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Whole sales market for fresh potatoes in Finland

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The study estimates a conditional mean and conditional variance model for producer prices of fresh potatoes. The results suggest that potato price movements are volatile exhibiting a symmetric and non-stationary process. Prices respond symmetrically to exogenous shocks and the shocks are, thereafter, predicted to prevail in prices to the end of the marketing year. The persistency of the price shocks makes potato price movements unpredictable and, therefore, increases price risks of holding potato inventories. The estimates indicate elastic price response with respect to annual potato yield shocks. A ten percent yield increase is predicted to decrease prices by 20%. The information on inventory levels is included in prices and this information is not increased by surveying the inventory levels. Because of the elastic price response, the largest risk for a farmer is an exceptionally large total yield of potatoes. Information on the aggregate potato yield, which arrives during the growing season, will be quickly incorporated in prices. Therefore, pre-harvest hedging strategies are more efficient than after-harvest hedging strategies in managing potato price risks.

Key words: potato market, producer prices, volatility, stationarity

Introduction

The market for fresh potatoes is volatile because the demand for potatoes is inelastic and the supply exhibits large annual shocks (e.g. Kuhmonen 1994). Potato price movements also escalate in the supply chain such that producer prices are more volatile than retail prices (Young II et al. 1997). Particularly, in Finland the annual yield variations alone cause such large supply shocks that market clearing requires large price changes at the farm gate. Market volatility is an important problem for potato growers because it significantly contributes to producer uncertainty and increases risks. Production costs are increased because risk is always a cost. In Finland production costs of potatoes are, already for climatic reasons, far above the costs in the neighboring EU countries, as in Sweden and Denmark.

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The market for potatoes was liberalised as a result of Finland's entry into EU when the border controls enhancing high domestic prices were abolished. Spatial market integration between Finland and other European countries has directly increased competition particularly in the market for processed potato products and industry potatoes, i.e. potatoes supplied to large industrial processors. The local markets for fresh potatoes are affected indirectly by spill-over effects in the market for the processed potato products. An example of these spill-over effects is that increased imports of the processed potato products decrease demand for domestic industry potatoes which, in turn, strengthens the supply for domestic fresh potatoes. Trade liberalisation is, therefore, expected to have important implications in the market for fresh potatoes, even if these markets have been, at least traditionally, for a significant part local.

Local potato markets can further be characterized by even a smaller number of buyers than suppliers. Suppliers are also less organized than buyers. Less than 10% of Finnish potato production is horizontally co-ordinated by organised groups of growers, as producer co-operatives (Runsten 1999). It may therefore be suspected that retailers can use their market power and potential imports as a threat to unorganised local suppliers when bargaining contracts for potato shipments. Asymmetric bargaining power between potato growers and local retailers would imply asymmetric price response to the exogenous supply shocks.

Increased competition and decreased prices are compensated to potato growers by direct subsidies, introduced after Finland joined the EU. Nevertheless, most farmers have yet to adjust to the new market environment in order to maintain an adequate income level. Succesful adjustment can be promoted by market information that can be utilized in production, investment, and marketing decisions. But currently we lack statistically tested quantitative information on price movements and price volatility of the Finnish potato market. An efficient knowledge accumulation, built also on the experience on past market behavior, requires statistically tested information on how Finland's entry to the EU changed this market.

The goal of this paper is to estimate a conditional mean and conditional variance model for producer prices of fresh potatoes. The mean and variance are conditioned on current information, such as current prices.

This paper is structured as follows. Subsequent section explains the autoregressive conditional heteroskedasticity (ARCH) model and its variations, used in estimation. Then, the text moves on to present the data and empirical results. The last section gives concluding discussion.

The econometric model

Conditional mean

The conditional mean process is constructed as an autoregressive, AR(k), model for logarithms of potato producer prices ($ln\ p_t$) with k denoting the number of lagged prices in the model. The standard AR-equation is augmented by seasonal effects $S(t)$ and a certain set of price shifters (explained below). The model is in the general form:

$$\ln p_{t+1} = \phi_0 + \sum_{i=0}^{k} \phi_{1+i} \ln p_{t-i} + \sum_{j=1}^{s} \alpha_j D_j \ln A_\tau + S(t) + \theta_1 D_I I_t + \theta_2 D_{EU} + \varepsilon_{t+1} \tag{1}$$

where ϕ, α, and θ are parameters and ε_{t+1} is an error.

When an exceptionally large yield is harvested the opening price quotations of that particular marketing year are expected to be below their long run averages. Therefore, the total potato yield harvested (A_τ) during the marketing year τ is expected to negatively affect the first $j=1,..,s$ price quotations at the beginning of each marketing year. D_j is a dummy variable having value one for the j^{th} price observation of each marketing year and otherwise it is zero. The yield

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information is expected to be gradually included in prices such that in a dynamically complete price process the annual yield information is fully included in prices.

Potato price movements have a strong cyclical component within marketing years because inventories can smooth the supply within a marketing year but not between the marketing years. After harvest, the prices are first expected to increase with time to cover the storage cost. But after the marketing year or at the end of the marketing year, prices are expected to decrease sharply because new harvest of early potato varieties will substitute for the potatoes in storage (Fig. 1). This seasonal variation is controlled for including a quadratic polynomial $S(t)=\xi_1 t_s+\xi_2 t_s^2$, in the price equation (1). Here $t_s=1,\ldots,T$ denotes time within the marketing years, T is the length of the inventory period, and ξ's are parameters.

D_I and D_{EU} are dummy variables. D_I receives value one at the time when the survey results on the amount of current potato inventories I_t are announced. These potato inventories are announced twice a marketing year. The potential regime shift, caused by Finland's entry to the Europen Union (EU) is controlled for by D_{EU}. It has value zero prior to 1995 and, thereafter, value one.

Stationarity of the price process is first tested by the Augmented Dickey-Fuller (ADF) tests, using non-stationary unit root process as the null-hypothesis (Dickey and Fuller 1979). For obtaining the ADF-test statistics, the conditional mean process was re-parametrisized and estimated in the form

$$\ln p_{t+1} = \phi_0 + \rho \ln p_t + \sum_{i=0}^{k} \mu_{1+i} \Delta \ln p_{t-i} + \sum_{j=1}^{s} \alpha_j D_j \ln A_\tau + S(t) + \theta_1 D_I I_t + \theta_2 D_{EU} + \varepsilon_{t+1} \qquad (2)$$

where $\mu_{1+i} = \left(\sum_{i=0}^{k} \phi_{1+i} \right) - 1$ and ρ is a parameter.

These tests are known to have low power problems particularly in small samples when the series has a structural break (Leybourne and Newbold 2000). A potential structural break caused by Finland's entry to the EU is controlled for either by the dummy variable D_{EU} or by estimating the model using the data after Finland joined EU, i.e. 1995 and thereafter. The other low power problems of the ADF-tests are taken into account by testing the series by the test developed by Kwiatkowski, Phillips, Schmidt and Shin (1992). This test has stationarity as the null hypothesis and it is later referred to as the KPSS-test.

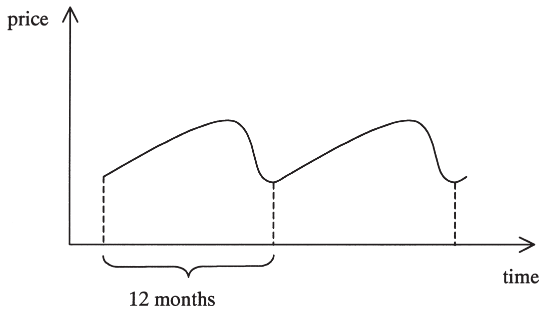

Fig. 1. Seasonal cycles in the potato prices.

The purpose of both of these tests is to give signals on statistical grounds whether price shocks will persist in the future prices (i.e. prices are non-stationary) or whether they will gradually dampen such that prices tend to move back towards their steady state after a shock (stationary prices). Stationarity of the conditional mean process plays a crucial role in price expectations and in searching for optimal timing of potato marketing.

If the error ε turns out non-stationary having a unit root in (1) and (2), then the unit root is imposed in a difference form

$$\Delta \ln p_{t+1} = \phi_0 + \sum_{i=0}^{k} \mu_{1+i} \Delta \ln p_{t-i} + \sum_{j=1}^{s} \alpha_j D_j \ln A_\tau + S(t) + \theta_1 D_I I_t + \theta_2 D_{EU} + \varepsilon_{t+1} \qquad (3)$$

where $\Delta lnp_t = ln(p_t / p_{t-1})$ and the error ε is stationary.

To test for the asymmetric response of prices to exogenous shocks the error term was modified such that it follows a moving average (MA) representation of the form

$$\varepsilon_{t+1} = \eta_0 + \eta_1(D_+)\varepsilon_t + \eta_2\varepsilon_t + \upsilon_{t+1} \tag{4}$$

where D_+ is a dummy variable having value one if $\varepsilon_t > 0$ and zero otherwise, η's are parameters and υ is an independent and identically distributed (*i.i.d.*) error. Under the null hypothesis of symmetric response, $\eta_1 = 0$, the conditional mean follows the standard autoregressive moving average (ARMA(k,q)) form with $q = 1$, provided prices are stationary. If the price series exhibits a unit root, it is estimated as an autoregressive integrated moving average (ARIMA(k,d,q)) process with the order of integration (d) being one.

Conditional volatility

In the most general form, the conditional volatility is expected to follow

$$\sigma_{t+1}^2 = \psi_0 + \sum_{j=0}^{l} \psi_{j+1}\varepsilon_{t-j}^2 + \varphi D_{EU} + \beta_3 t_s + \beta_4 t_s^2 + u_{t+1} \tag{5}$$

where σ_{t+1}^2 is the conditional variance for the potato prices at time $t+1$ and ε_{t-j}^2 is the squared error in the conditional mean process lagged by j periods. The potential structural break caused by Finland's EU membership is expected to affect the volatility process. Thus, the volatility equation was augmented by the dummy variable D_{EU} when the full sample was used in estimation. The Greek letters ψ, φ, and β are parameters and u_{t+1} is an *i.i.d.* error.

Within a marketing season, the volatility of potato prices is expected to increase with time because the supply for potatoes is expected to get more inelastic towards the end of the marketing season (Fig. 2). This market characteristic is tested in the conditional volatility process having time constant volatility as the null hypothesis. The alternative hypothesis is time increasing volatility.

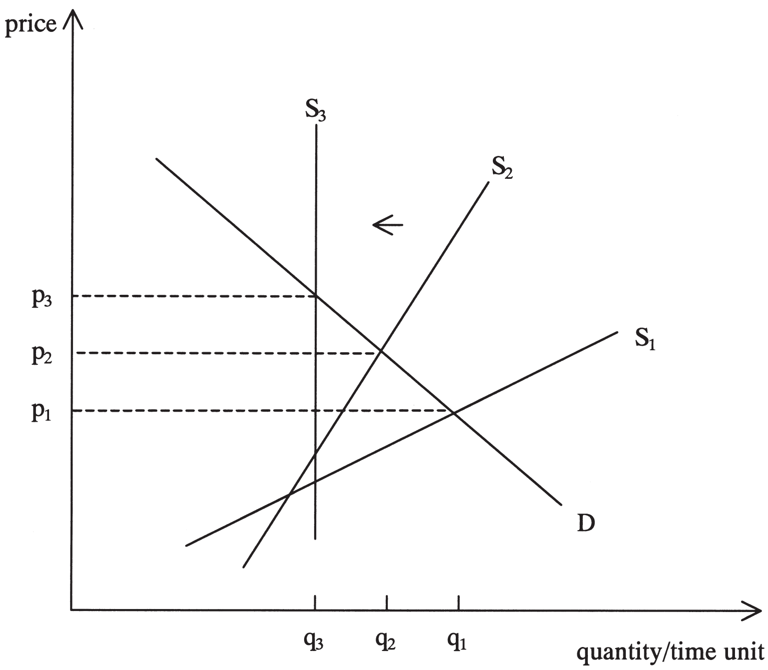

Fig. 2. The decreasing elasticity of supply within a marketing year. The subscripts denote passage of time.

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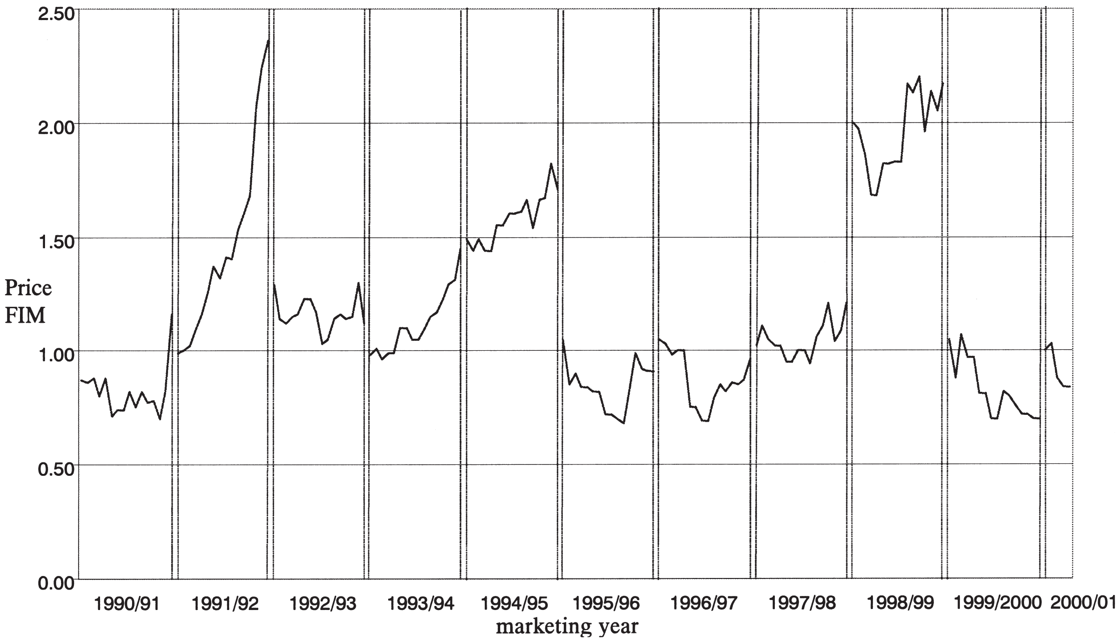

Fig. 3. Potato prices in 1990–2000 (Food and Farm Facts Ltd 2000).

The data

The data are farm gate prices for unpackaged fresh potatoes over marketing years. The marketing year used in this study starts after harvest in October (week 43) and ends at the end of May (week 22) due to the availability of the data. The length of the marketing year is, thus, eight months. Thus, the data span the period January 1990 – December 2000 having 11 years * 16 two week observations i.e. 176 observations in total (Fig. 3). The price observations are trade volume weighted averages for first class fresh potatoes during a two week period. The data represent about half of the volume of all fresh potatoes traded in Finland. The price and yield data are from Food and Farm Facts Ltd (2001).

With two exceptions, the price tends to increase with time towards the end of the marketing year. Particularly, in spring 1992, the price goes up, because the total potato yield harvested in Fall 1991 was small and a shortage of potato supply was observed. In 1998/99 the price is exceptionally high also because one of the most serious crop damage over a decade was experienced. The price movements cannot, nevertheless, be characterised as systematic and easily predictable. In only three out of ten years, for example, the data show the quick price decrease at the end of the season. Thus, the data show the high volatility of potato market.

Results

Conditional mean

The parameter estimates of the conditional mean process in the symmetric ARCH-model of equation (2) are reported in Table 1. The significance of the lagged price differences indicate that the conditional mean process has a memory of two time periods. Note that the lagged price differ-

Table 1. Parameter estimates of the conditional mean process (Equation 2). Standard errors are in parenthesis.

	Full sample [a]		EU period (1995–) [b]	
	1 lag ($i = 0$)	2 lags ($i = 1$)	1 lag ($i = 0$)	2lags ($i = 1$)
Intercept (ϕ_0)	–0.0438	–0.0431	–0.0713**	–0.0715**
	(0.0248)	(0.0248)	(0.0000)	(0.000)
Lagged price (ρ)	0.9986**	1.0024**	0.9992**	1.0007**
	(0.0229)	(0.0236)	(0.0253)	(0.0251)
Lagged price difference (μ_1)	–0.1837*	–0.1977*	–0.1971	–0.2043
	(0.0872)	(0.0897)	(0.1087)	(0.1076)
Twice lagged price diff. (μ_2)	–	–0.0598	–	–0.0316
		(0.0923)		(0.1046)
Yield effect on first price (α_1)	–1.8858**	–1.8850**	–2.3277**	–2.3285**
	(0.2620)	(0.2635)	(0.3232)	(0.3241)
Yield effect on 2nd price (α_2)	–0.1272	–0.1208	–0.2980	–0.2957
	(0.2576)	(0.2583)	(0.3243)	(0.3249)
Within season trend (ξ_1)	0.0074	0.0071	0.0100	0.0098
	(0.0063)	(0.0063)	(0.0079)	(0.0079)
Within season trend squared (ξ_2)	–0.0001	–0.0000	–0.0002	–0.0002
	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Inventory surveys (θ_1) [c]	0.0023	0.0009**	–0.0019	–0.0033
	(0.0173)	(0.0000)	(0.0229)	(0.0222)
Dummy variable for EU (θ_2)	–0.0209	–0.0221	–	–
	(0.0138)	(0.0139)		

a) Number of observations is 176.
b) Number of observations is 96.
c) Equal effects were imposed on the inventory surveys that were announced twice a year, since they did not significantly differ from each other.
An asterisk (*) denotes statistical significant at 5% level. The double asterisks (**) denote statistical significant at 1% level.

ence includes twice lagged price level. The same length of the statistically significant memory is obtained by estimating the standard ARCH model in price levels. The result supports the view that market information included in the current prices and current prices lagged by one period cannot be increased by past prices. In other words, the conditional mean process is dynamically complete when it is conditioned on current and once lagged prices.

ADF-tests were carried out with two specifications. The first specification is under a condition that the true process does not have a drift ($\phi_0 = 0$) whereas the second specification assumes that the true process has a non-zero drift ($\phi_0 \neq 0$). These test statistics are greater than the critical values at 5% risk level (Table 2). The test statistics are also stable over different number of lagged prices. The statistical model is still allowed to have non-zero ϕ_1 to get a zero mean for the error term in the sample. The null hypothesis of non-stationary unit root process is not, therefore, rejected in favour of stationary process at a reasonably low 5% risk level.

To complete the testing of the stationarity properties, the null hypothesis was then reversed to be stationary around a deterministic trend (trend stationarity). Within season trend was included in the tests because it is expected that prices increase with storage costs within a harvest year. The KPSS-test statistics on this hypothesis are greater than the critical values at

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Table 2. ADF and KPSS test statistics. Estimated in Equation 2.

	Full sample		EU period (1995–)	
	1 lag ($i=0$)	2 lags ($i=1$)	1 lag ($i=0$)	2 lags ($i=1$)
ADF, without drift	–0.9583	–0.1638	–0.3030	–0.1991
ADF, with drift	–0.2082	0.3359	–0.0642	0.0544
KPSS, with trend	0.2826	0.1970	0.3973	0.2757

ADF test = augmented Dickey-Fuller test. KPSS test = Kwiatkowski, Phillips, Schmidt & Shin test. ADF critical values are at the 5% level without drift –7.9 and with drift –13.7. Non-stationarity is rejected if the entry is greater than the critical value. KPSS critical values for trend stationarity are 0.146 at 5% level and 0.119 at 10% level. Stationarity is rejected if the entry is greater than the critical value.

Table 3. Parameter estimates of the conditional mean process. The unit root imposed (Equation 3). Standard errors are in parenthesis.

	Full sample [a)]		EU period (1995–) [b)]	
	1 lag ($i=0$)	2 lags ($i=1$)	1 lag ($i=0$)	2 lags ($i=1$)
Intercept (ϕ_0)	–0.0438	–0.0431	–0.0713**	–0.0715
	(0.0248)	(0.0249)	(0.0000)	(0.2847)
Lagged price difference (μ_1)	–0.1851*	–0.1950*	–0.1978	–0.2035
	(0.0844)	(0.0857)	(0.1053)	(0.1044)
Twice lagged price diff. (μ_2)	–	–0.0575	–	–0.0310
		(0.0893)		(0.1090)
Yield effect on first price (α_1)	–1.8859**	–1.8849**	–2.3278**	–2.3285**
	(0.2620)	(0.2636)	(0.3231)	(0.3242)
Yield effect on 2nd price (α_2)	–0.1246	–0.1251	–0.2963	–0.2972
	(0.2545)	(0.2542)	(0.3199)	(0.3203)
Within season trend (ξ_1)	0.0075	0.0071	0.0100	0.0098
	(0.0062)	(0.0063)	(0.0078)	(0.0079)
Within season trend squared (ξ_2)	–0.0001	–0.0000	–0.0002	–0.0002
	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Inventory surveys (θ_1) [c)]	0.0023	0.0009	–0.0019	–0.0034
	(0.0172)	(0.0176)	(0.0239)	(0.0224)
Dummy variable for EU (θ_2)	–0.0209	–0.0221	–	–
	(0.0138)	(0.0139)		

a) Number of observations is 176.
b) Number of observations is 96.
c) Equal effects were imposed on the inventory surveys that were announced twice a year, since they did not significantly differ from each other.

An asterisk (*) denotes statistical significant at 5% level. The double asterisks (**) denote statistical significant at 1% level.

5% level and the tests reject the null hypothesis of stationarity around a deterministic trend (Table 2). Thus, the data suggest that the conditional mean process is non-stationary with a unit root. Therefore, the form imposing the unit root process (5) is used for testing the model characteristics further (Table 3).

Non-stationary conditional mean process has the property that after an exogenous price shock is observed, it is expected to prevail in future prices. Non-stationarity of conditional mean process has important implications to timing of potato marketing because a shock observed in the market will not gradually dampen down with a passage of time. For example, if a supply shock decreases the price, it is expected to stay below its long run mean (adjusted by the price shifters such as seasonal effects).

The estimates on the logarithm of the total yield (A_τ) indicate both statistically significant and economically elastic effects. A ten percent yield increase is expected to decrease steady state prices by 20%. This aggregate effect consists of two components. The opening price quotation after harvest is predicted to decrease by 18.8% and the second price quotation is further decreased by 1.2%. It was also tested whether the yield shock affects the third price quotation but this effect turned out non-significant. Thus, the two first price quotations of the marketing year include all the information of the annual yield effects.

The parameters measuring seasonal effects confirm that prices increase linearly with time over the marketing year. Nevertheless, the predicted price increase is not large enough to fully cover all storage costs. The data neither support the expectation that prices increase fastest in early fall, then stabilise and turn decreasing in spring. It may be that the price decrease occurs so late that it was not spanned by the sample available in this study. The low marginal returns to storage suggest that most storage costs are sunk. Storage is nevertheless important in meeting consumer demand over the full marketing season and getting an access to market. Otherwise, there could be potential to profit through free riding. Free riding refers to selling all potatoes at harvest without investing in storage.

The survey results on the amount of potato inventories got insignificant estimates suggesting only negligible price effects. The low statistical significance and the small magnitude of the parameter estimates indicate that the survey results on the inventory levels may not increase market information. The information on inventory levels is included in prices. This result is also consistent with the foundation that the yield shocks are quickly incorporated in prices.

The effects of EU entry on the mean prices suggests only a small one time persistent price decrease. The result is consistent with the view of Potato growers association (Suomen Perunaseura 1997) such that the Finnish potato market was liberalised before Finland's entry to EU. Market liberalisation started already in 1994 when a tariffs system was substituted for the stringent licensing scheme in foreign trade for potatoes. The tariffs increased trading costs and decreased the amount of trade, but they allowed for transmitting price information better than the licensing scheme. The domestic potato producers were also competing with each others since the domestic potato supply was not controlled by any production rights (such as quotas in the milk sector). Thus, spatial potato market integration between Finland and other European markets started before the formal accession date.

The parameter estimate used to identify potential asymmetric response of prices to exogenous shocks did not differ significantly from zero (Table 4). The data do not, therefore, support the claim that local retailers have market power to dump prices when the supply is strong and increase prices only moderately when the supply is weak.

Conditional volatility

Parameter estimates of conditional volatility models (5), estimated jointly with (3), are given in Table 5. The data do not support the phenomenon that price volatility significantly increases as time passes by within a marketing season. The results suggest however that the entry to the EU decreased price volatility by almost 10%. In other words, spatial market integration has been successful in stabilising the local potato markets.

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Table 4. Moving average presentation for the error term. Estimated in Equation (4). Standard errors are in parenthesis[a)].

	Full sample	EU period (1995–)
Intercept (parameter η_0)	0.00995	0.00270
	(0.0103)	(0.0141)
Lagged positive error (parameter η_1)	–0.20883	–0.1049
	(0.2173)	(0.2664)
Lagged error (parameter η_2)	0.02180	–0.0020
	(0.1268)	(0.1554)

a) Conditional mean estimated in Equation (3) with $i = 1$.

Table 5. Parameter estimates of the conditional volatility process. Estimated in Equation (5). Standard errors are in parenthesis[a)].

	Full sample		EU period (1995–)	
	1 lag ($i = 0$)	2 lags ($i = 1$)	1 lag ($i = 0$)	2 lags ($i = 1$)
Intercept (ψ_0)	–4.5979**	–4.5865**	–4.9429**	–4.9352**
	(0.2500)	(0.2536)	(0.4034)	(0.4213)
Within season trend (β_3)	–0.0034	–0.0054	–0.0163	–0.0173
	(0.0212)	(0.0219)	(0.0340)	(0.0342)
EU (φ)	–0.4263	–0.4211	–	–
	(0.2237)	(0.2239)		

a) The parameters attached to lagged and squared errors (ψ_{j+1}) and to the squared within season trend (β_4) could not be identified in estimation.
The double asterisks (**) denote statistical significant at 1% level.

Concluding remarks

In this paper conditional mean and conditional volatility for the prices of fresh potatoes in Finland has been estimated over the period of January 1990 – December 2000. The results support the view that potato price movements exhibit a symmetric and non-stationary process. In other words, prices respond symmetrically to exogenous shocks and the shocks are, thereafter, predicted to prevail in prices to the end of the marketing year. This result has important implications for optimal potato marketing decisions. After a negative price shock it is not optimal to postpone potato sales accounting on prices that gradually increase towards their long run average. The persistency of the price shocks will make future prices unpredictable and increase price risks of holding potato inventories. These risks will increase the value of selling now relative to the value of waiting and holding the inventories, provided potato sales are irreversible such that speculation is too costly of being feasible.

The estimates on the total yield (A_τ) suggest that prices and returns to storage decrease elastically with total yields. A ten percent yield increase is expected to decrease prices and the returns to storage, in average over the marketing season, by 20%. A positive supply shock driven up by an exceptionally good yield will, therefore, significantly shift welfare from producers to consumers. Producers' marketing organisations could have potential to substantially increase producer welfare by buying excess supply out from the market when an exceptionally good harvest is experienced. Nevertheless, the antitrust legislation in EU does not allow for these marketing organisations in the potato sector. Marketing organisations are allowed, for example, for carrot and tomato producers.

The results support the view that the potato market was, in practice, liberalised before Finland's accession to the EU. Information included in the current and once lagged prices cannot be significantly increased by past prices or surveying inventory levels. Information on inventory levels has already been in the market before the survey results have been announced. The data do not therefore provide evidence against efficient market. The term efficient market refers to a market that incorporates efficiently expectations and information in prices. Reference is not made to an allocationally and Pareto-efficient market. For more details see the discussion in Campbell et al. (1997, Chapter 1.5).

The estimated seasonal effects predict that the prices increase linearly with the passage of time within a marketing year. Nevertheless, the low rate of the price increase does not fully cover all storage costs. This result suggests that storage is a prerequisite for getting an access to the potato market but during the marketing season most storage costs are sunk and, therefore, not covered by marginal returns to keep potatoes in storage. Particularly, when an exceptionally large yield is harvested it is not optimal to delay potato sales if they are to be sold without contract commitments, in open cash market. Free-riders having no storage and selling all potatoes at harvest could make the highest profit, provided they could have access to market.

Overall, the results indicate that pre-harvest hedging strategies are more efficient than after-harvest hedging strategies in managing potato growers' price risks, because the between-year price variation contributes to larger uncertainty than the within-year price variation. After the yield information is in the market, it is either too late to hedge (large yield and low price) or hedging is not needed (low yield and high price). Thus, farmers could efficiently manage price risks by locking in a share of the potato shipment contracts already in spring when there is no information on the yield. Note that there is also a risk from selling short if a low yield is observed.

The elastic price response to the annual yield level calls also for further research to develop efficient pre-harvest risk management strategies, for example, through risk sharing contracts and hedging through the potato derivatives traded in the Amsterdam Stock Exchange.

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SELOSTUS

Suomen ruokaperunamarkkinoiden toimivuus

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Tutkimuksen tavoitteena oli lisätä tietoa Suomen ruokaperunamarkkinoista, edesauttaa markkinoiden toimivuutta ja parantaa markkinaosapuolten, etenkin ruokaperunantuottajien, kilpailuasemaa. Tutkimuksessa estimoitiin samanaikaisesti tuottajahintojen ehdollinen keskiarvo ja ehdollinen varianssi.

Tutkimustulosten mukaan nykyinen ja kaksi viikkoa sitten toteutunut hinta selittävät tulevaa hintaa. Tätä vanhemmat hinnat eivät lisää markkinatietoa. Tehokkailla markkinoilla myös tieto varastomääristä sisältyy hintoihin. Ruokaperunan hinnan todettiin olevan erittäin joustavaa kokonaissadon suhteen. Kokonaissadon kasvu 10 prosentilla laskee ruokaperunan hintaa 20 prosenttia. Kokonaissadon muutokset välittyvät tuottajahintoihin kahden ensimmäisen toteutuneen hinnan kautta. Hintashokit ovat symmetrisiä, mikä tarkoittaa sitä, että hinnat muuttuvat yhtä joustavasti tarjonnan vahvistuessa ja heikentyessä. Tulosten perusteella kauppa ei näytä käyttävän markkina-asemaansa väärin perunan hinnoittelussa. Hintashokit ovat pysyviä, joten hintojen yllättäen laskiessa tai noustessa, ne eivät todennäköisesti enää palaa ennalleen saman varastointikauden aikana.

Perunamarkkinoiden toimivuutta voitaisiin parantaa johdannaiskaupan, laajemman sopimustuotannon ja aktiivisemman tuottajien järjestäytymisen avulla. Suurin riski perunantuottajalle perunan hinnan joustavuuden takia on poikkeuksellisen suuri perunan kokonaissato. Siksi perunantuottajien tulisi suojautua hintariskeiltä jo keväällä ennen perunan istutusta. Sadonkorjuun jälkeisillä toimenpiteillä ei hintariskeihin voida enää vaikuttaa.