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VERTICAL PRICE TRANSMISSION ANALYSIS OF VEGETABLE MARKETS IN FINLAND

Sami Pakarinen
Kyösti Arovuori
Perttu Pyykkönen

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ABSTRACT: This paper examines the impact of changes in producer and import prices on consumer prices on the Finnish vegetable markets. In the analysis, price series from years 2000-2010 for both domestic and imported cucumber and tomato were used. Considering the stationary behaviour of the price series, the dynamic relationship between producer price and consumer price is analysed with Autoregressive Distributed Lag (ADL) models and Error Correction Models (ECM). The results show that the vertical price transmission is symmetric with tomato and cucumber excluding the import cucumber. The data used in this analysis has strong seasonality which is normal with vegetables as the production conditions varies. Therefore the results from the price transmission analysis of import vegetables should be interpreted carefully as price series lack observations. The analysis concentrates on the speed of adjustment towards the equilibrium of prices. The applied linear model does not take into account the magnitude of the price change.

Key words: *Price transmission, autoregressive distributed lag model, error correction model, food markets.*

Pakarinen, S., Arovuori, K. and Pyykkönen, P. 2014. KASVISTEN HINTOJEN VÄLITTYMINEN SUOMEN MARKKINOILLE. PTT työpapereita 158. 33 s. ISBN 978-952-224-145-0 (pdf), ISSN 1796-4784 (pdf)

TIIVISTELMÄ: Tässä tutkimuksessa tarkasteltiin tuottaja- ja tuontihinnoissa tapahtuvien muutosten vaikutuksia kuluttajahintoihin Suomen vihannesmarkkinoilla. Tutkimusaineistona käytettiin kurkun ja tomaatin pakkaamo-, tuonti ja kuluttajahintoja vuosilta 2000–2010. Analyysissa hyödynnettiin aineistoa, josta oli erikseen saatavissa kuluttajahinnat sekä kotimaisille että ulkomaisille vihanneksille. Vertikaalista hintasiirtymää tutkittiin aikasarjaekonometrisin menetelmin käyttämällä dynaamisia ADL- ja virheenkorjausmalleja aineiston stationaarisuudesta johtuen. Tulokset osoittivat, että hintasiirtymä on symmetrinen kaikissa muissa tapauksissa lukuun ottamatta ulkomaista kurkkua. Analyysin kannalta aineiston rajallisuus hyödykkeiden kausittaisuudesta johtuen vaikeuttaa hintasiirtymisen tutkimista. Valittu lähestymistapa tarkastelee hintasiirtymistä ajallisesti ja mallin lineaarisuuden vuoksi hintamuutoksen suuruutta ei huomioida.

Avainsanat: *Hintasiirtymä, ADL -malli, virheenkorjausmalli, elintarvikemarkkinat.*

YHTEENVETO

Tutkimuksen tulokset osoittavat, että koti- ja ulkomaisten kasvisten tuottaja- ja tuontihintojen muutokset siirtyvät kuluttajahintoihin pääasiassa samalla viiveellä riippumatta siitä, laskevatko vai nousevatko hinnat (Taulukko 1). Tässä suhteessa hintasiirtymät ovat symmetrisiä. Poikkeuksena edelliseen on ulkomailta tuotava tuontikurkku, jonka tapauksessa tuontihinnassa tapahtuva nousu ei välity kuluttajahintaan. Tuontihinnan nousun vaikutus ei kuitenkaan ole tilastollisesti merkitsevä.

Taulukko 1. *Vihannesten tuottajahinnoissa tapahtuvien muutosten siirtyminen kuluttajahintaan.*

	Lyhyt aikaväli		**Pitkä aikaväli**		**Symmetria**		
Selitettävä muuttuja	Tuottaja-hinta	Substituutti	Tuottaja-hinta	Substituutti	Positii-vinen	Negatii-vinen	Symmetria
Kotimainen kurkku	0.633	0.357	0.673	0.424	-0.954	-0.932	kyllä
Tuonti kurkku	0.664	0.601	0.581	0.947	0.036	-0.920	ei
Kotimainen tomaatti	0.478	0.457	1.025	0.736	-0.470	-0.437	kyllä
Tuonti tomaatti	0.537	0.316	1.017	0.007	-0.655	-0.479	kyllä

Kotimaisen kurkun osalta tuottajahinnan vaihtelusta siirtyy kuluttajahintaan lyhyellä aikavälillä yhtä paljon kuin pitkällä aikavälillä. Hintamuutosten siirtyminen on myös ajallisesti hyvin nopeaa. Vastaavasti tomaatin tapauksessa lyhyellä aikavälillä vain puolet tuottajahinnassa tapahtuvasta muutoksesta siirtyy kuluttajahintaan. Pitkällä aikavälillä tomaatin kuluttajahinnan muutokset ovat puolestaan suuremmat kuin tuottajahinnassa tapahtuneet muutokset.

Substituutiovaikutuksia tarkastellessa kurkun ja tomaatin välillä on eroa. Kotimainen kurkku on selkeä substituutti ulkomaiselle kurkulle ja tuontitomaatti substituutti kotimaisille tomaateille.

Tuotteiden kausittaisuus selittää osittaista siirtymistä sekä lyhyellä että pitkällä aikavälillä. Myös esimerkiksi hintamuutoksesta kaupalle koituvat kustannukset voivat olla hintamuutoksen tuomaa hyötyä suuremmat, jolloin tuotantoportaan alemmalla tasolla tapahtuva hintamuutos ei välity kuluttajahintaan. Osittainen siirtyminen tarkoittaa sitä, että hintamarginaali (kuluttajahinnan ja tuottajahinnan erotus) vaihtelee ajan mukaan, mutta ei kuitenkaan välttämättä kasva. Esimerkkeinä olleiden kasvisten hintamarginaali on jopa pienentynyt tarkasteluperiodin aikana.

Tämä tutkimus on osa Kuluttajatutkimuskeskuksen, MTT:n ja PTT:n laajempaa ruokamarkkinoiden tehokkuutta koskevaa tutkimushanketta, jolle on saatu rahoitus Maatilatalouden kehittämisrahastosta (MAKERA). Hankkeessa tarkastellaan laajasti elintarvikkeiden hinnanmuodostusta, elintarvikemarkkinoiden rakennetta ja kilpailullisuutta sekä näihin vaikuttavia tekijöitä.

Toimivien elintarvikemarkkinoiden edellytyksenä on, että hintamuutokset välittyvät täysimääräisesti ja samanaikaisesti riippumatta siitä, laskevatko vai nousevatko hinnat. Pakarisen (2010) aiemmassa tutkimuksessa vastaava analyysi tehtiin kotimaan hintasiirtymää hedelmämarkkinoilla. Hedelmät ja kasvikset ovat esimerkkejä tuoteryhmistä, joissa tuote siirtyy kuluttajalle ilman jalostusta, ja joissa tuotteet ovat käytännössä yhdenmukaisia. On perusteltua olettaa, että kasvisten ja hedelmien hinnanmuodostus on tästä syystä huomattavan suoraviivaista. Pakarisen (2010) analyysistä poiketen, tässä tutkimuksessa kotimaisten ja tuontikasvisten hintasiirtymiä on tarkasteltu erikseen.

Tutkimuksessa sovellettiin aikasarjaekonometrisia malleja kuvaamaan hintasiirtymisen viivettä tuontihinnasta kuluttajahintaan. Aineistona käytetyt hintasarjat (2000–2010) ovat hintasarjoina epätyypillisesti stationaarisia, joten hintojen välistä riippuvuutta mallinnettiin stationaarisille sarjoille sopivilla dynaamisilla ADL (*autoregressive distributed lag*) –malleilla sekä niistä johdetuilla virheenkorjausmalleilla (*error correction model*). Vertikaalista hintasiirtymistä kuvaava malli kuvaa hintasiirtymisen (a)symmetrisyyttä ajallisesti, eikä lineaarisuutensa vuoksi huomioi hintamuutoksen suuruuden vaihtelua.

Contents

1 INTRODUCTION

In production process, changes in input prices are reflected to output prices. If changes are equal in both directions, margins remain at the same level. Vertical price transmission and its functioning in a production chain are important concepts when examining the efficiency of the markets. Vertical price transmission is actively studied especially in the area of agricultural economics (Ben-Kaabia & Gil 2007; Conforti 2004; Tappata 2007; Vavra and Goodwin 2005; Von-Cramon Taubadel 1998). In this paper we examine the vertical price transmission in vegetable markets in Finland. We apply similar approach as Pakarinen (2010), which studied the vertical price transmission in the Finnish fruit markets.

Vertical price transmission is used to analyze how the price changes in certain production level are transmitted through the production chain. A price transmission is symmetric when the magnitude and the speed of price change are both fully transmitted to all levels of the chain whether prices at a certain level are increasing or decreasing. Thus, the asymmetric price transmission occurs when either the price change is not the same on other levels or it is transmitted with some time lag. The asymmetric price transmission is usually a reflection of market power (Meyer and Von Cramon-Taubadel 2004). Thus, increasing the competition on every level of the production chain may reduce the asymmetry. Other explanation for asymmetric price transmission can be found from menu costs. They prevent all minor price changes to transmit to other levels if menu costs exceed the realized price change. Identifying the source of asymmetric price transmission may be problematic since both fore mentioned reasons can be overlapping.

In Finland vegetables are the fourth largest group of food consumption after meat, dairy and grain products. Among vegetables tomato and cucumber have the greatest volume in retail sector. The vertical price transmission analysis with vegetables is interesting for several reasons.

First, both vegetables are sold to the consumers mainly without processing so any intermediary costs are not present.[1] Also, fresh vegetables are not branded as many other food products which may affect the price formation (James and Alston 2002).

[1] In Finland the retail firms in the food sector largely own the wholesale trade.

Second, we can scrutinize if there exists any difference in price transmission between domestic and imported vegetables. In recent years Finnish food sector has met increasing competition from international markets, but in retail sector the concentration development has continued (Arovuori et al. 2011). Thus, retail sector has a possible negotiation power over other actors in the food chain. To address this problem, we have a possibility to use unique data obtained from Statistics Finland that contains the consumer price for both, domestic and imported tomato and cucumber.

Third, we can compare and discuss how the results are related to previous analysis made with fruits in Pakarinen (2010). From that comparison it is possible to find similarities in terms of price transmission although the analyzed products vary from each other.

Usually price series exhibit non-stationary behaviour. Obvious reasons for this could be for example various weather conditions, changing technology or policy acts, among others. There are different estimation strategies depending on whether the time series data is stationary or not. Methods based on cointegration have been popular in examining the vertical price transmission. Using these methods require that the data at hand is non-stationary and that the relationship between modeled variables share equilibrium in the long-run. Error Correction Model (ECM) is widely used to characterize this relationship (see e.g., Conforti 2004; Von Cramon-Taubadel 1998). However, contrary to the conventional assumption, the price series examined in this paper are stationary. This might be a cause of productivity increase in the vegetable sector in the last ten years. Thus, the methods used in this paper should be appropriate to analyze stationary time-series.

Price asymmetry is studied with Autoregressive Distributed Lag (ADL) models and Error Correction Models (ECM), that are the most used methods in studying the asymmetric price transmission (Frey and Manera 2007, 401). By economic theory it is reasonable to assume that producer and consumer prices share equilibrium at least in the long-run. In theory, a change in the producer price has both short and long term effects on the consumer price and the causality is assumed to go from producer price to the consumer price. Both ADL and ECM models enable to examine the equilibrium concept between producer and consumer price and how the process is adjusted back to the equilibrium after a price shock. These estimation methods also reveal the short and long-term effects of producer price on consumer price.

This paper is organized as follows: In Section two a brief overview of the Finnish vegetable markets is presented. Section 3 describes the estimation methods for detecting the asymmetric price transmission and Section 4 the data used in analysis. The results are reported in Section 4 and Section 5 concludes.

2 OVERVIEW OF THE FINNISH VEGETABLE MARKETS

The vegetable sector in Finland is rather small but spatially highly concentrated. Vegetables are the fourth largest group in food consumption after meat, dairy and grain products. Its share is about 11 percent of the whole food products in consumer price index in Finland.

Tomato and cucumber are the most important vegetables. Due to the evident seasonality in production, the prices of cucumber and tomato vary significantly during the year (Figure 1). Given that the price series in Figure 1 include observations from both domestic and imported vegetables, it is reasonable to assume that there exists a large substitution effect mainly on winter season when the Finland's domestic production is significantly lower than in the summer.

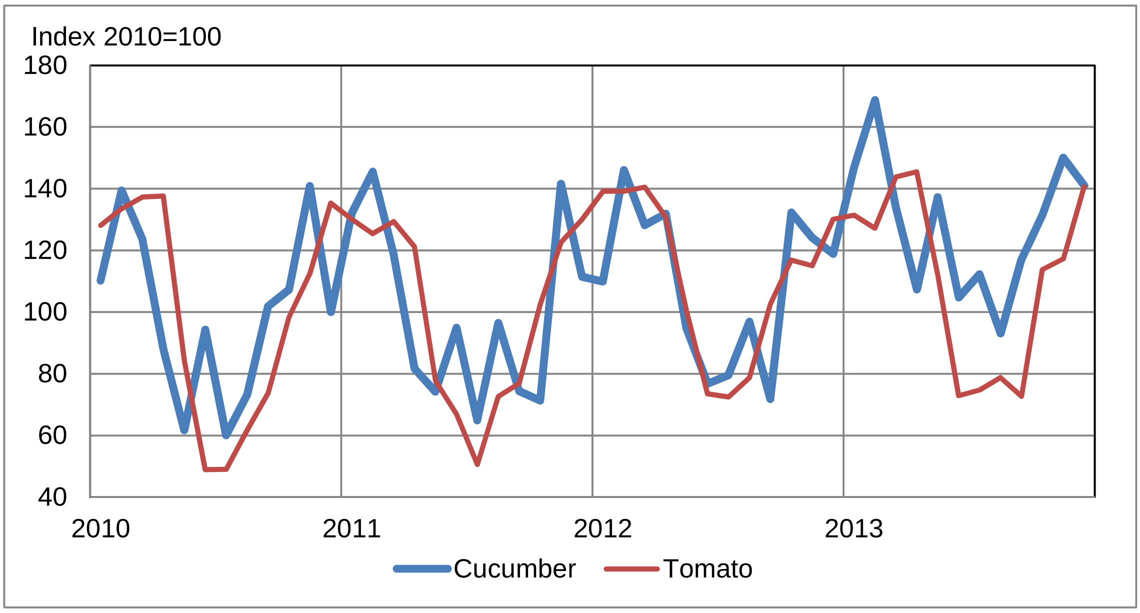

Figure 1. *Price indices of cucumber and tomato. Source: Statistics Finland.*

High price movements are partly caused by production costs which are heavily affected by the weather conditions. Cold winter raises the electricity costs in production and is directly transmitted to the producer's price of particular vegetables.

The price variation of domestic vegetable prices is partly explained by the price of imported vegetables and with the price margin of retail sector (Peltoniemi and Varjonen 2010). But the main driver behind the price variation of domestic vegetables is the changing production environment in Finland. The impact of imported vegetables is highest in off-season when the prices of imported vegetables are relatively low compared to domestic production. The substitution effect of foreign vegetables vanishes in the summer, when tomato and cucumber markets contain only domestic products.

The domestic production of tomatoes and cucumbers has increased steadily during the years 2000-2012 (Figure 2). A rapid increase in production was seen especially from 2009 until 2011, while 2012 saw a reduction in production. At the same time, the amount of imported cucumber has slightly decreased.

In the case of tomato the picture is quite different. Domestic tomato production has remained relatively stable since the mid-2000. However, the amount of imported tomatoes has steadily increased. The product mix of tomatoes is greater compared to cucumber. Therefore the imported tomatoes are major substitutes to domestic tomatoes also during the in-season.

Total amount vegetables supplied in terms of domestic production and imports does not directly equal to consumer demand.. Some proportion of vegetables produced and imported is processed in the industrial sector. Nevertheless, the amounts depicted in Figure 2 are mainly sold to customers as raw products and they indicate at least in some level the market situation in Finnish vegetable markets.

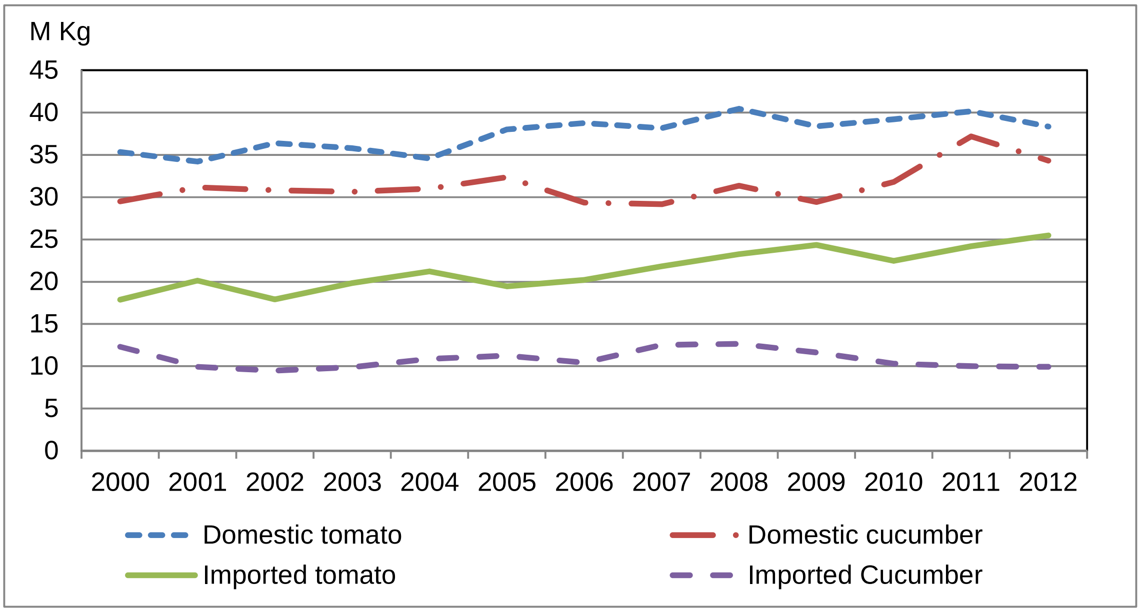

Figure 2. *Total production and imports of tomatoes and cucumbers 2000-2012.*

The diversification of vegetable products has influenced also on the consumption habits of Finnish consumers. The share of expenditures used for tomatoes and cucumber relative to total food expenditures has steadily increased (Figure 3). In 2012, approximately 3,2 percent of total food expenditures were consumed on tomatoes and cucumbers compared to less than 2,5 in 1995. The share also includes pea and paprika which cannot be separated from the 2012 data. However, tomato and cucumber together constitute a clear majority of the vegetables consumption.

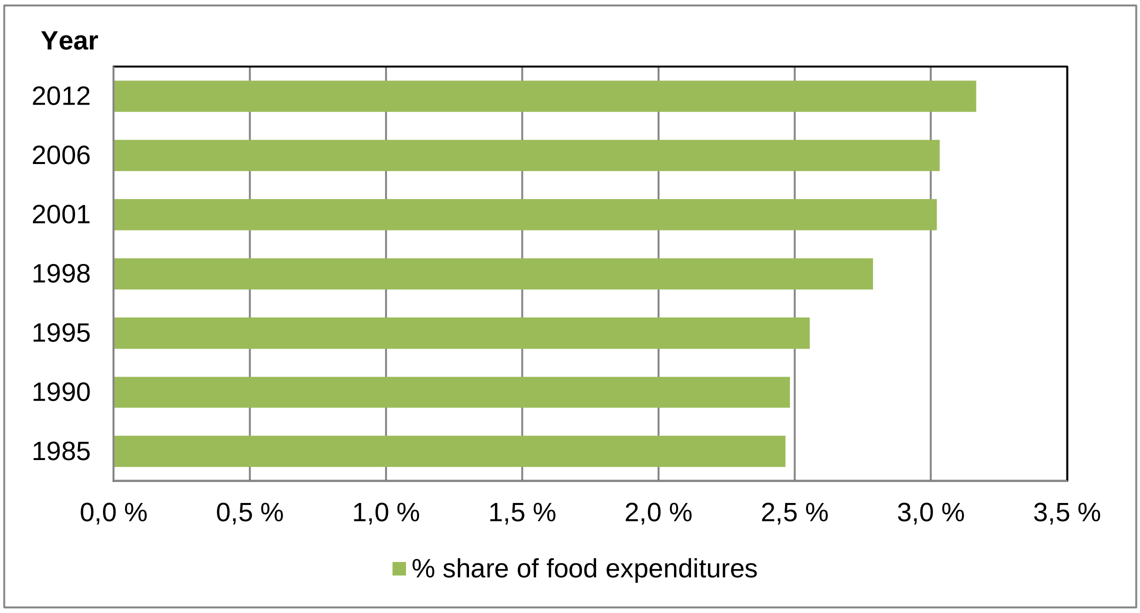

Figure 3. *Tomato, cucumber, pea and paprika consumer expenditures as a share of total expenditures on food in years 1985-2012. Source: Statistics Finland.*

The demand of Finnish consumers has influence on the domestic production possibilities. Increased demand has given room for production increase at wintertime even though the heating and enlightening of glasshouses at wintertime consumes heavily electricity. In year 2000 there was almost no production in Finland during the 4-5 winter months. The increased winter production has also enabled large market shares for domestic production, more than 60% in tomatoes and more than 70% for other vegetables.

Based on previous analysis, it is evident that the Finnish vegetable market encounters competition especially in wintertime. Thus the market is competitive but meanwhile the domestic market is highly concentrated. This is especially true in the packing sector where a few major players constitute almost all the market. Finnish consumers tend to have a preference towards domestic production. Thus, in-season competition is mainly domestic, while during the off-season imports may have major price impacts on the average price levels. However, the producer price levels in Finland are dependent on the total production levels, energy and other input costs as well as retailers' margins.

Although the number of vegetable growers is relative large, the packing markets in Finland are relatively concentrated. Vegetables packing is usually operated by producers themselves or some form of collaborative operations mainly in logistics and marketing, among others. The largest players in the Finnish vegetables sector are Laitila and Närpes Grönsaker, which are farmer owned marketing and packaging companies. These companies negotiate prices with retailers, handle packaging and logistics. In 2013, Laitila had almost 300 owners and contract producers with more than 900 hectares in production. It has approximated 60 percent market share in all fresh market vegetables production in Finland, while the greenhouse production forms only part of its total operation. Närpes Grönsaker is a co-operative with 52 large and small scale greenhouse producers. It is a market leader in tomatoes and cucumbers with approximately 30 percent market share in 2013. Both companies supply their products directly to wholesalers and retailers.

3 ESTIMATION METHOD

In perfectly flexible markets, price changes in input prices are immediately transmitted to upper levels in the chain. However, this is not the case in the real markets where price changes can be transmitted only partially or not at all. The price transmission is influenced by several factors for example menu-costs or negotiation power. We approach this vertical price transmission question with econometric methods that utilize the time series properties of different price series. We assume that the input and output price have relation that can be characterized as

$$\mathrm{P_t^o} = \mathrm{AP_t^i} \tag{1}$$

where $\mathrm{P^i}$ and $\mathrm{P^o}$ are the input and output price, respectively. A is the factor of proportionality. We assume that the transmission is always from the bottom to the top and not vice versa. Since we have two different outputs, the substitution effect must be taken into account since the output price of a substitute has an impact to demand for the explained output price. Thus, after we include substitution effect and take the logarithmic form of Eq. (1) the model becomes

$$p_\mathrm{t}^\mathrm{o} = \mathrm{a} + p_\mathrm{t}^\mathrm{i} + p_\mathrm{t}^\mathrm{s} \tag{2}$$

where $p_\mathrm{t}^\mathrm{o} = \ln \mathrm{P_t^o}$, $a = \ln \mathrm{A}$, $p_\mathrm{t}^\mathrm{i} = \ln \mathrm{P_t^i}$ and $p_\mathrm{t}^\mathrm{s} = \ln \mathrm{P_t^s}$. $\mathrm{P^s}$ refers to price of a substitute. Then, suppose that the Eq. (2) is estimated assuming that the disturbances follow a first-order autoregressive, AR(1) process. The model is then written as

$$\begin{gathered} p_\mathrm{t}^\mathrm{o} = \beta_0 + \beta_1 p_\mathrm{t}^\mathrm{i} + \delta_2 p_\mathrm{t}^\mathrm{s} + \varepsilon_t, \\ \varepsilon_t = \rho\varepsilon_{t-1} + u_t, \quad t = 1, \dots, T. \end{gathered} \tag{3}$$

The error term in Eq. (3) is said being autocorrelated meaning that the error term from previous period affects current period error term. This violates the Gauss-Markov assumption that error terms should not correlate and being identically and independently distributed (iid). To handle the autocorrelation problem, we insert the disturbance process above to the model which leads us to autoregressive distributed lag model (ARDL). The model is then in the form of

$$p_\mathrm{t}^\mathrm{o} = \beta_0 + \rho p_\mathrm{t-1}^\mathrm{o} + \beta_1 p_\mathrm{t}^\mathrm{i} + \beta_2 p_\mathrm{t-1}^\mathrm{i} + \delta_1 p_\mathrm{t}^\mathrm{s} + \delta_2 p_\mathrm{t-1}^\mathrm{s} + u_t, \tag{4}$$

where $\beta_2 = \rho\beta_1$and $\delta_2 = \rho\delta_1$. The Eq. (4) is referred as ARDL(1, 1, 1) model the numbers refer the how many lags are included in. This model can be estimated efficiently with OLS as long as the assumption of identically distributed disturbances holds.

Usually price series exhibit non-stationary behaviour. As was considered in Pakarinen (2010), price series with stationarity behavior can be analyzed with Error Correction Model (ECM). To detect the vertical price transmission, we use the ECM to measure is the price change in lower levels of production chain reflected to the upper levels. With ECM model it is possible only to characterize the speed of an adjustment but not the magnitude. This is a consequence of the linearity of our model. From Eq. (5) we can derive the error correction mechanism straight forward by adding and subtracting as

$$\Delta p_{\mathrm{t}}^{\mathrm{o}} = \beta_0 + \beta_1 \Delta p_{\mathrm{t}}^{\mathrm{i}} + \delta_1 \Delta p_{\mathrm{t}}^{\mathrm{s}} + \phi_1 \left(p_{\mathrm{t}-1}^{\mathrm{o}} - \phi_2 p_{\mathrm{t}-1}^{\mathrm{i}} - \phi_3 p_{\mathrm{t}-1}^{\mathrm{s}}\right) + u_t, \tag{5}$$

where $\phi_1 = \rho - 1$, $\phi_2 = \beta_1 + \beta_2$ and $\phi_3 = \delta_1 + \delta_2$. The difference operator is denoted with Δ. The model selection above is justified by two reasons. First, it characterizes the equilibrium concept between the output, input and substitute price. In addition, ECM allows one to analyze both short and long run effects. Second, it is possible to circumvent the non-stationarity assumption with single-equation ECM (Keele 2005).

Now, the long-run equilibrium between the output, input and substitute prices can be characterized as

$$p_{\mathrm{t}}^{\mathrm{o}} = \alpha_1 + \alpha_2 p_{\mathrm{t}}^{\mathrm{i}} + \alpha_3 p_{\mathrm{t}}^{\mathrm{s}} \tag{6}$$

where $\alpha_1 = \frac{\beta_0}{\phi_1} = \frac{\beta_0}{\rho-1}$, $\alpha_2 = \frac{\phi_2}{\phi_1} = \frac{\beta_1+\beta_2}{\rho-1}$ and $\alpha_3 = \frac{\phi_3}{\phi_1} = \frac{\delta_1+\delta_2}{\rho-1}$. The previous model assumes symmetric price transmission. However, since the objective is to examine the asymmetric price transmission it is possible to calculate residuals as

$$p_{\mathrm{t}}^{\mathrm{o}} - \hat{\alpha}_1 - \hat{\alpha}_2 p_{\mathrm{t}}^{\mathrm{i}} - \hat{\alpha}_3 p_{\mathrm{t}}^{\mathrm{s}} = e_t \tag{7}$$

and then divide the residuals into positive and negative terms (Granger and Lee 1989) as $e_t = e_t^+ + e_t^-$, $e_t^+ = \max(e_t, 0)$, $e_t^- = \min(e_t, 0)$ to construct an ECM as

$$\Delta p_{\mathrm{t}}^{\mathrm{o}} = \beta_0 + \beta_1 \Delta p_{\mathrm{t}}^{\mathrm{i}} + \delta_1 \Delta p_{\mathrm{t}}^{\mathrm{s}} + \gamma_1 e_{t-1}^+ + \gamma_2 e_{t-1}^- + \varepsilon_t \tag{8}$$

To detect the asymmetric price transmission, a null hypothesis $\gamma_1 = \gamma_2$ is tested. The residuals terms in Eq. (8) enable to observe whether the correction towards the equilibrium is the same if we are above or below the long run equilibrium. However, the correction in Eq. (8) is linear so a constant proportion of the deviation is corrected regardless of the size of this deviation (Meyer and Von Cramon-Taubadel 2004, 597). Hence, this estimation strategy concentrates only on the speed of adjustment towards the equilibrium and not on the magnitude.

When estimating the vertical price transmission in vegetable markets, two important features must be taken into account. First, the seasonality is evidently present in price series. This is controlled by adding seasonal dummies in the estimated regression. For convenience, we use quarterly dummies instead of monthly in order to reduce the loss of degrees of freedom. Secondly, there is a problem of missing observations. Usually observations are missing randomly. In this case, there is a known reason for missing observations. The supply of domestic vegetables can cover the demand in summer and there is no need for imported vegetables. Thus, we are missing price observations from the summer months knowing that they are consciously missing. To address this problem, we include dummy variables in the regression equation to control these effects.

4 DATA

4.1 Price series

The seasonality of price changes is easily observed from the price series of tomato and cucumber (Figures 4 and 5.) The data is obtained from Statistics Finland which collects the price data via phone survey to retail firms. In this survey they separate the domestic from foreign products. Given this information, we can analyze does the price adjustment differ between domestic and foreign vegetables. The producer's prices and import prices are collected from Agricultural Statistics and Finnish Customs.

From figure 4 we can see that the price of domestic cucumber has decreased during the analyzing period 2000-2010. Meanwhile, the packing price or producer's price has remained at the same level. The seasonal variation is evident. The consumer price of imported cucumber is less than domestic, but the data covers only to 2008. The import price of cucumber is relatively cheap to domestic producer's price. Hence it is profitable to increase the proportion of imported cucumber in winter time and substitute the vegetable markets.

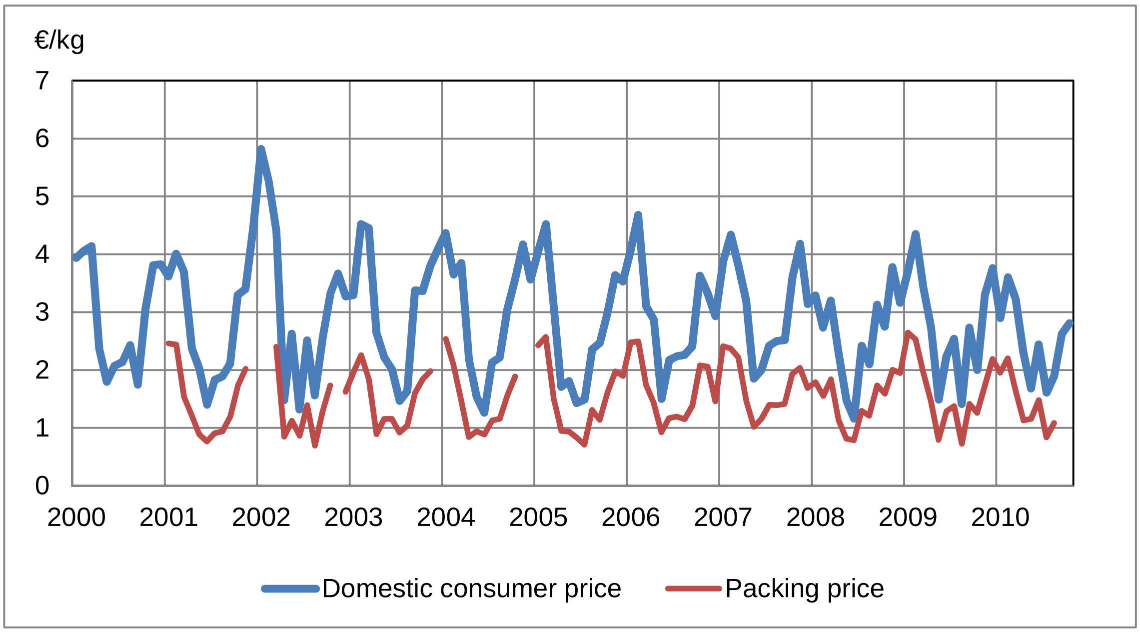

Figure 4. *Domestic cucumber price series 2000-2010. Source: Statistics Finland and Tietokappa.*

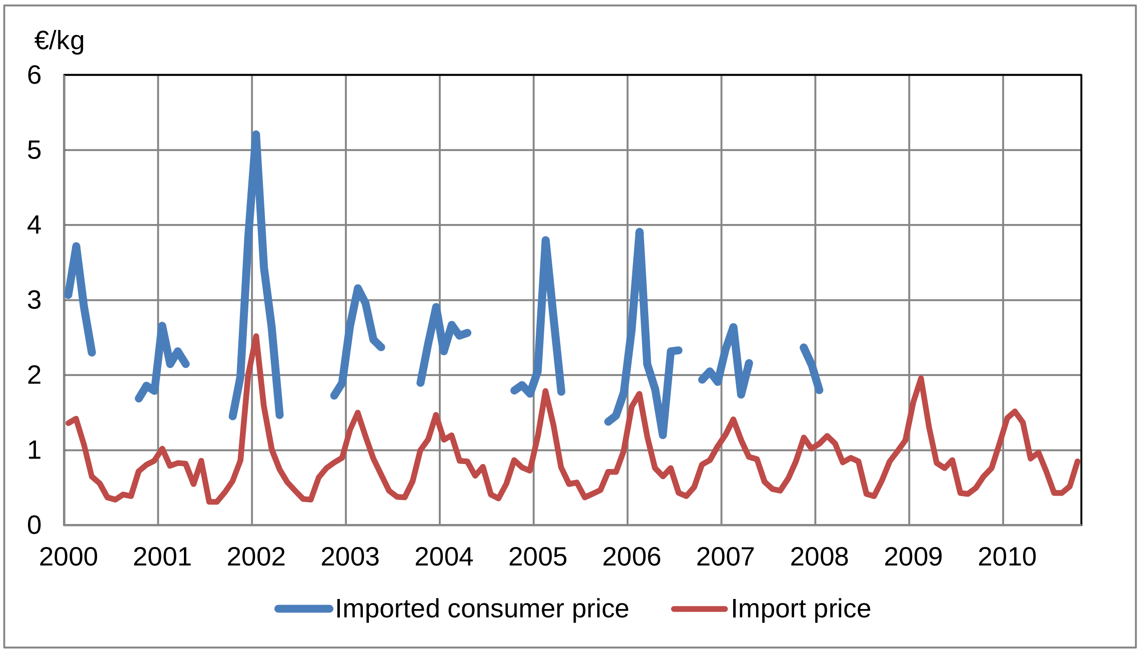

Figure 5. *Imported cucumber price series 2000-2010. Source: Statistics Finland and Tietokappa.*

In the case of tomato, we can see from the Figure 6 that the declining consumer price with domestic product is present as it was with cucumber. The packing price is missing from several winter months and it is rather high compared to cucumber production. The seasonality is stronger than with cucumber and the level of prices is clearly higher than with cucumber.

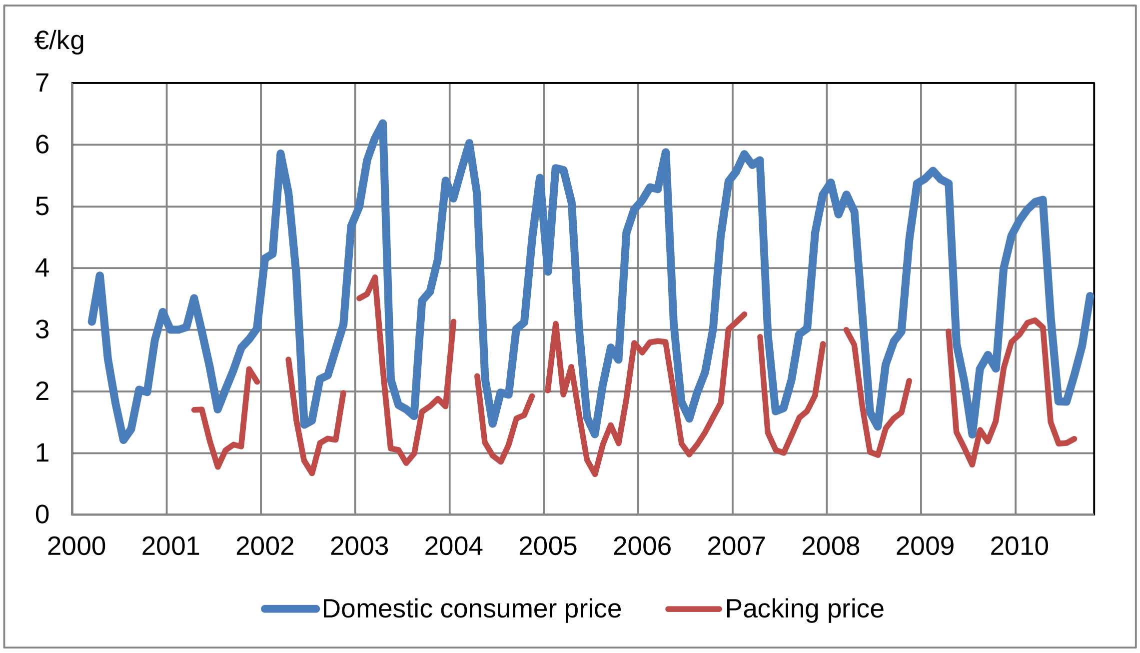

Figure 6. *Price series of domestic tomato 2000-2010. Source: Statistics Finland and Tietokappa.*

When we look the price variations of imported tomatoes we can conclude that the price changes are clearly milder than with domestic tomatoes. Also the lower price level characterizes the difference to domestic tomato which is a consequence of more stable production environment.

Figure 7. *Price series of imported tomato 2000-2010. Source: Statistics Finland and Tietokappa.*

In line with cucumber, the lack of observations poses a real challenge to estimation of vertical price transmission. As observations behind the imported tomato consumer prices are low, the reliability of price data comes into question. This problem is addressed in more detail in results section.

4.2 Price margins

As was noted in previously, the consumer price of both vegetables have decreased in the long term. This implies that the price margin is decreased since the packing or import price has remained at the same level. The price margins of domestic and imported tomatoes are plotted in Figures x and y. The price margin is highest in the beginning of the year in whole period. With domestic tomato, the price margin is lowest in summer when the new crop is in the market. As the share of domestic tomatoes increases, it is not profitable to import tomatoes.

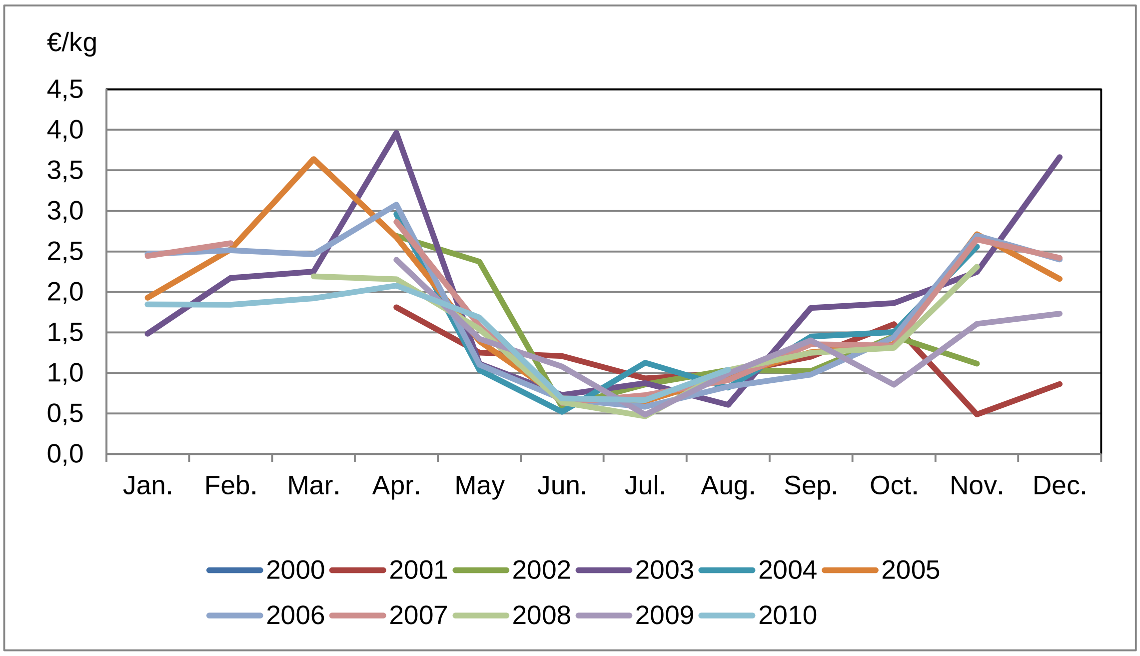

Figure 8. *Price margin of domestic tomato. Source: Statistics Finland, Tietokappa.*

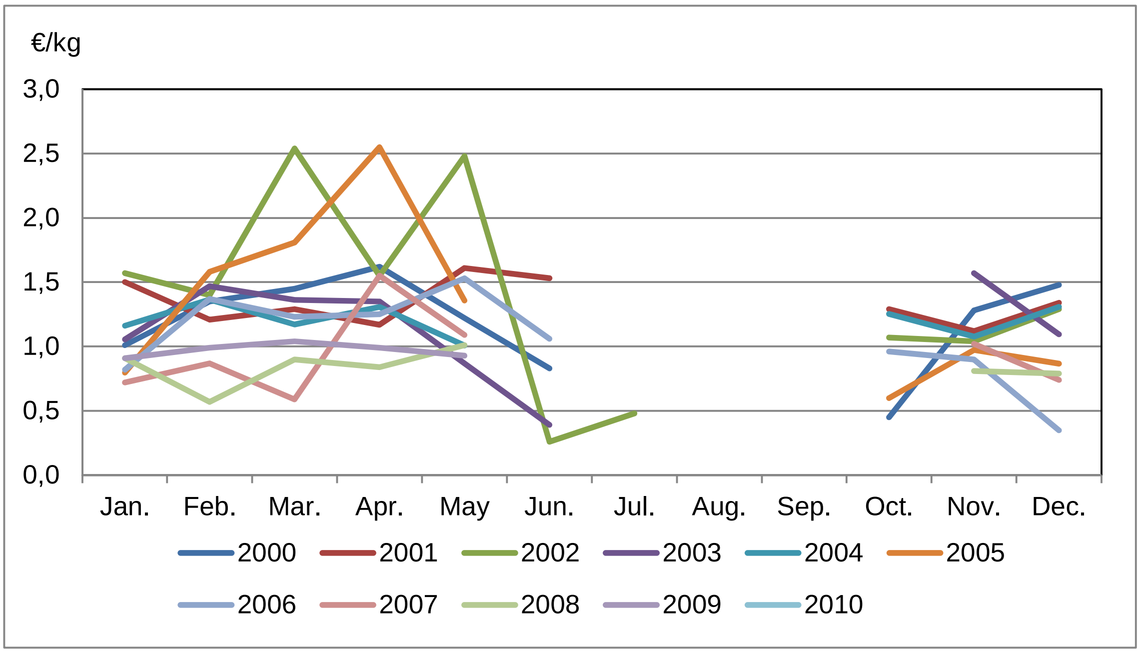

Figure 9. *Price margin of imported tomato. Source: Statistics Finland, Tietokappa.*

The price margin of domestic tomatoes is greater than with imported in winter season. The price margin of domestic tomato increases steadily from the summer and decreases more rapidly when the new crop is completed. The rising margin may reason from consumers' persistent habit that domestic vegetables are demanded even though the consumer price is rising. The variation in price margin is greater with imported tomatoes while domestic tomatoes follow similar pattern every year.

The same kind of evidence is found with cucumber. The price margin is greater with domestic product. A difference to tomato is the level of price margin which is lower than with tomato. The variation in import cucumber's price margin is greater than with domestic cucumber. This is due to amounts of cucumber imported since lower amounts imported cause greater variation in prices.

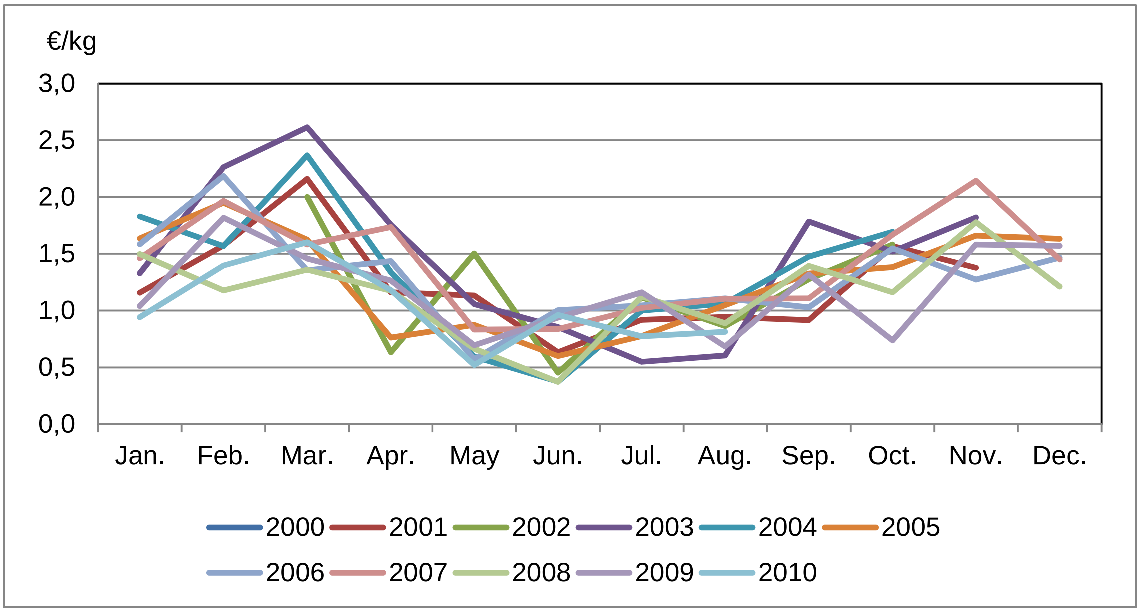

Figure 10. *Price margin of domestic cucumber. Source: Statistics Finland, Tietokappa.*

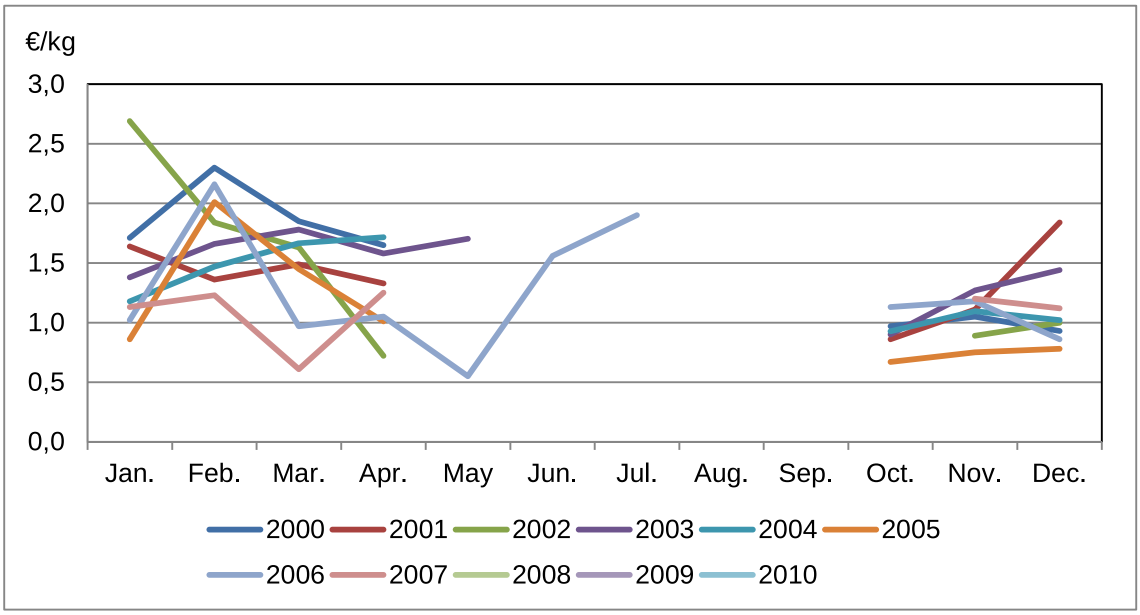

Figure 11. *Price margins of imported cucumbers. Source: Statistics Finland, Tietokappa.*

In summary tomatoes and cucumbers differ from each other especially in imports. The volume of tomato imports implies that it is evidently more substitute to domestic tomato than imported cucumber. Also the variation in domestic production price margin is greater with cucumber than with tomato.

As we mentioned previously, the seasonality is heavily present in price series. To highlight the reliability of price observations it is worth to mention that observations from import vegetables are scarce as we can see from the Figure 12. In addition, those observations are concentrated on summer months but still, they are relatively low level compared to observations behind domestic price series.

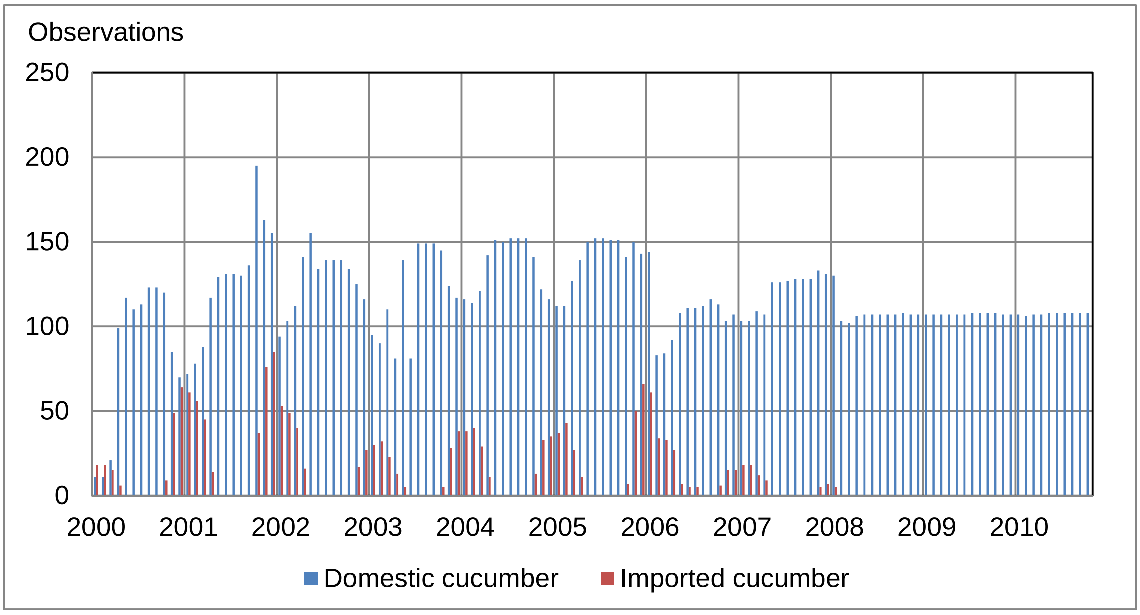

Figure 12. *Price observations behind consumer prices of cucumber.*

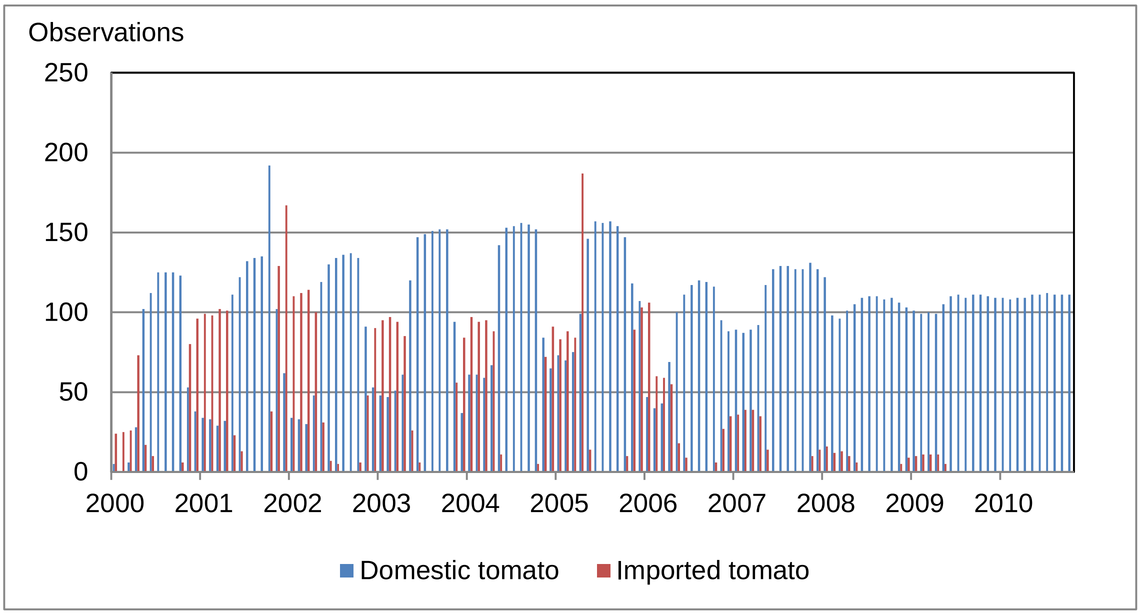

Figure 13. *Price observations behind consumer prices of tomatoes.*

The same applies also with observations of tomatoes which can be seen from Figure 13. This data validity should be considered when interpreting the estimated results. Nevertheless, the price series are valid in statistical terms since they contain enough observations to form a consumer price.

5 RESULTS

The econometric analysis of price series of vegetables indicates that vertical price transmission is not asymmetric. This is more evident in the case of domestic vegetables and less evident with imported vegetables. Next we discuss the result in more general terms and clarify the price transmission in more detail. All estimations can be found from the appendices. In this way we try to keep the presentation of results more compact and coherent. All important results are summarized in Table 2.

All variables used in estimation were in natural logarithms. The performed unit root tests to every price series are not reported in this study and all time-series indicate stationary behavior.[2]

5.1 Cucumber

The domestic vegetables price series contained in total about 130 observations. With imported vegetables the sample was half of this varying from 50 with cucumber to 68 in the case tomatoes. When the packing and imported cucumber consumer prices were regressed on domestic consumer price, all coefficients of variables were significant including the seasonal and missing observations dummy variables as we can see from the Table 2. The results indicate that the short-run effect of packing price on the consumer price is 0.63. This means that the proportional change in the consumer price is 63 % of the proportional change in the packing price, or in other words, one Euro change in packing price causes a change of 63 cents on consumer price. This can be considered to be relatively high since there exists always menu costs etc. which prevent all price variation transmitting to consumer price. The short-run effect of substitute imported cucumber is slow, only 36 % is transmitted to domestic consumer price. The slow effect can be due to seasonality. Imported cucumber is substitute only in winter and domestic cucumber price is adjusted rather slowly.

[2] The unit root test results can be obtained from author upon request.

Table 2. *Estimation results for cucumber and tomato.*

	Short-run effects		Long-run effects		Symmetry		
Explained variable	Producer price	Substitute	Producer price	Substitute	Positive	Negative	Symmetry
Domestic cucumber	0.633	0.357	0.673	0.424	-0.954	-0.932	yes
Imported cucumber	0.664	0.601	0.581	0.947	0.036	-0.920	no
Domestic tomato	0.478	0.457	1.025	0.736	-0.470	-0.437	yes
Imported tomato	0.537	0.316	1.017	0.007	-0.655	-0.479	yes

When the short-run effects are examined from the imported cucumber, we found that the effect of import price is the same size as with domestic, 0.66. In this case, however, the short-run effect of domestic cucumber price is much faster, 0.6 compared to previous opposite examination. As the coefficients of lagged variables are all statistically significant and the coefficient of lag of regressed variable is negative, the error correction mechanism is assured.

The long-run relationship between consumer price, packing price and substitute price indicates that changes in packing price are transmitted more efficiently (67 %) to consumer price than import price to consumer price (58 %). The substitute effect is more dramatic and reflects the problems with data. In the long-run, the substitute effect of imported cucumber consumer price is only 42 percent on domestic cucumber consumer price. However, vice versa the effect is approximately 95 %. Given this result, we can say that the domestic cucumber determines the general market level price and the imported cucumber only levels the supply of cucumber in winter season.

To detect the asymmetry of vertical price transmission we divided the residuals from the estimation to positive and negative and we ran a regression with these on difference on consumer price. The results show that there is no asymmetric price transmission with domestic cucumber. The correction towards the equilibrium is very rapid from both directions, since over 90 % of the deviation is corrected in the first period. The estimates of residuals do not differ from each other (F-statistics 0.01). The same does not apply to imported cucumber. In this case, the estimate of negative residuals is great and negative (-0.92) as it should be. But the estimate of positive residuals is slightly positive (0.04) which is implies that any deviation higher than the equilibrium price is not corrected back towards the equilibrium. However, the estimate is not statistically significant. Thus, there is asymmetric price transmission present with imported cucumber (F-statistics 5.01) but several reasons make this conclusion irrelevant. First, the data provides only 50 observations since the consumer price of imported cucumber is recorded only in winter season. Second, due to seasonality and the lack of observations behind the consumer price, far-reaching conclusions are not worth to do considering the validity of the data.

5.2 Tomato

The results for estimated error correction model for tomatoes are represented in previous Table 2. In summary, the short-run effects are milder than with cucumber. When we examine the effects to domestic tomato, from the proportional change in packing price less than half (48 %) is transmitted to consumer price. The substitution effect is 46 % in the short-run. Respectively, changes in consumer price of imported tomato are 54 % for import price and 32 % for domestic tomato as substitute.

In the long-run, the vertical price transmission from lower price chain level to consumer level is more than 100 %. This means that the consumer price varies more than either packing or import of tomato independently which way the prices are moving. Secondly, the substitution effects differ clearly. Price changes from imported tomato have significant substitution effect as 74 % of the proportional price change is transmitted to the consumer price of domestic tomato in the long-run. On the contrary, domestic tomato has no substitution effect to the import tomato in the long-run.

The results from the long-run relationship indicate that consumer prices varies more than packing or import price of tomato. This implies that pricing in the retail sector is affected not only from the price changes in lower levels of the chain. A certain explanation could be the substitution effect which is present in pricing the domestic tomato. Imported tomato plays a major role in smoothing the supply in off-season period.

To detect the vertical price asymmetry, we found no evidence that asymmetry exists. The residuals from error correction model for import tomato suffered the autocorrelation problem (LM test statistic 5.119 with p=0.024). Despite this shortcoming, the results indicate that the adjustment back towards the equilibrium is medium sized, approximately 50 % in both cases irrelevant of which way the deviation occurs.

6 CONCLUSIONS

In production process, changes in input prices are reflected to output prices. If changes are equal in both directions, margins remain at the same level. We examined the vertical price transmission in Finnish vegetable markets. We apply the same kind of approach as Pakarinen (2010) which studied the vertical price transmission in the Finnish fruit markets.

The results indicate that there is no asymmetric price transmission among Finnish vegetable markets. Hence, the price transmission is the same whether packing prices or import prices are increasing or decreasing. All changes are transmitted fully to the consumer prices except only with imported cucumber the price transmission was not symmetric. This is due to data problems which reduced the number of observations behind the analysis. With cucumber the short and long-run effects were approximately same implying that 60 percent of price variation in producer's price is transmitted to the consumer price. In the case of tomato, the short-run effects are milder than with cucumber but in the long-run the consumer price varies more than producer's price. The substitution effect was different between cucumber and tomato. While the domestic cucumber had a significant effect on the consumer price of imported cucumber, respectively the imported tomato had significant effect on domestic tomato. This result is as expected since the variety of tomatoes in retail sector is greater than with cucumber. The imports of tomatoes compared to cucumber imports also support this view.

If we compare the results from this analysis to previous analysis made with fruits, we found that with domestic products the vertical price transmission is symmetric. Also the corrections towards the equilibrium states are more rapid with domestic vegetables. The difference between vegetables and fruits arises from the substitution effects. With fruits there are no substitution effects since the whole supply is imported from abroad. In summary, we found that vertical price transmission in Finnish fruit and vegetable markets is symmetric though there are some discrepancies with some products. The data problems are also present which are mainly a cause of seasonality of products.

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Appendix
Estimation results

D.consumer_price_domestic				
Variable	Estimate	Std. Err.	t-value	P>|t|
Intercept	0,581	0,0910	6,38	0,000
D.producer_price	0,633	0,0596	10,62	0,000
D.consumer_price_foreign	0,357	0,0777	4,59	0,000
L1.consumer_price_domestic	-0,945	0,0718	-13,16	0,000
L1.producer_price	0,636	0,0785	8,10	0,000
L1.consumer_price_foreign	0,401	0,0801	5,00	0,000
producer_price_dummy	0,306	0,0453	6,76	0,000
consumer_price_foreign_dummy	0,169	0,0651	2,60	0,011
q1	-0,094	0,0448	-2,09	0,039
q2	-0,234	0,0488	-4,80	0,000
q3	-0,131	0,0492	-2,66	0,009
	N	129		
	F(10, 118)	61,16		
	Prob>F	0		
	R^2	0,8383		

D.consumer_price_domestic				
Variable	Estimate	Std. Err.	t-value	P>|t|
Intercept	0,002	0,0369	0,05	0,958
D.producer_price	0,634	0,0386	16,41	0,000
D.consumer_price_foreign	0,356	0,0477	7,47	0,000
producer_price_dummy	0,307	0,0373	8,23	0,000
consumer_price_foreign_dummy	0,168	0,0326	5,17	0,000
L1.positive_residuals	-0,954	0,1200	-7,95	0,000
L1.negative_residuals	-0,932	0,1563	-5,97	0,000
q1	-0,094	0,0360	2,60	0,011
q2	-0,234	0,0397	-5,90	0,000
q3	-0,131	0,0409	-3,21	0,002
	N	129		
	F(9, 119)	68,53		
	Prob>F	0		
	R^2	0,8383		

	chi2	Prob>chi2
Breusch Godfrey for autocorrelation	0,172	0,6781

Symmetry test	F-value	Prob>F
L1.positive_residuals = L1.negative_residuals	0,01	0,9278

D.consumer_price_foreign				
Variable	Estimate	Std. Err.	t-value	P>|t|
Intercept	-0,169	0,2471	-0,69	0,497
D.import_price	0,664	0,0949	7,00	0,000
D.consumer_price_domestic	0,601	0,1280	4,70	0,000
L1.consumer_price_foreign	-0,355	0,1651	-2,15	0,038
L1.import_price	0,206	0,1548	1,33	0,190
L1.consumer_price_domestic	0,336	0,1786	1,88	0,067
q1	0,025	0,0548	0,45	0,653
q2	0,351	0,0850	4,13	0,000
q3	0,627	0,1760	3,56	0,001
	N	50		
	F(8, 41)	27,25		
	Prob>F	0		
	R^2	0,8417		

D.consumer_price_foreign				
Variable	Estimate	Std. Err.	t-value	P>|t|
Intercept	-0,038	0,0380	-1,01	0,319
D.import_price	0,671	0,0744	9,02	0,000
D.consumer_price_domestic	0,531	0,0932	5,70	0,000
L1.positive_residuals	0,036	0,2135	0,17	0,866
L1.negative_residuals	-0,920	0,2807	-3,28	0,002
q1	0,012	0,0427	0,27	0,788
q2	0,266	0,0776	3,42	0,001
q3	0,381	0,1956	1,95	0,058
	N	50		
	F(8, 41)	27,25		
	Prob>F	0		
	R^2	0,8417		

	chi2	Prob>chi2
Breusch Godfrey for autocorrelation	1,638	0,2006

Symmetry test	F-value	Prob>F
L1.positive_residuals = L1.negative_residuals	5,01	0,0306

D.consumer_price_domestic

Variable	Estimate	Std. Err.	t-value	P>|t|
Intercept	0,099	0,1100	0,90	0,372
D.producer_price	0,478	0,0596	8,03	0,000
D.consumer_price_foreign	0,457	0,1036	4,41	0,000
L1.consumer_price_domestic	-0,453	0,0850	-5,34	0,000
L1.producer_price	0,465	0,0783	5,93	0,000
L1.consumer_price_foreign	0,334	0,1081	3,09	0,003
producer_price_dummy	0,278	0,0567	4,90	0,000
consumer_price_foreign_dummy	0,232	0,0997	2,32	0,022
q1	-0,082	0,0578	-1,42	0,158
q2	-0,281	0,0598	-4,72	0,000
q3	-0,005	0,0655	-0,08	0,936
	N	127		
	F(10, 116)	61,16		
	Prob>F	0		
	R^2	0,7236		

D.consumer_price_domestic

Variable	Estimate	Std. Err.	t-value	P>|t|
Intercept	0,003	0,0421	0,08	0,937
D.producer_price	0,479	0,0514	9,31	0,000
D.consumer_price_foreign	0,457	0,0608	7,52	0,000
producer_price_dummy	0,274	0,0489	5,61	0,000
consumer_price_foreign_dummy	0,232	0,0559	4,15	0,000
L1.positive_residuals	-0,470	0,0783	-6,00	0,000
L1.negative_residuals	-0,437	0,0789	-5,54	0,000
q1	-0,081	0,0478	-1,70	0,092
q2	-0,285	0,0536	-5,31	0,000
q3	-0,008	0,0562	-0,14	0,891
	N	127		
	F(9, 117)	34,09		
	Prob>F	0		
	R^2	0,7239		

	chi2	Prob>chi2
Breusch Godfrey for autocorrelation	1,735	0,1878

Symmetry test	F-value	Prob>F
L1.positive_residuals = L1.negative_residuals	0,14	0,7051

D.consumer_price_foreign

Variable	Estimate	Std. Err.	t-value	P>|t|
Intercept	0,296	0,1387	2,13	0,037
D.import_price	0,537	0,1366	3,93	0,000
D.consumer_price_domestic	0,316	0,0831	3,81	0,000
L1.consumer_price_foreign	-0,607	0,1271	-4,77	0,000
L1.import_price	0,617	0,1562	3,95	0,000
L1.consumer_price_domestic	-0,004	0,0763	-0,06	0,953
q1	0,060	0,0522	1,15	0,254
q2	0,123	0,0656	1,87	0,066
q3	0,001	0,1685	0,01	0,995
	N	68		
	F(8, 41)	16,01		
	Prob>F	0		
	R^2	0,6846		

D.consumer_price_foreign

Variable	Estimate	Std. Err.	t-value	P>|t|
Intercept	0,010	0,0493	0,20	0,842
D.import_price	0,540	0,1218	4,44	0,000
D.consumer_price_domestic	0,313	0,0764	4,10	0,000
L1.positive_residuals	-0,655	0,1685	-3,88	0,000
L1.negative_residuals	-0,479	0,3469	-1,38	0,172
q1	0,060	0,0467	1,28	0,205
q2	0,121	0,0597	2,03	0,046
q3	0,010	0,0493	0,20	0,842
	N	68		
	F(8, 41)	18,67		
	Prob>F	0		
	R^2	0,6854		

	chi2	Prob>chi2
Breusch Godfrey for autocorrelation	5,119	0,0237

Symmetry test	F-value	Prob>F
L1.positive_residuals = L1.negative_residuals	0,15	0,6982

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