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## **Vertical Price Transmission in the International Fresh Fruit and Vegetable Supply Chain: Israeli Grapefruit Exports to the EU after Export Liberalisation**

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### **Abstract**

We investigate competitiveness and price behaviour in the Israeli citrus export sector following the removal of the government export monopoly and the entry of private export companies in 1991. We identify asymmetric price transmission for some exporters even in the liberalized market which only became symmetric when a minimum price agreement was established by the government in the grapefruit market. Our findings indicate that citrus growers' seasonal losses resulting from asymmetric price transmission amounted to as much as 4.0% of their total revenues, and a much larger share of their profits. This result is consistent with the hypothesis that the observed asymmetry in price transmission was caused by Israeli exporters exerting market power over Israeli citrus growers. Concluding, our analysis demonstrates that the liberalization of the Israeli grapefruit export market by the abolishment of the government marketing board alone was not sufficient to establish a competitive market. Rather, an additional temporary government market intervention was necessary to foster competitive pricing behaviour by the exporting companies vis-à-vis the Israeli grapefruit growers.

**Keywords:** international fresh fruit and vegetable supply chain, vertical price transmission, export liberalization, market power, Israel, citrus

**JEL:** F13, Q13, Q17, Q18

## 1 Introduction

The Israeli citrus export sector was liberalized in 1991 in the light of decreasing Israeli citrus exports and shrinking profitability of citrus growing. The export monopoly of the government citrus marketing board was abolished and the board ceased export operations. Market entry of other trading companies was enabled with the aim of increasing efficiency and competitiveness in the citrus export sector. Four private companies started to export citrus mainly to the EU market in the 1991/92 season. However, fresh fruit and vegetable (FFV) export sectors are many times characterized by low competition despite free market entry because transparency regarding grower price determination is often very low. In particular, business in the international FFV supply chain is characterised by oral contracts. Typically, growers supply their produce to exporting companies on consignment and are thus not provided with information on the grower price until after the produce has been sold in the export market. Prices achieved in the export market are also influenced by the quality of the produce at the point of time of arrival in the export market. This is determined by on-site inspection which is beyond growers' control. Thus, even liberalized international FFV trade is especially susceptible to the abuse of market power. To protect growers against the abuse of market power by exporting companies, the Israeli government intervened in the newly liberalised market by subsidizing the use of standardized contracts instead of oral agreements between exporting companies and grapefruit exporters in the 1994/95 and 1995/96 seasons (KACHEL, 2003; KACHEL et al., 2003).

Against this background we investigate the competitiveness of the Israeli citrus export sector in the aftermath of liberalization. Did the removal of the export monopoly of the government citrus marketing board and the entry of private exporting companies lead to competitive price behaviour? We aim to determine whether the private exporting companies exert market power vis-à-vis citrus growers. It is often hypothesised that imperfect competition will manifest itself in asymmetric price transmission (APT; e.g. MEYER and VON CRAMON-TAUBADEL, 2004; RAPSOMANIKIS et al., 2006). In most cases, it is predicted that market power will lead to positive asymmetric price transmission whereby margin-squeezing price changes will be transmitted faster and more completely than margin-stretching changes. We test for APT in international<sup>1</sup> grapefruit trade from import markets in the EU to growers in Israel, and for possible structural changes in the nature of any APT that we find over the course of the 1990s, in the framework of a vector error correction model. Such studies are scarce since

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<sup>1</sup> In contrast, previous studies of asymmetric price transmission in the FFV sector analyse price transmission within national marketing channels (e.g. WARD, 1982; PICK, KARRENBROCK and CARMAN, 1990; BROOKER, EASTWOOD, CARVER and GRAY, 1997; WILLETT, HANSMIRE and BERNARD, 1997; GIRAPUNTHONG, VANSICKLE and RENWICK, 2003; RICHARDS and PATTERSON, 2003).

analysing seasonal FFV data within time-series models faces the problem of seasonal gaps in the data implying that a continuous price time series does not exist. One exception is SANTERAMO and CIOFFI (2010) which focuses on inter-country price transmission in tomato and cauliflower markets within the EU.

Positive asymmetric transmission is present if Israeli exporters transmit price increases in the EU import market for grapefruits at a lower speed than price decreases, implying that the exporters' margin increases whereas the growers' margin decreases<sup>2</sup>. However, only few theoretical models explicitly link the exercise of market power to specific forms of asymmetric price transmission<sup>3</sup> (MEYER and VON CRAMON-TAUBADEL, 2004). Furthermore, APT might be caused by factors other than market power. That notwithstanding, the Israeli grapefruit exports provide a case study that is well suited to isolating the link between market power and APT. First, as described in the following section, exports are in the hands of a few firms so imperfect competition is possible and might be reflected in APT. Second, since the grower price of the Israeli grapefruits exported to the EU is determined *ex post* only after the products are sold in the export market, and FFV products are highly perishable, several other factors that might cause APT, such as adjustment and menu costs, caused by adjusting a firm's prices to a change in the price or quantity of inputs or outputs and inflation, can be disregarded. Furthermore, asymmetry in price transmission cannot result from market intervention by the EU since the EU entry price system does not apply to grapefruits.<sup>4</sup> Third, the post-liberalisation period that we study includes two important developments that may have changed exporters' pricing behaviour. These developments are the promotion of a minimum price agreement in 1994/95 and 1995/96, and a 30% decrease of the EU import price over the period underlying this analysis.

LLOYD et al. (2006) and LLOYD and MORGAN (2007) point out that asymmetric price adjustment might result from an increase in marketing costs inducing a rise in the price spread even in a competitive market environment. In this study we observe relatively increasing marketing costs caused by the decline in the French import price during the underlying time period. We explicitly account for this by allowing for structural breaks in the cointegration regressions. Furthermore, the Israeli government's enforcement of a minimum price agreement in 1994/95 was designed to protect growers from the

<sup>2</sup> The EU imports grapefruits from several countries, e.g. USA, Turkey, Cyprus, South Africa (KACHEL, 2003).

<sup>3</sup> MCCORRISTON et al. (1998), MCCORRISTON et al. (2001), WELDEGEBRIEL (2004) and LLOYD et al. (2006) develop models of vertical price transmission in the presence of market power and non-constant returns to scale. However, these models explore implications for long run elasticities of price transmission and not for APT.

<sup>4</sup> For an overview on the EU entry price system see GOETZ and GRETHE (2009).

abuse of market power by Israeli exporters. This provides strong evidence that market power was indeed exerted by exporters in the first years after liberalization.

Government export marketing boards in the agricultural sector have been reformed or even abolished particularly in developing countries. Yet, the expected income gains to farmers did not accrue in many cases. For example, MATHER and GREENBERG (2001) analyse the effects of privatisation of the citrus marketing board of South Africa in 1994, where new exporters entered the market in 1996. They find that liberalisation shifted market power from the former export monopoly and cooperative packing stations to privately-owned large citrus enterprises. WILCOX and ABBOTT (2004) use a conjectural variations approach and find evidence of market power exerted by exporters and processors over growers in the post-liberalized cocoa bean market in the Ivory Coast. For the cashew nut export sector in Mozambique MCMILLAN et al. (2002) find that the largest share of the benefits from removal of the export tax was captured by traders and little accrued to farmers. In their model of a concentrated developed country food market, SEXTON et al. (2007) show that even relatively small deviations from perfect competition can imply that the majority of the benefits from trade liberalisation accrue to the marketing companies and not to farmers.

The rest of this paper is structured as follows. Section two provides information on the liberalisation of the Israeli citrus export sector. Section 3 explains characteristic features of the data set and how they are accounted for in the empirical specification. The methodological concepts are explained in section 4 and empirical results are presented in section 5. Chapter 6 concludes and provides suggestions for future research.

## **2 Structure and Practices of the Israeli Citrus Export Sector**

Prior to 1991, Israeli fresh citrus fruits were exported exclusively by the parastatal Citrus Marketing Board of Israel (CMBI). The goal of liberalising the Israeli citrus export sector was to increase the citrus growers' income and to strengthen the efficiency of the Israeli citrus export marketing channel by establishing competition between exporting companies. The CMBI's citrus export activities were mainly taken over by four large companies. In the first 10 years after liberalisation, these companies accounted for over 90% of all Israeli citrus exports. In contrast, Israel's citrus production was fragmented with about 500 out of 3 000 citrus growers with groves larger than 10 ha accounting for roughly 80% of the citrus growing area and the remaining citrus growers with small groves accounting for the rest (KACHEL, 2003).

Tnuport, the largest grapefruit exporter in the 1990s, and Mehadrin had own packing stations and provided packing services prior to liberalisation. After liberalisation Tnuport and Mehadrin started to engage in providing citrus export services as well.

Mehadrin also owns citrus plantations and thus only partially buys citrus fruits from individual citrus growers. Agrexco, a company which had an export monopoly for fruit (other than citrus) and vegetables, started to engage in the export and packing of citrus fruits after liberalisation of the citrus sector. Exporters with own packing facilities did not provide packing services to other exporters which might have obstructed market entry. The fourth largest citrus exporter was Pardess, a cooperative of citrus growers.

The restricted number of exporters provides only limited opportunities for the citrus growers to choose between exporters. This makes it possible for the exporters to exert market power vis-à-vis the Israeli citrus growers by paying lower grower prices. In addition, the consignment system of the former monopoly was maintained after liberalisation. This induced the government, in the 1994/95 and 1995/96 seasons to intervene in the newly liberalised market by establishing a minimum price agreement for oranges to protect growers against the abuse of market power by exporting companies. According to this agreement, exporters qualified for a government subsidy if they signed written, standardised contracts with growers, guaranteeing a minimum grower price and stating the timetable of payments and conditions triggering additional payments to the growers. The minimum price agreement was extended to include grapefruits over most of 1994/95 export season and part of 1995/96 (KACHEL, 2003).

This study investigates whether the newly established companies in the Israeli citrus export sector have asymmetrically transmitted price changes to citrus growers implying short-run additional revenues to the exporters and losses to the citrus growers.

### 3 Dataset and Critical Issues

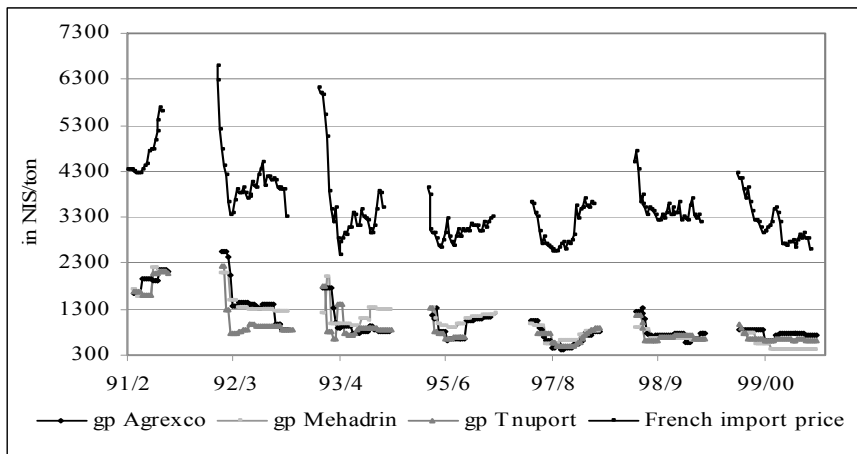
The analysis is based on weekly<sup>5</sup> grower price data for each of the three largest Israeli grapefruit exporting firms (Tnuport, Mehadrin and Agrexco), and the corresponding aggregated French import price for red 'Sunrise' grapefruits for the time period 1991/92 to 1999/00 (Figure 1).<sup>6</sup> Over the study period, Tnuport was Israel's largest red grapefruit exporter with a market share of 38%, followed by Mehadrin (28%) and

<sup>5</sup> BROOKER et al. (1997) point out that due to the perishability of FFV and the high volatility of supply, the planning horizon in the fresh produce marketing channel is short and pricing strategies can change several times per month. Therefore, at least weekly data is required to adequately capture price transmission in the FFV sector.

<sup>6</sup> The Israeli firm-level grower prices were surveyed by the Citrus Growers' Association of Israel. The grower prices are paid by exporters to Israeli growers for their grapefruits which are exported to different countries, primarily to the EU market. The French import prices were collected by a large French fruit import company by a telephone survey of the major fruit importers in France. The grapefruit import prices are aggregated over all grapefruit imports by France from USA, Turkey and Cyprus which compete with grapefruits originating in Israel in the EU market.

Agrexco (26%). Figure 2 shows the development of export shares for Tnuport, Mehadrin and Agrexco. The EU is Israel's primary export market for grapefruits. Between 1991 and 2000, the EU accounted for 75% to 90% of total Israeli red grapefruit exports, and France alone accounted for between 20% and 40% (C.L.A.M., various years).

**Figure 1. Firm-level Israeli grower prices (gp) for the three largest Israeli exporting companies and the French import price 1991/92 to 1999/00 (real NIS/t)**

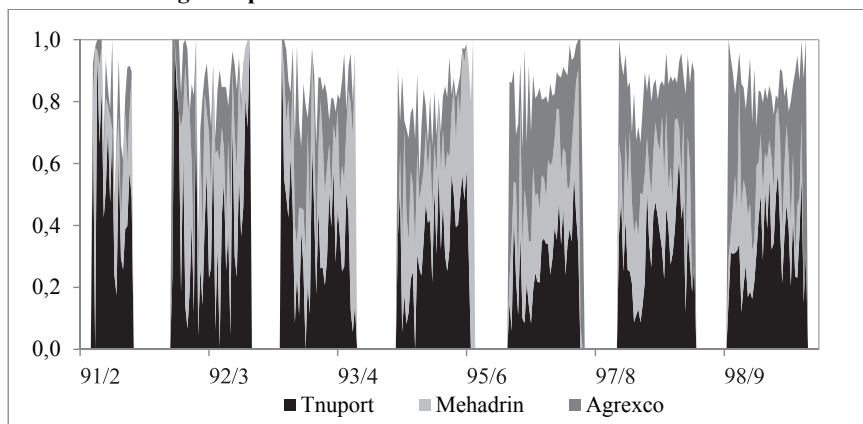


Source: own illustration data: POMONA (2008)

The Israeli firm-level grower prices for red grapefruits for export and the corresponding French import prices are weighted averages of the prices for different fruit sizes.<sup>7</sup> The Israeli grower prices and the French import prices are stated in New Israeli Shekel (NIS) per ton and deflated with the Israeli monthly consumer price index (2000=100; CBS Israel). The data set is balanced by including only those weeks for which grower price data is available for all three exporters, and contains altogether seven seasons with a total of 205 observations. In the context of this study, weekly data is sufficient to fully capture price transmission since fresh grapefruits are delivered from Israel to the EU once a week by ship during the harvest season.

<sup>7</sup> The Israeli grower prices are weighted with a standard size distribution for each season.

**Figure 2. Development weekly market shares (%) red grapefruit exports of the 3 largest exporters**



Source: Citrus Growers' Association of Israel

We identify three empirical particularities which are explicitly accounted for in our estimation approach:

- 1) It is likely that the pricing behaviour of the citrus exporting companies changed during the post-liberalisation period. The French grapefruit import prices decreased significantly over the period of this analysis. Table 1 shows that the mean French import price weighted by the actual export quantity of each season fell by 30% from 4547 NIS/ton in the 1991/92 season to 3165 NIS/ton in the 1999/00 season. All exporters will have attempted to pass decreased French import prices on to the growers, but firm-specific strategies and the scope for passing this on may have varied depending *inter alia* on each firm's market power. Furthermore, exporters might have adjusted their long-run pricing strategies following the minimum price agreement imposed by the government particularly in the 1994/95 and 1995/96 seasons. This intervention signalled that the government was willing and able to intervene in response to what were perceived to be unfair pricing practices by the exporting firms. The data indicate that the homogeneity of grower prices increased over time, which may be evidence of increasing competition. Also, the difference between the maximum and minimum grower price (price spread) of the three major exporters decreased significantly over the 1990s (Figure 3). The mean spread of the three grower prices was 400 NIS/t in 91/92-95/96, and fell to 180 NIS/t in 97/98-99/00. This suggests that



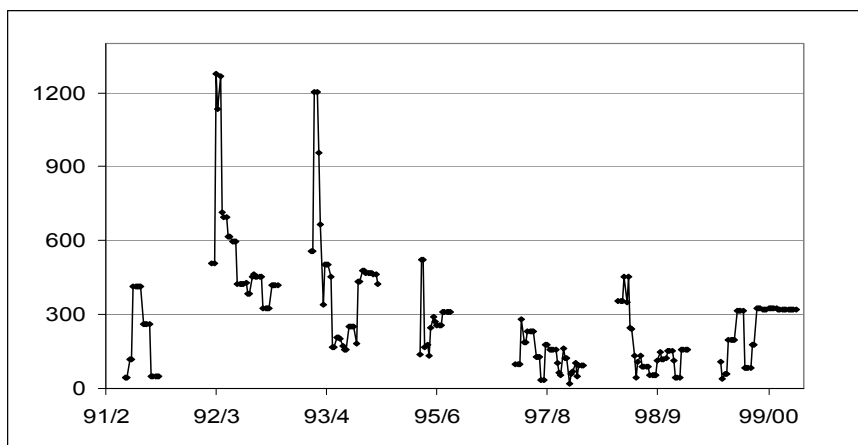
exporters changed their pricing behaviour between 95/96 and 97/98. We account for these possible changes by conducting the Gregory-Hansen test for a structural break in the cointegration regression. Based on the results of these tests (section 5), we distinguish the price phase in 91/92, 92/93, 93/94 and 95/96 from the price phase in 97/98, 98/99 and 99/00, and estimate separate ECMs for these two phases, referred to as SUBSET 1 and SUBSET 2 in the following.

**Table 1. Weighted mean French import price for grapefruits, by season (NIS/t)**

Season	1991/92	1992/93	1993/94	1995/96	1997/98	1998/99	1999/00
Mean French import price	4 547	4 135	3 579	3 028	3 076	3 483	3 165

Source: own illustration

**Figure 3. Spread of the weekly grower prices of Agrexco, Mehadrin and Tnuport (NIS/t)**



Source: own illustration

- 2) The data set is characterised by gaps resulting from seasonal interruptions in grapefruit production and trade. This implies that for the first observations in each season, no or only incomplete information on the preceding observations is available, so that a complete set of lagged variables cannot be created. How many observations are lost in this manner depends on the chosen lag specification.

WARD (1982) introduces additional dummy variables for those observations for which lags are missing in his model to ensure that each observation can be included in the estimation. We take the alternative course of omitting observations for which the required lags cannot be constructed. Our approach leads to a loss of degrees of freedom whereas WARD'S approach may lead to estimation bias. Given the often very large differences in our data between the last observation of one season and the first observation of the next (see Figures 1 and 2), we are more concerned about bias than degrees of freedom.

- 3) We account for the lag between the week in which the grower price is recorded, and the week in which the corresponding French import price is determined. The grower price represents the value of the produce at the point of time of its delivery to the packing station, while the French import price is determined at the border to France. According to the consignment system, the grower price is determined *ex post*, i.e. after the produce is sold in the French import market. The minimum time lag between those two points in the transport chain is seven to nine days. Since delays may occur at several points, this lag is stochastic. Simplifying, we assume a transport lag of two weeks for all models.<sup>8</sup>

## 4 Methods

We choose a cointegration approach as the framework to analyze APT in the context of non-stationary, but cointegrated variables. It is based on the Engel-Granger representation theorem that cointegrated time series, i.e. for which a long-run equilibrium relation exists, can be represented by an ECM (1987). This approach was first applied to APT by VON CRAMON-TAUBADEL and FAHLBUSCH (1994) and generalized by VON CRAMON-TAUBADEL and LOY (1999).

We start our analysis by determining the order of integration of the data series by the Dickey-Fuller (1981) test and the KPSS test of KWIATOWSKI et al. (1992). The Dickey-Fuller (DF) test allows testing on the existence of a unit root and determining the order of integration. The DF-test is conducted within three models 1) a random walk, 2) a random walk with drift and 3) a random walk with drift and deterministic trend. Since the DF requires that the model residuals are white noise, autocorrelation is accounted for by augmenting the model with lagged dependent variables as regressors in the model. The Augmented Dickey Fuller test (ADF) in the framework of a random walk with drift as defined as

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<sup>8</sup> We estimated the model for lags of 1 to 3 weeks, but coefficients did not differ substantially.

$$\Delta y_t = \alpha + \delta y_{t-1} + \sum_{i=2}^k \lambda_i \Delta y_{t-i+1} + \varepsilon_t \quad (1)$$

It tests the null hypothesis  $\delta = 0$ , meaning that the data series  $y_t$  contains a unit root and is non-stationary, against the alternative hypothesis that  $\delta < 0$ .

For comparison we also apply the KPPS test of KWIATOWSKI et al. (1992) which, unlike the ADF test, tests the null hypothesis of stationarity against the alternative of nonstationarity.

To identify asymmetry in price transmission we estimate an error correction model (ECM) following ENGLE and GRANGER'S (1987) two-step approach. First, the long-run equilibrium relationship between the Israeli grower price  $p_{it}$  and the French import price  $p_{jt}$  for Israeli grapefruits is estimated as:

$$p_{it} = \alpha_0 + \alpha_1 * p_{jt} + v_t \text{ with } t = 1, \dots, T. \quad (2)$$

The data are in logarithms, so  $\alpha_1$  corresponds to the price transmission elasticity, indicating the percentage price change in  $p_{it}$  if  $p_{jt}$  changes by 1%. If price changes are transmitted completely, then  $\alpha_1 = 1$ . If there is no price transmission,  $\alpha_1$  is not significantly different from zero. The residual vector  $v_t$  represents the short-run deviations from this long-run equilibrium. The actual grower price may be higher or lower than its long-run equilibrium value in any given period, thus  $v_t$  might be greater or smaller than zero, respectively. The estimated residuals are lagged by one period and enter the ECM as the error correction term (ECT), where  $ECT_{t-1} = p_{it-1} - \hat{\alpha}_0 - \hat{\alpha}_1 * p_{jt-1}$ :

$$\Delta p_{it} = \sum_{n=0}^K \beta_{1n} \Delta p_{jt-n} + \sum_{m=1}^L \beta_{2m} \Delta p_{it-m} + \phi ECT_{t-1} + \varepsilon_t. \quad (3)$$

In this model,  $\sum_{n=0}^K \beta_{1n} \Delta p_{jt-n}$  captures contemporaneous and previous change effects of  $p_{jt}$  on  $p_{it}$  up to lag  $K$ , and  $\sum_{m=1}^L \beta_{2m} \Delta p_{it-m}$  accounts for autocorrelation up to order  $L$ .  $\phi$  indicates the speed with which deviations from the long-run equilibrium in the previous period are corrected, and is referred to as the adjustment parameter.

To allow for APT, contemporaneous and lagged effects caused by price increases are distinguished from those caused by price decreases by splitting the respective variables into positive and negative components in the ECM. The ECT is included as a split variable as well.  $ECT^+$  contains the positive, and  $ECT^-$  the negative lagged residuals

from equation (1). Thus, positive and negative error correction behaviour can be identified separately:

$$\Delta p_{it} = \sum_{n_1=0}^{K_1} \beta_{1n_1}^+ D_{1t}^+ \Delta p_{jt-n_1} + \sum_{n_2=0}^{K_2} \beta_{1n_2}^- D_{1t}^- \Delta p_{jt-n_2} + \sum_{m=1}^L \beta_{2m} \Delta p_{it-m} + \phi_1 D_{2t}^+ ECT_{t-1} + \phi_2 D_{2t}^- ECT_{t-1} + \varepsilon_t \quad (4)$$

with  $D_{1t}^+ = 1$  if  $\Delta p_{jt-n_1} > 0$  and 0 otherwise,  $D_{1t}^- = 1$  if  $\Delta p_{jt-n_2} < 0$  and 0 otherwise,  $D_{2t}^+ = 1$  if  $ECT_{t-1} > 0$  and 0 otherwise, and  $D_{2t}^- = 1$  if  $ECT_{t-1} < 0$  and 0 otherwise (MEYER AND VON CRAMON-TAUBADEL, 2004).

This model structure allows for different numbers of lags for the positive and negative short-run effects. APT is present if the null hypothesis that the estimated coefficients of the respective positive and negative variable are equal is rejected by an F-test.

Standard tests for cointegration (e.g. the residual-based ENGLE and GRANGER (1987) test) require that the cointegrating vector be time-invariant. If the cointegrating vector changes during the sample period, the results of these tests might be misleading (GREGORY and HANSEN, 1996). In GREGORY and HANSEN'S (1996) cointegration test, the null hypothesis of no cointegration is tested against the alternative hypothesis of cointegration allowing for the presence of a structural break at an unknown point of time according to the following three model frameworks:

a) Level shift

$$p_{it} = \alpha_{01} * \varphi_{t\tau}^1 + \alpha_{02} * \varphi_{t\tau}^2 + \alpha_1 * p_{jt} + \nu_i \quad (5);$$

b) Level shift with trend

$$p_{it} = \alpha_{01} * \varphi_{t\tau}^1 + \alpha_{02} * \varphi_{t\tau}^2 + \alpha_1 * p_{jt} + \alpha_2 * t + \nu_i \quad (6); \text{ and}$$

c) Regime shift

$$p_{it} = \alpha_{01} * \varphi_{t\tau}^1 + \alpha_{02} * \varphi_{t\tau}^2 + \alpha_{11} * \varphi_{t\tau}^1 * p_{jt} + \alpha_{12} * \varphi_{t\tau}^2 * p_{jt} + \alpha_1 * p_{jt} + \nu_i \quad (7).$$

In all three cases,  $\varphi_{t\tau}^1 = 1$  if  $t \leq [n\tau]$ ,  $\varphi_{t\tau}^1 = 0$  if  $t > [n\tau]$ ,  $\varphi_{t\tau}^2 = 0$  if  $t \leq [n\tau]$ , and  $\varphi_{t\tau}^2 = 1$  if  $t > [n\tau]$ , where  $\tau \in (0,1)$ .

In this test, the residuals of the individual cointegration regressions in (4)-(6) for all possible breakpoints are tested for the existence of a unit root by an Augmented Dickey Fuller (ADF) test.

This procedure is followed for all model frameworks in (4) to (6). Estimates and their standard errors are compared and additional information, if available, is utilized to select the model framework which fits best. If the standard ADF test does not reject the null hypothesis of no cointegration, but the ADF statistic of the Gregory-Hansen test does, this is interpreted as evidence of a structural break in the cointegration regression. The timing of the structural break corresponds to the break point of the cointegration regression for which the ADF statistic is lowest. Critical values are non-standard and are tabulated in GREGORY and HANSEN (1996). In previous studies of price transmission, this approach has been applied by BAKUCS and FERTÖ (2006), GUILLOTREAU, GREL and SIMIONI (2005) and TIFFIN and DAWSON (2000).<sup>9</sup> GREGORY and HANSEN (1996) point out that this test is not a test for the existence of a regime shift, but rather a test for cointegration which allows for the existence of a regime shift.

## 5 Empirical Results

We begin by determining the order of integration of the data series by the ADF test and the KPSS test of KWIATOWSKI et al. (1992). We find the French import price ( $p_{fr}$ ) to be I(0) according to the ADF test, but I(1) according to the KPSS test. Thus, we have no clear statistical evidence that the French import price is nonstationary. However, Israeli grower price series for all three exporters are I(1) according to the ADF and KPSS tests. According to JUSELIUS (2008), the unit root property is a useful approximation for empirical analysis, but a unit root is not a characteristic of a time series per se but rather depends on the time frame considered. Based on our test results, we regard the Israeli import price as having a unit root and being I(1).

We utilize the residual-based test by ENGLE and GRANGER (1987) to test for cointegration between the French import price ( $p_{fr}$ ) and the Israeli grower price ( $p_{is}$ ) of each of the three exporters. The consignment system strongly suggests that the Israeli grower price is the dependent variable and the French import price the independent variable. The results in Table 2 indicate cointegration between the French import price and the Israeli grower price for Agrexco (5% significance level) alone.

The failure to find cointegration for the other exporters may be due to structural breaks as outlined above. Hence, we next test for cointegration allowing for the existence of a structural break using the Gregory-Hansen test. For Agrexco, Mehadrin and Tnuport a regime shift is identified at the 1% level of significance in March 1993, (observation 42),

<sup>9</sup> In a multivariate setting, BARASSI and GOSHRAY (2007) detect an unknown break-point by employing a testing procedure proposed by BARASSI and TAYLOR (2004) for a change in the cointegration rank.

October 1997, (observation 103), and October 1992 (observation 19), respectively, and cointegration is confirmed in all 3 cases (Figure 4). This suggests that a new equilibrium between the French import price and the Israeli grower price emerged in the aftermath of liberalization for each of the three exporters, though at different points of time. Also, the structural break is identified earliest for Tnuport, the exporter with the largest market share and thus probably the largest degree of market power, whereas it is observed the latest for Mehadrin, a company which owns citrus plantations and only partially buys citrus fruits from individual citrus growers. The estimated coefficients of the long-run equilibrium regression according to equation (6) for each exporter are presented in Table 3. In all cases the long-run price elasticity in the new equilibrium ( $\alpha_{12}$ ) is lower than the price elasticity in the previous equilibrium ( $\alpha_{11}$ ). This decrease in the slope coefficient can be attributed to the decrease in the French import price resulting in relatively higher marketing costs and reducing the share of the Israeli grower price in the French import price. The long-run price transmission elasticity in the new equilibrium ( $\alpha_{12}$ ) is lowest by far for Tnuport, the largest exporter with the potentially largest market power, suggesting that – compared with the other exporters – Tnuport transmits increases in the French import price the least to Israeli growers in the liberalized market.

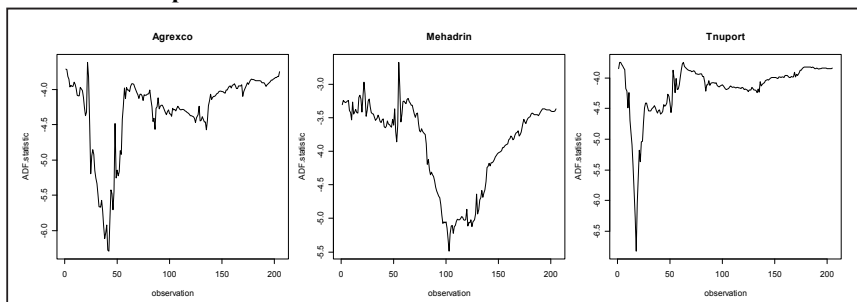
**Table 2. Results of the residuals-based tests for cointegration between the French import price and the individual Israeli grower prices**

	ADF ( $H_0$ : $p_{it}$ and $p_{jt}$ are not cointegrated)	
	Test-statistic	Conclusion
Agrexco	$ -3.922  >  -3.37 $ (5%)	reject $H_0$ at the 5% level; variables are cointegrated
Mehadrin	$ -2.398  <  -3.37 $ (5%)	cannot reject $H_0$ ; variables are not cointegrated
Tnuport	$ -3.172  <  -3.37 $ (5%)	cannot reject $H_0$ ; variables are not cointegrated

Source: own illustration

The identified break-points of the cointegration regressions for Agrexco, Mehadrin and Tnuport are accounted for in the estimation of the cointegration residuals, which enter the ECM (equation 3) as ECT terms. To test whether the exporters' price transmission behaviour may have changed, we estimate separate ECMs for the first years after liberalisation (SUBSET 1) and the subsequent phase (SUBSET 2) starting 97/98, after new long-run price equilibria were established for all 3 exporters, as suggested by the results of the Gregory-Hansen test.

**Figure 4. ADF-values obtained by the Gregory-Hansen test for different break-points of the disaggregated grower price for Agrexco, Mehadrin and Tnuport**



Source: own illustration

Lag-lengths  $K_1$  and  $K_2$  are chosen according to the Bayesian Information Criteria (BIC)<sup>10</sup>. Lag-length  $L$  is adjusted to account for autocorrelation, which is detected by the Breusch-Godfrey test. If the Breusch-Pagan test identifies the presence of heteroscedasticity, White's heteroscedasticity consistent standard error is estimated.

We find asymmetry in the error correcting behaviour for Agrexco and Tnuport in SUBSET 1. In particular, deviations from the long-run equilibrium are corrected faster if the grower price is above its long-run equilibrium level, and slower if the grower price is below. The identified asymmetry is of the kind that is beneficial to exporters but reduces growers' revenues. For example, when the import price falls, implying that the grower price lies above its long-run equilibrium level and squeezing Agrexco's margin, the grower price is reduced by 43.8% of this "error" in the next week. If, on the other hand, the import price increases so that the grower price falls below its long-run equilibrium level and Agrexco's margin is stretched, the grower price increases only by 0.9% in the next week. In the case of Tnuport the estimated coefficient for  $\phi_2$  is positive. This indicates that if the grower price is below its equilibrium level, price adjustment reduced it even farther below its equilibrium level. However, this coefficient is not significantly different from zero. Further, our results show that price transmission is symmetric in SUBSET 2 for Agrexco and Tnuport.

<sup>10</sup> In a simulation study on various criteria for estimating the order of a vector autoregressive process, LUETKEPOHL (1985) finds that the BIC criterion chooses the correct autoregressive order most often.

**Table 3. Estimated coefficients of the cointegration regression for the three exporters**

Coefficient	$\alpha_{01}$	$\alpha_{11}$	$\alpha_{02}$	$\alpha_{12}$
Agrexco	-261.29	0.456	-184.11	0.295
Mehadrin	-27.054	0.378	-54.74	0.258
Tnuport	-1157.0	0.577	287.0	0.138

Source: own calculations

This suggests that the minimum price agreement in 1994/95 and 1995/96 was successful and stopped Agrexco and Tnuport from exerting market power by transmitting prices asymmetrically. For Mehadrin, price transmission is found to be symmetric in both SUBSET 1 and SUBSET 2. Since Mehadrin also markets citrus produce from its own plantations, Mehadrin might have had less motivation for squeezing the citrus growers' profits and thus symmetrically transmitted price changes from the French import market to the Israeli growers.

## 6 Welfare Implications

MEYER and VON CRAMON-TAUBADEL (2004) stress the importance of supplementing the statistical detection of APT by analysing its economic implications and relevance. Based on the results documented in Table 4, we estimate the revenue that Israeli grapefruit growers have foregone as a result of asymmetric price transmission in the study period.

The calculation of the welfare implications of asymmetric price transmission in the Israeli grapefruit export chain is confined to Tnuport and Agrexco, and to the seasons 1991/92, 1992/93, 1993/94 and 1995/96 since APT is only found for these firms and seasons (SUBSET 1). To calculate the grower price under APT, the estimated coefficients of the asymmetric ECM are utilized to calculate the grower price in period  $t+1$  ( $p_{it+1}^{as}$ ) as the grower price in the previous period  $t$  ( $p_{it}^{as}$ ) plus the changes in the grower price in period  $t+1$ :

$$\begin{aligned}
 p_{it+1}^{as} = & p_{it}^{as} + \sum_{n_1=0}^{K_1} \beta_{1n_1}^+ D_{1t+1}^+ \Delta p_{jt+1-n_1} + \sum_{n_2=0}^{K_2} \beta_{1n_2}^- D_{1t+1}^- \Delta p_{jt+1-n_2} + \sum_{m=1}^L \beta_{2m} \Delta p_{it+1-m} \\
 & + \phi_1 D_{2(t+1)}^+ ECT_{(t+1)} + \phi_2 D_{2(t+1)}^- ECT_{(t+1)}
 \end{aligned} \quad (8)$$



For Agrexco  $K_1 = K_2 = L = 1$  and for Tnuport  $K_1 = K_2 = L = 0$ . For Tnuport we assume  $\phi_2 = 0$  in the estimation of  $p_{it(t+1)}^{as}$  since the estimated coefficient for  $\phi_2$  is positive and not statistically significant (more details are given in the previous section).

**Table 4. Selected parameter estimates of the ECM for the complete data set and data subsets<sup>1</sup>**

	SUBSET 1						SUBSET 2					
	Agrexco		Mehadrin		Tnuport		Agrexco		Mehadrin		Tnuport	
Coef./ test stat.	Estim. value	Stand. error (t-val)	Estim. value	Stand. error (t-val)	Estim. value	Stand. error (t-val)	Estim. value	Stand. error (t-val)	Estim. value	Stand. error (t-val)	Estim. value	Stand. error (t-val)
Speed of adjustm. $\phi_1$	-0.438	0.121 (-3.63)*	-0.034	0.087 (-0.40)	-0.180	0.076 (-2.38)*	-0.408	0.184 (-2.24)*	-0.012	0.070 (-0.17)	0.025	0.084 (0.297)
$\phi_2$	-0.009	0.089 (-0.10)	-0.061	-0.061 (-0.60)	0.258	0.208 (1.244)	-0.106	-0.047 (-2.27)*	-0.061	0.074 (0.822)	-0.063	0.038 (-0.16)
Breusch-Godfrey test (p-val.)	0.053		0.801		0.443		0.069		0.981		0.266	
Breusch-Pagan test (p-val.)	0.006		0.019		0.329		0.005		0.371		0.163	
Emp. & theor. F-val. (sym. error corr. beh.) $\phi_1 = \phi_2$	6.728 > 3.939**		0.714 < 3.939		3.940 > 3.939**		1.942 < 3.934		0.513 < 3.935		0.827 < 3.938	

<sup>1</sup> theoretical F-values are given for the 5% significance level indicates 5% significance level;

\*\* indicates 1% significance level

Source: own calculations

To calculate the grower price ( $p_{it(t+1)}^s$ ) under the assumption of symmetric price transmission, we assume that the speed of adjustment for positive and negative price changes is equal ( $\phi_1 = \phi_2$ ). The estimated coefficient for  $\phi_1$ , which exceeds  $\phi_2$ , is utilized for Agrexco and Tnuport, on the assumption that if such rapid transmission is possible in one direction, equally rapid transmission should be possible in the other as well. The quantitative effect of price asymmetry ( $qe^{as}$ ) for one season with  $t=v$  and  $t=w$  corresponding to the beginning and the end of a season, respectively, equals:

$$qe^{as} = \sum_{t=v}^{t=w} (p_{it}^s - p_{it}^{as}) * q_{it} \quad (9),$$

with  $q_{it}$  equal to the amount of products exported in time period  $t$ .

The estimated values for the growers' losses are presented in Table 5. For growers delivering to Agrexco, the seasonal losses vary between about 5,000 NIS and 330,000 NIS, corresponding to between 0.17% (in 1995/96) and 3.95% of seasonal revenues (in 1992/93). For Tnuport the seasonal losses add up to between about 52,000 NIS and 580,000 NIS. These losses correspond to between 0.36% and 3.50% of the seasonal revenues and are highest in 1991/92.

**Table 5. Growers' losses due to asymmetry in price transmission**

Growers' losses		1991/92	1992/93	1993/94	1995/96
Agrexco	in NIS	17,157	331,530	23,649	5,237
	in % of revenue	0.421%	3.945%	0.359%	0.167%
Tnuport	in NIS	579,620	55,060	158,376	52,164
	in % of revenue	3.496%	0.358%	1.480%	1.553%

Source: own calculations

As growers' profits are only about 20% of their total revenues (own calculation based on REGEV and MAOZ, 1996)<sup>11</sup>, the losses in grower profits due to the revenue effects of APT outlined in Table 5 are likely very relevant.

## 7 Conclusions

We analyse price transmission in the international FFV supply chain based on firm-specific grower price data. Our results indicate that the price transmission Israeli citrus exporters' behaviour changed in the post-liberalisation period after 1991. We identify asymmetric price transmission for some exporters even in the liberalized market. These exporters only began to transmit prices symmetrically when the Israeli government introduced a minimum price agreement on the grapefruit market. In particular, the Israeli exporters Agrexco and Tnuport transmitted grapefruit price changes in the EU import market asymmetrically, while Mehadrin transmitted prices symmetrically to Israeli growers in the first years after liberalization. Later, all 3 companies transmitted prices symmetrically. We explain the differing pricing behaviour of Mehadrin by the fact that Mehadrin also markets citrus produce from its own plantations and thus had less incentive to squeeze citrus growers' profits. We also show that the estimated asymmetry in price transmission by Tnuport and Agrexco in the first years

<sup>11</sup> Further details on the calculation are available from the authors upon request.

after liberalisation was economically significant. Our findings indicate that growers' seasonal losses resulting from asymmetric price transmission amounted to as much as 4.0% of their total annual revenues, and a much larger share of their profits. This result is consistent with the hypothesis that the observed asymmetry in price transmission was caused by Israeli exporters exerting market power over Israeli citrus growers.

Concluding, our paper demonstrates that the liberalization of the Israeli grapefruit export market by the abolishment of the government marketing board alone was not sufficient to establish a competitive market. Rather, an additional temporary government market intervention was required to foster competitive pricing behaviour by the exporting companies vis-à-vis Israeli grapefruit growers. This suggests that the temporary minimum price agreement, whereby a subsidy was paid by the government to traders who signed written contracts guaranteeing a minimum price to growers, was an effective complementary policy to foster the market development towards more competition and greater efficiency. Our findings support the view that the privatization of government marketing boards and the liberalization of the export market do not guarantee competitive pricing behaviour but it can be a central element of a strategy to improve market efficiency. Often, additional measures are necessary which need to be tailored by policy makers to the specific sector and country conditions (WORLD BANK, 2005).

As an area for future research, price transmission in the international FFV supply chain should be investigated, particularly between export prices in developed country markets and grower prices obtained by small farmers in developing countries under different supply chain governance structures. As pointed out above, although APT might result from many different causes, in the context of international trade in FFV, grower prices are generally determined *ex post* by the consignment system. In this setting it is unlikely that APT is due to menu and adjustment costs, and it is possible to focus on market power as the most likely cause.

However, analysing price transmission in international FFV trade faces particular challenges regarding data requirements. First, we used an aggregated price as the EU import price for grapefruits. Of course, different exporters might achieve different prices for their produce in the same market, particularly since the quality of fresh produce can vary sharply with the maturity of the fruits at the time of picking, or with the time required to move the produce from the farm gate to the ship. The higher the variability in product quality between growers, the higher the distortions that will result from utilizing aggregated import prices. If exporter-specific import prices are not available (which is likely to be the rule), analysis should concentrate on products originating in countries which exhibit homogeneous quality.

Second, to exactly measure the weekly average export price achieved by an exporter, export price data for all markets served by this exporter is required. However, our analysis is based on price data for exports to the EU (France) alone. The more diverse the export markets served, the more data is required to exactly measure the average export price achieved by exporters and to analyse asymmetry in price transmission correctly. Data requirements for exports that are concentrated on one or a few markets are lower and thus more suitable for this kind of analysis.

Finally, frequency of the data set has to be chosen adequately, depending e.g. on how often fresh products are delivered from the exporting to the importing country.

## References

- BAKUCS, L.Z. and I. FERTŐ (2005): Marketing Margins and Price Transmission on the Hungarian Pork Market. In: Brosig, S. and H. Hockmann (eds.): *How effective is the Invisible Hand? Agricultural and Food Markets in Central and Eastern Europe*. In: *Studies on the Agricultural and Food Sector in Central and Eastern Europe* 31: 134-149.
- BARASSI, M.R. and A.M.R. TAYLOR (2004): A test for Change in the Cointegrating Rank. Mimeo. University of Birmingham, Birmingham.
- BARASSI, M.R. and A. GHOSHAY (2007): Structural Change and Long-run Relationships between US and EU Wheat Export Prices. In: *Journal of Agricultural Economics* 58 (1): 76-90.
- BROOKER, J., D. EASTWOOD, B. CARVER and M. GRAY (1997): Fresh Vegetable Price Linkage between Grower/Shippers, Wholesalers, and Retailers. In: *Journal of Food Distribution Research* 28 (1): 54-61.
- CBS (Central Bureau of Statistics Israel) (2008): Price Indices-Shipping. URL: <http://www.cbs.gov.il/sidfilee.cgi>.
- C.L.A.M. (Comité de Liaison de l'Agrumiculture Méditerranéenne) (various years): *Les Exportacions d'Agrumes du Bassin Mediterraneen*. Madrid.
- CRAMON-TAUBADEL, S. VON and J.P. LOY (1999): The identification of asymmetric price transmission processes with integrated time series. In: *Jahrbücher für Nationalökonomie und Statistik* 218: 85-106.
- CRAMON-TAUBADEL, S. VON and S. FAHLBUSCH (1994): Identifying asymmetric price transmission with error correction models. Poster Paper, EAAE European Seminar "Food policies and the food chain: Structures and interrelationships", Reading, UK.
- DICKEY, D.A. and W.A. FULLER (1981): Likelihood ratio statistics for autoregressive time series with a unit root. In: *Econometrica* 49 (4): 1057-1072.
- ENGLE, R.F. and C.W.J. GRANGER (1987): Cointegration and error correction: Representation, estimation and testing. In: *Econometrica* 55 (2): 251-276.
- GOETZ, L. and H. GRETHE (2009): The EU Entry Price System for Fresh Fruits and Vegetables – Paper Tiger of Powerful Market Barrier? In: *Food Policy* 34 (1): 81-93.

- GIRAPUNTHONG, N., J. VAN SICKLE and A. RENWICK (2003): Price Asymmetry in the United States Fresh Tomato Market. In: *Journal of Food Distribution Research* 34 (3): 51-59.
- GREGORY, A.W. and B.E. HANSEN (1996): Residual-based tests for cointegration in models with regime shifts. In: *Journal of Econometrics* 70 (1): 99-126.
- GUILLOTREAU, P., L. LE GRE and M. SIMIONI (2005): Price-Cost Margins and Structural Change: Sub-Contracting within the Salmon Marketing Chain. In: *Review of Development Economics* 9 (4): 581-597.
- JUSELIUS, K. (2008). *The Cointegrated VAR Model: Methodology and Applications*. Oxford University Press, New York.
- KACHEL, Y. (2003): *The Influence of Industry Structure on Performance: The Case of the Israeli Citrus Industry*. PhD Thesis. Hebrew University of Jerusalem, Department of Agricultural Economics, Israel.
- KACHEL, Y. Y. KISLEV and I. FINKELSHTAIN (2003): *Equilibrium Contracts in the Israeli Citrus Industry*. Discussion Paper No. 10.04. The Hebrew University of Jerusalem, The Center for Agricultural Economic Research.
- KWIATOWSKI, D., P.C.P. PHILLIPS, P. SCHMIDT and Y. SHIN (1992): Testing the Null Hypothesis of Stationarity against the Alternative of a Unit Root. In: *Journal of Econometrics* 54 (1-3): 159-178.
- LLOYD T., S. MCCORRISTON, C. MORGAN and A. RAYER (2006): Food scares, market power and price transmission: the UK BSE crisis. In: *European Review of Agricultural Economics* 33 (2): 119-147.
- LLOYD, T. and W. MORGAN (2007): Market Power in UK Food Retailing. In: *EuroChoices* 6 (3): 22-29.
- LUETKEPOHL, H. (1985): Comparison of criteria for estimating the order of a vector autoregressive process. In: *Journal of Time Series Analysis* 6 (1): 35-42.
- MATHER, C. and S. GREENBERG (2003): Market Liberalisation in Post-Apartheid South Africa: the Restructuring of Citrus Exports after Deregulation. In: *Journal of Southern African Studies* 29 (2): 393-412.
- MCCORRISTON, S., C.W. MORGAN and A.J. RAYNER (1998): Processing Technology, Market Power and Price Transmission. In: *Journal of Agricultural Economics* 49 (2): 185-201.
- (2001): Price transmission: the interaction between market power and returns to scale. In: *European Review of Agricultural Economics* 28 (2): 143-159.
- MCMILLAN, M., D. RODRIK and K.H. WELCH (2002): When economic reform goes wrong: cashews in Mozambique. NBER Working Paper 9117. NBER, Cambridge, M.A.
- MEYER, J. and S. VON CRAMON-TAUBADEL (2004): Asymmetric price transmission: A survey. In: *Journal of Agricultural Economics* 55 (3): 581-611.
- PICK, D., J. KARRENBROCK and H. CARMAN (1990): Price Asymmetry and Marketing Margin Behaviour: An Example for California-Arizona Citrus. In: *Agribusiness* 6 (1): 75-84.
- POMONA (2008): *Import Prices of Citrus Fruit to France*. Unpublished.
- RAPSOMANIKIS, G., D. HALLAM and P. CONFORTI (2006): Market integration and price transmission in selected food and cash crop markets of developing countries: review and applications. In: Sarris, A. and D. Hallam (eds.): *Agricultural Commodity Markets and Trade*: 187-217. Edward Elgar, Cheltenham, UK.

- RICHARDS, T. and P. PATTERSON (2003): Competition in Fresh Produce Markets: An Empirical Analysis of Marketing Channel Performance. USDA Contractor and Cooperator Report No. 1. USDA, Washington, D.C., USA.
- REGEV, A. and E. MAOZ (1996): Investment Calculations for Citrus Orchards. Israeli Ministry of Agriculture, Extension Service, Tel Aviv.
- SANTERAMO, F.G. and A. CIOFFI (2010): Spatial price dynamics in the EU F&V sector: the cases of tomato and cauliflower. Paper presented at the International EAAE-SYAL Seminar-Spatial Dynamics in Agri-Food Systems, October 2010, Parma, Italy.
- SEXTON, R.J., I. SHELDON, S. MCCORRISTON and H. WANG (2007): Agricultural trade liberalization and economic development: the role of downstream market power. In: *Agricultural Economics* 36 (2): 253-270.
- TIFFIN, R. and P.J. DAWSON (2000): Structural breaks, cointegration and the farm-retail price spread for lamb. In: *Applied Economics* 32 (10): 1281-1286.
- WARD, R.W. (1982): Asymmetry in Retail, Wholesale, and Shipping Point Pricing for Fresh Vegetables. In: *American Journal of Agricultural Economics* 64 (2): 205-212.
- WELDEGEBRIEL, H. (2004): Imperfect Price Transmission: Is Market Power Really to Blame? In: *Journal of Agricultural Economics* 55 (1): 101-114.
- WILCOX, M.D. and P.C. ABBOTT (2004): Market Power and Structural Adjustment: The Case of West African Cocoa Market Liberalization. Selected Paper AAEA Annual Meeting, Denver, Colorado, August 1-4, 2004, USA.
- WILLETT, L., M. HANSMIRE and J. BERNARD (1997): Asymmetric Price Response Behaviour of Red Delicious Apples. In: *Agribusiness* 13 (6): 649-658.
- WORLD BANK (2005): Economic Growth in the 1990s: Learning from a Decade of Reform. The World Bank, Washington, D.C., USA.

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