PSE, decoupled PSE and credit for supply management policies (application in the context of the EC dairy quota scheme)

Herve Guyomard, Louis Pascal Mahe, . International Agricultural Trade Consortium

LM26/10/89

INSTITUT NATIONAL DE LA RECHERCHE AGRONOMIQUE

Station d'Economie Rurale
65, rue de Saint-Brieuc - 35042 RENNES CEDEX

PSE, DECOUPLED PSE AND CREDIT FOR SUPPLY MANAGEMENT POLICIES
(application in the context of the EC Dairy Quota Scheme)

Paper for IATRC - Meeting December, 1989

Hervé Guyomard
Louis P. Mahé

September 1989
Revised October 1989

International Agricultural Trade Consortium
November Meeting
November 13 and 14
Economic Research Service
Washington, D.C.

When the commodity under consideration is subject to a production quota which is binding at the level y^o, there is a case for a distinction between a Decoupled PSE (DPSE) and a Supply Inducing PSE (SIE, Supply Inducing Equivalent). The former transfer does not enhance the production, it is the quasi rent associated with the quota. The latter is the part of the PSE which is required to induce production just at level y^o without the quota implemented. The variation of SIE is directly related to the notion of debit/credit in which we are interested.

As illustrated on the classical figure 1 the quota is binding if

$$y^o < S\ [p^o,\ p^1,\ K] \tag{2}$$

where $S(.)$ is the supply function of y^o, p^1 a vector of variable input prices, and K a vector of fixed factors.

There is a virtual price level μ^o which would exactly bring the production level at y^o,

$$y^o = S\ [\mu^o,\ p^1,\ K] \tag{3}$$

Solving (3) for μ^o defines μ^o as a function of p^1, K and y^o, and of input subsidies IS^o in as much they influence p^1.

$$\mu^o = g\ (y^o,\ p^1,\ K) \tag{4}$$

With these familiar definitions, it is possible to decompose the PSE which is the total transfer into the DPSE which is only a domestic matter and the SIE which affects output and therefore trade. The DPSE is defined by the following equation.

$$DPSE = y^o\ (p^o - \mu^o) \tag{5}$$

This is also the quasi-rent due to the quota. Although proportional to the level of production, it does not induce any output increase[1].

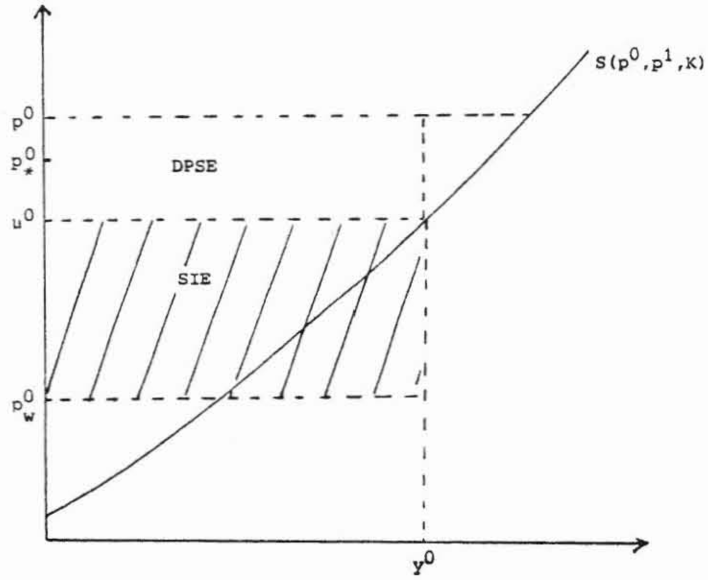
It is not the same for the component of the PSE which is the gap between the shadow price μ^o and the world price $p^o{}_w$:

$$SIE = y^o\ (\mu^o - p^o{}_w) + IS^o \tag{6}$$

As can be seen on figure 1, the SIE is the income transfer which, in the absence of a quota restraint, would have increased production from free trade up to y^o.

1 least in a rather static point of view, the DPSE has no effect on the level of production. Nevertheless, as it affects income, it may eventually affect the output of ressources from the farm sector and therefore production capacity. The label "Decoupled" given to the quasi rent is also somewhat too strong in as much as the producer does have to produce y^o to receive the quasi rent.

Figure 1 - Decomposition of the PSE in the Decoupled Subsidy Equivalent (DPSE) and the Supply Inducing Equivalent (SIE), in the presence of a production quota.



Note : In the presence of production quotas only one part of the PSE, i.e. y^o $(\mu^o - p^o{}_w)$ where μ^o is the shadow price corresponding to the level of the quota has an effect on production,

It is clear from (1), (5) and (6) that :

$$PSE = DPSE + SIE \tag{7}$$

The estimate of the credit to be granted for policy action clearly depends on the interpretation of the notion of credit/debit. As the debate on PSE as opposed to TDE has shown, the PSE is an income concept which is equivalent to the amount of transfer which induces the same supply level, only under special cases where prices, taxes, subsidies, tariffs are policy instruments. From the point of view of agricultural trade relations, the real issue is the impact of policies on ouptut, utilisation and trade. This perspective leads to correct the PSE in the case where supply control measures are implemented. The evaluation of credit/debit for policy changes should therefore emphasize the SIE part of the PSE rather than the whole transfer. It is clear, as a simple case, that cutting p^o down to $p^o{}_*$ on figure 1 will have no effect on production, and therefore on trade.

a) Definition of the debit/credit (small country case $dp^o_w = 0$)

The credit/debit can be measured by the variation of the SIE due to changes in the level of policy instruments, which are supposed here to be p^o, y^o, and/or IS^o ; i.e. domestic support price, output quota and/or input subsidies.

The credit to be granted for effective cuts in price support can be defined as a negative variation of the SIE ; a debit being an increase in the effective support SIE. A general definition of credit due to changes dy^o, dIS^o, dp^o can be defined as follows.

$$\text{Debit} = - \text{Credit} = d\ (SIE) \tag{8}$$

$$= y^o d\ \mu^o + d\ (IS^o) + (\mu^o - p^o_w)\ dy^o$$

The important variables in the determination of $d\mu^o$ will be examined below. Clearly, if the shadow price increases as a result of policy changes the first term is positive. That would be the case is the supply function for y^o shifts to the left as a result of a cost increase or a cut in subsidies. As can be seen from figure 1 also, an increase in the level of the quota would increase μ^o. The algebraic sum of the three terms in (8) which may or may not offset each other, determines the eventual sign of the debit/credit.

b) Graphical illustration of credit/debit for selected policy changes

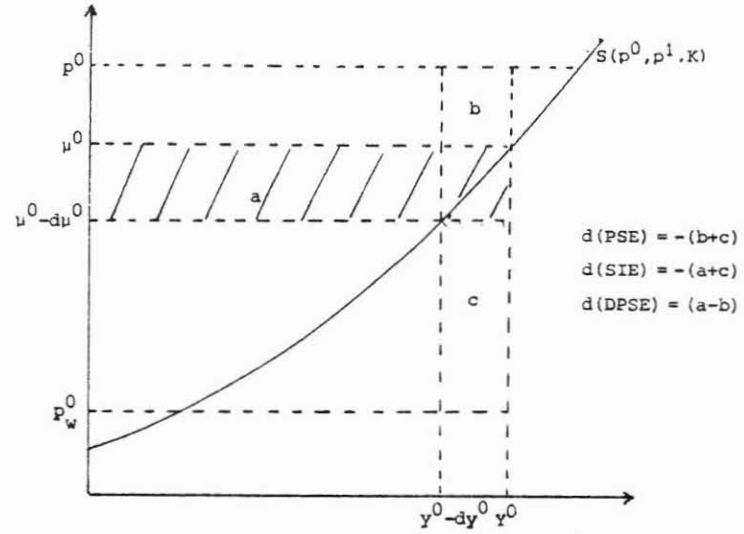
b1. An isolated reduction in the level of the quota

In that case the evaluation of the debit according to equation (8), letting $d(IS^o) = 0$, gives :

$$\text{Debit} = y^o\ d\mu^o + (\mu^o - p^o_w)\ d\ y^o$$

where $d\mu^o = (\delta\mu^o / \delta y^o) dy^o$ is calculated along the supply curve given by (3).

Figure 2 - Change in SIE and credit/debit estimate (case of a change in quota level)



In the case of a reduction dy^o of the level of allowed quota (by dy^o), the shadow price falls by $d\mu^o$ and the PSE will decrease by area (b + c), which is an approximation of the income effect. But the equivalent income effect which would have produced the same supply reduction is given by area -(a+c). It is clear that the component a is just shifted from the SIE to the DPSE and is not inducing supply any more . Area a should be considered as the appropriate measure of the credit obtained from quantity restriction. Area (a + c) could also be used to follow the more traditional calculation of PSE.

Note that the presence of area c under the supply curve, which represent the cost saved when output is reduced, is an artefact of the practical implementation of PSE calculations. If the producer's surplus rather than the PSE was used, area c would not be included in d(PSE) nor in d(SIE). In section 2, where a more rigorous approach is used in the evaluation of AMS, the contribution of the good under quota to the aggregate credit will only be area a (when only the quota level is altered).

b2) The credit due to a support price cut of the good subject to quota is zero

Expression (5) shows that a change dp^o has an impact on DPSE of $y^o dp^o$ but no effect on SIE as can be seen from expression (6), where p^o does not appear.

Figure 3 - Credit and support price cut under a constant level of quota

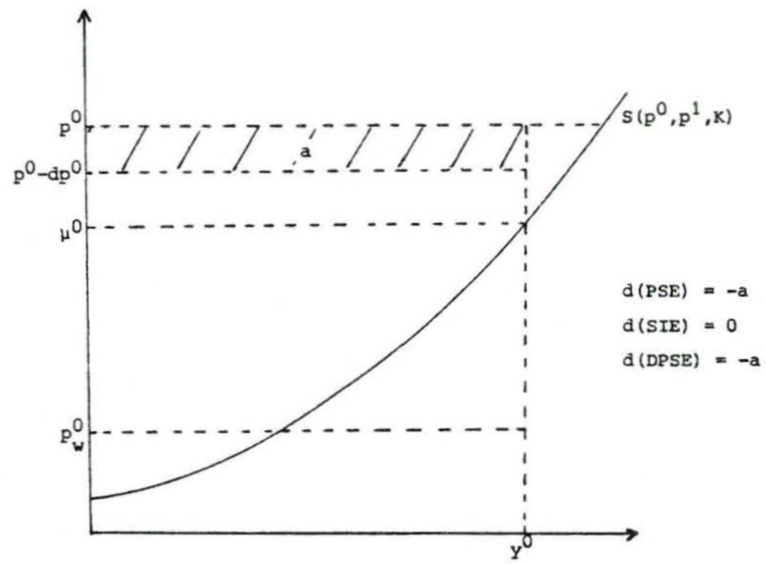


Figure 3 illustrates the simple case of a price cut by dp^o smaller than the wedge between p^o and μ^o. The only effect is a cut in the decoupled transfer by area a. There is no credit to be gained from such an action if the concept of trade distorting equivalent or supply inducing equivalent is the one chosen. If however political economy considerations or inefficiencies due to the artificially created asset value of quota rights are taken into account, some weighted sum of (DPSE) and (SIE) might be considered, with the heavier weight placed on SIE.

b3) A change in input subsidies

From expression (7), when only $d(IS^o)$ is different from zero, the debit amounts to :

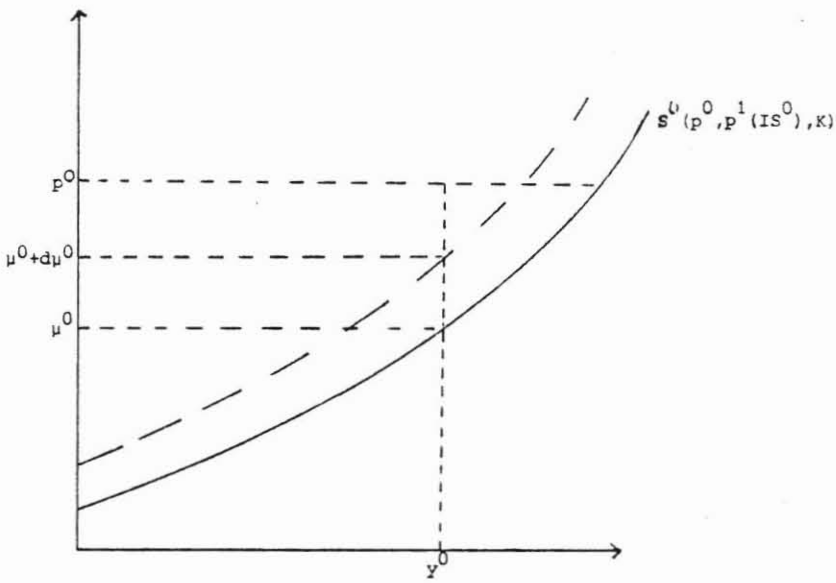
$$\text{Debit} = d(SIE) = y^o\ d\mu^o + d(IS^o)$$

where, $d\mu^o = (\delta\mu^o/\delta p^1).\ (\delta p^1/\delta IS^o).d(IS^o)$

It can be noted in this case that the two components of d(SIE) have opposite signs under normal input conditions since one expects that $\delta\mu^o/\delta p^1 > 0$ and $\delta p^1/\delta IS^o < 0$, i.e. a positive effect of input prices on marginal cost and a negative effect of subsidies on input prices.

This change in IS^o will have an effect on both DPSE and SIE. The change in DPSE is only a function of the shadow price, which is shifted to or from SIE. But the change in SIE is the negative of the latter plus the change in input subsidies. The sum of the two components, i.e. d(PSE), will therefore be affected by the input subsidy change only as can also be seen directly from equation (1).

Figure 4. Effect of a decrease in input subsidy on the credit



c) Estimation of the shadow price change

In order to use expression (8), we need to know the initial level of the quota and the gap between the shadow price and the free trade or no policy price $p^o{}_w$. We also need to estimate the change in the shadow price $d\mu^o$.

When there is a market for quota rights or for rented quotas, the gap between support price p^o and shadow price μ^o can be estimated on that basis, as well as changes in the level of the shadow price over time.

In the case of EC where a real market for quotas does not exist in most countries[2], we will use a different approach based on the idea that in 1983, before the implementation of the quota, support or rather market price and marginal cost (i.e. shadow price) were equal. Then the simple comparative statics of the dairy supply function will provide an estimate of the shadow price change from 1984 to 1988.

The shadow price change is obtained from the comparative statics of the supply function (3), with technical change included and y^o the new policy instrument instead of p^o. [The shadow price is now endogeneous].

$$dy^o = \frac{\delta S}{\delta \mu^o} d\mu^o + \sum_i \frac{\delta S}{\delta p^1_i} dp^1_i + \frac{\delta S}{\delta t} dt + \sum_j \frac{\delta S}{\delta K_j} dK_j \qquad (9)$$

This expression can be easily written in terms of own supply elasticity E_{oo} and cross elasticities, with respect to variable input prices $E_{oi} = \delta \log S / \delta \log p^1_i$; with respect to technical change

$\delta \mathrm{Log} S/\delta t = E_{ot}$, and with respect to quasi-fixed inputs $E_{oj} = \delta \mathrm{Log}\ S/\delta \mathrm{Log}\ K_j$. Denoting by $\hat{x} = d \log x$ a relative change :

$$\hat{y}^o = E_{oo}\ \hat{\mu}^o + \sum_i E_{oi}\ \hat{p}^1_i + E_{ot}\ dt + E_{oj}\ \hat{K}_j \qquad (10)$$

Since the shadow price μ^o is now endogeneous, (10) must be solved for $\hat{\mu}^o$ in fonction of exogeneous variables $\hat{y}^o$, $\hat{p}^1$, dt and $\hat{K}$.

$$\hat{\mu}^o = (E_{oo})^{-1} \cdot (\hat{y}_o - \sum_i E_{oi}\ \hat{p}^1_i - E_{ot}\ dt - \sum_j E_{oKj}\ \hat{K}_j) \qquad (11)$$

Since the supply function is homogeneous of degree zero in prices, $E_{oo} + \sum E_{oi} = 0$ and μ^o is homogeneous of degree one in variable input prices p^1_i. If prices changes are nominal the shadow price cut is also nominal, and similarly for real changes.

This expression shows how both shifts of the supply curve and moves along this curve determine the shadow price. As E_{oo}, the own price supply elasticity, is positive, a reduction in the level of the quota drives the shadow price down. Both a positive technical change bias and an input price fall work in the same direction under normal conditions. Such changes will

---

2 in section 3 where practical matters will be discussed further, the results of the method used will be compared with the partial information available on quota values.

tend to give credit for policy adjustement under quota. However the flow of fixed or primary factors K_j out of the industry at rate $\dot{K}_j$, as one expect it to be the case in the farm sector, will tend to slow down the fall of the shadow price.

As can be seen from table 1, the main contributing factors to the fall in the shadow price from 1986 to 1988 are the cut in the level of the quota and the rate of technical change. When the deflated shadow price is considered, the contribution of input prices is also significant (about - 7 percent). The decrease in primary factors use works as expected in the opposite direction and has reduced the amount of credit that can be requested from the dairy quota[3]. However technical change bias on quasi-fixed inputs (labor and capital) more than offsets the outflow of resources from the sector (Mahé, Guyomard 1989). These estimates will be set in wider perspective below, since policy changes carried in the EC since 1986 have not dealt only with the dairy sector.

3 The supply elasticities used to estimate this change from equation (11) are derived from the MISS model, as revised in Mahé-Guyomard (1989).

Table 1 - Provisional Estimate of Milk shadow price change and credit due to quotas in EC-10 (1987-88) (single commodity - small country case)

1. Estimation of shadow price variation (per cent)

Contributing factor	change in factor (per cent)	impact in nominal terms (per cent)	impact in real terms (per cent)
quota	- 8.5	- 9.4	-9.4
technical change	3.1	- 3.45	-3.4
variable inputs prices	-	+ 1.13	-6.8
quasi-fixed inputs quantities	-	- 0.46	-0.46
Total shadow price variation			
nominal		-12.2	-
deflator		7.9	-
deflated		-20.1	-20.1

2. Estimation of credit in terms of SIE decrease

1986 quota (million tonnes)		99
1986 price[1] (ECU/tonne)		278
1986 shadow price (Ecu/t)		233
credit (million ECU)		
	$y^{\circ} d\mu^{\circ}$	4613
	$(\mu^{\circ} - p^{\circ}_{v}) dy^{\circ}$	783
	Total	5396
credit (million ECU)		

[1] see annex I where the cumulative evolutions of nominal, shadow and observed, prices of milk are plotted.

2 - The multi-commodity case (small country)

The previous approach can be extented to the whole farm sector in order to decompose an aggregate measure of support (AMS) into two components : a Decoupled Aggregate Measure of support (DAMS) and a Supply Inducing Aggregate Measure of Support (SIAMS). In the multi-commodity case, that is in the multi-input multi-output case, cross effects between outputs and inputs should be taken into account. The AMS change must include the credit /debit on both commodities under quota and the others for which support prices have been adjusted.

The different measures of support can be defined directly from production theory, on the basis of several relevant concepts of profit functions. The formulae which are eventually used in the implementation, are quite simple and can be understood intuitively without reading the derivations below.

For an enterprise facing exogeneous market prices (v^1, v^o), but with some netputs constrained at level q^o several notions of profit functions are useful to assess income transfers due to various changes in exogeneous variables. The first is the unconstrained or long-run total profit function corresponding to the case where all netputs are free to adjust to their optimal level.

$$\Pi^u(v^1, v^o) = \max_{(q^1, q^o)} [v^1.q^1 + v^o.q^o ; (q^1, q^o) \varepsilon T] \qquad (12)$$

where[4] q^1 is the vector of netputs free to vary, with corresponding prices v^1 and likewise for quota and restricted inputs q^o, v^o.

The second is the constrained or short-run total profit function which corresponds to the constrained profit <u>actually received under rationing</u>. It is the sum of the restricted profit and the value of fixed netputs at market prices.

$$\Pi^c(v^1, q^o, v^o) = \Pi^R (v^1, q^o) + v^o q^o \qquad (13)$$

where $\Pi^R(v^1, q^o)$ is the restricted or variable profit function defined by

$$\Pi^R(v^1, q^o) = \max_{(q^1)} [v^1 q^1 ; q^1 \varepsilon T(q^o)] \qquad (14)$$

The third is the virtual or shadow total profit function, which is the one received by the firm if it were facing v^1 for variable netputs and the shadow prices μ^o for the constrained ones.

$$\Pi^v(v^1, q^o, \mu^o) = \Pi^u(v^1, \mu^o) = \Pi^R(v^1, q^o) + \mu^o q^o \qquad (15)$$

where, by Hotelling's lemma, $\mu^o = -\delta\Pi^R(v^1, q^o)/\delta q^o$, which defines the virtual price as a function of variable netput prices and the level of quotas. μ^o does not depend on actual support price v^o but actual profit $\Pi^c(.)$ does. It should be noted that when all netputs are in equilibrium $\Pi^u = \Pi^c = \Pi^v$. Furthermore, the constrained profit function $\Pi^c(.)$ may be also written by using (15) as,

$$\Pi^c(v^1, q^o, \mu^o) = \Pi^u(v^1, \mu^o) + (v^o - \mu^o).q^o \qquad (16)$$

4 Transposed vectors are not explicitely indicated as it is clear that v.q is the inner product. Matrix operations below are also written without the transpose sign.

From these definitions, an AMS is simply defined as the difference between the constrained profit function evaluated at this point (v^1, q^o, v^o) where prices are supported at v^1, v^o and some netputs are restricted at q^o and the unconstrained profit function evaluated at world prices (v^1_w, v^o_w).

$$AMS = \Pi^c(v^1, q^o, v^o) - \Pi^u(v^1_w, v^o_w) \quad (17)$$

$$= \Pi^R(v^1, q^o) + v^o q^o - \Pi^u(v^1_w, v^o_w) \quad (18)$$

$$= \Pi^u(v^1, \mu^o) - \mu^o q^o + v^o q^o - \Pi^u(v^1_w, v^o_w)$$

$$= [\Pi^u(v^1, \mu^o) - \Pi^u(v^1_w, v^o_w)] + [(v^o - \mu^o) q^o] \quad (19)$$

$$= [SIAMS] + [DAMS] \quad (20)$$

<u>In the case of a small country</u>, that is assuming $dv^1_w = dv^o_w = 0$, the variation of the aggregate measure of support is obtained by total differentiation of $\Pi^c(v^1, q^o, v^o)$ i.e.

$$d(AMS) = d\Pi^c(v^1, q^o, v^o)$$

$$= \delta\Pi^c/\delta v^1 . dv^1 + \delta\Pi^c/\delta q^o . dq^o + \delta\Pi^c/\delta v^o . dv^o \quad (21)$$

This differentiation may be also written using (18) as.

$$d(AMS) = (\delta\Pi^R/\delta v^1) dv^1 + (\delta\Pi^R/\delta q^o) dq^o + v^o . dq^o + q^o . dv^o$$

$$= (\delta\Pi^R/\delta v^1) dv^1 + q^o dv^o + [v^o - \mu^o(v^1, q^o)] dq^o$$

$$= q^1 dv^1 + q^o dv^o + [v^o - \mu^o(v^1, q^o] dq^o \quad (22)$$

Differentiating the alternative expression of Π^c, i.e. equation (16), we obtain

$$d(AMS) = d\Pi^c (v^1, q^o, v^o)$$

$$= d\Pi^u (v^1, \mu^o(v^1, q^o)) + d((v^o - \mu^o) . q^o)$$

$$= d(SIAMS) + d(DAMS)$$

The variation of the AMS is the sum of two components : (i), the variation of the SIAMS which measures supply inducing Aggregate measure of support effects and (ii), the variation of the DAMS which has no impact on supply. The variations of both measures may be written as a function of exogeneous or control variables (v^1, q^o, v^o)

$$d(SIAMS) = d\Pi^u \ (v^1, \mu^o(v^1, q^o))$$

$$= (\delta\Pi^u/\delta v^1)dv^1 + (\delta\Pi^u/\delta\mu^o)[(\delta\mu^o/\delta v^1)\ dv^1 + (\delta\mu^o/\delta q^o)dq^o]$$

$$= q^1.dv^1 + q^o[-(\delta^2\Pi^R/\delta q^o\delta v^1)\ dv^1 - (\delta^2\Pi^R/\delta q^o\delta q^o)dq^o] \quad (23)$$

$$d(DAMS) = d\ [(v^o - \mu^o)\ q^o]$$

$$= (v^o - \mu^o)\ dq^o + q^o\ (dv^o - d\mu^o)$$

$$= (v^o - \mu^o)dq^o + q^o\ dv^o - q^o[-(\delta^2\Pi^R/\delta q^o\delta v^1)dv^1 - (\delta^2\Pi^R/\delta q^o \delta q^o)\ dq^o] \quad (24)$$

The importance of this decomposition is illustrated in figures 5 to 7 where only one exogeneous variable changes at a time, the other instruments variables being held constant. To make the results more transparent and easier to interpret, we consider the case of a single rationed output.

a) Change in quota level

First, let us consider the case where the quota level q^o varies from q^o to $q^o + dq^o$ (figure 5). Then the variation of the AMS, (holding $dv^1 = dv^o = dv^1_w = dv^o_w = 0$) is by (22),

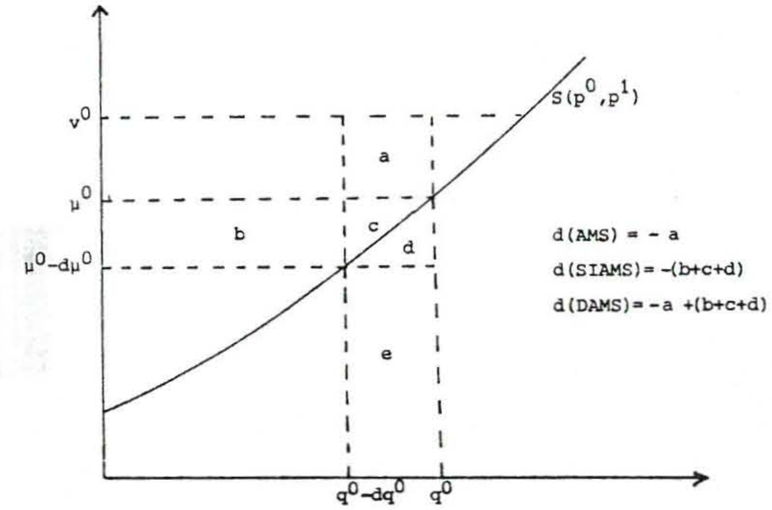
$$d(AMS) = (v^o - \mu^o(v^1, q^o))dq^o$$

$$= d(SIAMS) + d(DAMS)$$

$$= [-(\delta^2\Pi^R/\delta q^o\delta q^o).dq^o.q^o] + [(v^o - \mu^o(v^1, q^o))\ dq^o + (\delta^2\Pi^R/\delta q^o\ \delta q^o).\ dq^o.\ q^o] \quad (25)$$

On figure 5 dealing with the market for output q^o, the variation in the aggregate measure of support is given by the area -a ; d(SIAMS) is given by the area -(b+c+d) and d(DAMS) is represented by -a+(b+c+d).

Figure 5. AMS, SIAMS and DAMS variations in the case of a decrease in the level of the production quota ($dv^1=dv^0=dv^1_w dv^0_w=0$)



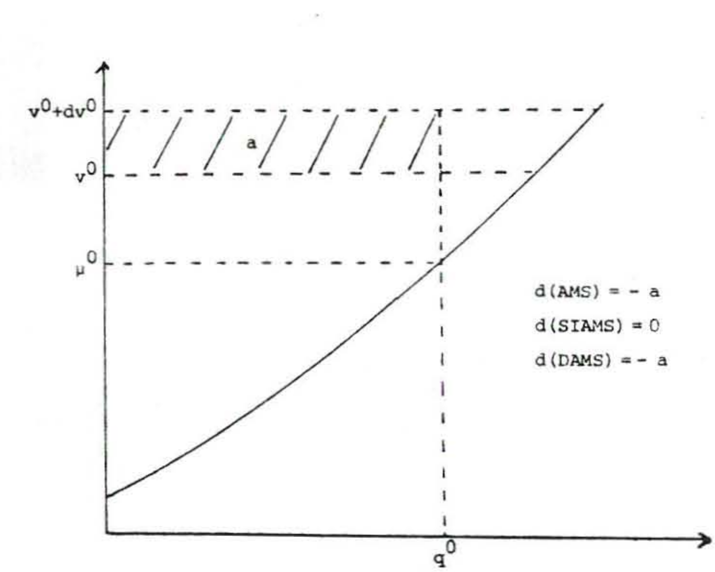
b) a change in support price only

The second example is simpler and corresponds to a variation of the market price v^o of the output under quota. The variations of the three measures of aggregate support are now written as

$$d(AMS) = q^o\ dv^o \quad = d(DAMS)\ ;\ d(SIAMS) = 0 \qquad (26)$$

In such a case, d(SIAMS) is equal to zero since Π^u evaluated with v^1 and μ^o does not depend on v^o as long as the quota is binding, i.e. as long as the shadow price μ^o is lower than the suppor price v^o (see equation (...)). This case is illustrated by figure 6.

Figure 6. AMS, SIAMS and DAMS variations in the case of a change in the market price of the output under quota ($dv^1 = dq^o = dv^1_w = dv^o_w = 0$)



c) a change in variable netput prices

The third particular case corresponds to a change of a market price v^1 of the unconstrained output q^1, other instrument variables being held constant. This case results in

$$
\begin{aligned}
dAMS &= q^1 \; dv^1 . \\
&= [q^1 \; dv^1 + q^0 \; \delta\mu^0/\delta v^1 \; dv^1] - [q^0 \; \delta\mu^0/\delta v^1 \; dv^1] \qquad (27) \\
&= d(SIAMS) + d(DAMS)
\end{aligned}
$$

d(SIAMS) is represented by the area a on figure 6a corresponding to the output q^1 market plus the area b on figure 3b corresponding to the output q^0 market ; d(DAMS) is represented by the area - b on figure 7b.

Figures 7 : AMS, SIAMS et DAMS variations in the case of a change in the market price v^1 of an unconstrained output q^1.

Figure 7a.

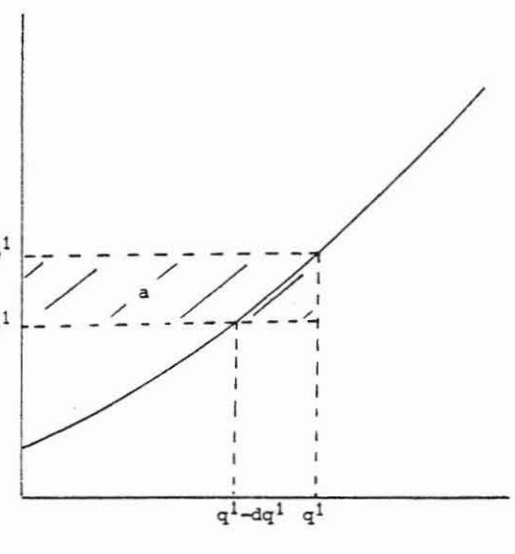
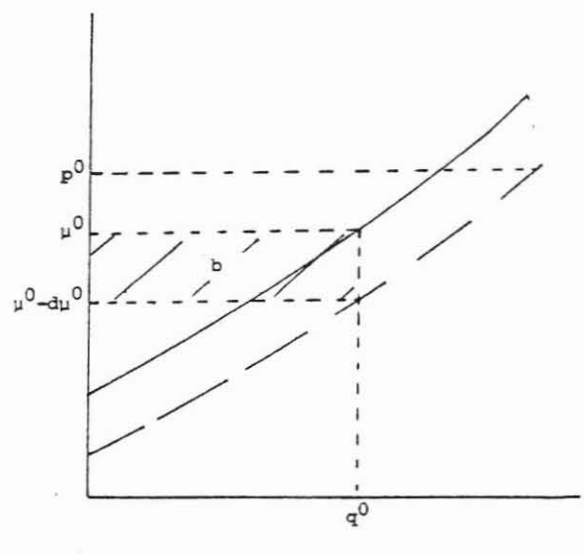


Figure 7b.



To conclude, a very simple expression based on expression (23) can be used to evaluate the overall debit, when the relevant shadow prices are estimated (see annex II). Using y_1

for outputs (prices $p^1{}_i$), $x^1{}_j$ for inputs (prices $w^1{}_j$) and y^o for the quota (shadow price μ^o),

$$\text{Debit} = - \text{credit} = d(\text{SIAMS}) = \Sigma y^1{}_i \; dp^1{}_i + y^o \; d\mu^o - \Sigma \; x^1{}_j \; dw^1{}_j \tag{28}$$

3 - Empirical issues, terms of trade and assessment of results

The analytical expressions presented in the previous sections provide a simple way to calculate the debits and credits, when the effects of policy actions on prices are known. This raises at least three issues (i) the actual contribution of policy action to observed changes in prices received and paid by producers (ii) the measurement of shadow price changes (iii) the impact of policy action on world prices which may also contribute to a decrease in the SIAMS when support is cut and prices move up on world markets.

(i) Contribution of policy changes to observed market prices

No perfect answer can be provided to this question as part of the observed changes in output and input prices is due to the reduction in price support, but part is also due to changes in the general economic outlook ; and in the case of tarif-ridden commodities world market fluctuations are the main cause for price changes on the domestic market.

In the empirical assessment of the debit/credit for EC policy changes we have kept in the calculation only the components of change in supply inducing income support which can be easily connected with actual EC policy changes. As can be seen in table n°4, the effects of observed and shadow price changes are included into the credit only for grains, oilseeds, beef, dairy and sugar on the output side and only for grains on the variable input side. The dramatic change in pork and poultry prices, the reduced price of the sub aggregate "rest of agriculture", and the change in intermediate input cost are not included as they are not considered as consequences of policy adjustments from 1986 to 1988 but rather as results of the general economic situation.

It should be noted however, that when an output is regulated by a quota, the changes in cost, technical progress and market conditions contribute indirectly to the credit. As dairy and sugar are prevented from expanding as a result of e.g. technical change, there is an equivalent cut in support price which should be included since it is due to the role of the restriction on output in preventing market conditions to influence the level of supply.

(ii) Measurement of shadow price changes

The method used above in the estimation of shadow price changes depends on the parameters of the supply equation. In order to check the order of magnitude, casual or quoted informatiopns on prices of quota rights for rent or for sales were used.

Table n°2. Informal estimates of leasing or selling prices of quota rights (1988)

	rental price	sales price	support price	rate of quasirent as per cent of support price[5]
United Kingdom (£/l.) (Burrel, 1989)	0.06	0.034[1]	0.16	21-37 p.c.
Ireland (I£/l.) (Conway, 1989)	0.036		0.20	18.0 p.c.
Netherlands[2] (Hfl/l.)		3	0.75	40.0 p.c.
Denmark[3] (D. Kr/l.)		4.5	2.0	22.5 p.c.
France[4]				25-40 p.c.

Sources :
[1] Calculated on the basis of the quoted quota price of 1.700 $ per cow and informal inquiry.
[2] personal interview
[3] personal interview
[4] estimates from cost function and from a similar method as used here (Guyomard, Mahé 1989)
[5] When a sales price was the data, a 10 percent discount rate was applied.

The estimates quoted in table 2 are rather casual in most cases. However the orders of magnitude are not so far away from our estimate for the whole of EC-10, which amounts to a decrease in shadow price of about 6 p.c. from 1983 to 1986 and a further 21 p.c. from 1986 to 1988 (annex I).

(iii) terms of trade effects of policy adjustment.

The general decomposition of the AMS given in section 2 was :

$$AMS = [\Pi^u(v^1, \mu^o) - \Pi^u(v^1{}_w, v^o{}_w)] + (v^o - \mu^o)\, q^o$$

$$= \quad SIAMS \quad + DAMS$$

Up to now we have discussed the effect of policy changes on $\Pi^u(v^1, \mu^o)$. If there are policy instruments g_n ($n = 1, \ldots N$), this effect can be written as the total differential of the virtual profit function around domestic and shadow price level,

$$d\Pi^u \ (v^1, \mu^o) = \sum_n (\delta\Pi^u \ (.) \ / \ \delta g_n) \ dg_n$$

Likewise the terms of trade effect of policy changes in EC, has increased the level of the virtual profit function at world market prices,

$$d\Pi^u \ (v^1{}_w, v^o{}_w) = \sum_n (\delta\Pi^u \ (.) \ / \ \delta g_n) \ dg_n$$

In order to discover the magnitude of the second effect, the MISS model (Mahé, Tavéra et Trochet, 1988 ; Guyomard, Mahé, Tavéra et Trochet, 1988) was used to assess the impact of policy changes on world prices. Table 3 summarizes the outcome of implementing theses changes in support prices (grain, oilseeds, beef) and in the dairy quota.

Table 3. Terms of trade effects and increase in farm income at world market prices.

function $d\Pi^u(v^1{}_w, v^0{}_w)$	world price change (per cent)	change in profit at world prices (millions ECU,1986)
grains	+ 2.4	350
oilseeds	+ 0.6	27
beef	+ 1.9	292
dairy	+ 5.9	860
sugar	+ 0.3	-
pork and poultry	-	-
rest of agriculture	-	-
Total agriculture	-	1 529

4 - Summary of credit for policy measures in EC from 1986 to 1988 (million ECU, 1986)

	actual or shadow[1] price variation nominal (per cent)	deflated (per cent)	support or shadow price cut (million ECU, 1986)	inclusion in the debit measure
. unconstrained outputs			$y^{l}_{i}\, dp^{l}_{i}$	
grains	- 3.7	- 11.6	- 2 850	yes
oilseeds	- 15.5	- 23.4	- 1 172	yes
beef	+ 7.4	- 0.5	- 136	yes
pork and poultry	- 12.6	- 20.5	- 4 692	no
rest of agriculture	3	- 4.9	- 219	no
. outputs under quota			$y^{o}_{i}\, d\mu^{o}_{i}$	
dairy*	- 13.1	- 21	- 4 844	yes
sugar*	-	-	-	-
. inputs			$-x^{l}_{i}\, dw^{l}_{i}$	
grains	- 3.7	- 11.6	+ 1 462	yes
proteins	- 5.9	- 13.8	+ 464	no
milk feed	6.4	- 1.5	+ 20	no
other feed	- 0.8	- 8.7	+ 22	no
other int. consumpt	+ 1.9	- 6	+ 244	no
Debit = total change in SIAMS (small country)				- 7 540
World price change effect				- 1 529
Debit = total change in SIAMS (large country)				- 9 069

[1] Sugar contribution to the credit was judged to be small and negligible..

REFERENCES

BURREL A. ed, 1989, Milk quotas in the European Community. C.A.B. international, 214 p.

BURREL A., 1989, The microeconomics of quota transfer ; in A. BURREL ed., chapter 8, pp. 100-118.

CONWAY A.G., 1989, The exchange value of milk quotas in the Republic of Ireland and some future issues for EC quota allocation, in A. BURREL ed., chapter 9, pp. 119-129.

GUYOMARD H., MAHE L-P., TROCHET T., 1988. Modelling agricultural trade policy interactions between the EC and US : comparative projection. International Agricultural Trade Consortium, San-Antonio, 25 p.

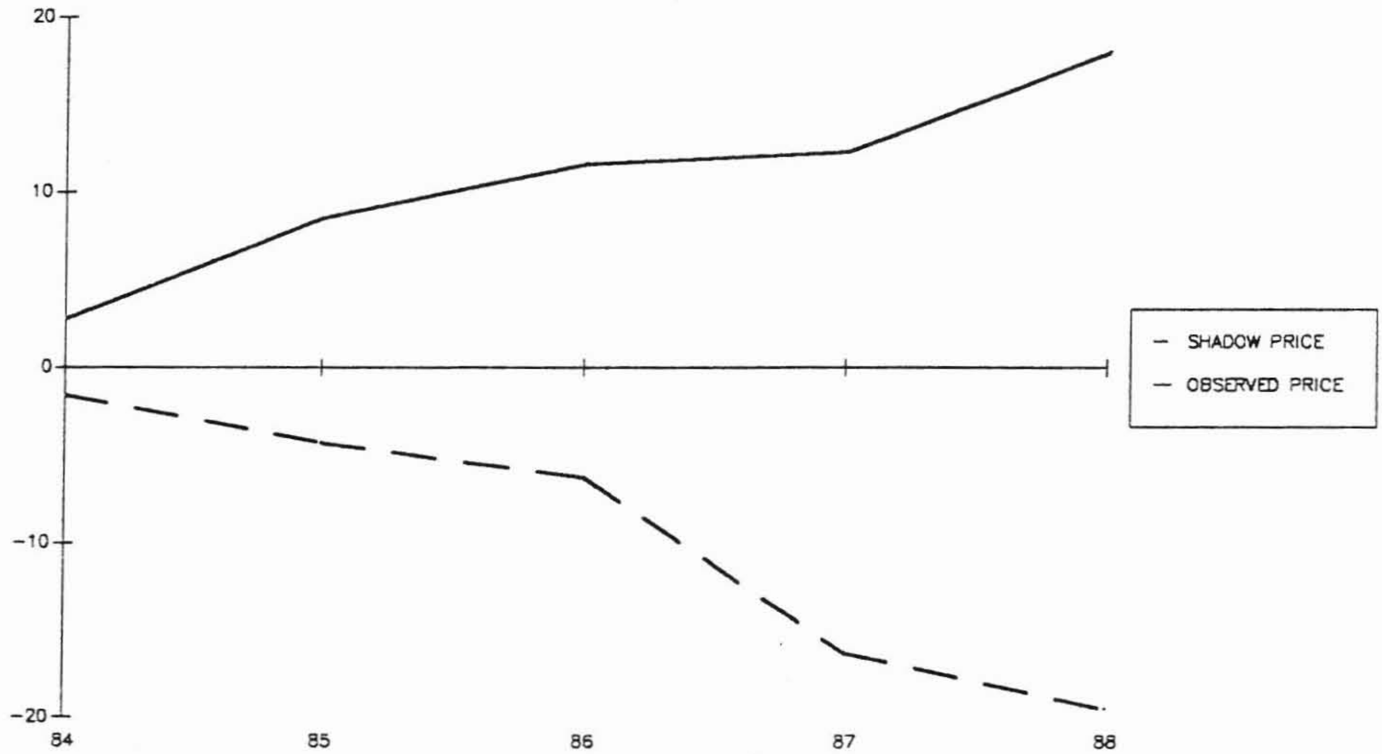
GUYOMARD H., MAHE L-P., 1989, Théorie du producteur en présence de rationnements : application aux quotas lait en Europe. Paper presented at Societé Française d'Economie Rurale, 27-28 September 1989.

MAHE L-P., GUYOMARD H., 1989, Supply behavior with production quotas and quasi-fixed factors. Paper presented at 6èmes journées de microéconomie appliquée, Orléans, June 1989.

MAHE L-P., TAVERA C., TROCHET T., 1988, An analysis of interaction between EC and US agricultural policies with a simplified world trade model : MISS. Background paper for the report to the Commission on Disharmonies on EC and US Agricultural Policies, INRA, Rennes.

ANNEX I.

CUMULATIVE EVOLUTION OF SHADOW AND OBSERVED PRICES OF MILK (EEC 10)



ANNEX II.

This appendix is based on Mahé Guyomard (1989) and Guyomard, Mahe (1989).

When all prices are given and producers are free to adjust immediately, the familiar producer problem is :

$$\underset{(q)}{\mathrm{Max}}\ [vq\ ;\ q\ \varepsilon\ T] = \Pi^u\ (v) \qquad \text{(a)}$$

where q is the vector of (n + m) netputs quantities, v the vector of corresponding prices and Π^u (v) the (unconstrained) profit function. The feasible set T is assumed strictly convex so that optimal quantities are uniquely determined and well behaved function of prices. The vector q is partitioned into two subvectors of quantitities q^1 always variable and quantitities q^o susceptible of being constrained. A similar subdivision applies to the vector of prices v. Problem (a) may then be written as :

$$\underset{(q^1,q^o)}{\mathrm{Max}}\ [v^1\ q^1 + v^o\ q^o\ ;\ (q^1,\ q^o)\ \varepsilon\ T] = \Pi^u\ (v^1, v^o) \qquad \text{(b)}$$

The complete system of supply response can be written in terms of the Jacobian of this unconstrained profit function

$$\begin{vmatrix} dq^{1u} \\ dq^{ou} \end{vmatrix} = \begin{vmatrix} \Pi^u_{v1vo}\ (v^1,\ v^o) & \Pi^u_{v1vo}\ (v^1, v^o) \\ \Pi^u_{vov1}\ (v^1,\ v^o) & \Pi^u_{vovo}\ (v^1, v^o) \end{vmatrix} \quad \begin{vmatrix} dv^1 \\ dv^o \end{vmatrix} \qquad \text{(c)}$$

When quantitites are pegged at say q^o by policy instruments (production quotas, set-aside,...), variable quantities do not behave in the same way with respect to exogeneous prices v^1, since they are also a function of fixed quantities q^o. Define μ^o the vector of virtual prices, which ensure that the unconstrained quantities q^{ou} as functions of prices will stay at level q^o, by :

$$q^{ou}\ (v^1,\ \mu^o) = q^o \qquad \text{(d)}$$

Solving (d) for the virtual prices μ^o as function of v^1 and q^o, we can define the relationship between the restricted behavioral functions[5] $q^{1R}(.)$ and the unconstrained functions $q^{1u}(.)$

5 When some netputs q^o are fixed at q^o, the constrained producer problem is written as : max $[v^1\ q^1\ ;\ q^1\ \varepsilon\ T\ (q^o)] = \Pi^R\ (v^1,\ q^o)$. Supply and demand equations for variable netputs q^1 are then given by $q^{1R}\ (v_1,\ q_o) = \delta\Pi^R\ (v^1,\ q^o)/\delta v^1$.

$$q^{1R}(v^1, q^o) = q^{1u}[v^1, \mu^o(v^1, q^o)] \qquad \text{(e)}$$

Differentitating (d) and (e) yields

$$\begin{vmatrix} dq^1 \\ \\ dq^o \end{vmatrix} = \begin{vmatrix} \Pi^u_{v1v1}(v^1, \mu^o) & \Pi^u_{v1vo}(v^1, \mu^o) \\ \\ \Pi^u_{v1vo}(v^1, \mu^o) & \Pi^u_{vovo}(v^1, \mu^o) \end{vmatrix} \begin{vmatrix} dv^1 \\ \\ dv^o \end{vmatrix} \qquad \text{(f)}$$

The cross partial derivatives of Π^u are evaluated at the point (v^1, q^o), i.e. $(v^1, \mu^o(v^1, q^o))$. The comparative statics of the constrained regime is obtained by solving (f) for the actual endogeneous variables $(dq^{1u}, d\mu^o)$ with respect to the new set of exogeneous ones which are (dv^1, dq^o), that is

$$\begin{vmatrix} dq^1 \\ \\ d\mu^o \end{vmatrix} = \begin{vmatrix} \Pi^u_{v1v1} - \Pi^u_{v1vo}(\Pi^u_{vovo})^{-1}\Pi^u_{vov1} & \Pi^u_{v1vo}(\Pi^u_{vovo})^{-1} \\ \\ -(\Pi^u_{vovo})^{-1}\Pi^u_{vov1} & (\Pi^u_{vovo})^{-1} \end{vmatrix} \begin{vmatrix} dv^1 \\ \\ dq^o \end{vmatrix} \qquad \text{(g)}$$

The virtual price changes are analysed using the second row of (g) : these changes may equivalently be written in terms of unconstrained price elasticities.

$$\hat{\mu}^o = -(E_{oo})^{-1} E_{o1} . \hat{v}^1 + (E_{oo})^{-1} \hat{q}^o \qquad \text{(h)}$$

where $\hat{\mu}^o$, $\hat{v}^1$ and $\hat{q}^o$ are the vectors of percentage changes in virtual prices, unconstrained netput prices and fixed netputs respectively ; and E_{oo} and E_{o1} are the matrices of price elasticities of netputs q^o under unconstrained regime. Technical change effects may also be included (for more details, see Guyomard and Mahe, 1989).