Modelling of agricultural markets and econometrics of disequilibrium. A review of some applications to markets with minimum prices and to export models

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MODELLING OF AGRICULTURAL MARKETS AND ECONOMETRICS OF DISEQUILIBRIUM

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RESUME

Ce papier présente quelques applications de l'économétrie du déséquilibre à la modélisation des marchés agricoles. Certaines spécifications issues de l'économétrie du déséquilibre semblent particulièrement adaptées pour prendre en compte les caractéristiques spécifiques des marchés agricoles. C'est particulièrement le cas des modéles de marchés soumis à un prix minimum, en vue de représenter le système européen d'intervention, pratiqué pour la plupart des produits agricoles.
Mais les résultats d'estimation permettent de montrer qu'une telle spécification n'est pas nécessairement la plus appropriée. Elle conduit à des résultats peu satisfaisants lorsqu'elle est utilisée pour modéliser des marchés qui sont presque toujours dans le même régime de déséquilibre. Cette situation structurelle peut être observée lorsque les données utilisées ne sont disponibles qu'avec une périodicité annuelle. De plus, cette spécification n'est pas appropriée lorsqu'il est nécessaire d'utiliser une hypothèse de non-observabilité du prix minimum. En effet, dans ce cas, la séparation de l'échantillon est inconnue.
En revanche, l'économétrie du déséquilibre, sous sa forme "originale" et éventuellement avec quelques adaptations visant à prendre en compte l'hétérogénéité, peut être utile lorque le but est d'identifier et de mesurer les effets de la demande et de l'offre sur un marché, et de déterminer - *ex-post* - les occurences et les causes des changements de régime. L'estimation de modèles d'exportation de produits agricoles en fournit une application satisfaisante.

Mots-clés : REVUE, MARCHE AGRICOLE, ECONOMETRIE, DESEQUILIBRE, PRIX-PLANCHER, EXPORTATION, EFFET DE REPORT, AGREGATION DE MICRO-MARCHES, CEREALE, FRANCE, CEE.

ABSTRACT

This paper attempts to cope with some applications of econometrics of disequilibrium to modelling of agricultural markets. Some specifications derived from econometrics of disequilibrium seem to be quite relevant in order to take into account specific features of agricultural markets. That is particularly the case for models of markets with a minimum price, in order to represent the European intervention system on most agricultural markets.
But according to estimation results, such a specification is not necessarily the best one. It leads to poor results when applied to a market which is always in the same disequilibrium regim. This structural situation may occur when data are only available at the annual level. Moreover, this specification is not appropriate when it is necessary to add an assumption on the unobservability of the price limit. In this case, sample separation is unknown.
Conversely, econometrics of disequilibrium - in its original specification and eventually with adaptations to take into account heterogeneity - is appropriate when the aim is to identify and to measure supply and demand effects on a market, and to determine - *ex-post* - switching between excess-supply and excess-demand. Estimation of export models gives a satisfying application of it.

Key-words : REVIEW, AGRICULTURAL MARKET, ECONOMETRICS, DISEQUILIBRIUM, THRESHOLD PRICE, EXPORT, SPILL-OVER EFFECT, AGGREGATION OVER MICRO-MARKETS, CEREAL, FRANCE, EEC.

MODELLING OF AGRICULTURAL MARKETS AND ECONOMETRICS OF DISEQUILIBRIUM

A Review of Some Applications to Markets with Minimum Prices and to Export Models

0. Introduction

Public regulation of agricultural markets involves unique features which are to be taken into account in the process of modelling. On the one hand, these specific features act upon the market functioning itself. Then, it is not possible to specify models as if markets are cleared in a competitive way. The existence of a minimum price at the producer level involves non-equilibrium situations on the domestic market, when the market clearing price is below this minimum price. Then, classical equilibrium models are not necessarily appropriate. Furthermore, the EC trade regulation with third countries (through export refunds and import levies) involves specific export and import models. For an EC member state, there are two distinct markets to face. So there are two different export or import demands which turn toward this country. Then, in a disequilibrium framework[1] it is necessary to take into account the possibility of spill-over effects between these two markets.

On the other hand, these specific features can influence the agents' behavior. For example, producer price expectations are settled by the existence of price regulation policy, rather than by past information. In this case, the accuracy of adaptative or rational expectations is not ensured, or it is necessary to adapt them to this specific context (cf. Le Roux, 1991-a).

This paper deals with only the first point. That is to take into account structural features of agricultural markets when modelling them. Thus, we will see how econometrics of disequilibrium can be used to model some characteristics of agricultural markets, and we will present some illustrations of this methodology.

Section 1 provides a brief outlook over econometrics of disequilibrium when applied to the market of one good. Implications on estimation procedures are mentioned.

One particular case of markets in disequilibrium is the case of markets characterized by threshold - or minimum - price regulation. For such markets, disequilibrium does not necessarily occur at each period: it is only the case when the clearing price is lower than the minimum price. Section 2 presents econometric models of markets with a minimum price, and an application to the French cereal market.

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[1] *That is disequilibrium between export (or import) supply and demand.*

Another field of application for econometrics of disequilibrium is trade modelling. This field of application is not reduced to agricultural commodities, and in fact most applications have been made for industrial sector (e.g. Artus, 1987). Section 3 is about the econometrics of disequilibrium applied to export models[2]. In this case, the transacted quantity results of the confrontation - and is the minimum - between a domestic supply for exports and a foreign demand. When applied to European agricultural commodities, it is required to specify a disequilibrium model on two markets. Within the Common Agricultural Policy (CAP), trade regulation with third countries induces two kinds of demands which turn toward two kinds of supplies. The specification of a multi-market disequilibrium model allows the existence of spill-over effects among these markets. These effects are transfers of constraints (on supply or on demand) from one market onto another one. One application concerns French wheat exports to third countries. Another one is about a European model of intra and extra-EC exports of cereals.

1. Econometrics of Disequilibrium : principles and canonical models

Econometrics of disequilibrium has been developped following the post-keynesian advances involving the theory of *macroeconomic* disequilibrium. But basic models of disequilibrium only deal with markets of one good, not the whole economy.

1.1. The canonical model

The canonical model of disequilibrium assumes that the transacted quantity on a market is, at each period, the minimum between a demand function and a supply function. An observed quantity belongs either to the demand curve, either to the supply one, but never to both. It can be explained, for example, by the rigidity of the price, which cannot instantaneously clear the market. So either the demand or the supply is constrained. Such a model of market is also called a quantity rationing model.

The model of disequilibrium was first specified in the seminal work of Fair and Jaffee (1972)[3]. This canonical model usually consists of the following functions:

$$
\begin{aligned}
D_t &= x_{1t}\, b_1 + u_{1t} \\
S_t &= x_{2t}\, b_2 + u_{2t} \\
Q_t &= Min\,(D_t\,, S_t) \\
t &= 1, \ldots\, T
\end{aligned}
$$

---

[2] *Imports can be modelled by the same way.*

[3] *See Le Roux (1991-a) for a list of references.*

where D_t is the demand function,

S_t is the supply function,

Q_t is the transacted quantity,

x_{1t} and x_{2t} are sets of explanatory variables,

u_{1t} and u_{2t} are vectors of random errors with standard errors σ_1 and σ_2.

A price adjustment could be added to this model. Then the regim could be determined by the direction of price movement. Without loss of generality, such an assumption is not required. If demand and supply are unknown (that is, sample separation between excess supply and excess demand is unknown), only data on transacted quantity and explanatory variables are given. In this case (assume that error terms are normally distributed and not contemporaneously correlated), the density of Q_t is:

$$l_t(q_t) = \frac{1}{\sigma_1}\varphi(\frac{q_t - x_{1t}\,b_1}{\sigma_1})\,\Phi(\frac{x_{2t}\,b_2 - q_t}{\sigma_2}) + \frac{1}{\sigma_2}\varphi(\frac{q_t - x_{2t}\,b_2}{\sigma_2})\,\Phi(\frac{x_{1t}\,b_1 - q_t}{\sigma_1})$$

φ and Φ are the probability density function and the cumulative distribution function of the standard normal.

Parameter estimates can be given by maximizing the likelihood function:

$$L = \prod_{t=1}^{T} l_t(q_t)$$

Then, for each period t, it is possible to get an estimation of the probability that the observation belongs to the demand function (or, consequently, to the supply function).

Two major criticisms can be made about the specification of the previous disequilibrium model. First it is not realistic to assume that such a structural model is valid at the aggregate level. Secondly this model assumes that disequilibrium, when occurs, exists at each period: equilibrium periods cannot be observed. Some modifications or extensions of the canonical model can solve these problems.

1.2. Some adaptations of the canonical model

The first problem is about the validity of the 'Min' condition at the aggregate level. That is, it is not realistic to assume that the whole economy, or a sector of it, switches, from one period to the following one, from one regim to the other. In fact, all the agents are not in the same disequilibrium regim at the same time, and only a part of the set of agents switches from one regim to the other. Then, if the market is a set of different micro-markets, the transacted quantity at the aggregate level is the sum of supplies on markets in excess-demand plus demands on markets in excess-supply. This quantity is necessarily less than the minimum between the aggregate demand and the aggregate supply.

Once more in economic analysis, it is the problem of heterogeneity which has to be taken into account when modelling economic behaviors or activities. It is also the classical problem of switching from the micro-level to the macro-level, that is the problem of aggregation.

A solution here is to consider that the aggregate market is set up by N micro-markets. For each of them the canonical model of disequilibrium applies:

$$
\begin{aligned}
D_t^i &= x_{1t}\, b_1 + \varepsilon_{1t}^i \\
S_t^i &= x_{2t}\, b_2 + \varepsilon_{2t}^i \\
Q_t^i &= Min\,(D_t^i\,, S_t^i) \\
i &= 1, \dots\ N \\
t &= 1, \dots\ T
\end{aligned}
$$

$x_{1t}\, b_1$ and $x_{2t}\, b_2$ are deterministic parts of demands and supplies, which are common to all micro-markets.

When only aggregate data are available, it is possible to estimate such a model of aggregation over micro-disequilibria by several methods. It is possible to write a pseudo-likelihood of the model and to maximize it (Pseudo-Maximum of Likelihood method, see Le Roux (1991-a)). Under several assumptions, it is also possible to get an expression for the expectation of the transacted quantity at the aggregate level:

If $\overline{D}_t$ and $\overline{S}_t$ are the deterministic parts of demand and supply at the aggregate level, then:

$$EQ_t = \overline{S}_t\, \Phi(\frac{\overline{D}_t - \overline{S}_t}{\sigma}) + \overline{D}_t\, [1 - \Phi(\frac{\overline{D}_t - \overline{S}_t}{\sigma})] - \sigma\, \varphi(\frac{\overline{D}_t - \overline{S}_t}{\sigma})$$

where $\sigma = \mathrm{var}(\varepsilon_{2t} - \varepsilon_{1t})$.

Then it is possible to get estimates of demand and supply parameters (and to characterize the distribution of micro-markets) by using a Non Linear Least Squares estimator. For applications of these two methods, see later and Le Roux (1991-a, 1991-b).

The second problem is about the assumption that the market is always in a disequilibrium regim. That is, with the canonical model, the probability of disequilibrium is either one, either zero. A class of disequilibrium models avoids this problem: these models are relative to markets with a minimum price.

If the market clearing price is greater than the minimum price, supply equals demand and the effective price is the market price: the market is in an equilibrium state. If the market price is less than the minimum price, the effective price equals this limit: the market is in excess-supply.

Specification and estimation of such a model of market depends on whether the minimum price is endogenous or exogenous, and moreover whether it is observable or not. The following section presents some of these situations and an application.

2. Models of Markets with a Minimum Price

Markets which are regulated by a minimum price[4] are characterized by two possible regims: equilibrium and excess-supply (or demand regim). The latter occurs when the minimum price is effective. Within such a market the demand is never constrained: all the observations belong to the demand curve.

Models of markets with a minimum price seem to be particularly relevant to represent European agricultural markets, where market prices are guaranteed through intervention system (and through intervention prices which are minimum prices). However regulation of these markets is a little more complicated than a simple market with a minimum price, due to specific modes of enforcement (e.g. periods of intervention, limitation of quantities which are bought by the European Community, through tenders for meat purchases, for example, ...). First, we present the canonical model of market with a minimum price. Then we will see which improvements can be made to take into account these specific features, with an application to the French soft wheat market.

2.1. The canonical model

Within the canonical model, both the effective price and the minimum price are observable. Moreover the minimum price is assumed to be exogenous. This model is written as following:

$$
\begin{aligned}
D_t &= a_1\, p_t + x_{1t}\, b_1 + u_{1t} \\
S_t &= a_2\, p_t + x_{2t}\, b_2 + u_{2t} \\
p_t &= \begin{cases} p_t^m \ \text{if} \ p_t^e < p_t^m & (\text{then}\ Q_t = D_t < S_t) \\ p_t^e \ \text{if} \ p_t^e \geq p_t^m & (\text{then}\ Q_t = D_t = S_t) \end{cases} \\
t &= 1, \ldots T
\end{aligned}
$$

where p_t is the effective price,

p_t^m is the minimum price,

p_t^e is the market clearing price,

other variables have the same definitions as previously.

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[4] *Similar models can be built for markets with a maximum price, or with both a minimum price and a maximum price (see Maddala, 1983).*

Within this specification, sample separation is perfectly known. So it is possible to write the density of the model according to the prevailing regim. For equilibrium observations, the endogenous variables are the effective price and the transacted quantity, whereas for excess-supply observations the endogenous variables are the transacted quantity (which equals the demand) and the supply. Given a probability density function for the error terms, joint density is given for each observation. Then Maximum of Likelihood estimator can easily be applied. The likelihood of the model is:

$$L = \prod_{t \in \theta_1} l_{1t}(q_t, p_t) \prod_{t \in \theta_2} l_{2t}(q_t, s_t)$$

where θ_1 is the set of equilibrium observations,

θ_2 is the set of excess-supply observations,

$$l_{1t}(q_t, p_t) = (a_2 - a_1)\, f\,(q_t - a_1\, p_t - x_{1t}\, b_1\, , q_t - a_2\, p_t - x_{2t}\, b_2)$$

$$l_{2t}(q_t, s_t) = f\,(q_t - a_1\, p_t^m - x_{1t}\, b_1\, , s_t - a_2\, p_t^m - x_{2t}\, b_2)$$

where $f\,(.,.)$ is the joint density function of $(u_{1t}\, , u_{2t})$.

An estimation of this model has been made by Vigier (1987), in the case of the French bovine meat market. He used monthly data from 1977 until 1986. At the monthly level, it is possible to observe both equilibrium and excess-supply data, while at the annual level the market is always in a disequilibrium state. Using specification tests, Vigier concluded that it is better to specify and estimate a model of market with a minimum price rather than independent estimations of supply and demand.

Because monthly data are available for this market, on which both demand and supply are observable, the canonical model can be used without particular trouble. As shown in the following paragraph, it is not always the case.

2.2. The case of an unobservable price limit

Through the case of the French soft wheat market, here we deal with a market where the effective price is always higher than the 'administrative' minimum price, but on this market excess-supply quantities are bought by public authorities.

This case can be met when the effective price is only observed at the aggregate level and on an annual average. This situation can also be explained, for the French soft wheat market, by the fact that the minimum price is not effective all along the marketing year, and this 'posted' minimum price can be altered according to cereal quality.

The solution of an estimation with monthly data is not possible here, because we are interested in an annual crop production.

Another solution is to consider that the national market is an aggregation of micro-markets which can be in different regims at the same period.

As previously seen (paragraph *1.2.*), this methodology can be used even if data are only available at the aggregate level. But in the model of aggregation over micro-disequilibria, it is not possible to explicitly deal with the minimum price situation. The previous model (*1.2.*) assumes that disequilibrium on a micro-market only occurs according to the values of error terms (because deterministic demands and supplies are common to all micro-markets). And only distribution assumptions are made on these error terms.

However, estimations of models of markets with aggregation over micro-disequilibria have been made for the French soft wheat market (Le Roux, 1991-a). Different specifications for the supply function (with different formulations for price expectations and supply adjustment) have been introduced. In all cases, estimation has shown that demand is always observed: even if the minimum price regulation is not explicitly introduced in these models, it is the proof this regulation is correctly taken into account in such a model of aggregation. See Le Roux (1991-a) for details on different specifications and results of estimation using Pseudo-Maximum of Likelihood and Non Linear Least Squares estimators.

Finally, with the original specification of a model of market with a minimum price, the last solution is to add an assumption about the observability of the price limit.

We assume there exists a virtual price limit which is not observable, and consequently which does not equal the posted price limit (intervention price). This assumption allows to specify the model at the aggregate level. It involves to build a supplementary endogenous variable. This new endogenous variable is the virtual minimum price which actually determines switching between equilibrium and excess-supply regims.

The model has to be re-written as following:

$$
\begin{aligned}
D_t &= a_1\, p_t + x_{1t}\, b_1 + u_{1t} \\
S_t &= a_2\, p_t + x_{2t}\, b_2 + u_{2t} \\
p_t &= \begin{cases} p_t^m \text{ if } p_t^e < p_t^m & (\text{then } Q_t = D_t < S_t) \\ p_t^e \text{ if } p_t^e \geq p_t^m & (\text{then } Q_t = D_t = S_t) \end{cases} \\
p_t^m &= x_{3t}\, b_3 + u_{3t} \\
t &= 1, \ldots\, T
\end{aligned}
$$

where x_{3t} is a set of exogenous variables which explain the minimum price.

By the same way as previously, it is possible to determine the density of the model. An additional difficulty is that the sample separation is unknown. So it is necessary to integrate over the unobservable variable (p_t^m) to get the density.

Then an estimation can be obtained by the Maximum of Likelihood method. Finally, an estimation of the regim probability for each period can be derived.

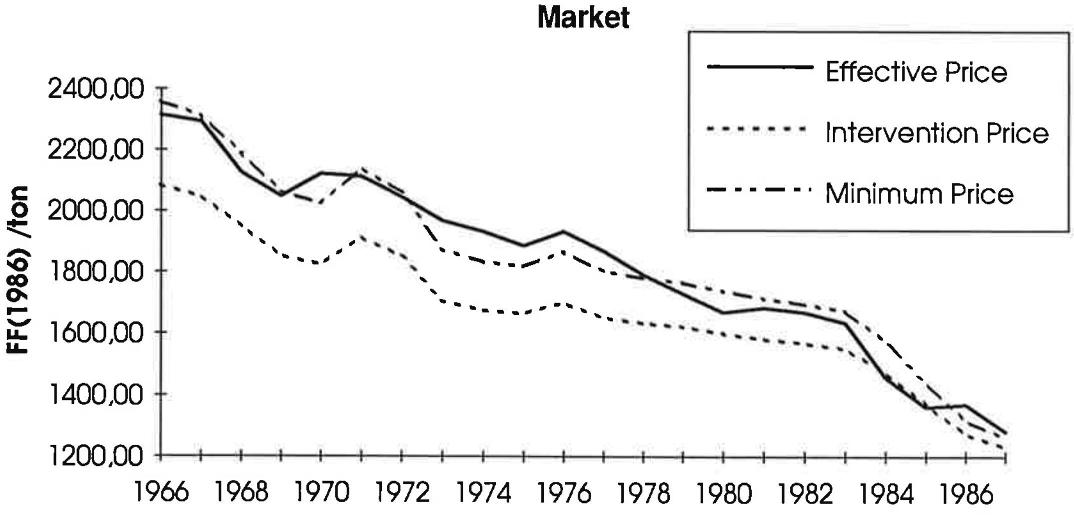
Even with simplifying assumptions (on the independence among the error terms, for example), the expression of the likelihood function has a complex form. It forces to retain simple specifications for demand and supply functions. If the advantage of such a model is to perfectly take into account the non-competitive functioning of the market (through the minimum price regulation), it does not allow functional forms which could closely represent the actual complexity of supply and demand. When applied to the national wheat market, total demand has to simultaneously catch domestic and foreign demand. Domestic demand would have to be divided into feed, food, and non food demands. The supply function would have to take into account price expectation formulation, and not only the existence of a minimum price.

In spite of the necessity for such simplifying assumptions, the model with an unobservable minimum price has been estimated on annual data (1966-1988) for the French soft wheat market. Demand is a function of the observed price and of terms representative of the export variations. Supply is a function of the per-hectare product (that is, the producer price multiplied by the yield), and of the relative price of soft wheat to corn.

Due to the model specification, estimations for parameters of demand are the same with an independent estimation by ordinary least squares, or under the assumption of the minimum price regulation. On the other hand, estimates for supply parameters are widely altered with the minimum price regulation specification. Particularly, supply elasticity to producer price is greatly higher within the disequilibrium framework. It induces a fitted series for supply which is always higher than the transacted quantity.

The estimation of this model gives fitted values for the unobservable minimum price, which almost everywhere equals the effective price (see graphic).

Unobservable Minimum Price: The French Soft Wheat Market



Moreover, estimations of the equilibrium probability give very small values (about .4 at the beginning of the estimation period, but less than .05 after). That means that aggregate data on transacted quantities never belong to the aggregate supply function. It involves very large standard errors for parameter estimations of supply.

If such a specification gives a close representation of the actual market, estimation results are not satisfying (in terms of explanation power) because of the structural excess-supply. Estimation can just confirm this result and can give an idea about the magnitude of the disequilibrium[5].

Price expectations

Another specific feature has to be considered when modelling most agricultural markets. Because there is not simultaneity between decision production and the time supply faces demand on the market, producers have to form expectations about these prices.

Formulations of adaptative or rational expectations can be introduced into the supply function. Within the model of market with a minimum price, it is possible to substitute the effective price by an expected price in the supply function, then to add a relation to determine this price expectation. Chanda and Maddala (1984), and Shonkwiler and Maddala (1985), have developed a full specification with rational expectations, and suggested relevant methods of estimation. An application was completed for the US market for corn. But their method only applies for an (observable) exogenous price limit.

We specified supply models with a kind of adaptative expectations (following Nerlovian works) but with an additional source of expectation due to the posted minimum price. When writing such a model in a reduced form, it is possible to get a model of market with price expectations. This model has been estimated by the method of aggregation over micro-disequilibria (Le Roux, 1991-a). But, as we previously said, the minimum price regulation cannot be explicitly taken into account in this case.

Due to structural features about the market under study, and to the data availability, model of markets with a minimum price are not perfectly suitable when structural disequilibrium occurs. They are appropriate when sample separation is perfectly known and when infra-annual data are available, in order to better catch regim switching.

Original econometrics of disequilibrium is more suitable when the aim is to correctly identify supply and demand effects on actual transactions, as seen in the following section.

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[5] *Full results about this estimation can be found in Le Roux (1991-a).*

3. Export Models with Spill-over Effects

Traditional modelling of trade is based on the assumption that the trade level is constrained by the demand. This assumption involves that the import demand (from the domestic economy to foreign producers) and the export demand (from foreign economies to national producers) are not bounded by supply effects. For several fields this assumption is strong enough: production capacity can often constrain the demand, for example.

So modelling of trade has progressively taken into account this feature: export (or import) relations have to be specified with both demand and supply effects. Moreover, econometrics of disequilibrium may be helpful to specify such models in a structural manner. It is possible to determine a relation for export demand and another one for export supply (the same for import). Then the traded quantity is the minimum between demand and supply. Estimation provides information on the regim which prevails at each period (is the demand bounded by the supply constraint ?), and on relative weights of demand and supply effects.

In the case of export modelling, and at an overall level, supply effects are essentially the stock of capital, the production cost relative to the producer price, the profitability of export relative to the domestic market, the rate of utilization of production capacities, and so on ... On the other hand, demand effects are the price competitiveness (in fact the world price relative to the export price) and the actual revenue of foreign consumers.

We present here applications to cereal exports. In this case, supply effects may be represented by the level of production (or the yield) and by the level of domestic stocks. Demand effects are mainly the EC export price relative to a representative world price, and the total world demand for cereals, which can be a proxy of the actual revenue of foreign consumers.

First a generalization of the disequilibrium model is presented in the two-markets case, with an application to French soft wheat exports. Then, we end with another application - only inspired by econometrics of disequilibrium - and relative to European models of intra and extra-EC exports of cereals.

3.1. Multi-Market Disequilibrium Models with Spill-over Effects

Multi-market disequilibrium models have to take into account the fact that the demand (or the supply) on one market may be altered by constraints stemming from another market.

One particular case can be found for European exports of cereals (or for exports of most agricultural commodities). For one EC member state, say France, it is necessary to distinguish two markets. The first one is the European market, which is not actually a domestic market. There are differences between supply and demand on the national market and supplies and demands of the other EC countries (differences of specialization, production costs, types of farming).

Overall is the monetary problem. European Monetary System and Monetary Compensatory Amounts have to correct - in theory - differences between exchange rates. Assuming they do, it is only true for intra-EC trade[6]. But monetary differences stay at the internal level, so they have different effects on national supplies and demands.

The second market to face is of course the world market. It is actually a different market because of the European trade regulation with third countries through export refunds and import levies.

Then a possible linkage may exist between these two markets: the level of trade on one of them can act upon - or can be influenced by - the level of trade on the other one. If on one market the demand (or the supply) is constrained, a spill-over effect on the other market can appear. Such a multi-market situation with spill-over effects can be written as following:

$$
\begin{aligned}
D_t^{WM} &= x_{1t}\, a_1 + \gamma_1\, Q_t^{EC} + u_{1t} \\
S_t^{WM} &= z_{1t}\, b_1 + \nu_1\, Q_t^{EC} + v_{1t} \\
D_t^{EC} &= x_{2t}\, a_2 + \gamma_2\, Q_t^{WM} + u_{2t} \\
S_t^{EC} &= z_{2t}\, b_2 + \nu_2\, Q_t^{WM} + v_{2t} \\
Q_t^{WM} &= Min\,(D_t^{WM}, S_t^{WM}) \\
Q_t^{EC} &= Min\,(D_t^{EC}, S_t^{EC}) \\
t &= 1, \ldots T
\end{aligned}
$$

WM: world market,

EC: European Community,

$\gamma_1, \gamma_2, \nu_1, \nu_2$ are the parameters of spill-over effects.

For example, $\nu_1\, Q_t^{EC}$ is the spill-over effect on the French supply to third countries (S_t^{WM}), due to constraints on the EC market.

This general specification leads to the formulation of the likelihood function, under assumptions on error terms. This likelihood function has a rather complex form. Simplifying assumptions on the separation between endogenous and exogenous variables allow more tractable computation (but a direct estimation of the previous model is made in Sylvain (1993), with an application to bovine meat trade).

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[6] *Single currency should exist at the frontiers ...*

3.2. Applications

A model of French soft wheat exports

In the case of the French soft wheat exports, we assume that French exports to EC are exogenous: only spill-over effects of these quantities (on exports to third countries) are taken into account[7].

The disequilibrium model has been estimated for French exports to third countries, with the method of aggregation over micro-disequilibria and with the Non Linear Least Squares estimator. Estimation results are presented in the following table (monthly data, 1970-7 to 1990-7):

	Independent estimations by OLS	Aggregation over micro-disequilibria
Demand		
Intercept	2.44 *(2.3)*	0.04 *(0.1)*
World Price/ EC Fob Price	1.93 *(8.4)*	2.64 *(6.0)*
Trend	0.009 *(13.2)*	0.006 *(4.0)*
Supply		
Intercept	16.39 *(11.8)*	20.88 *(12.9)*
Trend	0.011 *(13.6)*	0.013 *(9.6)*
Rate of utilization of stock capacity	1.487 *(8.1)*	1.756 *(6.7)*
French exports to EC (spill-over effect)	-0.268 *(-2.3)*	-0.587 *(-4.6)*

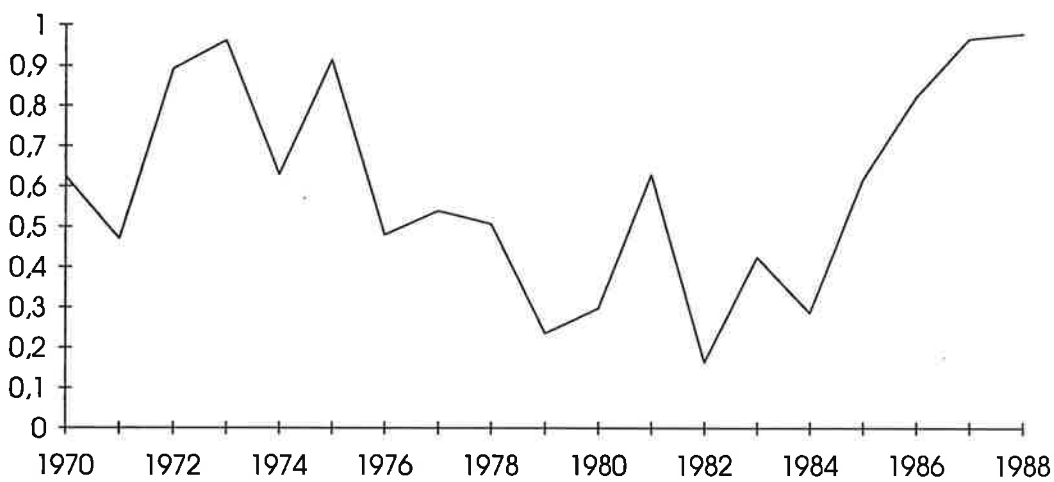
(t-values are reported in parentheses)
Except the trend, all variables are in logarithmic form.

[7] *We assume that French supply to the EC and demand to the EC can act upon supply to the world market and demand from the world market, but not the opposite. It does not seem to be a strong assumption, at least for demands.*

Among others, one result to be pointed out is the high level of the price-competitiveness effect on export demand (the elasticity of demand to the world price relative to the EC export price equals 2.6). The significance of this parameter emphasizes the actual importance of this price-competitiveness on exports, but it proves too that the 'law of the one price' does not apply for cereal trade. At last, the significance of the spill-over effect is particularly strengthened by these estimation results.

This estimation has been made on monthly data, in order to better catch supply and demand effects[8]. Indeed, estimation results lead to the computation of the estimated proportion of micro-markets in each regim, for each monthly period. We present in the following graphic an average annual proportion of micro-markets in excess-demand. Unlike results on annual data, this proportion is not unimportant. That means supply may be sometimes constrained by demand.

Annual Proportion of Micro-Markets in Excess-Demand



From 1970 to 1976 there are more micro-markets in excess-demand than in excess-supply (on an average), except July and August because of the harvest effect. Then, in 1977 and 1978, micro-markets are equally shared in both regims. From 1979 to 1985 the proportion of micro-markets in excess-supply is more important. But finally the end of the period shows more excess-demand micro-markets (at the monthly level).

[8] *Estimation on annual data has shown a proportion of micro-markets in excess-supply larger than the proportion of micro-markets in excess-demand, almost all along the estimation period (see Le Roux, 1991-b).*

European models of intra and extra-EC exports of cereals

An extension of the previous model has been made to all the major exporters of cereals. Intra-EC imports have been added in order to balance intra-EC trade for each cereal. Due to the linkage between all these models, it was not possible to preserve the pure disequilibrium specification which would have lead to untractable computational difficulties.

But for each country and for each cereal[9] a simultaneous model is written, with one relation for intra-EC exports and another for extra-EC exports. In each of these relations, supply and demand effects are introduced. For one country i and one cereal j the model is:

$$XEC_{ij} = f\,(\,XW_{ij}\,, (ECP_{ij})_{i=1,\dots N}\,, PROD_{ij}\,)$$
$$XW_{ij} \;= g\,(\,XEC_{ij}\,, (WP_j \,/\, EXECP_{ij})_{i=1,\dots N}\,, PROD_{ij}\,)$$

where XEC_{ij} = Intra-EC exports of country i in cereal j

XW_{ij} = Extra-EC exports of country i in cereal j

ECP_{ij} = Intra-EC export price of country i in cereal j

$EXECP_{ij}$= Extra-EC export price of country i in cereal j

WP_j = World price of cereal j

$PROD_{ij}$= Production of cereal j in country i .

These models have been estimated on annual data (1977-1990) by full-information maximum of likelihood estimator[10].

At the intra-EC level, we get negative own-price effect, positive cross price effect (intra-EC price competitiveness), and positive effect - when occurs - for production.

At the extra-EC level, the ratio of the world price to the exporter (i) price has a positive effect: when the world price is higher than the fob-EC export price, exports are facilitated. But the ratio of the world price to the EC-competitor ($i' \neq i$) price is positive or negative: that means the competitor may have a 'following' behavior relatively to the concerned exporter.

At last, the production effect on extra-EC exports is positive, when occurs.

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[9] *In fact: soft wheat and barley. Only France has a significant level of trade for corn.*

[10] *Full results can be found in Jayet and Le Roux (1992).*

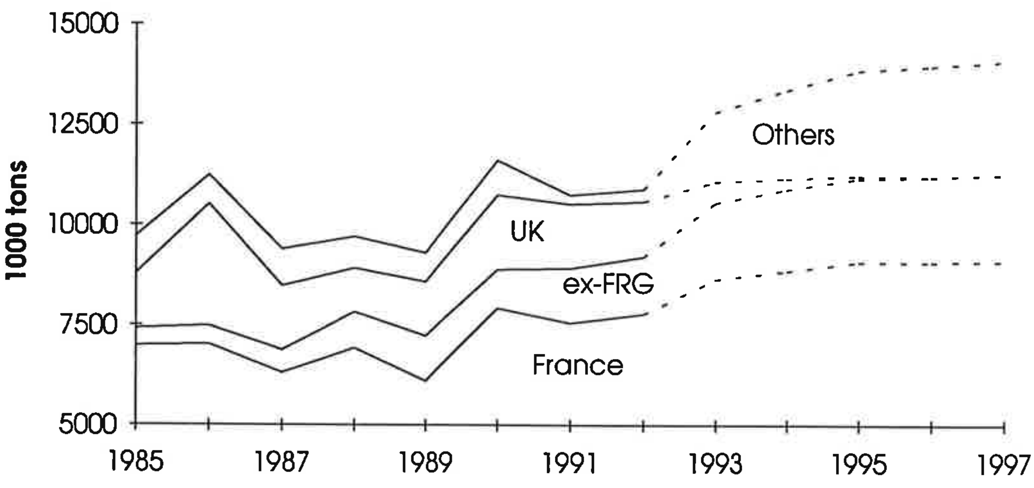
The interest of such models is to get export forecasts under price and production scenarii. Then, these models may be appropriate to measure effects of the Common Agricultural Policy reform on intra and extra-EC exports of cereals.

The period of simulation is 1992-1997. Intra-EC prices are assumed to follow the same variation as intervention prices (in real Ecu) until 1995. Relative prices (in US dollars) on the world market are assumed to be constant all over the period of simulation.

Existing supply models measure effects of price variations (and other CAP instruments) on production levels. It is the case of the French model AROPAJ, for example (an extension of it is made for United-Kingdom and Italy: see Jayet communication, this workshop). We used another supply model, due to its specialization in crop production and to its existence for the major EC producers and exporters of cereals (France, United-Kingdom, and Germany). This model is the MONIC[11] model. Scenarii are built under all these previous assumptions. They lead to following results for soft wheat trade[12] (see graphics).

Intra-EC trade of soft wheat would increase (about 3 million tons), due to price-effects stronger than production-effects: the demand-side seems to prevail over the supply-side. This evolution is not in favour of the United-Kingdom, because of an assumption of a very large production decrease.

Intra-EC Exports of soft wheat (cumulated quantities)



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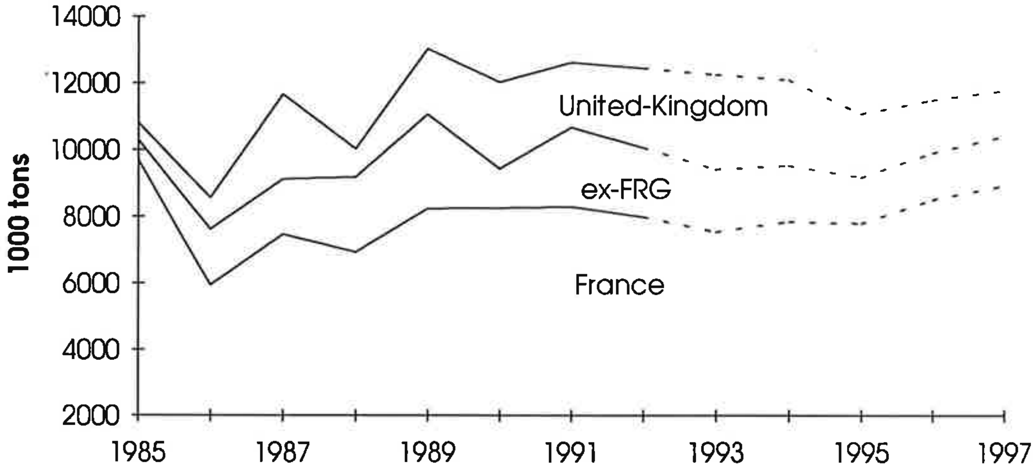
[11] *Modèle d'Offre Nationale et Internationale de Céréales, ONIC, Bureau de la Stratégie, Paris.*

[12] *Other results can be found in Le Roux (1992)*

At the extra-EC level, European exports of soft wheat would not be greatly altered: they stay at about 12 million tons. Only France would increase its exports on the world market, to the detriment of Germany and the United-Kingdom. Finally, effects of the CAP reform would only be significant on barley exports, and globally European cereal exports on the world market would decrease of about 20%.

Extra-EC Exports of soft wheat (cumulated quantities)



4. Conclusion

This paper has attempted to cope with some applications of econometrics of disequilibrium to modelling of agricultural markets. Some specifications derived from econometrics of disequilibrium seem to be quite relevant in order to take into account specific features of agricultural markets. That is particularly the case for models of markets with a minimum price, in order to represent the European intervention system on most agricultural markets.

But according to estimation results, such a specification is not necessarily the best one. It leads to poor results when applied to a market which is always in the same disequilibrium regim. This structural situation may occur when data are only available at the annual level. Moreover, this specification is not appropriate when it is necessary to add an assumption on the unobservability of the price limit. In this case, sample separation is unknown.

Conversely, econometrics of disequilibrium - in its original specification and eventually with adaptations to take into account heterogeneity - is appropriate when the aim is to identify and to measure supply and demand effects on a market, and to determine - *ex-post* - switching between excess-supply and excess-demand. Estimation of export models have given a satisfying application of it.

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