Quality pricing international soybean markets : models and real world

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QUALITY PRICING IN INTERNATIONAL SOYBEAN MARKETS : MODELS AND REAL WORLD

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It is in the nature of many commodities, particularly agricultural commodities, that quality varies from batch to batch. Theoretical competitive markets should bring prices to reflect quality differences. However, quality is quite a complex concept with different meanings for different stages of the product from the producers to the final consumer. In order to decrease marketing costs between producers and consumers, quality attributes are defined by professionals as well as objective measurement methods. Classification techniques are then used in order to describe each batch of product. Grading techniques used mainly in the U.S. or F.A.Q. techniques have been much used for describing various agricultural products. These techniques, and particularly the US grading, are supported by the public authority or by strong professional organisations. As a consequence, public information is quite large and symetric market information for buyers and sellers brings chance for a competitive market between them. The changes into market regulations throughout the world, the concentration of market participants, the technology development are main sources of change into market practices. One of them is "specification contracts" where private specific conditions on product quality are required. These conditions are completly private between the seller and the buyer, or they are additional conditions to the public trading rules such as grading. In these conditions, private information is increasing with respect to public one. Therefore, the competitiveness of the market should be an increasing concern for professionals, for the administration of the main regions of production and consumption, and of course for the final consumer. Economic research is required for analyzing the market trends and checking for "sufficient" or "optimal" market competition with respect to professional needs, available techniques and market structure.

The first part of this paper is related to the theoretical models used to analyze the price of commodities with respect to quality. The second part is a development of the theoretical background of the models when taking into consideration the particular case of the soybean market where the two major components, oil and meal, are actively traded around the world. Finally, the third part is a description of the research potential for analyzing quality pricing on the soybean market and possibilities of improvement of market behavior with the new international environment.

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I - The structural hedonic pricing model

1.1 Commodities as a bundle of characteristics and/or components

Many commodities can be viewed as bundles of individual valuable characteristics and/or components. For instance, numerous identifiable characteristics are embodied in cotton fiber. The most widely recognized, and the attributes on which data on individual bales of cotton are usually availlable, are color, fiber length, micronaire which indicates the fiber fineness and maturity, fiber strength and length uniformity. In another hand, milk quality is identified and paid with respect to its main components, fat content, proteins and solids-not-fat (lactose), and with respect to characteristics such as microbiology factors. Traditionally, soybeans have been traded on a component pricing approach[2] on the international market. The two major components are the oil and the protein contents of the beans.

Quality pricing is a constant question for professionnals as well as economists. Does the price reflect the real market value of the product ? Does the consumer demand for the various products manufactured with the commodity influences the production conditions through the quality pricing mechanism ? What is the meaning of the common producer comment around the world "Quality is not paid !" ?

1.2. The general hedonic model

Hedonic prices are defined as the implicit prices of characteristics or components. They are revealed with hedonic models which associate observed prices of various batchs of products and specific "intensity" of characteristics or contents of components associated with each batch. Econometrically, implicit prices are estimated by the first-step regression analysis (commodity price regressed on characteristics) in the construction of hedonic price indexes. In other words, a vector of implicit marginal values is obtained by differentiating P(Z) with respect to its *i*th argument Z_i, and evaluating the derivative at the level of the characteristics purchased or sold (Rosen 1974)

$$P = f(Z_i) \qquad \text{such that } V_i = \delta P(Z) / \delta Z_i$$

where P is the price of the commodity, Z_i are the characteristics, and V_i are the characteristics' marginal values. Hypothesizing a linear additive model, which is the simplest approach, the hedonic model can be expressed as :

$$P(Z) = \sum_{i=1}^{n} (Z_i x P_i) \quad \text{with } V_i \text{ estimated by the regression coefficient of } Z_i$$

A regression of commodity price P(Z) against product characteristics yields rough estimates of marginal impicit prices. Several improvements can be developped in order to

[2] Farmers are usually paid on a commodity pricing approach on the basis of weight, generally adjusted only for moisture content. While it is likely that prices paid to all farmers are adjusted in some way for differences in the average component content between producing areas or between crop years, prices paid to individual farmers are not adjusted to reflect the component content of his lot of beans.

better evaluate the regional features of the market (exporting and importing regions) and the structure of characteristics' markets.

1.3. Developments of the general hedonic model

. Market prices are affected by quantitative and qualitative dimensions. The quantitative dimension consists of fundamental supply and demand forces affecting the price of the product considered as homogeneous. The qualitative dimension is the effect on price as quality characteristics change. Under this conceptualization, it is useful to define a base set of quality attributes and a base price for a "product of reference".

For instance, soybean prices batch per batch may be defined as differences with the US base prices and regressed on differences in components and characteristics with base characteristics of the US beans. The hedonic model is then expressed as the following for the international soybean market :

$$(P - P_b) = a_0 + V_1.(X - X_b) + V_2.(Y - Y_b) + \varepsilon$$

where P is price([3]) of soybeans with characteristics X for oil content and Y for meal content; P_b is the price with base characteristics which is usually the US futures price for soybeans([4]), X_b is the US average oil content of beans and Y_b is the US average meal/protein content of beans; ε is a disturbance factor which contains soybean price what is not explained. Implicit values of oil and meal are determined as $V_1 = \delta P / \delta X$ and $V_2 = \delta P / \delta Y$.

. For improving the approach, the analysis may focus on the various origins and destinations of the product. It is indeed important to explicit the price differences between destinations in order to determine the local market characteristics. Many buyers believe climatology is different in Brazil between the Rio Grande hinterland and the Paranagua hinterland. Consequently, it may happen that with the same component contents, price of one origin has a systematic premium over the other. The general hedonic model may be adjusted to include region intercept and slope-shift dummy variables to capture regional differences.

The regression model presents the following features with four different origins :

$$\begin{aligned}(P_j - P_b) = {} & a_0 + a_{1,i}.R_i + V_1.(X_j - X_b) + V_2.(Y_j - Y_b) \\ & + a_{2,i}.(X_j - X_b).R_i + a_{3,i}.(Y_j - Y_b).R_i + \varepsilon\end{aligned}$$

where subscript j denotes values in region j, R_i denotes region dummy variables ($R_1 = 1$ for Brazil/Rio Grande, $R_2 = 1$ for Brazil/Paranagua, $R_3 = 1$ for Argentina; when $R_1 = R_2 = R_3 = 0$, region of origin is the US) and ε is the disturbance factor.

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[3] All prices are expressed in US dollars as a common practice on the international market.

[4] N° 2 Yellow soybeans and substitutions at differentials established by the Chicago Board of Trade. Basically, the description by the Exchange of a bushel of soybeans is the following. "It weighs 60 pounds. The solvent-extraction process used to convert the beans into their component products yields 47 pounds of meal - 78.5 % - or flake and 11 pounds of oil - 18.5 % - from each bushel of soybeans. Two pounds are lost in processing (3 %).

. The general hedonic model as presented above may be improved with a second-stage analysis. The hedonic model, considered as a first-stage of analysis, does not provide any information on the market of each characteristic or component within the commodity. Demand for components is a function is a function of implicit prices but also a function of a set of shifting parameters which influences purchasing decisions. Supply of components is a function of another set of shifting parameters influencing sellers' decisions. Rosen, and Brown and Rosen (1982) present a second stage in the hedonic model estimation designed to elicit the sets of shifting parameters influencing commercial decisions. If the supply and deman for characteristics are both price-dependent, they are determined simultaneously.
In equilibrium,

$$V_i(Z) = g(Z_1, \ldots , Z_n, Y_1) \text{ for demand}$$

$$V_i(Z) = h(Z_1, \ldots , Z_n, Y_2) \text{ for supply.}$$

The demand equation states that the marginal demand price of a component (or characteristic) is a function of product component contents (characteristic levels) and a set of shifters Y_1, which influence the demand of component *i*. The supply equation is equivalent. Because there are demand and supply functions for each component, the structural model is a set of 2n equations.

Bowman and Ethridge (1992) present two shifters of characteristics (component) demand for cotton, the base price reflecting the fundamentals of the commodity market and changes in the proportion of rotor to ring spindles in U.S. textile mills. They present also variety as the main shifter of characteristics supply for cotton, and variety as a function of regional weather variables (rainfall and temperature per season). Estimated characteristic demand relationships show that factors affecting demand vary among regions. The characteristic supply equations show the effects of environmental factors on characteristic levels, rainfall per season and temperature.

The second-stage of the hedonic price model is an important approach for the international soybean market. In theory, this second stage brings the possibility to test additional parameters affecting processing regions, including the US, Europe and Asia. Some of them are quoted by Hill (1995), such as mold damage, test weight, free fatty acid, moisture or protein contents. Considering the data available from the batch to batch study at several processing plants in Europe and Japan from all destinations, it looks like the second-stage for these shifting parameters could be performed. However, additional parameters are often quoted by professionals, such as plant technology, ability of origins to assure really contract specifications and so on. These parameters are very difficult to operationalize and to measure, but they may explain a lot on differences between beans value and price.

In conclusion, the complete hedonic model looks like a very powerful model to estimate implicit values of components or characteristics of commodity products. The objective of these structural models is to explain the maximum of the commodity price variability, therefore it is important to be able to elicit the right characteristics and the right set of characteristics demand and supply shifters.

II - Additional quantitative analysis for the soybean complex

Two additional approaches of the general hedonic model should be able to better explain the pricing and sourcing decisions of soybean merchandisers and processors. The first approach is based upon implied arbitrage opportunities on the two major soybean components , the second is an attempt to analyze the dynamic interactions with lead-lag relationships between markets.

2.1. Arbitrage models for the soybean complex

The soybean market is quite unique in the sense that the main value of the commodity is spread into two components, oil and proteins, each of them benefiting of competitive markets. The oil market is very active, on the cash and on the futures market. In addition, soybean oil has substitutes in the oil world complex, such as rapeseed([5]), sunflower and palmoil. Futures markets for most of these products are spread around the world for such products. The soybean meal market is also very active with futures market in the US. All the products with high protein content compete with soybean meal, eventhough it looks like the meal is leading the vegetal protein market.

The component futures prices of oil and meal, as discovered on the Chicago Board of Trade, explain more than 90 % of the soybean price, without any consideration of processing costs. Any quantitative model should be considered as excellent with such explicative power. In the other hand, hedonic and engineering models are able to estimate the implicit prices (or values) of the major soybean components, mainly oil and protein. These models brings what is called the "estimated processed value" (EPV) of the soybean processed batch.

As a consequence, the soybean markets brings strong opportunities of arbitrage between value and price of soybeans. These opportunities computed on limited components and quality characteristics of soybeans are pertinent information to be structured for price and value analysis. "Arbitrage models" should be developped to structure the information and bring more insignts in the pricing decisions throughout the market as well as sourcing decisions for the main importing world regions (especially, European Union and Japan)

Arbitrage models are testing the pertinence of parameters to explain arbitrage value, meaning the difference between local market price and implicit values of commodity components. Models should present the following form :

$$A_i = (P_i - V_i) = f(R_i, Y_i, T_i)$$

where P_i is the component market price (i.e. oil, meal or others), V_i the implicit value (or hedonic prices), Z_i region dummy variables, Y_i shifters dummy variable such as processing technology or plant flexibility and T_i other shifters such as exchange rates, transportation costs including interest (financing) rates.

These arbitrage models should be developped with three main objectives, (1) more information on pertinent and valuable components, commodity characteristics, demand and

[5] Now "canola" in Canada, one of the major producer and exporter in the world.

supply parameters, (2) more information on the origin of the arbitrage opportunity, which component/characteristics/parameter is pertinent, where and when, (3) more information on the cash market behavior with "noises" such as transportation costs, exchange rates or interest rates.

First of all, the observed arbitrage opportunities per batch between simultaneous component values and component market prices brings the necessary potential for analyzing more deeply either the commodity components in terms of quantity or quality, or additional characteristics to be evaluated, or quality demand/supply shifters (local market conditions, processing technology, flexibility of plants in terms of demand shifters, weather factors, soybean variety in terms of supply shifters).

Next, quantitative analysis should structure the information contained into the arbitrage opportunities in order to elicit the most important factors of the arbitrage, the type of component, the region of production, the period of the year (seasonal effects).

Finally, the arbitrage models based upon data on every vessel received at several processing plants in the European Union and Japan may explore the role of exchange rates, transportation costs per origin on pricing decisions. The necessary data may become very large as each component market prices should be expressed in local currency

2.2. Lead-lag relationships between soybean and components markets

Hedonic models and the previously described arbitrage models are static. They consider cash-cash marketing margin (CMM) with instantaneous defined prices for input and outputs of the processing industry. This is a limited approach when considering the existence of futures markets for the products going in and out of the industry. Omission of futures in the analysis of marketing industries has potentially significant consequences on results. Paul (1966) in a quite old paper illustrate very clearly the impact of such omission. For example, as expressed by Lence, Hayes and Meyers (1992), the standard practice of employing CMM to infer the efficiency or competitive nature of the industry may be misleading because it does not reflect profit opportunities of the complete market, cash and futures.

What is called later "pricing and trading" in the real business decisions is a concept able to take into account the dynamics of the firms decisions in relation with commodity markets as well as exchange rates or other associated markets. That is the problem of market dynamics. Two quantitative techniques can be used for analyzing such dynamics of the markets and business practices. The first one is called cointegration analysis and the second causality analysis.

Many economic time-series wander extensively (i.e. are not stationary) when considering alone, but form stable equilibrium relationships when two or more nonstationary time series are jointly considered. Engle and Granger (1987) have proposed an extension of the idea of time series integration through unit root testing. They point out that if individual time series are integrated, say of order one, it is still possible that certain linear combinations of the time series in the system will be integrated of order zero. They describe such systems as cointegrated. The use of the cointegration tests is to discover if individual market prices are responding to their own set of fundamentals or if they are determined by a common set of forcing variables. The number of cointegrating vectors corresponds to the number of independent functional relationships among the variables. For a group of variables, a single cointegrating vector implies that any single variable can be expressed as a function of the other variables. If a group of n variables has n-1 independent cointegrating vectors, any variable may be expressed in terms of any of the other variables.

In a quality pricing analysis, which would focus on input/output price dynamics and interactions, vector cointegration analysis should first bring results on instantaneous price relationships.entire group when there are (n-1) cointegration relationships. This first kind of model should bring results close to the traditional hedonic models.

The particular interest of cointegration analysis should be to define the optimal lags between prices which would maximise the number and the intensity of cointegrating vectors. To complete the analysis, all the available data on the cash and on the futures markets, and why not substituable markets, should be used for testing the number of significant cointegrating vectors (and intensity).

Causality analysis was developped before cointegration. From Wiener's suggestion (1956), Granger (1969) introduced a formalization of the concept of causality in a time series context. This Granger causality has stimulated great interest among econometric theorist and practitioners. Starting with bivariate cases, the techniques are using now Vector Autoregression techniques for causality tests and shock analysis (Indjehagopian and Mourad - 1993).

Using time series data on the futures markets, which are generally available, and on the cash markets which are less obvious to obtain and to qualify for practical reasons, causality analysis can be performed to look at the lead-lag relationships between prices, but also between prices and component shares within the commodity. The results may be useful to detect the leading role of such component, regional effects, seasonal effects with much more details than with hedonic models.

As a conclusion, empirical analysis such as causality or cointegration analysis is able to bring valuable information on leads and lags between cash and futures prices of soybeans, soybean oil and meal to better understand the dynamics of markets and prices. These information may be useful to improve the hedonic and arbitrage models as designed traditionally.

III - Models and business practices on markets

Business practices should be taken in great consideration for quality pricing analysis. Models have technical limitations, but their power to interpret data is important when considering various fundamental and practical technical approaches.Traders, even, are using models for helping business decisions. The core problem may be the right interpretation of data. When considering the price of a soybean batch, is it "the" real price of the batch ? Two major difficulties to develop and run pertinent models can be cited: first of all, the characteristics to be considered for quality and second, the real meaning of a market price for each product batch.

3.1. Pertinent characteristics to be used in models and business practices

Buying and selling soybeans is basically a problem of crushing margin. Margin is first the difference between the price of the components minus the cost of the beans. But the cost of processing is also endogeneous to the margin as a function of seeds quality. Therefore quality is important in the soybean markets, not only in terms of component content, oil and protein, but also in terms of other characteristics which influence processing costs. In the first part of this paper, the set of other than major characteristics are called "set of shifters" within the hedonic models. The question is therefore to define the pertinent characteristics really used by professionals and to be used for model analysis.

In theory and in practice, the optimal level of information which defines the set of pertinent characteristics to be monitored is reached when the marginal value of the information gained is equal to the marginal cost spent to obtained it. When checking the last contracts between sellers and buyers for soybeans in the international market, there is no more quality information than ten years ago. It could be concluded that no additional information was required for quality pricing within the last decade. That is not true. But the additional characteristics, and related information on geographical origins and particular values (or related costs) for processing firms are private. The concentration of the processing industry throughout the world allowed the internalisation of quality valuation : in on hand, it is possible for the firms within the industry to obtain the information worlwide with private information systems and in another hand, it is possible for the firms to have a private valuation of the products from various origins with respect to their own technology and plant characteristics and locations.

This private part of the information brings two remarks. One, quality pricing requires a close relationship between research and the industry in order to develop accurate data base for quality market modelling. Two, classification techniques enforced by public authorities are very often behind the real way of pricing products. Specification contracts and "finalized prices", meaning price established after crushing with respect with yields and technological results, will be much more used in the future than nowadays. Soft seeds, such as sunflower or rapeseed, are basically traded with such techniques, soybeans trading should move towards these exchange methods. The consequences on fair competition and fair pricing on commodity markets are not obvious.

3.2. "Trading" and "Pricing", the real meaning of a market price per product batch

Markets post prices for futures delivery through futures markets as well as international forward markets. Traders are using the futures markets as basic prices. They compute the so-called Board Margin which is the margin from the three futures price, beans, oil and meal, at the Chicago Board of Trade for various horizons. Then they negociate premiums for selling and buying products with respect to futures prices in consideration with expected quality characteristics and also market opinions. They will buy the premium when expecting a value increase and reciprocally. The economical result of the trading operations depend upon a good risk management of premiums and quality. This is "trading".

"Pricing" is required for administrative and legal constraints. When products are shipped from the seller to the buyer, they must be priced for commercial documents (commercial invoice) but more generally for export documents (movement certificates, letter of credit, certificate of insurance, customs certificates and so on). An agreement is frequent between premium buyers and sellers to price the product with respect to the futures market price close to the shipment date. But these prices have nothing to do with the real purchasing price of the input (soybeans) or the output prices (oil and meal) as a consequence of the trading activity. Therefore, data for pricing analysis should be taken with great care.

"Trading" and "pricing" bring a practical difficulty for research on quality pricing. It is necessary to work with traders to compute the real value or price of a product batch. Without a close cooperation, results from theoretical models applied to official data on shipments can bring spurious results.

These two difficulties are both interesting for research studies but also limits for valuable results. They reveal the necessity for modelling work to keep close contact with professionals in order to interpret data and take businnes practices into consideration.

IV - Conclusions

Quality pricing of commodities, and particularly soybeans, on international markets is an important topic for professional, producers, elevators, processors but also for governmental agencies in charge of quality regulations including classification rules. Structural models such as the general hedonic pricing or arbitrage models are suitable models for analyzing the relationship between value and price of soybeans. Cointegration and causality models are potentially useful for a better understanding of the dynamics of the market pricing process between input and output products. However, all these technical approaches may be worthless if all the necessary data are not available or if they are are not checked for real meaning.

Concentration of the processing industry may bring market inefficiencies on quality pricing, with negative impact on short term for the total economic surplus. On the long term, ne negative impact may even cause problems to the industry as producing activity could vary inconsistently with respect to demand requirements.

Applied research on commodity quality pricing is useful for decreasing total marketing costs improving the total market efficiency. A close cooperation between the industry and the academic work is necessary for reaching the right level of information and the right knowledge of business and technical practices.

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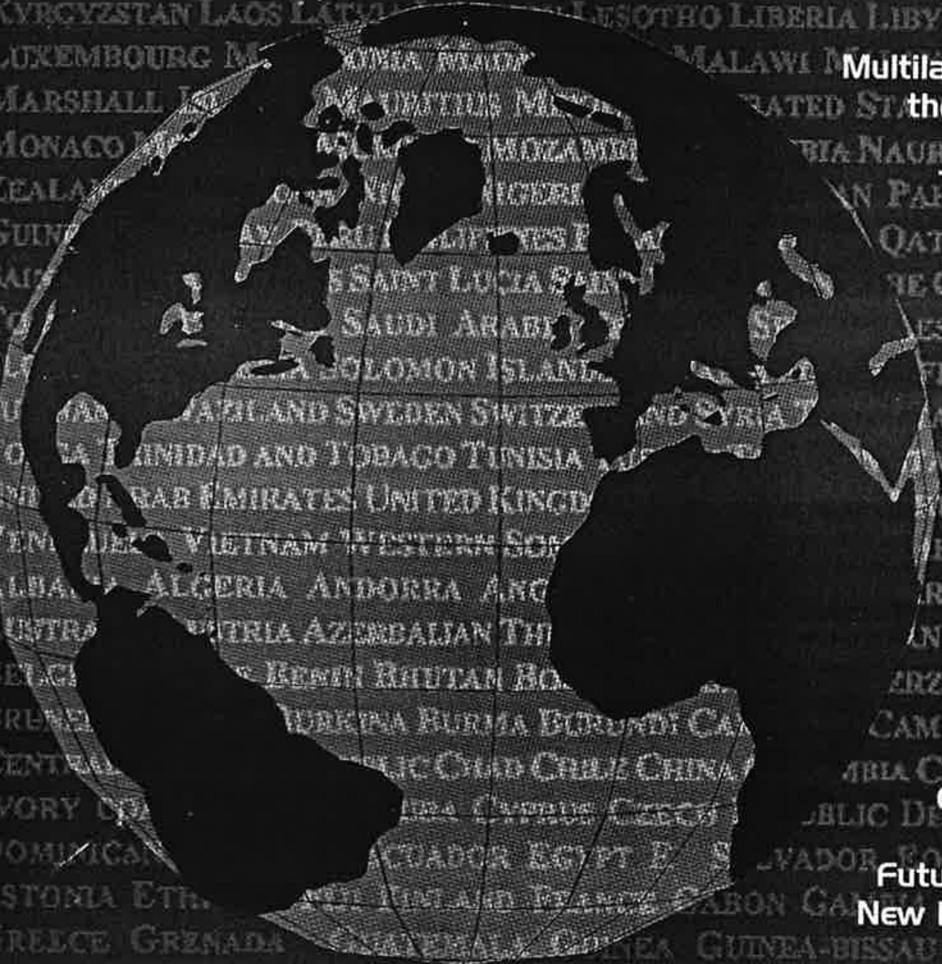

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