How and to what extent support to agriculture affect farmland markets and prices: a literature review

Laure Latruffe, Chantal Le Mouel

JADE#34145

How and to what extent support to agriculture affect farmland markets and prices: A literature review

Laure Latruffe and Chantal Le Mouël

INRA-ESR, 4 allée A. Bobierre, CS 61 103, 35 011 Rennes cedex, France[1]*

Report for the OECD, Directorate for Food, Agriculture and Fisheries

27 March 2006

---

[1] Laure.Latruffe@rennes.inra.fr ; Chantal.LeMouel@rennes.inra.fr

We thank Christine Valade for very helpful assistance on documentation.

1. Introduction

A central purpose of agricultural policies in OECD countries is to support farmers' income. Whether agricultural support actually benefits farmers however is an open question. Agricultural support policies raise farmers' gross income and then contribute to increase returns to resources that individual farmers use. As a consequence agricultural support policies contribute to increase the market prices of these resources and ultimately benefit the owners of these resources. Hence, whether agricultural support benefits farmers closely depends on whether farmers own the resources they use in production.

Among agricultural primary factors of production (land, family labour and capital), land has been paid higher attention regarding this issue for at least two reasons. First of all in a lot of OECD countries, a substantial share of farmland is rented, sometimes from other farmers but also commonly from non-farmer landlords. Secondly in all OECD countries an increasing number of government payments are tied to farmland. Hence the question of the extent to which agricultural subsidies do translate into higher land values and rents and finally benefit landowners is a critical issue.

Concern over the capture of agricultural policy benefits by the landowners is not new. And the question of the capitalisation of support into farmland values and rents has a long tradition in Agricultural Economics. The objective of this report is to provide an overview of existing literature on that subject.

This overview is organised along two lines. The first section reviews the main insights that can be drawn from the theory about how agricultural support may affect farmland values and rents and what are the key assumptions and parameters regarding this issue. The second section reviews empirical evidence about the extent to which agricultural support affects farmland values and rents.

2. Agricultural support does affect farmland markets and prices: Insights from the theory

By which mechanisms agricultural support does affect farmland markets and prices? What are the main assumptions and parameters that play a key role as regards the extent of the impact of agricultural support on farmland markets and prices? Who finally benefit from agricultural support?

This section synthesises the main insights that can be drawn from the theory regarding these 3 questions. The relationships between agricultural support and farmland rental markets and prices (i.e., when farmland is considered as a production factor) are investigated first. Then, we focus on the relationships between agricultural support and farmland sale markets and prices (i.e., when farmland is considered as an asset).

In each case, we point out the main mechanisms that underlie the impact of agricultural support on farmland markets and prices. For that purpose, relying on existing theoretical literature, we propose very simple analytical frameworks that are designed to illustrate these mechanisms. This first step allows to detect the key assumptions and parameters regarding the extent of the impact of agricultural support on farmland markets and prices. Then these key assumptions and parameters are discussed. Finally, implications on the relevance of aggregate models (such as the PEM model developed by the OECD) for assessing the impact of various agricultural policy reforms are derived.

Examining the impact of all kinds of policy instruments on farmland markets and prices would be too long and out of the scope of this study. Hence we concentrate on two types of policy instruments: output price support and land subsidy. These both instruments have been selected because they reflect the evolution of agricultural policies in OECD countries over the last decade where output price support has been progressively replaced by direct payments linked to production factors, especially land.

2.1. Farmers' production decisions, agricultural support and the rental price of land

The main insights that can be drawn from theory on the effects of output price support on farmland rental markets and prices are first reviewed. Then, we focus on what we do know from the theory about the effects of factor (especially land) subsidies.

In both cases, using very simple frameworks, the main mechanisms that underlie the effects of policy instruments are described by the mean of a graphical analysis, while corresponding analytical results are reported in appendix. This first step allows to point out the key assumptions and parameters as regards the extent of the effects of policy instruments on farmland markets and prices.

Then, the sub-section follows with a discussion on these assumptions and parameters and ends with some modelling issue considerations.

2.1.1. Output price support and farmland rental markets and prices

One paper extensively cited in the existing literature is Floyd (1965). This seminal paper shows, using a rather simple analytical model, that: i) output price support affects the prices of production factors[2]; ii) the extent of the impact of output price support on factor prices closely depends on the elasticities of supply of factors (that is the extent of factor mobility within the economy) and on agricultural production technology (that is, specifically, the extent of factor substitution possibilities); iii) output control programmes (through production quota or acreage restriction) modify the effect of output price support on factor prices either by creating a new fixed production factor (production rights) in the case of the quota or by changing the opportunity cost of land in the case of acreage restriction.

[2] In this report the term production factors refer to land, family labour and capital while the term inputs designate all other (variable) inputs such as hired labour, energy, fertiliser, pesticides, etc.

A number of papers have re-examined in alternative ways Floyd's results or extended them by relaxing restrictive hypotheses of Floyd's model and/or including various alternative policy instruments in order to compare their respective effects (e.g., Gardner, 1987; Hertel, 1989; 1991; Leathers, 1992; Dewbre et al., 2001; Dewbre and Short, 2002; OECD, 2002a; Guyomard et al., 2004). Usually however, although analytical results are much more complicated and effects of policy instruments more difficult to disentangle, interpret and sign, main insights from Floyd's model do remain.

The one output-one factor case: Illustrating the key role of factor supply elasticity

Let's consider a representative farmer using one factor (which may be land) in quantity l to produce an aggregate agricultural output in quantity y, according to a given production technology ($y = f(l)$). Figure 1 below depicts the domestic output and factor markets in the considered country. On the output market, $D_y(p_y)$ is the domestic demand while $S_y(p_y, p_l^0)$ is the initial domestic supply. Both the domestic demand and supply depend on the domestic output price p_y. The initial output supply also depends on the initial equilibrium price of the factor p_l^0. Let's assume that the considered country is a small country for the output y. Hence, at initial equilibrium domestic output price is p_y^0 corresponding to the exogenous world price. The representative farmer produces quantity y^0, which is partly consumed domestically and partly exported. On the factor market, $D_l(p_l, p_y^0)$ is the initial domestic derived demand, as a function of the factor price and the initial output price, while $S_l(p_l)$ is the domestic factor supply. On panel 1.b this factor supply is assumed to be perfectly inelastic in quantity l^0 (l is a specific factor to agriculture), while in panel 1.c it is assumed as perfectly elastic at price p_l^0. Let's assume that the factor is not traded. Hence, in both cases, at initial equilibrium domestic demand equals domestic supply at price p_l^0 and quantity l^0.

Let's imagine that the government decides to support the farmer's income through output price support. Hence the output price increases to p_y^1.[3] In a first step, this output price increase is an incentive for the farmer to produce more. Other things being equal, the farmer would seek to produce

[3] This output price support may be provided through a fixed support price or a fixed (ad-valorem or specific) output subsidy. Such alternative instruments would have different impacts for domestic consumers and in terms of net welfare loss for the considered country but not for the representative farmer, nor on the factor market. As we are only interested in the farmer's situation in conjunction with the impact of output price support on the factor markets, we do not specify which type of instrument is used.

y^1. However, such an output supply increase would require to use more factor. This factor adjustment requirement is depicted through the shift in the derived curve from $D_l(p_l, p_y^0)$ to $D_l(p_l, p_y^1)$ on the factor market. At this stage one guesses the key role of the factor supply elasticity:

- In panel 1.b, as the factor supply is perfectly inelastic (i.e., there is no additional quantity of factor available), this factor demand increase translates into a factor price increase from p_l^0 to p_l^1. This factor price increase makes the output more costly to produce. The resulting increase in the marginal cost of y is depicted on panel 1.a through the shift of the output supply curve from $S_y(p_y, p_l^0)$ to $S_y(p_y, p_l^1)$. Finally, figure 1 shows that following the induced price adjustment on the factor market, the final equilibrium output quantity is unchanged in y^0.
- In panel 1.c, as the factor supply is perfectly elastic (i.e., at price p_l^0 there is no restriction on available quantity of the factor), the factor demand increase does not affect the factor price, which remains at p_l^0 level. Hence, marginal cost of y is unchanged. Factor demand and output supply increase simultaneously, to y^1 and l^1 respectively.

Finally, figure 1 shows that the effects of output price support on both the output and the factor markets are quite different according to the level of the factor supply elasticity. One may synthesised the main findings as follows.

When the factor supply elasticity is low (the extreme case being zero, as illustrated by panel 1.b):

- The increase in the price of the output is totally translated into an increase in the price of the factor (as shown in appendix, the percentage change in the factor price equals the percentage change in the output price).
- As the factor becomes more expensive, price support indirectly increases the production cost of the output.
- The farmer's surplus is unchanged since the totality of support provided through the output price is transferred to the owner of the factor.
- If the owner of the factor is the farmer, then the price support policy actually contributes to supporting the farmer's income. At reverse, if the owner of the factor is not the farmer, but an individual who is outside the agricultural sector, the price support policy completely misses its initial objective since the provided support "leaves" the agricultural sector.
- On an intergenerational basis, by contributing to increase the price of the factor, the price support policy increases the cost of setting-up for future farmers. Finally, not only the price

support policy misses its initial target group (the current farmers) but also contributes to worsen the situation of future farmers.

When the factor supply elasticity is high (the extreme case being the infinity, as illustrated by panel 1.c):

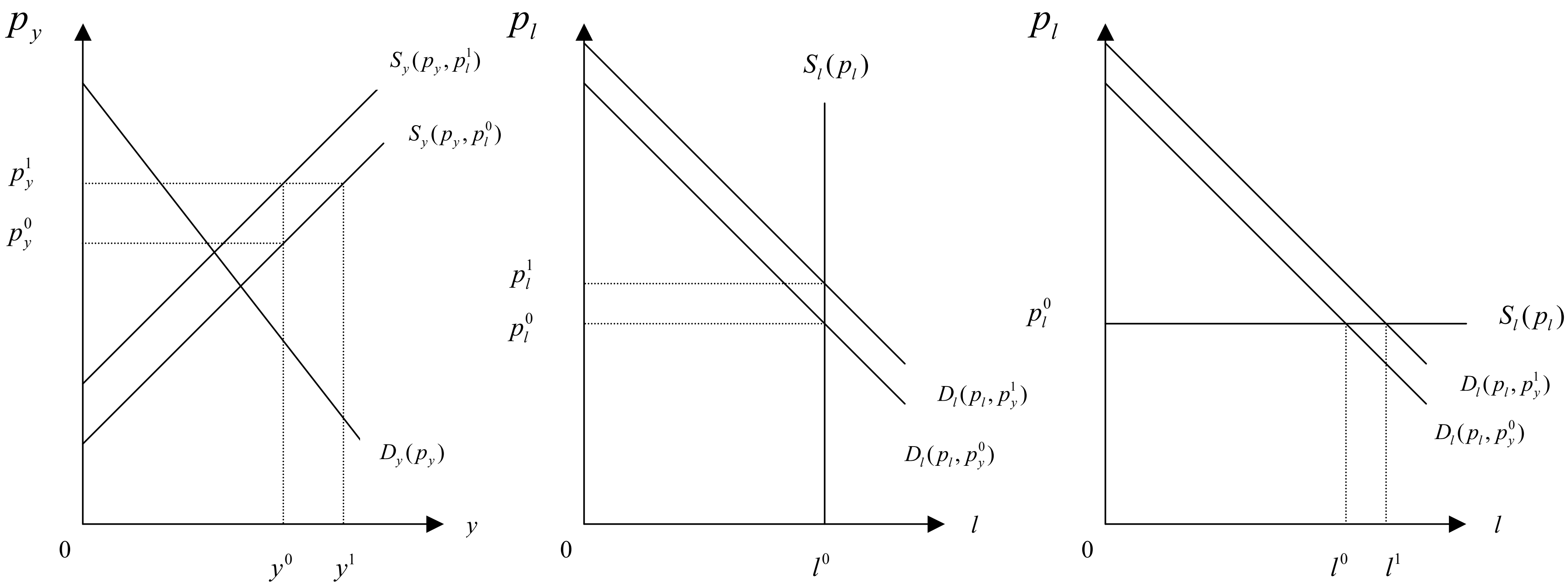
- The increase in the price of the output translates into a quantity adjustment on the factor market and has no impact on the price of the factor.
- In that case, the production cost of the output is unchanged. Price support induces an increase in output supply.
- The farmer's surplus increases since the totality of support provided through the output price is gained by the farmer. In that case, the price support policy actually contributes to supporting the farmer's income.
- On an intergenerational basis, as the price support policy does not affect the factor price, it does not change the situation for future farmers.

Finally, if we consider that the factor in figure 1 is land, this figure illustrates the key role of the land supply price elasticity as regards the effect of output price support on the rental price of land: if this elasticity is very low, output price support is nearly totally "capitalised" in the rental price of land, while if this elasticity is very high, output price support has nearly no effect on the rental price of land. In other words, the lower the land supply price elasticity the higher the share of output price support "capitalised" in the rental price of land.

At this stage two remarks are in order. Firstly, it is commonly recognised that agricultural land supply elasticity is rather low (cf. discussion in point 2.1.3). Hence, in most OECD countries land supply is probably closer to the situation depicted in panel 1.b than in panel 1.c. In other words, it is most likely that in OECD countries the support (still or previously) provided to farmers through price support is or has been at least partially transferred to landowners and has finally, at least partially, not benefited to farmers who do not own their land.[4] Secondly, most policy analyses that adopt a partial equilibrium framework implicitly assume that factor prices are exogenous and constant. In other words they implicitly adopt the framework of panel 1.c. This is obviously a restrictive assumption, especially regarding land. Therefore, one must keep in mind that all commonly admitted results in terms of market and welfare effects of alternative agricultural policy instruments are obtained conditionally on the constant factor price hypothesis. Panel 1.b clearly shows that once this hypothesis is relaxed, such

[4] We acknowledge that the reality is far more complex than the situation described in figure 1 and that a great number of other factors do affect land rental price adjustment and the adjustment on agricultural output markets as well.

effects may change. As an extreme illustration, in panel 1.b., one may consider that the price support policy is decoupled since following the factor price adjustment, it has no effect on the output supply quantity.



1.a Output market

1.b. Factor market (supply perfectly inelastic)

1.c. Factor market (supply perfectly elastic)

Figure 1. Effects of output price support on domestic output and factor markets: the one-factor case

The one output-two factor case: Illustrating the key role of factor substitution possibilities

Let's assume now that our representative farmer produces an aggregate agricultural output by combining two factors, according to a given production technology ($y = f(l, x)$). The first factor is land and is used in quantity l. The second factor may be an aggregate of family labour and capital and is used in quantity x. Figure 2 below depicts the domestic output and factor markets in the considered country.

Notations are similar to the previous case. Panel 2.b. describes the domestic land rental market. We assume that the land supply is imperfectly elastic and consequently increasing in the rental price of land. Panel 2.c depicts the domestic market of the other factor. The domestic supply of this other factor is assumed to be perfectly elastic in p_x^0. On panel 2.a output supply now depends on the output price and on both factor prices. On panels 2.b and 2.c derived demands of factors also depend on the output price and on both factor prices. Therefore, $S_y(p_y, p_l^0, p_x^0)$ is the initial output supply curve, while $D_l(p_l, p_y^0, p_x^0)$ and $D_x(p_x, p_y^0, p_l^0)$ are the initial derived demand curves of land and of the other factor respectively.

All other assumptions adopted in the previous case are still valid here. At initial equilibrium the domestic output price is p_y^0, the representative farmer produces quantity y^0 using quantity l^0 of land and quantity x^0 of the other factor. The initial rental price of land is p_l^0, while the initial price of the other factor is p_x^0.

As in the previous case, we assume that, following the implementation of an output price support policy, the output price increases to p_y^1. In a first step, this output price increase is an incentive for the farmer to produce more. Other things being equal, the farmer would seek to produce y^1. However, such an output supply increase would require to use larger quantities of factors. This is at this stage that the key role of substitution possibilities between both factors does appear.

- Let's consider first the case where both factors are highly substitutable. As the supply of factor x is perfectly elastic, an increase in its derived demand would have no impact on its initial equilibrium price. While as the supply of land is imperfectly elastic an increase in its derived demand would lead the land rental price to increase relative to its initial equilibrium level. Therefore, in the new output price context, the representative farmer who wants to increase his/her output quantity has incentive to change his/her factor quantity ratio in favour of factor x, trying to keep nearly unchanged his/her use of land. Such a situation is represented in panels 2.b and 2.c by the small shift to the right (from $D_l(p_l, p_y^0, p_x^0)$ to $D_l^{sub}(p_l, p_y^1, p_x^0)$)

of the derived demand of land and the large shift to the right (from $D_x(p_x, p_y^0, p_l^0)$ to $D_x^{sub}(p_x, p_y^1, p_l^{1sub})$) of the derived demand of factor x. Hence, at final equilibrium, the farmer produces quantity y^{1sub} using quantity l^{1sub} of land and quantity x^{1sub} of the other factor. In this case, factor prices are nearly unchanged (one observes only a slight increase in the rental price of land from p_l^0 to p_l^{1sub}) with respect to the initial equilibrium.

- Let's consider now the situation where land and the other factor are hardly substitutable. In that case, the representative farmer is more constrained in the adjustment of his/her factor quantity ratio in favour of factor x. This more constrained factor substitution process is illustrated in panels 2.b and 2.c by the shift to the right of similar extent of the derived demands of land and factor x (from $D_l(p_l, p_y^0, p_x^0)$ to $D_l^{nsub}(p_l, p_y^1, p_x^0)$ and from $D_x(p_x, p_y^0, p_l^0)$ to $D_x^{nsub}(p_x, p_y^1, p_l^{1nsub})$ respectively). Hence, at final equilibrium, the representative farmer produces quantity y^{1nsub} (lower than y^{1sub} due to the higher increase in the rental price of land) using quantity l^{1nsub} of land and quantity x^{1nsub} (lower than x^{1sub} due to the lower factor substitution possibilities) of the other factor. In this case, the rental price of land increases more than in the previous situation (p_l^{1nsub} is greater than p_l^{1sub}). In other words, when land and the other factor are less substitutable in production, a larger share of output price support is "capitalised" in the rental price of land.

Finally, figure 2 shows that the effects of output price support on the output and both factor markets are quite different according to the degree of factor substitution possibilities in production (i.e., the level of the elasticity of substitution between factors) on the one hand and the relative level of both factor supply elasticities on the other hand. Regarding the impact of output price support on land rental market and price, one may synthesise the main findings as follows.

The lower the supply price elasticity of land, the higher the supply price elasticity of the other factor and the lower the substitution elasticity between land and the other factor:

- The higher the increase in the rental price of land and the higher the share of output price support "capitalised" in the rental price of land.
- The higher the increase in the production cost of the output (and the lower the positive effect of output price support on output quantity supply).
- The lower the gain of the farmer in terms of increased surplus and the higher the share of output price support transferred to the landowner.
- On an intergenerational basis, the higher the increase in the cost of setting-up and the worst the situation for future farmers.

As shown by Floyd (1965), Gisser (1993) and Hertel (1989) for instance, these results may be generalised for the multi-factor/input case, using a Cobb-Douglas or a CES production function and under the constant return to scale assumption.

Finally, the above analysis suggests that when one is interested in the impact of agricultural output price support policies on land rental markets and prices, the main parameters to consider and work on are the supply price elasticities of agricultural production factors and inputs as well as the elasticities of substitution in production between these factors and inputs. That is the main reason why a discussion on the meaning of these parameters and on the common knowledge about their respective levels is proposed in point 2.1.3. of this sub-section.

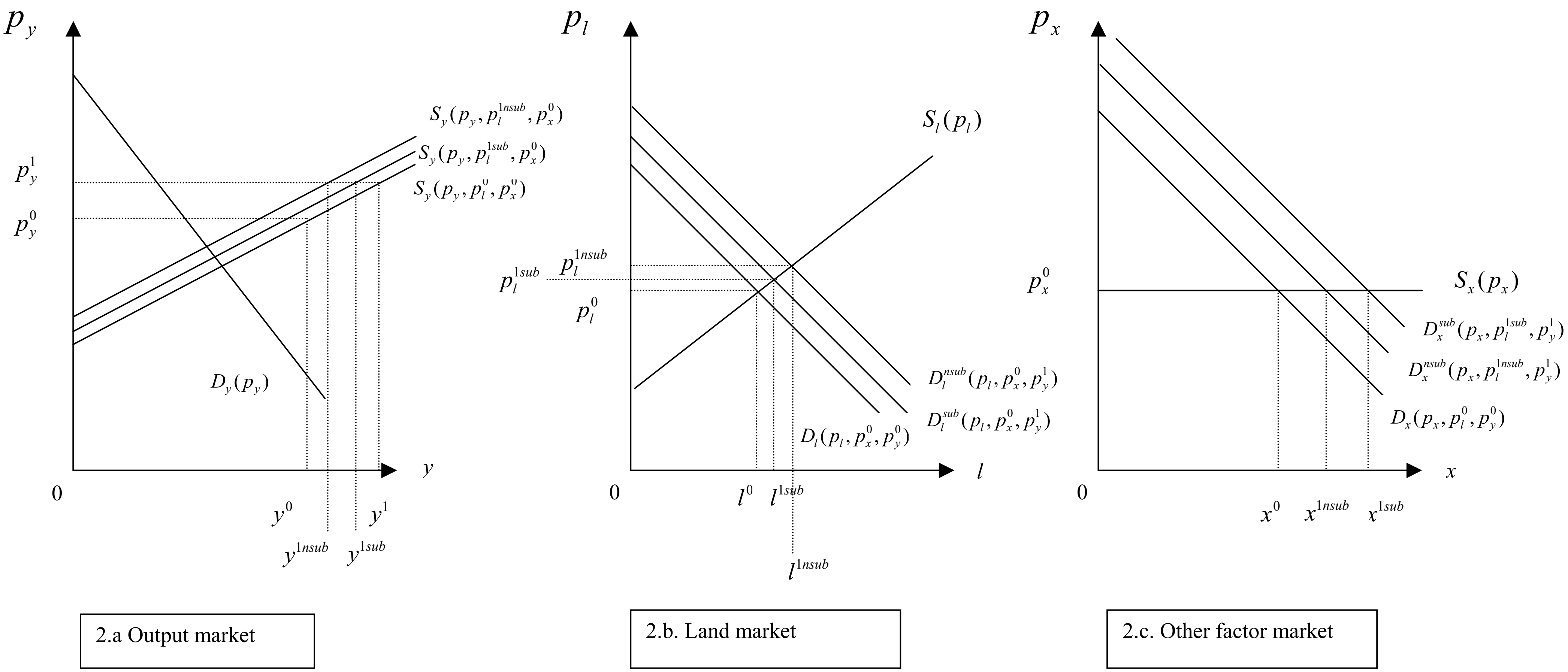


Figure 2. Effects of output price support on domestic output and factor markets: the two-factor case

2.1.2. Factor subsidies and farmland rental markets and prices

Among papers already cited some are aimed at comparing the effects on output and factor/input markets as well as sometimes on farmers' income of various alternative agricultural support policy instruments. Most often considered policy instruments are various kinds of output price support, various kinds of input and/or factor subsidies and various kinds of decoupled payments. It is then possible to extract from these analyses some theoretical insights about the effects of factor/input subsidies on farmland rental markets and prices (see e.g., Hertel, 1989; 1991; Dewbre et al., 2001; Dewbre and Short, 2002; OECD, 2002a; Guyomard et al., 2004). All available analytical results show that the the main mechanisms by which support provided to farmers through input/factor subsidies affect farmland rental markets and prices are similar to those described previously in the case of output price support policy. And once again, these results indicate that the key factors regarding the extent of the effects of input/factor subsidies on farmland rental markets and prices are the relative levels of supply price elasticities of inputs and factors as well as the extent of input/factor substitution possibilities in production.

The one output-one factor case: Illustrating the key role of factor supply elasticity

Let's return to our previous one-factor framework. All assumptions and notations initially adopted remain except the policy instrument considered as to support the representative farmer's income: we assume now that this instrument is a factor subsidy (or a payment based on the factor use). As depicted on figure 3 initially the farmer uses quantity l^0 of the factor that he/she buys on the factor market at price p_l^0 (or at opportunity cost p_l^0) and produces quantity y^0 of output that he/she sells on the output market at exogenous (world) price p_y^0. The first incidence of the factor subsidy is to decrease the buying-in price (or the opportunity cost) of the factor for the farmer. This first incidence is represented on panels 3.b and 3.c by the decrease in the price of the factor "paid" by the farmer from p_l^0 to $p_l^0 - s_l$, where s_l is the factor subsidy.[5] This reduction in the buying-in price of the factor makes the farmer's marginal cost of output production to decrease. On panel 3.a this induced decrease in the marginal cost of production is depicted by the shift to the right of the output supply curve from $S_y(p_y, p_l^0)$ to $S_y(p_y, p_l^0 - s_l)$. Hence at first stage, the factor subsidy generates an incentive for the farmer to increase his/her output supply: other things being equal, the farmer would seek to produce

[5] The subsidy is assumed to be of the specific form, meaning that it is a total amount per unit of factor used. This kind of subsidy is similar to and may be interpreted as a payment based on the factor use. Main results of our graphical analysis would remain valid in the case of an ad-valorem subsidy, that is a subsidy that would be defined as a percentage share of the initial equilibrium market price of the factor.

y^1. However, such an output supply increase would require to use more factor. From this stage induced adjustments on the output and factor market differ according whether the factor supply is totally inelastic or elastic (i.e., from panel 3.b to panel 3.c).

- In panel 3.b, as the factor supply is perfectly inelastic, the farmer cannot adjust his/her factor use up to the quantity l^1 corresponding to output quantity y^1. Then the factor adjustment requirement translates into a shift to the right of the factor derived demand curve from $D_l(p_l, p_y^0)$ to $D_l^{sl}(p_l, p_y^0)$. This factor demand increase translates into a rise of both the market price (from p_l^0 to p_l^1) and the buying-in price (from $p_l^0 - s_l$ to $p_l^0 = p_l^1 - s_l$) of the factor. The resulting increase in the marginal cost of y is depicted on panel 3.a through the shift back to the left of the output supply curve from $S_y(p_y, p_l^0 - s_l)$ to $S_y(p_y, p_l^0 = p_l^1 - s_l)$. Finally, figure 3 shows that following the induced price adjustment on the factor market, the final equilibrium output quantity is unchanged in y^0.
- In panel 3.c, as the factor supply is perfectly elastic, the farmer can adjust his/her factor use quantity without affecting the market price nor his/her buying-in price of the factor (which remain at p_l^0 and $p_l^0 - s_l$ respectively). Hence, following the factor subsidy implementation, factor demand and output supply increase simultaneously, to y^1 and l^1 respectively.

Finally, figure 3 shows that the effects of the factor subsidy on both the output and the factor markets are quite different according to the level of the factor supply elasticity. Figure 3 also suggests that the market effects of the factor subsidy are rather similar to those of the output price support as described previously. One may synthesised the main findings as follows.

When the factor supply elasticity is low (the extreme case being zero, as illustrated by panel 3.b):

- The decrease in the buying-in price of the factor following the factor subsidy implementation is totally translated into an increase in the market price of the factor.
- The factor subsidy then just allows to maintain the buying-in price of the factor at its initial equilibrium level for the farmer. As a result, output production is unchanged relative to its initial level as well as factor quantity used.
- The farmer's surplus is unchanged since the totality of support provided through the factor subsidy accrues to the owner of the factor.
- If the owner of the factor is the farmer, then the price support policy actually contributes to supporting the farmer's income. At reverse, if the owner of the factor is not the farmer, but an

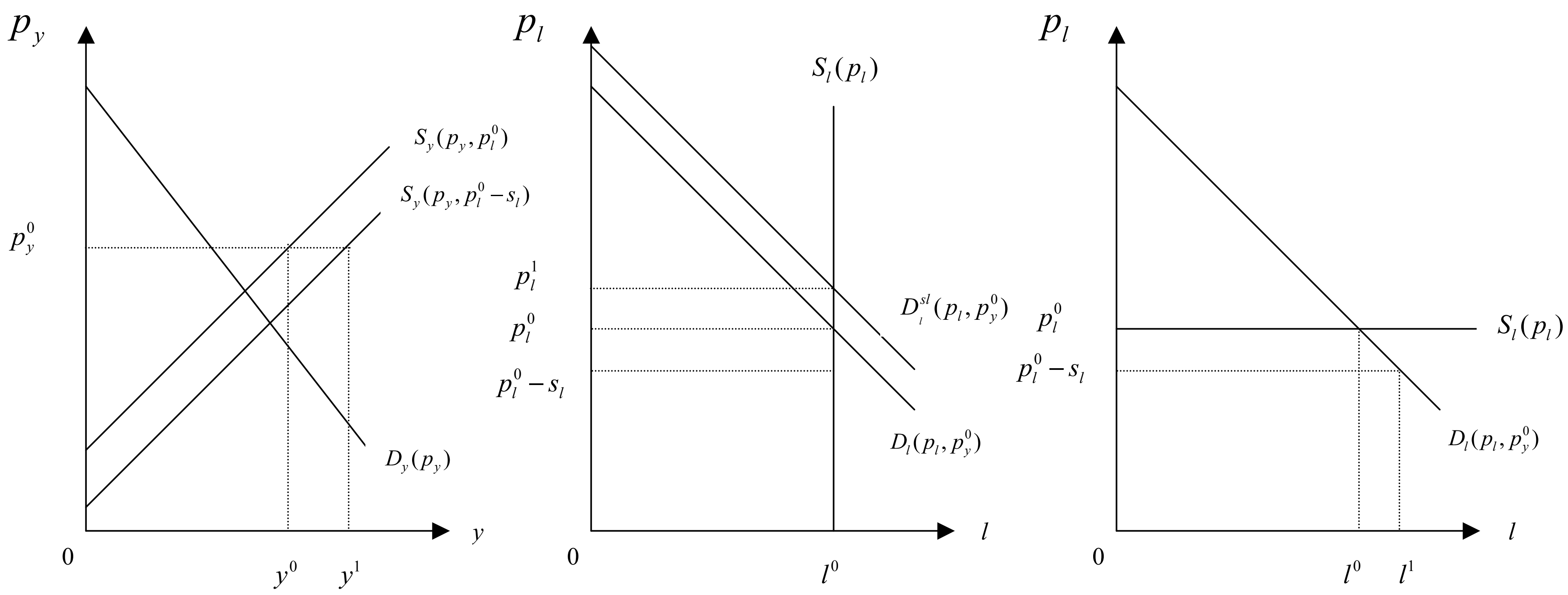
individual who is outside the agricultural sector, the price support policy completely misses its initial objective since the provided support "leaves" the agricultural sector.

- On an intergenerational basis, as the factor subsidy acts to compensate for the market price increase of the factor in such a way that the corresponding buying-in price remains unchanged for the farmer,the factor subsidy has no impact on the cost of setting-up for future farmers.

When the factor supply elasticity is high (the extreme case being the infinity, as illustrated by panel 3.c):

- The decrease in the buying-in price of the factor following the factor subsidy implementation is totally translated into a quantity adjustment on the factor market and has no impact on the market price of the factor.
- In that case, the factor subsidy induces an increase in both output supply and factor use.
- The farmer's surplus increases since the totality of support provided through the factor subsidy is gained by the farmer through the decrease in his/her production cost. In that case, the factor subsidy actually contributes to supporting the farmer's income.
- On an intergenerational basis, as the factor subsidy does not affect the factor price, it does not change the situation for future farmers.

Finally, comparing figures 1 and 3 and the syntheses of the main effects of the output price support and the factor subsidy instruments indicates that market adjustments and impact in terms of farmer's income of both instruments are quite similar. This is no so surprising in our simplified one output-one factor framework. Indeed one guesses that knowing the form of the production function it may be quite easy to transform output price support into an equivalent factor subsidy and reversely. Existing theoretical literature shows however that if using more sophisticated frameworks actually makes the analysis more complex and the effects of policy instruments more ambiguous, it adds no new intuition: factor supply price elasticities do remain key parameters as regards the extent of the impact of agricultural support policy instruments on the rental price of farmland, as well as on prices of other factors and inputs, output produced and factor/input use quantities and finally farmers income.



3.a Output market

3.b. Factor market (supply perfectly inelastic)

3.c. Factor market (supply perfectly elastic)

Figure 3. Effects of a factor subsidy on domestic output and factor markets: the one-factor case

The one output-two factor case: Illustrating the key role of factor substitution possibilities

Let's return to the case depicted by figure 2. We change only 2 assumptions. Firstly the considered support policy instrument is no longer output price support but a land subsidy. Secondly the supply of the other factor is now assumed to be imperfectly elastic. Therefore, the supply curve of this other factor is increasing in its price, as shown on figure 4, panel 4.c.

Figure 4 indicates that at initial equilibrium, the domestic output price is p_y^0, the representative farmer produces quantity y^0 using quantity l^0 of land and quantity x^0 of the other factor. The initial rental price of land is p_l^0, while the initial price of the other factor is p_x^0.

As in the above case, described by figure 3, the first incidence of the land subsidy is to decrease the buying-in price (or the opportunity cost) of land for the farmer. This first incidence is represented on panel 4.b by the decrease in the price "paid" by the farmer from p_l^0 to p_{ld}^1. This price decrease induces a rise in the farmer's land demand (from l^0 to l^1) that, due to the relative scarcity of available land, implies an increase in the market (or supply) rental price of land up to p_{ls}^1. As a result the land subsidy generates a gap between the demand and the supply rental prices of land (i.e., $p_{ls}^1 - p_{ld}^1 = s_l$). Following the reduction in the buying-in price of land the farmer's marginal cost of production is going to decrease inducing a shift to the right of the output supply curve. However, this shift is not represented on panel 4;a at this stage because its extent closely depends on the range of substitution possibilities between land and the other factor.

- Let's consider first the case where land and the other factor are highly substitutable. As the land subsidy makes the buying-in price of land to decrease, the farmer has incentive to substitute land to factor x in the production process. As the available technology allows such factor substitution adjustment the derived demand of factor x starts to decrease (the demand curve of factor x shifts to the left on panel 4.c). However, as the supply of factor x is imperfectly elastic the price of factor x starts to adjust down slowing down the substitution process between land and factor x. Hence at last a new equilibrium is reached where, as shown by panels 4.b and 4.c, both derived demand curves have shifted to the left due to factor price adjustment interactions (from $D_l(p_l, p_y^0, p_x^0)$ to $D_l^{sub}(p_l, p_y^0, p_x^{1sub})$ for land and from $D_x(p_x, p_y^0, p_l^0)$ to $D_x^{sub}(p_x, p_y^0, p_{ld}^{1sub})$ for factor x). As both the buying-in price of land and the price of factor x have decreased following the land subsidy implementation the farmer's marginal cost of production has lowered from the initial to the final equilibrium. Hence on panel 4.a the final output supply curve is $S_y^{sub}(p_y, p_{ld}^{1sub}, p_x^{1sub})$. Therefore in this case the land subsidy induces an increase in output quantity from y^0 to y^{1sub}. This new equilibrium output quantity is obtained by combining an increased quantity of land (from l^0 to l^{1sub}) and a decreased quantity of factor x (from x^0 to x^{1sub}).

- Let's consider now the situation where land and the other factor are hardly substitutable. In order to simplify the analysis and keep figure 4 readable we assume that land and factor x are complementary. In such a case, the first increase in land demand following the land subsidy implementation is accompanied by a simultaneous increase in the demand of factor x (since both factors are complementary). Hence on the factor x the price starts to rise. This price increase acts as to slow down, firstly the increase in both factor demands, secondly the lowering of the farmer's marginal production cost (following the decrease in the buying-in price of land) and finally the expansion of output supply. Hence at last a new equilibrium is reached where on panel 4.a the final output supply curve is $S_y^{nsub}(p_y, p_{ld}^{1nsub}, p_x^{1nsub})$ and the output quantity y^{1nsub}. This later is lower than y^{1sub} essentially because contrary to the above "substitution case", the complementarity between land and factor x in production prevents the farmer from exploiting fully the decrease in the buying-in price of land by substituting cheaper land to relatively more expensive factor x. As a result the output marginal cost of production decreases less in the "complementarity case" than in the "substitution case". For the same reason, the new equilibrium quantity use of land l^{1nsub} is lower than the one observed in the "substitution case", but still higher than the initial level l^0 (cf. panel 4.b). However, contrary to the "substitution case", the factor complementarity relationship makes the land subsidy to induce an increase in the quantity use of factor x (from x^0 to x^{1nsub} on panel 4.c).

Finally, figure 4 shows that the effects of a land subsidy may be quite different according to the degree of factor substitution possibilities in production. First of all figure 4 indicates that a land subsidy may induce a decrease, no change or an increase in the quantity use and the market price of the non-land factors/inputs depending on to the range of substitution possibilities between land and non-land factors/inputs from strong substitutes to complements. Secondly, figure 4 shows that if the land subsidy unambiguously induces an increase in the output supply quantity, the extent of this increase closely depends on the degree of land and non-land factor/input substitution in production: the higher the substitution possibilities the greater the output supply increase. Thirdly, figure 4 indicates that if the land subsidy unambiguously induces an increase in the rental market price of land, a decrease in the corresponding buying-in price for the farmer and an increase in the land use quantity, the extent of these adjustments closely depends on the land to non-land factor/input substitution possibilities: the higher the substitution possibilities the greater the increase in both the land use quantity and the rental market price of land.

It is interesting to point out at this stage that the overall support provided through the land subsidy is shared between the farmer, the landowner and the non-land factor/input supplier. Whatever the factor substitution possibilities, both the farmer and the landowner experience a gain resulting from respectively the decrease in the buying-in price of land and the increase of its market price. The gain for both agents is however greater when land and non-land factors/inputs are strong substitutes in production since in that case the benefit of support is not shared with the non-land factor/input supplier. Indeed in that case the non-land factor/input supplier may experience a loss, part of his/her surplus being transferred to the farmer via the decrease in the non-land factor/input price and to the landowner via the stronger increase in derived demand on the land rental market. At reverse and as shown by figure 4, when land and non-land factors/inputs are complements in production the non-land factor/input supplier may experience a gain that reduces the benefit for the farmer and the landowner.

Finally, as regards the impact of the land subsidy on land rental market and price, one may synthesise the main findings as follows.

For given supply price elasticities of land and non-land factors/inputs, the higher the substitution elasticity between land and non-land factors/inputs:

- The higher the increase in the rental market price of land and the higher the amount of support "capitalised" in the rental price of land.
- The greater the decrease in the production cost of the output (and the higher the positive effect of the land subsidy on output quantity supply).
- The higher the gain of the farmer in terms of increased surplus and the higher the amount of support transferred to the landowner.

Comparing the effects of both the output price support and the land subsidy instruments one may draw the main following insights (still for given supply price elasticities of land and non-land factors/inputs):

- Both instruments are expected to increase output supply and for both instruments the higher the degree of substitution between land and non-land factors/inputs the greater the extent of the output increase.
- Both instruments are expected to increase land use and land rental price. For the output price support instrument, the higher the degree of substitution between land and non-land factors/inputs the lower the extent of land use and land rental price increases. At reverse, for the land subsidy instrument, the higher the degree of substitution the greater the extent of land use and land rental price increases. The main reason for this reverse impact of the substitution

possibilities lies in the differentiated first incidences of both instruments. The first incidence of the output price support instrument is to generate an incentive for the farmer to increase output supply. As expanding output requires using more factors/inputs, this first incidence then spreads within all factor and input markets. And the higher the substitution possibilities between factors/inputs the greater the dilution of support across factors/inputs. In other words the higher the substitution possibilities the less the support is allowed to concentrate on one specific factor or input (in our example, land). At reverse, the first incidence of the land subsidy is to decrease the buying-in price of land for the farmer. Hence, in this case the support initially concentrates on land and then spreads within the output and other factor/input markets. But the higher the substitution possibilities between land and non-land factors/inputs, the more the farmer can increase his/her land use and consequently the less the support is allowed to spread within non-land markets.

The previous graphical analysis does not allow to conclude about the comparative effect on output supply of the same amount of support given through either the output price support or the land subsidy instrument. However, Hertel (1989), Dewbre et al.(2001) and Guyomard et al. (2004) using different frameworks (and hence different assumptions) have obtained some analytical results to this regards.

- Under constant return to scale assumption, perfectly elastic supplies of non-land inputs and imperfectly elastic land supply, Hertel (1989) shows that an input subsidy will have greater impact on output supply than an equal cost output subsidy, provided the subsidised input substitutes for land. Contrary to our case, the subsidised input in Hertel’s study is not land but a non-land input with a perfectly elastic supply. And this is exactly because the subsidy is applied to an input with perfectly elastic supply that Hertel obtains the above presented result.
- In Dewbre et al. (2001), the subsidy is alternatively applied to land and non-land inputs and the supply of both categories of inputs may be perfectly/imperfectly elastic or perfectly inelastic. Under constant return to scale and small country assumptions, Dewbre et al. show that market price support will have greater impact on output supply than an equal cost land subsidy (or payment based on area) if the elasticity of supply of land is lower than that of the non-land inputs.
- In a more general framework (no constant return to scale assumption, no small country assumption, free entry and exit in the agricultural sector) Guyomard et al. (2004) show that an output subsidy will unambiguously have greater impact on output supply than an equal cost land subsidy. They also demonstrate that an output subsidy will unambiguously have lower impact on land rental price than an equal cost land subsidy. In other words, and conform to the intuition that arises from our previous graphical analysis, a larger part of support is

"capitalised" in the rental price of land when this support is provided through a land subsidy than through output price support.

At this stage, it is interesting to point out that the current evolution of agricultural policies in OECD countries is likely to reinforce the capitalisation of support in the farmland rental price. Indeed, according to Guyomard et al.'s result, the decapitalisation of support that should follow the decrease in the support based on output should be more than counterbalanced by the intensification of capitalisation of support that should follow the increase in support based on area. Of course, there are a lot of other factors that can influence the evolution of farmland rental prices in OECD countries (such as legal factors for instance, see e.g., Latruffe and Le Mouël, 2006). In addition, the land subsidy as designed in Guyomard et al. (2004) and in this report does not fit the much more complex area payment systems that some OECD countries have actually implemented (see discussion in point 2.1.4. below). However, this is a matter of fact that the current evolution of agricultural policies in OECD countries mainly consists in replacing market price support instruments through which the support is based on output and likely to "capitalise" less in farmland rental prices by direct payment systems through which the support is most often (explicitly or implicitly) based on area and likely to "capitalise" more in farmland rental prices.

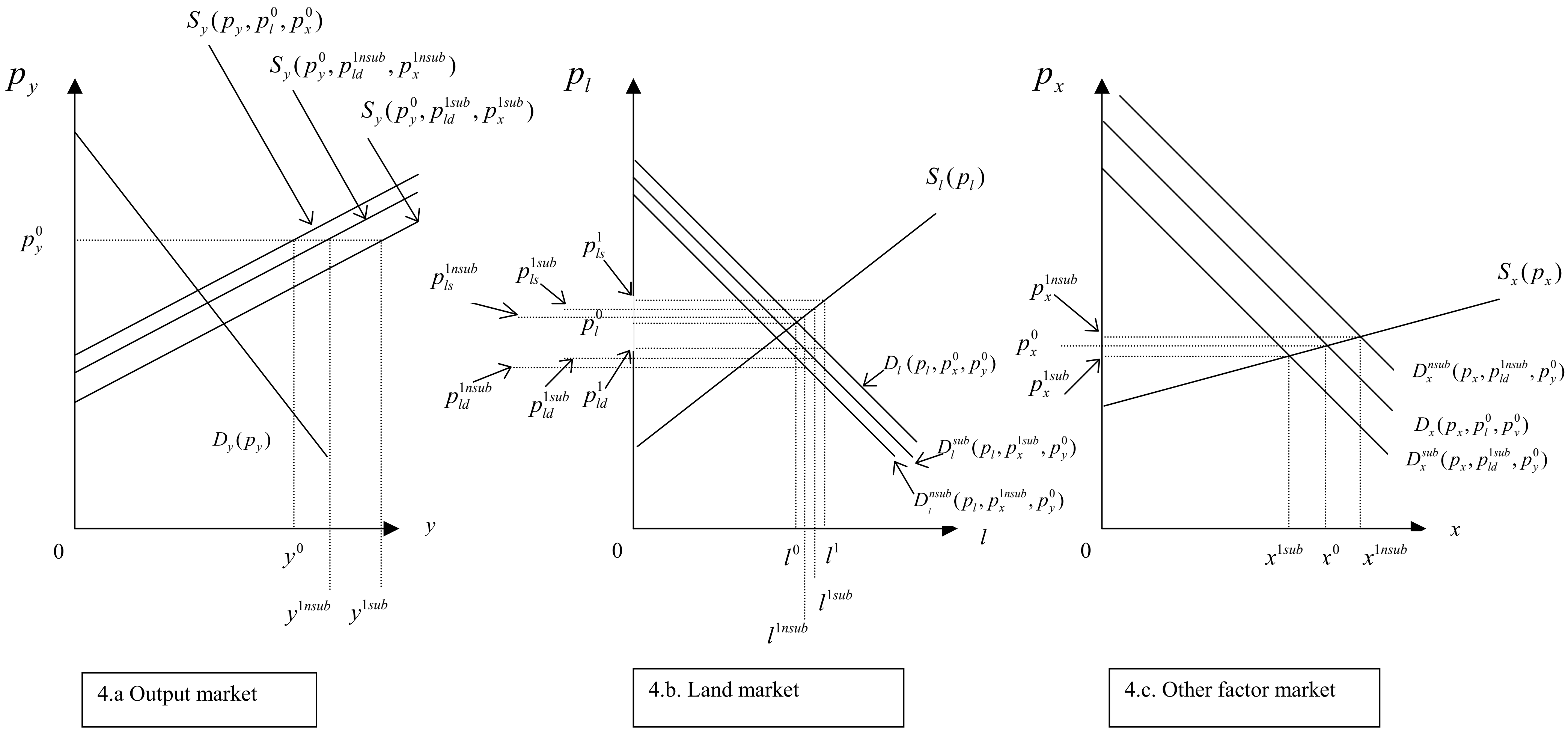


Figure 4. Effects of a land subsidy on domestic output and factor markets: the two-factor case

2.1.3. factor supply price elasticities and substitution elasticities: Discussion

As shown by the previous graphical analysis, whatever the policy instrument used, the extent to which support is "capitalised" in the rental price of farmland closely depends on i) the level of the supply price elasticity of farmland relative to those of other agricultural factors/inputs and ii) the range of substitution possibilities between agricultural land and non-land factors/inputs in production.

What do these parameters mean and measure exactly? What do we know exactly about their respective values?

Factor supply elasticities: Indicators of the extent of mobility of factors

Let's consider a representative landowner who owns the whole available land area in a country and whose objective is to maximise his/her revenue from renting out this land. Let's first assume that the only possible use for this whole land area is agriculture and that the national agricultural sector produces only one output. In that case, the only way for the landowner to get back some revenue from his/her land is to allocate all available land to the agricultural sector. As there is not any alternative use for this available land, the quantity supplied will not depend on the land rental price. In other words, land is a specific factor to the agricultural sector and the supply price elasticity of land is at its lower bound level, i.e., 0 (land supply is perfectly inelastic). This first case characterises the situation where land is completely fixed and cannot move from agriculture to an alternative use.

Let's assume now that there are two alternative uses for the whole available area, agricultural and non-agricultural uses. Hence the landowner is now able to split his/her available land between both uses so as to maximise his/her revenue. As a result, the quantity of land supplied to the agricultural sector will now vary according to the observed price on the rental market of farmland: an increase in this price, other things being equal, will lead the landowner to allocate more land to the agricultural sector. In other words, land is no longer a specific factor to the agricultural sector and the supply price elasticity of farmland becomes positive (farmland supply is imperfectly inelastic). This second case characterises a situation where land can move from agriculture to another use (land is mobile between alternative uses).

At this stage, one may wonder what makes land to be more or less mobile between alternative uses (or the level of the price elasticity of farmland to be more or less high)? There are at least to key factors to consider here.

The first one is technical and relates to the homogenous or heterogenous nature of land. Homogeneity means that all available hectares of land are identical (i.e., exhibit the same characteristics and so are of the same quality) and can be used equally in agriculture or in non-agricultural activity. In such a case, starting from a situation where the landowner faces equivalent rental prices for both possible land uses, as soon as say the rental price of farmland becomes higher than the rental price of non-agricultural land there is no reason for the landowner not to allocate all his/her available hectares to agriculture. Hence homogeneity contributes to make land supply to each potential user sector very responsive to price changes. Conversely, heterogeneity implies that available hectares are different and do not suit equally to alternative uses. In that case, once the rental price of farmland increases relative to the one of non-agricultural land, the landowner will still have incentive to allocate more land to the agricultural sector but will be more constrained in doing so because his/her available hectares will be more and more difficult to convert to the agricultural use. In the extreme case where part of available hectares are well-suited only for agricultural use while the remaining hectares only suit for non-agricultural use, we return to the above first case: there are two types of land, each specific to one use, and supplied in fixed quantities to agriculture and non-agricultural activity. Finally the more homogenous the land, the higher the degree of mobility between alternative uses and the higher the elasticities of land supply to each user sector.

The second key factor as regards the extent of land mobility across alternative uses relates to land management laws and policies in force in most countries that most often prevent landowners to convert their land from agricultural to non-agricultural uses. OECD (1996) and Latruffe and Le Mouël (2006) for example show that in most OECD countries there are planning or zoning legislations that designate land as farmland, building land, etc. and there are laws that prevent converting land from its administratively designated use to alternative uses. This is particularly true for agricultural land which is highly protected from the competition of other uses in a lot of OECD countries. Such legislations clearly contribute to lower land mobility across alternative uses, especially farmland mobility from the agricultural to other sectors. Therefore the stricter the legislation as to protect agricultural land from competing uses, the lower the degree of mobility of farmland between agriculture and other sectors and the higher the elasticity of supply of farmland.

Finally, one may advocate the case where the agricultural sector produces more than one output. This case is in fact very close to the situation described above where the two alternative uses of land would be two agricultural uses, say crop and livestock for instance. In that situation, if the role of land management laws and policies would likely to be less important as regards the extent of land mobility, the later would continue to closely depend on the degree of land homogeneity.[6] At this stage one

[6] Such laws and policies usually apply to the whole agricultural land and therefore essentially affect the extent of land mobility between agricultural and non-agricultural uses. Most often they are not designed as to protect specific agricultural land uses (say crop) from competing agricultural land uses (say livestock). One may underline however that in many countries there are actually legal provisions that prevent converting specific agricultural land areas (environmentally sensitive areas for example) to certain agricultural uses (intensive livestock production for instance).

guesses easily that land is likely to be more homogenous when considering two alternative agricultural uses than when considering an agricultural use vs. a non-agricultural use. In other words, it is likely that the elasticity of land supply to the crop sector is higher than the elasticity of land supply to the agricultural sector as a whole and it is even more likely that the elasticity of land supply to the grain production sector for instance is higher than the one to the whole agricultural sector.

If the above statement gives some indication about the ranging of land supply elasticities according to the overall possible uses of land, it says nothing about the expected values of these parameters. Indeed one must admit that we know nothing about the values of these parameters since there are no available land supply elasticity estimates in existing literature (e.g., OECD, 2001). One expect that these parameters differ across countries (and even across regions within countries) since firstly available land in countries is more or less homogenous due to observed natural and weather conditions, secondly land management laws and policies differ across countries.

It is commonly admitted that the elasticity of land supply to the agricultural sector is very low, at least in OECD countries. And this is globally the only available information on land supply elasticity parameters. Therefore, most global simulation models centred on agriculture assume no land mobility between agriculture and other sectors in national economies, that is a perfectly inelastic supply of agricultural land (i.e., a zero elasticity).

It is also commonly admitted that amongst all factors/inputs used in agriculture, land is likely to be the less mobile from agricultural to non-agricultural uses. Hence at the whole agricultural sector level, land supply elasticity is probably lower than supply elasticities of all other factors/inputs. Common knowledge about agriculture in OECD countries is that family labour is the second factor that is likely to be hardly mobile between agriculture and other sectors. Usually it is recognised however that family labour is likely to be more mobile than land. Hence, at the whole agricultural sector level the supply of family labour is likely to be imperfectly elastic, but with a higher elasticity than land supply. Finally, it is also well-admitted that all other factors/inputs are likely to be very mobile between agriculture and other sectors, at least and once again in OECD countries. Hence supplies of these other factors/inputs are, always in theoretical models and most often in global simulation models, assumed to be perfectly elastic (i.e., an infinite elasticity).[7]

What does it mean as regards the effects of policy support instruments? As shown by the previous graphical analysis, whatever the used policy instrument the higher the supply elasticity of a factor the higher the share of support “capitalised” in its market price. Hence it is likely that:

---

[7] Usually, the same ranging is adopted regarding the mobility of factors/inputs within the agricultural sectors, but with all elasticity values moving up to higher levels indicating that land, family labour and, to a lesser extent, other factors/inputs are more mobile across alternative agricultural uses than across agriculture and other uses.

- a significant share of agricultural support in OECD countries is "capitalised" in the rental price of farmland;
- family labour also benefits from agricultural support but to a lesser extent than land and particularly when support is provided through output price support instruments;
- when support is provided through a land subsidy a larger share of support is "capitalised" in the price of land while family labour may be hurt if land is a sufficiently strong substitute to family labour in production.

Elasticities of substitution: Indicators of the flexibility of the technology

Neoclassical production theory recognises the possibility of substituting one factor/input to another. The degree to which one factor/input may be substituted to another is implicitly determined by the form of the production function. The elasticity of substitution between two factor/inputs measures, for a cost-minimising producer, the percentage change in the ratio of both factor/input uses per percentage change in the ratio of their prices.

There are two important features here. First of all, the elasticity of substitution is defined for a cost-minimising producer. This means that the elasticity of substitution is defined for a given output quantity. In other words the elasticity of substitution indicates how the relative uses of two factor/inputs vary when their relative prices vary, keeping constant the output quantity produced. Secondly, there is a crucial difference between the definition of the elasticity of substitution when moving from a 2-factor/input framework to a n-factor/input framework. The elasticity of substitution is defined for pairs of factor/inputs. Hence when dealing with more than two factor/inputs, the elasticity of substitution between factor/input i and factor/input j is partial, meaning that it measures the percentage change in the ratio of used quantities of i and j per percentage change in the ratio of their prices, holding constant all other factor/inputs. Therefore, in a n-factor/input framework, the elasticities of substitution do not represent the full degree of substitution possibilities present in the production function.

At reverse to previous factor supply price elasticities, one can find numerous estimates of elasticities of substitution between factor/inputs used in agricultural production. This is obviously out of the scope of this study to make a review of these estimates. OECD (2001) provides an extensive review of available estimates of elasticities of substitution in agricultural production for Canada, the European Union, Mexico and the US. This review was carried out in the course of the development of the PEM model as to support the parameter calibration stage.

According to this review and additional huge existing literature:

- at aggregate agricultural level, broad categories of factor/inputs (mainly land, family labour, capital and purchased inputs, such as hired labour, fertilisers, pesticides, seeds, energy, etc.) are in average found to be rather substitutes than complements in production;
- at aggregate agricultural level, land is likely to be stronger substitute with purchased inputs than with family labour and/or capital;
- however estimates vary widely across studies, pairs of factor/inputs sometimes moving from strong substitutes to strong complements.

What does it mean as regards the effects of policy support instruments? The main insight here relates to the current evolution of agricultural policies in OECD countries, i.e., the shift from output price support instruments to factor (especially land) subsidy instruments. Provided that land is rather a substitute to other factor/inputs in agricultural production, it is likely that output price support was spread within all factor/input markets through the game of substitution in production, allowing factor/inputs with imperfectly elastic supply (family labour for example) to benefit from support to the detriment of the "capitalisation" in the rental price of land. The shift from price support to land subsidy instruments is likely to play conversely. More specifically, provided that land is a substitute to other factor/inputs in agricultural production, it would be able to "retain" a larger share of support, the later being driven towards the subsidised factor through the game of substitution in production. In such a case, family labour is likely to benefit less from the support provided through a land subsidy. At this stage, one guesses that the way the land subsidy system is designed and particularly who is the beneficiary (the farmer or the landowner?) and under which conditions the subsidy is given are crucial elements as regards the sharing out of support between imperfectly mobile agricultural production factors (i.e., mainly farmland and family labour).

2.1.4. Some modelling issues

All existing global simulation models centred on agriculture (of either partial or general equilibrium nature) may be considered as elaborated versions of the very simple models we adopted throughout the above graphical analysis. They all rely on implicitly or explicitly specified agricultural (and, in multi-sector or general equilibrium models, other sectors') production functions and on supply functions of production factors (resulting from optimisation behaviours of factor owners, either part of the model itself or considered as outside from the model). The main difference is of course the number of considered outputs and factor/inputs. As a result, much more markets are simultaneously responding to an exogenous (policy) shock, making much more difficult to predict the outcomes.[8]

[8] Another important difference with respect to the basic models used in our graphical analysis is that global simulation models most often consider several countries, some of them assumed to be large countries. Hence, an

What are these global simulation models able to say regarding the capitalisation of support in farmland prices?

Global simulation models deal only with farmland rental markets and rely on uncertain parameter values

Global simulation models implicitly rely on the basic assumption that farmers maximise their profit from period to period and not their intertemporal profit over a long-term period. This implies that farmland is considered as a production factor and not as an asset. In other words it is assumed that at the beginning of each period farmers buy the stream of services provided by say an hectare of farmland but not the hectare itself. This is exactly what a farmer does when he decides to rent in an hectare of farmland. Therefore, global simulation models only deal with rental markets of farmland. Hence they may be able to tackle the question of the "capitalisation" of support in rental prices of farmland but this is clear that they are not designed as to deal with the question of the capitalisation of support in farmland values or sale prices.[9]

Secondly as already mentioned, global simulation models encompass much more agricultural output and factor/input markets than the very simple models used in our graphical analysis. However the basic mechanisms described throughout this graphical analysis still hold in these models. Therefore simulation results obtained from these models about the effects of alternative agricultural support policy instruments on rental prices of farmland closely depend on both their calibrated elasticities of agricultural factor/input supply and calibrated elasticities of substitution in agricultural production. This is clear that global simulation models differ in the parameters they use and, above all in the "quality" of these parameters, that is in the amount of work that has been put and the amount of information that has been compiled in calibrating them. Some models rely on very rough assumptions implying lower-bound or upper-bound level elasticities. This induces a very stylised representation of the characteristics and functioning of concerned agricultural sectors and markets and consequently leads to very "stylised" results regarding the "capitalisation" of support in the rental prices of farmland.

To this regards, the OECD PEM model benefits from at least two advantages over other existing similar models. Firstly it relies on the heterogenous land assumption. More precisely land is assumed

---

exogenous (policy) shock in one of these large countries will induce adjustments on world markets and in turn of output prices on national markets, which is not the case in our graphical analysis.

[9] Obviously it may be assumed that the buying and selling prices of farmland can be adequately approximated by the discounted sum of future rental prices, so that a prediction about the direction of the rental prices is equivalent to a prediction about the direction of the buying and selling prices (e.g., Leathers, 1992; Guyomard et al., 2004). However this is a rather restrictive assumption as shown in the following sub-section.

to be imperfectly mobile between the agricultural and the non-agricultural sectors and within agriculture between alternative uses. Although the land heterogeneity assumption is commonly recognised as fitting better the reality in most (even all) countries, a lot of existing models rely on the assumption of a fixed and homogenous land in agriculture. Secondly, agricultural factor/input supply elasticities and substitution elasticities in agricultural production used in PEM are empirically founded, which is far from being the case in a significant number of other existing models. Indeed PEM elasticities have been calibrated on the basis of comprehensive reviews of available empirical estimates provided by the existing literature (OECD, 2001). Of course this does not ensure that values finally adopted in PEM for these elasticities are the "true" values, but it ensures that adopted values are in the range of estimates derived from observed data, the latter being, by construction and at least partly, the outcomes of the real functioning of concerned agricultural sectors and markets.

Representation of agricultural support policy instruments and programmes: The main drawback of global simulation models

In fact, the main drawback of global simulation models as regards their ability to deal with the question of the "capitalisation" of support in the rental prices of land lies in their ability or inability to depict correctly the way agricultural policy programmes are operating.

Evidently if all agricultural policy instruments used in OECD countries were "true" subsidies explicitly based on specific outputs, factors or inputs, the modelling of their first incidence would not raise any difficulty. In such a case, provided an appropriate model output-factor/input disaggregation (i.e., that the subsidised outputs and/or factors/inputs are not included in aggregates but considered independently), the observed levels of the "true" adopted subsidies could be introduced explicitly as gaps between the supply and the demand prices of concerned outputs and/or factors/inputs.[10] This is exactly the way "true" subsidies are operating and most existing models would be able to depict correctly their first incidence.

The problem is that, at least over the last two decades, agricultural policy instruments effectively used by OECD countries tend to differ increasingly from "true" subsidies. Market price support instruments (fixed market prices, fixed output support prices or output subsidies), which have been extensively used (and are still used) in OECD countries are "true" subsidies to outputs. Hence one may consider that existing global simulation models are most often able to depict correctly the way such instruments are actually operating. Consequently one may consider that such models, provided they rely on "high

[10] Furthermore each of these gaps could be defined as a fixed amount if the corresponding subsidy is of specific form or as a percentage of the initial market price if the corresponding subsidy is of ad-valorem form. These gaps could even very easily be introduced as endogenous variables in cases where adopted instruments are no longer "true" subsidies but fixed output supply or factor/input demand prices.

quality" elasticities (as well as other parameters and data), are able to assess correctly their effects, in particular their impacts on farmland rental markets and prices. In the same way, interest rate subsidies and subsidies or taxes to other agricultural inputs may rather easily be converted in "true" positive or negative subsidies.[11]

In fact more important problems arise when considering direct payment-type instruments. At this stage, one may start speaking of programmes rather than instruments since most direct payment systems used in OECD countries are complex sets of several instruments: the payments themselves and a set of conditions required to receive the payments, such as mandatory set-aside, mandatory production (of possibly specific outputs), limiting base area, be a farmer, etc. Problems are even more important when, as it is increasingly the case in a certain number of OECD countries, direct payments are not explicitly based on a specific factor of production but given to farmers as a global amount calculated on the basis of the global amount of support they historically received over a given base period.

Let's consider first the case of payments based on area (all area or only area devoted to specific outputs, say crop for instance). The payment per hectare will act as to decrease the opportunity cost of eligible hectares for the farmers. In this regards, area payments operate like land subsidies. Hence as shown by the previous graphical analysis, the first condition for a model to be able to correctly account for these payments is that farmland rental demand and supply functions are explicitly modelled. In this case, area payments can be introduced as gaps between farmland rental demand and supply prices.

In a significant number of models however, farmland demand and supply functions are not modelled and area payments cannot be accounted for directly as described above. They must be introduced through an indirect way. Most often this indirect way is the conversion of area payments into "equivalent" output price changes. This approach may provide some indication about the effects of area payments on output supply.[12] But in any case nothing can be said on the "capitalisation" of area payments in the rental price(s) of farmland. In some other models farmland is considered as a fixed homogenous factor allocatable between alternative agricultural uses. In this case, a system of land allocation equations is specified, the area devoted to each use depending on the expected returns from each alternative uses. These returns involve both the returns from the market (i.e., the per hectare

---

[11] The main difficulty here results from the fact that effectively subsidised capital or other inputs are sometimes (even often) not considered explicitly in models but included in broad aggregates encompassing subsidised and non-subsidised elements.

[12] Keeping in mind however that these output effects closely depend on the retained "equivalent" output price changes, that is on the implicit ad-hoc assumption adopted on the degree of decoupling of area payments.

output margin resulting from each possible use) and the area payments. Hence the effects of area payments on land allocation and in turn on output supply may be accounted for.[13] It is also possible to derive the shadow price of farmland and consequently to simulate the effects of area payments on this shadow price, which is an approximation of the farmland rental price.

If the explicit modelling of farmland rental demand and supply functions is a necessary condition for the models to be able to account directly for area payments, most often it is not sufficient for at least two reasons:

- usually all hectares of farmland are not eligible and the model should be able to distinguish between eligible hectares and non-eligible ones;
- usually, there are conditions required for benefiting from the area payments and the model should be able, as far as possible, to account for these conditions.

Area payment systems in force in OECD countries nearly always apply to specific uses of farmland (often land area devoted to all or specific crops). Hence, the key modelling issue here is that the agricultural production function is specified so as it is possible to distinguish the land area that is used for eligible outputs from the land area that is used for non-eligible outputs. Otherwise, one faces the same problem as mentioned above for capital or purchased input subsidies: effectively subsidised land is not considered independently but included in a broad aggregate encompassing both subsidised and non-subsidised land.[14] Often general equilibrium models and multi ouput-factor/input market models, such as the PEM, rely on agricultural production functions that allow for this distinction between subsidised and non-subsidised land area. This distinction is even made more explicit and transparent when, such as in the PEM, land is considered as an heterogenous factor. As land heterogeneity results in different rental prices of land according to its use, it is then easier to depict the first incidence of output specific area payments, the fact that the support is first concentrated on a certain type of land and then spreads to a more or less extent (according to supply elasticities of the various land types and

[13] One may underline however that often the respective effects of returns from the market and of area payments on land allocation are not differentiated (i.e., only the total margins per hectare are considered -specified for each use as the sum of the return from the market and the area payment- their effects on land allocation being accounted for by a single parameter). In this case, it is implicitly assumed that both output prices and area payments have the same effect on land allocation.

[14] In such a case one must adopt an ad-hoc assumption about how the global amount of subsidy is split between all hectares, subsidised and non-subsidised ones. This results implicitly in adopting an ad-hoc assumption about how support spreads within the whole used farmland, assumption which, in turn, plays a key role as regards the "capitalisation" of support in the farmland rental price.

elasticities of substitution in production) to other types of land.[15] In particular, the land heterogeneity assumption allows to figure the expected outcome among which support provided through output specific area payments is likely to "capitalise" more in the rental price of land devoted to these outputs than in the rental price of land devoted to other uses.

Another modelling issue is the existence in most area payment systems in force in OECD countries of base areas, which aim is to limit the total area eligible to payments. Usually these base areas are historical areas that were devoted to eligible outputs over a given period. Once again models relying on the land heterogeneity assumption are better adapted to account for the effects of these base areas. The land heterogeneity assumption leads to specify several land supply functions (one for each considered type of land/use). Hence it is quite easy to figure the constraint imposed by the base area by making the supply of the subsidised type of land perfectly inelastic (depicting then the fact that a limited number of hectares devoted to the subsidised outputs can benefit from the payment).[16] This is the way that was retained in OECD (2002b) which, using PEM, provided an analysis of the impact of quantitative constraints (namely base area and mandatory set-aside provisions) on the degree of decoupling of the European union (EU) area payment system that was in force before the 2003 Mid-Term Review reform. Obviously it is much more difficult to account for the base area constraint in models relying on the land homogeneity assumption since in that case there is only one supply of land encompassing both subsidised land subject to the base area constraint and non-subsidised land out of the constraint.

Regarding the conditions that are required for benefiting from the area payments, systems that are in force in OECD countries show that they mainly relate to mandatory and voluntary set-aside. Mandatory set-aside may apply whether area payments are output specific or not while the question of voluntary set-aside mainly arises when area payments become non-output specific and when effective output production is not required in order to receive the payments. As for the mandatory set-aside, once again the key issue is whether it applies to output specific land or not. And once again the key modelling issue is whether the specification of the agricultural production function allows to distinguish the land area that is subject to set-aside from land area which is out of the constraint. Voluntary set-aside is more difficult to deal with since it requires to change the specification of the agricultural production function. Most general equilibrium models or multi output-factor/input market

---

[15] One may underline that the land heterogeneity assumption is also more adapted to depict the first incidence of area payments when they are differentiated according to outputs.

[16] One guesses easily that making the supply of eligible land perfectly inelastic will reinforce the asymmetric capitalisation process described above (the support will capitalise more in land devoted to eligible outputs than in land devoted to other uses). And this is exactly the expected outcome of the base area provision: it impedes the support to spreads progressively within all agricultural land.

models, such as PEM, may nevertheless be adapted. On the specification side, it is very easy since one has just to add one possible output in the model, which can be called "no production" for instance. The main problem is on the calibration side since required initial information (especially factor/input cost shares) are most often (even never) available.[17] That's the main reason why most models are not able to account for the voluntary set-aside that may potentially be observed following the implementation of non-output specific area payments under no mandatory production. This is clear that further work is needed for improving most current global simulation models, including PEM, for they are able to account for voluntary set-aside since "no production" or land abandonment is a key issue as regards the potential impacts of decoupling agricultural support.

This leads us to move from area payment systems to more decoupled direct payment systems such as the payments based on historical entitlements. The two typical examples of such payment systems are the Single Farm Payment (SFP) system newly adopted in the EU and the Production Flexibility Contract (PFC) payment system in force in the US. Very generally speaking, such systems calculate a global amount of support based on the historic amount farmers used to receive in average over a given base period (possibly through various policy instruments). Then this global amount of support is given to farmers without any condition on their output production decision.

Are these payments attached to farmland? Do they operate like land subsidies? If the answer to both these questions is yes then these payments may be assimilated to non-output specific area payments and there is no more modelling issues than the ones advocated above for area payment systems. Unfortunately, and least from out point of view, the observed way EU SFP and US PFC systems are operating is no so clear that one may answer unambiguously yes to both above questions. Apparently in both systems the right to receive the payment (i.e., the historical entitlement) only links to the observed fact that the farmer was producing a given mix of outputs using a given mix of factor/inputs at one point in time, which resulted in a global amount of support. If the right to receive the payment was effectively defined in this way, the payment would be implicitly attached to the farmer. Then either the payment rights are not exchangeable and the farmer would keep them until death (meaning that the support would progressively disappear from the agricultural sector) or the payment rights are exchangeable and would become a financial asset (meaning that the support would likely progressively exit from the agricultural sector).[18] In such a case the payments would rather be tied to

---

[17] At this stage one guesses the importance of cross-compliance conditions (such as the modalities that underlie the requirement of maintaining land in good agronomic conditions in order to benefit from the new single farm payments in the EU) that are key elements as regards the cost of producing the "no production" output. One may also guesses the difficulty one faces in calibrating this cost.

[18] This second case corresponds to the bond scheme system as proposed by Tangermann and Swinbank in the beginning 90's (Tangermann, 1991).

family labour and would rather be "capitalised" in the value of this factor. Hence it would rather operate like a family labour subsidy than like a land subsidy, and should be introduced as such in global simulation models.

However the way the EU SFP and the US PFC are operating suggests that the right to receive the payment is defined in a different way. Indeed there is a link between the payment rights and farmland. This link is explicit, simple and clear in the US PFC system, explicit but more complex in the EU SFP system. The way to highlight how the payment rights are defined and to which factor or input they are effectively tied to is to observe what happens to payments at the time of farm transmission to a new entrant.

In the US, operators of base acres are given a pre-determined amount of payment. Base acres are fields previously enrolled in supply management programmes for main crops (wheat, corn, barley, oats, sorghum and rice in the 1996 FAIR Act, plus oilseeds and peanuts in the 2002 FSRI Act). The amount of payment varies according to field-specific historical crop production and per acre yields. PFC allow nearly full planting flexibility (some restrictions are placed on land use, mainly non-agricultural use and fruits and vegetables). Payments are made directly to operators of programme acres, including tenants, not landowners. Programme eligibility is transferable with the sale of lease of base acres (USDA, 2003).

The way US PFC effectively operate suggests that the payment rights are embedded in eligible or base acres: to receive the payment you must operate an eligible acre. Therefore there is a clear link between PFC payments and land. Hence, at least from our point of view, the US PFC system is likely to operate like a land subsidy. This is the way, this programme is introduced in PEM for example.[19]

In the UE, SFP are calculated as the sum of direct payments (based on area and based on livestock heads) that farmers were receiving during a given base period. In a second stage an eligible area is defined (corresponding, very roughly, to the area devoted to certain uses –supported crops and forage and pasture area for supported livestock production- during the base period). This allows to calculate the Single Payment Rights (SPR). The number of SPR globally equals the number of hectares of the eligible area. The value of each SPR equals the amount of the SFP divided by the eligible area. EU

---

[19] The introduction of the US PFC programme as a land subsidy in PEM corresponds, at least from our point of view, to the way this programme is effectively operating: its first incidence is on the land market; PFC payments are likely to "capitalise" to a large extent in (eligible) farmland rents and values. Obviously, as PEM and most other models deal with aggregate agricultural production, the conversion of PFC payments into a land subsidy implies to use a very rough average rate of land subsidy that is applied in the whole US. This is clearly an approximation of the real situation where land subsidy rates differ from acre to acre, farm to farm, region to region, etc.

Member States have been let a great flexibility in calculating the SPR: they can be calculated on an individual historical basis (amount of SFP and based area calculated at the farm level leading to SPR values varying from farm to farm) or on a flat-rate regional basis (amount of SFP and base area calculated at the regional level leading to uniform SPR values within regions) or on the basis of a mix of both methods. SPR are given to operators, including tenants, not landowners. Finally, holding a SPR and an eligible hectare is the condition required for receiving the amount of payment corresponding to the value of the SPR. These SPR are exchangeable but for the moment, most Member-States apply restrictions that make transfers of SPR without simultaneous transfers of corresponding eligible hectares either impossible or unprofitable.

Hence, the main difference between US PFC payments and UE SFP is that in the later there is a distinction between the right to receive the payment and the land upon which the payment is based. As a result the link between the payments and (eligible) farmland is far less clear in the EU than in the US. At this stage, we need further work to derive unambiguous implications on the way EU SFP will exactly operate. However, at least from our point of view, it is likely that SFP will not completely operate like a land subsidy.

The main question here is whether it will be possible to exchange SPR without associated eligible land. If no we can guess that the right to receive the payment will finally be embedded in eligible land. In such a case, the functioning of SFP would be rather close to the functioning of a land subsidy. Consequently the SFP support would to a large extent capitalise in the eligible farmland values and rents.[20] Conversely, if there is some room to exchange (sell or rent) SPR without associated eligible land, the situation becomes less clear because part of the SFP support could be capitalised in the value of the SPR itself. As these SPR are owned by farmers, this means that part of support could be captured by farmers over landowners.[21]

Finally, the UE SFP system is likely to differ from a land subsidy. Further work is needed to determine unambiguously whether the SPR will finally be embedded in eligible farmland or will become an independent farm asset. In the second case, it is likely that part of the SFP support would capitalise in the value and rents of this new asset.

Currently, the EU SFP programme is introduced as a land subsidy in the PEM model. As suggested by the above analysis, this could lead to over-estimate the share of support that is "capitalised" in the

[20] This situation would be close to the case of dairy quotas in France for instance: quota rights are tied to land and it is not (legally) possible to sell or rent quota rights without selling or renting associated land. As a result milk price support is capitalised in the value (and rents) of associated land.

[21] This situation would be close to the case of dairy quotas in the UK for example: quota rights can be traded freely. As a result milk price support is capitalised in the value (and rents) of quota rights.

rental prices of farmland. However, once again further work is needed before being able to conclude unambiguously as regards the real functioning of SFP and the resulting sharing out of support between farmland and payment rights.

2.2. Farmers' production intertemporal decisions, agricultural support and the sale price of land

2.2.1. The relationship between farmland rental price, farmland value and farmland sale price: The present value framework

The basic capitalisation formula

The present value model (PVM) stipulates that the price of an income-earning asset is equal to the discounted expected value of the stream of future net returns or rents to this asset. Hence, according to the PVM, the price of farmland should be driven essentially by the discounted expected value of the stream of future net returns to farming or rents. Assuming that the value of an income-producing asset is the capitalised value of the current and future stream of earnings from owning this asset, the equilibrium asset price at the beginning of time period *t* (L_t) may be written as:

$$L_t = \sum_{i=0}^{\infty} \frac{E(R_{t+i})}{(1+r_{t+1})(1+r_{t+2})...(1+r_{t+i})} \qquad [1]$$

where R_t is the net real return at the end of time period *t*, generated from owning the asset, r_t is the time varying real discount rate for year *t* and *E* is the expectation on return conditional on information in period *t*.

If it is assumed that the discount rate is constant, agents are risk neutral and differential tax treatments of capital gains and rental income are ignored, then equation [1] becomes:

$$L_t = (1+r)^{-1} \sum_{i=0}^{\infty} \frac{E(R_{t+i})}{(1+r)^i} \qquad [2]$$

Assuming the net return is constant in each period (*R**), equation [2] simplifies to the basic capitalisation formula:

$$L_t = \frac{R^*}{r} \qquad [3]$$

This basic capitalisation formula underlies most of the studies concerned with farmland price formation, with L_t as a farmland value or price and R_t as the real net return to farmland (most often measured by net farm income or some -cash- rent). However, equation [3] is derived under very restrictive assumptions and actually most of existing studies used refined versions of the basic capitalisation formula that were obtained in much more flexible frameworks.

Various refinements of the basic capitalisation formula

Considering the set of equations [1] to [3], one realises easily that numerous differentiated capitalisation formulas can be derived, according to the adopted assumptions. For example, starting from equation [1], equation [2] is derived assuming a constant discount rate and risk neutral individuals while ignoring differential tax treatments of capital gains and rental income. Obviously, one would obtain different formulas if it was assumed a time-varying discount rate and/or risk adverse individuals while differentiated taxes were considered. In the same way, equation [3] is derived from equation [2] assuming a constant net return. Once again, one would obtain different formulas if the net return was assumed to change over time and/or if various expectation schemes were considered and/or if it was considered that this return to farmland may result from alternative uses of land (such as farming or housing for example). Moreover, as it is also possible to mix the various alternative assumptions regarding each of the above aspects, this results in a very wide set of possible capitalisation formulas. This is exactly the situation one faces when reviewing studies on farmland price formation. Furthermore, it is extremely difficult to categorise these studies since they do not differ by one single aspect (for example the studies which have dealt with expectations schemes) but most often by a combination of several aspects (for example, some studies can effectively put emphasis on expectations aspects but in the same time they also include other aspects such as opportunity cost of capital or other considerations). Consequently, it is also extremely difficult to compare their results.

Nevertheless, adopting a chronological approach, as proposed by Weersink et al. (1999), one can illustrate two main features. First of all, starting from capitalisation formulas essentially centred on agricultural-related explanatory variables (especially the net real return to farming), authors have progressively introduced out of agriculture-related variables (mainly macroeconomic variables such as inflation, alternative uses of capital and alternative uses of land) along with more complex arbitrage-pricing rules and expectation schemes. Secondly, thought on the main determinants of farmland prices has evolved dramatically from studies showing that net real returns to farming are the main determinant of farmland prices to studies suggesting that farmland price fluctuations are mainly driven by macroeconomic and capital use considerations.

In the mid-60's, the common approach to farmland pricing was to use a supply-demand framework with the quantity of land supplied for sale as an ad-hoc function of the price of land and other variables (urban pressure for example) and the demand for land as an ad-hoc function of the price of land and other variables (such as net farm income or productivity increase for example). Examples of these land supply-demand models are Herdt and Cochrane (1966), Tweeten and Martin (1966), Reynolds and Timmons (1969) and Cowling et al. (1970). Harvey (1974) pointed out however that such an approach is theoretically incorrect for two reasons. Firstly, there is not a stable relationship between the number of transactions and the supply of or demand for land. Given that transactions merely restore equilibrium, a given price may be associated with a large number of transactions or no transactions. Secondly, the same factors (farm incomes, riskiness, capital gains prospects, etc.) cause shifts in both the supply and the demand functions. Therefore, their separate influences cannot be identified. Due to these theoretical and other empirical unresolved problems, following studies focused exclusively on the role of demand side forces.

One major modification of the basic capitalisation formula was proposed by Melichar (1979) who supported the idea that the growth rate in returns had been the driving force behind increasing land values throughout the 70's in the US. This idea may be incorporated into the traditional capitalisation formula by considering that the price of land at the beginning of each year t is equal to the discounted expected real return over t plus the discounted expected real price of land at the beginning of year t+1. Traill (1979) used the Melichar's capital gains formulation for specifying a farmland price equation, which was then estimated on the basis of UK time series data. He specified the current farmland price as a linear function of expected net farm income (calculated as a weighted average of observed net farm income over the three preceding years), discounted by the expected rate of interest (measured as the one year lagged interest rate), the expected land price change (calculated as a weighted average of observed land price change over the previous three years) and the current total area of land sold. He found that the estimated equation fit the data fairly well and that the net farm income was a major determinant of UK farmland fluctuations. The introduction of growth in earnings from land was also followed by Baker et al. (1991), who additionally allowed for capital gains taxation. Applied to Canada, their model showed that both the growth in earnings and the capital exemption increased the price of land.

Alston (1986) and Burt (1986) also adopted the capital gains formulation. Alston considered in addition the differential tax treatment of income and capital gains and also decomposed the discount rate into a risk premium for land and the nominal interest rate. In doing so, Alston allowed for more flexibility on the capitalisation rate. At reverse, Burt assumed a constant capitalisation rate but proposed a more flexible specification of the composite effects of both expectations with regard to rents and the adjustment mechanism for land price. Although, he found that the percentage change in expected land prices was the major determinant of the annual percentage change in Illinois land prices, Burt noted that expected land prices were not the traditional measure of capital gains but rather an exogenous component depending implicitly on lagged rents. Hence, Burt concluded that land prices were driven mostly by changes in net rents.

In a similar perspective, Feldstein (1980) proposed a capitalisation formula allowing to account, in a flexible way, for the portfolio impacts of changes in non-farmland investment opportunities and in doing so to consider the role of inflation. The idea supported by Feldstein was that increased expected inflation caused a decrease in the discount rate due to the preferential treatment given to capital gains income. Therefore real land prices should increase with expected inflation. However, Alston (1986) tested for Felsdtein's assumption and concluded that inflation had a non-significant effect on real land prices in the US.

Shalit and Schmitz (1982) argued that credit market constraints and imperfections could explain part of US farmland price fluctuations. Assuming that rising land prices provide extra equity for loan collateral, Shalit and Schmitz derived a capitalisation formula where the accumulated debts per acre appeared as a positive determinant of land prices. Burt (1986) tested Shalit and Schmitz's hypothesis but found debts per acre to have a very small effect on land prices.

One could mention many other factors considered by authors as important determinants of farmland price fluctuations, implying many other differentiated capitalisation formulas. Among these factors, one may report expectation schemes (Lloyd et al., 1991), risk and risk aversion (Chavas and Jones, 1993), transaction costs (Shiha and Chavas, 1995), etc. One may also mention non-agricultural land uses, in particular urban pressure, which effect on farmland prices has been investigated in several studies relying on the present value framework where potential returns from non-agricultural uses of land are introduced (e.g., Arnott and Lewis, 1979; Robison et al., 1985; Plantiga and Miller, 2001; Plantiga et al., 2002).[22]

Pointing out the lack of conclusive results obtained by existing studies regarding all alternative factors hypothesised to affect farmland values, Just and Miranowski (1993) suggested that the partial nature of these studies, examining each factor individually, could explain the conflicting results obtained. Hence, they developed a comprehensive and theoretically consistent framework, encompassing all these factors, and allowing to assess their relative importance as regards farmland price fluctuations. Under the general case, the capitalisation formula derived by Just and Miranowski is rather complex, but the various possible specific cases allow to isolate the specific impact of each considered factor on the current price of land. For example, if all the complications of inflation, taxes, credit market imperfections, transaction costs and risk aversion are ignored, the Just and Miranowski's general capitalisation formula reduces to the basic capitalisation formula. Then, using cross-section/time series data by US State Just and Miranowski estimated their farmland price equation under alternative regimes for expectations on land prices and returns per acre (i.e., naive, extrapolative, adaptative and rational expectations). Overall, obtained results show that the US farmland price fluctuations are largely explained by inflation rates and changes in real returns on alternative uses of capital. For

[22] The other approach most commonly used rely on hedonic price equations, with the region's population density, the accessibility to a city or a motorway, etc. considered as potential factors (e.g., Maddison, 2000; Tsoodle et al., 2006). Recently studies rather rely on urban economic model of residential location derived from Urban Economics (e.g., Cavailhès and Wavresky, 2003).

example, the increase in the rate of inflation explained 25% of the predicted 1973 price increase in Iowa, while the effect of the opportunity rate of return on capital explained 23% of this predicted 1973 price increase. By comparison, the increase in returns to farming explained 30% of the predicted land price change in 1973. Over the period 1972-75, the rate of inflation and the real rate of return on capital had effects similar in magnitude to the effects of farming return. Just and Miranowski also found that government payments accounted only for a small part of fluctuations in US farmland prices. Minor effects of credit availability were also estimated (rejecting the Shalit and Schmitz's hypothesis). Hence, Just and Miranowski concluded that inflation and changes in the real returns on capital were major explanatory factors in US farmland price fluctuations, in addition to returns to farming.

At this stage, one may conclude that while it is clear that farm income or rent can help explain a significant portion of farmland price movements, it cannot be considered as the only, even the major, determinant of farmland price fluctuations. This suggests that simple capitalisation formulas fail to provide an accurate representation of farmland prices. This idea was actually present in most of previously mentioned studies. However, Just and Miranowski were the first to provide empirical results on the relative importance of the main alternative explanatory factors proposed across the literature. And the main insight that can be drawn from their study is that if returns to farming are one determinant of farmland price formations, they are not the only one, nor the major one.

2.2.2. The present value approach questioned

Featherstone and Baker (1987) is one of the first studies that questioned the empirical finding that net real returns are the major factor explaining land values. Covering a long time period and using vector autoregression (VAR), Featherstone and Baker estimated the simultaneous system of equations of asset value, returns to asset and interest rates. The lags of each variable were used as regressors in each equation and both authors were able to test for the presence of an asset price fad and/or bubble. Such a fad or bubble may result from speculative behaviours in farmland prices. Featherstone and Baker's results confirmed that speculative forces played a major role in US farmland price fluctuations. Likely large and random price responses are inconsistent with a present value formulation.

A number of studies using co-integration techniques reached similar conclusions. Campbell and Shiller (1987) showed that if the PVM is correct, then land rents and land prices should have the same time series properties and the spread, defined as the stationary linear relationship between land rents and prices should add useful information in forecasting future changes in rents given past changes in rents. These restrictions have been used as a test for the appropriateness of the PVM in a number of subsequent studies. Falk (1991) found that although highly correlated, US land price movements are more volatile than rent movements. Therefore, Falk rejected the PVM on the basis of the second Campbell and Shiller's set of restrictions. Using the same procedure, Clark, Fulton and Scott (1993) also showed that the PVM did not hold for US farmland prices. As for Hallam et al. (1992) they rejected the first set of restrictions for UK data. They showed that all variables considered as land returns proxies (rent, farm income and real gross product) could not be co-integrated with land prices as the series did not present the same order of integration.

Then, a number of studies tested for two main reasons for rejection of the PVM: time-varying discount rates and the presence of speculative bubbles (as already suggested by Featherstone and Baker). Using the Campbell and Shiller's approach, Falk (1992) tested and rejected the time-varying version of the PVM as an explanation of Iowa farmland prices. Hanson and Myers (1995) allowed for a time-varying risk premium, but also rejected the PVM. Tegene and Kuchler (1993) tested for the presence of speculative bubbles in US farmland prices and concluded to the rejection of such an explanatory factor of land price fluctuations. However, their tests were challenged by Engsted (1998). Finally, Falk and Lee (1998) proposed an approach to decompose farmland price series into movements attributable to fundamental factors (i.e., factors that influence the time paths of rents and interest rates) and movements attributable to nonfundamental factors (e.g., speculative behaviour). The approach is then applied to annual Iowa farmland prices (over the 1922-94 period). Falk and Lee found that nonfundamental shocks appear to play an important role in explaining the short-run behaviour of farmland prices. In the long-run however, farmland prices are mostly explained by permanent fundamental shocks. Thus, they concluded that deviations of farmland prices from predictions of the PVM are important in the short-run but not in the long-run. Furthermore, the short-run deviations appear to be a combination of overreactions to temporary fundamental shocks and reactions to nonfundamental factors.

In line with the underlying idea of Falk and Lee, a number of studies proposed to decompose farmland price movements into a market-driven fundamental price and a speculative nonfundamental price, with the latter allowed to exhibit differentiated dynamic behaviours. A general regime-switching model that may nest many types of speculative behaviours as special cases can thus be estimated in order to test which speculative behaviour prevailed according to the data used. Such an approach, together with a review of previous similar studies, was used by Roche and McQuinn (2001) in order to test for the presence of speculative behaviours in Irish agricultural land prices. Their results suggested that the partially collapsing bubbles model provides a reasonable description of the dynamic movements in Irish agricultural land prices over the 1911-96 period.

Following this literature, co-integration testing has become a routine in many studies. For example Clark, Klein and Thompson (1993) for the US and Shigeto and Hubbard (2004) for Japan had the specific objective to test the validity of the basic PVM and confirmed it, while other studies tested the properties of their data as a preliminary step before the empirical application of their modified version of the PVM (e.g. Weersink et al., 1999; Flanders et al., 2004, Duvivier et al., 2005).

3. Agricultural support does affect farmland markets and prices: Empirical evidence

This section reviews studies that have given some empirical evidence regarding the influence of agricultural policies on land markets and prices. The literature review concentrates mainly on a time period from the early 90es. All papers are reviewed firstly in terms of the method they use (in subsection 3.1.) and then in terms of their findings (in subsection 3.2.). A general view is provided in Table 1, that lists the studies by their publication date and gives their main characteristics (method and data used), and by Table 2 that summarises findings for the same studies.

3.1. Methods used in the empirical studies: evolution of the present value model and other approaches

As mentioned in Section 2, the basic PVM has been modified over time after doubts were raised about its capability of representing the true behaviour of land values. The PVM, which hypothesises the exclusive role of returns to farming on farmland value, has been used only by a few studies investigating the impact of agricultural policy on land values. In general studies have used an extended version of the PVM, by assuming varying and different discount rate, by specifying various expectations forms, or by including possible non-agricultural land uses. Other studies have however employed a completely different approach, based for example on utility maximisation or hedonic frameworks.

3.1.1. Traditional present value approaches

The simplest capitalisation formula ($L=R/r$) was applied by **ERS USDA (2001a)**. Using farm real estate values (L) and farm-sector net cash income (R), the authors calculated the capitalisation rate (r) for each year of the period studied. This rate was then applied to income without government payments to evaluate the real estate value in the absence of the payments.

Goodwin and Ortalo-Magné (1992) used the PVM in its simple form as well, but estimated the relationship with econometrics, that is to say assuming measurement errors. The authors estimated their model with GMM to handle rational expectations. They estimated the logarithm form of the model on pooled data, using lagged values as instruments. Their land returns were proxied by two variables: wheat yield and agricultural producer prices. The authors found significant positive effect of these proxies and high R-square (0.91), indicating that the model was a good representation of price behaviour.

As for **Clark, Klein and Thompson (1993)**, they used the basic PVM with a separation of land returns into farm income and (indirect and direct) grain subsidies. They did not estimate it, but simply tested its validity with co-integration tests. They confirmed that the model was appropriate for their data.

3.1.2. The present value approach extended

Despite some studies confirmed with co-integration tests the validity of the PVM (see above Clark, Klein and Thompson, 1993; see later Weersink et al., 1999, Flanders et al., 2004, Duvivier et al., 2005), most of the papers about the effect of agricultural support have used modified versions of the PVM, following the literature questioning the validity of the basic PVM. The most common extensions are specifying varying discount rates, accounting for expectations and including non-agricultural land uses.

Specification of varying or different discount rates

Several authors have specified their discount rates as varying over time (referred later as varying discount rates) or as different between distinct sources of income (referred later as different discount rates), in particular market returns and government returns.

Three studies allowed varying-over-time discount rate for the land returns variable considered in their study, either market-based returns or returns from governmental policy. **Vantreese et al. (1989)** based their study theoretically on the PVM with varying-over-time discount rate for the quota variable. They accounted for this temporal adjustment by multiplying the regressors by the ratio of land value divided by the base period land returns (proxied by rents), calculated as average for the whole region studied. They estimated their linear equation with OLS. **Cavailhès and Degoud (1995)** also estimated with OLS their linear relationship between land prices on the left-hand side, and returns to land and interest rate on the right-hand side, but all variables were taken in logarithm. Hence the authors, although not specifying any expectational forms in the PVM, assumed varying-over-time discount rate via the inclusion of the interest rate. Regarding the land returns, they used gross value added as a proxy, and found that the variable had a significant impact on the data for the whole country, with a short-term, respectively long-term, elasticity of 0.28, respectively 1.67. As for the interest rate, although it had a small (negative in the short term, positive in the long term) impact on land price, its fluctuations explained a large part of the price decrease. They concluded that, from a methodological point of view, it confirmed that a capitalisation formula with constant discount rate was not correct, and that, from a policy point of view, providing subsidised loans for land purchase had the negative consequence of increasing land prices. However, when performing the regression on data separated according to production regions, the land returns variable's estimate was not significant in 8 out of 20 regions studied. They then extended their model with adaptive expectations (see later). **Flanders et al. (2004)** followed the same approach as Cavailhès and Degoud (1995) mentioned above (varying rate, no expectations, logarithm form), but estimated their equation with maximum likelihood to account for autocorrelation. Land returns were approximated by cash rents. The authors reported that Dickey-Fuller tests for land values, land returns (as cash rents) and interest rates did not reject the hypothesis of unit roots that would indicate nonstationarity, suggesting that their model was appropriate.

In opposite to the above studies that accounted only one source of land returns, the following three studies extended the basic PV theoretical formulation, by separating the returns to land into market returns and government payments. **Weersink et al. (1999)** allowed the discount rate not only to vary over time, but also to differ between these two sources. This enabled them to test whether government payments were seen as more transitory or permanent than market returns. The authors assumed rational expectations but specified that both incomes followed a stochastic process, and estimated their system of equations using non-linear SUR. They tested and confirmed that their data were trend stationary series. Similarly to Weersink et al. (1999) **Duvivier et al. (2005)** discounted the distinct sources of income by different rates that were varying over time, and also showed that market returns and direct payments were co-integrated with land prices. By contrast, **Lamb and Henderson (2004)** also separated land returns into market returns and government payments in the PVM, but both sources were discounted similarly albeit with a varying rate over time.

Treatment of expectations

Just and Miranowski (1993) tried several expectation specifications fro their PVM: rational, adaptive (using a geometric lag structure), extrapolative (extending a four-year trend) and naive (using lagged values). The chosen final model was with naive expectations, as it brought the best fit: R-squares were over 0.91 for each state.

However, in the PVM authors most often specified adaptive expectations. Using the basic PVM, **Featherstone and Baker (1988)** did so by introducing in their OLS regression a weighted average of the current and past land returns. **Veeman et al. (1993)** followed Burt (1986) by specifying adaptive expectations in the PVM on the basis of a distributed lag structure on real earnings. Their model was estimated by maximum likelihood, applied to data on farmland and buildings for whole Canada and for four separate provinces, Alberta, Saskatchewan, Manitoba and Ontario, over the period 1961-1987. The short-run elasticity of land price with respect to land returns, proxied by total cash receipts, was 0.38 for Canada. As for the provinces, it ranged between 0.26 (for Saskatchewan) and (0.47 for Ontario). The long-run elasticities were estimated to be 1.79 for Canada and between 0.55 (Manitoba) and 1.61 (Ontario) for the four provinces. Hence, long-run impacts of changes in farm earnings were relatively larger than short-run impacts. The adjusted R-squares being greater than 0.85 for all five regressions, the authors concluded that the earning variable used was a primary determinant of land prices. This method was also applied by **Cavailhès and Degoud (1995)**, who specified adaptive expectations in another PVM used in their paper. They estimated their regression with instrumental techniques (using lagged prices as instruments) to account for serial correlation. They found that the prices calculated with their model closely followed the prices observed.

As for **Goodwin et al. (2005)**, followed later by **Duvivier et al. (2005)**, their treatment of expectations in the PVM implied using average values of land returns over the past few years.

Goodwin et al. (2005) averaged each income source over the two to five past years in each country considered, while Duvivier et al. (2005) averaged only the market returns over the past four years. The former authors estimated their model with probability-weighted bootstrapping, while the latter authors estimated their linear relationship firstly with OLS and then using several panel data specifications. Tests showed that their individual and time fixed-effect specification was the most appropriate.

Account for alternative land uses

Goodwin et al. (2003) extended the PVM to account for possible land conversion. This extension was also used by **Just and Miranowski (1993)**, and by **Goodwin et al. (2005)** in their model elaborating on expectations. As for **Barnard et al. (1997)** and **Duvivier et al. (2005)**, without any theoretical justification they included in their regression proxies representing alternative uses of the land.

Other extension

Just and Miranowski (1993) assumed that the driving force in land markets besides the discounted value of land returns was wealth accumulation. This allowed them to introduce debt and land sale taxation in their PVM.

The study by **Shaik et al. (2005)** (taken up later by **Shaik et al. (2006)** with a time period extension) is the only one that accounts for the counter-cyclical nature of government payments, that is to say the inverse relationship between these payments and the land returns. Separating firstly the two income sources in the PVM, they added an equation explaining the amount of the payments as a function of several determinants including land returns, proxied by the farm crop returns. They estimated the recursive model using a triangular-structure simultaneous equation.

3.1.3. Other methods used

Lence and Mishra (2003) and **Roberts et al. (2003)** used a profit maximisation framework for investigating the effect of agricultural policy on land rents. Although the use of this framework was not explicit in Roberts et al. (2003), Lence and Mishra (2003) developed a theoretical model based on expected profit, and treated expectations by using GMM with lagged regressors as instruments. They also accounted for spatial autocorrelation, and reported R-squares between 0.51 and 0.74.

A few studies based their investigation on the hedonic pricing approach. This approach is common in consumer research and environmental valuation, and was firstly applied to land by Palmquist (1989). According to the approach, in the market for the commodity considered, sellers and consumers are assumed to maximise their profit, and hence their specific bid can be expressed as a function of several parameters influencing their respective profit. In equilibrium the bids are perfectly matched, leading to the hedonic function, that is to say the function of a commodity's price. The interpretation of the function is that observed prices of a product are explained by a vector of specific amounts of quality components. In practice however, the components entering the hedonic function are usually chosen without theoretical justification. **ERS USDA (2001b)** and **Taylor and Brester (2005)** followed this approach, and included as determinants soil quality, urban influence, irrigation and parcel's size, but without justifying their choice. The most ad hoc approach was however used by **Barnard et al. (1997)**, who set an empirical regression of the land prices over several determinants without any reference to any theoretical model, even not hedonic. They estimated with OLS the log-linear form of the regression, which did not include any land returns variable. Their analysis was complemented by a non-parametric regression to investigate in more details the geographical differences in the responsiveness of land prices.

A few other approaches can be mentioned. **Offut and Shoemaker (1990)** used a translog cost function to evaluate the share of land in production costs. **Rutherford et al. (1990)** used a GE model focused on the capitalisation of wheat subsidies, while **Traill (1982)** used a PE model, where the price of land was assumed to depend on net farm income, expected growth in land prices and in net farm income, interest rate and amount of land sold. The author estimated the equations with iterative GLS. As for **Bierlen et al. (2000)**, they undertook a survey to investigate the effect of a change in payments on land tenure arrangements.

3.2. Findings from the empirical studies: Extent of the impact of agricultural policy

Studies about the effect of agricultural policy on farmland prices can be split into four broad groups according to their findings. Studies in the first group provided simple empirical support of the effect of public support on land prices. Studies in the second group gave an estimation of the elasticity of the land prices with respect to the support. This can give insights into the effect of the increase or decrease of support by one currency unit on land prices. Studies in the third group have proposed an evaluation of the share of land value accounted for by support, which can help forecast the consequence on land prices of the removal of support. Finally, the last group consists in studies investigating the effect according to the beneficiaries of the capitalisation gains.

3.2.1. Evidence of the effect of public support on land prices

Clark, Klein and Thompson (1993) tested the PVM to assess the existence of subsidies capitalisation in Canadian Saskatchewan province over the period 1950-1987. They used the basic PVM with a separation of land returns into farm income and (indirect and direct) grain subsidies. Using co-integration tests, they confirmed that the model was appropriate for their data: the land price and the income plus subsidies were co-integrated, strongly in the short run and more weakly in the long run. However, the land price and the income alone were not. These findings demonstrated evidence of capitalisation of government payments at least in the short run.

Cavailhès and Degoud (1995), for their analysis of price determination in France between 1961 and 1993, introduced a dummy to test for the impact of the 1992 CAP reform. This dummy was not found to be significant, suggesting that the reform did not affect the price determination. Besides, for three production regions (Parisian area and South-West cereal regions, and Jura livestock region) the actual price was much lower than the predicted price for the year 1993 only. This suggested that farmers in those regions had modified their expectations in 1992, possibly anticipating a decrease of the CAP support.

Flanders et al. (2004) estimated their model separately for cropland and for pasture, in the US state of Georgia between 1967 and 2002. Results showed that the elasticity of cropland prices with respect to cash rents (proxying land returns) was 0.51, while the elasticity of pasture prices with respect to cash rents was 0.79. The R-square value of each regression indicated that cash rents explained more variability in land values for cropland than for pasture. The authors concluded that such finding suggested that other factors, in particular non-agricultural ones, had a stronger impact on pasture, while market returns, including government payments, influenced more cropland.

3.2.2. Estimation of the elasticity of the land values with respect to the support

Elasticity of land prices with respect to the support

Traill (1982) was one of the first empirical studies investigating the effect of a change in policy on land prices. Applying his PE model to data of the UK agricultural sector over 1950-1978, the author simulated that an increase in agricultural prices by 1% would increase land prices by about 10% (or £130) over the next twenty years.

Goodwin and Ortalo-Magné (1992) applied their PVM model to the effect of wheat PSE on land and building prices in the US states of Kansas and North Dakota, the Canadian provinces of Manitoba and Saskatchewan, and the French Centre and Picardie regions, pooled together and over the period studied, 1979-1989. The elasticity of land price with respect to producer price was found to be 1.19, and the elasticities with respect to national yields were about 1.10, but were not tested significantly different from 1. These two variables were taken as proxies for land returns. As for the elasticity with respect to wheat PSE, it was shown to be 0.38.

Barnard et al. (1997) investigated the capitalisation of direct payments in cropland farmers' estimated values for 20 main regions (Land Resource Regions) in the US between 1994 and 1996. The objective was to evaluate the extent of the reduction in land values that would be triggered by the 1996 FAIR Act. Using their ad hoc regression, they found that although for more than half of the regions the estimated elasticity with respect to government payments was less than 0.10, it reached 0.69 for the Region 6. As for their non-parametric regression, it enabled them to conclude that the southern Corn Belt and parts of North Carolina, Georgia and Alabama presented the highest elasticities.

Weersink et al. (1999) applied their model, which included distinct discount rates between market returns and government payments, to Ontario between 1947 and 1993. They used several crop, livestock and natural disaster federal and provincial direct subsidies as government payments, and cash income from farm operations as market returns. They firstly tested for co-integration, and showed that the trend in land prices was driven by the trend in government payments rather than the trend in market returns. Short-run elasticities of land prices with respect to market returns and government payments were found to be 0.062 and 0.009 respectively, while in the long run they were 0.433 and 0.625 respectively. This showed that in the long run land prices were more responsive to government payments than to market returns.

Goodwin et al. (2003) and **Goodwin et al. (2005)** investigated the effect of various government payments on crop farmers' estimates of bare land in the US in 1998-2001. Applying a simple version of the PVM including non-agricultural uses, Goodwin et al. (2003) provided various estimates for the effect of the different government payments. The results are not reported here however, since the authors themselves questioned their findings, on the ground that they had not introduced any expectation specification. They later extended their research, giving rise to the paper Goodwin et al. (2005), which uses an elaborated PVM as explained before. In this study the market returns were proxied by gross revenues, given by average county's yields multiplied by state level prices, minus average costs (weighted per specific crops) as given by various research institutions. The authors found that an increase by one dollar of market returns, respectively of total government payments, increased land values by 7.13, respectively 13.44 dollars. This showed that government payments had a stronger impact on land values than market-based returns did. Breaking down the government payments in another estimation, the authors reported that one additional dollar of market earnings still tended to increase land values by 7 dollars approximately. As for the government payments, one additional dollar of LDP, respectively of market transition payments, increased land values by 23.37 dollars, respectively 4.16, while the estimate for disaster payments was not significant. The authors explained this finding by the uncertainty surrounding the disaster payments, which were decided on a year-to-year basis. Conform to the intuition, the effect of one dollar of conservation reserve payments was reverse, reducing land values by 26.45 dollars. The reason behind was that farmers tended to withdraw from production land with low potential productivity, and thus with low potential market returns.

Duvivier et al. (2005) analysed the effects of the 1992 CAP reform on arable land sale prices in Belgium. They applied their extended PVM on average data from 42 districts of the country between 1980 and 2001. Agricultural support was represented by direct payments to cereals, rapeseed, flax and fallow land, and market returns were approximated by the sum of agricultural family income and land costs, net of the direct payments. Results indicated that the estimated elasticity of land prices with respect to market returns was 0.078 and weakly significant. As for the estimates of elasticities with respect to yearly direct payments, they were significant only from 1996 onwards. These estimates ranged between 0.17 and 0.34, that is to say that they were greater than the estimates with respect to market returns. The authors also showed that the effect of direct payments was stronger in a district with a higher share of eligible crop (Wallonia, compared to Flander).

Shaik et al. (2005) had the objective to analyse the effect of 12 farm bills (1940-2002) on US land values. Using their recursive model accounting for the counter-cyclicality of government payments, they found that land prices had an elasticity of 0.77 with respect to crop returns, while they had an elasticity of 0.35 with respect to government payments. **Shaik et al. (2006)** used the same approach but extended to 1940-2004 in order to include the mist recent Farm Bill, and additionally undertook separate analysis for the 12 Southern States and for the other states. They found that the elasticity of land prices with respect to farm returns in the whole US ranged from 0.29 to 0.77 over the period. As for the elasticity with respect to government payments, it was between 0.10 and 0.46 over the period. The highest elasticity was reached during the 1960-1965 and it has since decreased, with an estimate of 0.12 in the last Farm Bill (2002-2004). Comparing the elasticity estimates of the Southern States with those of the other states revealed that the estimated for the former were lower than the estimates for latter until the 1996 Farm Bill, since when the relationship was opposite.

Taylor and Brester (2005) focused on the implication of the US sugar policy on irrigated land sale prices in Montana in 1986-1999. The investigation was in fact focused on the impact of domestic sugar beet prices, which are kept high mainly due to import restrictions. Estimating a hedonic equation with GLS the authors found that the elasticity of land prices with respect to cash receipts from crop sales (i.e. land returns) was 0.10, while the elasticity with respect to the annual price of sugar beets was 0.16. They concluded that non-cash income transfers generated by the US sugar policy were capitalised in land prices, and that changes in the policy that would encompass a reduction of domestic sugar beet prices would result in a fall in land prices.

Elasticity of land rentals with respect to the support

Lence and Mishra (2003) were interested in the effect of public support on land rents. The application of their expected profit maximisation model was to cash rents in Iowa between 1996 and 2000, and to the influence of various government payments. The authors reported that one additional dollar of government payments increased the rent by 0.13 dollar only. However, when decomposing the various payments, they found that the market loss assistance payments and production flexibility contracts (PFC) had a strong influence (increase of about 0.85 dollars in rent for one additional payment dollar), while deficiency payments had a weaker but unexpected negative impact (decrease of 0.23 dollars).

Roberts et al. (2003) also focused their research on land rents, and more particularly on the influence on them of the PFC launched by the 1996 FAIR Act. They estimated the impact of PFC payments (less conservation payments) on land rentals for US Census farms in 1992 and in 1997. For each year several models were estimated, including one or more explanatory variables besides the PFC payments. Results indicated that according to the models, in 1997 the effect of one additional PFC dollar was to increase rentals by 0.33 to 1.55 dollar, the smallest (largest) value being obtained with the most (only one) additional explanatory variables. In 1992 the respective figures were 0.23 and 0.76 dollar.

Goodwin et al. (2005) estimated two additional models using respectively cash rentals and share rentals as the dependent variable for US farms in 1998-2001. They found that the increase of market earnings by one dollar increased cash rentals by 0.35 and share rentals by 0.51. However, one additional dollar of LDP had a stronger effect on cash rentals than one additional of market earnings did: +0.88. The effect of market transition payments was +0.29. The effect of one dollar of disaster payments was not significant, confirming the uncertainty of this program, while the effect was conform to the intuition for conservation reserve payments: –0.41 dollars. As for share rentals, LDP and market transition payments had no significant effect, while the effect was +4.66 for disaster payments. The authors suggested that the reason behind these findings was that land receiving disaster payments was associated with a larger risk premium than other type of land, and that this large risk effect was likely to offset the effect of other payments.

Dilution and uncertainty

Studied usually found that the effect of one additional dollar of payment was an increase of less than one dollar of land price. This dilution can be explained by the fact that, in the case of some support programs, farmers have to fulfil some requirements such as set-asides which imply reduced income. Cross-compliance requirements might also decrease farm income by imposing maintenance costs. **Rutherford et al. (1990)** also gave evidence of this dilution effect using a GE model of global trade in wheat calibrated with 1981 data. The authors forecasted that the capitalisation rate of the US wheat price support program was 25%, meaning that 75% of the capitalisation was diluted. They explained this result by the conditionality of the support: set-aside requirements imply additional costs for participants, which might offset the benefit of the support.

Most of the studies reporting an elasticity estimate of land values with respect to public farm programs found an estimate less than one. This inelastic response could be explained by the way agents discount the government payments. Were the latter seen as transitory, they would be heavily discounted, implying a lower elasticity of response. The agents would however discount less heavily payments that they would consider permanently available. In other words, if agents have doubts about the certainty of farm programs, land prices will be lower than if payments were to continue indefinitely. **Schmitz (1995)** was the first one to highlight this uncertainty issue, by showing that Ricardian rents (including government payments) and wealth did not bear a one-to-one relationship.

Using estimated wheat supply elasticity from another study, the author calculated the fall in farm asset values for Canadian farmers in the Prairie region in 1982-1986, that would result from a drop in wheat prices. The actual decrease was much lower than the predicted drop, suggesting that not all rents from the government were capitalised into land values. The author therefore offered the explanation that government payments were heavily discounted due to uncertainty nature of the ad hoc farm programs in Canada. **Weersink et al. (1999)** found however the opposite for Ontario land prices during 1947-1993. The authors discounted differently market-based returns and direct government payments. The test for equality of the discount factors for these two income sources was rejected. The implication was that government payments were less heavily discounted than market returns. In other words, the payments were considered as more stable than the market returns by the Ontario farmers during the period studied. As for **Goodwin et al. (2005)**, they had found that an additional dollar of disaster payments had no significant impact on cropland in the US in 1998-2001, while LDP and market transition payments had a positive influence. The authors attributed this non-significant effect to the uncertainty surrounding the disaster payments, which were decided on a year-to-year basis.

3.2.3. Evaluation of the share of land value accounted for by support; effect of removal of support

Featherstone and Baker (1988) used their PVM with adaptive expectations to the case of land prices and cash rents in Tippecanoe County in Indiana between 1960 and 1985. Country's average data on 1 February of each year were used. Returns to land were proxied by the gross revenue (yield time price) minus all direct and indirect costs for corn and soybean productions. The estimated coefficient for land returns were 5.94, respectively 0.08, for the regression with cash rent, respectively land price, as dependent variable. They performed a simulation of cash rents and land prices behaviour under two alternative scenarios: a continuation of the current (1985) policy and a move towards a more free market over 1985-1990. Cash rents and land prices were forecasted with the OLS parameters, after having simulated the change in land returns with FEEDSIM model. Results showed that cash rents would decrease more and land prices would increase less under the more free market than under the policy continuation. More precisely, cash rents would decrease on average from 82 dollars per acre to 80, respectively 70, dollars per acre under policy continuation, respectively in case of a freer market. For land prices, the figures were an increase from 1,058 to 1,284, respectively 1,118 dollars per acre. The authors also indicated that the average land price projected in 1990 was relatively close to the long run equilibrium, under both scenarios.

The case of the burley tobacco US program was the object of the paper by **Vantreese et al. (1989)**. This program combines quotas tied to specific land and price support, and the authors estimated the capitalised value of the base burley tobacco quota in pounds per acre. The data used were sales of bare land parcels larger than 10 acres in Kentucky during 1973-1985. Results revealed that over this period the quotas accounted for between 12.1% (in 1985) and 38.9% (in 1976) of the land prices. Generally, after 1980 the share in land values was not more than 15%.

The GMM procedure used by **Goodwin and Ortalo-Magné (1992)** enabled them to perform simulations of land price changes in 1990-1995 under different scenarios in the specific regions considered in the US, Canada and France. They found that a reduction of wheat PSE by one half of their 1989 value would reduce more land prices than a continuation of the present policy would do, but in France only. Prices in Centre and Picardie regions were indeed forecasted to be lowered by 60-120 dollars per acre by the PSE reduction. The effect was however found to be reverse in the US and Canada states considered: land prices would be greater by 50 dollars per acre under the liberalisation scenario than under the present policy. The authors concluded that their findings were consistent with the theoretical predictions that factor prices would equalise under free trade.

Just and Miranowski (1993) applied their PVM for US data of land values from 1963 to 1986, using net farm returns to farming as land returns. In the final model with naive expectations, the authors found that government payments accounted for 15-25% of land prices, but did not account for fluctuations in those prices during the period studied.

Veeman et al. (1993) had estimated elasticity of land prices with respect to farm earnings for whole Canada and for four separate provinces, Alberta, Saskatchewan, Manitoba and Ontario, over the period 1961-1987 (see before). The authors used these estimates to evaluate the effect on land prices of a removal of all direct payments in Canada from 1991 onwards. Assuming that such abolition would decrease farm income by 13.1% on average, they estimated that land prices would decrease by 4.98% in the short run and 18.47% in the long run. As regard to the four provinces studied, the short-run effect would range between a 3.76% (Ontario) and a 6.48% (Alberta) reduction, while the brackets for long-run impacts were 12.16% (Ontario) and 29.87% (Saskatchewan). Exploring in details the adjustment paths revealed that the price decrease would follow an exponential trend, with the sharp reduction occurring in the first six years.

The use of the simplest capitalisation formula enabled **ERS USDA (2001a)** to calculate the land value in the absence of government payments. Results showed that the observed value and the evaluated value without payments were very similar between 1970 and 1979, differing only by less than 4%. However, from this date onwards the calculated value was lower than the observed value by less than 19% in the 80es. The gap between both values reached the highest peak of 25% during the last years of the period studied, 1998-2001. This indicated that government payments accounted for a substantial share of land values from the 80es. The authors however acknowledged the limits of their approach, namely that their model assumed that government payments contributed dollar-for-dollar to net income and that the potential alternative uses of land were not taken into account.

In another piece of research **ESR USDA (2001b)** investigated the effect of crop direct payments on bare land of farms receiving such payments in the US in 2000. Using a hedonic model on county's averages, the authors estimated that the payments accounted for 19.7% of the value of land in the US.

Performing separate regressions for various regions revealed that the lowest rate of capitalisation was found in the Mississippi Portal region (with 7.5% of the value of land attributed to them), and the highest rates were found in the Heartland region (24%), the Prairie Gateway region (23%) and the Northern Great Plains (22%).

Lamb and Henderson (2004) investigated the effect of the 1996 FAIR Act (implying reduced support) on land values in the US Corn Belt over the period 1996-2002. In order to use the PVM with two sources of income, they calculated projected market returns for the period studied with a representative farm model for each state, using corn production costs and revenues. They estimated that during 1995-1997 the average cropland values were supposed to increase by 30.7%. As this projection was consistent with findings from an existing survey, they concluded that their model was appropriate for representing land prices behaviour. They then forecasted that the land values would decrease by 16% between 1998 and 2002. They also reported that the states where the average production cost for corn was the lowest would experience a boom in land prices over 1996-2002. For example in Minnesota prices would increase by 9.3%. By contrast, prices in Colorado where production costs are high would drop by 35%.

Shaik et al. (2005) estimated a second model by restricting the sum of the elasticity of crop returns and the elasticity of government payments to unity, which would enable them to conclude about the share of payments accounted in the land value. They found elasticities of 0.69 and 0.30 for crop returns and government payments respectively, indicating that such payments accounted on average for 30% of land prices in the US over 1940-2002. Examining more deeply the values for each of the 12 farm bills of this period by interacting time dummies with the payments variable, they found that over the period the share of value accounted by the payments ranged between 30 and 70% across time and states. On average for the whole US a peak was reached in 1965 to 38% and since then consistently declined to 19% in the last year studied (2002). Using the same approach to the comparison of Southern States with other states, **Shaik et al. (2006)** found that the share of land values attributed to government payments were lower in the Southern States until 1990, where it became greater than 40% (with a peak at 67% in the last Farm Bill) while the share for the other states decreased around 20% from 1990. According to the authors, such difference might be due to differences in the type of agriculture and supported commodities between Southern and other states.

3.2.4. Who benefits from the capitalisation?

While it is recognised that the distribution of the payments' benefits between owners and tenants is a key issue (see Introduction), it has not been significantly investigated in the literature. The situation in the US is relatively complex to study, since lease arrangements could be cash-based or share-based. Under a cash lease agreement farmers and landowners agree about the rent before the production realisation. This means that landowners do not share the risk of production and hence should not share the government payments; they can however capture the benefits by increasing the rent that they ask. Under a share lease agreement the exact rent amount is known only after farmers are sure about what earnings and payments they will get, but shares of the revenue that will go to each part are decided ex ante. Hence, government payments are given to the tenanted farmer and to the landowner, on the basis of the proportions agreed in the arrangement. For example, according to ERS USDA (2001b) in South Dakota and Nebraska in the mid 80es surveys showed that most of the landlords received one-third or one-quarter of the payments.

Offut and Shoemaker (1990) investigated the effect of acreage control on the share of land in the value of production. Using a translog cost function for aggregate US data between 1948 and 1984, they found that although land-saving technological change had decreased this share by 2 percent per year, the effect had been countered by the acreage programs, which increased the land cost share by almost 1 percent annually. The authors therefore concluded that any elimination of such programs would have a negative effect mainly on landowners rather than on the providers of labour and capital.

From their study **ERS USDA (2001b)** reported that on average for the US 38% of the payments in 2000 were received by operator landowners and 62% by non-operator owners. In most of the regions the non-operator landlords received the largest share of the payments, up to 75% in the Mississippi Portal region. Only in the Eastern Uplands region the operator landowners received more than half of the payments (61%). The authors highlighted that this finding was crucial, since operator owners owned only 40% of the farmland in the US. The authors also reported that the capitalisation of payments differed according to the farmers' age. Farmers over 55 received 38% of the payments, while farmers under 35 received only 6%.

Goodwin et al. (2005) found that one additional dollar of LDP and of market transition payments had a significant positive effect on cash rentals (+0.88 and +0.29 dollar respectively) for US farms in 1998-2001. This suggested that landlords were successful in getting a large share of the government payments despite the legislation that supposedly directed the benefits to the operators in the case of cash lease arrangements.

Goodwin et al.'s (2005) finding that cash-lease landlords were successful in getting a large share of the government payments had been investigated earlier by **Bierlen et al. (2000)** for Arkansas farmers. The authors hypothesised that the 1996 FAIR Act would induce landlords to ask for higher cash rent as the level of government payments were known by certainty and tied to assets. To test their hypothesis they surveyed 214 farm operators in Arkansas in November 1997. However, contrary to their expectations, most of the tenant respondents indicated that the FAIR Act had no influence in changing their lease arrangements. Additionally, only less than 7% of the tenants reported termination of a lease, supposedly for the reason that landlords would farm the land themselves in order to collect the government payments. This weak support for their prior hypothesis conducted the authors to conclude that their survey might had been done at an early stage which did not reflect full adjustment, or that landlords were not well informed about the policy change.

Table 1: Characteristics of the studies cited in the main text

Study	Objective	Data used			Method used	
		Region	Date	Type of data	Base model	Econometrics used
Traill (1982)	Effect of an increase in agricultural prices on land prices	UK	1950-1978	Annual data	PE	Iterative GLS
Featherstone and Baker (1988)	Effect of a move towards more free market on land prices and cash rents	Tippecanoe Country in Indiana	1965-1985	County's averages on 1 February 26 obs	PVM with adaptive expectations	OLS
Vantreese et al. (1989)	Effect of burley tobacco quotas on land values	Kentucky	1973-1985	Sales>10 acres Bare land 2,327 obs	PVM with varying discount rate	OLS
Offut and Shoemaker (1990)	Effect of acreage control programs on share of land in production costs	US	1948-1984	Aggregate data	Translog cost function	ML
Rutherford et al. (1990)	Effect of conditionality in wheat programs on land prices	US	Calibration with 1981	Aggregate data 13 countries	GE model	None
Goodwin and Ortalo-Magné (1992)	Effect of wheat subsidies on land values	US Kansas and North Dakota, Canada Manitoba and Saskatchewan, French Centre and Picardie regions	1979-1989	Annual averages	PVM	GMM on pooled data
Clark et al. (1993)	Whether direct and indirect payments are capitalised in land prices	Canada Saskatchewan	1950-1987	Annual averages	PVM	Co-integration tests
Just and Miranowski (1993)	Share of government payments in explaining land prices and fluctuations in land prices	US	1963-1986	Annual and state averages	PVM introducing wealth accumulation Account of debt, taxation Naive	Non-linear SUR

					expectations	
Veeman et al. (1993)	Effect of direct payments on land prices	Canada, Alberta, Saskatchewan, Manitoba, Ontario	1961-1987	Land and buildings	PV with adaptive expectations	ML
Cavailhès and Degoud (1995)	Effect of the 1992 CAP reform on land prices	France	1961-1993	Sale prices Annual averages	Basic PVM and PVM with adaptive expectations and varying discount rate	OLS and instrumental techniques
Barnard et al. (1997)	Effect of direct payments on cropland prices	20 US Land Resource Regions	1994-1996	Farmers' estimates of cropland	None	OLS and non-parametric regression
Weersink et al. (1999)	Effect of direct payments on land prices	Ontario	1947-1993	Annual averages	PV with varying and different discount rate	Non-linear SUR
Bierlen et al. (2000)	Effect of 1996FAIR Act on lease arrangements	Arkansas	November 1997	214 obs	Survey	None
Lamb and Henderson (2000)	Effect of 1996 FAIR Act on land prices in Corn Belt	US states in the Corn Belt	1965-2002	Annual averages	PVM with varying discount rate	None
ERS USDA (2001a)	Effect of direct payments on land prices	US	1972-2001	Land and buildings	PVM	None
ERS USDA (2001b)	Effect of crop direct payments on land prices	US	2000	Bare land of farms receiving payments County's averages	Hedonic	Not specified
Lence and Mishra (2003)	Effect of various government payments on land cash rents	Iowa	1996-2000	County's annual averages	Profit maximisation	GMM; account for spatial autocorrelation
Roberts et al. (2003)	Effect of PFC payments on land rents	US	1992 and 1997	> 61,000 obs	Profit maximisation	OLS
Flanders et al. 2004	Effect of land returns on cropland vs. pasture	Georgia	1967-2002	Annual data during early months 36 obs	PVM	ML
Goodwin et al.	Effect of various	US	1998-2001	Crop farmers'	PVM with	Probability-weighted

(2003)	government payments on land prices and rentals			estimates Pooled data 13,606 obs	non-agricultural uses	bootstrapping
Goodwin et al. (2005)	Effect of various government payments on land prices and rentals	US	1998-2001	Crop farmers' estimates Pooled data 5,929 obs	PVM with non-agricultural uses; expectations accounted with averaged past values	Probability-weighted bootstrapping
Duvivier et al. (2005)	Effect of 1992 CAP reform on arable land prices	Belgium	1980-2001	Sale price District's average	PVM with different discount rates; expectations accounted with averaged past values	OLS and several panel data specifications
Shaik et al. (2005)	Effect of 12 Farm Bills on land values	US	1940-2002	Not specified	PVM accounting for counter-cyclicality of payments	Triangular-structure simultaneous equations
Taylor and Brester (2005)	Effect of US sugar policy on land values	Montana	1986-1999	Sale price Irrigated land 569 obs	Hedonic	GLS
Shaik et al. (2006)	Effect of 13 Farm Bills on land values	US, Southern and other states	1940-2004	Not specified	PVM accounting for counter-cyclicality of payments	Triangular-structure simultaneous equations

Notes:
'Land prices/values' stands for 'agricultural land prices/values'. 'Obs' stands for 'observations'. 'Different' discount rate stands for 'different across income sources', while 'varying' discount rate stand for 'varying over time'.

Table 2: Findings of the studies about effect of agricultural support cited in the main text

Study	Main country	Date	Type of support investigated	Elasticity of land value with respect to the support (%)	Share of land value accounted for support or effect of decrease of support	Other findings
Traill (1982)	UK	1950-1978	Increase of agricultural prices by 1%	10		
Featherstone and Baker (1988)	US	1960-1985	Move towards more free market		Move would increase less land prices and decrease more cash rents than under policy continuation	
Vantreese et al. (1989)	US	1973-1985	Burley tobacco quota in pounds per acre		12-39% <15% after 1980	
Offut and Shoemaker (1990)	US	1948-1984	Acreage control programs			Increased by 1% the value share of land in production costs
Rutherford et al. (1990)	US	Calibration with 1981	Wheat price support			Dilution of 75% of the capitalisation
Goodwin and Ortalo-Magné (1992)	US, Canada, France	1979-1989	Wheat PSE	0.38		Decrease of 50% PSE would increase by 60-120$ (resp. decrease by 50$) prices in France (resp. US and Canada)
Clark et al. (1993)	Canada	1950-1987	Direct and indirect subsidies for grain			Evidence of capitalisation
Just Miranowski (1993)	US	1963-1986	Government payments		15-25%	Government payments do not account for fluctuations in land prices
Veeman et al. (1993)	Canada	1961-1987	Direct payments		Removal would decrease prices by 4-6% in SR and 12-30% in LR	
Cavailhès and Degoud (1995)	France	1961-1993	Dummy for 1992 CAP reform			In 3 regions the prices are lower after reform due to pessimistic expectations

Barnard et al. (1997)	US		Direct government payments	0.12-0.69		
Weersink et al. (1999)	Canada	1947-1993	Direct government payments	Short-run: 0.009 Long-run: 0.625		Government payments discounted less heavily than market returns
Bierlen et al. (2000)	US	1997	1996 FAIR Act			No strong changes in lease arrangements
Lamb and Henderson (2000)	US	1996-2002	Time period that includes 1996 FAIR Act			Prices increased by 31% in 1996-1998 but decreased by 16% in 1998-2002
ERS USDA (2001a)	US	1972-2001	Government payments		4% in 1972-1981 19% in 1982-1989 13% in 1990-1997 25% in 1998-2001	
ERS USDA (2001b)	US	2000	Crop direct payments		20%	38% (resp. 62%) of payments were received by operator (resp. non-operator) owners
Lence and Mishra (2003)	US	1996-2000	Total government payments According to type of payments	Effect of 1$ payment on rent: +0.13$ Figures are +0.85$ for PFC and market loss payments, -0.23$ for LDP		
Roberts et al. (2003)	US	1992 and 1997	PFC payments without conservation payments	Effect of 1$ payment on rent: +0.23-0.76$ in 1992, +0.33-1.55$ in 1997		
Goodwin et al. (2003)	US	1998-2001	Total government payments According to type of payments			Findings questionable due to the non-account of expectations Method extended in Goodwin et al. (2005)
Goodwin et al. (2005)	US	1998-2001	Total government payments According to type of payments	Effect of 1$ payment on price: +13$ Effect of 1$ LDP on price / cash rental / share		Cash-lease landlords successful in getting part of payments although such sharing is not established by legislation

				rental: +27$ / +0.83$ / not significant		
Duvivier et al. (2005)	Belgium	1980-2001	Direct payments to crop and set-aside	0.17-0.34		
Shaik et al. (2005)	US	1940-2002	Government payments	0.35	30% 38% in 1965, 19% in 2002	
Taylor and Brester (2005)	US	1986-1999	Domestic price of sugar beet (kept high due to import restrictions)	0.16		
Shaik et al. (2006)	US	1940-2004	Government payments	0.12 in 2002-2004	Lower (higher) before (after) 1990 in Southern States than in other states	

4. Conclusion

The economic literature clearly suggests that agricultural policies do affect farmland rental and selling prices. Consequently it is likely that, at least, part of agricultural support is capitalised into farmland values and rents and ultimately benefits landowners.

As shown by this report, agricultural production theory allows to derive some general insights as regards the impact of various policy instruments on the rental price of farmland. These main insights may be summarised as follows:

- agricultural support policy instruments contribute to increase the rental price of farmland;
- the extent of this increase closely depends on the level of the supply price elasticity of farmland relative to those of other factors/inputs on the one hand, the range of the possibilities of factor/input substitution in agricultural production on the other hand;
- whatever the policy instrument the lower the elasticity of farmland supply the higher the increase in the rental price of farmland;
- for the output price support instrument, the higher the degree of substitution between land and non-land factors/inputs the lower the extent of land use and land rental price increases. At reverse, for the land subsidy instrument, the higher the degree of substitution the greater the extent of land use and land rental price increases;
- as shown by some authors, an output subsidy will unambiguously have lower impact on land rental price than an equal cost land subsidy. In other words, a larger part of support is "capitalised" in the rental price of land when this support is provided through a land subsidy than through output price support.

These results suggest that:

- the current evolution of agricultural policies in OECD countries is likely to reinforce the capitalisation of support in the farmland rental price. Indeed, the decapitalisation of support that should follow the decrease in the support based on output should be more than counterbalanced by the intensification of capitalisation of support that should follow the increase in support based on area. Hence the current evolution of agricultural policies in OECD countries makes the issue of capitalisation of support into farmland prices even more crucial;
- as effects of agricultural policy instruments on the rental price of farmland are very sensitive to supply price elasticities of factors/inputs and elasticities of substitution in agricultural production, these parameters should be assessed very cautiously.

Supply price elasticities of factors/inputs, in particular land, closely relate to the degree of mobility of these factors/inputs between agricultural and non-agricultural sectors and within agriculture between alternative agricultural uses. The degree of mobility of land between alternative uses depends on two main factors. The first one is technical and refers to the homogenous or heterogenous nature of land. The second one is institutional and relates to land management laws and policies that most often prevent landowners to convert their land from agricultural to non-agricultural uses. It is commonly admitted that the elasticity of land supply to the agricultural sector is very low, and lower than the supply price elasticities of non-land factors/inputs, at least in OECD countries. But an overview of existing literature reveals that there are no available empirical estimates of supply price elasticities of land. Therefore, further work is needed in this field in order to get a clearer idea about the levels of these parameters in various countries.

Substitution elasticities provide indications on the degree of flexibility of the production technology. One can find numerous estimates of elasticities of substitution between factors/inputs used in agricultural production. However estimates vary widely across studies, pairs of factors/inputs sometimes moving from strong substitutes to strong complements.

These results shed some lights on the ability of global simulation models to deal with the question of the capitalisation of support in the farmland prices:

- global simulation models most often rely on the framework of the standard agricultural production theory. Hence the price of farmland that is considered is the rental price. Therefore, global simulation model are adapted to deal with the effects of agricultural policies on the farmland rental prices;
- simulation results of the effects of agricultural policies on farmland rental prices, obtained from these models, closely depend on both their calibrated elasticities of agricultural factor/input supply and calibrated elasticities of substitution in agricultural production. Global simulation models differ in the parameters they use and, above all in the "quality" of these parameters, that is in the amount of work that has been put and the amount of information that has been compiled in calibrating them;
- global simulation models are well-adapted to represent the first incidence of "true" subsidies. They may face difficulties to account for the first incidence of direct payment-type instruments;
- the land heterogeneity assumption is better adapted to represent the first incidence of area payments used in association with constraints such as base area and set-aside provisions;
- although most currently used direct payments are more or less explicitly tied to farmland this is not clear whether they operate like "true" land subsidies. Hence further work is needed to

determine whether payment rights are actually embedded in eligible farmland or can be considered as a new asset that would be able to capture part of the support.

The impact of agricultural policies on the selling price of farmland has very rarely been examined from a theoretical point of view. Indeed it is commonly assumed in existing studies that the buying and selling prices of farmland can be adequately approximated by the discounted sum of future rental prices, so that a prediction about the direction of the rental prices is equivalent to a prediction about the direction of the buying and selling prices. As a result most theoretical work has focused on the rental price of farmland.

The hypothesis that buying and selling prices of farmland can be approximated by the discounted sum of future rental prices is exactly the one that underlies the present value approach. This approach has been extensively used in empirical studies on farmland price formation. Early studies used a basic capitalisation formula derived under basic assumptions regarding individuals' expectations of net returns to farming and the used discount rates. Then, this basic capitalisation formula has been widely modified in order to account for many aspects that authors thought as to be important determinants in farmland price formation. These aspects cover mainly different expectations schemes, the explicit account of government support programs, capital gain considerations, credit market constraints and imperfections, changes in risk and nonfarmland returns to land. Such studies usually use traditional regression analyses where the impact of each farmland price potential determinant (including government support programmes) is summarised through a single parameter. Hence no theoretical insight can be derived from such an approach where the extent of the capitalisation of support in farmland prices becomes a pure empirical issue.

The review of empirical literature regarding the impact of agricultural policy on farmland values identified several relevant papers written from the late 80es. Despite the wide differences between the studies in terms of method and data, one can try to summarise the findings in a few main points.

- Government payments and other types of support (price support, quotas) are important in explaining land prices. Not only they are major trends in land prices (Clark, Klein and Thompson 1993; Weersink et al., 1999), but they also account for a large share of the land prices. In general studies agree about a share around 15-30%, although it could be up to 70% depending on specific regions and dates.
- Land prices and rents have a significant positive response to government support. Although the magnitude of the response varies across studies[23], it has almost consistently been showed

[23] Oltmer and Florax (2001) attempted to compare statistically the findings from 17 different studies reporting elasticities of land prices with respect to earnings including farm support. Using meta-analysis based on several factors regarding the methodology, the commodity, the location, the period and the type of data, they found no

to be less than 1. Such inelastic response is thought to reflect uncertain future of the farm programs. However, there is no consensus about whether government payments are discounted more heavily (that is to say, are seen as more transitory) than market earnings. Despite this, in general studies have indicated that land prices are more responsive to government-based returns than to market-based returns.

- One dollar of government payment is not fully transmitted to land prices. This dilution of the capitalisation might be due to costly requirements that accompany farm programs (set-aside, cross-compliance).
- Farmers are not the sole beneficiaries of the programs. A large share of the support is going to non-operator landowners.

Although some contradictions remain among findings from the empirical studies, what appears clearly is that part of the payments are capitalised in land prices, implying that governments have partially missed their target of providing income support to farmers. It is also clear that the way agents see the policy (credible, transitory) has crucial implications for the welfare of farmers.

---

significant differences between elasticities of land prices with respect to land returns according to the methodology used. They also reported that the elasticities with respect to returns in which both price and income support were included, were higher than with respect to returns including only one type of support.

References

Alston, J.M. 1986. An analysis of growth of US farmland prices, 1963-82. *American Journal of Agricultural Economics*, 68(1): 1-9.

Arnott, R.J., Lewis, F.D. 1979. The transition of land to urban use. *Journal of Political Economy*, 87: 161-170.

Baker, T.G., Ketchabaw, E.H., Turvey, C.G. 1991. An income capitalization model for land value with provisions for ordinary income and long-term capital gains taxation. *Canadian Journal of Agricultural Economics*, 39(1): 69-82.

Barnard, C.H., Whittaker, G., Westenbarger, D., Ahearn, M. 1997. Evidence of capitalization of direct government payments into U.S. cropland values. *American Journal of Agricultural Economics*, 79(5): 1642-1650.

Bierlen, R., Parsch, L., Dixon, B., Ahrendsen, B. 2000. The 1996 FAIR Act: Measuring the impacts on land leasing. *Review of Agricultural Economics*, 22(2): 336-354.

Burt, O.R. 1986. Econometric modeling of the capitalization formula for farmland prices. *American Journal of Agricultural Economics*, 68(1): 10-26.

Campbell, J.Y., Shiller, R.J. 1987. Cointegration and tests of present value models. *Journal of Political Economy*, 95(4): 1062-1088.

Cavailhès, J., Degoud, S. 1995. L'évaluation du prix des terres en France: Une application de la réforme de la PAC. *Cahiers d'Economie et de Sociologie Rurales*, 36: 49-77.

Cavaillès, J., Wavreski, P. 2003. Urban influences on periurban farmland prices. *European Review of Agricultural Economics*, 30(3): 333-357.

Chavas, J.P., Jones, B. 1993. An analysis of land prices under risk. *Review of Agricultural Economics*, 15: 351-366.

Clark, J.S., Fulton, M., Scott, J.T.Jr. 1993. The inconsistency of land values, land rents, and capitalization formulas. *American Journal of Agricultural Economics*, 75: 147-155.

Clark, J.S., Klein, K.K., Thompson, S.J. 1993. Are subsidies capitalized into land values? Some time series evidence from Saskatchewan. *Canadian Journal of Agricultural Economics*, 41: 155-168.

Cowling, K., Metcalf, D., Rayner, A.J. 1970. *Resource structure of agriculture: An economic analysis*. Pergamon Press, Oxford.

Dewbre, J., Anton, J., Thompson, W. 2001. The transfer efficiency and trade effects of direct payments. *American Journal of Agricultural Economics*, 83(5): 1204-1214.

Dewbre, J., Short, C. 2002. Alternative policy instruments for agriculture support : Consequences for trade, farm income and competitiveness. *Canadian Journal of Agricultural Economics*, 50(4): 443-464.

Duvivier, R., Gaspart, F., Henry de Frahan, B. 2005. *A Panel Data analysis of the Determinants of Farmland Price: An Application to the Effects of the 1992 CAP Reform in Belgium.* Paper presented at the XIth European Association of Agricultural Economists Congress , Copenhagen, Denmark, 23-27 August.

Engsted, T. 1998. Do farmland prices reflect rationally expected future rents? *Applied Economics Letters*, 5: 75-79.

ERS USDA. 2001a. *Government Payments to Farmers Contribute to Rising Land Values*. Agricultural Outlook June-July 2001. Economic Research Service, United States Department of Agriculture, Washington DC.

ERS USDA. 2001b. *Higher Cropland Value from Farm Program Payments: Who Gains?* Agricultural Outlook November 2001. Economic Research Service, United States Department of Agriculture, Washington DC.

Falk, B. 1991. Formally testing the present value model of farmland prices. *American Journal of Agricultural Economics*, 73(1): 1-10.

Falk, B. 1992. Predictable excess returns in real estate markets: A study of Iowa farmland values. *Journal of Housing Economics*, 2: 84-105.

Falk, B., Lee, B.S. 1998. Fads versus fundamentals in farmland prices. *American Journal of Agricultural Economics*, 80: 696-707.

Featherstone, A.M., Baker, T.G. 1988. Effects of reduced price and income supports on farmland rent and value. *North Central Journal of Agricultural Economics*, 10(1): 177-90.

Feldstein, M. 1980. Inflation, portfolio choice and the prices of land and carporate stocks. *American Journal of Agricultural Economics*, 62(4): 532-546.

Flanders, A., White, F.C., Escalante, C.L. 2004. *Comparing Land Values and Capitalization of Cash Rents for Cropland and Pasture in Georgia.* Paper presented at the Southern Agricultural Economics Association Annual Meeting, Tulsa, Oklahoma, 14-18 February.

Floyd, J.E. 1965. The effects of farm price supports on the returns to land and labor in agriculture. *Journal of Political Economy*, 73: 148-158.

Gardner, B.L. 1987. *The Economics of Agricultural Policies*. New-York, Macmillan.

Gisser, M. 1993. Price support, acreage controls, and efficient redistribution. *Journal of Political Economy*, 101(4): 584-609.

Goodwin, B.K., Ortalo-Magné, F. 1992. The capitalization of wheat subsidies into agricultural land values. *Canadian Journal of Agricultural Economics*, 40(1): 37-54.

Goodwin, B.K., Mishra, A.K., Ortalo-Magné, F. 2003. What's wrong with our models of agricultural land values? *American Journal of Agricultural Economics*, 85(3): 744-752.

Goodwin, B.K., Mishra, A.K., Ortalo-Magné, F. 2005. *Landowners' Riches: The Distribution of Agricultural Subsidies*. University of Wisconsin-Madison School of Business, Department of Real Estate and Urban Land Economics, April 2005, unpublished. Cited with permission.

Guyomard, H., Le Mouël, C., Gohin, A. 2004. Impacts of alternative agricultural income support schemes on multiple policy goals. *European Review of Agricultural Economics*, 31(2): 125-148.

Hallam, D., Machado, F., Rapsomanikis, G. 1992. Co-integration analysis and the determinants of land prices. *Journal of Agricultural Economic*s, 43(1): 28-37.

Hanson, S.D., Myers, R.J. 1995. Testing for a time-varying risk premium in the returns into farmland. *Journal of Empirical Finance*, 2(1): 265-276.

Harvey, D.R. 1974. *A theoretical and empirical analysis of agricultural land values in England and Wales*. M.A. Dissertation, University of Manchester.

Herdt, R.W., Cochrane, W.W. 1966. Farm land prices and technological advance. *Journal of Farm Economics*, 48(2): 243-263.

Hertel, T. W. 1989. Negotiating reductions in agricultural support: Implications of technology and factor mobility. *American Journal of Agricultural Economics*, 71(3): 559-573.

Hertel, T.W. 1991. Factor market incidence of agricultural trade liberalization: Some additional results. *Australian Journal of Agricultural Economics*, 35(1): 91-107.

Just, R.E., Miranowski, J.A. 1993. Understanding farmland price changes. *American Journal of Agricultural Economics*, 75(1): 156-68.

Lamb, R.L., Henderson, J. 2000. FAIR Act implications for land values in the Corn Belt. *Review of Agricultural Economics*, 22(1): 102-119.

Latruffe, L., Le Mouël, C. 2006. *Description of agricultural land market functioning in partner countries*. IDEMA working paper, deliverable 09.

Leathers, H.D. 1992. The market for land and the impact of farm programs on farm numbers. *American Journal of Agricultural Economics*, 74(2): 291-298.

Lence, S., Mishra, A. 2003. The impacts of farm programs on cash rents. *American Journal of Agricultural Economics*, 85(3): 753-761.

Lloyd, T.A., Rayner, A.J., Orme, C.D. 1991. Present value model of land prices in England and Wales. *European Review of Agricultural Economics*, 18: 141-166.

Maddison, D. 2000. A hedonic analysis of agricultural land prices in England and Wales. *European Review of Agricultural Economics*, 27(4): 519-532.

Melichar, E. 1979. Capital gains versus current income in the farming sector. *American Journal of Agricultural Economics*, 61(4): 1085-1092.

OECD, 1996. *Policies affecting farmland mobility*. OECD/GD(1996)125, OECD, Paris.

OECD, 2001. *Market effects of crop support measures*. OECD, Paris.

OECD, 2002a. *The incidence and income transfer efficiency of farm support measures*. AGR/CA/APM(2001)24/Final, OECD, Paris.

OECD, 2002b. *Effects of quantitative constraints on the degree of decoupling of crop support measures*. AGR/CA/APM(2002)12/Final, OECD, Paris.

Offut, S., Shoemaker, R., 1990. Agricultural land, technology and farm policy. *Journal of Agricultural Economics*, 41(1): 1-8.

Oltmer, K., Florax, R.J.G.M. 2001. *Impacts of Agricultural Policy Reform on Land Prices: A Quantitative Analysis of the Literature*. Paper presented at the Annual Meeting of the American Agricultural Economics Association and the Canadian Agricultural Economics Society, Chicago, 5-8 August.

Palmquist, R.B. 1989. Land as a differentiated factor of production: A hedonic model and its implications for welfare measurement. *Land Economics*, 65(1): 23-28.

Plantiga, A.J., Miller, D.J. 2001. Agricultural land values and the value of rights to future land development. *Land Economics*, 77(1): 56-67.

Plantiga, A.J., Lubozski, R.N., Stavins, R.N. 2002. The effects of potential land development on agricultural land prices. *Journal of Urban Economics*, 52: 561-581.

Reynolds, J.E., Timmons, J.F. 1969. Factors affecting farmland values in the United States. Iowa Agricultural Experiment Station Research Bulletin, 566.

Roberts, M.J., Barrett, K., Hopkins, J. 2003. The incidence of government program payments on agricultural land rents: The challenges of identification. *American Journal of Agricultural Economics*, 85(3): 762-769.

Robison, L.J., Lins, D.A., VenKataraman, R. 1985. Cash rents and land values in U.S. agriculture. *American Journal of Agricultural Economics*, 65(4): 794-805.

Roche, M.J., McQuinn, K. 2001. Testing for speculation in agricultural land in Ireland. *European Review of Agricultural Economics*, 28(2): 95-115.

Rutherford, T.F., Whalley, J., Wigle, R.M. 1990. Capitalization, conditionality, and dilution: Land prices and the U.S. wheat program. *Journal of Policy Modeling*, 12(3): 605-622.

Schmitz, A. 1995. Boom/bust cycles and Ricardian rent. *American Journal of Agricultural Economics*, 77(5): 1110-1125.

Shaik, S., Helmers, G.A., Atwood, J.A. 2005. The evolution of farm programs and their contribution to agricultural land values. *American Journal of Agricultural Economics*, 87(5): 1190-1197.

Shaik, S., Atwood, J.A., Helmers, G.A. 2006. *Farm Programs and Agricultural Land Values: The Case of Southern Agriculture.* Paper presented at the Southern Agricultural Economics Association Annual Meeting, Florida, 5-8 February.

Shalit, H., Schmitz, A. 1982. Farmland accumulation and prices. *American Journal of Agricultural Economics*, 64(4): 710-719.

Shigeto, S., Hubbard, L. 2004. *The Farmland Market in Japan: A Present Valuation Model*. Paper presented at the 78th Annual Conference of the Agricultural Economics Society, Imperial College London, 2-4 April.

Shiha, A.N., Chavas, J.P. 1995. Capital segmentation and US farm real estate pricing. *American Journal of Agricultural Economics*, 77: 397-407.

Tangermann, S. 1991. A bond scheme for supporting farm incomes. In Marsh J., Green B., Kearney B., Mahé L., Tangermann S., Tarditi S., *The changing role of the Common Agricultural Policy: The future of farming in Europe*. London: Belhaven Press.

Taylor, M.R, Brester, G.W. 2005. Noncash income transfers and agricultural land values. *Review of Agricultural Economics*, 27(4): 526-541.

Tegene, A., Kuchler, F. 1993. A regression test of the present value model of US farmland prices. *Journal of Agricultural Economics*, 44(1): 135-143.

Traill, B. 1979. An empirical model of the UK land market and the impact of price policy on land values and rents. *European Review of Agricultural Economics*, 6: 209-232.

Traill, B. 1982. The effect of price support policies on agricultural investment, employment, farm incomes and land values in the U.K. *Journal of Agricultural Economics*, 33(3): 369-385.

Tsoodle, L.J., Golden, B.B., Featherstone, A.M. 2006. Factors influencing Kansas agricultural farm land values. *Land Economics*, 82(1): 124-139.

Tweeten, L.G., Martin, J.E. 1966. A methodology for predicting United States farm real estate price variation. *Journal of Farm Economics*, 48(2): 378-393.

USDA, 2003. *Decoupled payments: Household income transfers in contemporary US*. ERS, USDA, report n° 822.

Vantreese, V.L., Reed, M.R., Skees, J.R. 1989. Mandatory production controls and asset values: A case study of burley tobacco quotas. *American Journal of Agricultural Economics*, 71(2): 319-325.

Veeman, M.M., Dong, X.Y., Veeman, T.S. 1993. Price behavior of Canadian farmland. *Canadian Journal of Agricultural Economics*, 41(2): 197-208.

Weersink, A., Clark, S., Turvey, C.G., Sarker, R. 1999. The effect of agricultural policy on farmland values. *Land Economics*, 75(3): 425-439.