Mapping the Decoupling : Transfer Efficiency of the Single Farm Payment Scheme

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Abstract— **This paper focuses on the question of the transfer efficiency of the SFP scheme and represents graphically the results of an analytical framework with the seminal Surplus Transformation Curve initiated by Josling (1974) and developed by Gardner (1983). The special feature of the SFP scheme resides in the paradox that exists between the tradability of the entitlements and the activation constraint that creates a particular link to the land. The main result is that redistributive effects between landowners and farmers depend on the total number of entitlements, so they have to be considered as a lever to increase the transfer efficiency of the scheme.**

Keywords— **Single Farm Payment, transfer efficiency, surplus transformation curve.**

I. INTRODUCTION

In accordance with the principle of decoupling, the last 2003 Common Agricultural Policy (CAP) reform introduced a new way to distribute subsidies to farmers. The eligibility for payments is no longer relative to the number of farmed hectares or heads of cattle but relies on a tradable entitlement scheme which gives access to subsidies: the Single Farm Payment (SFP) scheme. Although production is no longer required to get the payment attached to entitlements, the SFP's owner has to "activate" his entitlements by keeping in good agricultural and environmental conditions (GAEC) as many eligible hectares as SFP entitlements he owns in order to receive the dedicated payments. The so-called "activation constraint" acts as a specific link between the SFP and the land which keeps the SFP inside farming sector and makes them different from both a simple bond scheme and the previous direct area payments system. The special feature of the SFP scheme resides in the paradox that exists between the tradability of the entitlements and the activation constraint. On the one hand, compared with area payments the tradability offers an autonomy to the right of access to subsidies from the land. But on the other hand, without eligible hectares the SFP entitlements are worth nothing.

The objective of this paper is to focus on the question of the transfer efficiency of the SFP scheme and to represent graphically the results of our model in terms of landowners and producers surplus by taking up a framework initiated by Josling (1974) [1], developed by Gardner (1983) [2] and generalized by Bullock et al. (1999) [3] and Bullock and Salhofer (2003) [4]. This framework aims at mapping agricultural policies in three different spaces :

- the "policy instrument space" where policies are depicted as sets of elementary instruments ;
- the "welfare outcome space" where policies are presented according to their effects on the welfare

of groups in the form of a Surplus Transformation Curves (STC) ;

- and between these two spaces, the ‘price-quantity space’ offers a representation of the economy that allows to translate the policies into surplus variations for the different groups.

The rest of the paper is organized as follows. The second section presents a model of the SFP scheme. The third one takes up the seminal Josling’s framework in the current context of the shift from area payment program to more decoupled entitlement scheme. The last one concludes.

II. A MODEL OF THE SINGLE FARM PAYMENT SCHEME

The benchmark : farmers’ behaviour in an area subsidy regime

Basically, the impact of an area subsidy is modelled as fallows. First of all, a restricted profit function is defined for each producer i :

$$(1)\quad \pi_i\ (p,w,h_i) = \underset{y_i,x_i}{Max}\left[py_i - wx_i ; y_i\ = f\,(x_i,h_i)\right]$$

where p is the output price, y_i is the output level, x_i is the vector of input quantities other than land, w is the vector of input prices, h_i is the land quantity, $f_i(x_i,h_i)$ is a well-behaved production function.

Without policy, the agent seeks to maximise his profit by renting in the optimal number of hectares, with r as the land rental price:

$$(2)\quad \underset{h_i}{Max}\ \ \pi_i(p,w,h_i) - rh_i \equiv \theta_i(p_i,w,r)$$

By differentiation of the program (2) with respect to the land rental price, an expression of the land demand function for agent i is obtained (Hotelling’s lemma):

$$(3)\quad h_i(p,w,r) = -\partial\theta_i(p,w,r)/\partial r$$

The land market equilibrium is defined by equating farmers’ land demands to land supply:

$$(4)\quad \sum h_i(p,w,r^{wp}) \equiv D(r^{wp}) = S(r^{wp})$$

For convenience $D(r)$ is used for the aggregate land demand and $S(r)$ is the land supply function to the farm sector by landowners, with $\partial S(r)/\partial r \geq 0$. Equation (4) solved for r defines the equilibrium land rental price r^{wp} as a function of output and variable input prices.

With an area payment program that offers the amount a for each hectare, the agent’s program becomes:

$$(5)\quad \underset{h_i}{Max}\ \ \pi_i(p,w,h_i) - rh_i + ah_i$$

This program (5) defines a similar profit function than the previous case without policy, $\theta_i(p_i,w,r-a)$, and a similar land demand function $h_i(p,w,r-a)$. In the same way, the land market equilibrium is thus defined by the equation (6) :

$$\sum h_i(p,w,r^*-a) = D(r^*-a) = S(r^*). \qquad (6)$$

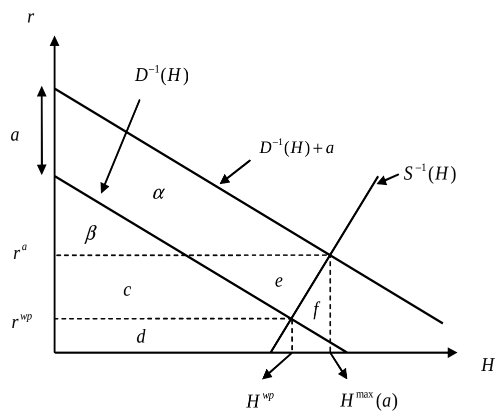

Fig. 1 : Land market equilibrium with an area subsidy program

The area subsidy program moves up the inverse aggregate land demand from $D^{-1}(H)$ to $D^{-1}(H)+a$. This shift increases both the area devoted to a farm use, from H^{wp} to $H^{\max}(a)$, and the land rental price, from r^{wp} to r^a. Moreover, it appears that the less elastic land supply is, the less the farmed area rises, the more price increases.

Once the market equilibrium characteristics stated, redistributive effects of the policy may be shown up by using Marshallian surplus as a measure of the agents' welfare[1]. Defining three groups of agents, the landowners, the producers and the taxpayers, the variation of their welfare are expressed analytically and graphically as follows:

$$\Delta LS = r^a H^{Max}(a) - \int_0^{H^{\max}(a)} S^{-1}(H)dH - r^{wp}H^{wp} + \int_0^{H^{wp}} S^{-1}(H)dH = c+e$$

$$\Delta PS = \int_0^{H^{\max}(a)} (D^{-1}(H)+a)\,dH - r^a H^{Max}(a) - \int_0^{H^{wp}} D^{-1}(H)dH + r^{wp}H^{wp} = \alpha - c$$

$$\Delta TS = -a.H^{\max}(a) = -\alpha - e - f$$

It appears that the landowners take the lion's share of the benefit from this kind of support. The variation of producers' surplus is positive since $r^a - r^{wp} < a$ for a land supply not totally inelastic. But the more inelastic the land supply is, the less the producers' surplus varies. Thus the policy induces a social welfare loss equals to the area *f*.

Agricultural producers' behaviour in the SFP regime

In the SFP policy regime, each producer i maximizes his profit by optimising his number of hectares and his number of entitlements. We keep the assumption that he rents in all

[1] For the discussion about the drawbacks of the Marshallian surplus in welfare analysis due to the fact that they are not utility-constant, we could not add anything better than Gardner (1987) Chap. 7.

the land from landowners and we assume that he could exchange entitlements that are initially endowed to farmers. His profit program is expressed as follows:

$$(7) \quad \underset{h_i, n_i}{Max}\; \pi_i(p, w, h_i) - rh_i + bn_i - v(n_i - n_i^0)$$

$$\text{s.t. } 0 \le n_i \le h_i \;;\; n_i \le N$$

with b the face value of payment entitlements, n_i the number of entitlements for farmer i, n_i^0 the initial endowment in entitlements for farmer i, v the rental price of entitlements and N the total number of entitlements. The difference $v(n_i - n_i^0)$ represents thus either the costs of renting in, or the earnings of renting out, additional payments at a price v per unit.

The inequality constraint $n_i \le h_i$ captures the fact that payments are granted only for entitlements for which the farmer holds an eligible hectare, i.e., the activation constraint.

From program (7), we define first-order conditions and the exclusion conditions for program with λ, μ and γ as the multipliers associated with the inequality constraints $0 \le n_i$, $n_i \le h_i$ and $n_i \le N$:

(8a) $\partial\pi_i(h_i)/\partial h - r + \lambda = 0$

(8b) $b - v + \mu - \lambda - \gamma = 0$

(8c) $\mu \; n_i = 0$

(8d) $\lambda\,(h_i - n_i) = 0$

(8e) $\gamma(N - n_i) = 0$

System (8a) to (8e) defines agent's demands for land and for entitlements with respect to land and entitlement rental price.

(i) For $v > b$. Under this assumption, $\mu > 0$ (from 8b), $n_i = 0$ (from 8c), $\lambda = 0$ (from 8d)[2] and $\partial\pi_i(h_i)/\partial h = r$ (from 8a).

(ii) For $v = b$. Under this assumption, $\mu = \lambda = \gamma = 0$ (from 8b, 8c, 8d and 8e), $\partial\pi_i(h_i)/\partial h = r$ (from 8a) and $0 \le n_i \le h_i$.

(iii) For $v < b$. Under this assumption, $\lambda + \gamma > \mu \ge 0$ (from 8b). Three sub cases appear depending on what constraint is binding first between $n_i \le h_i$ and $n_i \le N$:

a) $\lambda > 0$ and $\gamma = 0$ thus $\partial\pi_i(h_i)/\partial h = r + v - b$ (from 8a and 8b) and $n_i = h_i \le N$ (from 8d and 8e);

[2] The analysis excludes the uninteresting (unrealistic) case where the land rental price is "sufficiently" high so that the marginal profit of the first hectare is lower than the land rental price.

b) $\lambda > 0$ and $\gamma > 0$ thus $\partial \pi_i(h_i)/\partial h = r + v - b + \gamma$ (from 8a and 8b) and $n_i = h_i = N$ (from 8d and 8e);

c) $\lambda = 0$ and $\gamma > 0$ thus $\partial \pi_i(h_i)/\partial h = r$ (from 8a) and $h_i \geq n_i = N$ (from 8d and 8e).

From this analysis, one can thus implicitly define the land demand function and the entitlement net demand function for farmer i as follows:

(9) when $v > b$, $\partial \pi_i(h_i)/\partial h = r$ and $n_i = 0$.

(10) when $v = b$, $\partial \pi_i(h_i)/\partial h = r$ and $0 \leq n_i \leq h_i$,

(11) when $v < b$, land and entitlement demands depend on the relative values of r and N as graphically represented as follows :

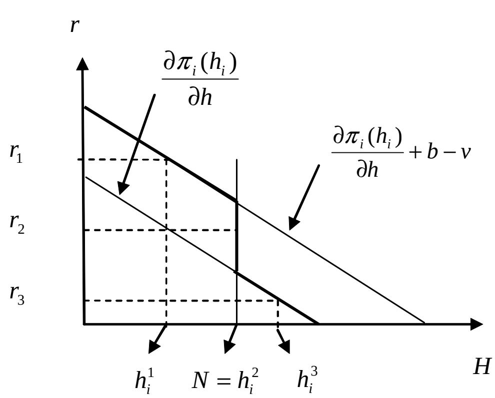

Fig. 2 : Demand for land when v < b with respect to the total number of entitlements, N, for three different values of land rental price

The demand for land when the entitlement price is less than the face value of the entitlements is represented in the shape of 3-part kinked curve.

(11a) for relative high land rental prices, for instance r_1, the demand for land is defined by $\partial \pi_i(h_i^1)/\partial h = r + v - b$ and entitlement net demand is $n_i = h_i \leq N$;

(11b) for relative medium land rental prices, for instance r_2, the demand for land and the net demand for entitlement are the same $h_i^2 = n_i = N$;

(11c) for relative low land rental prices, for instance r_3, the demand for land is defined by $\partial \pi_i(h_i^3)/\partial h = r_3$ and entitlement net demand is binding $n_i = N < h_i^3$.

So, the total number of entitlements and the number of entitlements held by the agent modify his demand for land, $h_i\ (p, w, r, b - v, N)$. The curve is kinked at the abscise N and while staying continuous the left part is moved up by the distance $b - v$.

Land and entitlement market equilibriums

We now establish the conditions for a simultaneous equilibrium on land and entitlement markets. In doing so, the land demands of all the agents are aggregated and confronted to a land supply function. Considering that entitlement demands are net demands, their aggregation are confronted to the total number of entitlements. As a consequence, if the aggregate net demand for entitlements, whatever the entitlement price, is strictly less than the total number of entitlements, the market-clearing condition impose that the price is zero.

(12) $\sum h_i(p,w,r,b-v,N) \equiv D(r,b-v,N) = L(r)$

(13a) $\sum n_i \leq N$

(13b) If $\forall\ v$ we have $\sum n_i < N$ thus $v = 0$

Three regimes have to be distinguished depending on $N \leq H^{wp}$, $H^{wp} < N < H^{\max}(b)$ or $H^{\max}(b) \leq N$ where H^{wp} is total agricultural land used in the zero support situation, i.e. $\sum h_i(p,w,r^{wp}) = L(r^{wp}) = H^{wp}$, and $H^{\max}(b)$ is the number of hectares that would be demanded in a support regime of per-hectare direct aids of unit amount equal to the entitlement face value, $\sum h_i(p,w,r^b - b) = L(r^b) = H^{\max}(b)$.

Regime 1. $N \leq H^{wp}$

One then shows that equilibrium conditions may be defined as :

(14a) $r^* = r^{wp}$

(14b) $H^* = \sum h_i(p,w,r^{wp}) = L(r^{wp}) = H^{wp}$

(14c) $v^* = b$

(14d) $\sum n_i^* = N \leq \sum h_i^* = H^{wp}$

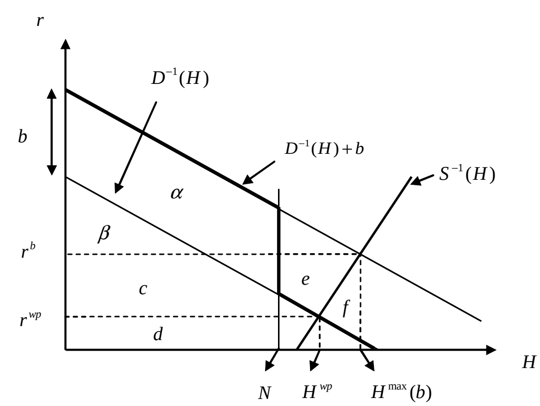

Figure 3 : Land market equilibrium when $N \leq H^{wp}$

Proposition 1. When $N \leq H^{wp}$, introducing tradable SFP entitlements has no impact on the land market: the farmers' land demands, the land rental price and the total agricultural area are unchanged. The SFP scheme is decoupled at the extensive margin of production and there is no capitalization of entitlements into land prices.

Regime 2. $H^{wp} < N < H^{\max}(b)$

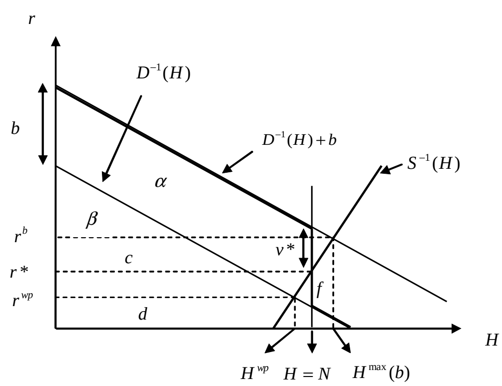

Fig. 4 : Land market equilibrium

when $H^{wp} < N < H^{\max}(b)$

In that case equilibrium conditions may be written as :

(15a) $r^{wp} < r* < r^b$

(15b)

$$H* = \sum h_i(p, w, r*-b+v*) = L(r*-b+v*) = N > H^{wp}$$

(15c) $0 < v^* < b$

(15d) $\sum n_i^* = N = \sum h_i^* > \sum h_i^{wp}$

Proposition 2. When $H^{wp} < N < H^{\max}(b)$, then the SFP scheme is not decoupled at the extensive margin of production and is partly capitalized into land rental price. The higher the number of entitlements, the higher the effect on land used in the farm sector, the higher the land rental price and the capitalization into land rental prices, and the lower the entitlement price.

Regime 3. $H^{\max}(b) \le N$

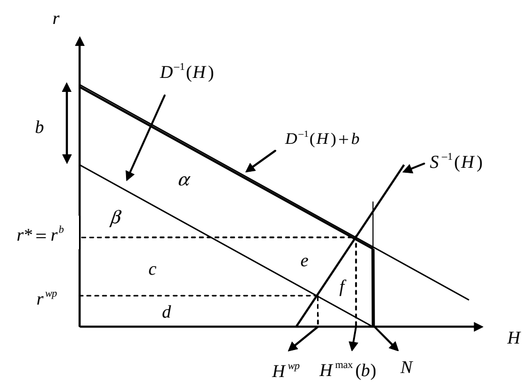

Fig. 5 : Land market equilibrium

when $H^{\max}(b) \le N$

In that case equilibrium conditions are defined by:

(16a) $r* = r^b$

(16b)

$$H* = \sum h_i(p, w, r*-b) = L(r*-b) = H^{\max}(b)$$

(16c) $v^* = 0$

(16d) $\sum n_i^* = \sum h_i^* \le N$

Proposition 3. When $H^{\max}(b) \le N$, then the SFP scheme acts as an area payment program. Thus the farmers' land demands, the land rental price and the total agricultural area are the same than with an area payment program of an amount of *b* per hectare. In this case, the SFP scheme is coupled to the land and a large part of the support is capitalized in land rental price. All of the entitlements are not activated, their relative abundance induces that their value is zero.

To conclude this section, we show that the link between land and entitlements induced by the activation constraint differs largely from the link between land and area payments. Moreover, it appears that the degree of capitalization of the SFP support into the land rental price can be zero, partial or total depending on the scarcity of entitlements relative to the number of hectares and on the land supply elasticity. Thus, the total number of entitlement has to be considered as a lever to improve the transfer efficiency of the income support to farmers. That's what we map on the next section.

III. MAPPING THE DECOUPLING

In this section we recycle the initial framework initiated by Josling (1974) [1] in the context of the decoupling of area payments and their conversion into SFP entitlements by focusing on the transfer efficiency and redistribution effects between producers and landowners.

The policy instrument space

We decompose the two major European income support policies in a continuous set of area payments and SFP scheme, with respect to a ceiling budget constraint.

Let us introduce the two 'decoupling variables'. First of all, t is the coupling rate ($0 \le t \le 1$), i.e., the share of the budget devoted to the area payment program. And secondly, N is the total number of SFP entitlements.

We define $\Omega(A)$ as the continuous set of policies X with respect to A, the ceiling budget *:*

$$\Omega(A) = \{X(A,t,N)\}$$

Each policy is defined as a mix between two instruments

- an area payment program $x_1(a)$ with a the payment amount for an hectare ;
- - a SFP scheme $x_2(b;N)$ with b the face value of the SFP entitlements and N the total number of SFP entitlements.

The ceiling budget leads to the following relation : $A = aH + bN$. With H the total number of hectares demanded by all the farmers, any policy j can therefore be expressed as follows :

$$X(A,t,N) = \left\{ x_1\left(\frac{tA}{H}\right);\ x_2\left(\frac{(1-t)A}{N};N\right) \right\}$$

So, the policy instrument space could now be presented in the following figure with the two decoupling variables t and N .

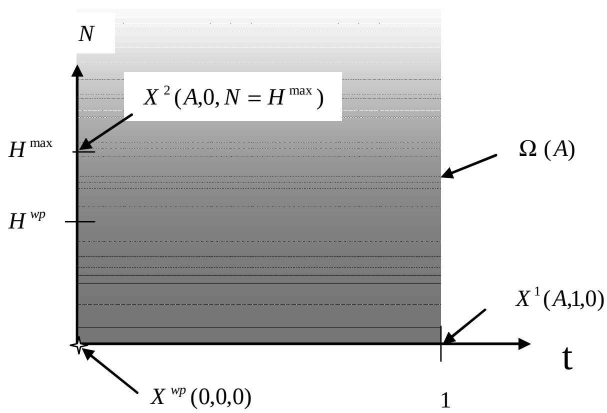

Fig. 6 : the policy instrument space $\Omega(A)$

The total number of entitlements has no upper value, the set $\Omega(A)$ is infinite. Two particular values of N are distinguished, $H^{\max} = H(X^1(A,1,0))$ is the total area demanded for a fully coupled policy and $H^{wp} = H(X^0(0,0,0))$ is the total demanded area in a no support regime.

The price-quantity space

Instead of the output market in Josling (1974)'s seminal paper, the instruments that we study here bring us to consider the land input market. By referring to what has been developed in the previous section, the demand for land of the agent i under $X(A,t,N)$ is $h_i\ (p,w,r-a,b-v,N)$,

with $a = \frac{tA}{H}$, $b = \frac{(1-t)A}{N}$ and

$$H = \sum h_i(p,w,r-a,b-v,N) = S(r).$$

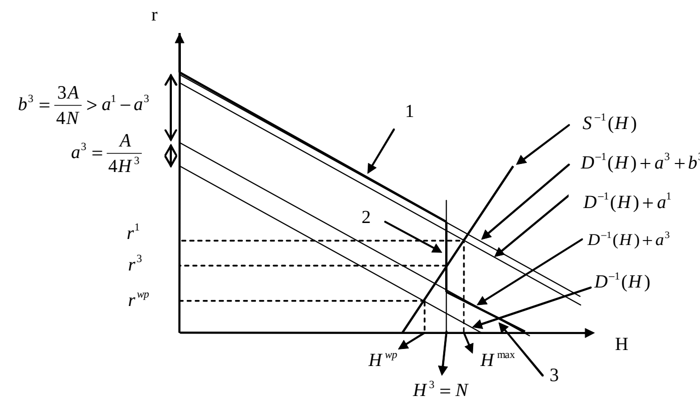

Fig. 7 : the price-quantity space affected by $X^3(A,\frac{1}{4},H^{wp} < N < H^{\max})$

In figure 7, the land market equilibrium is presented in the case of a partially coupled policy where the total number of entitlements lies between H^{wp} and $H^{\max}$, i.e., $X^3(A,\frac{1}{4},H^{wp} < N < H^{\max})$.

At equilibrium, the land rental price and the total number of demanded hectares are respectively r^3 and H^3. The aggregated land demand is represented as a 3-part kinked curve. The first segment (quoted 1 in the figure 7) is merged with the straight line $D^{-1}(H)+a^3+b^3$. For a number of hectares less than or equal to the number of SFP entitlements, the land demand is moved up from the distance $a^3 + b^3$ which corresponds to the sum of the area payment amount by hectare and the face value of the SFP entitlements. In this case, we notice that $a^3 + b^3$ is greater than $a^1 = \frac{A}{H^{\max}}$ because of the "concentration effect" due to a total number of entitlements lesser than $H^{\max}$. At the opposite, in the situation where N is greater than $H^{\max}$, the face value of the entitlement suffers from a "dilution effect", because the same amount would have been shared in a larger number of entitlements because of the ceiling budget. This dilution (concentration) effect brings about a drop (rise) of the first segment of the land demand curve. Moreover, an other effect of the variations of N is the translation of the segment 2 of the aggregate land demand : when N increases (decreases) then the segment 2 moves to the right (left).

When t rises (decreases) a^3 increases (decreases) and b^3 decreases (increases). Graphically, when t rises the first segment moves down and the third one moves up.

The welfare outcome space

From the land market equilibrium, we should now translate $\Omega(A)$ in terms of variation of producer surplus, ΔPS, and variation of landowner surplus ΔLS. To distinguish the proper effects of each decoupling variable, we adopt a two-step procedure. Firstly, we focus on N while considering $t = 0$. And secondly the impacts of variable t on the surplus of the two groups are shown.

To discuss welfare implications of variations of N, we use graphic support for the three regimes identified in the previous section. In figure 8, welfare outcomes of a SFP scheme where $N \le H^{wp}$ are highlighted.

We have shown before that in those cases the SFP scheme has no effect on the land market. Therefore, it appears that the landowner's surplus are not affected by the policy. Thus, the farmers are the only beneficiaries of the policy $X^4(A,0,N \le H^{wp})$.

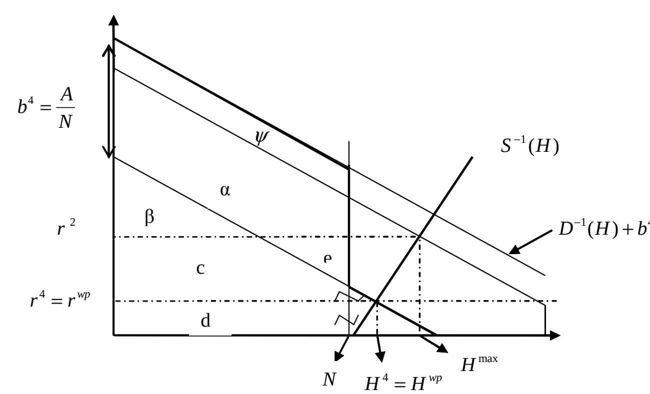

Fig. 8 : Welfare outcomes of policy $X^4(A,0,N \le H^{wp})$

Then, because of the concentration effect that increases the face value of the entitlements and because the land allocation is not affected, the transfer efficiency of the SFP scheme is perfect when $N \leq H^{wp}$. There's no deadweight loss.

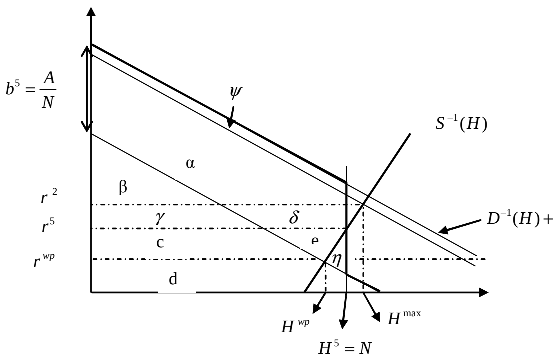

Fig. 9 : Welfare outcomes of policy

$$X^5(A,0,H^{wp} < N < H^{\max})$$

When the total number of entitlements lies between H^{wp} and $H^{\max}$, an increase of N induces a decrease of farmers' welfare and an increase of landowners' one, because of the rise of the land rental price. The area η is the deadweight loss associated with the policy $X^5(A,0,H^{wp} < N < H^{\max})$. The closer to H^{wp} the total number of entitlements is, the thinner the deadweightloss area is.

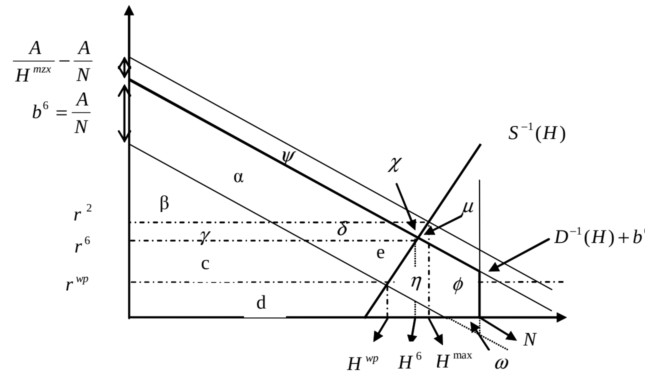

Fig. 10 : Welfare outcomes of policy

$$X^6(A,0,N > H^{\max})$$

The dilution effect induced by $N > H^{\max}$ results in the relation $\psi + \chi + \mu = \phi + \omega$. Both the landowners and the farmers suffer from the dilution effect because, in the one hand, weaker face values reduce demand for land and, in the other, because many entitlements ($N - H^6$) can not be activated. Without loss of generality, we indeed consider that non activated entitlements are not given back to the taxpayers[3]. In the extreme, when the total number of entitlements tends to infinity, the face value tends to zero, and the welfares of landowners and farmers are those of a non support regime.

From these developments, we now build the surplus transformation curve (STC) associated to the 'decoupling variable' *N*.

[3] This is for instance what happens when a Member State see his net budget return be affected by a misuse of the Community funds allocated to it. From this point of view, non activated entitlements are a loss.

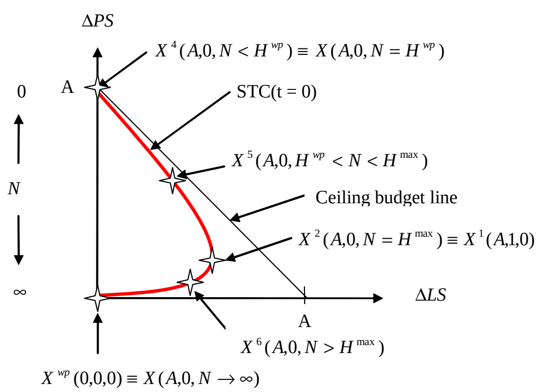

Fig. 11 : the welfare outcome space for a pure SFP scheme (t = 0)

The coordinates of each point of the STC are the value of the welfare of the landowners and the farmers for a specific value of the total number of entitlements. The higher part of the STC corresponds to the lowest values of *N*, and vice-versa. The ceiling budget constraint is represented by a straight line of ordinate at the origin *A* and of slope equals to -1. Thus the losses due to both the misallocation of the land and the non activated entitlements are a function of the distance between each point of the STC and the ceiling budget line.

We now include in the welfare analysis the impacts of the second decoupling variable, *t*, the budget share devoted to the area payment program. In doing so, we refer to the figure 7. First of all, we have seen that a pure SFP scheme with $N = H^{max}$ is equivalent to a pure area payment policy. Thus for $t = 1$ we have the following relationship:

$$X^{1}(A,1,0) \equiv X^{2}(A,0,H^{max})$$

Considering the cases where $t \in \left]0;1\right[$, we show on figure 7 that the area payment instrument acts as a floor for the land rental price and the number of demanded hectares. As a result, this floor reduces the welfare transfers allowed by variations of the total number of entitlements. These floor values are encountered for both low and high values of the total number of entitlements. The lowest ones are for a total number of entitlements less than the number of hectares demanded for a pure area payment policy with a total budget limited to tA. Under this minimum, policies have similar effects : when $N \leq H(X(tA,1,0))$ we have $X(A,t,N < H(X(tA,1,0))) \equiv X(A,t,N = H(X(tA,1,0)))$.

The highest ones are for the extreme values of *N*, i.e., when *N* tends to infinity. In this (hypothetical) case, this policy has similar effects to a pure payment policy with a restricted budget of tA : when $N \to \infty$, we have $X(A,t,N) \equiv X(tA,1,0)$. Thus for any given *t*, the landowner surpluses are the same when the number of SFP is less than or equal to $H(X(tA,1,0))$ or tends to infinity, because for this values the land rental price and the total number of demanded hectares do not change.

For the intermediate value of N, it appears that where $N \in \left[H(X(tA,1,0); H^{\max}\right]$, the land market equilibrium is not affected by the coupling part of the policy :

$$X(A,t,N \in \left[H(X(tA,1,0); H^{\max}\right])$$
$$\equiv X(A,0,N \in \left[H(X(tA,1,0); H^{\max}\right])$$

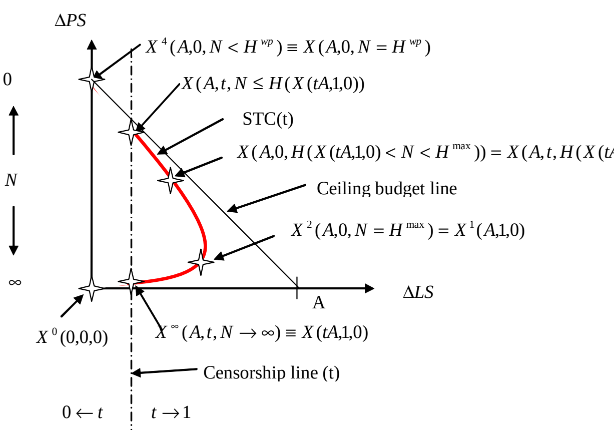

Fig. 12 : the welfare outcome space for a

non pure SFP scheme ($t \in \left]0;1\right]$)

By building the STC for $t \in \left]0;1\right]$, we find out that it is merged with the STC ($t = 0$) on the right of a vertical straight line of abscise equals to landowners' surplus variation for a pure area payment program of a budget restricted to tA. In fact, t acts as a censorship of the STC. Finally, the variation of the coupling rate does not offer opportunities to increase the transfer efficiency. It just limits the redistribution possibilities by censoring the STC.

IV. CONCLUDING REMARKS

The analytic framework presented in this paper allows us to discuss the transfer efficiency and the redistribution effects of the SFP scheme. The main result is that the SFP scheme is able to attain the optimal transfer efficiency of the theoretical lump sum transfer in spite of the activation constraint that creates a particular link between the entitlements and the land. Indeed, we found out that the transfer efficiency of the SFP scheme reaches its peak when the total number of SFP is less than or equal to the total number of hectares that would be demanded in a no support regime. Thus the total number of entitlements has to be considered as a lever to increase the transfer efficiency of the scheme. Because each Member State of the former EU-15 has implemented his own SFP scheme, the impacts of the last CAP reform could largely differ among them. Nevertheless complete impact assessments of the reform have to pay attention to land regulations that exist in most western European countries to regulate land markets and limit capitalisation.

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