Testing Separability for Common Wheat Qualities in French Import Demand Market Using Aids and Rotterdam Demand Models

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TESTING SEPARABILITY FOR COMMON WHEAT QUALITIES IN FRENCH IMPORT DEMAND MARKET USING AIDS AND ROTTERDAM DEMAND MODELS

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Abstract:

This study has used a corrected likelihood ratio, with AIDS and Rotterdam demand models, to test separability in three separable (A, B, C) wheat import demand structures on the French common wheat market. It appears from the study that the three separable Rotterdam structures are accepted by the test, while only two of them (B and C) are accepted in the case of AIDS at 5% level of significance. Meanwhile, model B seems to be more indicated in demand analysis with AIDS since it is the only one accepted at 15% level of significance. The results obtained demonstrate not only the necessity to test separability in demand structures, but also the necessity to know how the allocation models can be used for demand analysis purpose. The study has also shown a great difference in econometric results for AIDS and Rotterdam and pose once more the issue of the choice of a functional form in demand analysis.

I.   Introduction

Allocation models are usually used to analyse trade of agricultural products, mainly because they are well taking into account the intra-industry (product differentiation) exchange that characterized the agricultural trade. Dixit and Stiglitz (1977), and Krugman(1980) have contributed to the theoretical foundation of those models which are then conforms with the new international trade theory based essentially on the monopolistic competition. Since the critics of the Armington model, (especially to what concerns homotheticity assumption), which is the precursor of allocation models, these models are based essentially on the weak separability (WS) assumption of consumers preferences or producers technology.

Weak separability (WS) allows the splitting of a utility function (technology) into many sub-utility functions. As pointed out by Phlips (1983), it is a necessary and sufficient condition for multi-stage budgeting that allows conditional demand systems where demand for a product belonging to a group depends only on the price of products in the same group and on the expenditure allocated to that group. The consequences of this assumption are of great importance both to the method and to the policy implication of the results. With regard to the method, the conditional demand systems allows to reduce the number of goods in the demand model, and consequently to facilitate the econometric estimation. This allows the use of flexible functional forms even if the number of goods in the demand system is large, avoiding then the Hanoch (1975) apprehension about the use of those functional forms in demand or supply analysis. This assumption also limits the possibility of substitution when goods are not closed to each other. With regard to policy, the WS allows evaluating price policies on a specific group of goods without carrying to the direct impacts on the consumption of goods not belong to that group. For this importance, and especially in what concerns econometric analysis, WS is widely used in imports demand analysis, but is not generally tested, leading to bias elasticities estimates and to a consequently wrong policy analysis when this assumption doesn't hold. The only way to efficiently use WS is to test whether it is appropriate in the given context. This is the aim of this study which intends to know whether and how trade allocation models can be used to analysed the EU common wheat import demand.

EU common wheat market is one of the more important in the world. Economic Research Service (ERS) statistics shows that between 1990/91 and 1994/95, the average annual EU wheat production represents 15,8% of the world wheat production in front of USA (11,7%) and behind China (18%). EU is the first world wheat exporter with 32% of total world exports against 32% for the USA and 20% for Canada. EU also imports 16% of total world imports against 17% for the USA and 9% for China. The balance sheet of these figures shows that EU is the second world wheat consumer with 12% of the world wheat consumption behind China(20%). The importance of EU market and

especially of the France Wheat market (which represent more than 30% of the EU market) is mainly due to the market protection and price support of the Common Agricultural Policy (CAP) implemented since 1962. Since 1992, and following the international trade negotiations, CAP have been reformed twice (Mac Sharry and Agenda 2000) in the sense of diminishing market protection and price support). This new situation of wheat trade liberalisation open the EU wheat market to the US, Canada and other European countries wheat. Because it is known that EU common wheat is not enough competitive either in quality or in prices as compared to the imported common wheat, and given the current international trade negotiations, it appears necessary to know how the EU common wheat market reacts to this trade liberalisation policy reinforced by agenda 2000, especially in what concerns the common wheat import demand.

The use of trade allocation models is suitable for this analysis since it has been demonstrated by Hjort(1988) and Larue (1991) that wheat is not an homogeneous product. The wheat import demand analysis should consequently take into account, as stressed by Bale and Ryan(1977), the wheat end use and import source differentiation. This differentiation, especially among the various common wheat classes should be firstly tested by testing weak separability among them. Because of the difference in consumption structure of different EU members states, and because the EU common wheat is more concerns with the competition of the imported wheat, this paper is concentrating on the French common wheat market. Table 1 gives a summary characteristics of French common wheat market mainly in import demand.

Table 1:   End use for different quality wheat (HQW, MQW and LQW) and the mean budget share (1980-1998) for each import source and for each quality wheat.

Common wheat quality	End use	Mean budget share per import source					
		France	EU	USA	Canada	ROW	Total
High Quality Wheat (HQW)	High quality flour for high quality bakeries products	0,510 (0,047)	0,331 (0,017)	0,120 (0,009)	0,037 (0,003)	0,002 (0,000)	1.000 (0.076)
Medium Quality Wheat (MQW)	Medium quality flour for medium quality bakeries products	0,986 (0,718)	0,003 (0,002)	0,009 (0,006)	0,002 (0,002)	0,000 (0,000)	1.000 (0.728)
Low Quality Wheat (LQW)	Low quality flour for biscuits, cakes and pastries products	0,996 (0,195)	0,004 (0,001)	0 (0)	0 (0)	0 (0)	1.000 (0.196)

Source: computed from the Office National Interprofessionnel des Céréales (ONIC) data.
Figures in brackets are budget share as compared to the total common wheat expenditure. The other figures are budget shares for an import source as compared to the total expenditure for the corresponding wheat quality. Imports from France (as an import source) are computed by removing stocks and exports from the production. Canada and rest of the world price for MQW and the world price for HQW are not available. They are replaced by the USA prices.

The French common wheat market is made up of three qualities. (i) high quality wheat (HQW) is used for high quality bakeries product, (ii) medium quality wheat (MQW) is used in the medium quality bakeries production, and (iii) low common quality wheat (LQW) used in cakes, biscuits and pastries industry. There are some relationship between the three wheat qualities. The HQW can be mixed with the LQW to increase the its quality. Table 1 also shows that each wheat quality is imported from different sources. The French source dominates the French market for each wheat quality. Canada and USA are the main extra UE import sources. The weakness of the mean budget share of the extra EU imports sources can be explained as a consequence of the protective and interventionist CAP. These budget shares are expected to increase with trade liberalisation, and justify more the need of analysing EU common wheat import demand, and consequently the need to test weak separability among the three common wheat qualities.

Numerous studies have tested the weak separability in demand models using different tests. One can mentioned Winters(1983), Eales and Unnevehr (1988), Brenton (1988), Lafrance (1993), Nayga and Oral Capps(1994), Moschini and al(1994), Sckokai and Moro(1995), Sellen and Goddard(1996), and more recently Eales and Henderson (2001). None of these studies has tested separability of import demand with regard to wheat quality in the E.U in general and on the French

market in particular. De Gorter (1986) and Mohanty and Peterson (1999), have analysed, the wheat import demand in the EU. But they only assume Weak separability between the different wheat classes, without testing it. The present study is made up of four sections. It begins by an introduction, followed by theoretical framework, empirical results and discussions, and conclusion.

II.   Testing Weak separability: Theoretical framework

Trade allocation theory is based on individual consumer theory or on firm theory depending of the nature (final or intermediate good) of the traded product. The present paper is dealing with common wheat grain, and it is expected to use the firm theory. But this is not the case because of the following reasons: (i) a part of common wheat imported on French market is directly consumed and another part is used in agro-industries. We don't have the accurate statistics of each of these parts. (ii) There is a lack of data concerning the prices of other inputs and prices of products produced by common wheat transformation. There is also a possibility of substituting and/or mixing two wheat classes and we don't have accurate information about these relationships. In this frame, we use the consumer theory to estimate imports demand models, being conscious of the bias that can be introduced in the econometric results as mentioned by Terry and Marsch (2000). But, we think that this bias can be minimised if we consider that we are in a case of a multi-products multi-factors firm, were common wheat is considered as a factor to produce manufactured products. In this case, we considered only that the firm, given the technology used and the product market situation, decides firstly for the total quantity of wheat to import. In a second budgeting procedure, it allocates his budget to the different wheat classes, and so on. Thus, this procedure joint the Davis and Jensen (1994) procedure of budgeting in which the demand models in the intermediary and the last stages of budgeting are almost equals, since costs of common wheat as input equals expenditures for common wheat as final product.

Consumer theory stipulates that from a utility function $u=u(q)$ maximisation, subject to a budget constraint $y=p'q$ (where q is the vector of quantities consumed and p the corresponding vector of price) a Marshallian demand system $q=(p,y)$ is obtained. When the number of good i $(i=1,...,n)$ is large, then the demand system becomes difficult to estimate. The WS assumption allows separating a set of goods into bundles that become the arguments of the sub-utility functions.

Once the separability conditions are respected, the utility function u can be written as follows
$$u=u(q)=u(u_1(q_1),....u_s(q_s),..., u_r(q_r)) \tag{1}$$
Where $s=1,...,r$, and r is the total number of groups, u_s the sub-utility function associated to the consumption of q_s, and q_s the vector of goods belonging to the s group.

According to equation (1), the consumer decides firstly to allocate his budget to the different group of goods (first stage) and secondly, he decides for the quantity of good to be purchased in each group. This two stage budgeting allows deriving s conditional demand systems; each one $q_s=q_s(p_s,y_s)$ equals the non-conditional demand system $q=(p,y)$. WS imposes restrictions on consumer behaviour as pointed out by Alston and al (1990). First, the marginal rate of substitution between two products from the same group is independent of the consumption of goods in other groups. Second, the substitution effects between goods in different group is limited, meaning that a price change of a commodity in one group affects the demand for a commodity in another group only through the group income effect. Third, it implies a restrictive relationship between price and income effect. Algebraically, the necessary and sufficient condition for weak separability can be written as follows:

$$S_{ik}=\frac{\partial h_i}{\partial p_k}=\mu_{GH}\frac{\partial q_i}{\partial y}\frac{\partial q_k}{\partial y} \tag{2}$$

Where $i \in G$, $k \in H$, and $G \neq H$ denote two groups,

μ_{GH} is the proportionality term that is the same for all goods in the two groups involved.

S_{ik} is the compensated cross price effect, and h_i is the Hichksian demand function.

Given the equation (2) and the Allen-Uzawa elasticity of substitution $\sigma_{ij} = \frac{\eta_{ij}^*}{w_j}$ (where η_{ij}^* is the compensated cross price elasticity, and w_j is the budget share), and the expenditure elasticity η, equation (2), following Goldman and Uzawa (1964), can be written for symmetric weak separability:

$$\frac{\sigma_{ik}}{\sigma_{jm}} = \frac{\eta_i \, \eta_k}{\eta_j \, \eta_m} \quad (i, j) \in G \text{ and } (m, k) \in H, \text{ for all } G \neq H, \text{ and} \tag{3}$$

and for asymmetric weak separability, $\dfrac{\sigma_{ik}}{\sigma_{jk}} = \dfrac{\eta_i}{\eta_j}$ (4)

Because of the large number of restrictions that can be derived from (3) when the number of goods n (and the number of groups) is large, one needs only the non-redundant restrictions to test separability restrictions in a demand or a supply model. The number of non-redundant restrictions n_R, following Moschini and al (1994), is given as follows: $n_R = n_0 - n_\mu$ (5) where $n_0 = \frac{1}{2}(n(n-1) - \sum_1^s n_s(n_s - 1))$ is the number of cross substitution terms, and $n_\mu = \frac{1}{2}s(s-1)$ is the number of proportionality terms. Theoretically, separability can be tested by using Wald (W), Likelihood Ratio (LR) and the Lagrange multiplier (LM) tests. All of these tests, as stressed by Italianer (1985) are asymptotically equivalent. Because of the weakness of Wald test, due to its non-invariance according to the algebraic form of the non-linear constraints, the Corrected Likelihood ratio test is used in testing weak separability. The corrected LR test (CLR), is given by the following equation:

$$CLR = LR \left[\frac{MT - \frac{1}{2}(N_U + N_R) - \frac{1}{2}M(M+1)}{MT} \right] \tag{5}$$

Where $LR = 2(l\beta nr - l\beta r)$ is the classic Likelihood Ratio (LR) test with $l\beta nr$ and $l\beta r$ which are respectively the log likelihood of the unrestricted model and of the restricted (separable) model, N_U and N_R are respectively the number of parameter in the unrestricted model and in the restricted model, M the number of equations in the models, and T is the number of time series observations. The CLR follows a $\aleph^2$ with r degrees of freedom where r equals the number of constraints.

III.   Methodology: empirical models, estimation and data

The CLR test consist of comparing a general unrestricted (without an allocation procedure) model to a series of restricted (many allocation procedure) model using two empirical demand models.

Empirical demand models

The Almost Ideal Demand System (AIDS) and Rotterdam models are used to estimate the French common wheat demand model. This choice is done only because these two models are the most popular flexible demand models. Meanwhile, the two models are different. Rotterdam model is a first difference model while AIDS model is at level. The two models used budget shares. As mentioned by Moschini and al (1994), Rotterdam demand model is separability flexible, which means that the separability can be tested and maintained at the whole point, on the contrary to AIDS which is a separability inflexible demand model. On the other hand, AIDS is considered as an exact representation of consumer's preference at least at a point whereas Rotterdam cannot be considered as an exact representation of preferences unless very strong conditions are imposed. This critic on Rotterdam model, as noticed by Barnett (1979), does not detract at all from his usefulness.

Two variables have been introduced into each of the two models to take into consideration some specific aspect of food (wheat) import demand in the French market. These variables are the trend (T) for the evolution of the consumers taste and a dummy for the 1992 Mac Shary (CAP) reform. The dummy (*dum*) is taking the value 1 before the CAP reform and 0 after. Consequently the two demand models used in this study are specified as follows:

a)　　For the Rotterdam model:

$$w_i\, d\log q_i = b_i \sum_i w_i\, d\log q_i + \sum_j c_{ij} d\log p_j + e_i\, d\log T + d_i\, ddum + v_t \tag{6}$$

With $b_i = w_i \eta_i = p_i \dfrac{\partial q_i}{\partial y}$ (7) and $c_{ij} = w_i \eta_{ij}^* = s_{ij} \dfrac{p_i p_j}{y}$ (8), where s_{ij} is the ijst term of the Slutsky matrix of substitution and w_i the budget share of good i in the system considered. η_{ij}^* is the compensated (Hicksian) price elasticity and the non compensated (Marshalian) price elasticity η_{ij} can be computed from the Slutsky[1] equation using elasticities. $y = \sum_i p_i q_i$ is the total expenditure of the n goods, $b_i's$, $c_{ij}'s$, $e_i's$ and $d_i's$ are parameters to be estimated and v_t is the error term. In the empirical studies, budget shares are replaced by their arithmetic mean w^* given by $w_i^* = (w_{it} + w_{it+1})/2$. The theoretical demand conditions are satisfied when $\sum_i b = 1$ and $\sum_i c_{ij} = 0$, $\sum_i c_{ji} = 0$, $c_{ij} = c_{ji}$ and $[c_{ii}] \leq 0$. Given the expression of the Allen-Uzawa elasticity ($\sigma_{ik} = \frac{c_{ik}}{w_i w_k}$), and the expenditure elasticities in Rotterdam models, (3) becomes $c_{ik} = c_{jm} \dfrac{b_i b_k}{b_j b_m}$ (9). The trend and dummy enter the model as differential to be in conformity with the specification of the Rotterdam model.

b)　　For AIDS model:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i \log(y/P) + e_i \log T + d_i\, dum + v_t \,, \tag{10}$$

With $i, j = 1, \dots, n$, characterising the goods. P is a general price deflator and is specified as

$$Log\, P = \alpha_0 + \sum_j \alpha_j \log p_j^k + \frac{1}{2} \sum_i \sum_j \gamma_{ij} \log p_i^k \log p_j^k \tag{11}$$

According to Deaton and Muellbauer (1980), the general price deflator can be approximated by the Stone index specified as follows: $\log P = \sum_i w_i \log p_i$. Despite the critics of Buse (1994) from which this approximation end up with inconsistent parameter estimates which yield wrong elasticities, this linear approximation is very easy to use when testing separability because the restricted separable models become very non linear as the number of separability constraints increase. The adding up, symmetry homogeneity and symmetry conditions respectively require that $\sum_j \alpha_j = 1$, $\sum_j \beta_j = 0$, $\sum_i \gamma_{ij} = 0$, $\sum_j \gamma_{ij} = 0$, and $\gamma_{ij} = \gamma_{ji}$. The negativity condition is verified if the Slutsky matrices of

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[1] $\eta_{ij} = \eta_{ij}^* - w_j \eta_i$

the terms of substitution $s_{ij} = \dfrac{y}{p_i p_j} c_{ij}$ or c_{ij} is negative semi-definite. This Slutsky substitution terms

can be written as $s_{ij} = \dfrac{y}{p_i p_j}\left[\gamma_{ij} + w_i w_j - \delta_{ij} w_i + \beta_i \beta_j \log\left(\dfrac{y}{P}\right)\right]$ $\qquad$ (12)

Where δ_{ij} is the Kronecker delta taking the value 1 for $i=j$ and 0 for $i \neq j$. At the mean point (where data can be scaled to obtain that point of maximum information) $p_i = y = 1$, (12) can be written as $s_{ij} = \left[\gamma_{ij} + w_i w_j - \delta_{ij} w_i\right]$ in which w_k is replaced by a_k if the added variables could be scaled to one at the mean point. According to Green and Alston (1990), elasticities in AIDS can be expressed as: $\eta_i = 1 + \beta_i / w_i$ for income elasticity, $\eta_{ij}^* = -\delta_{ij} + w_j + \gamma_{ij} / w_i$ for compensated elasticity. The Allen Uzawa

elasticity of substitution is expressed as $\sigma_{ik} = \dfrac{\gamma_{ik}}{w_i w_k} + \dfrac{\beta_i \beta_k}{w_i w_k}\log\left(\dfrac{y}{P}\right) + 1$. The separability restrictions

in AIDS model at the mean point is given by the expression

$$\gamma_{ik} = \left(\gamma_{jm} + a_j a_m\right)\left(\dfrac{(a_i + \beta_i)}{(a_j + \beta_j)}\dfrac{(a_k + \beta_k)}{(a_m + \beta_m)}\right) - a_i a_k \qquad (13)$$

Models to be tested

Due to the reduced number of observation, to the non-availability of certain data, and to the specificity of common wheat as compared to durum wheat, this paper is testing the separability only between the different common wheat classes (qualities). The low budget share of certain import sources has conducted to aggregate them with other sources. It is the case of the EU low quality wheat with France source of the same quality, the case of Canada and USA for the high quality wheat, and the case of USA, Canada and EU sources for medium quality Wheat. According to this aggregation, the unrestricted model, which entails finally six goods, is expressed as follows:

$$u_{NR} = u_{NR}(q_1, q_2, q_3, q_4, q_5, q_6) \qquad (14)$$

Where:

q_1 is the quantity of low quality wheat (LQW) imported from the world, including France,

q_2 is the quantity of medium quality wheat (MQW) imported from France

q_3 is the quantity of medium quality wheat (MQW) imported from the rest of World (including EU, Canada and the USA),

q_4 is the quantity of high quality wheat (HQW) imported from France,

q_5 is the quantity of High quality wheat (HQW) imported from the EU,

q_6 is the quantity of High quality wheat (HQW) imported from the rest of the world (including USA, Canada).

Table 2 below gives the different separable structures or restricted models to be tested.

Table 2:   The different common wheat consumer's preference structures (A, B and C) to be tested and the corresponding non redundant restrictions

SS[a]	CRM[b]	Utility function	n_R	Non redundant restrictions (NRR)
	A1	$u = u_{a1}(q_1,(q_2,q_3,q_4,q_5,q_6)$	4	$\dfrac{\sigma_{12}}{\sigma_{16}} = \dfrac{\eta_2}{\eta_6}, \dfrac{\sigma_{13}}{\sigma_{16}} = \dfrac{\eta_3}{\eta_6}, \dfrac{\sigma_{14}}{\sigma_{16}} = \dfrac{\eta_4}{\eta_6}, \dfrac{\sigma_{15}}{\sigma_{16}} = \dfrac{\eta_5}{\eta_6}$
A	A2	$u = u_{a2}(f(q_1, h(q_2,q_3, g(q_4,q_5,q_6)))$	8	NRRA1, $\dfrac{\sigma_{24}}{\sigma_{26}} = \dfrac{\eta_4}{\eta_6}, \dfrac{\sigma_{25}}{\sigma_{26}} = \dfrac{\eta_5}{\eta_6}, \dfrac{\sigma_{34}}{\sigma_{36}} = \dfrac{\eta_4}{\eta_6}, \dfrac{\sigma_{35}}{\sigma_{36}} = \dfrac{\eta_5}{\eta_6}.$

	A3	$u = ua_3(f(q_1, h(v(q_2, q_3), g(q_4, q_5, q_6)))$	9	NRRA2, $\dfrac{\sigma_{26}}{\sigma_{36}} = \dfrac{\eta_2}{\eta_3}$
	B1	$u = ub_1(q_1, q_2, q_3, i(q_4, q_5, q_6))$	6	$\dfrac{\sigma_{14}}{\sigma_{16}} = \dfrac{\eta_4}{\eta_6},\ \dfrac{\sigma_{24}}{\sigma_{26}} = \dfrac{\eta_4}{\eta_6},\ \dfrac{\sigma_{15}}{\sigma_{16}} = \dfrac{\eta_5}{\eta_6},\ \dfrac{\sigma_{25}}{\sigma_{26}} = \dfrac{\eta_5}{\eta_6},$ $\dfrac{\sigma_{34}}{\sigma_{36}} = \dfrac{\eta_4}{\eta_6},\ \dfrac{\sigma_{35}}{\sigma_{36}} = \dfrac{\eta_5}{\eta_6}$
B	B2	$u = ub_2(l(q_1, q_2, q_3), k(q_4, q_5, q_6))$	8	NRRB1, $\dfrac{\sigma_{16}}{\sigma_{36}} = \dfrac{\eta_1}{\eta_3},\ \dfrac{\sigma_{26}}{\sigma_{36}} = \dfrac{\eta_2}{\eta_3}$
	B3	$u = ub_3(l(q_1, j(q_2, q_3)), k(q_4, q_5, q_6))$	9	NRRB2, $\dfrac{\sigma_{12}}{\sigma_{13}} = \dfrac{\eta_2}{\eta_3}$
C	C	$u = uc(q_1, i(q_2, q_3), g(q_4, q_5, q_6))$	8	$\dfrac{\sigma_{12}}{\sigma_{13}} = \dfrac{\eta_2}{\eta_3},\ \dfrac{\sigma_{14}}{\sigma_{16}} = \dfrac{\eta_4}{\eta_6},\ \dfrac{\sigma_{15}}{\sigma_{16}} = \dfrac{\eta_5}{\eta_6},\ \dfrac{\sigma_{24}}{\sigma_{26}} = \dfrac{\eta_4}{\eta_6},$ $\dfrac{\sigma_{25}}{\sigma_{26}} = \dfrac{\eta_5}{\eta_6},\ \dfrac{\sigma_{34}}{\sigma_{36}} = \dfrac{\eta_4}{\eta_6},\ \dfrac{\sigma_{35}}{\sigma_{36}} = \dfrac{\eta_5}{\eta_6},\ \dfrac{\sigma_{26}}{\sigma_{36}} = \dfrac{\eta_2}{\eta_3}$

Source: The author (NRRXi: The non redundant restrictions of model Xi)
[a] Separable structure, [b] Corresponding restricted model

Structure A entails 3 restricted models. A1 assumes that the importers, in a first stage budgeting, firstly separate LQW from the other wheat. For a second stage, they separate HQW from the MQW sources, and in a third stage, they separate MQW from the HQW.
Structure B is also a three stage budgeting that ends up with a weak separability between LQW and MWQ, and both are separated from the HQW.
Structure C is the common structure based on the quality difference where the three wheat qualities are separable each to other.

The different utility trees entails by the structure A, B and C are reported in figures 1a, 1b and 1c below.

Fig1a: utility tree entails by structure A
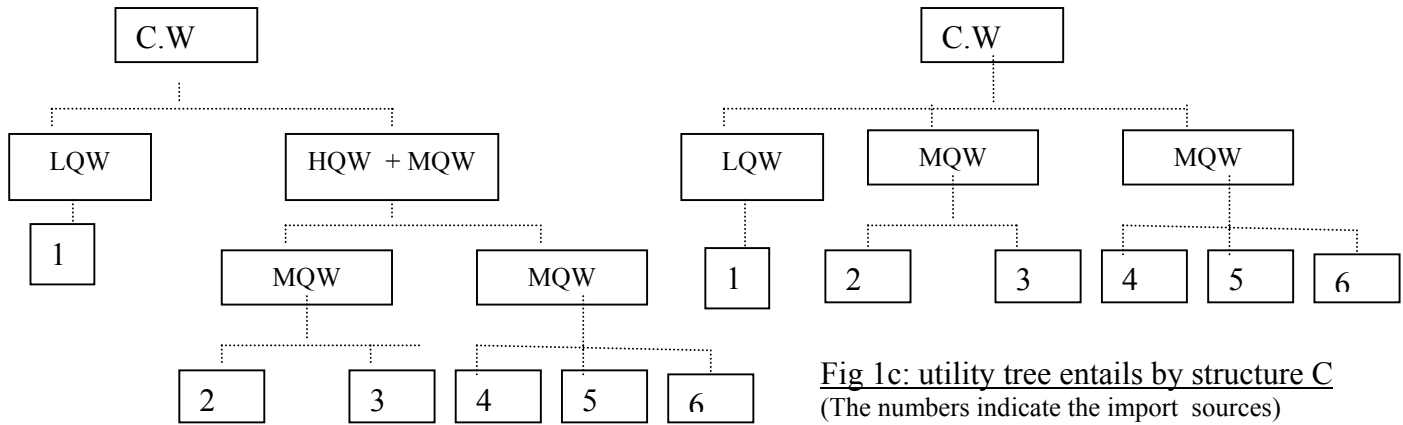(The numbers indicate the import sources)

Fig 1c: utility tree entails by structure C
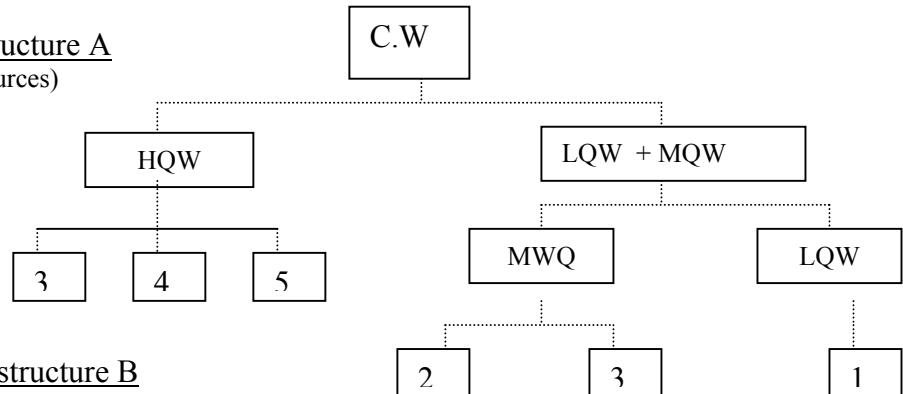(The numbers indicate the import sources)

Fig 1b: utility tree entails by structure B
(The numbers indicate the import sources)

Data

We use data covering the period 1980-1998. For each wheat quality, we know the annual quantities imported from different sources (including the domestic source) and the corresponding annual prices at the French border have been collected. They have been collected mainly from ONIC[2]. The domestic quantities imported have been computed (for each wheat quality), from the difference of French production and exports. Prices of non-EU import have been computed by adding import taxes to the different CIF Rotterdam prices. Data on import taxes have been collected from IGC[3] for 1986 to 1999 and estimated for the 1980-1986 period. The EU quantities and unit prices have been computed from the Eurostat data. USDA[4] and CWB[5] have also been consulted to complete the data. Quantities are given in 1000 tons whereas prices are given in French Francs per ton.

Estimation

The demand models estimated are of the following econometric form

$$Y_t = X_t \beta + v_t \tag{14}$$

Where Y_t is a $(MT x1)$ vector of dependant variables, X_t a $(MT x K)$ matrix of independent variables, β a $(K x1)$ matrix of coefficients to be estimated, and v a $(MT x1)$ matrix of error terms.

M is the number of equations or number of goods in the system, $K = \sum_{i=1}^{M} K_i$ is the number of parameters and T the number of observation. A contemporaneous auto-correlation between equations is assumed. Given the adding up conditions and because of the singularity of the covariance matrix, one equation (and especially equation 6: high quality wheat from the rest of the world) is deleted for the estimation purpose. The estimates obtained by deleting this equation are consistent with likelihood estimators and invariant to which equation has been deleted. After imposing adding up, homogeneity and symmetry on each model, a likelihood ratio test is made to appreciate whether the two variables added (trend and dummy) are significant or not, in order to definitely choose the best model that the parameters should be used in the study. After this likelihood ratio test, a Wald test[6] for serial auto-correlation is done on the best model (retained). When the Wald test shows that there is auto-correlation in the errors terms, we used the Moschini and Moro (1994) test of the first order auto-correlation by posing $v_t = R v_{(t-1)} + x_t$ where v_t is assumed to be independent identically distributed random vector with $E(x)=0$ and $E(xx')=\Sigma$. General least square (LSQ) using time series processor (TSP 5.1) is used for estimations.

For both AIDS and Rotterdam wheat demand models, the negativity condition is verified through the computed eighen values of the matrix of Slutsky terms of substitution. When the Slutsky matrix is not semi-negative definite, the negativity condition is imposed using Cholesky decomposition (of this Slutsky matrix) following Diewaert and Wales (1987) method. In that case, we used a test of semi-flexibility to obtain the parsimonious estimates as indicated by Moschini (1996). Due to the difficulty to impose separability and negativity simultaneously in demand models, separability test is done on demand model even if it doesn't satisfied spontaneously the negativity condition. The results obtained in that case are valid since it is known that negativity is not a necessary condition to impose separability as mentioned by Brenton (1989). Eales and Henderson (2001) also

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[2] *Office National Interprofessionnel des céréales (A public French cereal board)*
[3] *International Grain Council*
[4] *United States Department of agriculture*
[5] *Canada Wheat Board*
[6] *The Wald statistic is given by $W = T^{0.5} \rho_i$, where T is the number of observation, ρ_i the first order autocorrelation coefficient of equation i. The W statistic is distributed as a normal law and the null hypothesis that there is no first order if $W < t_0$*

demonstrated that the imposition of negativity rarely alter separability test when the model does not spontaneously satisfied negativity condition.

The separability test using the CLR is done by comparing the restricted (constructed) separable demand models to the unrestricted demand model. The null hypothesis is that the restricted model equals the unrestricted ones, meaning that the unrestricted can be, at a certain level of significance (generally 5%), written as the restricted models. Otherwise, the acceptation of the null hypotheses means that consumers allocate their resource as indicated by the corresponding restricted model.

IV   Empirical results and discussions

Econometric estimates and elasticities[7]

The Likelihood test results for the alternatives models to the general model show that the dummy and trend variables are significant in both AIDS and Rotterdam demand models at 10% level of significance, meaning that the concerned variables have a significant impact on common wheat import demand on French market. Meanwhile, at 5% level of significance, with an upper tail area of 7.2% (more than 5%), dummy is not significant in the Rotterdam model.

The econometric results including the added variables show that both AIDS and Rotterdam common wheat demand models behave differently:

Dummy and trend are more significant in AIDS model than in Rotterdam model. At 5% level of significance, apart from the equation 4 (HQW imported from France) the trend is significant in all AIDS common wheat demand equations whereas only equations 3 and 6 are significantly influenced by trend variable in the Rotterdam model. The dummy has a significant impact on three AIDS equations (3, 5 and 6) whereas it is significant only on equation 5 in the Rotterdam model.

The single R^2 are relatively satisfactory in AIDS model with almost all of them apart from the one of equation 2 (41%) equals or higher than 50% whereas the Rotterdam show very poor single R^2 for equation 2 (30%) and equation 4 (17%). This relatively satisfactory values of AIDS single R^2 means that variations in dependent variables in AIDS models are relatively well explained by the independent variables, meaning also that the parameters estimated are valid for import demand and policy analysis. The fact that the Rotterdam R^2 for equations 2 and 4 are relatively low is not a surprise since Rotterdam is a first differential equation. The R^2 system for both models approximate 100%, meaning that the demand systems are fit well with the data.

The AIDS demand model, on the contrary to the Rotterdam, didn't satisfy spontaneously the negativity condition. We then imposed it by Cholesky decomposition of the Slutsky terms of substitution matrix using Diewart and Wales (1987) method. The parsimonious estimates have been chosen from a semi-flexible AIDS that preserves, as noticed by Moschini (1996), the distinguishing features of the original AIDS. The semi-flexible AIDS estimates show that 32 estimates over 45 (more than 75%) are significant at 5% level of significance whereas only 6 over 39 (less that 20%) are significant in Rotterdam.

A Wald test for auto-correlation has shown that the AIDS residues were not auto-correlated. Rotterdam model in the contrary shows that error term of equation 4 is auto-correlated. We have tried to solve this problem, which makes the estimates obtained be inefficient even if they are unbiased (Judge and Al, 1985), by the Moschini and Moro (1994) general method. But we didn't obtain the convergence of the estimates, probably due to the reduced numbers of observation and

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[7] *Due to space constraints, econometric results and some computed elasticities are available from the authors upon request.*

the loose of 2 degrees of freedom due to the double differentiation of the model in that case were we are trying to solve the first order auto-correlation. We have then tried to solve the problem by using a specific Berndt and Savin (1975) method, but while solving the problem for equation 4 (high quality wheat from France), a new Wald test shows that the equation 3 was auto-correlated in is error term. This result confirms very well the critics[8] of the specific Berndt and Savin (1975) method for solving auto-correlation. Facing this problem, we have decided to maintain the original general Rotterdam model with auto-correlation in the error terms of equation 4, as the best model we could obtain from the data available. The impact of this first order auto-correlation, given the interrelation between the equations, is not certainly limited only on the equation 4 parameters.

The number of significant elasticities is about 50% for the semi-flexible AIDS (25 over 42) and less than 25% for the Rotterdam (9 over 42). The imposition of negativity and the use of semi-flexible AIDS has increased the number of significant elasticities from 18 for the non negative AIDS model to 25 for the negative semi-flexible AIDS model.

Some elasticities are very high (more than 1.5), particularly in AIDS model where the Marshalian own price elasticity of good 6 and cross price elasticity for good 6 according to the price of goods 3 and 4 are respectively –8.83, -3.12 and 8.33. These high elasticities can be explained by the following reasons: (a) we are dealing with complete systems of demand where the weak separability assumption have been made without taking care of the possible relationship between some common wheat import sources with other goods. This reason can be used to partially explain the level of single R^2 that are not often too near of 100%. (b) as explained in section II, we have considered common wheat grain as food (final good) because of the lack of information about the exact part of common wheat use in agro industry and as final good. (c) There is a great spatial and temporal variability in the budget shares in the studying period 1980-1998 as shown by figure A2.

AIDS general model show that good 5 is an inferior good with an expenditure elasticity that is –1.00, significant at 5% whereas Rotterdam show rather that good 4 is an inferior good with an expenditure elasticity of –3.33, significant at 10%. AIDS general model also shows a substitution relationship between good 4 and good 6 whereas this relationship doesn't exist in the Rotterdam model. There is even a contradiction in the relationship between goods from one model to another. Rotterdam shows for example a substitution relationship between good 6 and good 3 whereas for the same goods, AIDS show rather a complementary relationship.

The econometric results obtained confirm once more the importance of model choice in the demand analysis procedure. For the present case, with regard to the econometric results obtained, AIDS model seems to be suitable for French common wheat demand analysis. We are meanwhile conscious for the bias that can be introduced in our analysis by the unsolved first order auto-correlation problem on the Rotterdam model, not only on the elasticities, but also for separability test.

Separability test results and policy implication

Table 3a and 3b below exhibits the results of the corrected likelihood test for weak separability between the three separable structures tested.

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[8] The use of a diagonal matrix of error terms which are all equals is very limited to solve a first order auto-correlation. It constitute a specific case of the general Moschini and Moro method.

Table 3a   *Test results for weak separability at mean share with the different structures and corresponding models using AIDS common wheat demand model*

Structure	Model	Restric-tions	LL	LR Test		CLR Test		Decision (5%)
				VLR	UTA	VCLR	UTA	
General	General	-	333.78					
Restricted A	A1	4	328.10	11.34	0.023	4.97	0.290	Accepted
	A2	8	324.76	18.01	0.021	8.21	0.413	Accepted
	A3	9	319.67	42.30	0.000	19.48	0.021	Rejected
Restricted B	B1	6	328.66	10.24	0.115	4.58	0.599	Accepted
	B2	8	319.67	28.21	0.000	12.87	0.116	Accepted
	B3	9	319.62	28.31	0.000	13.04	0.161	Accepted
Restricted C	C	8	319.64	28.06	0.000	12.80	0.118	Accepted

VLL= Value of the log of likelihood. VLR= Value of the likelihood ratio. VCLR: Value of the Corrected Likelihood Ratio. UTA= Upper Tail Area. DF= degree of freedom or the number of separable restrictions. Decisions are made on null hypothesis (H0) on the basis of the CLR results, at 5% significance level.

Table 3b   *Test results for weak separability with the different structures and corresponding models using Rotterdam common wheat demand model*

Structure	Model	Restric-tions	LL	LR Test		CLR Test		Decision (5%)
				LR	UTA	VCLR	UTA	
General	General	-	294.83					
Restricted A	A1	4	290.98	7.70	0.103	3.56	0.468	Accepted
	A2	8	288.44	12.80	0.119	6.16	0.629	Accepted
	A3	9	288.40	12.87	0.168	6.26	0.714	Accepted
Restricted B	B1	6	289.85	9.97	0.126	4.71	0.582	Accepted
	B2	8	290.57	8.52	0.384	4.10	0.848	Accepted
	B3	9	290.44	8.78	0.458	4.27	0.893	Accepted
Restricted C	C	8	290.46	8.76	0.363	4.21	0.837	Accepted

Tables 3a and 3b show that there is a difference between AIDS and Rotterdam results as expected, given the differences of the econometric estimations It appears that at 5% level of significance, the general Rotterdam model accepts the three separable structures tested, meaning that each of them can be used for the demand analysis purpose. Structure A is rejected by AIDS model at 5%, meaning that this structure doesn't reflect the allocation procedure of the French common wheat importers. By raising the level of significance, the results become different. At 15 % level of significance for example, structure C for AIDS is rejected and the three structures are still accepted by the Rotterdam model. This sensitivity of results to level of significance raised the problem of appropriate level of significance in this kind of test. When considering 5% level of error, as always used statistically, we draw a statistical conclusion that is statistically valid. But in the reality, for this kind of test, may it not be possible to be very careful as mentioned by Morrin and Surry (1997) in the case of the level of significance to be considered in the semi-flexibility test by consideration a level of more than 25%? In the case of this study, a high level of significance can be justified by the following two non-exhaustive reasons. Firstly, the data have been constructed by ONIC in the absence of data availability collected by a specialised structure. Secondly, some import sources have been aggregated. These reasons are of nature to introduce bias in the data used that can be minimised by considering the traditional 5% level of significance. Given this situation, it seems normal to deal with a high level of significance. By working at 25%, it appears that none of the AIDS structure is accepted. The presence of autocorrelation in the Rotterdam model needs us to be very prudent in the use of the Rotterdam results. A reasonable level of significance of 15% allows

the AIDS model to accept only the structure B that seems to be the best one to analyse the French common wheat import demand.

By considering structure B as the more indicated one, we meant that the French importers in a first allocation stage distinguish between the high quality wheat and the other wheat. In a second stage, they distinguish between the medium quality wheat and the low quality wheat, while allocates their high quality wheat resources to the different imports sources (France, EU, and the rest of the world). In a third stage, they allocate the MWQ and the LWQ resources to the respective sources. This allocation procedure seems to be very normal in the sense that the importers focus their attention to the high quality wheat, especially the US hard red spring (HRS) and the Canada western red spring (CWRS) that justify partially the common wheat import in the EU.

The policy implication of this structure B result is that, a policy price, specific to high quality wheat, can be implemented on the common French market without taking care to the impact this policy could have directly to other quality wheat in what concerns demand analysis. The high quality wheat is weakly separable to the medium and low quality wheat which are also separable each from other on the French market. This result, if it could be the same at the European community level, is an element to justify a specific tariff policy on the medium and low wheat quality, different from the high quality tariff policy.

We have been interested to analyse the impact of maintaining separability in both Rotterdam and AIDS models by comparing the elasticities in the unrestricted and the ones in restricted models A, B, and C that are the final models for the structures tested. It appears that there is a difference even in the own price elasticities from unrestricted model to restricted models, on the contrary of the Moschini and al (1994) results where at least own price elasticities where maintained between the compared models. These results necessitate a further investigation to be explained.

V.   Conclusion

This study attempted to use a corrected likelihood ratio to verify weak separability between the three common wheat classes or qualities in import demand on French market using two popular demand models that are AIDS and Rotterdam. It appears with the Rotterdam model that all the three separable structures are accepted even at a high level of significance. With AIDS, only the structure B is accepted at 15% level of significance, meaning that the high quality wheat (HQW) is weakly separable from the Medium and low quality wheat which are weakly separable each from other on the French import demand market. This results implicates that a specific price or tariff policy can be apply to the HWQ without having a direct impact on the demand of other wheat qualities. Meanwhile, there exists some dark points which needs further investigation, especially on why the elasticities, at least the own price elasticities are not maintained from the unrestricted model to restricted models. The study shows also that the estimation results obtained from the two models (AIDS and Rotterdam) are different and this can results to a different policy implication. The importance of functional form choice becomes then very evident. It is clear that the corrected likelihood test ratio used in this study allows verifying whether the unrestricted model can be written as the restricted models without being destroyed. Given the power of Wald test as compared to the other asymptotic tests such as LR and Lagrange, it could be necessary to test this weak separability with a corrected Wald test by using the Phillips and Park method on the formulation of Wald tests of non-linear restrictions. While being prudent in the Rotterdam separability test results interpretation because of the unsolved auto-correlation problem, we remain very careful in the interpretation of the AIDS results that are valid only at one point (mean point). This is the drawback of using AIDS to test separability in demand models.

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Annexes

Table A1a: Non compensated price elasticities and expenditures elasticities for the General unrestricted semi-flexible AIDS model (with negativity imposed) at the mean share

|	Prices						
Quantities	P1	P2	P3	P4	P5	P6	Expenditure
Q1	-1,008***	-2,539***	0,023	-0,170**	0,174**	0,036	3,484***
	(0,370)	(0,431)	(0,021)	(0,068)	(0,072)	(0,033)	(0,781)
Q2	-0,105	-0,396***	0,015***	-0,027	0,000	0,027***	0,486**
	(0,096)	(0,129)	(0,006)	(0,026)	(0,020)	(0,009)	(0,230)
Q3	1,066***	1,212***	-2,163***	3,800***	-0,336	-3,960***	0,381*
	(0,405)	(0,375)	(0,546)	(0,762)	(0,304)	(0,676)	(0,205)
Q4	0,060	0,243	0,797***	-2,533***	-0,333	2,201***	-0,435
	(0,277)	(0,516)	(0,159)	(0,818)	(0,244)	(0,647)	(0,915)
Q5	2,934***	1,079	-0,184	-0,921	-2,269***	0,362	-1,001**
	(0,853)	(0,885)	(0,179)	(0,691)	(0,729)	(0,225)	(0,496)
Q6	1,220**	1,795***	-3,116***	8,326***	0,465	-8,829***	0,140
	(0,519)	(0,491)	(0,533)	(2,453)	(0,300)	(2,371)	(0,211)

Figures in brackets are asymptotic standard errors. The stars indicate the significance of the parameter at different levels (*=10%. **=5% and ***=1%).

Table A1b: Non compensated price elasticities and expenditures elasticities for general unrestricted Rotterdam model at the mean share

	Prices						
Quantities	P1	P2	P3	P4	P5	P6	Expenditures
Q1	-4,177*	-0,258	-0,008	0,393	0,112	-0,011	3,949***
	(2,214)	(1,897)	(0,021)	(0,640)	(0,104)	(0,034)	(1,258)
Q2	0,592	-1,144**	-0,001	-0,049	0,030	0,005	0,567*
	(0,567)	(0,547)	(0,007)	(0,217)	(0,035)	(0,012)	(0,327)
Q3	0,629*	0,406	-0,649*	1,391*	0,010	-1,732***	-0,055
	(0,347)	(0,448)	(0,351)	(0,796)	(0,212)	(0,643)	(0,202)
Q4	3,059	2,058	0,321*	-2,535	0,008	0,422	-3,333*
	(2,882)	(3,750)	(0,168)	(3,872)	(0,517)	(1,956)	(1,779)
Q5	2,311*	2,474	0,016	-0,082	-3,899***	0,275	-1,096
	(1,246)	(1,620)	(0,124)	(1,439)	(0,836)	(0,225)	(0,777)
Q6	0,678	0,972	-1,361***	1,461	0,356	-1,720	-0,386
	(0,509)	(0,643)	(0,506)	(7,416)	(0,303)	(7,415)	(0,271)

Figures in brackets are asymptotic standard errors. The stars indicate the significance of the parameter at different levels (*=10%. **=5% and ***=1%).

Figure A2: *budget shares evolution of the different common quality import sources from 1980 to 1998.*
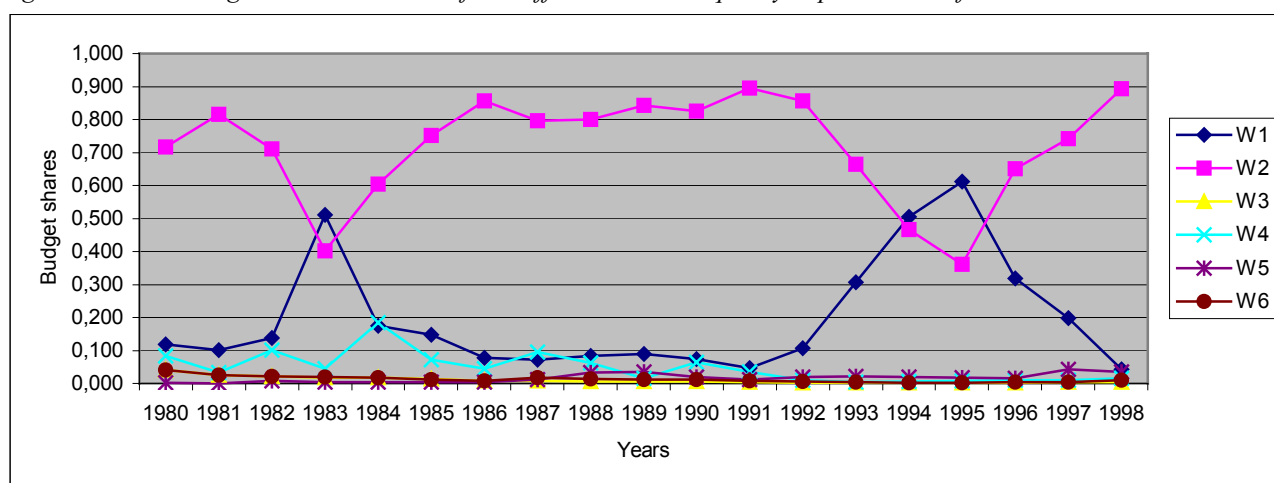
 1=Low quality Wheat, 2= medium Quality Wheat from France, 3= medium quality wheat from the EU, 4=high quality wheat from France, 5= high quality wheat from the EU, 6= high quality wheat from the rest of World (USA and Canada)