Paper presented at the IAMA World Congress, Food and Agribusiness Forum, June 24-28, 2000, Chicago, USA

Farmers' risk management through the futures markets in the Common Agricultural Policy of the EU - fact or fiction?

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Abstract
It is usually considered so that there is little room for futures market in the heavily administered, supported, and consequently quite stable markets such as the agricultural markets in the EU controlled by the CAP, Common Agricultural Policy. However, as EU membership in 1995 changed the conditions on the Finnish grain markets by increasing price volatility and risk, this study examines the applicability of futures markets to reduce the price risk in Finland. The theoretical framework is concerned with the risk theory and theory of choice under uncertainty. Econometric cointegration analysis with error correction models were employed to estimate the possible cointegration between the Finnish cash prices and Chicago (CBOT) futures prices. Moreover, theme interviews of the different parties of the Finnish grain markets were made to identify attitudes towards and expectations of futures markets. This subject is gaining growing importance as the CAP and market conditions in the EU are gradually shifting to a more market-orientated direction, due to e.g. the Agenda 2000 CAP reform especially in the case of cereals, in which futures markets can be real alternatives.

Keywords: Futures, options, price risk, hedging, cointegration, stationarity of time series

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1. Background and objectives of the study

Producer prices of grains decreased overnight by about 50 % when Finland joined in 1995 the EU. Although EU agricultural markets are also heavily regulated by e.g. administered prices and support instruments of the CAP, the EU membership changed fundamentally the functioning of the strongly protected Finnish grain markets as prices collapsed and price volatility increased (Männistö et al. 1997). A clear need arose to study the applicability of new market operations in Finland in order to alleviate emerging price risks, because this kind of studies are still non-existent, although some applicability can be found in e.g. Lidfeldt & Andersson (1994).

Futures markets have a long tradition in the United States. The first futures contracts were introduced in 1885 at the Chicago Board of Trade (CBOT), the clearing house became the third party in the purchases first in Minneapolis in 1891, and the closing of the futures positions prior to maturity was introduced one year later (Leuthold et al. 1989, pp. 21-22.). In addition to the CBOT there is a grain exchanges in the U.S. in Kansas and another one in Chicago (the MidAmerican Commodity Exchange), in Canada in Winnipeg, in Australia in Sydney, in Japan in Tokyo, and in Europe there are grain exchanges in e.g. London, Paris, Amsterdam and Hannover. (Duffie 1989, pp. 376-382.)

This study examines the applicability of the grain exchange and trading strategies related to the futures markets in Finland by the means of the econometric cointegration analysis. The research problems are: (1) are the Finnish cash prices for wheat and oats cointegrated with the corresponding futures prices of the CBOT, and (2) are the imaginary positions in the CBOT economically justified? In addition, the interest of the parties operating on the Finnish grain market in using futures markets was studied by theme interviews. Alternative strategies related to the futures and options that might be suitable for the Finnish grain market are evaluated in the conclusions.

2. Theoretical framework

The theoretical framework for the study deals with the justification of the existence of the futures and options markets, and it is concerned with the risk theory and theory of choice under uncertainty (Gravelle & Rees 1992). The different possible attitudes towards risk and properties of the utility function affect farmers' decisions, and grain trade in general including the applicability of futures contracts. Risk can be defined as a cost, which reduces production. The bigger the risk and the more risk averse the agent is, the bigger is the cost of risk. Futures markets reduce a farmer's risk, because the price risk is assumed by the other party in the trade. The risk premium is a key concept in this respect. The risk premium can be added to marginal costs (MC) or reduced from marginal return (MR). Figure 1 illustrates how the MR curve shifts downwards due to the risk premium. This shift reduces both production quantities and prices on cash markets. Futures markets is a means to shift risks related to price variability to other investors, who have either different risk attitudes or different views of the future developments. Consequently, the very existence of futures markets has influence on production volumes on cash markets (Leuthold et al. 1989).

Risk premium is defined as $v(\bar{y}-r) = \pi v(y_1) + (1-\pi)v(y_2) = \bar{v}$, in which $v(y_i)$ = utility function with a certain level of return/income; π = probability of certain outcome/state. In this equation an agent is indifferent between the risky game, with expected return $\bar{y}$, and the certain return $\bar{y}$ - r. In money terms, the risk premium is the difference between the average return of the game and its certainty equivalent: $r = \bar{y} - y_c$. The risk premium corresponds to the amount of money, which the agent rather pays than plays the risky game, expected return of which equals his certain return. Risk taker, in turn, is willing to play the game, and then the risk premium is negative. As the second derivative of the concave function is less than zero, i.e., $v''(y) < 0$, we can, consequently, define a risk averse agent as a person whose marginal utility (MU) of return (income) is decreasing. In the case of risk neutral and risk taker, MU is constant and increasing, correspondingly.

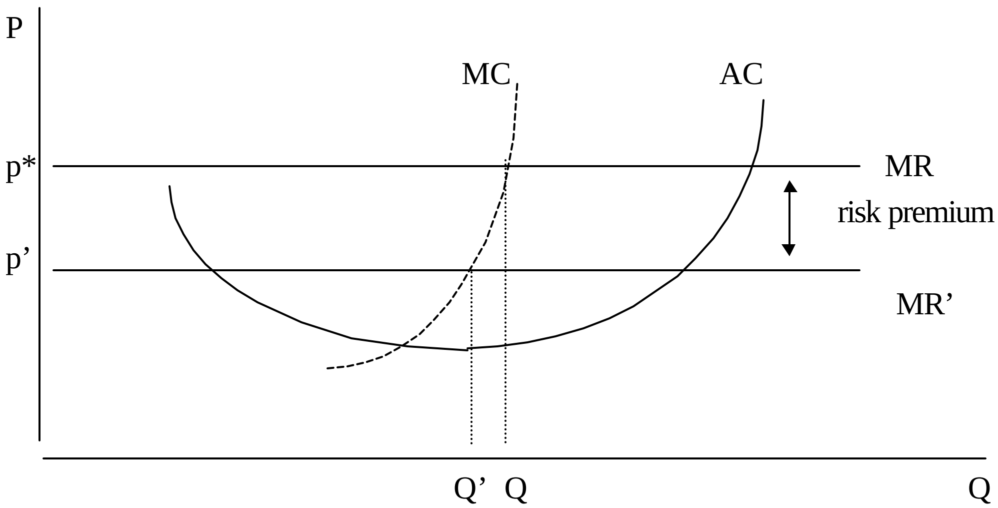

Figure 1. Effect of risk on production quantity.

3. Methods and data

In Finland there is no data available on actual futures transactions made and, consequently, the data for the present study was obtained by means of imaginary transactions from the CBOT. The trading strategy is to take advantage of the rising prices by buying either call options or futures. The data was analyzed using time series econometrics in the form of advanced co-integration analysis with the autoregressive distributed lag models (ADL) and error correction models (ECM) (Harris 1995). The cash prices for oats and wheat in Finland as weekly averages in 1995-1996, on purpose immediately after Finland's accession to the EU and the CAP price systems, and the Thursday's futures prices of the same grains and time periods at the CBOT were used as the data for the econometric estimation.

In the following it is briefly presented the basic ideas concerning the significance of the stationarity of the time series, testing of stationarity, estimation of the error correction models, and, finally, the testing of cointegration. It is problematic to analyse economic time series if they include unit root, meaning that they are non-stationary. A stochastic process is stationary if it fulfills the following conditions for all observations *t*: $E(y_t) = \mu$; $E[(y_t-\mu)^2] = \sigma_y^2 = \gamma(0)$; $E\{(y_t - \mu)(y_{t-\tau} - \mu)\} = \gamma(\tau)$, $\tau = 1, 2, ...$ (e.g. Harvey 1993). If we have two time series y and x, a simple dynamic explanatory model for, say, y_t is the following *autoregressive distributed lag* (ADL) model, in which p and q are the numbers of lags of the independent and dependent variables: $y_t = \alpha_0 + \gamma_0 x_t + \gamma_1 x_{t-1} + \alpha_1 y_{t-1} + u_t$ $(u_t \sim IN\ (0,\sigma^2))$. Parametre γ_0 shows the short run change in y_t as x_t changes. The aforementioned equation can be transformed to an *error correction model* (ECM) presentation by adding $\pm y_{t-1}$ and $\pm\gamma_0\ x_{t-1}$ and reorganising and renaming terms to get: $\Delta y_t = \gamma_0 \Delta x_t - (1-\alpha_1)\{y_{t-1} - \beta_0 - \beta_1 x_{t-1}\} + u_t$, $\beta_0 = \alpha_0/(1-\alpha_1)$. These two equations contain same information, but the latter equation, i.e. the ECM presentation, provides certain advantages. Firstly, if x and y are cointegrated, it includes both short and long run impacts. Secondly, all of its terms are stationary, which enables the use of conventional regression methods, provided that the time series are cointegrated and estimates for β_0 and β_1 can be calculated. To testing stationarity and cointegration we use *Dickey-Fuller* DF-test or *augmented Dickey-Fuller* ADF-test, depending on the degree of the autoregressive process. If time series y_t is AR (p)-process we write it as follows:

$$y_t = \psi_1 y_{t-1} + \psi_2 y_{t-2} + \ldots \psi_{t-p}\ y_{t-p} + u_t\ (u_t \sim IID\ (0,\sigma^2)) \quad \text{or,}$$
$$\Delta y_t = \psi^* y_{t-1} + \psi_1^* \Delta y_{t-1} + \psi_2^* \Delta y_{t-2} + \ldots + \psi_{p-1}^* \Delta y_{t-p+1} + u_t,$$

in which the lag polynomial is $\psi^* = (\psi_1 + \psi_2 + \ldots + \psi_p) - 1$. The applicable test is now the ADF-test. When we examine cointegration, we test whether ε_t is I(1) or I(0) series. An applicable ADF-test would be as follows (Engle & Granger 1987):

$$\Delta \hat{e}_t = \psi^* \hat{e}_{t-1} + \sum_{i=1}^{p-1} \psi_i^* \Delta \hat{e}_{t-i} + \mu + \delta t + \omega_t, \quad \omega_t \sim IID\ (0,\sigma^2).$$

In addition to the quantitative econometric analysis, qualitative analysis in the form of 10 theme interviews was made to identify the attitudes of the various parties operating on the grain market to futures markets strategies and the utilization of these on the Finnish grain market in connection with contracts with fixed prices (forward contracts).

4. Estimation results

In the following we present key estimation results of the different forms of the error correction models in the cointegration analysis between Finnish and CBOT grain price series. Although we found in the beginning quite clearly, even if the unit root testing remained somewhat undetermined, that the Finnish prices are stationary and Chicago prices mainly nonstationary, we proceeded to estimate cointegration to achieve better knowledge of the possible degree of cointegration. For wheat, from the open form of the ECM for the ADL model (Table 1), we can conclude that the price series of wheat of Finland and wheat of the U.S. are not cointegrated, implying that Chicago prices do not have a long run effect on Finnish wheat prices. The long run coefficient of Chicago wheat is insignificant (t-value 1.398). The one period lagged ECM-wheat looks significant (t-value –3.880 in the closed form) indicating that wheat is a stationary series.

Table 1. ECM for Finnish (F) and Chicago (C) wheat prices (open form; D means first differences, L logarithmic forms and _i # of lags of variables; observations 3-104).

Indep. variable	coefficient	std error	t-value	p-value
Intercept	0.82243	0.21419	3.840	0.0002
DLwheatF_1	0.11338	0.097811	1.159	0.2493
DLwheatF_2	0.16869	0.093021	1.813	0.0730
DLwheatC	-0.11969	0.042679	-2.804	0.0061
DLwheatC_1	0.11542	0.044683	2.583	0.0113
DLwheatC_2	-0.033539	0.045736	-0.733	0.4652
LwheatF_1	-0.19796	0.050035	-3.956	0.0001
LwheatC_1	0.015901	0.011372	1.398	0.1654

$R^2 = 0.262969$; $F(7, 93) = 4.7403$ [0.0001]; $= 0.017526$; DW = 1.94
RSS = 0.02856608411 for 8 variables of 101 observations

For oats, the closed form of the ECM shows clear cointegration between the Finnish and Chicago prices (one period lagged ECM-oats has t-value –3.453). In the open form ECM (Table 2) the long run coefficient of Chicago oats is not significant, which indicates, in turn, that there is no clear cointegration between the price series. However, this result also implies that the price series of oats show more signs of cointegration than those of wheat. As Finnish oats is exported to the U.S. and oats is not an intervention grain in the CAP, the Finnish and Chicago oats prices may well have some interdependence, at least more than wheat prices. Although there was non-existent or only weak cointegration between the Finnish and Chicago prices, the futures prices for wheat and oats in Chicago were cointegrated in 1995 and 1996, and in principle it was possible to utilize the wheat exchange of Chicago in order to hedge the transactions concerning Finnish oats.

Table 2. ECM for Finnish (F) and Chicago (C) oats prices (open form; D means first differences, L logarithmic forms and _i # of lags of variables; observations 4-104).

Indep. variable	coefficient	std error	t-value	p-value
Intercept	0.76545	0.25231	3.034	0.0031
DLoatsF_1	0.38082	0.086546	4.400	0.0000
DLoatsF_2	-0.31534	0.092811	-3.398	0.0010
DLoatsC	-0.056350	0.040451	-1.393	0.1669
DLoatsC_1	0.014695	0.040506	0.363	0.7176
DLoatsC_2	0.064356	0.040297	1.597	0.1137
Loats_1	-0.19943	0.066431	-3.002	0.0034
LoatsC_1	0.022289	0.011958	1.864	0.0655

$R^2 = 0.396794$ $F(7, 93) = 8.7395$ [0.0000] $= 0.0189465$ DW = 1.90
RSS = 0.03338412231 for 8 variables of 101 observations

5. Conclusions

In the econometric cointegration analysis we found that the Finnish prices are stationary and the prices in the United States are nonstationary. These results are quite clear, even if the unit root testing remained somewhat undetermined. By estimating error correction models it was observed that the cash prices for oats and wheat in Finland are not cointegrated with the corresponding futures prices in Chicago, although there were weak signs of cointegration for oats prices. These findings can be interpreted as quite expected and real, because the EU prices are influenced by administrative decisions within the CAP, whereas the prices in Chicago depend on factors related to the local, national and international demand and supply and market situation.

Although the EU membership brought major changes to the Finnish grain markets, they have still been in a quite stable situation indicating that the acquisition of, for example, futures positions only from the CBOT would involve too high risks on the Finnish grain market, because the cash prices for oats and wheat in Finland do not move in the same direction as the futures prices of the corresponding grains at the CBOT, i.e. the price series are not cointegrated. Yet, farmers may still benefit from the price peaks in the CBOT through options or, when the buyer agrees to this, through a price guarantee based on the futures, even if the prices and reasons for the prices differ from each other. Instead, the futures prices for wheat and oats in Chicago were cointegrated in 1995 and 1996, and in principle it would be possible to utilize the wheat exchange of Chicago in order to hedge the transactions concerning Finnish oats. Because the Finnish grain prices represent stationary time series, the need for hedging against price variation is not, however, that great, and the utilization of the CBOT involves the type of risk described above.

The theme interviews of the Finnish grain market experts revealed that the possibilities to apply the grain exchanges of the U.S. in Finland are still quite limited. Many of the interviewees knew little of the futures and options, and it was also suggested that the farmers would feel a great deal of uncertainty in terms of such new concepts, although their actual purpose is to reduce risk and uncertainty. Consequently, the utilization of futures can be considered to involve too high risks at present, at least if used in a larger scale, even if in the case of wheat the profit during the research period could have been FIM 0.14 per kilo (grain price being about FIM 0.80/kilo). Such a change in the prices on the single market of the EU is very unlikely. The risk-free options involve less uncertainty, but the use of these costs FIM 0.02-0.05 per kilo, depending on the market situation. The expected returns on options are smaller than in the case of futures because the buyer of the option has to pay a premium.

As a whole, instead of examining only the common hedging strategies, the more practical purpose here was to assess the possibilities to use retroactive payments based on the return on futures and options on the Finnish grain market in connection with forward contracting at fixed prices. If the buyer and seller of the grains agreed on delivery at a fixed price, the uncertainty related to the grain prices would be reduced. Retroactive payments would be used to encourage farmers to make contracts with fixed prices. But because the grain supply in Finland has been relatively stable, except some severe crop failures also in the 1990s, it has not been necessary to carry on trade using the price guarantees on the basis of the price development at the CBOT. In the case of oats the futures contracts are easier to utilize because oats are being exported to the U.S. On the other hand, the futures position may become unprofitable due to the changes in the exchange rates only. If the fixed basic price were reasonable, a price guarantee based on the development of the futures prices at the CBOT would be good for the farmers, because price variations on the international market are both more likely and greater than on the grain market of the EU. The maximum profit from the imaginary futures position would have been FIM 0.14 per kilo (grain price being about FIM 0.80/kilo).

The present study was the first attempt to assess the applicability and feasibility of futures markets on the Finnish grain markets and as such it serves the purpose to increase knowledge of the operating principles and strategies in the use of futures and options. Moreover, the market conditions of agricultural commodities in Finland and the EU are also gradually changing to the direction, especially due to the Agenda 2000 CAP reforms and WTO negotiations for further trade liberalization, in which futures markets become more and more feasible and important instruments.

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