Differentiated Demand and Supply of Wheat under Alternative European Trade Policies

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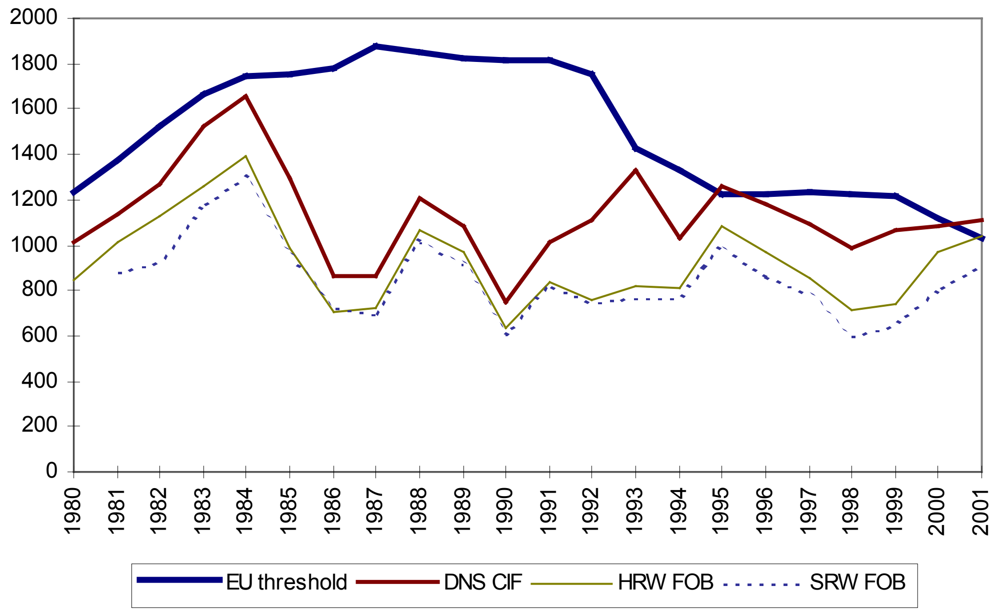
Abstract: This paper proposes a partial equilibrium displacement model that differentiates wheat according to its end-use and country of origin to investigate the impact of alternative European trade policies on wheat supply and demand in France. Transmission, demand and supply elasticities are estimated for each class and origin of wheat. Simulation results show that rebalancing trade protection across wheat classes encourages domestic supply of high quality wheat and displaces imports from North America.

Keywords: Differentiated wheat, almost ideal demand system, partial equilibrium displacement model, common agricultural policy, European Union

For the first time since the highly protective Common Agricultural Policy (CAP) inception, the European Union (EU) turned from a net exporter into a net importer of common wheat by the end of 2001. The lower harvest of common wheat through most of the EU because of climatic problems is not the only reason. A much fiercer competition from outside the EU, particularly from the United States (US) and from the Common Independent States (CIS) that exported large volumes of soft wheat into the EU, is the more fundamental reason. This outside competition is most likely to keep its pressure on the EU wheat market even when the European wheat harvest will recover as expected in the next 2002-03 season. The EU wheat market has indeed become much more open to imports since the intervention price and, hence, the duty-paid entry price for cereal imports have fallen with the full implementation of Agenda 2000 following the 1992 reform on the cereal common market organization (CMO) and the extra duty on grain deliveries from the Baltic, the Mediterranean and the Black Sea has been eliminated. The EU duty-paid entry price for cereal imports is now below the CIF world price of North American high value wheat, eliminating market protection for top-grade milling and durum wheat, and is coming close to the North American medium-grade wheat (Figures 1 and 2). The EU wheat sub-sector is now irreversibly more closely linked with the rest of the world since the 1992 CAP reform, particularly in 2001 (Figure 3).

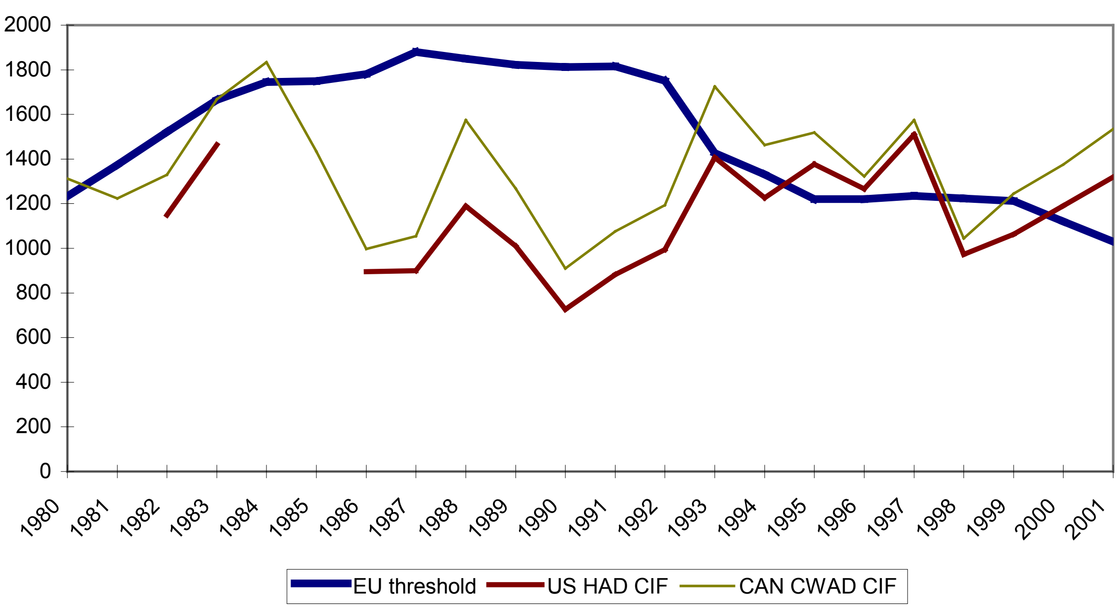
Because the EU market access differs according to wheat grade but, more fundamentally, because demand for wheat differs according to end use and country of origin (Veeman 1987, Larue 1991) and supply conditions may vary according to end use, any wheat trade model to investigate the effects of the greater openness of the EU wheat sub-sector needs to be built on differentiated demand and supply of wheat. Accordingly, a partial equilibrium displacement model (PEDM) that differentiates wheat according to its end use and origin is built using transmission, demand and supply elasticities estimated under explicitly stated product differentiation hypothesis. To avoid the strong separability and homotheticity restrictions among origins implied by the Armington framework, the demand elasticities are estimated with an almost ideal demand system (AIDS) specification to differentiate wheat demand according to its end use and origin (Alston, Carter, Green and Pick, 1990). The supply elasticities as well as the EU institutional and world price transmission elasticities are estimated according to end use. The built-on differentiated PEDM is then used to simulate alternative EU trade protection focusing on the trade, demand and supply effects of replacing the current duty-paid entry price system by a standard *ad valorem* and specific import duty in line with the general World Trade Organization (WTO) border protection principle. This non-discriminative form of wheat protection is expected to rebalance imports of wheat from higher to lower grades and encourage European producers to shift their production towards wheat of higher grades. Because of data availability, this model is confined to the French wheat market for which demand and supply could be disaggregated by end uses and sources of supply.

Figure 1. World prices of different US wheat classes and EU threshold wheat price from 1980 to 2001 [a]



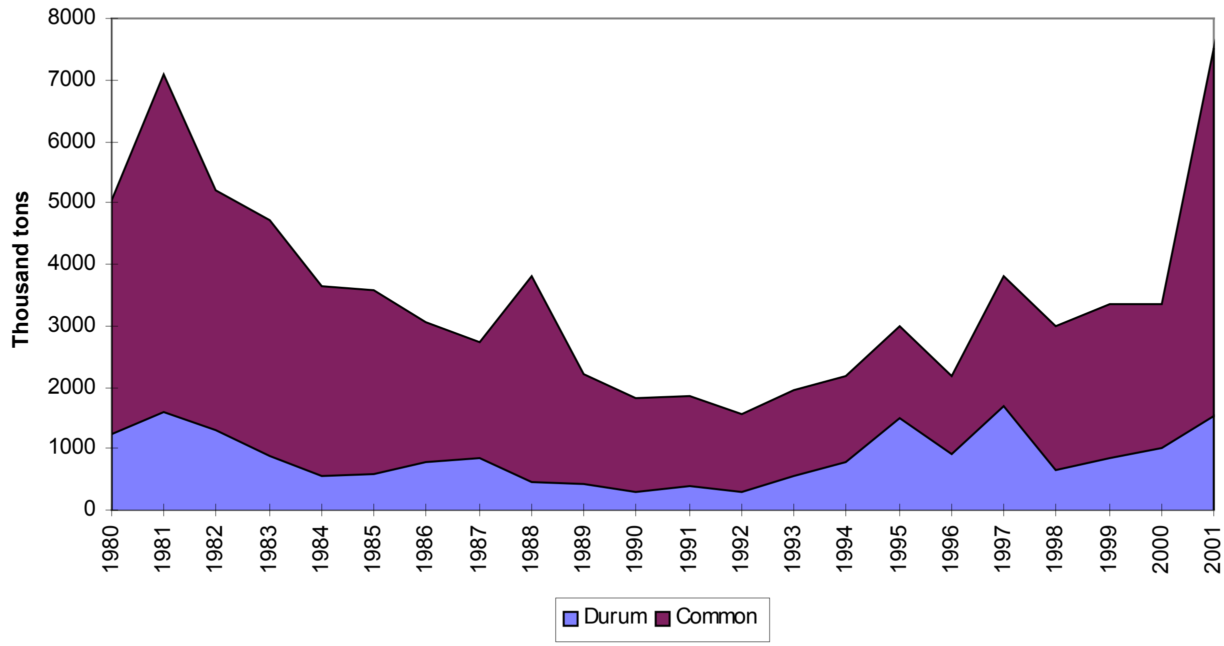
[a] All prices are in nominal French francs with 6,56 FF = 1 Euro = US $0,876.
Source: ONIC database

Figure 2. World prices of US and Canadian durum wheat and EU threshold wheat price from 1980 to 2001 [a]



[a] All prices are in nominal French francs with 6,56 FF = 1 Euro = US $0,876.
Source: ONIC database

Figure 3. EU total wheat imports from 1980 to 2001



Note: Figures for 2001 are estimated by ONIC
Source: ONIC database

In addition to durum wheat for pasta and semolina use, the French cereal professional organization ONIC distinguishes four classes of common wheat based on biophysical characteristics (Table 1). These four classes of wheat include class Elite, 1, 2 and 3 and end up in different industries, i.e., bread flour, starch, biscuit and feed industries. As Table 1 indicates, these ONIC wheat classes compete against their substitutes from the US and Canada, particularly for durum and hard wheat, but also from other UE countries, particularly durum and high protein level wheat from Italy and Germany respectively.[1] French wheat users differentiate wheat according to these different biophysical characteristics or end uses and different countries of origin, and pay different prices. Prices of French wheat classes are taken from records in specialized markets, for example, Eure et Loire for class 1, Rouen for class 2 and Champagne for class 3. Prices of US and Canadian wheat classes come from the US Department of Agriculture (USDA), the Canadian Wheat Board (CWB) and the International Grain Commission (IGC). Prices of other EU countries wheat classes are drawn from their trade unit values calculated from the COMEXT database considering that EU countries specialize into imports or exports of one specific wheat class, for example Germany in exports of wheat of class 1 and Italy in exports of durum wheat. Quantities of production, imports, use and exports by wheat class from 1980 to 2000 are reported in figures 4 to 7. They are obtained from Mahé and Chabe-Ferret (2001) who recoup different information from different sources including surveys on industrial uses and area planted in specific wheat varieties and expert intelligence on imports and exports.

[1] Competition against wheat from Australia and Argentine are negligible in the French market.

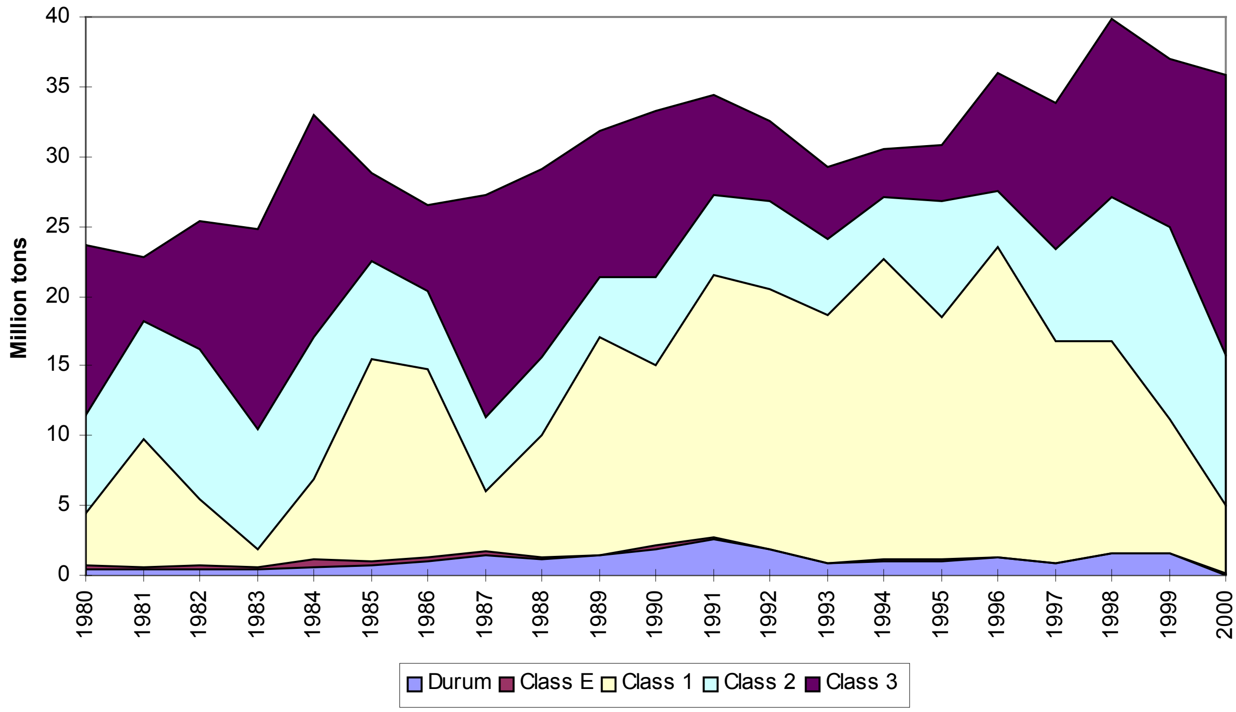
This paper is organized as follow. Price transmission, demand and supply elasticities are first estimated from systems differentiating wheat according to class and origin. The PEDM is then structured and used to simulate alternative trade policies. Results are discussed and conclusions made.

Table 1. Representative categories of wheat in France, the United-States and Canada

		Hard		Soft		Feed
	Durum	*Spring*	*Winter*	*Winter*	*White*	Wheat
Country						
France	Durum	Elite (E)	1 [a]	2 [b]	2 [b]	3 [c]
USA	HAD	DNS, HRS	HRW	SRW	WW	
Canada	CWAD	CWRS	CWRW	CESRW	CEWW	
Reference variety	CWAD	DNS	HRW	SRW		Maize [d]
Criterion						
Protein	≥13%	≥13%	11-13%	10-11%	10.5-11.5%	<10.5%
W [e]		≥300	≥160	≥130	≥130	-
Hagberg [f]		≥220	≥220	≥180	≥180	-
Use						
Pasta	▬					
Milling		▬	▬	▬		
Starch industry			▬	▬	▬	
Biscuit factory and other uses						▬
Quality [g]	Durum	High	Medium	Low	Low	Feed

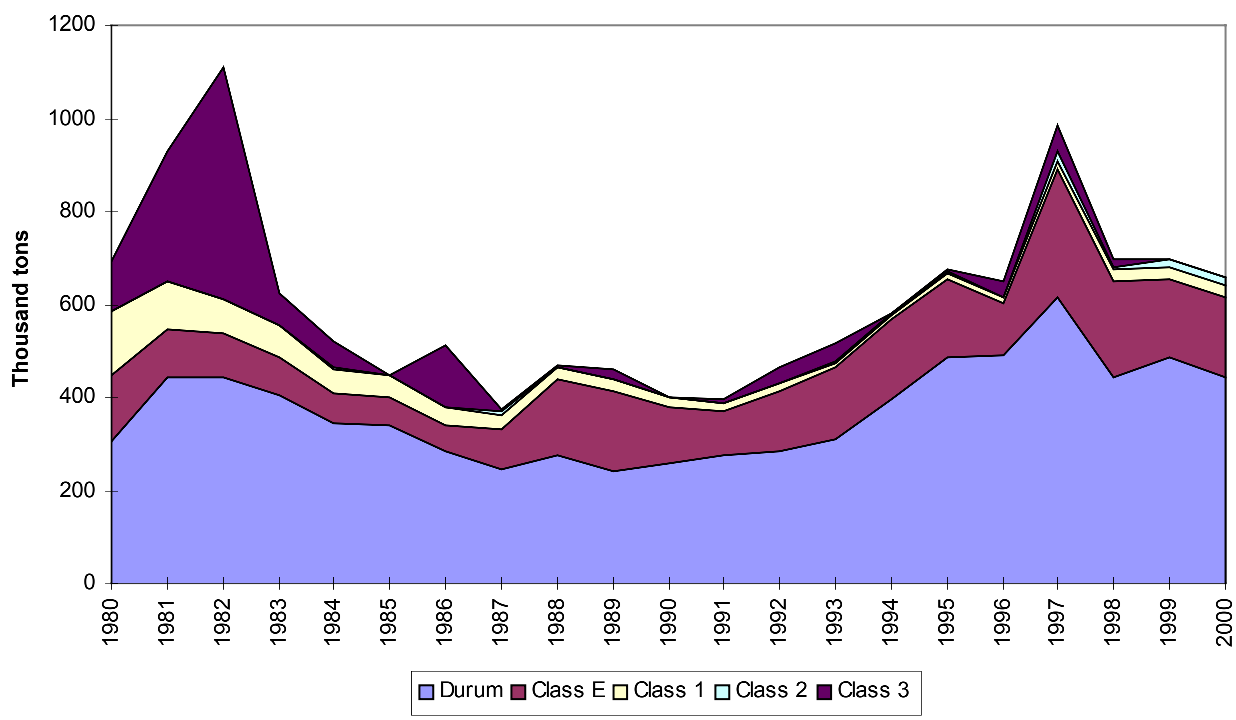
[a] Also referred to as Superior Bread Making Wheat
[b] Also referred to as Common Bread Making Wheat
[c] Also referred to as Other Usage Wheat
[d] FOB Rouen and FOB London
[e] W (bread-making strength) measured in 10^{-4} joules
[f] Hagberg measured in seconds
[g] According to Larue (1991)

Figure 4. French wheat production by wheat class from 1980 to 2000



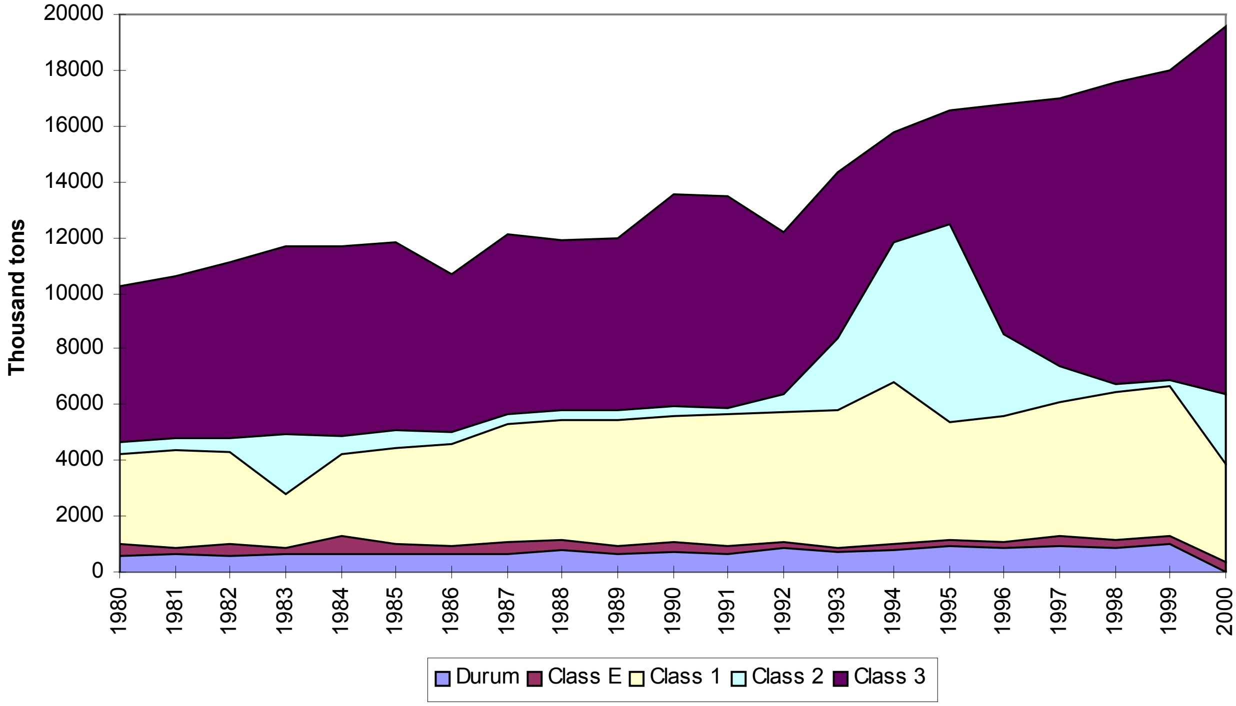
Source: Mahé et Chabe-Ferret, 2001

Figure 5. French imports by wheat class from 1980 to 2000



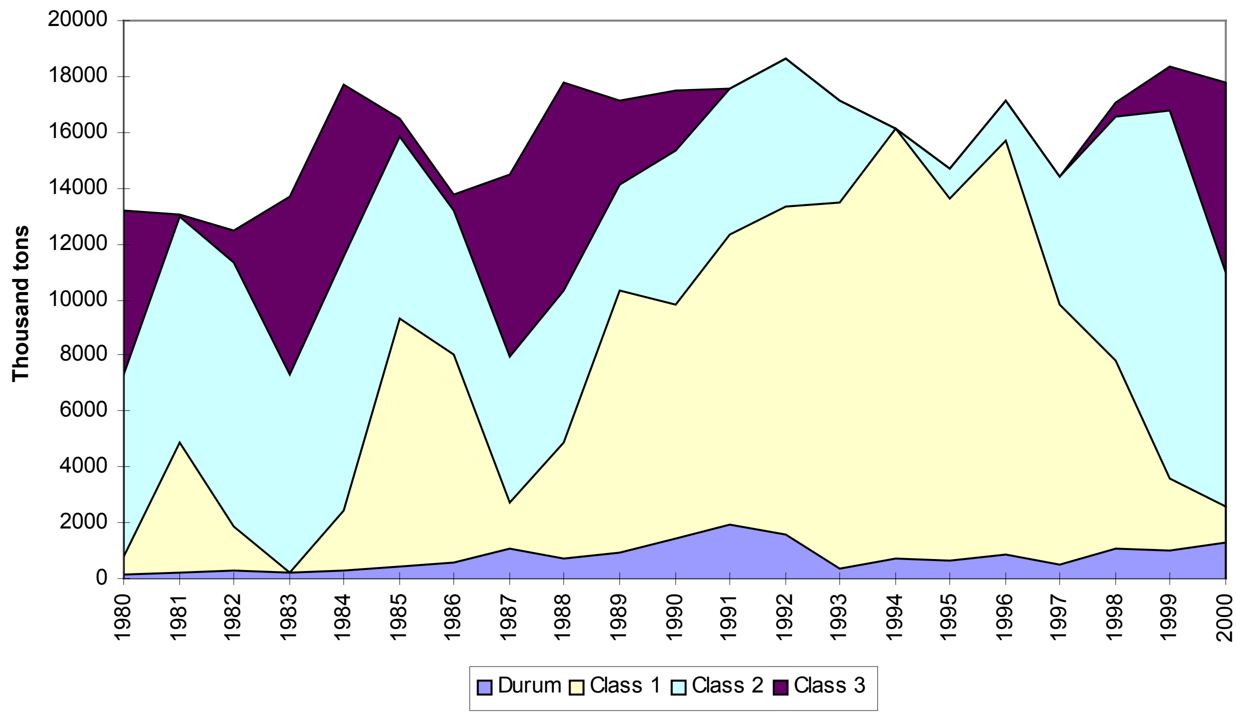
Source: Mahé et Chabe-Ferret, 2001

Figure 6. French use by wheat class from 1980 to 2000



Source: Mahé et Chabe-Ferret, 2001

Figure 7. French exports by wheat class from 1980 to 2000



Source: Mahé et Chabe-Ferret, 2001

Institutional and World Price Transmissions

Since wheat market prices in the EU fluctuate between the intervention and the duty-paid entry prices according to market conditions and the setting of these two institutional prices could be affected by world prices, a price transmission equation is adapted from Surry (1992) for each wheat class as follows:

$$p_{ijt}^{k} = \gamma_{0ij}^{k} - \gamma_{1ij}^{k} S_{ijt-1}^{k} + \gamma_{2ij}^{k} p_{ijt-1}^{k} + \gamma_{3ij}^{k} \left[p_{ijt}^{kc} + \frac{p_{ijt}^{kf} - p_{ijt}^{kc}}{1 + e^{\left[\sigma_{1ij}^{k} + \sigma_{2ij}^{k} XN_{it}^{k}\right]}} \right] + \gamma_{wij}^{k} p_{it}^{w}$$

where k represents the country, i the wheat class, j the country of origin, which in this equation is the same as k, and t the time index. The price p_{ijt}^{k} is the domestic market price, S_{ijt}^{k} the end of period stocks, p_{ijt}^{kf} and p_{ijt}^{kc} the institutional intervention and duty-paid entry prices, and p_{it}^{w} the world price. The variable XN_{it}^{k} represents net extra-European exports. The function $L = \left(1 + e^{\left(\sigma_{1ik}^{k} + \sigma_{2ik}^{k} XN_{it}^{k}\right)}\right)^{-1}$ is a logistic trade regime selecting function ranging in the interval $[0,1]$ with a value of $L = 0$ corresponding to a deficit situation where the duty-paid entry price is the market-directing price and a value of $L = 1$ corresponding to a surplus situation where the intervention price is the market-directing price. From the corresponding transmission coefficients γ, transmission elasticities are calculated for 1999 as follows.

Institutional price transmission elasticity:

$$\varepsilon_{3ik}^{k} = \gamma_{3ik}^{k} \frac{p_{ikt}^{kc} + \dfrac{p_{ikt}^{kf} - p_{ikt}^{kc}}{1 + e^{\left(\sigma_{1ik}^{k} + \sigma_{2ik}^{k} XN_{ikt}^{k}\right)}}}{p_{ikt}^{k}} = \gamma_{3ik}^{k} \frac{POL_{ikt}^{k}}{p_{ikt}^{k}}$$

where the institutional variable $POL_{ikt}^{k} = p_{ikt}^{kc} + \dfrac{p_{ikt}^{kf} - p_{ikt}^{kc}}{1 + e^{\left(\sigma_{1ik}^{k} + \sigma_{2ik}^{k} XN_{ikt}^{k}\right)}}$ with $t = 1999$.

World price transmission elasticity:

$$\varepsilon_{wik}^{k} = \gamma_{wi}^{k} \frac{p_{it}^{w}}{p_{ikt}^{k}} \text{ with } t = 1999 .$$

Table 2 shows the resulting transmission elasticities. As expected, transmission elasticities of the institutional variables are larger for the lower quality wheat class 3 than for the higher quality wheat classes 1 and 2 since these high quality classes are more subject to market forces. Institutional price transmission elasticities are null for rapeseed and sunflower since institutional price were eliminated in 1992 while world price transmission elasticities are higher for these oilseeds as well as for soy meal than for the other products for the same reason. All these transmission elasticities are significant at 5% except for wheat class 1 and protein crops while the world price transmission elasticities are significant at 5% only for the substitute and competing products.

Table 2. Institutional and world price transmission elasticities in 1999

	Wheat class					Substitute / competing product					
Short term elasticity	Durum	E	1	2	3	Maize	Rapeseed	Sunflower	Protein crops	Wheat bran	Soy meal
Institutional price	0.67	1.13	0.68	0.68	0.86	0.74	0.00	0.00	0.73 [a]	0.56 [a]	-
World price	0.12	0.02	0.07	0.15	0.10	0.17	0.30	0.59	0.39	-	1.05

[a] Price elasticity with respect to class 3 wheat

Source: Original estimations available upon request from the authors

Demand of Durum and Wheat Classes E, 1, 2 and 3

Because of the low substitution between durum, milling and feed wheat, weak separability is assumed among demands of these three wheat categories. The estimation of the demands for milling wheat classes by country of origin follows a three-stage budgeting procedure as illustrated in figure 8 while the estimation of the demands for durum wheat by origin follows a two-stage budgeting procedure. Weak separability hypothesis implied by these multi-stage budgeting procedures are not rejected using a Rotterdam specification in a submitted accompanying paper to this congress. In the last stage, the change in demand D_{ijt}^k for a specific wheat class i from a specific country of origin j in country k in period t is written as follows.

$$\frac{\partial D_{ijt}^k}{D_{ijt}^k}=\sum_{l\in C_i^k}\lambda_{ijl}^k\frac{\partial p_{ilt}^k}{p_{ilt}^k}+\mu_{ij}^k\frac{\partial y_{it}^k}{y_{it}^k}$$

where C_i^k denotes the set of indexes of wheat class i of all origins l demanded in country k and $y_{it}^k=\sum_j p_{ijt}^k D_{ijt}^k$ denotes the budget allocated to wheat class i in country k. The coefficients λ_{ijl}^k and μ_{ij}^k are the price and expenditure elasticities of demand respectively.

For the durum and milling wheat classes, the conditional demand elasticities are estimated within the multi-stage budgeting scheme with the AIDS model. Widely used in various demand and import demand studies (De Gorter and Meilke 1987, Moschini, Moro and Green 1994, Moschini 1996, Mohanty and Peterson 1999), the AIDS model has several advantages: (i) its flexibility which enables a quasi exact representation of consumer preferences at least at a given point in contrast, for example, to the Rotterdam model, (ii) the eventual direct use of its estimates to test for the theoretical conditions imposed on demand equations (i.e., adding up, symmetry, homogeneity and concavity restrictions), and (iii) a resulting non linear Engle curve which allows for income elasticity to vary according to income levels. The AIDS model has the additional advantage of not imposing the Armington restrictions of homotheticity and separability among demands in the last stage.

In the AIDS model, the budget share budget $w_{ij}^k=\frac{p_{ij}^k D_{ij}^k}{y_i^k}$ of demand from country k of a product i differentiated by its origin j is specified as follows:

$$w_{ij}^{k} = \alpha_{ij} + \sum_{l} \gamma_{ijl} \log p_{il}^{k} + \beta_{ij} \log(y_{i}^{k} / P_{i}^{k}) \text{ with } j, l = 1, ..., n,$$

where P_i^k is a general price deflator specified as follows:

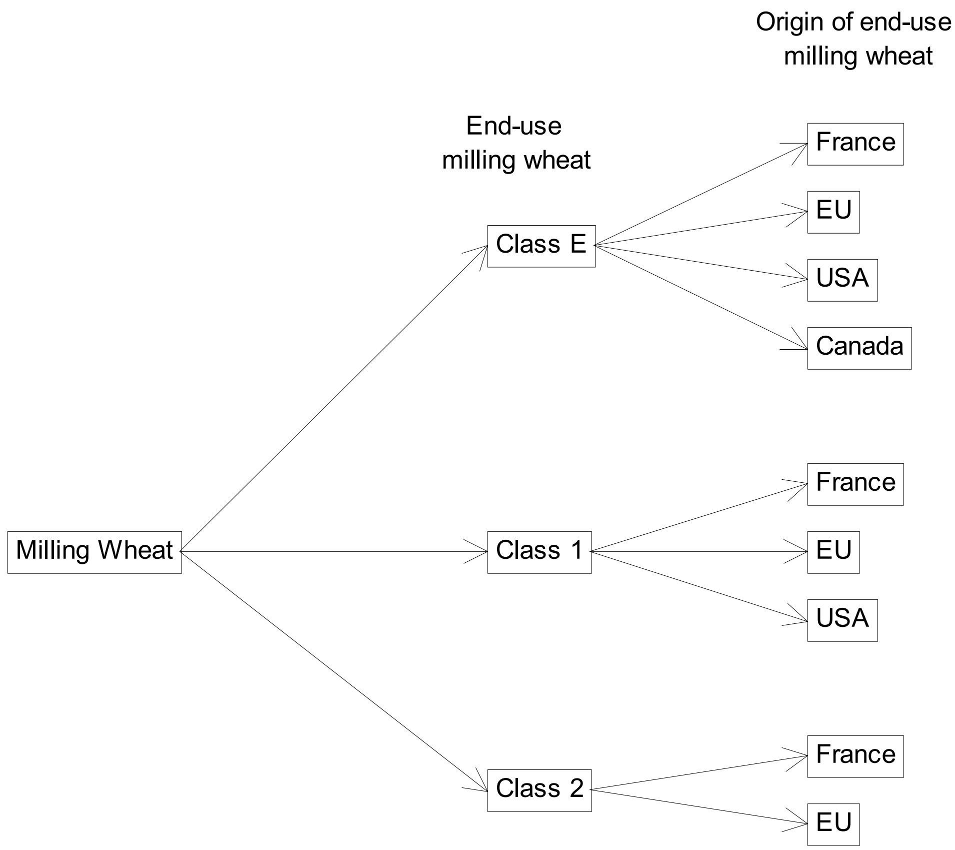
$$Log \; P_{i}^{k} = \alpha_{i0} + \sum_{l} \alpha_{il} \log p_{il}^{k} + \frac{1}{2} \sum_{j} \sum_{l} \gamma_{ijl} \log p_{il}^{k} \log p_{ij}^{k} .$$

Following Deaton and Muellbauer (1980), the general price deflator can be approximated by the Stone index specified as follows: $\log \; P_{i}^{k} = \sum_{l} w_{il}^{k} \log \; p_{il}^{k}$.

The adding up, homogeneity and symmetry conditions respectively require that:

$\sum_{j} \alpha_{ij} = 1$, $\sum_{j} \beta_{ij} = 0$ and $\sum_{j} \gamma_{ijl} = 0$; $\sum_{l} \gamma_{ijl} = 0$; and $\gamma_{ijl} = \gamma_{ilj}$. The negativity condition is verified if the Slutsky matrix of the terms of substitution $s_{ijl}^{k} = \frac{y_{i}^{k}}{p_{ij}^{k} p_{il}^{k}} c_{ijl}^{k}$ or, equivalently, c_{ijl}^{k} are negative semi-definite.

Figure 8. Three-stage demand for milling wheat



The estimation of the derived demands for feed wheat and its substitutes is obtained from a translog profit function.

$$s_i = \frac{p_i D_i}{\pi} = a_i + \sum_{i'} \beta_{ii'} \ln p_{i'} + \sum_f d_{if} \ln z_f \quad \text{with } i, i' = 1, \ldots, n$$

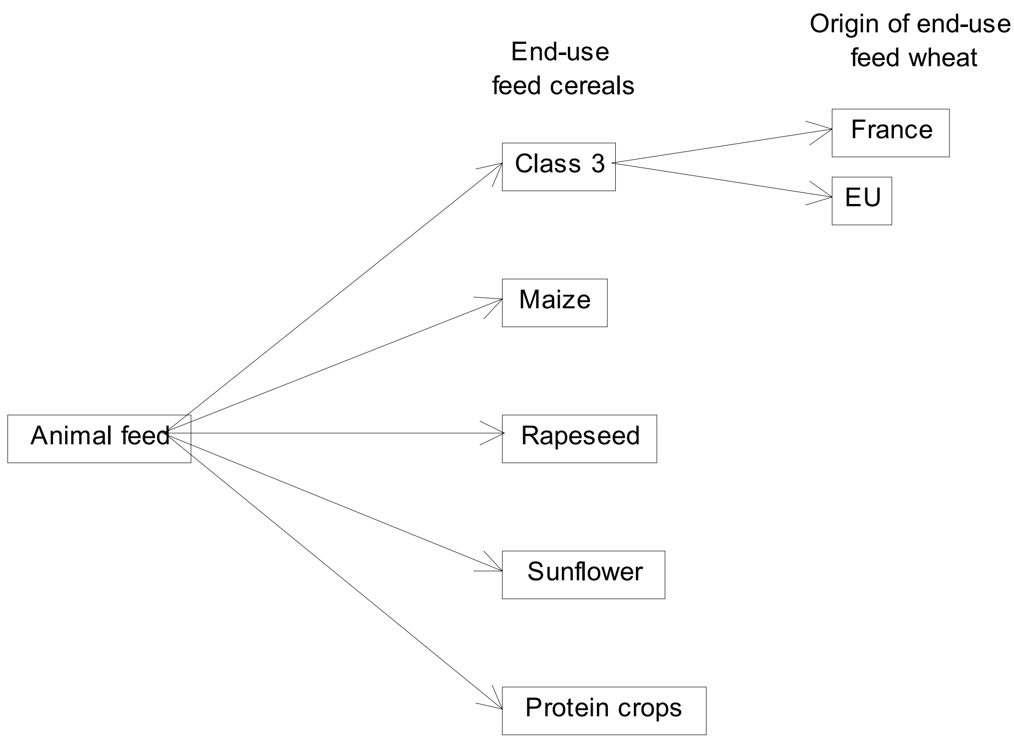
where s_i is a vector of profit share of i, z_f is a vector of fixed factors, and $p_{i'}$ is a vector of all input and output prices of the system.

The homogeneity conditions with respect to both prices and fixed factors require that:

$$\beta_{ii'} = \beta_{i'i}, \ \sum_i a_i = 1, \ \sum_{i'} \beta_{ii'} = 0, \ \sum_i d_{if} = \sum_f d_{if} = 0$$

The derived demand system distinguishes four feed substitutes as illustrated in figure 9. In a third stage budgeting scheme, the demand for the feed wheat class is differentiated according to the country of origin with the AIDS specification. Unconditional feed demand elasticities could be obtained from using a two-stage profit maximization approach as presented in Davis and Jensen (1994) but are not estimated here since the supply of feed substitutes is mainly domestic with the exception of soy meal. Because of lack of degree of freedom, no other variable input price and fixed factor are add to the demand system, a potential candidate for fixed factor being the herd size.

Figure 9. Three-stage Demand for Class 3 Feed Wheat



The demand systems are estimated using the non-linear least square (NLSQ) method with the usual theoretical restrictions (i.e., homogeneity, symmetry, concavity and negativity). Negativity is imposed by using the Cholesky decomposition suggested by Diewart and Wales (1987). Since both the AIDS and translog models are expressed in shares, one of the equations of each demand system is dropped to avoid singularity. The homogeneity constraint allows the recovery of the missing estimates. Each system is also corrected for autocorrelation by using the same autocorrelation coefficient for each equation as suggested by Berndt and Savin (1975).

Following Green and Alston (1990), the conditional demand elasticities are calculated as follows:

$$\lambda_{ijl} = -1 + \frac{(\gamma_{ijl} - \beta_{ij} w_{il})}{w_{ij}}, \quad \delta_{ijl} = -1 + \frac{\gamma_{ijl}}{w_{ij}} - w_{il}, \text{ and } \mu_{ij} = 1 + \frac{\beta_{ij}}{w_{ij}}$$

where λ, δ and μ are the uncompensated and compensated price elasticities and the expenditure elasticity respectively.

The derived demand elasticities for the feed wheat and its substitutes are calculated as follows:

$\lambda_{ii'} = s_{i'} + \frac{\beta_{ii'}}{s_i}$ for the cross-price elasticities and $\lambda_{ii} = -1 + s_i + \frac{\beta_{ii}}{s_i}$ for the own-price elasticities.

Most of the third-stage demand elasticities reported in Table 3 are significant at 5%. With the expected negative sign, the own-price elasticities are superior to unity as expected for differentiated product. Most of the cross-price elasticities have the expected positive sign. Substitution is particularly high between durum wheat from France and the rest of the world (i.e., Canada and the US), between class E wheat from the US and Canada and between class E from the rest of the EU and Canada. Most of the expenditure elasticities have the expected positive sign and are equal or superior to unity. Notice that expenditure elasticities for durum wheat are similar for the three origins and that expenditure elasticities are particularly high for class E wheat from France and for class 1 wheat from the US. That these elasticities are generally higher than those found in Mohanty and Peterson (1999), is not surprising since wheat classes add here an additional level of differentiation.

About half of the second-stage elasticities of demand for feed wheat and its substitutes reported in Table 4 are significant at 5%. As expected, all the own-price elasticities are negative. The cross-price elasticities that are significant are positive and, not surprisingly, particularly high between feed wheat and maize and between feed wheat and protein crops. Curiously, there is no substitution between protein crops and soy meal.

Supply of Durum and Wheat Classes E, 1, 2 and 3

Following Moro and Sckokai (1999), the supply model considers that the supply of a wheat class responds to its own and competing crop prices, direct payment, own and competing crop acreage, and other fixed factors. Accordingly, the change in supply O_{it}^k of a specific wheat class i in competition with crops i' for the fixed factors available in country k is written as follows.

$$\frac{\partial O_{it}^k}{O_{it}^k} = \sum_{i'} \xi_{ii'}^k \frac{\partial p_{i'kt}^k}{p_{i'kt}^k} + \sum_{i'} \zeta_{ii'}^k \frac{\partial r_{i't}^k}{r_{i't}^k} + \sum_{i'} \tau_{ii'}^k \frac{\partial v_{i't}^k}{v_{i't}^k}$$

where r_{it}^k is the direct acreage payment defined as $r_{it}^k = a_{it}^k + b_{it}^k \frac{c_{it}^k}{1 - c_{it}^k}$ with a_{it}^k the per hectare specific direct payment for crop i, b_{it}^k the set-aside payment and c_{it}^k the fixed set-aside percentage, and v_{it}^k is the level of the fixed factors of production. This supply specification allows for adjusting supply responses to the additional acreage response from the direct acreage payments progressively implemented in the EU since 1992. The coefficients $\xi_{ii'}$, $\zeta_{ii'}$ and $\tau_{ii'}$ are the elasticities of prices, direct acreage payments and fixed factors of production respectively.

Table 3. Third stage uncompensated demand elasticities by wheat class and origin in 1999 in France [a]

		Origin					
Wheat class	Origin	*France*	*European Union*	*United-States*	*Canada*	*Rest of world*	Expenditure
Durum							
	France	-1.29***	-0.69***			1.06***	0.917***
		(0.04)	(0.13)			(0.13)	(0.03)
	European	-0.79***	-0.96*			0.69	1.05***
	Union	(0.29)	(0.52)			(0.52)	(0.39)
	Rest of world	2.67***	1.68			-5.43***	1.09
		(0.79)	(1.53)			(1.49)	(1.04)
Class E							
	France	-2.19***	0.59***	0.49	-0.83***		1.94***
		(0.56)	(0.09)	(0.54)	(0.06)		(0.06)
	European	2.66***	-3.22***	0.17***	1.13***		-0.74***
	Union	(0.24)	(0.41)	(0.05)	(0.22)		(0.28)
	United-States	2.57	-0.03	-5.39***	2.22***		0.63***
		(2.09)	(0.07)	(2.06)	(0.13)		(0.03)
	Canada	-5.02***	3.24***	3.88***	-2.96***		0.87*
		(0.47)	(0.72)	(0.23)	(0.39)		(0.48)
Class 1							
	France	-1.04***	-0.00	0.03			1.02***
		(0.02)	(0.01)	(0.02)			(0.01)
	European	0.75	-0.60	-0.21			0.06
	Union	(1.45)	(2.07)	(1.29)			(0.50)
	United- States	2.59	-0.19	-6.56			4.12***
		(4.78)	(1.10)	(4.35)			(1.42)
Class 2							
	France	-1.00***	0.01***				1.00***
		(0.00)	(0.00)				(0.00)
	European	-0.31***	-0.40***				0.71***
	Union	(0.02)	(0.00)				(0.00)
Class 3							
	France	-1.01***	0.00				1.01***
		(0.00)	(0.19)				(0.00)
	European	1.99***	-1.42***				-0.57*
	Union	(0.00)	(0.00)				(0.09)

[a] Standard errors in parentheses; ***: significant at 1%, **: significant at 5%, *: significant at 10%.
Source: Original estimations available upon request from the authors

Table 4. Second stage uncompensated feed wheat and substitute demand elasticities in 1999 in France [a]

Product	Class 3 wheat	Maize	Wheat bran	Protein crop	Soy meal
Class 3 wheat	-2.17***	1.34***	0.10**	0.62***	0.10
	(0.57)	(0.38)	(0.05)	(0.18)	(0.18)
Maize	1.23***	-1.24***	-0.014	0.02	-0.01
	(0.35)	(0.29)	(0.03)	(0.10)	(0.09)
Wheat bran	0.51**	-0.069	-0.38***	-0.14	0.08
	(0.26)	(0.17)	(0.11)	(0.09)	(0.09)
Protein crop	1.70***	0.06	-0.07	-1.78***	0.10
	(0.49)	(0.29)	(0.05)	(0.36)	(0.23)
Soy meal	0.12	-0.01	0.02	0.04	-0.17
	(0.21)	(0.12)	(0.02)	(0.10)	(0.12)

[a] Standard errors in parentheses; ***: significant at 1%, **: significant at 5%, *: significant at 10%.
Source: Original estimations available upon request from the authors

Supply elasticities are first calculated from the estimation of a supply obtained from a normalized quadratic profit function following the Moro and Sckokaï (1999) specification:

$$O_{it}^{k} = \alpha_{i}^{k} + \sum_{i'} \alpha_{ii'}^{k} \overline{p}_{i't}^{k} + \sum_{i'} \delta_{ii'}^{k} \overline{r}_{i't}^{k} + \sum_{i'} \varphi_{ii'}^{k} v_{i't}^{k}$$

where $\overline{p}_{i't}^{k}$ is the normalized product or input price,
$\overline{r}_{i't}$ is the direct acreage payment to production,
$v_{i't}$ is a fixed factor of production.

Because of the poor results obtained with this specification, a general dynamic specification is used following the Wickens and Breuch (1988) procedure:

$$O_{it}^{k} = -d\left[\sum_{i'} \lambda_{i'}^{k} \Delta_{i'}^{k} O_{it}^{k} - \left(\sum_{i'} \delta_{i'}^{k}\right) \overline{p}_{i't}^{k} + \sum_{i'} \delta_{i'}^{k} \Delta_{i'}^{k} \overline{p}_{i't}^{k}\right] + \sum_{i'} \delta_{ii'}^{k} \overline{r}_{i't}^{k} + \sum_{i'} \varphi_{ii'}^{k} v_{i't}^{k} + du_{it}^{k}$$

where $d = \dfrac{1}{1 - \sum_{i'} \lambda_{i'}}$ is the long term coefficient,
Δ is the difference operator,
$\delta_{i'}$ is the vector of parameters in the static normalized quadratic supply system.

The final estimated supply system includes one lag on market prices and quantities only since expected direct acreage payments are known. Because of insufficient data on variable inputs and some fixed factors of production, only product prices and direct acreage payments are included in the supply system. Because of insufficient degrees of freedom, competing crops to durum wheat are limited to maize and sunflowers and those to common wheat limited to rapeseed and protein crops. In addition to this lack of degrees of freedom, multicollinearity problems among market wheat class prices impede to estimate simultaneously one single supply system made up of the four wheat classes and their competing products. The five individual systems are estimated separately. In the supply systems for the common wheat classes, prices and direct payments are normalized with the protein crop price, while in the supply system for durum wheat, they are normalized with the sunflower price.

The supply systems are estimated using the least square method with the usual theoretical restrictions (i.e., homogeneity, symmetry and convexity). Convexity is imposed by using the Cholesky decomposition. Elasticities are calculated for year 1998, simply by differentiating the supply equations with respect to prices and direct acreage payments.

Because the original estimated price elasticities of supply are particularly low for wheat classes 2 and 3, they are multiplied by 10 in Table 5. Similarly, because the original estimated direct payment elasticities of supply are particularly high for durum wheat, they are divided by 5 in Table 5. Standard errors are not reported for these adjusted elasticities. Even with this *ad hoc* adjustment, the supply elasticities associated to the direct acreage payments stay high relatively to those associated to prices. Otherwise, own-price and direct payment elasticities of supply are always positive but not always significantly. Most of the cross-price and direct payment elasticities of supply are significantly negative as expected.

Table 5. Adjusted supply elasticities in 1999 in France [a]

	Price					Acreage payment				
Wheat class	*Wheat*	*Rapeseed*	*Protein crop*	*Maize*	*Sunflower*	*Wheat*	*Rapeseed*	*Protein crop*	*Maize*	*Sunflower*
Durum	0.95***			-0.07	-0.88***	0.36***			0.01	-0.27***
	(0.05)			(0.07)	(0.05)	(0.10)			(0.08)	(0.05)
Class 1	0.53***	0.11***	-0.64***			0.24***	-0.08***	-0.07***		
	(0.01)	(0.03)	(0.03)			(0.01)	(0.02)	(0.02)		
Class 2	0.70	0.70***	-1.40*			0.10	0.08***	-0.02		
	(0.08)	(0.01)	(0.07)			(0.13)	(0.01)	(0.12)		
Class 3	0.90	0.50	-1.40***			0.32***	0.18***	-0.49***		
	(0.10)	(0.12)	(0.04)			(0.08)	(0.08)	(0.05)		

[a] Standard errors in parentheses; ***: significant at 1%, **: significant at 5%, *: significant at 10%.
Source: Original estimations available upon request from the authors

The Partial Equilibrium Displacement Model and Policy Scenarios

The complete partial equilibrium displacement model distinguishing wheat according to class and origin is structured as follows.

$$\frac{\partial p^k_{ikt}}{p^k_{ikt}}=\varepsilon^{kf}_{ikt3}\frac{\partial POL}{POL}+\varepsilon^{kf}_{ikw}\frac{\partial p^k_{iwt}}{p^k_{iwt}}$$

$$\frac{\partial D^k_{ijt}}{D^k_{ijt}}=\sum_{l\in C^k_i}\lambda^k_{ijl}\frac{\partial p^k_{ilt}}{p^k_{ilt}}+\mu^k_{ij}\frac{\partial y^k_{it}}{y^k_{it}}$$

$$\frac{\partial O^k_{it}}{O^k_{it}}=\sum_{i'}\xi^k_{ii'}\frac{\partial p^k_{i'kt}}{p^k_{i'kt}}+\sum_{i'}\zeta^k_{ii'}\frac{\partial r^k_{i't}}{r^k_{i't}}+\sum_{i'}\tau^k_{ii'}\frac{\partial v^k_{i't}}{v^k_{i't}}$$

subject to: $D^k_{ijt}\leq O^k_{it}$

$XN^k_{it}=O^k_{it}-\sum_j D^j_{ikt}$ with j = k and rest of EU.

The variable XN^k_{it} represents here the excess domestic supply over domestic demand and exports to the rest of the EU by wheat class at period t. The excess domestic supply as well as the excess domestic demand in turn affect the domestic market price through the institutional price transmission elasticity ε_{ikt3}^{kf} and the policy variable POL but not through the world price transmission elasticities since world prices are kept exogenous. This model is solved recursively starting with an initial value of XN_{it}^{k} and ε_{ikt3}^{kf} taken at t=1999 and ending with complete convergence of the values of the excess domestic supply and institutional price elasticities. At this stage of the analysis, changes in expenditure from changes in domestic demands and prices are not endogenized in the model.

Table 6 shows the policy scenarios that are simulated. The first scenario corresponds to the implementation of Agenda 2000 on the 1999 data set. Cereal intervention prices are cut while their direct acreage payments are increased and set-aside payments are reduced. The second and third sets of scenarios replace the cereal duty-paid entry price based on the 155% cereal intervention price as agreed at the final stage of the Uruguay Round negotiations, by three levels of *ad valorem* and specific import taxes respectively. A last scenario is the appreciation of 10% of the Euro against the US dollar, which is translated into a reduction of 10% in CIF. All scenarios keep the provisions of Agenda 2000 and are assessed against the EU market access and export competition provisions agreed to in the Agricultural Agreement of the Uruguay Round (AAUR) are translated into French trade constraints in proportion to the 1986-88 average French wheat consumption and export shares respectively.

Table 6. Simulation scenarios

	Policy Scenarios		
Instruments	**Agenda 2000**	**ad valorem import tax**	**specific import tax**
Cereal intervention price	-15%	-15%	-15%
Cereal reference or entry price	lower than 155% the intervention price	110, 120 et 130% the CIF price	100, 250 et 375 FF/ton on the CIF price
Average specific direct payment per hectare:			
Wheat and maize	+16%	+16%	+16%
Rapeseed and sunflower	-33%	-33%	-33%
Protein crops	-8%	-8%	-8%
Set aside premium	-8%	-8%	-8%
Effective set aside rate	-17%	-17%	-17%

Simulation Results and Interpretation

Tables 7 to 9 show the effects of these different scenarios on domestic demands by wheat class and origin, domestic supplies by wheat class and exports by wheat class. Without going into details because of space limitation, we observe that Agenda 2000 increases domestic demands of all classes of wheat (Table 7). These increases in domestic demands are met by:

- an increase in French imports of wheat of higher quality classes (i.e., durum and classes E and 1) from the rest of the world and French imports of wheat of lower quality classes (i.e., classes 2 and 3) from the rest of the EU (Table 7),
- an increase in domestic supply of wheat of higher quality classes (i.e., durum and classes E and 1) to the detriment to wheat of lower quality classes (i.e., classes 2 and 3) (Table 8),
- a dramatic decrease in French exports of wheat, particularly of classes E et 3 (Table 9).

Market access and export competition provisions agreed to in the AAUR are met since French imports from the rest of the world increase by 17%, the volume of subsidized exports decreases by 12% and the value of export subsidies by 58% (Tables 7 and 9).

Increasing *ad valorem* or specific import taxes instead of an duty-paid entry price based on the 155% cereal intervention price encourage even more domestic supply of wheat of higher quality classes (i.e., durum and classes E and 1) to the detriment to wheat of lower quality classes (i.e., classes 2 and 3) (Table 8). This import tax scheme is, however, detrimental to French imports of durum wheat from the rest of the world but slightly increases French imports of common wheat from the rest of the world (Table 7). This import tax scheme facilitates French exports of durum wheat and common wheat of class E but discourages French exports of common wheat of class 1 (Table 9). With a 10% *ad valorem* tax or a 100FF/ton specific import tax, export competition provisions agreed to in the AAUR are also met with such schemes since the volume of subsidized exports decreases by 15% and the value of export subsidies by 61% (Table 9). However, the market access provision is not met since French imports from the rest of the world decrease by 12% (Table 7).

An appreciation of 10% of the Euro against the US dollar translated into a reduction of 10% in CIF prices reduces the French wheat net exports by 10%.

Table 7. Demand changes by wheat class and origin (%)

		Scenario								
			Import tax							
				ad valorem			specific			
Wheat Class	Origin	Agenda 2000	null	10%	20%	30%	100 FF/t	250 FF/t	375 FF/t	CIF price -10%
Durum	*France*	5	7	9	11	12	9	11	12	6
	Intra-EU	8	6	6	5	4	6	5	4	9
	Extra-EU	39	-11	-46	-80	-114	-39	-80	-115	39
	Total	7	6	6	6	6	6	6	6	8
Class E	*France*	29	27	22	15	6	23	12	0	29
	Intra-EU	-13	-21	-12	-3	5	-13	-1	9	-13
	United States	-1	22	-1	-20	-36	4	-25	-43	-1
	Canada	22	13	19	22	23	18	23	22	23
	Rest of world [a]	0	0	0	0	0	0	0	0	0
	Total	-1	-6	-2	0	2	-3	1	3	-1
Class 1	*France*	9	16	14	13	12	14	11	9	10
	Intra-EU	1	6	5	4	3	5	3	1	1
	United States	61	239	204	169	135	190	116	55	60
	Total	9	16	14	13	12	14	11	9	10
Class 2	*France*	10	11	11	11	11	11	10	10	11
	Intra-EU	7	7	7	7	7	7	7	7	8
	Total	10	11	11	11	11	11	10	10	11
Class 3	*France*	9	11	9	9	9	9	9	9	12
	Intra-UE	7	9	7	7	7	7	7	7	9
	Total	9	11	9	9	9	9	9	9	12
Common	*France*	10	12	11	11	10	11	10	9	11
Wheat	*Intra-EU*	-9	-14	-7	-1	5	-9	1	8	-8
Total	*United States*	2	32	8	-11	-28	12	-19	-39	1
	Canada	22	13	19	22	23	18	23	22	23
	Total	9	12	11	10	10	11	10	9	11

[a] Not included in simulations

Table 8. Supply changes by wheat class (%)

	Scenario								
		Import tax							
	Agenda		*ad valorem*			specific			CIF price
Wheat class	2000	null	10%	20%	30%	100 FF/t	250 FF/t	375 FF/t	-10%
Durum	3	9	13	18	22	13	18	22	8
Class E	4	4	5	5	6	4	5	6	5
Class 1	3	-1	0	0	1	0	2	3	5
Class 2	-4	-4	-5	-5	-5	-5	-5	-5	-3
Class 3	-3	-4	-3	-3	-3	-3	-3	-3	-1

Table 9. Export changes by wheat class (%)

	Scenario								
		Import tax							
	Agenda		*ad valorem*			specific			CIF price
Wheat class	2000	null	10%	20%	30%	100 FF/t	250 FF/t	375 FF/t	-10%
Durum	3	10	15	20	26	14	20	26	9
Class *E*	-71	-65	-49	-26	5	-53	-17	24	-68
Class *1*	-5	-19	-17	-14	-11	-16	-10	-5	0
Class *2*	-5	-5	-6	-6	-6	-6	-5	-5	-3
Class *3*	-100	-100	-100	-100	-100	-100	-100	-100	-100
TOTAL	-12	-15	-15	-14	-13	-14	-13	-11	-10

Conclusions

Clearly, simulations of alternative wheat protection devices performed on an PEDM model that allows differentiation of wheat by classes and origins, show that the use of an *ad valorem* or specific import tax instead of the current *ad hoc* EU cereal protection agreed at the final stage of the AARU would encourage the supply of high quality wheat in France and displace wheat imports from the rest of the world. As a result, high quality wheat exporters such as Canada and the US are not likely to easily accept rebalancing wheat protection across wheat classes. For example, at a low import tax rate of 10% or 100FF/ton, French imports of durum wheat from these two countries drop dramatically. Since such rebalancing in wheat protection is likely to equally encourage supply of high quality wheat in the rest of the EU, particularly in Germany and Italy, imports of high quality wheat from the rest of the world may drop equally. Implementation of such an import tax scheme is likely to limit EU market access under the EU commitments to the AAUR and, eventually, to the next WTO round.

The results of this analysis could be enhanced by making use of a dynamic AIDS model as proposed in Mohanty and Peterson (1999) to estimate the demand systems and endogenizing income effects in the demand systems of the PEDM. Future work on this paper will include a sensitivity analysis on key parameters such as demand and supply elasticities, using a stochastic partial equilibrium displacement model as proposed in Davis and Espinoza (2000). Another direction of improvement will be to expand the model to other key EU countries such as Germany, Italy, the United Kingdom and, eventually, to the whole EU, and to estimate and include wheat demands from CIS and Central and Eastern European countries in the PEDM as these two groups of countries may become more active in exporting their high quality wheat into the EU.

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