Income Distribution Effects of EU Rural Development Policies: The Case of Farm Investment Support

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Abstract

This paper analyses income distribution effects of investment support granted under the EU RDP. It shows that implementation details of the support (the size of allocated funds, enforcement of additionality, eligibility limits) and market conditions (farm heterogeneity, farm access to credit, short-run versus long-run effects) affect income distribution effect of farm the investment support. With certain implementation of the support farms may gain part or even full support (when the additionality is not enforced and the total support is relatively small), while under different conditions farmers may loose (with perfect enforcement of the additionally and with significant increase in capital price). The implementation details interact with market structure and also determine the income distribution effects of the investment support. Introducing minimum thresholds as eligibility criteria may deter small farms from uptaking the investment support while maximum eligibility threshold may restrict big farms to take desired level of support. Benefits from investment support are shared with capital suppliers. Gains of capital suppliers depend on the size of the capital supply elasticity and are conditional on the EU support to increase capital prices.

Key words: rural development policies, policy rents, policy modelling, farm investment.

JEL classification: Q12; Q18

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Introduction

The Common Agricultural Policy (CAP) of the EU supports agricultural sector through two mechanisms. First, farms receive support through market intervention policies which are also known as first pillar policies. The first pillar policies include direct coupled and decoupled income support and other market intervention policies (e.g. market price support, trade measures, production quotas, etc.). Second, the CAP supports rural economy through the Rural Development Policies (RDP), known as second pillar policies. The RDP includes various measure targeted either at farm (e.g. investment support, agri-environmental support) or at rural community (e.g. infrastructural investments). In 2007 the total EU budget spending on CAP was around 52 billions, out of which 20% went to RDP (EUR-Lex 2008).

There is extensive literature analysing the income distributional effects of the first pillar types of agricultural policies (Alston and James, 2002; Ciaian and Swinnen 2006, 2009; Ciaian, Kancs and Swinnen 2008; Ciaian et al. 2001; Dewbre, Anton, and Thompson 2001; Gardner 1983; Guyomard, Mouël, and Gohin 2004; Salhofer 1996). Among others, studies have analyzed how these effects differ among policies and how results are affected by market imperfections and policy details (McCorriston and Sheldon 1991; Salhofer and Schmid 2004; de Gorter 1992; Munk 1994; OECD 2007).

However, little attention has been paid to income distribution effects of RDP in this literature. The RDP differ in several respects with the first pillar types of policies. The key differences are that the RDP have large diversity in policy focus and in implementation, the allocation of support is based on the additionality principle, the eligibility limits are imposed at beneficiary level, some RDP measures are allocated to non-agricultural activities, and in most cases the granting of EU support is not automatic but project based and subject to competition.

There are several studies in the literature which apply various types of modelling approaches with the aim of simulating the impact of RDP on the rural economy (see table 1). However, these applied RDP models contain several weaknesses. One important weakness is the assumption of how RDP measures are incorporated in the models. The modelling of RDP is not consistent among different studies and differs by study. Often studies group various RDP measures in a single variable and assume that all RDP measures included in the variable affect farm incentives in the same way. Concerning the farm investment support, most studies do not simulate the effect of the investment support individually but aggregated with other measures (e.g. Balamou and Psaltopoulos 2006; Haile and Slangen 2007; Oglethorpe and Sanderson 1999; Verburg et al. 2008).

The policy on which this article focuses is farm investment support granted under the EU RDP. Farm investment support is the second largest measure within the RDP accounting for more than 10% of the total RDP spending in the programming period 2007-2013 (European Commission 2007). We show that implementation details of the investment support (the size of allocated funds, enforcement of additionality, and eligibility limits) affect income distribution effects of farm investment support. Various studies have documented that implementation details of agricultural policies matter on how the policy changes farm incentives and affects income distribution (e.g. Alston 2007; Ciaian, Kancs and Swinnen 2008; Ciaian and Swinnen 2009; Kilian and Salhofer 2008). Additionally, the implementation details interact with farm heterogeneity and farm access to credit. We show that farm heterogeneity and farm access to credit have important implication for the income distribution effects of the EU farm investment support. To our knowledge, this paper is the first attempt to analyse the income distribution effects of EU RDP.

The paper is organized as follows. We begin with a brief literature review on RDP modelling. Next, we present the underlying partial equilibrium capital market model which we use for analyzing the income distributional effects. In section four we analyze the distributional impacts of farm EU investment support in the short-run considering different implementation characteristics of the support. Sections five, six and seven extend the analyses taking into consideration heterogeneous farms, imperfect rural credit markets and the long-run effects, respectively. The final section concludes by summarizing the key findings of the study.

The Current State of the Art in RDP Modelling

The RDP represent the second pillar support measures of the CAP. The RDP differ in several respects with the first pillar CAP market intervention policies: (*i*) the RDP include large number of measures each focusing on different areas of rural economy; (*ii*) implementation differs between measures and Member States; (*iii*) some RDP measures are allocated to non-agricultural activities; (*iv*) for the majority of measures not all farms are eligible for RDP support, the support is restricted per farm and at the Member State level, and is based on the additionality principle; (*iv*) the granting of the majority of RDP support is not automatic but is project based and is subject to competition.

According to EU regulation 1698/2005, the RDP support is divided in four Axes.[1] Each Axis is further split in several policy measures with each focusing on a specific area of rural development. In general, RDP measures can be grouped in eight socioeconomic areas of rural development: farm restructuring and competitiveness; improvement of human capital; innovation; provision of basic rural services and related infrastructure; improving the quality of agricultural products; support for sustainable use of agricultural land; diversification of the rural economy; and support for improvement of environment (Copus 2007; Dwyer 2005).

There is a growing body of research on the modelling of RDP. A summary of the literature is provided in Table 1. Most these studies are empirical and most of them simulate the effect of RDP on the rural economy. Little work was done to provide a consistent theoretical modelling framework of RDP.

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[1] Axis 1: improving the competitiveness of the agricultural and forestry sector; Axis 2: improving the environment and the countryside; Axis 3: quality of life in rural areas and diversification of the rural economy; and Axis 4: Leader instrument.

However, these empirical models contain several shortcomings. Various types of models were applied to simulate the effects of RDP: for example econometric models; regional SAM; general equilibrium models; partial equilibrium models; integrated assessment models, etc (Table 1). In general, these models focus on more than one RDP measure. Often the studies combine several RDP measures in one policy group (e.g. SCENAR 2020), group them by axis (e.g. Bergmann and Thomson 2008) or by area of RDP support (e.g. Psaltopoulos and Balamou 2006; Vollet 1998). To reduce the complexity of the model, the grouped measures are normally treated as one policy variable and are assumed to affect farm in the same way. This is an important weakness since different RDP measures are expected to create different incentives in the agricultural sector. Various studies have documented that implementation details of agricultural policies matter on how policies change farm incentives and how they affect the agricultural sector (e.g. Alston 2007; Ciaian, Kancs and Swinnen 2008; Kilian and Salhofer 2008).

Additionally, an important weakness of the applied models is related to the farm behavioural assumptions of RDP. Particularly this concerns the assumption made on the way the RDP measures are considered to affect farm incentives (table 1[2]). Often same RDP measures are modelled differently in different studies implying that the modelling of the RDP differs by study (table 1). For example, Psaltopoulos and Balamou (2006) model the agri-environmental measures similarly as the income support policies. On the other hand, Oglethorpe and Sanderson (1999) are more explicit. They assume that agri-environmental policies lead to adjustment of farm management practices (e.g. restricting stocking density, fertilizer use, etc.). In some cases the modelling of RDP appears to be ad-hoc and oversimplified. For example, Balamou and Psaltopoulos (2006) assume that RDP payments exogenously increase output demand of the construction sector in the analysed region (table 1). In most cases, the choice of behavioural assumptions is a compromise solution between various constraints faced by modellers such as the focus of the study, type of the model, model structure, data availability, or/and differences in regional implementation of RDP measures.

Many of the applied models are case or region specific (e.g. Haile and Slangen 2007; Oglethorpe and Sanderson 1999), restricting their use for other policies, problems and/or regions. Often this is caused be the fact that the modelling of RDP requires a large set of region/situation specific data which are not available at EU level. Another reason is that RDP impacts are case or region specific. This is particularly the case of models focusing on agri-environmental measures (van Ittersum *et al.* 2008). For example, Contingent Valuation Method is used to estimate the consumers' willingness to pay for environmental benefits (Drake 1992). The estimated willingness to pay for environmental product in one region is not applicable in other regions. This is because environmental products are heterogeneous goods and their supply quality and quantity is region specific depending on local characteristics.

Concerning the farm investment support, from all studies reviewed in table 1 only Felici et al. (2008) explicitly simulate the impact of the farm investment support on rural economy. They use regional economic model REMI-IRPET. They assume that the investment support (modernisation of agricultural holdings) reduces capital cost in agricultural sector. Based on the results derived in this paper, this assumption holds in the case when the investment additionality is perfectly enforced. Most other studies do not simulate the effect of the investment support individually. Often the studies aggregate the investment support with other RDP measures in one policy variable.

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[2] For some models it was not possible to indentify how RDP were modelled.

The model

In this section we develop a partial equilibrium model to analyse income distribution effects of farm investment support granted under the RDP. This approach is widely used in the literature to investigate the income distribution effects of agricultural policies (Alston and James, 2002; Ciaian and Swinnen 2006, 2009; Gardner 1983; Guyomard, Mouël, and Gohin 2004; Salhofer 1996). A key advantage of using partial equilibrium model as compared to the general equilibrium model is that it reduces the complexity of the analyses and it allows identifying the effects of the investment support on agricultural sector. The shortcoming of the partial equilibrium analysis is that it does not take into account inter-sectoral effects. Depending on the type of the effect, the partial equilibrium results may be strengthened or offset by the inter-sectoral effects. The share of the agricultural sector is small in the overall economy in the EU implying that the inter-sectoral effects should be relatively small.

The representative farm output is assumed to be a function of the amount of capital (K) and non-capital inputs (A), which we refer to as "land" but which captures also other non-capital inputs used by the farm (e.g. labor). The production function is represented by $f(A,K)$ with $f_i > 0$, $f_{ii} < 0$, $f_{ij} > 0$,[3] for $i, j = A$ and K. We assume decreasing/constant return to scale production function. We assume that the purchase of capital (K) is financed from the bank loan (L) at interest rate i assumed to be fixed. Farms are assumed to have unconstrained access to loans.[4] This model is based on the notion that capital price will equal the discounted present value of future rents.

More precisely, this model implies four agents in the agricultural capital good market: representative farm, loan suppliers (banks), capital suppliers (e.g. tractor suppliers), and the government. Loan suppliers provide loans to farms. Farms use loans to buy capital goods from capital suppliers. Farms use the services of the capital goods to produce agricultural products. Government intervenes in the capital market.

The farm profit function is given as follows:

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

where $k = R(i+\delta)$, p is the price of the final product[5], r is the price of non-capital inputs, k is rental price of capital and R is unit price of capital. The farm capital rental cost per unit of capital includes interest costs (payments) iR and the depreciation costs δR.

Farm equilibrium conditions are given as follows:

(2) $$pf_K = k = R(i+\delta)$$ Farm capital services FOC condition

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

[4] We will relax this assumption later.

[5] We assume that the economy is small and open, which implies that the output price is fixed.

(3) $pf_A = r$ Farm land FOC condition

(4) $L^D = RK$ Farm loan demand

(5) $K = S^K$ Capital good market equilibrium condition

(6) $A = S^A$ Land market equilibrium condition

where S^K is capital supply function and S^A is land supply function. Equations (2) and (3) represent the representative farm capital and land marginal conditions, respectively, derived from the farm profit maximization problem. The equilibrium condition (2) yields standard capitalization formula (i.e. $R = pf_K / (i + \delta)$) which implies that capital price is equal to the present value of the future capital rents. The total farm loan demand (L^D) in equation (4) is determined by the capital price and quantity of capital demanded by farm (RK). With perfect credit markets the farm access to loans is unconstrained which implies that farm can obtain loan for all its capital requirements. Equations (5) and (6) are market clearing equilibrium conditions for capital goods and land, respectively.

The capital market is illustrated in Figure 1. The conditions (2) and (3) determine the farm's (annual) demand for capital services. The total demand of capital services is represented by the curve D in the quadrant I in Figure 1.[6] The curve D shows capital rental price k which farm is willing to pay for capital services used in the production process.

We assume that the purchase of capital is financed from bank loan. The quadrant II shows the total farm loan demand L^D. The combination of farm capital demand (K) and farm willingness to pay for capital rental price (k) - given alongside the curve D - determine the farm loan requirement. More specifically, the farm willingness to pay the capital rental price k determines the per unit interest payment for loan ($iR = k - \delta R$). The total farm loan L^D is then determined by the interest payment and total farm capital demand given along the demand curve D.[7] With perfect credit markets all farm credit requirement are fulfilled. This implies that the shape of farm loan L^D is determined by the farm demand of capital services D. The L^D increases with farm capital demand (K) and decreases with capital rental costs (k) as shown by the downward slopping curve L^D in quadrant II.

The quadrant III shows the capital price curve (R^D) which represents the farm willingness to pay for capital. For a given interest rate and depreciation rate, the capital price is determined simultaneously with the value of farm loan L^D. This is because capital price is determined by the farm willingness to pay for capital rental price given in equation (2). In the same time the capital price represents the loan per unit of capital which farm can obtain in return for paying the interest payment iR. This implies that the loan per unit of capital is equal to the capital price. Similarly to L^D, the shape of the farm capital price curve R^D is determined by the farm demand of capital services D which implies downward sloping R^D.

The quadrant IV shows market for capital goods. Farm capital good demand D^K is determined by the combination of farm willingness to pay for capital goods R^D (shown in the quadrant III) and demand for capital services (shown in the quadrant I). Farm uses the loan to pay the

[6] One can extend the graphical exposition to land market. We restrict our attention only to capital market as farm capital is the main focus of the paper.

[7] Because the price of capital (R) is equal to the presents value of future stream of capital rents (equation (2)), this implies that for interest rate i farm can obtain per unit of capital a loan equal to the price of capital.

purchase of capital (shown in the quadrant II). The farm demand of capital goods D^K has a negative slope similar to the farm demand of capital services (D) shown in the quadrant I.

For example, if the capital rental price is k_1, the optimal farm capital use is K_1 (quadrant I). For a given interest rate i and capital depreciation rate δ, then k_1 implies that with perfect credit markets farm can obtain bank loan of size L_1 (quadrant II). Further, k_1, K_1 and L_1 imply that farm is willing to pay for capital K_1 the price equal to R_1. Similar can be shown for the rest of equilibrium situations which implies downward sloping capital good demand D^K.

Finally, the curve S^K in the quadrant IV represents supply of capital goods. In an analogous way to farm capital demand, one can derive from the supply of capital goods S^K the (annual) supply of capital services (S) (quadrant I). For example, capital suppliers are willing to sell K_2 for the price R_2 (given along the curve R^S in the quadrant III). The K_2 and R_2 imply loan L_2 (given along the curve L^S in the quadrant II)[8] which is needed to pay to capital supplier for the supply of capital K_2. This loan further implies unit capital rental costs equal to k_2. Similar can be shown for the rest of equilibrium situations which implies upward sloping supply of capital services S shown in the quadrant I.

The intersection between the demands (D, D^K) and the supplies (S, S^K) yields the equilibrium bundle of capital rental price, loan, capital price and quantity of capital (k^*, L^*, R^*, K^*), respectively (Figure 1). The quadrant I shows (annual) capital rents and supply and demand of capital services while the quadrant IV shows the discounted present value of annual capital rents and supply and demand of capital goods. In further analyses we restrict our attention to annual rents and supply and demand of capital services shown in quadrant I in Figure 1. This is consistent with the other studies on income distribution effects of agricultural policies (e.g. Alston and James, 2002; Ciaian and Swinnen 2006; Dewbre, Anton, and Thompson 2001; Gardner 1983; Guyomard, Mouël, and Gohin 2004).

To simplify the analyses we split the analyses in two effects: (*i*) short-run direct effect and (*ii*) long-run indirect effect.[9] We assume that in the short-run the investment support affects only capital market. Land input is assumed to stay fixed. This implies a situation where the farm reacts to the policy by adjusting capital use while it keeps other inputs unchanged. In the long-run it is assumed that the capital support induces indirect changes on the other agricultural markets. In terms of our model this implies that farm may also adjust non-capital inputs (land).[10]

The impact of farm EU investment support in the short-run

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[8] Note that the loan requirement corresponding to capital supply L^S differs with the loan requirement corresponding to the capital demand L^D except at the equilibrium point L^*. This is because the bundles of quantity of capital and capital price (or rental price) along demand and supply differ except at point L^*.

[9] This is only for exposition purposes. The general results of the paper are not affected.

[10] This is somehow inconsistent with the general use of this term in the literature. In general variable inputs are assumed to change in the short-run while capital is assumed to change only in the long-run. Because our objective is to analyse the effect of capital investment support, the change in farm capital is a short-run effect of the policy. Then in the long-run the farm adjusts other inputs taking in consideration the capital investment support.

In this paper we focus on the following three implementation details of the farm investment support granted under the EU RDP: (*i*) the investment support rate; (*ii*) farm eligibility limits (minimum and maximum thresholds imposed on the size of investment support a farm can obtain); (*iii*) the enforcement of investment additionality.

Under the EU RDP investment support programme farms can obtain a grand to partly finance the costs of capital purchases. The farm investment support is co-financed from the EU RDP budget and from the national budget. The support rate ranges between 40% and 75% of the total value of capital purchase costs. The support rate vary by region and by farm characteristics. Farms located in less developed/productive regions and younger farms may benefit from a higher support rate than other farms.

The size of the investment support is limited at farm level, regional level and EU level. For example, in England the maximum rate of grant per beneficiary is 400 000 EUR outside Less Favoured Areas (LFA) and 500 000 EUR within LFA. In Bavaria, Germany, the minimum grant eligible for this support is 30 000 EUR while the maximum grant is 150 000 EUR. Other MS impose similar eligibility limits.

In general, the policy objective is to increase the quantity or/and the quality of the farm capital, i.e. to create additionality effect. In terms of our model this implies that the policy objective is to increase the stock of capital relative to the capital stock used by farmers at the prevailing market prices of capital. We consider two cases in this paper: perfect enforcement of the additionality and imperfect (no) enforcement of the additionality.

We show that these implementation details importantly affect income distribution effect of the investment support. Additionally, we show that the impacts are affected by farm heterogeneity and farm excess to credit.

In this section we analyse the effect of investment support in the short-run (the direct effect) by assuming one representative farm and perfect credit markets. In the next two sections we extend the analysis by taking in consideration farm heterogeneity, imperfect credit markets and long-run (indirect) effects, respectively.

Perfect enforcement of additionality and no eligibility limits

In this section we assume that policy makers can perfectly enforce the additionality of investment and we assume that there are no limits imposed on the size of the eligible support. In the next sections we will relax these assumptions. The perfect enforcement of the additionality implies that the policy makers are able to enforce a situation where farm increase capital use by the size of the supported investment relative to the capital use at the prevailing market prices of capital. In other words, not all farm capital benefits from farm investment support. The support benefits only the additional farm capital.

Let α denote the investment support rate of the EU RDP programme. The support rate α is represented as the share of the total value of the supported investment (purchase costs of supported capital investment). With the investment support and perfect enforcement of the additionally the farm profit function (1) changes as follows:

(7) $\Pi = pf(A, K_o + K_s) - rA - (i+\delta)RK_o - [(R-\alpha R)i + \delta R]K_s = pf(A, K_o + K_s) - rA - kK_o - (k - \alpha Ri)K_s$

where $k = (i+\delta)R$, K_o is the farm capital use at prevailing market rental price of capital in the absence of the investment support, and K_s is capital which benefits from the investment support.

The value of support per unit of capital is equal to the capital price multiplied by the support rate (αR). Then the unit purchase cost of capital with the support is equal to $(R - \alpha R)$. The investment support reduces capital purchase costs. This further implies that capital interest costs with the support change to $(R - \alpha R)i = (1-\alpha)iR$.[11] Because we assume perfect enforcement the additionally only the farm capital in excess of K_o is eligible for the support (i.e K_s) as represented in the profit function (7). The farm capitol FOC changes as follows:[12]

(8) $pf_K - (k - \alpha iR) = pf_K - (1-\alpha)Ri - \delta R$

Equation (8) implies that the marginal interest costs of capital are reduced by the support rate α.

Hypothesis 1: *in the short-run, with perfect enforcement of investment additionality, with support rate* α*, with no eligibility limits, and with perfect rural credit markets (i) farms may gain or lose from investment supports; (ii) total welfare decreases and (iii) the optimal level of support uptake by farms depends on the support rate.*

Following the capital market illustrated in Figure 1 we focus our graphical exposition on the quadrant I which shows the relationship between the supply and demand of capital services and (annual) the capital rental price. The equilibrium bundle of capital rental price and the quantity of capital without support is (k^*, K^*) (Figure 2). If the investment additionality is perfectly enforced and if the total support is not constrained then the equilibrium with the support shifts to (k_1^*, K_1^*). The rental price of capital and the farm capital use increase. The capital K_s represents the optimal (maximum) amount of supported investment which farms are willing to undertake in the equilibrium. Farms are willing to uptake the investment support up to the point where the support rate is equal to the gap between the market rental price (k_1^*) and the farm willingness to pay for capital (k_3) given by the curve *D*. In Figure 2 this is the case at K_1^* where $\alpha i R_1^* = k_1^* - k_3$.[13] Higher or lower uptake of the investment support will reduce farm gains. With the additionality perfectly enforced only part of the capital (K_s) receives investment support while the rest of the capital equal to K_o does not receive the

[11] We consider the case when the support affects only the farm interest costs. This is consistent with the implementation of the RDP investment support. The support finances cost of purchase of capital. The depreciation costs (δR) are not eligible for the support.

[12] Note that land (*A*) in the short-run is assumed to be fixed.

[13] The maximum (optimal) amount of support which farm is willing to undertake is at the point where the curve D_s intersects the capital supply curve S. The curve D_s represents farm capital demand with the investment support. The curve D_s is not parallel with the capital demand without the support D because the support rate α is a share parameter.

support. The perfect enforcement of the additionally implies that only capital in excess of capital which farms would use at the market prevailing rental price k_1^* (i.e. $K_1^* - K_o = K_s$) is eligible for the support.

Note that the equilibrium increase in capital is smaller than the size of the supported investment K_s. This is because as capital price increases, farms reduce the capital use by $K^* - K_o$. In equilibrium, capital stock increases only by $K_1^* - K^*$ ($<K_s$). In order to offset the price effect, the supported investment must be higher than the size of the equilibrium capital increase, $K_s > K_1^* - K^*$.

Area *BC* represents farm loses due to capital price increase. Area *CDEFG* is total rental cost of supported investment K_s. Area *CDEF* is the farm gain from the support received for K_s. Finally, the area *CFG* is farm return from using K_s in production process. Subtracting farm costs from farm gains, the total farm net gain from the investment support equals area *F* – area *B*. Whether the farm gains or loses depends on the capital supply and demand elasticities. If area *F* is larger than area *B* then the farm gains otherwise the farm loses from the investment support.[14] The capital suppliers gain (area *BCD*) because of higher capital price. The net welfare effect is a loss equal to area *E*. The area *E* is deadweight loss resulting from the misallocation of capital recourses.

In Figure 3 we show the case with perfect elastic capital supply *S*. This implies that farm sectors cannot affect capital good price. The equilibrium without the support in Figure 3 is (k^*, K^*) and with the support is (k^*, K_2^*). Now the increase of capital is equal to the size of the support investment $K_2^* - K^* = K_s$. This is because with perfect elastic capital supply, higher demand for capital does not affect the capital rental price. Farms' gains equal to area *B*. The capital suppliers do not gain because the capital rental price does not change. Total welfare decreases by area *A*.

Perfect enforcement of additionality and eligibility limits

In this section we still assume that policy makers can perfectly enforce the investment additionality but now we add the eligibility limits. The eligibility limits implies that the support size a farm can receive is constrained by a lower and/or upper bound. We assume that the minimum and maximum size of the investment eligible for the support is $K_{\min}$ and $K_{\max}$, respectively. These eligibility limits imply that farm's supported investment must be larger than $K_{\min}$ but smaller than $K_{\max}$, $K_{\min} < K_s < K_{\max}$.

Hypothesis 2: *in the short-run, with perfect enforcement of investment additionality, with support rate α, and with perfect rural credit markets, minimum and maximum eligibility thresholds affect distribution of policy rents and may deter farms from uptaking the support.*

[14] Area *F* increases with farm capital demand elasticity and with capital supply elasticity. Area *B* decreases with capital supply elasticity and is not affected by farm capital demand elasticity.

To simplify the figure and the analyses we assume a perfect elastic capital supply. The effect is shown in Figure 4. The equilibrium without the support is (k^*, K^*). The eligibility limits determine farm support uptake and the farm gains from the support.

First, we assume that the minimum and maximum size of investment eligible for the support is such that $K_{\min} \le K_2^* - K^*$ and $K_{\max} \ge K_2^* - K^*$, respectively, where K_2^* is the equilibrium with no eligibility limits and with the support as shown in Figure 3. With these eligibility limits, the farm will not be constrained in terms of the support size it wishes to uptake. The equilibrium with the support shifts to (k^*, K_2^*) (Figure 4). This is the same equilibrium as in the case with no eligibility limits shown in Figure 3.[15] Farm's equilibrium supported investment is equal to K_s, where $K_s = K_2^* - K^*$. The equilibrium supported investment is lower than the maximum threshold and larger than the minimum threshold required, $K_{\min} < K_s < K_{\max}$. The equilibrium farm support uptake is determined at the point where the support level just covers the gap between the market rental price of capital and the farm marginal return to capital (i.e. at K_2^* where $\alpha i R^* = k^* - k_1$ (see hypothesis 1)) and this is not affected by the edibility limits. The farm gains from the support in Figure 4 is equal to area *BE* (which is equal to area *B* in Figure 3 with no eligibility limits). Total welfare decreases by area *AD*.

The equilibrium (k^*, K_2^*) will be affected by the eligibility limits only when the minimum eligibility threshold is larger than $K_2^* - K^*$ ($K_{\min} > K_2^* - K^*$) and/or when the maximum threshold is smaller than $K_2^* - K^*$, $K_{\max} < K_2^* - K^*$ (Figure 4). For example, if the minimum threshold is $K_{\min 1}$ (where $K_{\min 1} > K_2^* - K^*$), the farm must invest minimum $K_{\min 1}$ in order to be eligible for the support. With $K_{\min 1}$ farm profit change by area *BE* – area *G*. If area *BE* is larger than the area *G*, the farm gains. If area *BE* is smaller than area *G*, the farm loses and will not uptake the investment support. In the former case the equilibrium with the support shifts to (k^*, K_4^*). In the latter case the equilibrium with and without the investment support is the same (k^*, K^*) and farm will not uptake the support.

Consider the second case when the maximum threshold is lower than $K_2^* - K^*$, i.e. $K_{\max} < K_2^* - K^*$. For example, if the maximum eligibility threshold is $K_{\max 1}$ in Figure 4, the equilibrium with the support is (k^*, K_3^*). Because of the eligibility constraint the farm cannot obtain more support than $K_{\max 1}$, where $K_{\max 1} = K_3^* - K^* < K_s$. In this case the maximum threshold $K_{\max 1}$ reduces the uptake of the support and thus affects also farm gains/losses from the support. In Figure 4 the farm gains equal to area *B* which is less than the gain with no eligibility limits given by the area *BE*. Total welfare decreases by area *A*.

Imperfect enforcement of additionality and no eligibility limits

[15]The equilibrium (k^*, K_2^*) in Figure 4 is the same as in Figure 3.

In this section we consider a situation when policy makers are not able to enforce investment additionality. We also assume that there are no eligibility limits.

With the investment support and no enforcement of the additionally the farm profit function (1) changes as follows:

$$(9) \quad \Pi = pf(A,K) - rA - [(R - \alpha R)i + \delta R]K = pf(A,K) - rA - (k - \alpha Ri)K$$

Now all capital benefits form the support. The farm capitol FOC is given by equation (8).

Hypothesis 3: *in the short-run, with support rate α, with no eligibility limits, with perfect rural credit markets and if the investment additionally is not enforced farms and capital suppliers gain and total welfare decreases.*

This effect is shown in Figure 5. The equilibrium without the support is (k^*, K^*). The equilibrium with the support shifts to (k_2^*, K_2^*). In equilibrium total support uptake is equal to K_s, where $K_s = K_2^*$. Similar to the case of perfect enforcement of investment additionality shown in Figure 2, the farm is willing to uptake the investment support up to the point where the support level is equal to the gap between the equilibrium rental price of capital and the farm willingness to pay for capital. In Figure 5 this is the case at K_2^* where $\alpha i R_2^* = k_2^* - k_3$. However, farm receives support for all capital in Figure 5 because we assume no enforcement of the additionality. Because policy makers are not able to enforce the additionality, farm uses all capital to claim the support. The support increases farm capital by $K_2^* - K^*$. Now, farm gains from the support. Farm gains equal to area *HF.*[16] Capital suppliers gain area *BCD* because of higher capital price. Total welfare loss is equal to area *E*.

In Figure 6 we show the case with perfect elastic capital supply *S*. The equilibrium without the support is (k^*, K^*) and with the support is (k^*, K_2^*). Total support is equal to $K_s = K_2^*$ and the capital use increases by $K_2^* - K^*$. Farm gains equal to area *C*. The capital suppliers do not gain because the capital rental price is not affected by the support. Total welfare decreases by area *A*.

Imperfect enforcement of additionality and eligibility limits

In this section we assume that policy makers cannot enforce the additionality and that there are limits imposed on the support size a farm can receive. Again we assume that the minimum and maximum size of the investment eligible for the support is $K_{\min}$ and $K_{\max}$, respectively.

Hypothesis 4: *in the short-run, with no enforcement of investment additionality, with support rate α, and with perfect rural credit markets, minimum and maximum eligibility thresholds affect distribution of policy rents and may deter farms from uptaking the investment support.*

[16] This is because with no enforcement of the investments additionally higher farm capital costs induced by higher capital rental price (given by area *B* in Figure 5) are covered by the support as now all capital is eligible for the support. In the case with full enforcement of the additionality, the farm did not receive support for all capital. For example, in Figure 2 the support did not cover the farm capital costs given by area *B* which were induced by higher capital rental price (area *B* in Figure 5 is equal to area *B* in Figure 2).

To simplify the analysis we assume perfect elastic capital supply. The effect is shown in Figure 7. The equilibrium without the support is (k^*, K^*). First, we assume that the minimum and maximum size of investment eligible for the support is such that $K_{\min} \leq K_2^*$ and $K_{\max} \geq K_2^*$, respectively, where K_2^* is the equilibrium capital with the support and with no eligibility limits (see hypothesis 3). These eligibility limits do not constrain farm in terms of the size support it wishes to uptake. This implies that the equilibrium with the support and with and without the eligibility limits is the same at (k^*, K_2^*) (Figure 7 and Figure 6). The farm uses investment support equal to K_s, where $K_s = K_2^*$. The farm gains from the support equal area *CBE*. Total welfare effect is a loss equal to area *AD* (Figure 7).

The equilibrium (k^*, K_2^*) will be affected in all cases when the minimum eligibility threshold is larger than K_2^* (if $K_{\min} > K_2^*$) and/or when the maximum threshold is smaller than K_2^* (if $K_{\max} < K_2^*$) (Figure 7). For example, if the minimum threshold is $K_{\min 1}$ (where $K_{\min 1} > K_2^*$), the farm must invest minimum $K_{\min 1}$ in order to be eligible for the support. With $K_{\min 1}$ the farm profits change by area *CBE* – area *G*. If area *CBE* is larger than area *G*, the farm gains. However, if area *CBE* is smaller than area *G*, the farm loses and will not uptake the support. In the former case the equilibrium with the support shifts to (k^*, K_4^*). In the latter case the farm will not uptake the investments and the equilibrium with and without the support is the same (k^*, K^*).

The maximum threshold affects the equilibrium (k^*, K_2^*) if $K_{\max} < K_2^*$ (Figure 7). We distinguish two cases: 1) $K^* < K_{\max} < K_2^*$ and 2) $K_{\max} < K^*$. In the first case when $K^* < K_{\max} < K_2^*$ the investment support will still distort the capital market and the equilibrium capital use will be between K^* and K_2^* depending on the size of $K_{\max}$. Farm will be able to uptake less support than desired and thus farm policy gains will be reduced relative to farm gains with no eligibility limits shown in Figure 6.

In the second case when $K_{\max} < K^*$ the farm takes the decision on either to increase capital or to keep capital unchanged relative to the equilibrium capital without no support K^*. The farm will weight benefit of both options. If the benefits from keeping capital unchanged are larger than the benefits from the capital increase, the farm will choose not to increase capital.

Hypothesis 5: *in the short-run, with no enforcement of investment additionality, with support rate α, with perfect rural credit markets, and if $K_{\max} < K^*$ farms do not increase capital use and benefit all investment support.*

We show the effect in Figure 8. The equilibrium without the support is (k^*, K^*). We assume that maximum eligibility thresholds is $K_{\max 2}$, where $K_{\max 2} < K^*$.[17] The farm cannot obtain more support than $K_{\max 2}$.

[17] This implies that $K_{\min 2} < K_{\max 2}$.

In the case when the farm keeps capital unchanged at K^* and receives support its gain is equal to area *D*. Farm uses capital K_3 to claim the support, where $K_3 = K_{\max 2}$. However, if farm increases its capital use by the size of the maximum eligibility threshold $K_{\max 2}$, the equilibrium shifts to (k^*, K_3^*). In this case farm gain is equal to area *B*. Because area *D* is larger than area *B*, the farm's optimal decision is not to increase capital. Hence, the equilibrium with and without the support is (k^*, K^*) and all the support (area *D*) benefits farm. The support does not create distortions in the capital market.

The intuition behind this result is that with perfect credit markets farms can exploit all profitable investment opportunities even without the support. Perfect credit markets allow farms to finance all investments desired. Providing investment support to farmers does not alter investment opportunities available to farms. Farms optimal behaviour is to use the same quantity of capital with and without the support. We show in the section sixth that this will change if farms are credit constrained.

The impact of farm EU investment support with heterogeneous farms and eligibility limits

In this section we extend the analyses by taking in consideration farm heterogeneity. The impact of the investment support may be affected by farm heterogeneity in the case when the eligibility limits are imposed. Under certain conditions, the eligibility limits may either deter small farms from uptaking the support or it may constraint big farms in uptaking the desired level of the support. Farm size varies significantly across EU. In old EU Member States farm size varies from small size to medium size while in the New Member States the farm size varies from subsistence farms (1-6 ha) to large farms (up to 1000 ha). In this context, depending on the size of eligibility limits, the impact farm investment support may differ strongly among EU Member States.

To analyse the effect of farm investment support with heterogeneous farms, we assume two representative farms, farm 1 and farm 2, respectively. We also assume that the minimum and the maximum size of the investment eligible for the support is $K_{\min}$ and $K_{\max}$, respectively. The effect is shown in Figure 9 where D_1 and D_2 represent capital demand of farm 1 and farm 2, respectively. D represents aggregate capital demand.[18] As before *S* represents capital supply. For simplicity we assume perfect elastic capital supply.[19] The equilibrium without the support is (k^*, K_{10}^*) and (k^*, K_{20}^*), for farm 1 and farm 2, respectively.[20] For the aggregate market, the equilibrium without the support is (k^*, K^*).

Hypothesis 6: *in the short-run, with support rate* α*, with perfect rural credit markets, and with heterogeneous farms, whether farms uptake support or not and whether farms benefit*

[18] The aggregate capital demand is obtained by horizontal aggregation of farm 1 and farm 2 capital demands.

[19] The effects with inelastic capital supply can be obtained analogously.

[20] In terms of capital use Farm 1 is smaller than Farm 2, $K_{10}^* < K_{20}^*$.

from the support on depend on the size of minimum/maximum eligibility threshold and on the enforcement of investment additionality.

We analyse the case when *investment additionality is fully enforced*.[21] The eligibility limits may affect farms differently depending to what extent farms are heterogeneous and on the size of the eligibility limits. The minimum eligibility threshold may deter some (small) farms (i.e. farm 1) from uptaking the support if it is set to high. On the other hand, the maximum threshold may constraint some (big) farms (i.e. farm 2) in uptaking the desired level of the support if it is set to low.

For example, consider the minimum eligibility threshold $K_{\min}$ such that $K_{\min} < K_{21}^{*} - K_{20}^{*}$ and $K_{\min} > K_{11}^{*} - K_{10}^{*}$ where K_{11}^{*} and K_{12}^{*} are farm 1 and farm 2 equilibrium capital use with the support but without the edibility limits, respectively (Hypothesis 1). Without the edibility limits the optimal support uptake of farm 1 is smaller than the optimal support uptake of farm 2, $K_{11}^{*} - K_{10}^{*} < K_{21}^{*} - K_{20}^{*}$.

The eligibility limit $K_{\min}$ does not affect farm 2 investment support uptake. With the investment support and with and without the eligibility limit, farm 2 equilibrium is (k^{*}, K_{21}^{*}). Farm 2 gains equal to area B_2 (Figure 9). However, the eligibility limit $K_{\min}$ has different impact on farm 1. The difference between farm 1 and farm 2 is that the marginal productivity of capital decreases faster with capital for farm 1 than for farm 2.[22] The optimal level of support which farm 1 would be willing to undertake is $K_{11}^{*} - K_{10}^{*}$ if the eligibility limit is not imposed. However, the minimum threshold is larger than $K_{11}^{*} - K_{10}^{*}$, $K_{\min} > K_{11}^{*} - K_{10}^{*}$. Farm 1 must invest minimum $K_{\min}$ in order to be eligible for the support. The effect of uptaking the support for capital $K_{\min}$ on farm 1 profits is given by area B_1 – area E_1. If the area B_1 is larger than the area E_1, farm 1 gains from the support. Otherwise farm 1 loses. In Figure 9 we assume that the area B_1 is smaller than the area E_1,[23] implying that farm 1 would lose from the support and thus will not apply for the support. The minimum threshold is set too high for farm 1 and makes the support uptake unprofitable. Hence, the farm 1 equilibrium with and without the support is (k^{*}, K_{10}^{*}).

Now we look at the impact of the support on the aggregate market. If reading Figure 9 from the left hand side to the right hand side, the aggregate capital demand shifts from $D\,D$ (which is the aggregate demand without the support) to $D\,D_s$ (which is the aggregate demand with the support). For aggregate capital use larger than K^{*}, the slope of the aggregate capital demand with the support is determined only by farm 2 capital demand. The equilibrium capital use of farm 1 will stay fixed at K_{10}^{*}. This is because farm 1 does not apply for investment support and it does not increase its capital beyond K_{10}^{*}. The aggregate market equilibrium shifts from

[21] Similar analysis can be conducted for the case when the *investment additionality is not enforced*.

[22] For well behaved production function this implies that farm 1 is smaller than farm 2.

[23] We acknowledge that visually this is not the case.

(k^*, K^*) to (k^*, K_s^*). The aggregate capital increases. The capital increase is equal to the farm 2 capital increase, $K_s^* - K^* = K_{21}^* - K_{20}^* = K_{2s}$.

The maximum eligibility threshold $K_{\max}$ affects farms investment uptake if it is set too low. For example, if $K_{\max} < K_{21}^* - K_{20}^*$ and $K_{\max} > K_{11}^* - K_{10}^*$, then the maximum eligibility threshold will constraint farm 2 in obtaining the desired level of support. The farm 2 optimal level of support uptake is $K_{21}^* - K_{20}^*$ but it can obtain support only for capital $K_{\max}$. Farm 1 is not affected by $K_{\max}$ (Figure 9).

Similar analysis can be conducted for the case when the *investment additionality is not enforced*. The minimum eligibility threshold may deter some (small) farms from uptaking the support while the maximum threshold may constraint some (big) farms in uptaking the desired level the support. For example, consider the minimum eligibility threshold $dK_{\min 1}$ in Figure 9 such that $K_{\min 1} > K_{11}^*$ and $dK_{\min 1} < K_{20}^*$. In this case farm 1 gains equal to area F_1B_1 – area E_1. If the area F_1B_1 is larger than the area E_1 farm 1 gains. However, if the reverse holds, farm 1 loses implying that the farm will choose not to uptake the support. In the former case the equilibrium with the support shifts to (k^*, K_{12}^*). In the latter case the farm will not uptake the investments and the equilibrium with and without the support is the same (k^*, K_{10}^*).

The impact of EU farm investment support with imperfect rural credit markets

With the presence of rural credit market imperfections, investment support can have an important impact on farm behaviour and hence on farm income. Access to rural credit is particularly the problem in new MS (e.g. Curtiss *et al.* 2007; Latruffe 2005; Petrick 2004; World Bank 2001). However, there is evidence that farms in developed economies are also credit constrained (e.g. Benjamin and Phimister 2002; Blancard *et al.* 2006; Färe, Grosskopf, and Lee 1990). [24] We follow the approach of Mishra, Moss and Erickson (2008) and Ciaian and Swinnen (2009) to introduce farm credit constraint in the model.

We analyze the impact of farm investment support with imperfect rural credit markets in the short-run. It is assumed that the maximum amount of credit that the farm can borrow (L_c) depends on farm characteristics (W) such as reputation and assets, i.e. $L_c = L_c(W)$. With credit constraint the loan equation (4) changes as follows:[25]

(10) $RK \leq L_c(W)$

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

[25] This modeling of credit constraint implies that farm total capital use is constrained. The size of the constraint depends on various factors such as the ability to obtain credit from a bank which depends on the size of collateral, own savings, the ability to obtain credit through informal markets, etc.

In the short-run with a credit constraint the decision-making problem of the farms is the maximization of the profit function $\Pi = pf(A,K) - rA - kK$, for a given land A, and subject to the credit constraint (10), as represented by the LaGrangean function:

(11) $\Psi = pf(A,K) - rA - kK - \lambda(RK - L_c)$

where λ is the shadow price of the credit constraint.

When the credit constraint is binding farms cannot use the unconstrained optimal level of capital and capital use is determined by $K = L_c(W)/R$. The farm optimal conditions with binding credit constraint ($\lambda > 0$) are given by:

(12) $pf_K - k - \lambda R = 0$

(13) $RK - L_c = 0$.

From equation (12) it follows that the farm marginal value product of capital is higher than the marginal cost of capital k: $pf_K > k$. By increasing capital use the farm could increase its profit but it cannot use more capital because of the credit constraint.

The effect is illustrated in Figure 10. We use the complete capital model as shown in Figure 1 but with added credit constraint. The farm credit unconstrained loan size is given by the curve $L^D\ L^D$ in quadrant II in Figure 10. With credit constraint the farm loan curve shifts to $L^D\ L_c^D$. Up to loan size L_c^* (and capital use K_c) farm is not credit constrained. At low levels of capital use the credit constraint is not binding, and the constrained loan curve $L^D\ L_c^D$ coincides with the unconstrained curve $L^D\ L^D$.[26] The L_c^* represents the maximum loan which farm can obtain which implies vertical farm loan curve L_c^D at L_c^* in quadrant II. The credit constraint implies that the farm demand of capital services shifts from $D\ D$ to $D\ D_c$ in quadrant I. This corresponds to a shift in the farm demand of capital goods from $D^K\ D^K$ to $D^K\ D_c^K$ in quadrant IV. The equilibrium without the credit constraint is (k^*, L^*, R^*, K^*). The equilibrium with the credit constraint shifts to (k_c^*, L_c^*, R_c^*, K_c^*). With credit constraint farms use less capital ($K_c^* < K^*$).

The impact of the farm investment support

When farms are granted investment support an important issue is how the support affects farm access to credit. One may expect an improvement of farm access to credits as the support reduces risk associated with the repayment of the loan. However, the size of the increase in the credit depends on various farm characteristics and market conditions. With the support the farm credit constraint changes as follows:

(14) $RK \le L_c(W) + \beta RK_s$

[26] The shape of the farm loan curve with the credit constraint $L^D\ L_c^D$ depends on the elasticity of farm demand of capital services.

where K_s is total supported investment, and β measures the extent to which the support affects farm access to credit. If $\beta = 1$ then farms access to credit increases by the value of the total supported investment. In the case $0 \le \beta \le 1$ farm's credit increases by less than the size of total supported investment.

Hypothesis 7: *in the short-run, with support rate α, and with imperfect rural credit markets, (i) farms will have incentive to increase capital stock even without the enforcement of additionally, (ii) farms may gain or lose, and (iii) total welfare may increase.*

Next we consider two cases: (i) when the farm access to credit increases by the size of the supported investment ($\beta = 1$) and (ii) when the access to credit increases by less than the size of the supported investment ($0 < \beta < 1$). We assume that total supported investment is K_s. Further we assume that $K_s = K_{\min} = K_{\max}$. We illustrate the effects in Figure 11. Again we focus only on the quadrant I of Figure 10. For simplicity we assume perfectly elastic capital supply.

Note, that with credit constraint farms have always incentive to increase capital use. This is because at the equilibrium with credit constraint (k_c^*, K_c^*), farms marginal willingness to pay for additional capital (k_1) is larger than the rental costs of capital, $k_1 > k^*$. This implies that it is profitable for farm to increase capital if access to credit increases. Moreover, the support marginally increases profitability by $\alpha i R_c^*$. With the support farm marginal benefit from the additional capital is equal to $k_1 - k^* + \alpha i R_c^*$. Hence farm has incentive to increase capital if the support improves farm access to credit. In the hypothesis 1 and 5 where it was assumed perfect credit market, it was shown that if the total investment support is not significant, farm's optimal decision was not to increase capital use. Farms increased capital only when the additionality was enforced. The intuition is that with perfect credit markets farms were able to exploit all profitable opportunities even without the support. With imperfect credit markets, unexploited profitable investment opportunities are available. Farms would like to use these opportunities but they cannot because of credit constraint. The support gives farms the possibility to invest in these investment opportunities. This will be the case only when the support alleviates farm access to credit.

First, we analyse the effect when the farm access to credit increases by the size of the supported investment ($\beta = 1$). We illustrate the case with the perfect elastic capital supply. The effect with imperfect elastic capital supply can be showed analogously. If the total investment support is equal to K_s and the farm access to credit increases by the same amount, the equilibrium in Figure 11 shifts to (k^*, K_{c2}^*). The farm gains from the investment support equal to area *BD* (Figure 11). Area *B* is productivity gain and area *D* is policy gain.[27] Now total welfare effect is positive and equals area *B*. Total welfare increases because the investment support solves the credit market imperfection and thereby increases farm productivity.

Second, we analyse the effect when the farm access to credit increases by less than the size of the supported investment ($0 < \beta < 1$). The effect is illustrated in Figure 12. If the total supported investment is equal to K_s, then the equilibrium shifts to (k^*, K_{c4}^*). Now the capital

[27] Note that with imperfectly elastic capital supply, capital suppliers will gain from the support and farms may lose or gain because of rental price of capital increases.

increases by less than the supported investment because we assumed that farm access to credit increases by less than the size of the supported investment, $K_{c4}^* - K_c^* < K_s$. $K_{c4}^* - K_c^*$ represents the size by which farm credit constrained is alleviated. The rest of the supported investment ($K_c^* - K_{c3}$) replaces the investment which the farm would make even without the support. The farm gains equal area *DB* (Figure 12). Area *B* is productivity gain and area *D* is policy gain. The total welfare increases by area *B*.

Note that if the support shifts the equilibrium to (k^*, K^*) then the farm credit constraint is effectively removed. The farm will increase capital beyond K^* only if the investment additionally is enforced or/and if farm can obtain support for the capital in excess of K^*. However, the capital increase beyond K^* would lead to welfare losses (see hypotheses 1-4).

The impact of EU farm investment support in the long-run

Up to now we analysed the short-run effects of the investment support. Farms were assumed to adjust only capital use as a response to introduction of the investment support. However, the indirect effect of the investment support is that farms adjust both inputs. Farms choose the quantity of capital and land that will maximize profits.

If the investment support increases farm capital then the marginal productivity of other inputs used in the production process increases. This in turn will increase capital marginal productivity which will stimulate farms to invest even more. In other words, the farm capital demand shifts upwards.

However, if the support does not increase capital use then the short-run and the long-run effects are the same. This is because the marginal productivity of other inputs are not affected if capital stays unchanged.

Hypothesis 8: *in the long-run farm gains from the investment support may be enhanced.*

The effect of investment support in the long-run is shown in Figure 13. We analyse the effect when the support is perfectly enforced implying that the support will lead to an increase in the capital use.[28] We assume that total supported investment is K_s.

In Figure 4 it was shown that in the short-run the farm capital demand is *D* and the equilibrium with the maximum eligibility threshold $K_{\max 1}$ is (k^*, K_3^*). In Figure 13 we also assume maximum eligibility threshold $K_{\max 1}$.[29] Then the short-run equilibrium with the support (k^*, K_3^*) in Figure 4 is equivalent to the short-run equilibrium with the support (k^*, K_3^*) in Figure 13, where $K_s = K_{\max 1}$. In equilibrium the farm capital increases by $K_3^* - K^* = K_s$.

In the long-run, the increase in capital use stimulates upward adjustment of other inputs. This in turn increases capital productivity and may stimulate farm to increase capital even more. In

[28] When the support is not enforced, the effect can be derived analogously.

[29] This implies that $K_{\min} < K_{\max 1}$.

terms of Figure 13, farm capital demand shifts up, from D to D_L. Capital productivity increases, by π.[30] In Figure 13 farm gains in the long-run equal to area *FB* plus area *E*.[31] The area *FB* is policy gain and the area *E* is productivity gain.[32] This implies that farm profits in the long-run (given by *FB* + area *E*) are higher relative to farm profits in the short-run (given by area *B*). Total welfare changes by area *E* – area *A*.

Conclusions

This paper analyses income distribution effects of investment support granted under the EU RDP. We have analysed how implementation details of the support (the size of allocated funds, enforcement of additionality, eligibility limits) affect income distribution effect of farm investment support. With certain implementation of the support farms may gain part or even all of the support (when the additionality is not enforced and the total support is relatively small), while under different conditions farmers may loose (with perfect enforcement of the additionally and with significant increase in capital price). Further, the implementation details interact with market conditions (farm heterogeneity, farm access to credit, short-run versus long-run effects) and also determine the income distribution effects of the investment support.

In the short-run and with perfect credit markets, the size of farm policy gains depend on the extent to which investment additionality is enforced and on the eligibility limits. If additionality is not enforced and when the size of the support is not significant then farms gain all investment support but do not increase capital use. This is because farms are able to exploit all profitable investment opportunities even without the support and perfect credit markets allow them to finance all the desired investments. However, if the size of total support is sufficiently high, the support leads to increase in farm capital use and causes welfare losses.

If the investment additionality is enforced, farm gains from the investment support are reduced. Moreover the total welfare decreases. This is because farms are forced to undertake socially unprofitable investments. With perfect credit markets farms can exploit all profitable investments even without the support. Farmers increase capital use because it is enforced. The size of capital increase depends on various factors but particularly on the capital supply elasticity and on the size of the support.

Eligibility restrictions may have an important impact on the uptake of the investment support among farms and hence on the distribution of policy benefits. Introducing a high minimum threshold as eligibility criteria may deter small farms from uptaking the support even if the

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[30] Note that for simplicity we assume a parallel shift (by π) of the farm capital demand in Figure 13. In reality this may not be the case.

[31] Note that these changes incorporate adjustments in other input use and that the profit changes in Figure 13 are an accurate representation of farm profit change induced by the support (see Just, Hueth, and Schmitz 2004).

[32] In the long-run even in the case of no enforcement of additionality farms may have incentive to increase capital relative to the situation without the support. This will be the case when the gain from increasing capital use by the supported investment *dK* (equal to area *FB* plus area *E* in Figure 13) is larger than the gain from replacing capital by *dK* (equal to $\alpha k^* dK$, where $\alpha k^* dK$ is equal to area *AFB* in Figure 13).

investment additionally is not enforced. The maximum eligibility threshold may restrict big farms to take desired level of support.

With imperfect rural credit markets, farms will choose to increase capital use even without the enforcement of the investment additionality. This is because with constrained rural credit markets, there are still available unexploited profitable investment opportunities. At the same time, total welfare may increases as the support solves credit market imperfections and thereby increases farm productivity. However, both these effects are conditional on the support to alleviate farm access to credit.

In the long-run perspective farm benefits from the investment support may be enhanced. This is induced by the indirect effect of support on the productivity of other inputs. If the investment support increases capital use, then the marginal productivity of other inputs used in the production increases. This in turn increases capital productivity which may lead to higher farm benefits from the investment support.

Gains from the investment support are shared with capital suppliers. The capital suppliers' gains depend on the size of the capital supply elasticity. Gains decrease with the capital supply elasticity. For a certain value of capital supply elasticity, all the policy support may be shifted to capital suppliers through the higher price of capital. Moreover, in the case of full enforcement of investment additionality if the capital supply elasticity is sufficiently low, farms may loose and the capital suppliers may gain disproportionally more than the size of the support. This is because with perfect enforcement of the investment additionality, the policy support may increase capital price at the margins but farms are not fully compensated for the induced higher capital costs. However, the capital suppliers' gains from the support are conditional on the support to increase farm capital demand and capital prices.

Tables and figures

Table 1. Summary of selected models used for analyzing impact of RDP

Name of model/ Author	Type of model	Regional implementation	Rural policies analyzed / modelled	Impact indicator(s)	Modelling of RDP measures
Bollman (1999)	Econometric, single equation	Community level data from the 1981 and 1991 Censuses of Population (Canada)	Human capital (average years of schooling; and percentage of individuals with schooling)	- Growth in labour earnings - Growth in employment	The size and statistical significance of estimated coefficients corresponding to human capital proxies represent the size of the impact of human capital on labour markets.
Balamou and Psaltopoulos (2006)	Regional Social Accounting Matrices	Three regions in Greece (rural municipalities Archanes and N. Kazantzakis and the urban centre of Heraklion)	Decrease of farm income support by 20% and shift to Pillar 2 in the Archanes region.	Output, income and employment	The extra payments spent on Pillar 2 in Archanes were assumed to exogenously increase output demand of construction sector in the Archanes economy.
Psaltopoulos and Balamou (2006)	Regional Social Accounting Matrices	Greece and one local economy of Archanes (NUTS5)	Various CAP scenarios: pillar 1 and pillar 2 measures combined.	Various indicators: e.g. output, employment, land use, pollution emissions, etc.	Pillar II support was assumed to increase capital in the case of investment measures or to increase agricultural subsidies in the case of agri-environmental measures. Their sectoral distribution was based on the 2000-06 area allocation.
REMI-IRPET model/ Felici et al. (2008)	Regional economic model	Tuscany region disaggregated at province level.	- Setting up of young farmers - Early retirement - Modernisation of agricultural holdings - Adding value to agricultural and forestry products - Diversification	Employment, value added, regional GDP, output, trade	- *Setting up of young farmers* and *early retirement* measures were assumed to increase retirement pensions (i.e. they increase incentives to retire) - Measures *modernisation*, *adding value* and *diversification* were assumed to reduce capital cost in agricultural, food processing, and agrotourism, respectively.
POMMARD model/ Bergmann and Thomson (2008)	Regional input-output supply model containing 11 modules.	Two rural areas from Northern Scotland: Caithness and Sutherland	Three scenarios: 1) all current Pillar 2 expenditure switched into Axis 1; 2) all current Pillar 2 expenditure switched into Axis 2; 3) growth of tourist industry.	Various variables: agricultural, non-agricultural, life quality, environmental, etc..	n.a.
Vollet (1998)	Economic base model (econometric)	Five rural regions in France	Diversification (residential and recreational functions of rural areas).	Employment: impact of recreational and residential functions on employment	The size and statistical significance of estimated coefficients corresponding to the relevant variables.
Cretegny (2002)	General equilibrium model (includes public good which enters individual utility functions)	Country level (Swisherland)	Multifunctionality	Household welfare	- Multifunctionality is modelled very generic. It is represented as joint production of a public goods and agricultural private goods, i.e. public goods are a function of direct payments and agricultural production. - Direct payments are assumed to remunerate production of public goods and create incentive for their provision.

Table 1. Continued

Name of model/ Author	Type of model	Regional implementation	Rural policies analyzed / modelled	Impact indicator(s)	Modelling of RDP measures
SCENAR 2020	Economic models (LEITAP, ESIM, CAPRI); biophysical IMAGE model; and land use allocation model (CLUE-s).	EU-25 and World regions	Three scenarios: - *baseline*: new financial perspective - *Regionalisation scenario*: increase in RDP funding. - *Liberalisation scenario*: decrease in funding of all RDP axes.	- Various variables: agricultural output, land use, employment, agricultural income, etc. - Long-run developments in rural economies.	n.a.
EURURALIS/ Verburg et al. (2008)	Spatial model: Combination of general equilibrium GTAP model; biophysical IMAGE model; and land use allocation model (CLUE-s).	EU-25 and World regions at different scale resolution (From global to the local, landscape level).	LFA, Nature conservation	Land use	n.a.
Oglethorpe and Sanderson (1999)	Farm level partial equilibrium model combined with ecological model.	Farm level case study from North-East of England	Agri-environment: farm management practices (in terms of stocking density, fertilizer use, etc.) related to grassland use	Impact of farm management practices on grassland value (in terms of diversity and abundance of various grass species) and farm income.	Scenarios with alternative management practices are simulated. The specific management practices are introduced in the model for example by restricting the stocking density, restricting fertilizers use, etc. Then the effect on diversity and abundance of various grass species and farm income is analysed.
PASMA/ Schmid and Sinabell (2004)	Mathematical Programming model	Farm level profit maximization at Regional level in Austria	LFA and agri-environmental measures.	Various indicators: viability of rural areas; output, land use, organic farming, etc.	n.a.
FARMIS/ Schader et al 2008.	Mathematical Programming model	Regional, farm group level for Germany	Agri-environment: organic payments, extensification payments	Various variables: income, input use, energy use, environmental indicators	The payments affect profitability and uptake level of measures. Transaction costs of policies are also taken in consideration.
Haile and Slangen (2007)	Contingent Valuation Method (Based on household Survey)	Local area of Winterswijk (the Netherlands)	Agri-environmental measures: cultural value of landscapes.	- Willingness to pay (WTP) for cultural value of landscapes - Factors affecting the WTP for cultural value of landscapes	- Econometric estimation of households WTP (in Euro) for landscape value. - The statistical significance of the estimated coefficients determines which factors affect WTP.
SEAMLESS/ van Ittersum et al. (2008)	Integrated assessment and modelling (IAM). Combines various models: e.g. APES (biophysical model), FSSIM (farm mathematical programming model), SEAMCAP (agricultural partial equilibrium model).	Provides a framework for impact analyses at EU level, MS, NUTS2, and field-farm level. Some resolution levels (especially farm level) are conditional on data availability.	Designed to access the impact of agricultural and agri-environmental policies. In the study van Ittersum et al. (2008) the model was tested with liberalization scenario.	Various environmental, economic and social indicators.	n.a.

Figure 1. Capital market

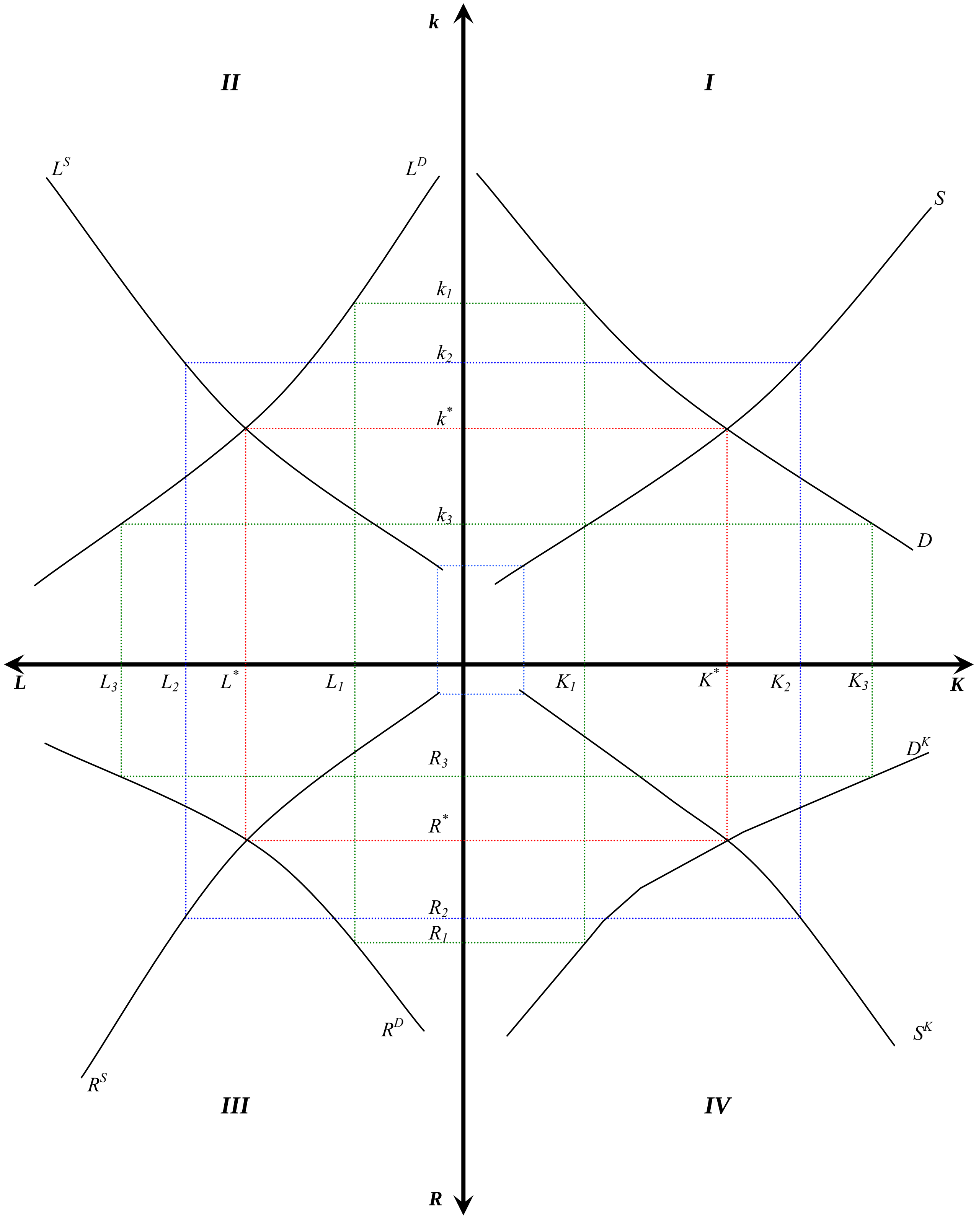


Figure 2. Income effect of farm investment support with perfect enforcement of additionality and no eligibility limits

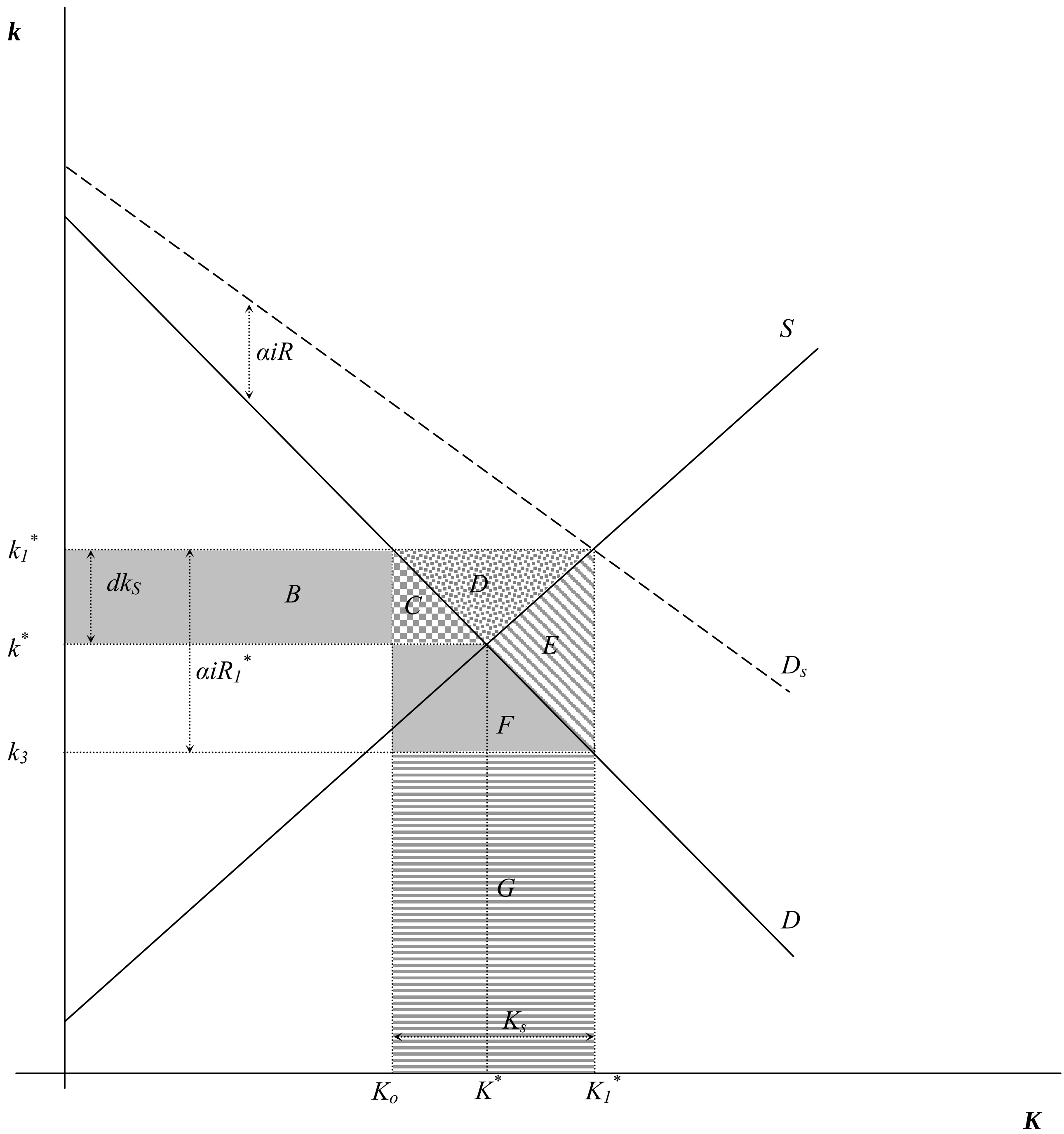


Figure 3. Income effect of farm investment support with perfect enforcement of additionality and perfect elastic capital supply

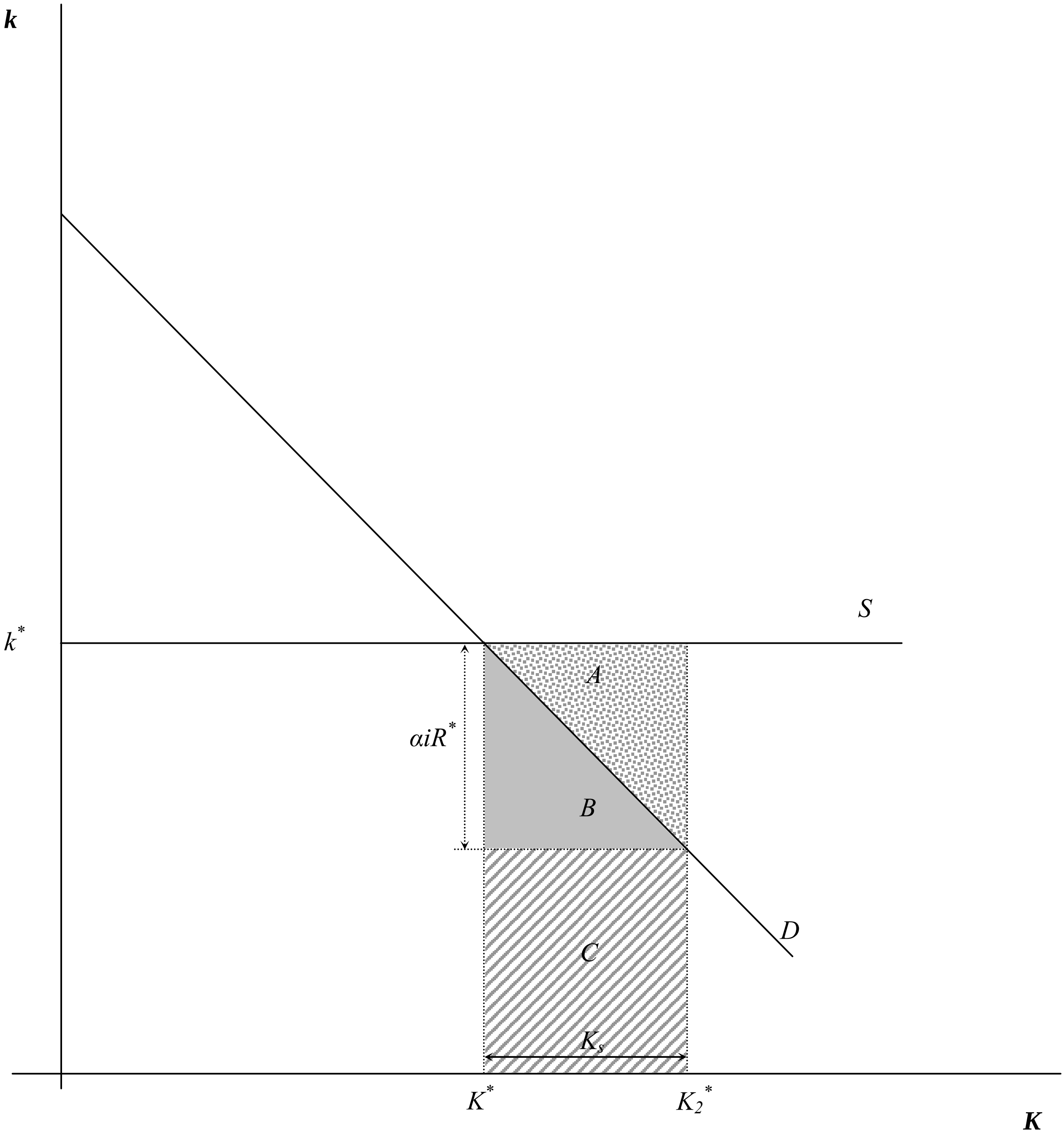


Figure 4. Income effect of farm investment support with perfect enforcement of additionality and eligibility limits

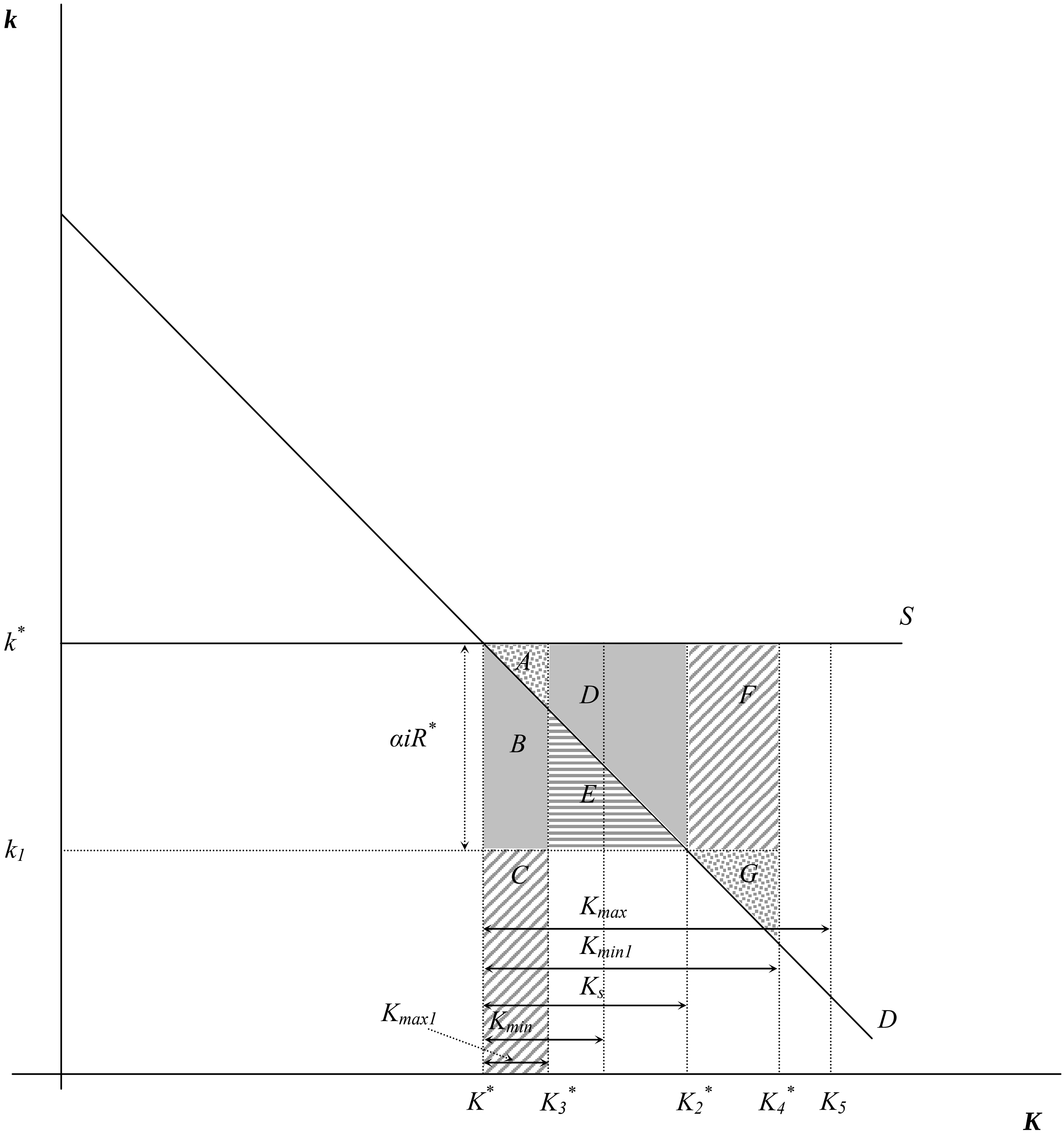


Figure 5. Income effect of farm investment support with imperfect enforcement of additionality and no eligibility limits

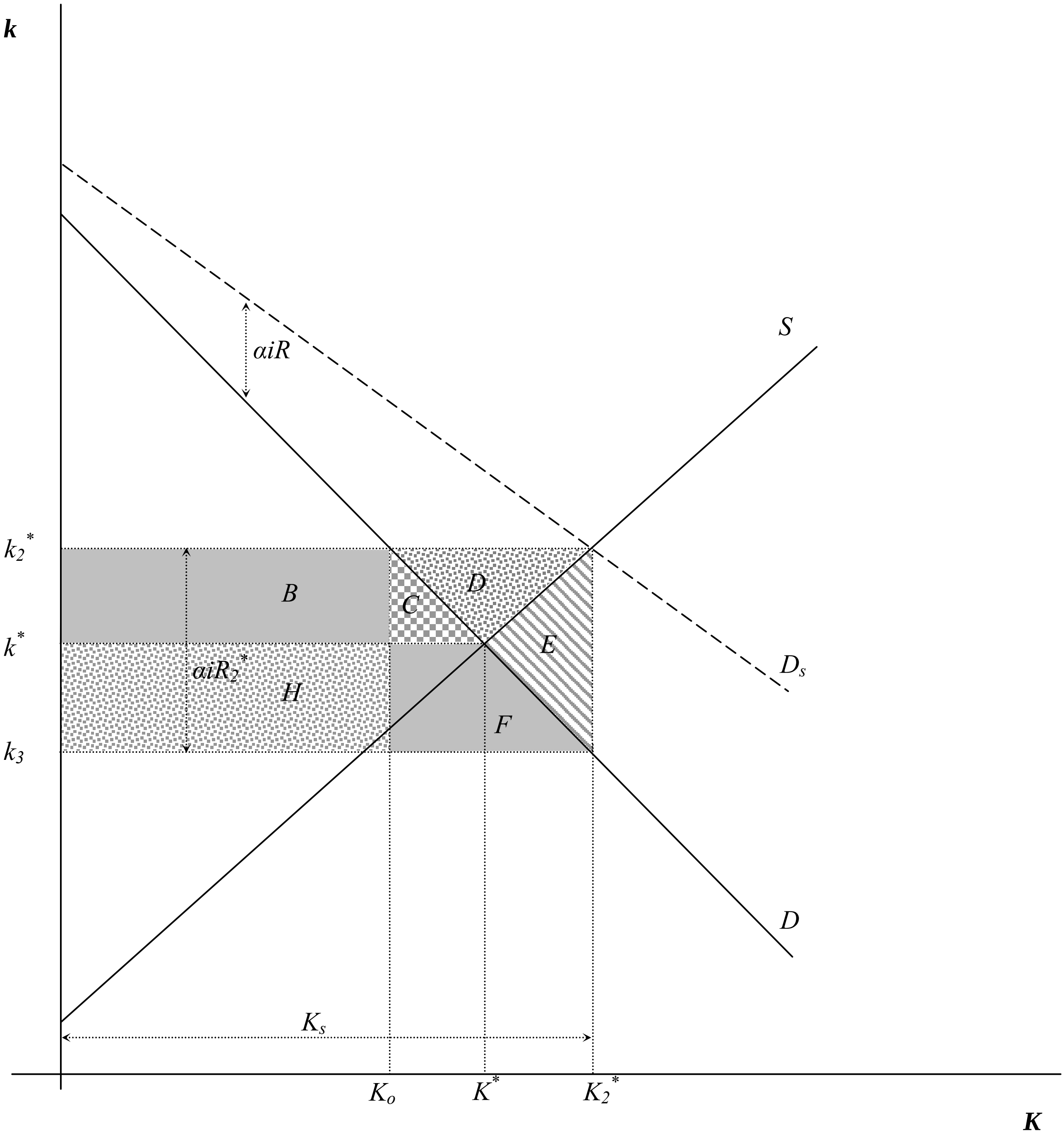


Figure 6. Income effect of farm investment support with imperfect enforcement of additionality, perfect elastic capital supply and no eligibility limits

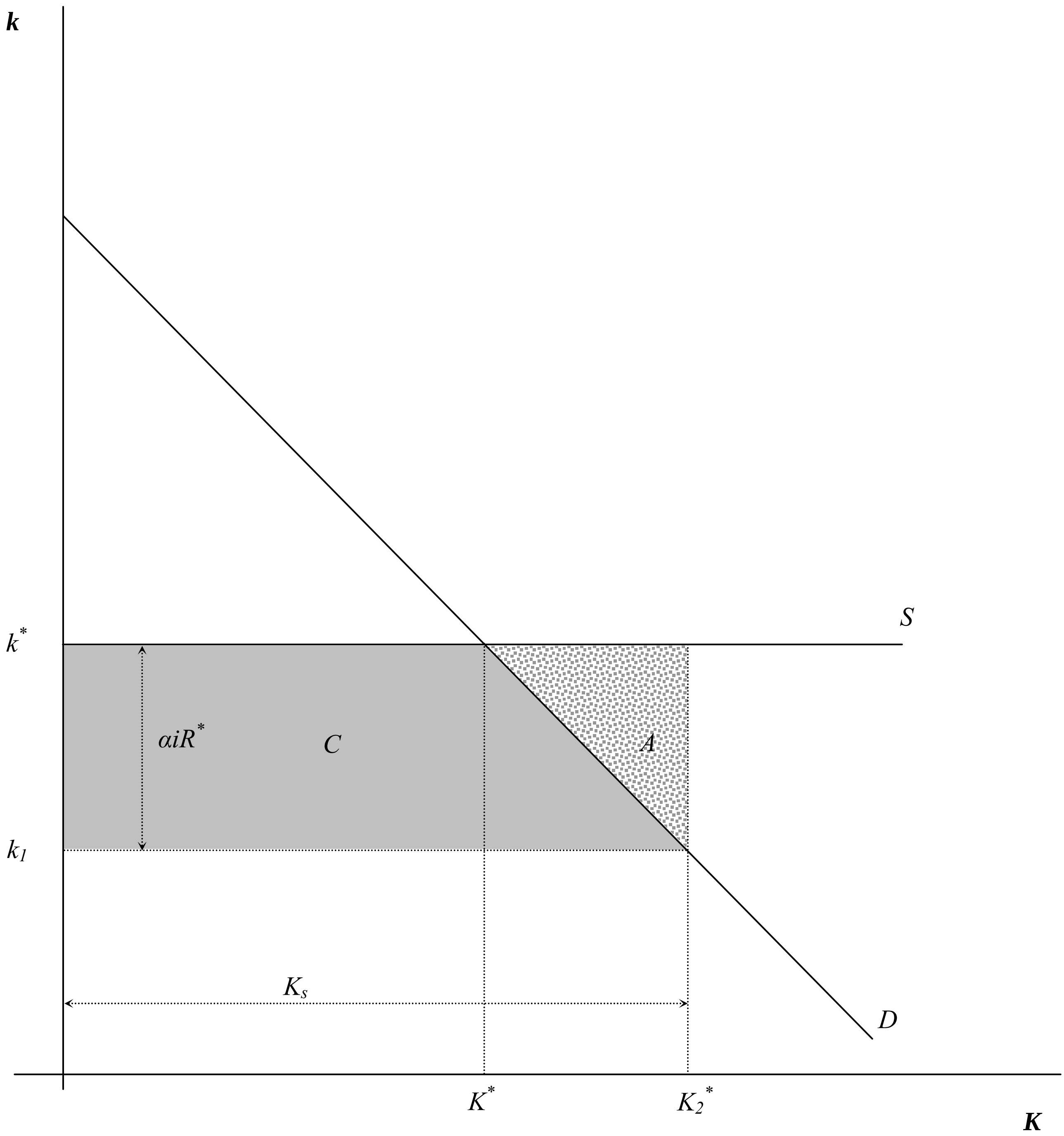


Figure 7. Income effect of farm investment support with imperfect enforcement of additionality and eligibility limits

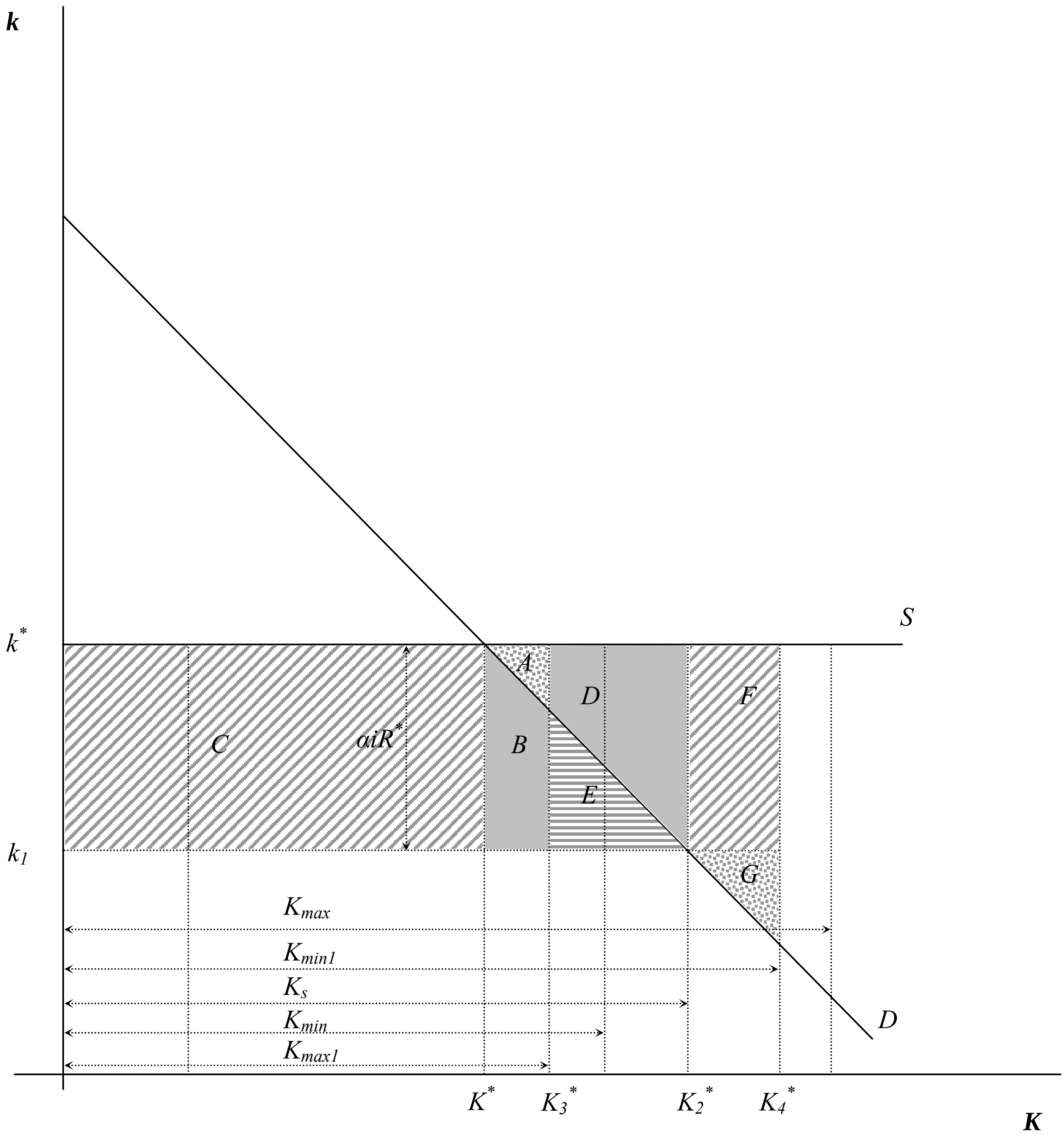


Figure 8. Income effect of farm investment support with imperfect enforcement of additionality

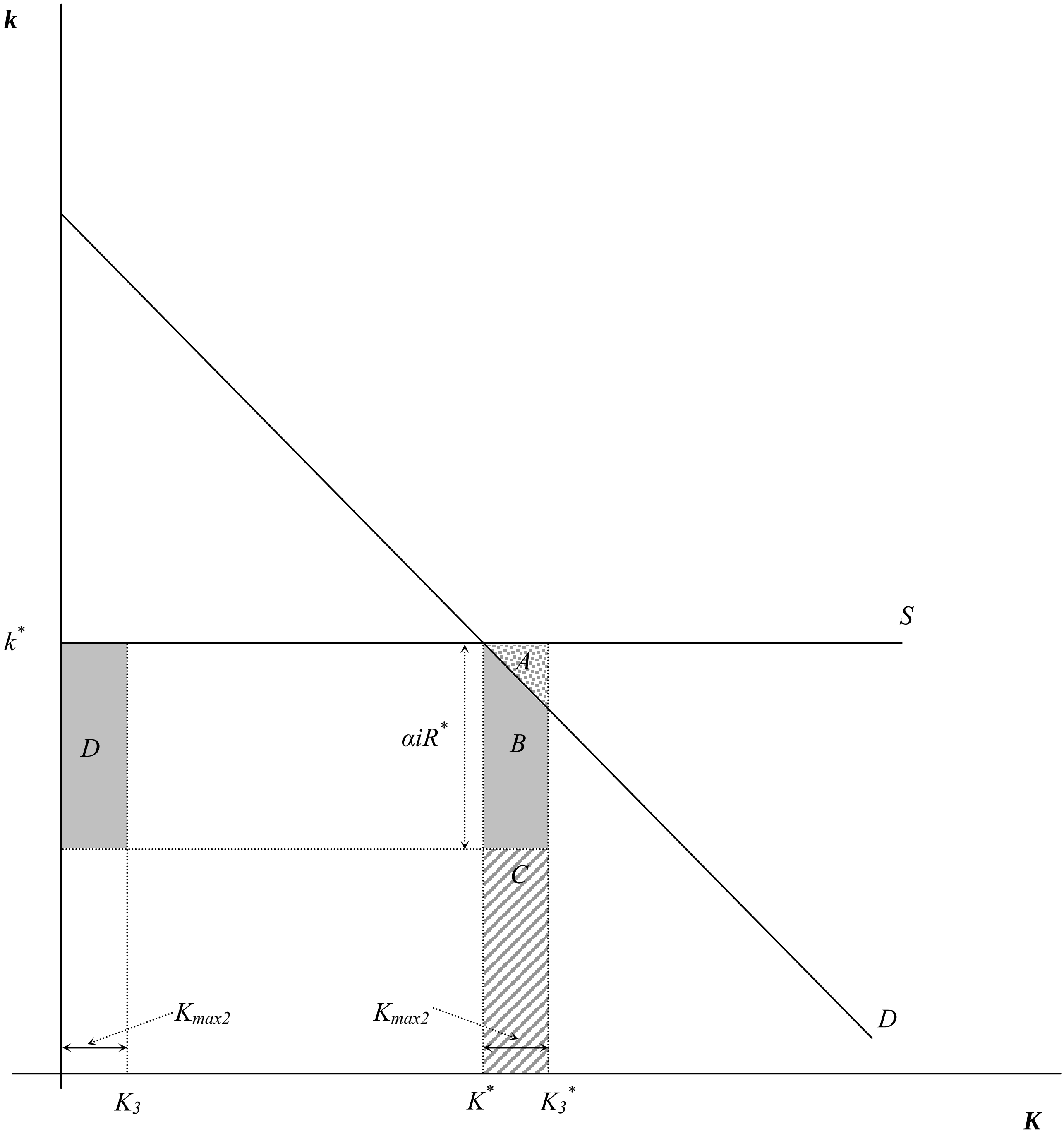


Figure 9. Income effect of farm investment support with heterogeneous farms

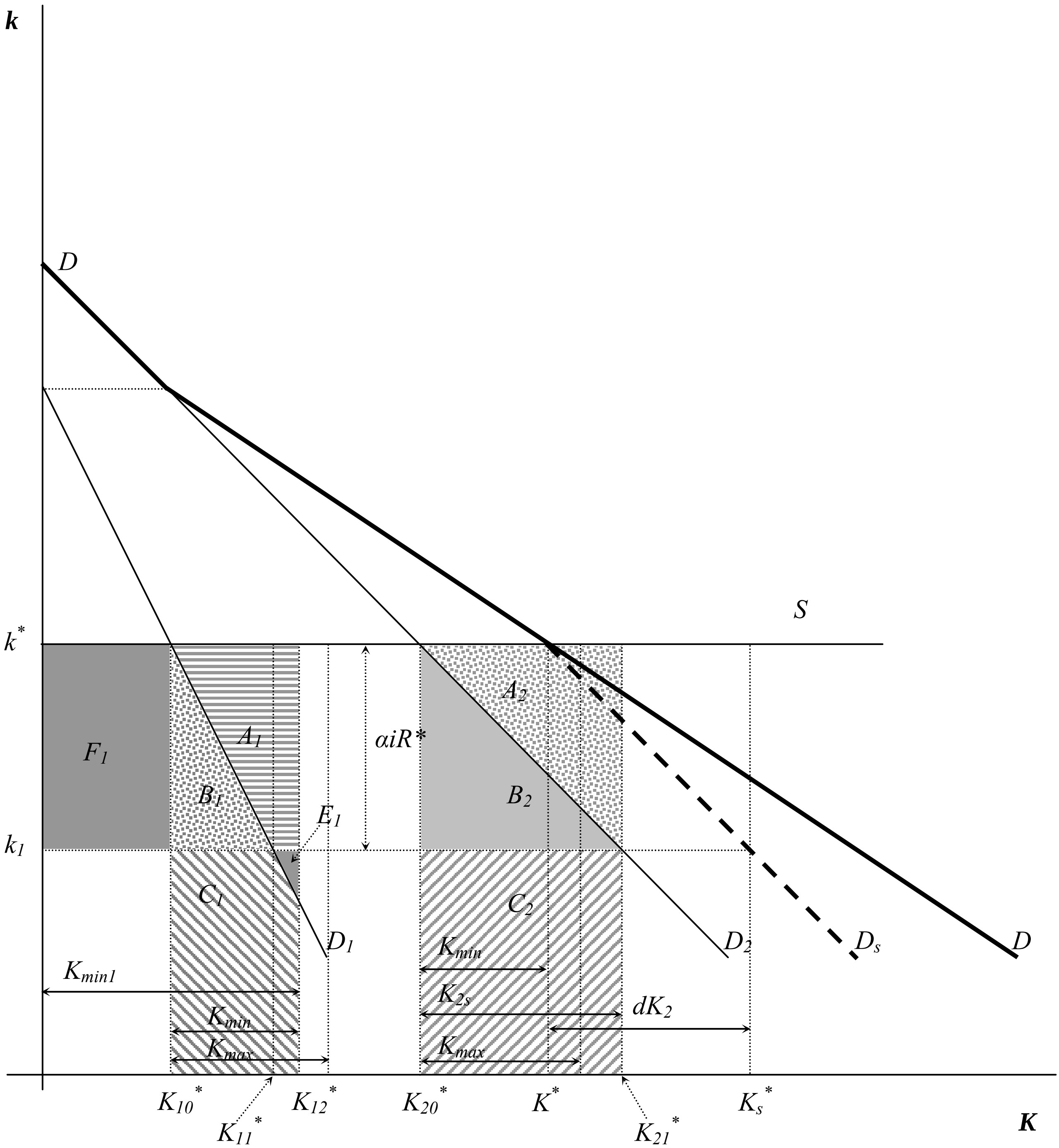


Figure 10. Capital market with credit constraints

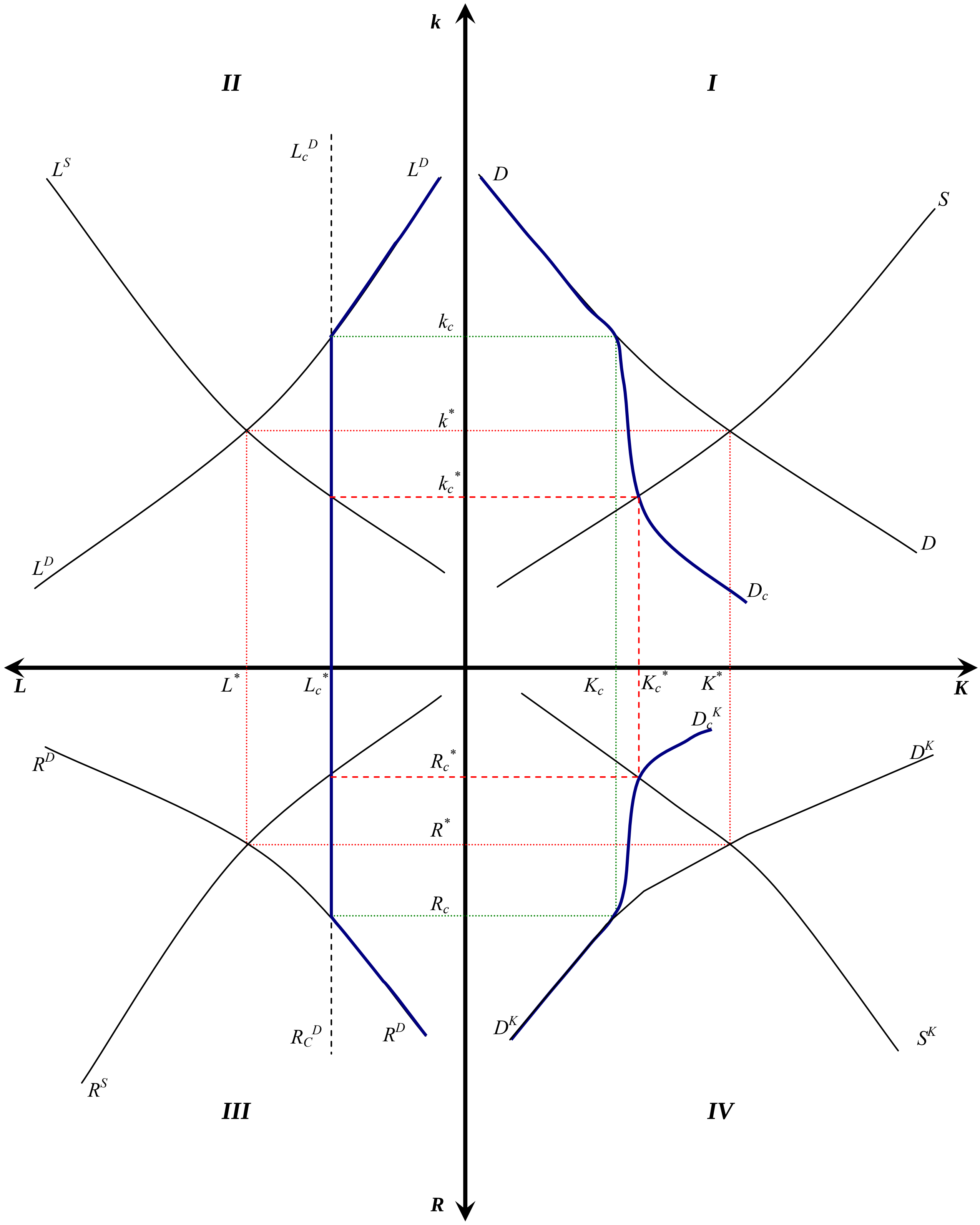


Figure 11. Income effect of farm investment support with farm credit constraint and perfect elastic capital supply when farm access to credit increases by the size of the support

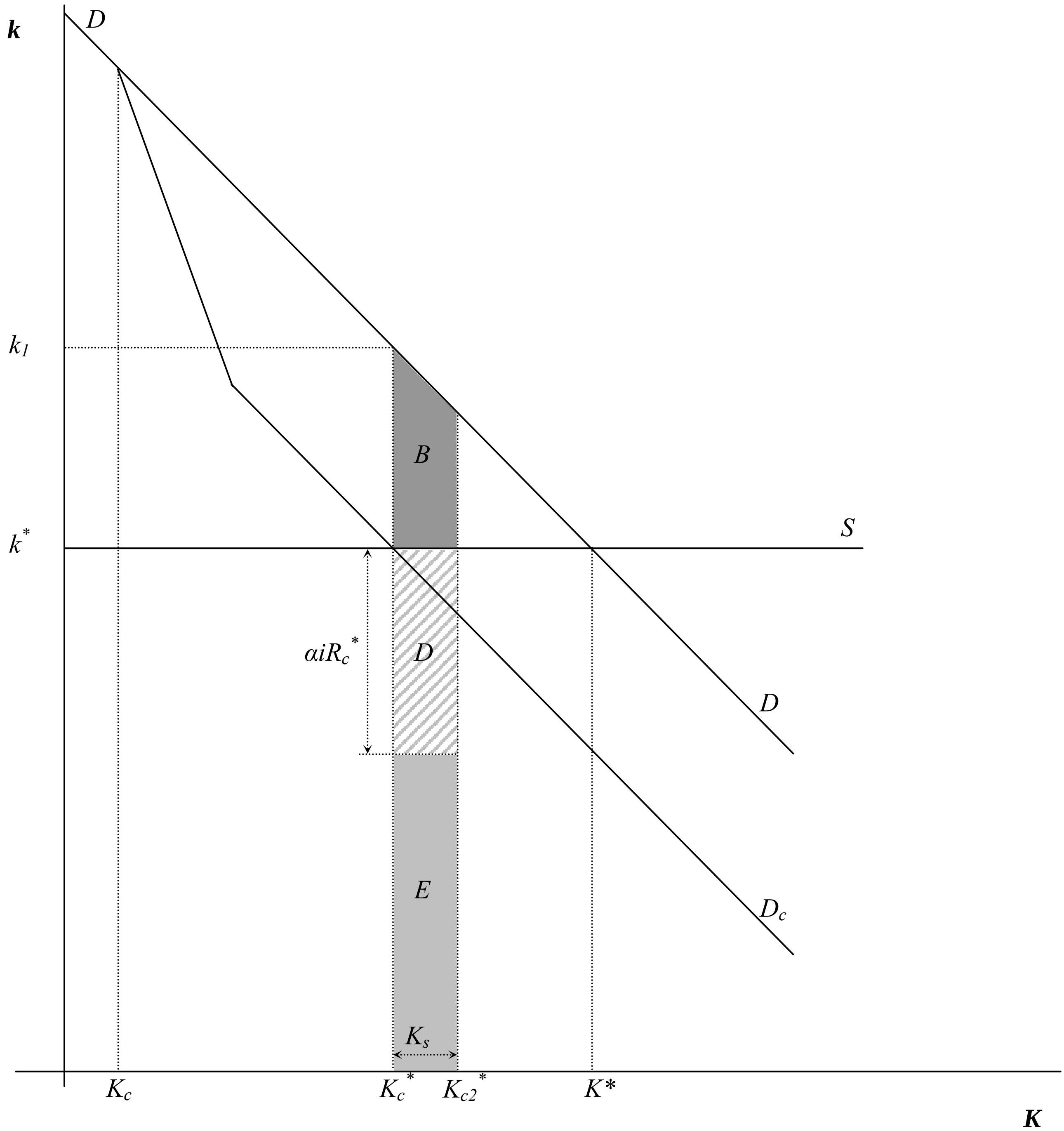


Figure 12. Income effect of farm investment support with farm credit constraint and perfect elastic capital supply when farm access to credit increases by less than the size of the support

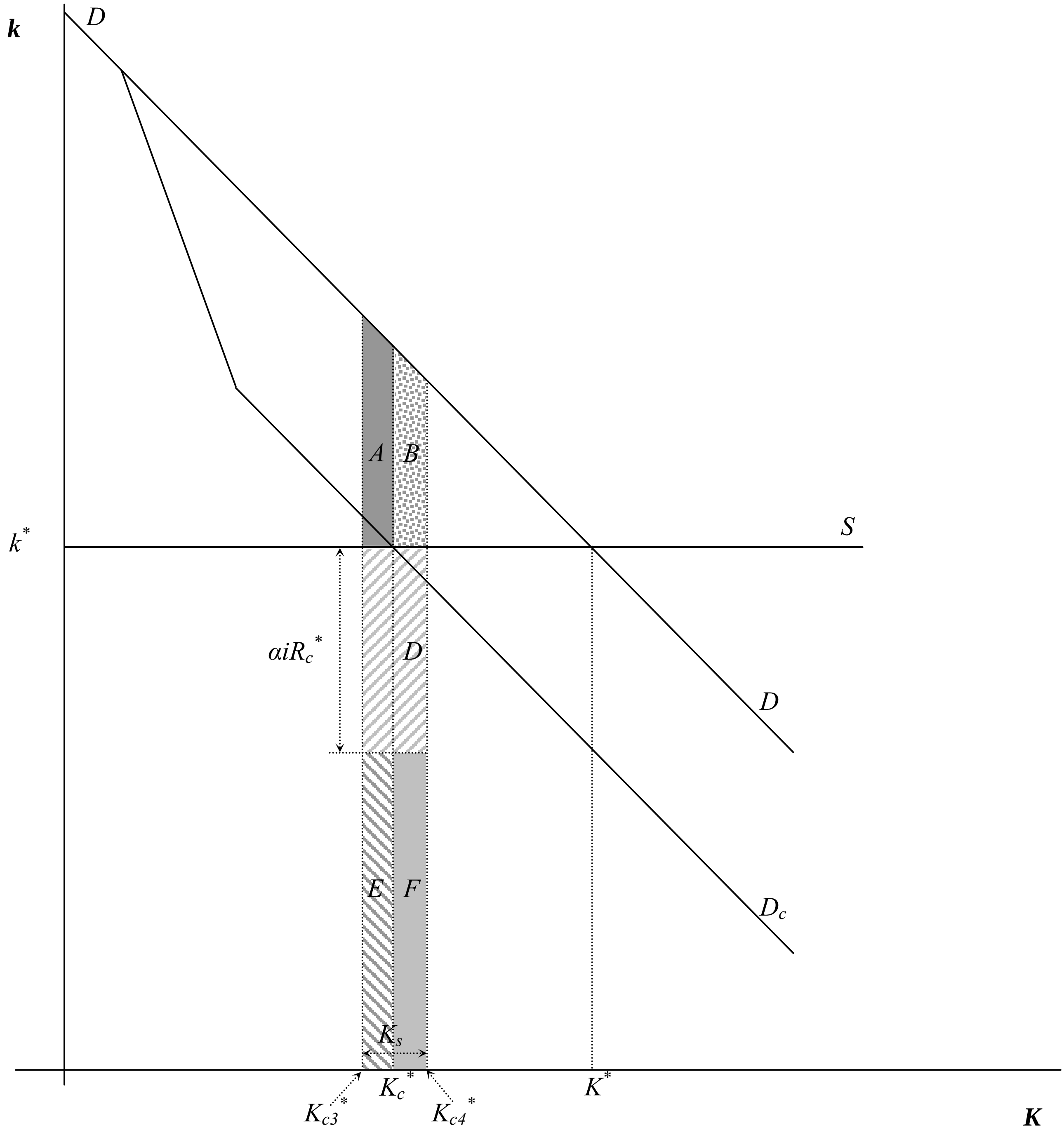
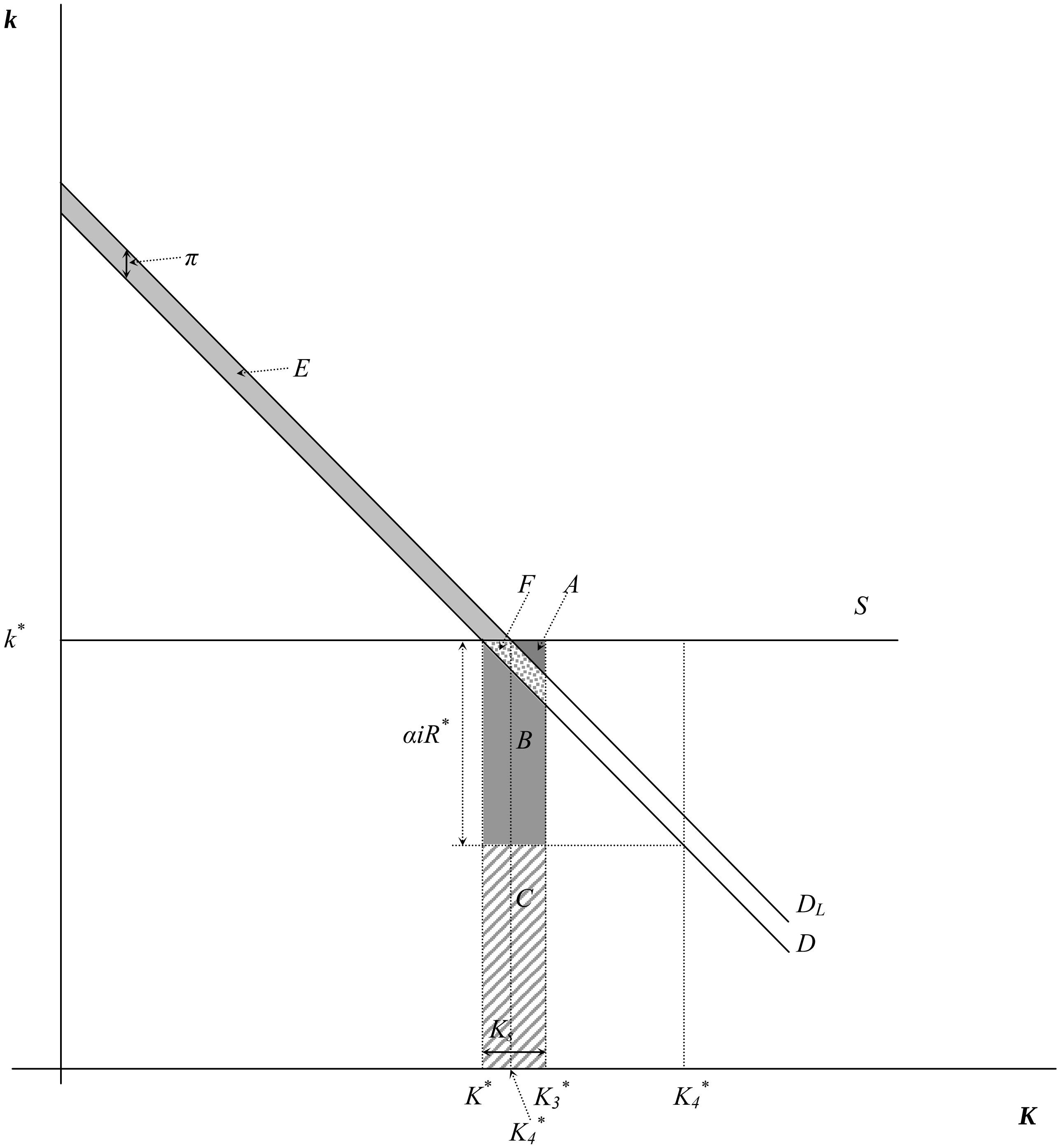


Figure 13. Income effect of farm investment support in the long-run



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