP these subsidies will thus relax the credit constraints and will allow farms to purchase more fertilisers. As with area payments, this results in higher marginal land productivity and therefore an upward shift in the land demand function (over the interval where the farm is credit constrained). However, in contrast to area payments, the only driving force behind the increase in land demand – and hence behind the resulting increase in land rents – is the marginal productivity increase from reduced credit constraints. In other words, there is only an indirect effect, while with area payments there was also a direct effect on land demand from the subsidies themselves.

Figure 6 illustrates how SFP affect the equilibrium allocation of land and the distributional effects (assuming that farms can use SFP to alleviate their credit constraints, i.e. $\alpha^I > 0$ and $\alpha^C > 0$).¹⁶ The equilibrium without SFP is (A_c^*, r_c^*) , the same as the one showed in figure 3. The eligible area of IF and CF is $A_E^I = A^I - A_c^*$ and $A_E^C = A_c^*$, respectively. Starting in the left hand side of the figure and following the thick lines, IF demand with SFP is given by D_{ce}^I . Analogously, CF demand with SFP is given by D_{ce}^C .¹⁷ At A_c^* the demands are represented by the thick vertical lines.

¹⁵ Three cases can occur: (1) $A_{FP}^I = A_E^I$ and $A_{FP}^C = A_E^C$ if in equilibrium IF and CF rent their eligible area: $A^I = A_E^I$ and $A^C = A_E^C$; (2) $A_{FP}^I = A_E^I$ and $A_{FP}^C = A^C$ if in equilibrium IF rent more land than their eligible area ($A^I > A_E^I$), and hence CF rent less than their eligible area ($A^C < A_E^C$) and (3) $A_{FP}^I = A^I$ and $A_{FP}^C = A_E^C$ if in equilibrium IF rent less land than the eligible area ($A^I < A_E^I$), and hence CF rent more than their eligible area ($A^C > A_E^C$). We discuss further when these cases may occur – see also appendix A2 for a more formal analysis.

¹⁶ If farms cannot use subsidies to buy more fertiliser, i.e. if $\alpha = 0$, there is no impact: their marginal land productivity will not be affected by e , and hence neither the rent nor the land allocation will change and all subsidies will benefit farms.

¹⁷ With SFP, the CF and IFs do not receive payments for land that they rent above the eligible area, A_E^C and A_E^I respectively. Consider first the case when the IFs want to rent more land, $A^I > A_E^I$. Since the total land supply is fixed, it implies that the CF would then rent less land than its eligible area, $A^C < A_E^C$. For the extra land (area $A^I - A_E^I > 0$), IFs cannot pay more than the marginal production value of

Note that this vertical shift at A_c^* is larger than the subsidy e when $\alpha^i > 0$, because with each unit of land they rent less than the eligible area farms lose not only e (i.e. the direct effect) but lose also because of a decline of their land marginal productivity (as farms cannot buy as much fertilizer without e). With SFP the equilibrium shifts to (A_{ce}^*, r_{ce}^*) .

In the situation illustrated in figure 6 landowners benefit from SFP – in contrast to when there are no credit constraints when all the benefits from SFP go to the farms. By reducing credit constraints and increasing marginal productivity of land, SFP will lead to higher land productivity, thereby increasing land demand and, consequently, land rents, and therefore benefit landowners: their gains equal area B . Farms gain for two reasons: they benefit from the direct subsidy effect and from the increase in land productivity, but they also have a loss with the increase of rents. The net effect on farm profits is not clear ex ante. In the case illustrated in figure 6, the land rent increases by less than the size of subsidies, $r_{ce}^* - r_c^* < e$, and farms retain part of the subsidies, equal to area A for CF and D for IF. In addition, IF gain F because of the increase in land productivity, so their net gains are $D+F (>0)$. CF gain E from increased productivity so their net gains are equal to area $A+E (>0)$.

As with the area payments, the benefits from the productivity increases are higher for the farms which are more credit constraint and/or have the strongest reduction in their credit constraint (ie higher α^i). In figure 6, IF are more credit constraint than the CF and they benefit more on a per hectare basis. Whether they

the land. In contrast the CF is willing to pay a higher rent, by e or more. CF are willing to pay minim e because with the reduction of renting below the eligible area, they lose e as well as land marginal productivity declines as long as $\alpha^C > 0$ because fertilizer use declines when loosing e . Then, consider the case when land rented by IFs is less than the eligible area, $A^I < A_E^I$ and $A^C > A_E^C$. In this case the reverse logic holds. The payments increase the IF land demand. The rent that IF is willing to pay is increased by e or more. In combination, this implies that both type of farms have kinked land demand functions with the SFP.

benefit more in total than CF obviously depends also on their share of land use, which does not change by the SFP in the case analyzed in figure 6.

If the impact of the SFP on farms' credit constraint is even stronger than in the case illustrated in figure 6, it is possible that both the land allocation may be affected and/or that farms may even lose from the SFP introduction. In figure 6 the rent rises by less than the size of the subsidy e because at the equilibrium land allocation, farmers' marginal land productivity increase is smaller than the average per hectare SFP payment, e . However, if productivity increases are such that the rent would increase by more than e , to $r_c^* + e$ or above, not only could the SFP affect the land allocation, they can also have the effect that some farms may lose from the SFP introduction.

Figure 7 illustrates the situation where the increase in IF marginal land productivity is large relative to the increase in CF marginal land productivity and relative to the subsidy e . In this case IF can offset the subsidy e that CF get for the eligible area and in equilibrium IF rent more land. Land demands with SFP are given by D_{ce}^I and by D_{ce}^C respectively for IF and CF and the equilibrium shifts to (A_{ce}^*, r_{ce}^*) . IF use more land ($A^T - A_{ce}^* > A^T - A_c^*$), and the rent rises to r_{ce}^* . The rent rises by more than the size of the subsidy: $r_{ce}^* - r_c^* > e$. Therefore land owners gain: their benefits equal area $ABCDEFGH$. The CF lose because their gains from productivity increases (area $K+L$) and from the SFP (area E) are smaller than the increase in rental costs (area $A+E+L$) and losses due to land renting decrease (area F): their net effect is $K+L+E-(A+E+L+F) = K - (A+F) < 0$. The IF gain from productivity increases by area $N+C$, from subsidies by area H , and from renting more land by area M . Their loss from increased rental costs is area $C+D+H$. The net effect is area $N+M-D$ which could be positive or negative.

In summary, landowners gain from the SFP and the gains may or may not be proportionally higher than the size of the allocated SFP to the farm sector. IF and CF may lose from the area payments. The effect on farm profits depends on the farms' credit constraints, on the extent to which farms can use subsidies to alleviate their credit constraint, on the size of subsidies, and on the (unconstrained) land demand elasticities, all affecting the relative increase in land market rents. These results, illustrated in figures 6 and 7, hold in general – see proof in Appendix A2.

Discussion and Conclusions

The distortions caused by farm policies and their effects on farm incomes has received renewed attention in the current WTO negotiations and policy reforms leading up to it. There is considerable discussion on whether the standard policy and trade models are sufficiently complex to capture all the policy effects which occur in reality, and hence to yield accurate conclusions.

The Eastern enlargement of the EU provides an interesting experiment to study these issues. Eastern enlargement implied integration of the agricultural economies of the NEMS in the CAP. As a consequence, farmers in the NEMS now receive subsidies per hectare of land they use, gradually increasing over a transition period. In well functioning markets such payments get incorporated in land values and thereby benefit mainly landowners and lead to increases in input costs for farmers. In the future NEMS farms will receive single farm payments, which are argued to be (more) decoupled. In well functioning markets such payments do not get incorporated in land values and benefit farms.

However, NEMS rural factor markets are characterized by important imperfections. In an earlier study Ciaian and Swinnen (2006) demonstrated that

imperfections in land markets do not change these conclusions and that the distribution of policy rents remains the same even with important transaction costs and imperfect competition in land markets.

In this article we have shown that imperfections in rural credit markets may lead to very different outcomes. 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 – for example because banks in some NEMS offer to provide credit with the subsidy payments as collateral – and thereby increase marginal productivity of land and thus land demand, in addition to the direct subsidy effect. The effect of area payments on farm profits can be positive or negative. Farms gain directly from the subsidy and indirectly from the increase in productivity. However they lose from the increase in land rents. Under certain conditions the land rent increase may be larger than their gains, causing a negative net impact. In general, the most credit constrained farms (ex ante) and those which are most effective in using the subsidies for the reduction of their credit constraints are most likely to gain.

Similar effects occur even with subsidies which are decoupled from current input use or output, such as the single farm payments in the CAP. While farms are better off with SFP than with area payments, since the SFP does not directly lead to an increase in land rents, the SFP will also induce an increase in land rents through their impact on the farms' credit constraints and, hence, on land productivity. As a consequence, landowners gain from the SFP when farms are credit constrained. Moreover, we have illustrated in this paper that in extreme cases farms may actually be net losers even with so-called decoupled payments such as the SFP. The effect on farm profits depends on how much farms are credit constrained, to what extent farms

can use subsidies to alleviate their credit constraint, on the size of subsidies, and on the (unconstrained) land demand elasticities, all affecting the relative increase in land market rents.

We should caution against simplistic interpretations of our results. The effects on rural households depend on whether the households are landowners or farmers, or both, and on the importance of credit constraints. These structural conditions differ strongly between NEMS (table 1). For example, farming in countries like Slovakia and the Czech Republic is concentrated on large-scale corporate farms, who rent most of their land. Land ownership is fragmented and many landowners are living in urban areas. In contrast, in countries such as Poland and Slovenia, farming is dominated by small family farms (IFs), owning most of their land. Most other countries, such as Hungary and Bulgaria, have a mixed structure. In Hungary, IFs use 59% of farm land and CF use 41%. CF rent most of the land they use, while IFs use both owned and rented land. The share of rented land typically increases with the size of the IF (Csaki and Lerman, 2002; Vranken and Swinnen, 2006).

Obviously, the implications of our analysis are different for these countries, with such different structures. Leakages of policy rents to land owners through increased rental rates is a major issue in countries like Slovakia and Hungary, while less of a problem in Poland since most farms are IFs who themselves own the land. However, also in Poland this analysis is relevant since (a) the most dynamic farmers are typically younger and land ownership is typically concentrated in older rural households, and (b) there are important regional variations: in the north and western regions of Poland, many larger farms operate on rented land (Csaki and Lerman, 2001; Fałkowski, 2005; Sabates-Wheeler, 2002).

Interestingly, there was a persistent view in the 1990s in NEMS that “land markets are not working” and “prices are very low”. All this changed dramatically since 2002. The anticipation and the implementation of CAP payments strongly pushed up land prices and rental rates in many NEMS. Table 2 presents data on changes in land prices over the past years in several NEMS. They demonstrate a dramatic increase in land prices just before and after accession. Even in Slovakia and the Czech Republic, where land prices are constrained by transaction costs and imperfect competition with CF dominating rental land markets, CF managers are lobbying the government to introduce regulations of land rental prices, which they claim is “unfairly benefiting urban land owners”. An alternative CF strategy was to lock land owners into long term rental contracts. Surveys show that land rental contracts with CF are typically longer than with IFs (Swinnen and Vranken, 2007a).

The smallest farms in those NEMS may suffer from the subsidies, as they may not get subsidies while facing increased land prices. In addition to the administrative hurdles, there is a regulatory size limit (eg 1 hectare) to apply for subsidies. However, this disadvantage may be limited as the smallest farms often use own land for farming.

Another important issue in interpreting these findings is that credit market imperfections may change for other reasons than the provision of farm subsidies, such as macro-economic reforms and the overall policy credibility provided by EU accession, lowering risks for rural finance. On the other hand there is increasing evidence that the agri-food industry has played a very important role in reducing some of the credit constraints by providing trade credit through vertical coordination with the farms (Cocks and Gow, 2003; Dries and Swinnen, 2004; Gorton, Dumitrashko,

and White, 2006; Swinnen, 2006). These changes will interact with the mechanisms identified in this paper in influencing the policy rent distribution.

Finally, an issue which needs further analysis is the interaction of the credit and land market imperfections and the subsidy systems with labor market imperfections. Labor market imperfections have an important impact on land allocation and farm structures in NEMS (Baum et al, 2006; Juvancic and Erjavec, 2005; Lerman and Schreinemachers, 2002; Rizov and Swinnen, 2004; Swinnen, Dries, and Macours, 2005). There are interactions between these imperfections and the subsidy effects. For example, labor market constraint will affect the farm restructuring and land reallocation impact of the various subsidies. These interactions are beyond the scope of analysis in this article. This is the topic of our future research.

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Appendix

A1. Proof of proposition 1

To show:

a. $\frac{d\Pi^L}{ds} = A^r \frac{dr}{ds} > 0$ and $\frac{dr}{ds} > 1$ with $\alpha^I > 0$ and/or $\alpha^C > 0$.

b. $\frac{d\Pi^I}{ds} + \frac{d\Pi^C}{ds} < 0$ or > 0

c. The signs of $\frac{d\Pi^I}{ds}$ and $\frac{d\Pi^C}{ds}$ depend on the relative credit constraints and on

$$\alpha^I / \alpha^C.$$

We start from the situation that all farms are credit constrained.¹⁸ We first analyze the situation when they remain credit constrained with the subsidy. Then (part 2) we analyze the case when some of the farms are no longer credit constrained with the subsidy.

Part 1: Farms remain credit constrained with s

With area payments the IF and CF credit constraints are given by (15) and (16).

In equilibrium condition (7) must be satisfied, as well as:

$$(A1.1) \quad pf_A^I + pf_K^I \frac{\alpha^I s}{k} - (r+t) + (1-\alpha^I)s = 0$$

$$(A1.2) \quad pf_A^C + pf_K^C \frac{\alpha^C s}{k} - r + (1-\alpha^C)s = 0$$

Totally differentiating (7), (A1.1) and (A1.2) yields:

$$(A1.3) \quad M^I dA^I + R^I ds - dr = 0$$

¹⁸ The situation when only part of the farms are initially credit constrained is a special case of this more general situation and the main results remain the same.

$$(A1.4) \quad M^I dA^C + R^I ds - dr = 0$$

$$(A1.5) \quad dA^I + dA^C = 0$$

where

$$(A1.6) \quad R^C = \frac{\alpha^C A^C}{k} \left(pf_{AK}^C + pf_{KK}^C \frac{\alpha^C s}{k} \right) + pf_K^C \frac{\alpha^C}{k} + (1 - \alpha^C) \geq 1,$$

$$(A1.7) \quad R^I = \frac{\alpha^I A^I}{k} \left(pf_{AK}^I + pf_{KK}^I \frac{\alpha^I s}{k} \right) + pf_K^I \frac{\alpha^I}{k} + (1 - \alpha^I) \geq 1,$$

$$(A1.8) \quad M^C = \left(pf_{AA}^C + pf_{AK}^C \frac{\alpha^C s}{k} + pf_{KA}^C \frac{\alpha^C s}{k} + pf_{KK}^C \frac{\alpha^{C^2} s^2}{k^2} \right) < 0,$$

$$(A1.9) \quad M^I = \left(pf_{AA}^I + pf_{AK}^I \frac{\alpha^I s}{k} + pf_{KA}^I \frac{\alpha^I s}{k} + pf_{KK}^I \frac{\alpha^{I^2} s^2}{k^2} \right) < 0.$$

Using (A1.3), (A1.4) and (A1.5) it follows that:

$$(A1.10) \quad \frac{dA^I}{ds} = \frac{R^C - R^I}{M^I + M^C}$$

$$(A1.11) \quad \frac{dr}{ds} = \frac{R^C M^I + R^I M^C}{M^I + M^C}$$

The necessary condition for a maximum for the CF and IF profit function is that its

second derivatives must be negative ($\Pi_{AA}^I = \frac{\partial^2 \Pi^I}{\partial A^{I^2}} < 0$, $\Pi_{AA}^C < 0$), implying that

$M^I < 0$ and $M^C < 0$. This implies that the denominators in equations (A1.10) and

(A1.11) are negative. To determine the signs of the equations (A1.10) and (A1.11),

the signs of equations (A1.6) and (A1.7) must also be determined.

With credit constraints it holds (a) that total farm fertilizer use is fixed and is given by

equations (15) and (16), i.e. $K^i = \frac{S^i + \alpha^i s A^i}{k}$ and (b) that $pf_K^i - k > 0$, for $i = I$ and

C. If farms are credit constrained, when using additional fertilizer land marginal

profitability must increase, $\Pi_{AK}^i > 0$, which implies that $\Pi_{AK}^i = pf_{AK}^i + pf_{KK}^i \frac{\alpha^i s}{k} > 0$,

for $i = I$ and C . If this is not the case, then by decreasing fertilizer marginal profitability of land increases which increases farms' profits. However, this would imply that farms are not credit constrained, i.e. equations (15) and (16) are not

binding and $K^i < \frac{S^i + sA^i}{k}$. Hence with $pf_K^i - k > 0$ and with

$\Pi_{AK}^i = pf_{AK}^i + pf_{KK}^i \frac{\alpha^i s}{k} > 0$ it follows that with credit constraints $R^C \geq 1$ and $R^I \geq 1$.

In summary, with $pf_K^i - k > 0$ and with $\Pi_{AK}^i = pf_{AK}^i + pf_{KK}^i \frac{\alpha^i s}{k} > 0$, for $i = I$ and C ,

it follows from (A1.6)–(A1.9):

1. if $\alpha^I = 0$ and $\alpha^C = 0$ then $\frac{dr}{ds} = 1$ and $\frac{dA^I}{ds} = 0$
2. if $0 < \alpha^I \leq 1$ and $0 < \alpha^C \leq 1$ then $\frac{dr}{ds} > 1$ and the sign of $\frac{dA^I}{ds}$ depends on R^I/R^C . If $R^I > R^C$ then $\frac{dA^I}{ds} > 0$; if $R^I < R^C$ then $\frac{dA^I}{ds} < 0$, and if $R^I = R^C$ then $\frac{dA^I}{ds} = 0$.

In words, if farms can use subsidies to alleviate their credit constraints (if $\alpha^I > 0$ and/or $\alpha^C > 0$) then the land market rent (equation (A1.11)) increases by more than the size of the subsidy s , $\frac{dr}{ds} > 1$. Otherwise (if $\alpha^I = \alpha^C = 0$) the land market rent increases by the size of the subsidy.

The more farms are credit constrained the less fertilizers they can use, implying (a)

that the higher is the increase in land marginal productivity, $pf_{AK}^i + pf_{KK}^i \frac{\alpha^i s}{k}$, when

adding additional fertilizers, and (b) the higher is the difference between fertilizers marginal value product and fertilizers price, $pf_k^i - k$. Hence, for a given α^I and α^C , such that $\alpha^I > 0$ and $\alpha^C > 0$, R^C and R^I are higher the more farms are credit constrained, implying that $\frac{dr}{ds}$ (equation (A1.11)) is larger when farms are more credit constrained than when they are less.

The impact on land reallocation - equation (A1.10) - is conditional: if $R^C > R^I$, then the IF land renting declines, otherwise IF renting increases. The size of R^I and R^C itself depends on α^i and on the credit constraints. More credit constrained farms and/or farms with higher α^i will increase renting with subsidies.

The profits of IF, CF, and landowners, respectively, are:

$$\Pi^I = pf^I(A^I, K^I) - (r + t - s)A^I - kK^I,$$

$$\Pi^C = pf^C(A^C, K^C) - (r - s)A^C - kK^C, \text{ and}$$

$$\Pi^L = rA^T. \text{ Then it follows:}$$

$$(A1.12) \quad \frac{d\Pi^I}{ds} = \frac{\alpha^I A^I}{k} (pf_k^I - k) - A^I \frac{dr}{ds} + A^I < \text{ or } > 0$$

$$(A1.13) \quad \frac{d\Pi^C}{ds} = \frac{\alpha^C A^C}{k} (pf_k^C - k) - A^C \frac{dr}{ds} + A^C < \text{ or } > 0$$

$$(A1.14) \quad \frac{d\Pi^L}{ds} = A^T \frac{R^C M^I + R^I M^C}{M^I + M^C} > 0$$

The impact of s on total farm profits is:

$$(A1.15) \quad \frac{d\Pi^I}{ds} + \frac{d\Pi^C}{ds} = \frac{\alpha^I A^I}{k} (pf_k^I - k) + \frac{\alpha^C A^C}{k} (pf_k^C - k) - A^T \frac{dr}{ds} + A^T < 0 \text{ or } > 0$$

Landowners always gain from subsidies and their gains increase with α^i and the stronger farms are credit constrained. The impact of s on farms' profits is undetermined. If gains from subsidies and from increased use of fertilizer in the production process, induced by the relaxation of credit constraint,

$\frac{\alpha^i A^i}{k} (pf_k^i - k) + A^i$ (for $i = I, C$), are higher than the rental cost increase induced by higher land market rents, $A^i \frac{dr}{ds}$ (for $i = I, C$), then the profits of farms increase.

Otherwise farms loose from subsidies. The same holds for overall farm profits.

The impact of subsidies on profits of landowners, IF and of CF can be summarized as follows:

1. if $\alpha^I = 0$ and $\alpha^C = 0$ then landowners gain all subsidies and CF and IF

profits are not affected by subsidies: $\frac{d\Pi^L}{ds} = A^T \frac{dr}{ds} > 0$ (with $\frac{dr}{ds} = 1$),

$$\frac{d\Pi^I}{ds} = 0, \quad \frac{d\Pi^C}{ds} = 0.$$

2. if $\alpha^I > 0$, $\alpha^C > 0$ and if $R^I = R^C$ then landowners gain proportionally more

then the size of subsidies and CF and IF loose: $\frac{d\Pi^L}{ds} = A^T \frac{dr}{ds} > 0$ (with

$$\frac{dr}{ds} > 1), \quad \frac{d\Pi^I}{ds} = -A^I \frac{\alpha^I A^I}{k} \left(pf_{AK}^I + pf_{KK}^I \frac{\alpha^I s}{k} \right) < 0, \quad \text{and}$$

$$\frac{d\Pi^C}{ds} = -A^C \frac{\alpha^C A^C}{k} \left(pf_{AK}^C + pf_{KK}^C \frac{\alpha^C s}{k} \right) < 0.$$

3. if $\alpha^I > 0$, $\alpha^C > 0$ and if $R^I \neq R^C$ then landowners gain proportionally more

then the size of subsidies, $\frac{d\Pi^L}{ds} = A^T \frac{dr}{ds} > 0$ (with $\frac{dr}{ds} > 1$), and CF and IF

may lose or gain: if $R^I > R^C$ then $\frac{d\Pi^I}{ds} < 0$ or > 0 , $\frac{d\Pi^C}{ds} < 0$, while if

$R^I < R^C$ then $\frac{d\Pi^I}{ds} < 0$, $\frac{d\Pi^C}{ds} < 0$ or > 0 .

Part 2: One or both farms are no longer credit constrained with s

Assume that CF are not credit constrained with s and that IF still are. Analogous results can be obtained in the case when IF are not credit constrained and CF remain credit constrained. Then in equilibrium (7) and (A1.1) must be satisfied as well as:

$$(A1.16) \quad pf_A^C - (r - s) = 0$$

$$(A1.17) \quad pf_K^C - k = 0$$

Totally differentiating (7), (A1.1), (A1.16), and (A1.17) yields (A1.3), (A1.5) as well as:

$$(A1.18) \quad pf_{AA}^C dA^C + pf_{AK}^C dK^C - dr + ds = 0$$

$$(A1.19) \quad pf_{KA}^C dA^C + pf_{KK}^C dK^C - dk = 0$$

Using (A1.3), (A1.5), (A1.18) and (A1.19) it follows that:

$$(A1.20) \quad \frac{dA^I}{ds} = \frac{1 - R^I}{\left(M^I + \frac{K^C}{A^C} \left(pf_{AA}^C \frac{A^C}{K^C} - pf_{AK}^C \frac{pf_{KA}^C}{pf_{KK}^C} \frac{A^C}{K^C} \right) \right)}$$

$$(A1.21) \quad \frac{dr}{ds} = \frac{M^I + R^I \frac{K^C}{A^C} \left(pf_{AA}^C \frac{A^C}{K^C} - pf_{AK}^C \frac{pf_{KA}^C}{pf_{KK}^C} \frac{A^C}{K^C} \right)}{\left(M^I + \frac{K^C}{A^C} \left(pf_{AA}^C \frac{A^C}{K^C} - pf_{AK}^C \frac{pf_{KA}^C}{pf_{KK}^C} \frac{A^C}{K^C} \right) \right)}$$

With decreasing returns to scale in production it follows that $f_{AK} < -f_{KK} \frac{K}{A}$ and

$f_{KA} < -f_{AA} \frac{A}{K}$ and with constant returns to scale in production it follows that

$\frac{A}{K} f_{AK} = -f_{KK}$, which implies that $\frac{K^C}{A^C} \left(pf_{AA}^C \frac{A^C}{K^C} - pf_{AK}^C \frac{pf_{KA}^C}{pf_{KK}^C} \frac{A^C}{K^C} \right) \leq 0$. So with

both decreasing and constant returns to scale it follows:

1. if $\alpha^I = 0$ then $\frac{dr}{ds} = 1$ and $\frac{dA^I}{ds} = 0$
2. if $0 < \alpha^I \leq 1$ then $\frac{dr}{ds} > 1$ and $\frac{dA^I}{ds} > 0$

The change in profits of IF, CF, landowners, and in aggregate is then given by equation (A1.12) as well as by:

$$(A1.22) \quad \frac{d\Pi^C}{ds} = -A^C \frac{dr}{ds} + A^C \leq 0$$

$$(A1.23) \quad \frac{d\Pi^L}{ds} = A^T \frac{dr}{ds} > 0$$

$$(A1.24) \quad \frac{d\Pi^I}{ds} + \frac{d\Pi^C}{ds} = \frac{\alpha^I A^I}{k} (pf_k^I - k) - A^T \frac{dr}{ds} + A^T < 0 \text{ or } > 0$$

Landowners gain while CF loose with $\alpha^I > 0$. For IF it is ambiguous. The term

$\frac{\alpha^I A^I}{k} (pf_k^I - k) > 0$ is positive, while from (A1.21) it follows that $\frac{dr}{ds} > 0$. If gains

from subsidies and from increased use of fertilizer induced by the relaxation of credit

constraint, $\frac{\alpha^I A^I}{k} (pf_k^I - k) + A^I$, are higher than the rental cost increase induced by

higher land market rent, $A^I \frac{dr}{ds}$, then the profits of IF increase. Otherwise IF loose

from subsidies. However, if $\alpha^I = 0$ then landowners gain all subsidies and IF and CF

profits are not affected by subsidies, $\frac{d\Pi^L}{ds} > 0$, $\frac{d\Pi^I}{ds} = 0$ and $\frac{d\Pi^C}{ds} = 0$.

The impact of subsidies on profits of landowners, IF and of CF can be summarized as follows:

1. if $\alpha^I = 0$ and $\alpha^C = 0$ then landowners gain all subsidies and IF and CF

profits are not affected by subsidies: $\frac{d\Pi^L}{ds} = A^T \frac{dr}{ds} > 0$ (with $\frac{dr}{ds} = 1$),

$$\frac{d\Pi^I}{ds} = 0 \text{ and } \frac{d\Pi^C}{ds} = 0.$$

2. if $\alpha^I > 0$, $\alpha^C > 0$ then landowners gain proportionally more than the

size of subsidies, $\frac{d\Pi^L}{ds} = A^T \frac{dr}{ds} > 0$ (with $\frac{dr}{ds} > 1$), CF loose $\frac{d\Pi^C}{ds} < 0$,

and IF may lose or gain $\frac{d\Pi^I}{ds} < 0$ or > 0 .

If both IF and CF are not credit constrained with s , then in equilibrium (7), (A1.16),

and (A1.17) must be satisfied as well as:

$$(A1.25) \quad pf'_A - (r + t - s) = 0$$

$$(A1.26) \quad pf'_K - k = 0$$

Totally differentiating (7), (A1.16), (A1.17), (A1.25), (A1.26), and solving for $\frac{dA^I}{ds}$

and for $\frac{dr}{ds}$ it follows that with no credit constraints $\frac{dA^I}{ds} = 0$ and $\frac{dr}{ds} = 1$. This also

implies that with no credit constraints subsidies will benefit only landowners. This is the result of Ciaian and Swinnen (2006), derived here in a more general model.

Q.E.D.

A2. Proof of proposition 2

To show:

$$a. \quad \frac{d\Pi^L}{de} = A^T \frac{dr}{de} > 0 \text{ and } \frac{dr}{de} > 0 \text{ with } \alpha^I > 0 \text{ and/or } \alpha^C > 0.$$

- b. The signs of $\frac{d\Pi^I}{de}$ and $\frac{d\Pi^C}{de}$ depend on the relative credit constraints and on α^I/α^C .

Three cases must be considered:

1. $A^I > A_E^I$, and hence $A^C < A_E^C$.
2. $A^I < A_E^I$, and hence $A^C > A_E^C$.
3. $A^I = A_E^I$, and hence $A^C = A_E^C$.

As in the proof of proposition 1, consider several situations requiring the impact of the subsidy on the farms' credit constraints.

Part 1: Farms remain credit constrained with e

Case 1.

When $A^I > A_E^I$, and hence $A^C < A_E^C$ profits of IF and CF, respectively, are:

$$(A2.1) \quad \Pi^I = pf^I(A^I, K^I) - (r+t)A^I - kK^I + eA_E^I$$

$$(A2.2) \quad \Pi^C = pf^C(A^C, K^C) - rA^C - kK^C + eA_E^C$$

In equilibrium condition (7) must be satisfied, as well as:

$$(A2.3) \quad pf_A^I - (r+t) = 0$$

$$(A2.4) \quad pf_A^C + pf_K^C \frac{\alpha^C e}{k} - r + (1 - \alpha^C)e = 0$$

Totally differentiating (7), (A2.3) and (A2.4) yields (A1.5) as well as:

$$(A2.5) \quad pf_{AA}^I dA^I + pf_{AK}^I \frac{\alpha^I A_E^I}{k} de - dr = 0$$

$$(A2.6) \quad N^C dA^C + D^C de - dr = 0$$

where

$$(A2.7) \quad N^C = \left(pf_{AA}^C + pf_{AK}^C \frac{\alpha^C e}{k} + pf_{KA}^C \frac{\alpha^C e}{k} + pf_{KK}^C \frac{\alpha^{C^2} e^2}{k^2} \right) < 0,$$

$$(A2.8) \quad D^C = \frac{\alpha^C A^C}{k} \left(pf_{AK}^C + pf_{KK}^C \frac{\alpha^C e}{k} \right) + pf_K^C \frac{\alpha^C}{k} + (1 - \alpha^C) \geq 1.$$

To show that $D^C \geq 1$ and that $N^C < 1$, the arguments are the same as those used in the proof of proposition 1 (Appendix A1).

Using (A1.5), (A2.5) and (A2.6) it follows that:

$$(A2.9) \quad \frac{dA^I}{de} = \frac{D^C - pf_{AK}^I \frac{\alpha^I A_E^I}{k}}{pf_{AA}^I + N^C}$$

$$(A2.10) \quad \frac{dr}{de} = \frac{N^C pf_{AK}^I \frac{\alpha^I A_E^I}{k} + D^C pf_{AA}^I}{pf_{AA}^I + N^C} > 1$$

It follows that in equilibrium $\frac{dA^I}{de} > 0$ if

$$(A2.11) \quad pf_{AK}^I \frac{\alpha^I A_E^I}{k} > D^C$$

i.e. in equilibrium with e IF use more land than the eligible area if the increase of IF land marginal productivity from using additional fertilizer is higher than the increase in the subsidy e that CF receive plus the increase in CF land marginal productivity induced by using more fertilizer.¹⁹ If this would not be the case then it implies that in equilibrium IF cannot rent more land than the eligible area, A_E^I , and it must be that we are either in case 2 ($A^I < A_E^I$, and hence $A^C > A_E^C$) or in case 3 ($A^I = A_E^I$, and hence $A^C = A_E^C$).

¹⁹ IF and CF have different change in land marginal returns from using additional fertilizer in the production process because for the case 1 when $A^I > A_E^I$, and hence $A^C < A_E^C$, a change in A^C also changes total subsidies that CF receive (eA^C) and this changes the quantity of fertilizer that can be bought. For IF this is not the case because they rent more land than the eligible area $A^I > A_E^C$ and therefore their total subsidies are fixed at eA_E^I , and do not change with land renting.

If $\alpha^c = 0$ then $D^c = 1$, and if $0 < \alpha^c \leq 1$ then $D^c > 1$. Hence this implies that if equation (A2.11) holds then $pf_{AK}^I \frac{\alpha^I A_E^I}{k} > 1$, and hence $\frac{dr}{de} > 1$. The rent increases by more than the size of e .

If equation (A2.11) holds it also implies that the effect of e on profits of IF, CF, landowners and of aggregate farm profits, respectively, is:

$$(A2.12) \quad \frac{d\Pi^I}{de} = \frac{\alpha^I A_E^I}{k} (pf_K^I - k) - A^I \frac{dr}{de} + A_E^I < 0 \text{ or } > 0$$

$$(A2.13) \quad \frac{d\Pi^C}{de} = \frac{\alpha^C A^C}{k} (pf_K^C - k) - A^C \frac{dr}{de} + A^C < 0$$

$$(A2.14) \quad \frac{d\Pi^L}{de} = A^T \frac{N^C pf_{AK}^I \frac{\alpha^I A_E^I}{k} + D^C pf_{AA}^I}{pf_{AA}^I + N^C} > 0$$

$$(A2.15) \quad \frac{d\Pi^I}{de} + \frac{d\Pi^C}{de} = \frac{\alpha^I A_E^I}{k} (pf_K^I - k) + \frac{\alpha^C A^C}{k} (pf_K^C - k) - A^T \frac{dr}{de} + A_E^I + A^C < 0$$

or > 0

Landowners gain and CF loose, while for IF and for aggregate farm profits it is undetermined. If the size of the gains from subsidies and from using more fertilizer are higher relative to the increase in rental costs, then IF gain and aggregate farm profits increase, otherwise IF loose and aggregate farm profits decrease.

Case 2.

When $A^I < A_E^I$, and hence $A^C > A_E^C$, the profits of IF and CF, respectively, are:

$$(A2.16) \quad \Pi^I = pf^I(A^I, K^I) - (r+t)A^I - kK^I + eA^I$$

$$(A2.17) \quad \Pi^C = pf^C(A^C, K^C) - rA^C - kK^C + eA_E^C$$

In equilibrium condition (7) must be satisfied, as well as:

$$(A2.18) \quad pf_A^I + pf_K^I \frac{\alpha^I e}{k} - (r+t) + (1-\alpha^I)e = 0$$

$$(A2.19) \quad pf_A^C - r = 0$$

Totally differentiating (7), (A2.18), and (A2.19) yields (A1.5) as well as:

$$(A2.20) \quad N^I dA^I + D^I de - dr = 0$$

$$(A2.21) \quad pf_{AA}^C dA^C + pf_{AK}^C \frac{\alpha^C A_E^C}{k} de - dr = 0$$

where

$$(A2.22) \quad N^I = \left(pf_{AA}^I + pf_{AK}^I \frac{\alpha^I e}{k} + pf_{KA}^I \frac{\alpha^I e}{k} + pf_{KK}^I \frac{\alpha^{I^2} e^2}{k^2} \right) < 0,$$

$$(A2.23) \quad D^I = \frac{\alpha^I A^I}{k} \left(pf_{AK}^I + pf_{KK}^I \frac{\alpha^I e}{k} \right) + pf_K^I \frac{\alpha^I}{k} + (1-\alpha^I) \geq 1.$$

To show that $D^I \geq 1$ and that $N^I < 1$, the arguments are the same as those used in the proof of proposition 1 (Appendix A1).

Using (A1.5), (A2.20) and (A2.21) it follows that:

$$(A2.24) \quad \frac{dA^I}{de} = \frac{pf_{AK}^C \frac{\alpha^C A_E^C}{k} - D^I}{N^I + pf_{AA}^C}$$

$$(A2.25) \quad \frac{dr}{de} = \frac{N^I pf_{AK}^C \frac{\alpha^C A_E^C}{k} + D^I pf_{AA}^C}{N^I + pf_{AA}^C} > 1$$

It follows that in equilibrium $\frac{dA^I}{de} < 0$ $\left(\frac{dA^C}{de} > 0 \right)$ if

$$(A2.26) \quad pf_{AK}^C \frac{\alpha^C A_E^C}{k} > D^I$$

i.e. in equilibrium with e CF use more land than the eligible area if the change of CF land marginal productivity from using additional fertilizer is higher than the change in

subsidy e that IF receive plus the change in IF land marginal productivity from using more fertilizer. If this would not be the case then it implies that in equilibrium CF cannot rent more land than the eligible area, A_E^C , and it must be that we are either in case 1 ($A^I > A_E^I$, and hence $A^C < A_E^C$) or in case 3 ($A^I = A_E^I$, and hence $A^C = A_E^C$).

If $\alpha^I = 0$ then $D^I = 1$, if $0 < \alpha^I \leq 1$ then $D^I > 1$. Hence this implies that if equation

(A2.26) holds then $pf_{AK}^C \frac{\alpha^C A_E^C}{k} > 1$, and hence $\frac{dr}{de} > 1$. The rent increases by more

than the size of e .

If equation (A2.26) holds it also implies that the effect of e on profits of IF, CF, landowners and of aggregate farm profits, respectively, is:

$$(A2.27) \quad \frac{d\Pi^I}{de} = \frac{\alpha^I A^I}{k} (pf_K^I - k) - A^I \frac{dr}{de} + A^I < 0$$

$$(A2.28) \quad \frac{d\Pi^C}{de} = \frac{\alpha^C A_E^C}{k} (pf_K^C - k) - A^C \frac{dr}{de} + A_E^C < 0 \text{ or } > 0$$

$$(A2.29) \quad \frac{d\Pi^L}{de} = A^T \frac{N^I pf_{AK}^C \frac{\alpha^C A_E^C}{k} + D^I pf_{AA}^C}{N^I + pf_{AA}^C} > 0$$

$$(A2.30) \quad \frac{d\Pi^I}{de} = \frac{\alpha^I A^I}{k} (pf_K^I - k) + \frac{\alpha^C A_E^C}{k} (pf_K^C - k) - A^T \frac{dr}{de} + A_E^C + A^I < 0 \text{ or } > 0$$

Landowners gain, IF loose, while for CF and for aggregate farm profits it is undetermined. CF gain and aggregate farm profits increase if the size of the gains from subsidies and from using more fertilizer are higher than the increase in rental costs. otherwise CF loose and aggregate farm profits decrease.

Case 3.

If (A2.11) and if (A2.26) do not hold then it must be the case that in equilibrium neither IF nor CF can rent beyond their eligible area. This implies that $A^I = A_E^I$, and

hence $A^C = A_E^C$ which implies that $\frac{dA^I}{de} = \frac{dA^C}{de} = 0$. The increase in marginal productivity of land induced by more fertilizer use with e is not sufficiently large to offset the other farms' benefits from e and from their higher land marginal productivity induced by more fertilizer use.

The following conditions determine the rent r that IF and CF, respectively, are willing to pay for an additional hectare of land in excess of the eligible area:

$$(A2.31) \quad pf_A^I - t = r$$

$$(A2.32) \quad pf_A^C = r$$

The payment e does not affect these conditions because IF and CF do not receive e for the area that exceeds the eligible area.

When the payment e changes, the change in the rent that IF and CF are willing to pay is, respectively:

$$(A2.33) \quad pf_{AA}^I \frac{dA^I}{de} + pf_{AK}^I \frac{\alpha^I A_E^I}{k} = \frac{dr}{de}$$

$$(A2.34) \quad pf_{AA}^C \frac{dA^C}{de} + pf_{AK}^C \frac{\alpha^C A_E^C}{k} = \frac{dr}{de}$$

But $\frac{dA^I}{de} = \frac{dA^C}{de} = 0$, hence:

$$(A2.35) \quad pf_{AK}^I \frac{\alpha^I A_E^I}{k} = \frac{dr}{de}$$

$$(A2.36) \quad pf_{AK}^C \frac{\alpha^C A_E^C}{k} = \frac{dr}{de}$$

Equations (A2.35) and (A2.36) determine the size of the increase in the marginal land productivity induced by e and it is the amount by which farms are willing to increase the rent. When farms are granted e , they can use more fertilizer which increases the rent that farms are willing to pay for each hectare of land. In equilibrium it holds that:

$$(A2.37) \quad \frac{dr}{de} = \text{Max} \left\{ pf_{AK}^I \frac{\alpha^I A_E^I}{k}; pf_{AK}^C \frac{\alpha^C A_E^C}{k} \right\}$$

If the marginal land productivity rises more to IF than to CF,

$pf_{AK}^I \frac{\alpha^I A_E^I}{k} > pf_{AK}^C \frac{\alpha^C A_E^C}{k}$, then the land market rent rises by $pf_{AK}^I \frac{\alpha^I A_E^I}{k}$ otherwise

it will rise by $pf_{AK}^C \frac{\alpha^C A_E^C}{k}$. The farm that has the largest gains from additional

fertilizers use (the one that is more credit constrained) is willing to pay the highest

rent and bid the rent up. The other farm pays this rent because otherwise it will lose

the land and the payment e with it. The increase of market rent is positive but its size

is undetermined. It could be lower than e or smaller than e . It depends on the rise of

marginal land productivity, i.e. to what extent farms are credit constrained. However

if $\alpha^I = \alpha^C = 0$ then $\frac{dr}{de} = 0$.

The effect on profits:

$$(A2.38) \quad \frac{d\Pi^I}{de} = \frac{\alpha^I A_E^I}{k} (pf_K^I - k) - A^I \frac{dr}{de} + A_E^I < 0 \text{ or } > 0$$

$$(A2.39) \quad \frac{d\Pi^C}{de} = \frac{\alpha^C A_E^C}{k} (pf_K^C - k) - A^C \frac{dr}{de} + A_E^C < 0 \text{ or } > 0$$

$$(A2.40) \quad \frac{d\Pi^L}{d\tau} = \text{Max} \left\{ pf_{AK}^I \frac{\alpha^I A_E^I}{k}; pf_{AK}^C \frac{\alpha^C A_E^C}{k} \right\} A^T > 0$$

$$(A2.41) \quad \frac{d\Pi^I}{de} + \frac{d\Pi^C}{de} = \frac{\alpha^I A_E^I}{k} (pf_K^I - k) + \frac{\alpha^C A_E^C}{k} (pf_K^C - k) - A^T \frac{dr}{de} + A^T < 0 \text{ or}$$

> 0

Landowners gain, while for IF, CF and for aggregate farm profits it is undetermined.

If the gains from subsidies and from using more fertiliser are higher than the increase

in rental costs, then farms gain; otherwise they lose. However if $\alpha^I = \alpha^C = 0$, then

$\frac{dr}{de} = 0$ and all subsidy benefits go to farms, i.e. $\frac{d\Pi^I}{de} = A_E^I > 0$, $\frac{d\Pi^C}{de} = A_E^C > 0$,

and $\frac{d\Pi^L}{de} = 0$.

Part 2: One or both farms are no longer credit constrained with e

Assume that CF are no longer credit constrained and that IF still are. Analogous results can be obtained in the case when IF are not credit constrained and CF remain credit constrained with e .

Case 1.

When $A^I > A_E^I$, and hence $A^C < A_E^C$ in equilibrium condition (7), (A1.17), and (A2.3) must be satisfied, as well as:

$$(A2.42) \quad pf_A^C - r + e = 0$$

Totally differentiating (7), (A1.17), (A2.3), and (A2.42) yields (A1.5), (A1.19), and (A2.5) as well as:

$$(A2.43) \quad pf_{AA}^C dA^C + pf_{AK}^C dK^C - dr + de = 0$$

Solving for $\frac{dA^I}{de}$ and for $\frac{dr}{de}$ yields:

$$(A2.44) \quad \frac{dA^I}{de} = \frac{1 - pf_{AK}^I \frac{\alpha^I A_E^I}{k}}{pf_{AA}^I + pf_{AA}^C - pf_{AK}^C \frac{pf_{KA}^C}{pf_{KK}^C}}$$

$$(A2.45) \quad \frac{dr}{de} = \frac{\left(pf_{AA}^C - pf_{AK}^C \frac{pf_{KA}^C}{pf_{KK}^C} \right) pf_{AK}^I \frac{\alpha^I A_E^I}{k} + pf_{AA}^I}{pf_{AA}^I + pf_{AA}^C - pf_{AK}^C \frac{pf_{KA}^C}{pf_{KK}^C}}$$

To show that $\left(pf_{AA}^C - pf_{AK}^C \frac{pf_{KA}^C}{pf_{KK}^C} \right) < 0$, the arguments are the same as those used in the proof of proposition 1 (Appendix A1).

It follows that in equilibrium $\frac{dA^I}{de} > 0$ if

$$(A2.46) \quad pf_{AK}^I \frac{\alpha^I A_E^I}{k} > 1$$

i.e. in equilibrium with e IF use more land than the eligible area if the change of IF land marginal productivity from using additional fertilizer is higher than the change in the subsidy e that CF receive. If equation (A2.46) does not hold then it implies that in equilibrium IF cannot rent more land than the eligible area, A_E^I , and it must be that we are either in case 2 ($A^I < A_E^I$, and hence $A^C > A_E^C$) or in case 3 ($A^I = A_E^I$, and hence $A^C = A_E^C$). However, if $pf_{AK}^I \frac{\alpha^I A_E^I}{k} > 1$ then $\frac{dr}{de} > 1$. The rent increases by more than e .

If equation (A2.46) holds it also implies that the effect of e on profits of IF, CF, landowners, and of aggregate farms profits, respectively, are (A2.12) as well as:

$$(A2.47) \quad \frac{d\Pi^C}{de} = A^C - A^C \frac{dr}{de} < 0$$

$$(A2.48) \quad \frac{d\Pi^L}{de} = A^T \frac{dr}{de} > 0$$

$$(A2.49) \quad \frac{d\Pi^I}{de} + \frac{d\Pi^C}{de} = \frac{\alpha^I A_E^I}{k} (pf_K^I - k) - A^T \frac{dr}{de} + A_E^I + A^C < 0 \text{ or } > 0$$

Landowners gain and CF loose from subsidies, while for IF it is ambiguous. The term

$\frac{\alpha^I A_E^I}{k} (pf_K^I - k) > 0$ is positive, while from (A2.45) it follows that $\frac{dr}{de} > 0$. If gains

from subsidies and from increased use of fertilizer in production process induced by

the relaxation of credit constraint, $\frac{\alpha^I A_E^I}{k} (pf_K^I - k) + A_E^I$, are higher than the rental costs increase induced by higher land market rent, $A^I \frac{dr}{de}$, then the profits of IF increase. Otherwise IF loose from subsidies.

Case 2.

When $A^I < A_E^I$, and hence $A^C > A_E^C$, in equilibrium condition (7), (A1.17), and (A2.18) must be satisfied, as well as:

$$(A2.50) \quad pf_A^C - r = 0$$

Totally differentiating (7), (A2.18), (A1.17), and (A2.50) yields (A1.5), (A1.19), and (A2.20) as well as:

$$(A2.51) \quad pf_{AA}^C dA^C + pf_{AK}^C dK^C - dr = 0$$

Solving for $\frac{dA^I}{de}$ yields:

$$(A2.52) \quad \frac{dA^I}{de} = \frac{-D^I}{\left(N^I + pf_{AA}^C - pf_{AK}^C \frac{pf_{KA}^C}{pf_{KK}^C} \right)}$$

It follows that in equilibrium $\frac{dA^I}{de} < 0$ $\left(\frac{dA^C}{de} > 0 \right)$ if

$$(A2.53) \quad D^I < 0$$

i.e. in equilibrium CF use more land with SFP if the change in subsidy e that IF receive plus the change in IF land marginal productivity from using additional fertilizer are negative. This cannot be the case because otherwise IF would not be credit constrained. This implies that CF which are not credit constrained cannot rent more than the eligible area A_E^C with SFP. In equilibrium it must be that we are either

in case 1 ($A^I > A_E^I$, and hence $A^C < A_E^C$) or in case 3 ($A^I = A_E^I$, and hence $A^C = A_E^C$).

Case 3.

If equation (A2.46) does not hold then it must be the case that neither IF nor CF can rent beyond their eligible area. This implies that $A^I = A_E^I$, and hence $A^C = A_E^C$ which

implies that $\frac{dA^I}{de} = \frac{dA^C}{de} = 0$.

The conditions (A2.31) and (A2.50) determine the rent r that IF and CF, respectively, are willing to pay for an additional hectare of land in excess of the eligible area:

When the payment e changes, marginally the change in the rent that IF are willing to pay for an additional hectare is given by (A2.35) and the change in the rent that CF

are willing to pay is zero, $\frac{dr}{de} = 0$. This implies that:

$$(A2.54) \quad 0 \leq \frac{dr}{de} = pf_{AK}^I \frac{\alpha^I A_E^I}{k} \leq 1$$

IF marginal land productivity increases with e , $pf_{AK}^I \frac{\alpha^I A_E^I}{k} > 0$ for $\alpha^I > 0$, which is the equilibrium land market rent increase. CF pays this rent because otherwise it will loose land and the payment e with it. CF are not credit constrained, hence their land marginal productivity does not increase with e . The increase of market rent is positive but its size is undetermined. It could be lower than e or equal to e . It depends on the rise of marginal land productivity of IF, i.e. to what extent IF are credit constrained. If

$pf_{AK}^I \frac{A_E^I}{k} > 1$, then case 1 holds. If $\alpha^I = 0$ then $\frac{dr}{de} = 0$.

The effect of e on profits is given by:

$$(A2.55) \quad \frac{d\Pi^I}{de} = \frac{\alpha^I A_E^I}{k} (pf_K^I - k) + \left(1 - \frac{dr}{de}\right) A^I > 0$$

$$(A2.56) \quad \frac{d\Pi^C}{de} = \left(1 - \frac{dr}{de}\right) A^C \geq 0$$

$$(A2.57) \quad \frac{d\Pi^L}{de} = A^T pf_{AK}^I \frac{\alpha^I A_E^I}{k} \geq 0$$

$$(A2.58) \quad \frac{d\Pi^I}{de} + \frac{d\Pi^C}{de} = \frac{\alpha^I A_E^I}{k} (pf_K^I - k) + \left(1 - \frac{dr}{de}\right) A^T \geq 0$$

Landowners and IF gain if $\alpha^I > 0$. If $0 < \frac{dr}{de} < 1$ (with $\alpha^I > 0$) then CF gain

($\frac{d\Pi^C}{de} > 0$). If $\frac{dr}{de} = 1$ (with $\alpha^I > 0$) then CF profits do not change ($\frac{d\Pi^C}{de} = 0$). If

$\alpha^I = 0$ then all subsidies benefit farms, $\frac{d\Pi^I}{de} = A_E^I > 0$, $\frac{d\Pi^C}{de} = A_E^C > 0$, and

$$\frac{d\Pi^L}{de} = 0.$$

Consider next the case when both farms are not credit constrained. In this case the conditions (A2.31), (A2.32) determine the rent r that IF and CF, respectively, are willing to pay for an additional hectare of land in excess of the eligible area. With no credit constraints, the subsidy e does not affect these conditions. This implies that with no credit constraints and with SFP $\frac{dA^I}{ds} = \frac{dA^C}{ds} = 0$ and $\frac{dr}{ds} = 0$. This also implies that with no credit constraints subsidies will benefit farms. This is the result of Ciaian and Swinnen (2006), derived here in a more general model.

Q.E.D.

Table 1. Farm Structures in CEECs

Country	Family farms		Corporate farms	
	Share in total agricultural area (%)	Average size (ha)	Share in total agricultural area (%)	Average size (ha)
Bulgaria	52	1	48	536
Czech Republic	28	20	71	942
Estonia	63	2	37	327
Hungary	59	4	41	312
Latvia	90	12	10	297
Lithuania	89	4	11	483
Poland	87	8	13	n.a.
Romania	55	2	45	274
Slovakia	12	42	84	915

Sources: European Commission and national statistics.

Table 2. Agricultural land prices and land rents in NEMS– percentage change in 2005 relative to 2003

		Land price change 2005/2003(%)	Land rent change 2005/2003 (%)
Hungary*		—	30
Latvia**		34	—
Czech R.	<i>All</i>	0.3	—
	<i>IF</i>	—	19
	<i>CF</i>	—	38
Slovakia	<i>All</i>	31	—
	<i>IF</i>	—	26
	<i>CF</i>	—	62
Poland***		43	23

Source: Swinnen and Vranken (2007b) and Czech Ministry of Agriculture

Notes:

* for arable land

**change 2004 relative to 2003

***land price change for private sales; rent change for public land

Figure 1. Equilibria in the land market with credit constraints

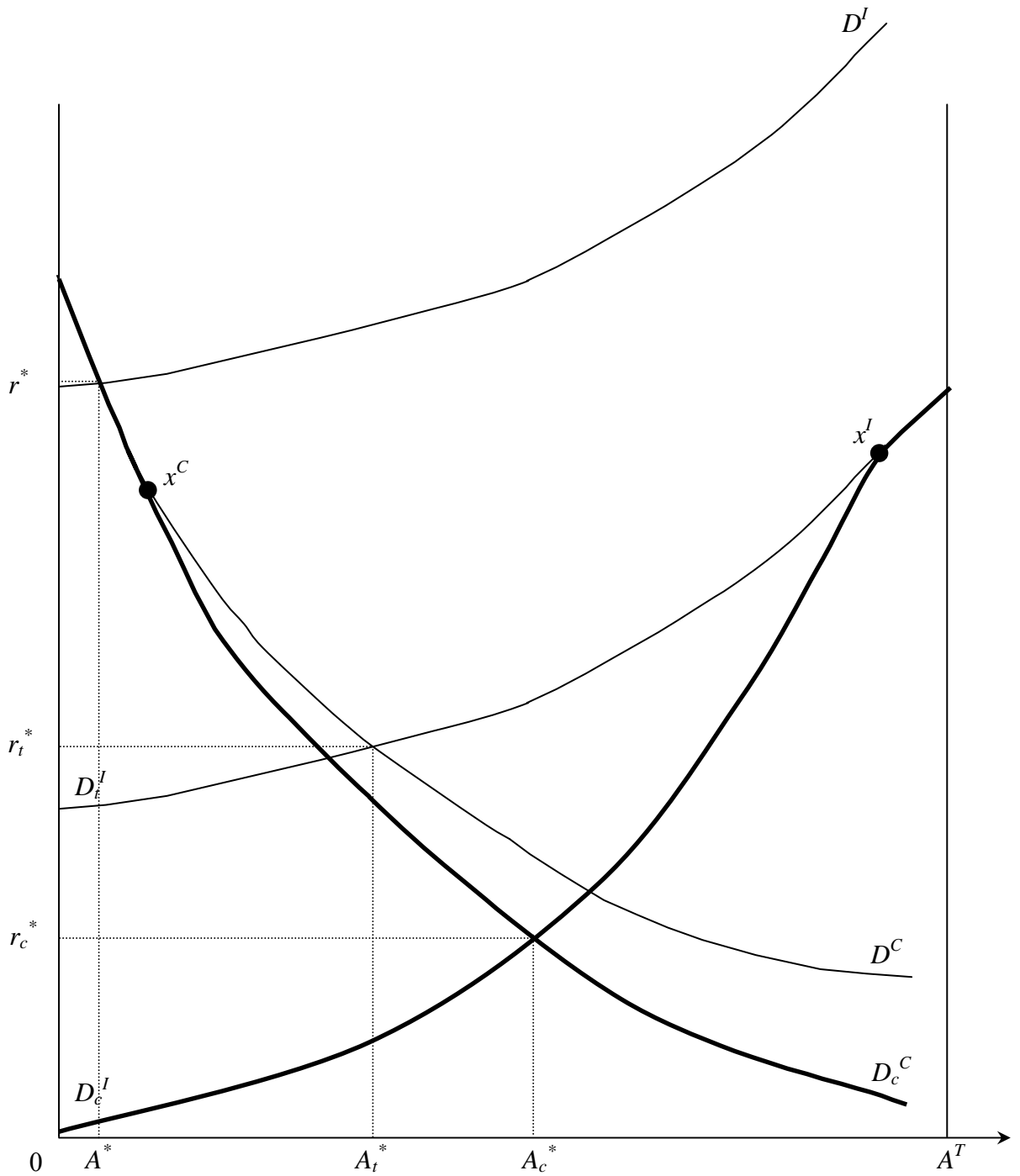


Figure 2. Equilibria in the land market with credit constraints and area payments

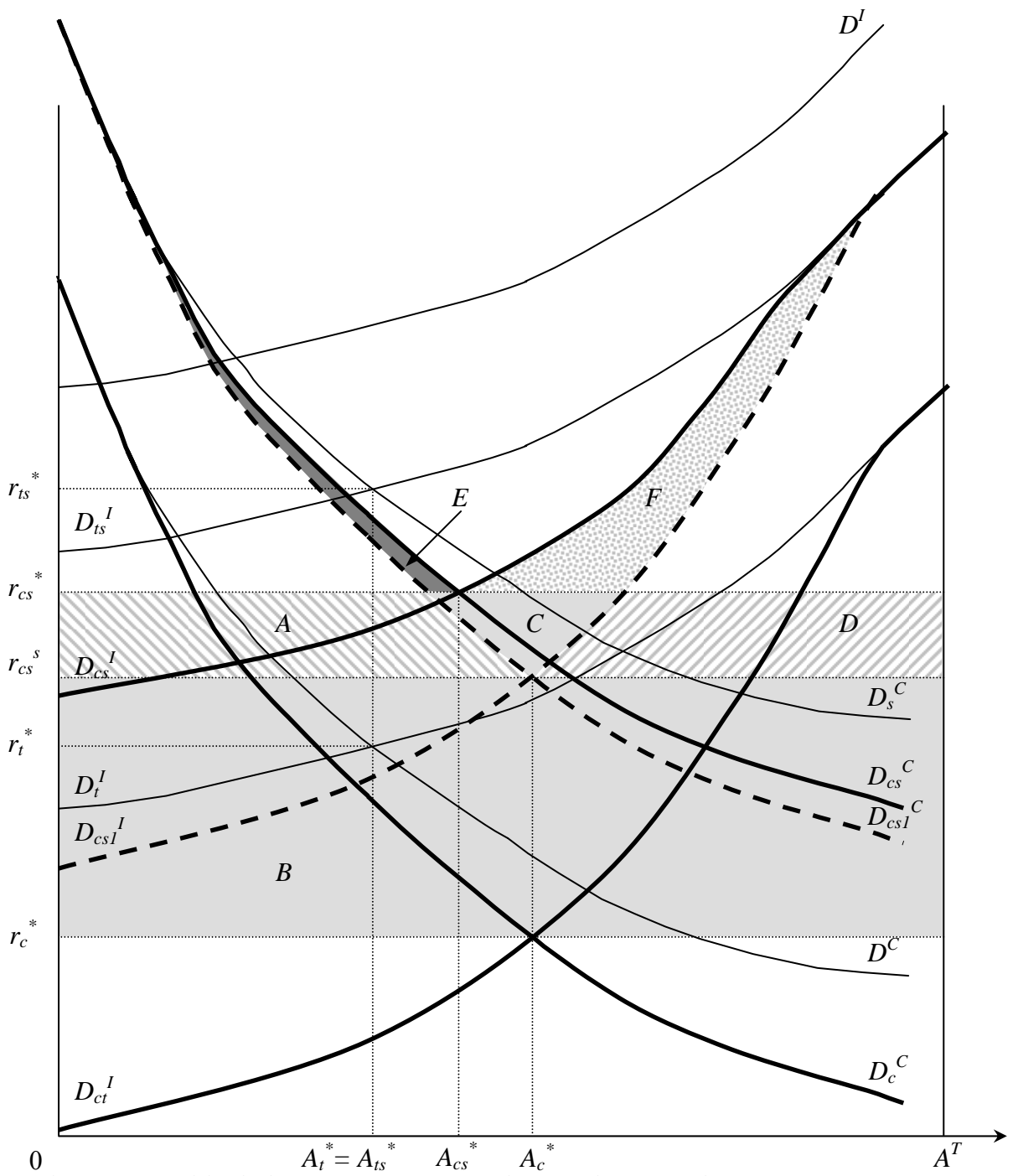


Figure 3. Equilibria in the land market with credit constraints and area payments

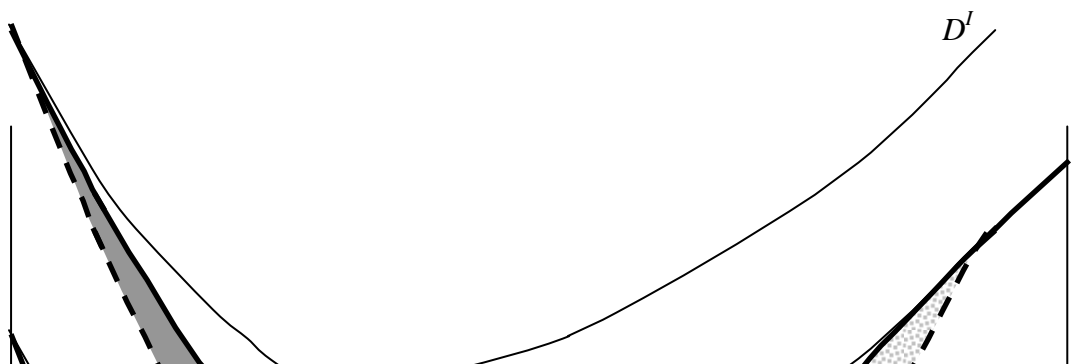


Figure 4. Equilibria in the land market with credit constraints and area payments

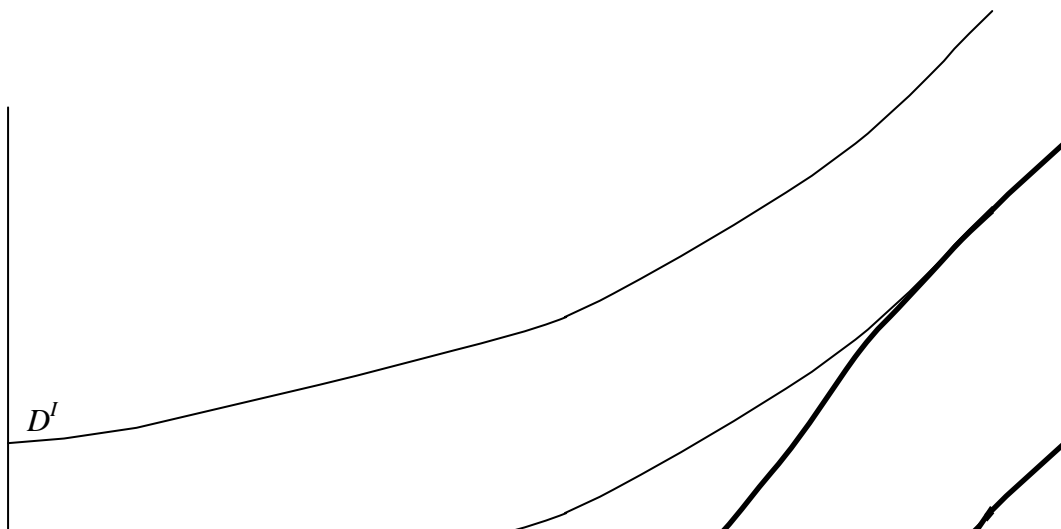


Figure 5. Equilibria in the land market with credit constraints and area payments

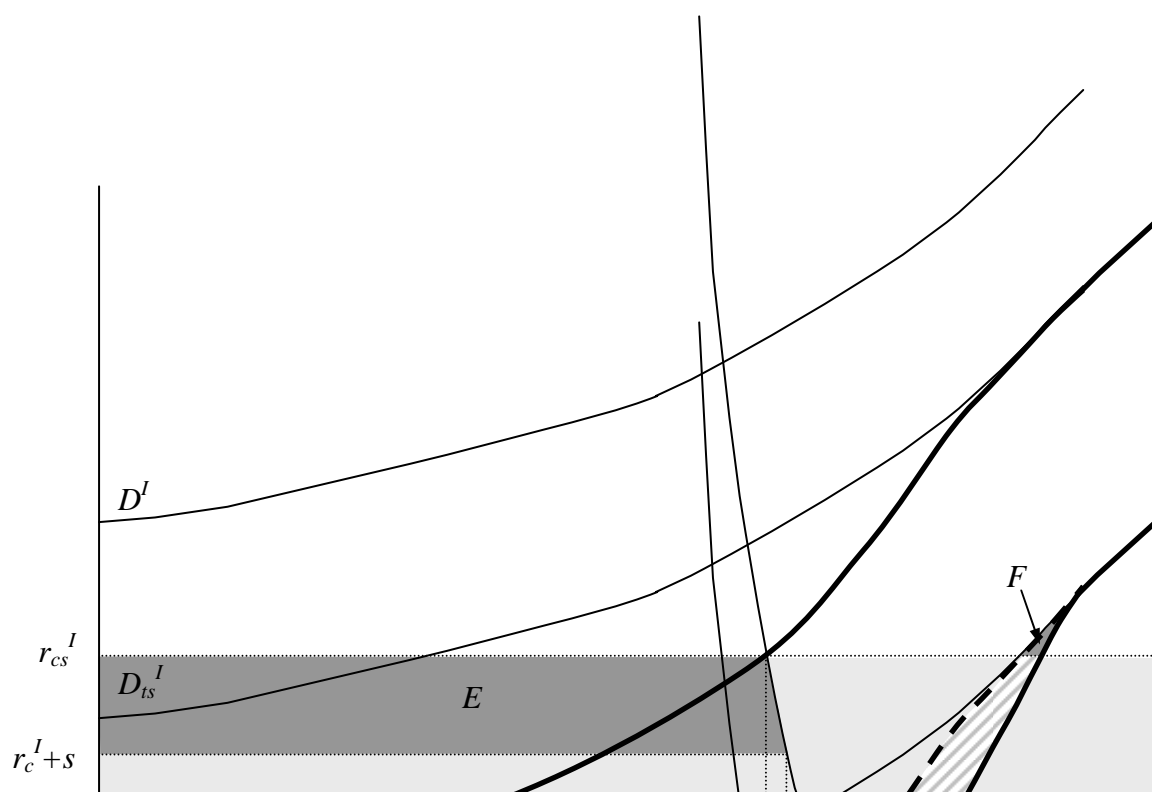


Figure 6. Equilibria in the land market with credit constraint and SFP

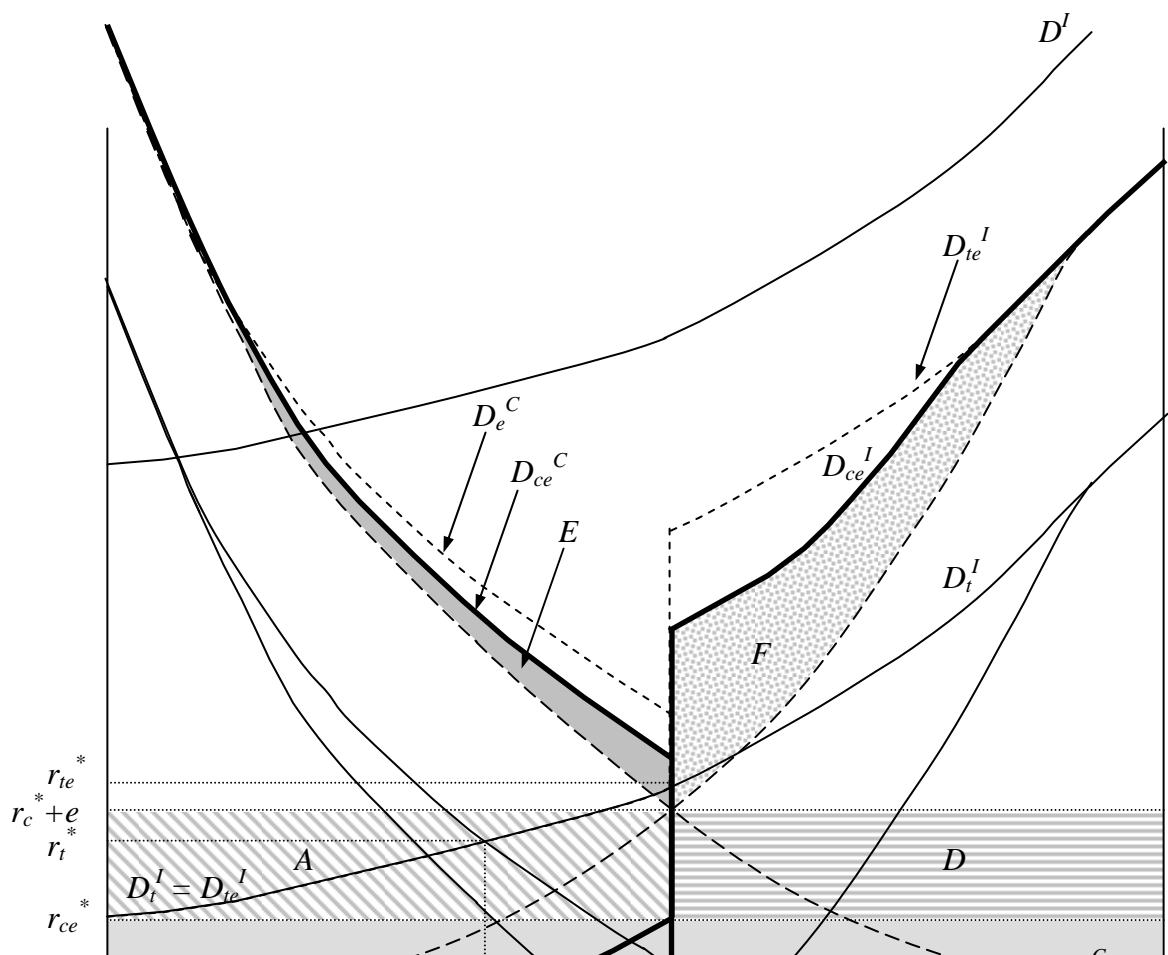


Figure 7. Equilibria in the land market with credit constraint and SFP

