# The price stabilization effects of the EU entry price scheme for fruits and vegetables

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# The Price Stabilisation Effects of the EU entry price scheme for fruits and vegetables

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***Abstract***

*The paper assesses the stabilization effects of the EU import regime for fresh fruit and vegetables based on the entry price system. The analysis is carried out on the EU prices of tomatoes and lemons and those of imports from some of the main competing countries on the EU domestic markets: Morocco, Argentina and Turkey. It is based on the estimation of a threshold vector autoregressive econometric model that is shown capable of taking the workings of the import regime into account. The model shows that prices behave differently when import prices are above/below the trigger entry price. This paper allowed to highlight the cases for which the isolation effect of EPS seems reached and the resulting stabilization effects.*

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# *The Price Stabilisation Effects of the EU entry price scheme for fruits and vegetables*

## 1. Introduction

The EU import regime for fresh fruit and vegetables (F&V) is rather complex changing according products, partner countries and seasonality. There are several reasons explaining such complexity arising from the circumstance that the EU is at the same time the largest importing country in the world and one of the most relevant producing country. Therefore the F&V import regime pursues different objectives that in some situations could also be conflicting. The protection and stabilisation of revenues of EU producer of F&V; the supply of large and differentiated provisions of F&V to EU consumers at reasonable price; the integration of the import regime within the international relationships that the EU is promoting, particularly with developing and neighbouring countries, are the most relevant aims that the import regime should help to attain.

One of the most controversial feature of the import regime is certainly the entry price system (EPS) that was introduced in 1995 after the signing of the Uruguay Round Agreement on Agriculture, replacing the old reference price system. The EPS is applied only to a limited number of products that are the most relevant to EU producers, while imports of other F&V products are only subject to duties.

The main objectives of the old reference price system introduced in the 1972 Common Market Organization of F&V, that are also pursued by the existing EPS, were to give a contribution both to the stabilization of EU domestic prices of F&V products and in the prevention of market crises that in the F&V sector are rather frequent. The stabilization effects of the EPS, in the sense of reducing price variability cutting the lower tail of price distribution, may arise from the avoidance of imports from a partner country whose import price or, more exactly, an index built on it, called Standard Import Value (SIV), is below the trigger entry price (TEP). The effect would be the consequence of the fact that in days in which the SIV of a product imported from a country is lower than the TEP of that product by less than 8%, besides the tariff, imports from that country are also charged of a specific duty that is roughly equal to the difference between the TEP and the SIV. If the SIV is below 92% of the TEP, the specific duty applied besides the tariff is the maximum tariff equivalent (MTE). The amount of the MTE for the different products is generally so high that its charge would make imports unprofitable. However, since the system works on a consignment basis it is possible to avoid the payment of the specific tariff showing that the actual sale price of the consignment was such that a lower duty was to be paid (Swinbank and Ritson 1995; Agrosynergie, 2008). Moreover, importers may also avoid the payment of the specific duty waiting for custom clearance when the SIVs are higher that the TEP.

Shortly after the introduction of the EPS, Swinbank and Ritson (1995) comparing the new import regime to the previous, were rather skeptical about its ability to increase significantly the EU F&V market openness. In recent years, there has been a growing number of papers and articles devoted to the analysis of the EPS. Some of them tried to analyse its effects on trade flows of F&V in comparison to the previous import regime. Cioffi and dell'Aquila (2004) highlighted that during the first years of implementation the EPS showed a selection effect on the growth of EU imports of F&V, preventing imports of low quality/price produce. However, a recent evaluation report on the EPS demonstrated that in recent years imports of F&V products covered by the import regime grew at a rate not differing from that shown by F&V not covered by the EPS (Agrosynergie, 2008). The econometric analysis by Emlinger *et al.* (2008) through a gravity model approach showed that the import regime had effects on the EU import flows of fruit and vegetables, although for some product other factors should also be taken into account. Goetz and Grethe (2009) by mean of a multivariate statistic analysis approach showed that the relevance of the EPS is not homogeneous among different products and origins, being wider for more perishable products and for neighbouring partner countries.

Since the effects of the EPS on EU import flows of F&V are not clear-cut, while the issue of the destiny of the EPS after the Doha round is open, it is worth to get deeper insight on the different effects it produces. Particularly, the question of understanding if the EPS contributes to EU domestic prices stabilisation, that is the main goal of the EPS, is achieved is still unresolved.

Recent papers by Garcia Alvarez Coque *et al.* (2009, 2010) found that the removal of the EPS, as well as the reduction of the TEP and of the specific tariff while keeping alive the EPS, would have moderate impact on prices of EU domestic products. Although the stabilization issue is not directly addressed in these papers, such findings also imply that the EPS would be effective in price stabilization. These results were obtained simulating changes in the border measures with partial equilibrium models of four products, that acknowledge the full effectiveness of the EPS in sheltering the EU domestic markets.

The problem addressed by this paper is twofold: on one hand we assess the effectiveness of the EPS, trying to evaluate how EU F&V domestic prices determination process changes when the SIVs fall below the TEP and if the EU market becomes isolated from the competition of partner countries products; on the other hand we measure the stabilization effects of the EPS. Of course the size of the stabilization effect of the EU domestic price of a product is linked either to the occurrence of the EU market isolation and to the size of imports with respect to the quantity of products traded in the EU internal market. The econometric approach we propose and the results that are derived by its application to the cases of study represent the main contributions to the current debate on the functioning of the EPS.

The task is not easy because the peculiarities of the price discovery processes in the F&V markets. Since world prices cannot be observed registering price of transactions on foreign markets and adding transportation costs to obtain *cif* prices as it happened in the past for the other EU import regime, in implementing the EPS they are estimated calculating the SIVs starting from prices registered on the main EU markets

The lack of prices on world markets, while the only available information are EU domestic prices and SIVs, obliges to carry out the analysis on the effects of the EPS on EU prices trying to evaluate what happens to their determination process when the SIVs fall below the TEP. This implies that the analysis will be carried out only on products that show a greater share of SIVs below the TEP, referred to countries whose exports to the EU have a significant share of the market, contributing significantly to the EU price determination process. On the contrary, the assessment of the stabilisation effects of the EPS arising from the deterrence effects in the case of products whose SIVs are rarely lower than the TEP it is not possible.

Our empirical analysis hinges on the idea that if the EPS affects EU domestic prices of F&V, their daily data series cannot be described by a random walk. We carry out an econometric analysis based on a model that derives its autoregressive structure from the competitive storage model by Deaton and Laroque (1992, 1996), modified to take into account imports from other countries and the EPS. Starting from this model, we estimate and test a nonlinear threshold model as proposed by Tong (1978, 1990) and generalized in the multivariate case in Tsay (1998). In our analysis the threshold is exogenous and is given by the 92% of the TEP that distinguishes two different regimes. By means of this nonlinear specification we will be able to identify price relationships of different markets and products and how they change in the two regimes, assessing if the EPS insulates the EU domestic market when SIVs are below the TEP.

Since the estimation of threshold models requires an adequate number of cases for each regime, our analysis is confined to products and partner countries that undercut frequently the TEP. For this reason, the analysis is concerning with four cases regarding the imports of tomatoes from relevant partner countries as Morocco and Turkey and of lemons from Turkey and Argentina. It is worth to underline that in the study on the relevance of the EPS of Goetz and Grethe (2009) these four combinations of products and origins belong to classes of higher relevance of the EPS. Although the analysis is confined to a limited number of cases, we believe that this is fairly enough to get useful insights on the effects of the EPS on EU domestic prices.

In the next section we outline shortly the features of market and trade of the two products on which the study is focused that are more relevant to the following analyses. The econometric model is presented in section 3, while results are set out and discussed in section 4. Conclusions and indications for further research are developed in section 5.

## 2. The main features of the import regime and seasonality of tomatoes and lemons

Tomatoes and lemons are particularly suited to the analysis that we are going to develop also because of the large number of SIVs calculated and published by the EU Commission, since the EPS is applied all year long. In the case of tomato the two most relevant EU partner countries are Morocco and Turkey, while for lemons the main partner countries are Argentina and Turkey. Given this choice it must be deemed that the import regime applied to the tomatoes imported from Turkey and Morocco is modified by preferential trade agreements although with different rules.

EU imports of agricultural products from Turkey benefit of a preferential regime within the Custom Union agreement. The preferential regime is defined by Council Decision 1/98 (1998) and for many fresh and processed fruit and vegetables tariff exemptions or reductions are bound by TRQs and import calendars. EU imports of tomatoes from Morocco benefit of a zero tariff quota also subject to a reduced preferential TEP while the specific duty is the MFN one. The tariff quota was initially agreed in 130,000 tons of tomatoes distributed in monthly quotas from November to March (Council Decision, 1994). In subsequent years the quota granted to tomato imports from Morocco was gradually increased and spread in monthly quotas from October to May under the reduced TEP (Table 1).

**< TABLE 1 ABOUT HERE >**

Among EU members, Spain is the chief exporter of tomatoes, except in summer when the Netherlands takes over. Morocco is the main exporting country of tomatoes to the EU, with a share of about 80% on total exports. Import volumes of tomatoes from other partner countries are much smaller: Israel and Turkey have a share of about 7-8%. However, Turkey exports tomatoes mainly during summer months, while exports of Israel are made of different varieties of tomatoes. The competition between Spain and Morocco is very intense due to the great similarity of their production seasons, target markets, technologies and varieties (de Pablo Valenciano and Perez Mesa, 2004). The period with the highest competition span from October to March, when imports from Morocco have zero tariffs if SIVs are above the preferential TEP and the volume of imports does not exceed the monthly quotas.

As far as lemons are concerned, Spain is the main EU producer with an average harvested production in the three years 2006-2008 of 681.400 tons according Eurostat data. Spain is also a net exporter of lemons to other EU countries. Globally, the EU is a net importer of lemons, around 400.000 tons per year, with Argentina that is the main partner country supplying the 50-60% of total import while Turkey is the second partner country with a share of 20%. Imports of lemons from Argentina are distributed from May to October while those from Turkey span from September to April.

## 3. The econometric model

Considering that very often the SIVs of a F&V products imported from partner countries are below their TEP only for a few days, to assess the effects played by the EPS on EU products prices it is necessary to use daily data.. Since prices and SIVs are the only data available on a daily base, we have to formulate a simplified market model in which the equilibrium affects only prices of domestic and imported products.

The dynamic structure of the econometric model we estimate may be seen as a reduced form of the competitive storage model proposed by Wright and Williams (1982) and Deaton and Laroque (1992, 1996). These models are based on the idea that consumers can buy both goods that have been stored from the previous periods as well as goods produced in the same period. The cost of inventories to risk neutral holders is given by the interest rate *r* paid on capital and by the shrinkage of stocks from one period to the next. Deaton and Laroque (1992, 1996) build and test a model using only product prices series whose dynamic is based on a unique stationary rational expectation equilibrium, while the estimation procedures enables the identification of the parameters characterising the structural form of the model. According to the competitive storage model, prices follow an autoregressive process of order one, switching to a white noise process in stockout periods.

The storage model could seem not appropriate to represent price determination processes in the case of F&V products, considering that they are generally highly perishable and it is only possible to store them for short periods whose length depends on the products characters. Moreover the storage of F&V bears costs as refrigeration and conditioning that add to the shrinkage cost. The justification of our referring at the competitive storage model is based on the fact that we have to analyse series of daily prices and therefore it seems plausible to assume that products can be transferred from one day to the other.

To evaluate the effects of the EPS on EU domestic prices of F&V we must also introduce assumptions regarding the relationships of such prices with that of imported products. At this aim we assume that price of imported products in the EU F&V markets follow the model of determination in a large country. Moreover since we have different prices for domestic and imported products we also assume that the domestic and imported F&V products are imperfect substitute in the EU consumers demand. This would allow the presence of relationships between the two prices and separate price determination models.

The reduced form representation of the price determination model in the EU market is an AR(1) system of equations 1-2:

1) $P_t = f(P_{t-1}, SIV_{t-1}) + \varepsilon_{1t}$

2) $SIV_t = g(P_{t-1}, SIV_{t-1}) + \varepsilon_{2t}$

where $P_t$ and $P_{t-1}$ represent the daily prices of EU domestic products, respectively at time *t* and *t-1*, $SIV_t$ and $SIV_{t-1}$ are the daily Standard Import Values, respectively at time *t* and *t-1*, *f* and *g* are two different functional forms, $\varepsilon_{1t}$ and $\varepsilon_{2t}$ are error terms assumed to be identically independently distributed with mean 0 and variance $\sigma^2$.

To assess the effect of the EPS on price determination of EU F&V markets we adopted a threshold autoregressive (TAR) model. TAR models belong to the general class of non-linear models. Introduced by Tong (1978) and later formalized by himself (Tong, 1990), they have been widely used, because of their interpretability in many economic analysis (see among others Kapetanios and Shin, 2006). These models allow to include non-linearity by separating the data in two or more linear regimes according to a "threshold variable". In our analysis the two regimes are separated by the following exogenous and deterministic switching variable ($I_t$):

$$I_t = \begin{cases} 1 \; if \; SIV_{t-1} \geq 0.92 * TEP_{t-1} \\ 0 \; if \; SIV_{t-1} < 0.92 * TEP_{t-1} \end{cases}$$

where again *TEP* stands for trigger entry price. The variable $I_t$ allows to separate the data in two sub-samples according to the relative position of SIVs with respect to the TEP[1].

Including the indicator $I_t$ into the system of equations 1-2 results into a two-regimes threshold system specified by:

$$3) \begin{cases} P_t = I_t * \{f_1(P_{t-1}, SIV_{t-1}) + \varepsilon_{1t}\} + (1 - I_t) * \{f_2(P_{t-1}, SIV_{t-1}) + \varepsilon_{3t}\} \\ SIV_t = I_t * \{g_1(P_{t-1}, SIV_{t-1}) + \varepsilon_{2t}\} + (1 - I_t) * \{g_2(P_{t-1}, SIV_{t-1}) + \varepsilon_{4t}\} \end{cases}$$

where $\varepsilon_{it}$ represent the error terms assumed to be *iid* $(0,\sigma_i^2)$, where $i$=1, … , 4.

[1] Since in many cases since the variable $I_t$ might be zero 1 or 2 days per week the adoption of time aggregated data (weekly or monthly) is not suitable.

In our analysis we are interested in testing if price series behave differently when the SIVs are above ("normal" regime) or below the 92% of the TEP, that is when the maximum specific duty is applied. Through the specification (3) we will be able to assess if the two regimes are different. The threshold model can be estimated if two conditions are satisfied: 1) a sufficient number of observations are attributed to each regime (Andrews, 1993; Seo, 2003); 2) the estimated coefficients of the model parameters differ in the two regimes.

A parametric form of system (3) may be obtained assuming an additive specification. The following threshold vector auto-regressive of order one (TVAR(1)) results:

$$4)\begin{cases} P_t = I_t * \left\{\alpha_1^I + \beta_{11}^I P_{t-1} + \gamma_{11}^I SIV_{t-1} + \varepsilon_{1t}^I\right\} + (1 - I_t) * \left\{\alpha_1^{II} + \beta_{11}^{II} P_{t-1} + \gamma_{11}^{II} SIV_{t-1} + \varepsilon_{1t}^{II}\right\} \\ SIV_t = I_t * \left\{\alpha_2^I + \beta_{21}^I P_{t-1} + \gamma_{21}^I SIV_{t-1} + \varepsilon_{2t}^I\right\} + (1 - I_t) * \left\{\alpha_2^{II} + \beta_{21}^{II} P_{t-1} + \gamma_{21}^{II} SIV_{t-1} + \varepsilon_{2t}^{II}\right\} \end{cases}$$

where the superscript index is referred to the regime (I or II) and the two subscript indexes are referred to the *i-th* equation (1 or 2) and to the lag order (one for specification 4).

For cases in which residuals autocorrelation might be an issue, we consider a specification of higher order. The TVAR of *n* lags (*n* > 1) of equation (5) represents a general case:

$$5)\begin{cases} P_t = I_t * \left\{\alpha_1^I + \sum_{j=1}^{n} \beta_{1j}^I P_{t-j} + \sum_{j=1}^{n} \gamma_{1j}^I SIV_{t-1} + \varepsilon_{1t}^I\right\} + (1 - I_t) * \left\{\alpha_1^{II} + \sum_{j=1}^{n} \beta_{1j}^{II} P_{t-j} + \sum_{j=1}^{n} \gamma_{1j}^{II} SIV_{t-1} + \varepsilon_{1t}^{II}\right\} \\ SIV_t = I_t * \left\{\alpha_2^I + \sum_{j=1}^{n} \beta_{2j}^I P_{t-j} + \sum_{j=1}^{n} \gamma_{2j}^I SIV_{t-1} + \varepsilon_{2t}^I\right\} + (1 - I_t) * \left\{\alpha_2^{II} + \sum_{j=1}^{n} \beta_{2j}^{II} P_{t-j} + \sum_{j=1}^{n} \gamma_{2j}^{II} SIV_{t-1} + \varepsilon_{2t}^{II}\right\} \end{cases}$$

where the subscript *j* indicates the lag order. The order of lags in the TVAR(*n*) is determined by the Schwarz Information Criteria (SIC).

In our analysis TVAR models were estimated using the full information maximum likelihood (FIML) method which is asymptotically efficient among estimators of simultaneous equation model and, for well-specified model, is able to provide consistent estimates of parameters either with *iid ~ N(0,1)* error terms and with errors autocorrelation (Greene, 2004).

For the sake of simplicity, we present the interpretation of results referring to the TVAR(1) specification of equation 4 since it is easily extendable to the TVAR(*n*) model. If the price determination processes of EU F&V products depend on the imports from a partner country and EPS affects such processes, the functional forms of the first and the second regime would differ each other. However, since the threshold variable discriminates the regimes according to the relative position of SIVs with respect to the TEP, the different competitive behaviors at different price levels might contribute to change the parameters of price transmission. Under the assumptions in the system of equations 1-2, SIVs and EU domestic prices should influence each other in the first regime. If the influence of SIVs on EU domestic price is observed in the first regime ($\gamma_{11}^{I} > 0$) and it is also maintained in the second regime ($\gamma_{11}^{II} > 0$) we cannot conclude that the EPS does isolate the EU market since the relationship stands in both regimes. According to model (4), if the coefficients of SIVs $\gamma_{11}^{I}$ and $\gamma_{11}^{II}$ in the equations will be, respectively, higher than zero and zero we can say that the EPS is effective in avoiding cheap imports from a country, isolating the EU domestic market from low price imports. Finally, when the estimated coefficients do not show an evidence that the SIVs effect the EU domestic prices in both regime we cannot conclude on the effectiveness of the EPS.

As far as tomato imported from Morocco is concerned, since the TRQ is binding, changes in the quota size agreed between EU and Morocco may have had effects on the market price determination process. In order to capture the effects of the quota expansion from 150.676 to 175.00 tons in 2003 and of the introduction of a further conditional quota (45.000 tons) by 2006, we modified the specification (4) accordingly:

$$4.b)\begin{cases} P_t = I_t * \left\{\alpha_1^I + \beta_{11}^I P_{t-1} + \gamma_{11}^I SIV_{t-1} + \delta_{11}^I D_1 + \delta_{12}^I D_2 + \varepsilon_{1t}^I\right\} + (1 - I_t) * \left\{\alpha_1^{II} + \beta_{11}^{II} P_{t-1} + \gamma_{11}^{II} SIV_{t-1} + \delta_{11}^{II} D_1 + \delta_{12}^{II} D_2 + \varepsilon_{1t}^{II}\right\} \\ SIV_t = I_t * \left\{\alpha_2^I + \beta_{21}^I P_{t-1} + \gamma_{21}^I SIV_{t-1} + \delta_{21}^I D_1 + \delta_{22}^I D_2 + \varepsilon_{2t}^I\right\} + (1 - I_t) * \left\{\alpha_2^{II} + \beta_{21}^{II} P_{t-1} + \gamma_{21}^{II} SIV_{t-1} + \delta_{21}^{II} D_1 + \delta_{22}^{II} D_2 + \varepsilon_{2t}^{II}\right\} \end{cases}$$

where $D_1$and $D_2$ are, respectively, dummy variavbles assuming value 1 for period from 2003 to 2006 and from 2006 to the end of the series. The TRQ expansion, allowing increased imports from Morocco, should lower the SIVs level, while the effect on EU domestic prices could be negligible due to the small dimension of additional quota respect to the total marketed quantities.

Furthermore, if the EPS is effective in isolating the EU price the quota expansion might not influence the price and SIVs in the second regime.

The relationships among EU domestic prices and SIVs of different products and partner countries are quantified and compared through the coefficient $\eta$ that normalize the regime/product-specific impact multipliers[2].

## 4. Empirical results

The daily prices data used to carry out the analysis were extracted from the Agriview database of the European Commission, which includes daily prices of F&V collected on EU wholesale markets of different member countries. Data on daily SIVs, proxy of border prices of imports, are calculated by the EU Commission. All prices are reported in euro and expressed in current terms. Since price series collected on the different EU markets within the Agriview database have several missing data, the selection of markets on which to carry out the analysis has been forced by data availability. The criteria adopted in the selection was to pick the longest series with the smaller number of missing price data. Choosing the market using the criteria of data availability may have the limit that market integration relationships could hidden possible relationships between the SIVs and EU prices observed on other markets. Concerning the analysis, when price series we choose still have missing data, they were omitted to obtain a full and continuous time series.

The effectiveness of EPS in stabilization of EU tomato prices has been analyzed through the cases of imports from Morocco and Turkey, which account, respectively, for 83% and 6% of the total fresh tomato imports from extra-EU countries. Since EU imports from Morocco are mainly spread from November to March, when the import monthly quotas are effective and wider, the

[2] The multipliers in finite lag dynamic models with stationary variables are represented by the regression coefficients (Greene, 2004). In order to compare the multipliers, the variable η is computed by normalizing the multipliers of interest by the ratio of price and SIVs means (e.g. the normalized multiplier $\eta_{P^I}^{SIV^I}$ that capture the change in price due to change in SIVs in the first regime is the following: $\partial {P^I}_t / \partial {SIV^I}_{t-1} = \gamma_{11}^I \frac{\overline{SIV^I}}{\overline{P^I}}$). In AR($n$) model the multiplier is given by the sum of coefficients.

econometric analysis is built on daily price data related to these months, using a time series starting on January 2000 and ending on February 2007. On the other hand, since imports from Turkey are distributed from April to October also in this case daily data are limited to these months. The EU domestic tomato price were collected on the Almeria (ES) wholesale market. Such market is of high relevance for a tomato producing area that is affected by the competition of products imported from Morocco. On the other hand, to analyze the relationships regarding the SIV of tomato imported from Turkey we used prices collected from the French market of Chateau Renard[3].

To analyze the effectiveness of the EPS in the case of lemon we considered the SIVs of imports from Argentina and Turkey while the EU domestic prices were collected on the Murcia (ES) wholesale market. This market is of high relevance for the Spanish lemon producing area. The SIVs of lemons imported from Turkey and Argentina show a high share of values belonging to the second regime (17%, 124 out of 729,and 35%, 213 out of 611, for Turkish and Argentinean imports respectively). Conversely, as far as tomato imports are concerned, 13% and 11% of SIVs of products imported respectively from Morocco and Turkey pertain to the second regime.

Summarizing, the econometric analysis was applied to two case studies related to the tomato market (a) Almeria (ES) prices and Moroccan SIVs, (b) Chateau-Renard (FR) prices and Turkish SIVs, and two cases of the lemon market (c) Murcia (ES) prices and Turkish SIVs, (d) Murcia (ES) prices and Argentinean SIVs. Time series of daily prices and SIVs refer to weekdays from Monday to Friday and contain data for the season in which transactions are registered: November-March (a); April-October (b); October–May (c); May-October (d). Prices from different years are combined to obtain a unique sample and cover the periods 2000-2007 (case *a*), 2000-2004 (case *b*) and 1998-2006 (cases *c* and *d*).

[3] We also conducted a preliminary analysis by using Almeria prices an SIVs of tomato imported from Turkey but no relationships between these prices and the Turkey SIVs were found.

**< TABLE 2 ABOUT HERE >**

**< GRAPH 1 ABOUT HERE >**

order to carry out the analyses some preliminary tests and transformations of time series were applied. Nelson and Plosser (1982) showed that a vast majority of economic series could be better characterized by a unit root process rather than by a deterministic trend. Furthermore, according to other authors (Fama, 1995), price series are likely to follow a random walk process, that is a non-stationary process in which the autocorrelation function is one everywhere. This constrains the number of applicable econometric techniques to the non-stationary ones. Alternatively, time series should be transformed into stationary time series. If the data are generated by a unit root process, subtracting a deterministic time trend is not sufficient to produce a stationary process, while a correct transformation could be into difference time series (Hamilton, 1994).

The presence of unitary roots in price series is usually tested by the conventional tests proposed by Dickey and Fuller (Dickey and Fuller, 1979) and by Philips and Perron (Philips and Perron, 1988). The two tests were derived for the null hypothesis of unit roots in linear time series. Taylor (2001) suggest to replace the unit root null hypothesis with a stationary null when time series are expected to have non-linear adjustments. We performed two different tests to assess the stationarity of time series: the DF-$DLS_u$ (Elliot et al., 1999), which assume under the null the presence of a local unit root, and the KPSS test (Kwiatkowski, et. al., 1992), in which the null hypothesis is the stationarity of the time series. Overall the tests reject the hypothesis of unit roots and fail to reject the stationarity of time series at 10% (Table 3) suggesting that price do not need transformations.

**< TABLE 3 ABOUT HERE >**

### *4. 1 Results: tomato market*

Final specifications for tomato cases are parsimonious and include only coefficients significant at least at 5%. In all equations the estimated coefficients of the lagged dependent variables (prices or SIVs) assume a larger absolute value in the second regime, which is an evidence of their tendency to return in the normal regime. In this case, the larger the absolute value of lagged dependent the closer the behavior of time series to a non-stationary process, hence the larger the tendency to switch to the normal regime.

As far as the case of tomatoes imported from Morocco is concerned, the two regimes contain respectively 566 and 85 observations. According to estimates in Table 4, the two regimes are different[4]: in the first regime $\beta_{11}^{I}$, $\gamma_{11}^{I}$, $\beta_{21}^{I}$ and $\gamma_{21}^{I}$are greater than zero and statistically significant (at 1% level), while in the second regime only $\beta_{11}^{II}$ and $\gamma_{21}^{II}$ are statistically significant, meaning that the reciprocal influence of the EU domestic price and the SIVs is lost in the second regime. We can interpret the results as an evidence of the effectiveness of the EPS in isolating the EU market from SIVs when the latter are below the TEP. As regard the coefficients of quota dummies, only $\delta_{21}^{I}$ $\delta_{22}^{I}$ in the second equation are statistically significant, and negative, as expected. Moreover, $\delta_{21}^{I}$ , the coefficient that capture the effect of the expansion of quota from 150.676 to 175.000 tons is (in absolute value) smaller than $\delta_{22}^{I}$ which consider also the further expansion of 45.000 tons. In other terms, the dummy coefficients allow to show that, *ceteris paribus*, larger quotas lowered the SIVs level while effects on EU domestic prices were not significant. In the first regime, the effect of EU domestic price on SIVs ($\eta_{P^I}^{SIV^I}$=0.141) largely exceeds, as expected, the effect of SIVs on price ($\eta_{P^I}^{SIV^I}$ equals 0.069) while no multipliers can be

[4] We introduced dummies in the TVAR(1) model to take into account series gaps, from the end of a season to the beginning of the following season. In all cases the dummies are statistically not significant and results are not affected by dummies. Therefore we do not consider dummies in final econometric specifications.

computed in the second regime. The results enforce the idea that SIVs follow the EU domestic price but the linkage between them is lost in the second regime.

As regard the Turkish tomatoes estimated coefficients support the idea that the EU domestic price influence the Turkish SIVs ($\beta_{21}^{I}$and $\beta_{21}^{II}$ are statistically significant), but not *vice-versa* ($\gamma_{11}^{I}$and $\gamma_{11}^{II}$are not statistically different from zero)[4]. These results do not lead to conclude that EPS is ineffective since the SIVs do not influence the EU domestic price in both regime but, according to the interpretation we provided in previous paragraph, we cannot conclude that the EPS isolates the EU market.The multiplier of EU price on SIVs ($\eta_{SIV}^{P}$) is lower in the first regime (0.198) than in the second (0.367) indicating that the EPS strengths the influence of EU domestic price on SIVs when they are below the threshold.

**< TABLE 4 ABOUT HERE >**

### *4.2. Results: lemon market*

The cross-correlogramms of residuals of estimated TVAR(1) models of lemon markets (Table 5) show that the autocorrelation of residuals is an issue, probably because for a product more storable than tomato in daily data there is a longer memory of the price determination process[5]. Therefore the next step in our analysis of the series of lemon market was the estimation of a threshold vector autoregressive (TVAR) models of higher order. We employed the Schwarz Information Criterion (SIC) for lag length selection[6]. Taking into account these results, we

[5] Contrary, the cross-correlogramms of residuals estimated for time series in case (a) and (b) indicate that a TVAR(1) specification might be appropriate.

[6] The SIC values for case *c* and *d* reach their minimum (respectively 12.338 and 12.058 ) at lag 3 and 2.

considered a TVAR(3) for case (c) and a TVAR(2) for (d). The preferred final specifications[7] are parsimonious and include only coefficients statistically significant at least at 5% level. The estimated coefficients of the lagged dependent variable assume a larger absolute value in the second regime, as we observed for tomatoes, in all but one equation: the coefficients of Argentinean SIVs are larger in the first regime[8].

The TVAR model estimated to find the relationships between the price of lemons on the Murcia market and the SIVs of Turkey (case *c*) confirms previous results: the estimated coefficient $\gamma_{11}^{I}$is statistically significant, while $\gamma_{11}^{II}$, $\gamma_{12}^{II}$ and $\gamma_{13}^{II}$ are not statistically different from zero. Therefore the estimates indicate that EPS is effective in isolating the Spanish market from Turkish imports. The values of the two multipliers in the first regime, $\eta_{SIV^I}^{P^I}$ and $\eta_{P^I}^{SIV^I}$, are respectively 0.079 and 0.032, leading to considerations similar to case *a*: in the normal regime the SIVs follow the EU domestic price but the linkage between series is lost in the second regime.

The results for case (*d*) show that the only relationship between series is the following: EU domestic price influence Argentinean SIVs in the first regime ($\gamma_{11}^{I}$ equals 0.101 being statistically significant while the correspondent multiplier is 0.091). Since the SIVs do not influence EU prices either in both regimes in this case we cannot conclude on the effectiveness of the EPS.

**< TABLE 5 ABOUT HERE >**

[7] We introduced dummies in the TVAR(*n*) model to take into account series gaps, from the end of a season to the beginning of the following season. In all cases the dummies are statistically not significant and results are not affected by dummies. Therefore we do not consider dummies in final econometric specifications.

[8] The result is not surprisingly since in case (d) the share of observations pertaining to the second regime is very large (35%).

### *4.3. The stabilization effect of the EPS*

The assessment of the stabilization effects of the EPS is pursued by evaluating changes of the first and second moments of the distributions of interpolated EU prices and SIVs from estimated models. Analytically we computed the mean and standard deviation of the samples under two scenarios: the first one simulates what is actually working with the EPS, while the second one is aimed at the simulation of a removal of the EPS under the assumption that the price determination model estimated in the first regime would remain unchanged even without the EPS. Therefore, under the two scenarios we have:

1) the dynamics of time series is governed by the coefficients estimated for the first and second regimes;
2) the dynamics of first regime is also true in the second regime.

Computationally the simulation of scenario 1 is made by interpolating observed data using the estimated coefficients of first regime when the observed SIVs are higher than the threshold and the coefficients of second regime when the SIVs are below the threshold. The simulation of the second scenario is always made using coefficients estimated in the first regime.

We expect EU prices and SIVs to be lower in mean and larger in standard deviation if no adjustments in price transmission are assumed (e.g. when coefficients of the first regime are adopted to interpolate data either in the first and in the second regime). The results of simulation are expressed as percentage change[9] (Δ%) of means and standard deviations computed under the second scenario with respect to those calculated in the first scenario (Table 6), for the whole sample period of each model and for each month we included in the sample.

**< TABLE 6 ABOUT HERE >**

[9] The percentage change has been computed with respect to the mean calculate for scenario 1, that is **Δ%** = $(E[\boldsymbol{X}|\Omega^I] - E[\boldsymbol{X}|\Omega^I,\Omega^{II}])/E[\boldsymbol{X}|\Omega^I,\Omega^{II}]$ where **X** = *P* or *SIVs*, $\Omega^I$ and $\Omega^{II}$ are the information sets containing, respectively, the estimated coefficients of the first and second regime.

Without the EPS the EU domestic prices and SIVs would be lower on average in all but case (d) with the largest effects detected for cases (b) and (c). As regard price variability, we found that for the EU domestic prices the removal of the EPS would increase standard deviation in cases (a) and (c), respectively by 0.12% and 0.64%, The variability of the SIVs would slightly increase in case (a) (0.04%) and more substantially in case (c) (3.5%). As far cases (b) and (c) are concerned, the simulated removal of EPS show that the variability would decrease.

Looking at the simulated effects of a removal of the EPS at the monthly level, we have decreases in EU domestic price in all months for cases (a) and (c) for which we detected a clear isolation effect played by the EPS. For cases (b) and (d) we observed no clear effects. Monthly changes in price variability are consistent with observed changes in price means. The removal of the EPS would decrease monthly SIVs increasing their variability in all months only in case (c), while in case (a) there are monthly changes rather small of different signs. In cases (b) and (d) the simulation did not give clear cut changes.

Summing up, we found that the EPS contributes to increase the EU domestic prices means in 3 out of 4 cases and to decrease the standard deviations, stabilizing EU prices in cases (a) and (c) for which we detected a clear isolation effect due to the EPS functioning.

## 5. Conclusions

This paper presents an econometric analysis of the effects of the EPS on the prices of EU F&V. It focuses on the cases of tomatoes and lemons, since for these two products the prices of imports from the main EU partner countries frequently fall below the 0,92 of TEP, the condition under which the maximum duty is enforced. The following hypotheses were tested: when the price of imports fall below the 0,92 of TEP is there any reaction in the prices of EU domestic produce? Is the EPS effective in isolating the EU domestic market in such cases? What is the effect of the EPS in terms of price stabilization? To this aim we specified a threshold model using the TEP as an exogenous threshold.

Since data used in the analysis are daily prices of domestic EU products sold on the main markets and the daily SIVs of imported products from the main partner countries, we specified a model whose autoregressive structure is derived from the competitive storage approach. Analysis of residuals from estimates showed that in the two cases of lemons the lag structure of the competitive storage model is not able to keep up with the dynamics of prices and SIVs asking for a different approach. The specification of TVAR models for lemons gave better results from an econometric point of view. Overall the performed econometric analysis highlights that the EPS affects the price determination processes of both tomatoes and lemons, in the sense that when SIVs are below the TEP the price determination process of EU products follows a pattern different from the one shown when SIVs are higher.

In the cases of tomatoes and lemons imported, respectively, from Morocco and Turkey, while their SIVs affect the prices of EU domestic product when they are higher than their threshold this does not hold when SIVs are below this level. Econometric analysis thus showed that, at least in these two cases, the EPS isolates the EU domestic prices determination process through the neutralization of the effects that low import prices could exert. This relationship doesn't hold in the case of Turkish tomato imports, as well as of lemons imported from Argentina, since they never affect EU domestic prices. On the contrary, the EU domestic prices affect the SIVs, trough a linkage that is lost in the II regime in the case of Turkish tomato SIVs while it still holds for Argentina lemons. These results may be due to the small import flows of tomatoes from Turkey compared to the EU domestic production and trade while in the case of lemons from Argentina it may be due to a different seasonality between domestic supply and imports. However this does not mean that the EPS is ineffective, indeed these results may be also due to the effect of a poor integration between the markets on which these products are sold.

The analyses highlighted the effectiveness of the EPS in sheltering the EU domestic market of F&V from low priced imports only in two out of four cases. However the resulting stabilization effect, as well as the support effect on EU domestic prices, is rather small, particularly in the case of tomatoes imported from Morocco. On this case there are some evidences coming from other studies that could be compared with our results. Particularly, the recent study by Garcia Alvarez-Coque *et al.* (2010) carried out through partial equilibrium models for some F&V produces, that includes tomatoes but not lemons, in the case of tomatoes found that the removal of the EPS would have the effect of a large increase in imports from Morocco that in the period 2004-2006 would soar by a percentage between 27,1% under a "low" scenario and a "high" of 74,5%. The last figure would produce a decrease of EU internal market prices in a range of -4.2% in October and -0.6% in May. These results show an impact of the EPS on EU domestic prices means larger than the one we found in our analyses. On the other hand we found that the EPS has very limited impact on SIVs, while changes simulated by Garcia *et al.* (2010) on Moroccan prices are much wider.

Regardless of the difficulty in comparing results obtained with very different methodological approach, the divergence could be explained by mean of two point

i) Our econometric model is estimated using price data that reflect a market in which the EPS is working while without it market agents would behave differently and therefore estimated parameters would also be different;

ii) The price variations resulting from the simulation with the partial equilibrium model of a removal of the EPS are obtained under an hypothesis of "high" elasticity scenario to stress the effects of the different policy scenario, it is therefore possible, as the Authors say, that such variations are overestimated and therefore with a lower scenario they could be closer to those we estimated.

Ending this analysis it is worth to ask what justifies to keep working the EPS if its main objective, the stabilization of EU domestic prices, is barely attained. The maintenance of a complex system as the one underlined by the EPS cannot be justified only on the ground that it improves market information since other instrument could reach the same results more efficiently. Probably the removal of the system could help to have more transparent rules to F&V trade without hurting very much the level and the stability of EU F&V producers incomes.

However, it must be acknowledged that price variability of F&V, particularly low price spikes when market crises occur, is still a relevant issue that deserves an appropriate set of policy tools. However, the EPS does not seem belonging to such set.

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## Appendix A

This appendix contains the detail on the calculation of the time series means and standard deviations under the two scenarios of presence and removal of the EPS.

**Scenario 1**

$$E\left[\widetilde{P_t}\middle|\Omega^I,\Omega^{II}\right] = I_t \cdot \left\{\widehat{\alpha_1^I} + \sum_{j=1}^{n}\widehat{\beta_{1j}^I}\,P_{t-j} + \sum_{j=1}^{n}\widehat{\gamma_{1j}^I}\ SIV_{t-1}\right\} + (1-I_t) \cdot \left\{\widehat{\alpha_1^{II}} + \sum_{j=1}^{n}\widehat{\beta_{1j}^{II}}\,P_{t-j} + \sum_{j=1}^{n}\widehat{\gamma_{1j}^{II}}\ SIV_{t-1}\right\}$$

$$E\left[\widetilde{SIV}_t\middle|\Omega^I,\Omega^{II}\right] = I_t \cdot \left\{\widehat{\alpha_2^I} + \sum_{j=1}^{n}\widehat{\beta_{2j}^I}\,P_{t-j} + \sum_{j=1}^{n}\widehat{\gamma_{2j}^I}\ SIV_{t-1}\right\} + (1-I_t) \cdot \left\{\widehat{\alpha_2^{II}} + \sum_{j=1}^{n}\widehat{\beta_{2j}^{II}}\,P_{t-j} + \sum_{j=1}^{n}\widehat{\gamma_{2j}^{II}}\ SIV_{t-1}\right\}$$

$$St.dev\left[\widetilde{P_t}\middle|\Omega^I,\Omega^{II}\right] = St.dev\left[\ I_t \cdot \left\{\widehat{\alpha_1^I} + \textstyle\sum_{j=1}^{n}\widehat{\beta_{1j}^I}\,P_{t-j} + \sum_{j=1}^{n}\widehat{\gamma_{1j}^I}\ SIV_{t-1}\right\} + (1-I_t)\cdot\left\{\widehat{\alpha_1^{II}} + \sum_{j=1}^{n}\widehat{\beta_{1j}^{II}}\,P_{t-j} + \sum_{j=1}^{n}\widehat{\gamma_{1j}^{II}}\ SIV_{t-1}\right\}\right]$$

$$St.dev\left[\widetilde{SIV}_t\middle|\Omega^I,\Omega^{II}\right] = St.dev\left[\ I_t \cdot \left\{\widehat{\alpha_2^I} + \textstyle\sum_{j=1}^{n}\widehat{\beta_{2j}^I}\,P_{t-j} + \sum_{j=1}^{n}\widehat{\gamma_{2j}^I}\ SIV_{t-1}\right\} + (1-I_t)\cdot\left\{\widehat{\alpha_2^{II}} + \sum_{j=1}^{n}\widehat{\beta_{2j}^{II}}\,P_{t-j} + \sum_{j=1}^{n}\widehat{\gamma_{2j}^{II}}\ SIV_{t-1}\right\}\right]$$

**Scenario 2**

$$E\left[\widetilde{P_t}\middle|\Omega^I\right] = \left\{\widehat{\alpha_1^I} + \sum_{j=1}^{n}\widehat{\beta_{1j}^I}\,P_{t-j} + \sum_{j=1}^{n}\widehat{\gamma_{1j}^I}\ SIV_{t-1}\right\}$$

$$E\left[\widetilde{SIV}_t\middle|\Omega^I\right] = \left\{\widehat{\alpha_2^I} + \sum_{j=1}^{n}\widehat{\beta_{2j}^I}\,P_{t-j} + \sum_{j=1}^{n}\widehat{\gamma_{2j}^I}\ SIV_{t-1}\right\}$$

$$St.dev\left[\widetilde{P_t}\middle|\Omega^I\right] = St.dev\left[\left\{\widehat{\alpha_1^I} + \sum_{j=1}^{n}\widehat{\beta_{1j}^I}\,P_{t-j} + \sum_{j=1}^{n}\widehat{\gamma_{1j}^I}\ SIV_{t-1}\right\}\right]$$

$$St.dev\left[\widetilde{SIV_t}\middle|\Omega^I\right] = St.dev\left[\left\{\widehat{\alpha_2^I} + \sum_{j=1}^{n}\widehat{\beta_{2j}^I}\,P_{t-j} + \sum_{j=1}^{n}\widehat{\gamma_{2j}^I}\ SIV_{t-1}\right\}\right]$$

where $\widetilde{P_t}$ and $\widetilde{SIV_t}$ are, respectively, the interpolated EU prices and interpolated SIVs, $\boldsymbol{\Omega}$ represents the information set, and more precisely, $\Omega^I = \{\alpha^I, \boldsymbol{\beta^I}, \boldsymbol{\gamma^I}\}$ and $\Omega^{II} = \{\alpha^{II}, \boldsymbol{\beta^{II}}, \boldsymbol{\gamma^{II}}\}$, the bold greek letters indicate the set of equation-specific parameters (e.g. $\boldsymbol{\beta^I} = \beta_{i1}^I + \cdots + \beta_{in}^I$).

For cases in which the EPS is effective we expect to observe the following:

$$E\left[\widetilde{P_t^{II}}\middle|\Omega^I\right] < E\left[\widetilde{P_t^{II}}\middle|\Omega^I,\Omega^{II}\right]$$

$$E\left[\widetilde{SIV_t^{II}}\middle|\Omega^I\right] < E\left[\widetilde{SIV_t^{II}}\middle|\Omega^I,\Omega^{II}\right]$$

$$Std.dev.\left[\widetilde{P_t^{II}}\middle|\Omega^I\right] > Std.dev.\left[\widetilde{P_t^{II}}\middle|\Omega^I,\Omega^{II}\right]$$

$$Std.dev.\left[\widetilde{SIV_t^{II}}\middle|\Omega^I\right] > Std.dev.\left[\widetilde{SIV_t^{II}}\middle|\Omega^I,\Omega^{II}\right]$$

**Table 1 - Preferential EP and TRQ granted to Morocco in 2006/07 and monthly imports**

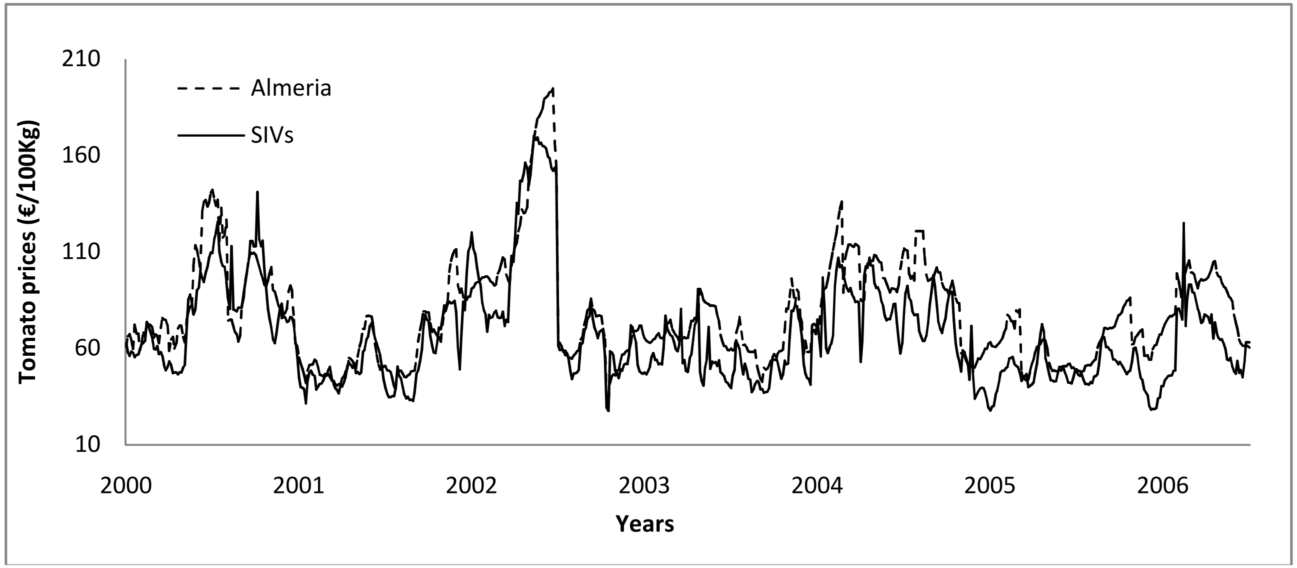
| | Tariff *(%)* | Entry price *(€/t)* | MTE *(€/t)* | Pref. Tariff | Pref. Entry price *(€/t)* | MTE *(€/t)* | TRQ *(t)* | Import 06/07 *(t)* |
|---|---|---|---|---|---|---|---|---|
| October | 14,4 | 626 | 298 | 0 | 461 | 298 | 10000 | 10198 |
| November | 8,8 | 626 | 298 | 0 | 461 | 298 | 26000 | 28813 |
| December | 8,8 | 626 | 298 | 0 | 461 | 298 | 30000 | 34780 |
| January | 8,8 | 846 | 298 | 0 | 461 | 298 | 30000 | 42807 |
| February | 8,8 | 846 | 298 | 0 | 461 | 298 | 30000 | 45513 |
| March | 8,8 | 846 | 298 | 0 | 461 | 298 | 30000 | 41975 |
| April | 8,8 | 1126 | 298 | 0 | 461 | 298 | 15000 | 36303 |
| May | 14,4 | 726 | 298 | 0 | 461 | 298 | 4000 | 12671 |
| Jun-Sept | 14,4 | 526 | 298 | | | | | 6859 |
| Conditional quota 2006/07 | | | | | | | 45000 | |

*Source: EU Commission Regulation 37/2004 and Eurostat.*

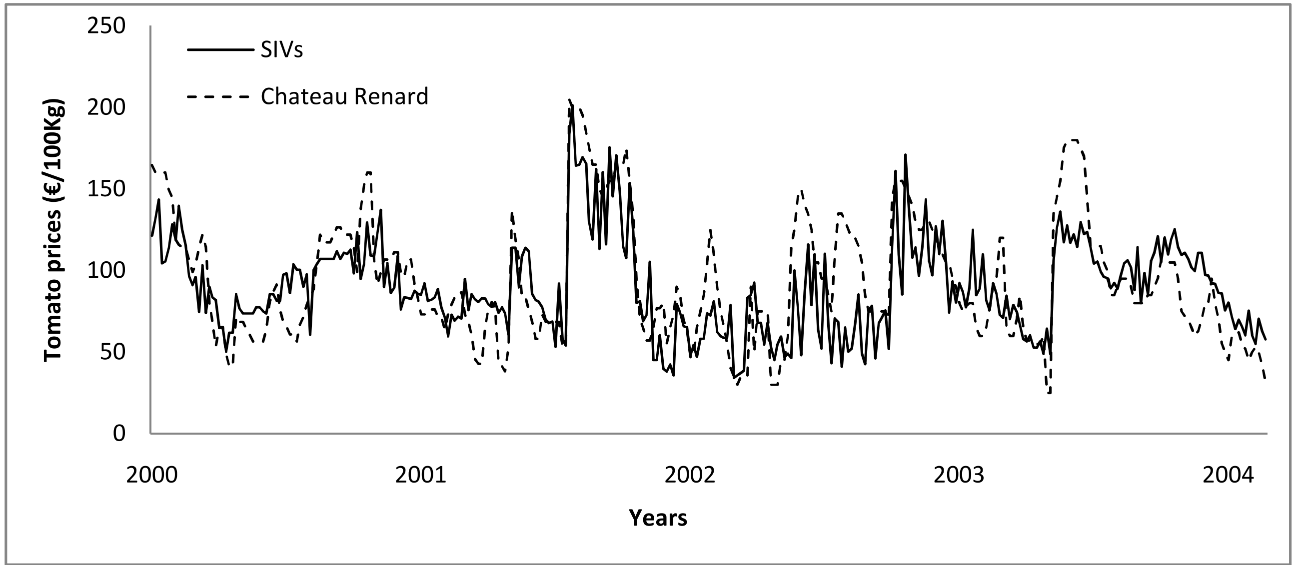
**Table 2 - Descriptive statistics per regimes**

| | **Tomato** | | | | | |
|---|---|---|---|---|---|---|
| | ***I regime*** | | | ***II regime*** | | |
| | ***Mean*** | ***Median*** | ***St. dev.*** | ***Mean*** | ***Median*** | ***St. dev.*** |
| **EU price** (Almeria) | 82.18 | 76.56 | 27.07 | 52.13 | 51.21 | 8.44 |
| **SIVs** (Morocco) | 70.77 | 64.1 | 25.98 | 37.18 | 38.6 | 4.19 |
| **EU price** (Chateau-Renard) | 94.83 | 83.85 | 38.98 | 84.57 | 80 | 33.31 |
| **SIVs** (Turkey) | 92.58 | 86 | 28.35 | 66.34 | 60.3 | 24.42 |
| | **Lemon** | | | | | |
| | ***I regime*** | | | ***II regime*** | | |
| **EU price** (Murcia) | 56.74 | 55 | 13.04 | 49.24 | 48.72 | 10.01 |
| **SIVs** (Turkey) | 61.39 | 60 | 10.01 | 42.36 | 43 | 6.31 |
| **EU price** (Murcia) | 60.44 | 58.75 | 10.45 | 56.15 | 55 | 9.36 |
| **SIVs** (Argentina) | 63.59 | 62 | 6.36 | 50.81 | 51.8 | 4.44 |

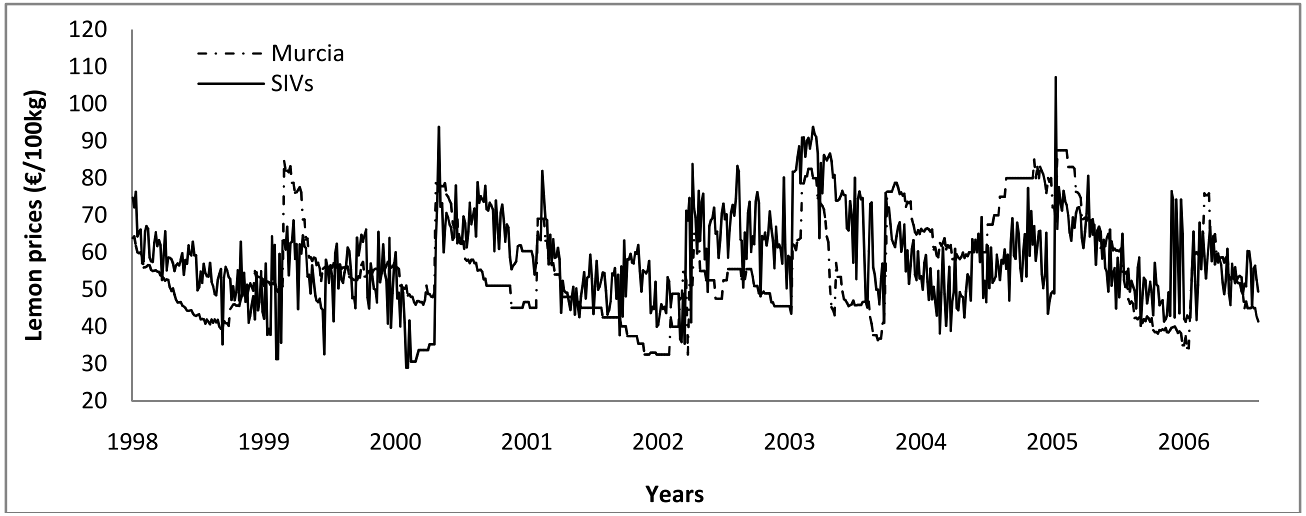
**Graph 1. Prices and SIVs time series** ***(Source: Agriview database)***



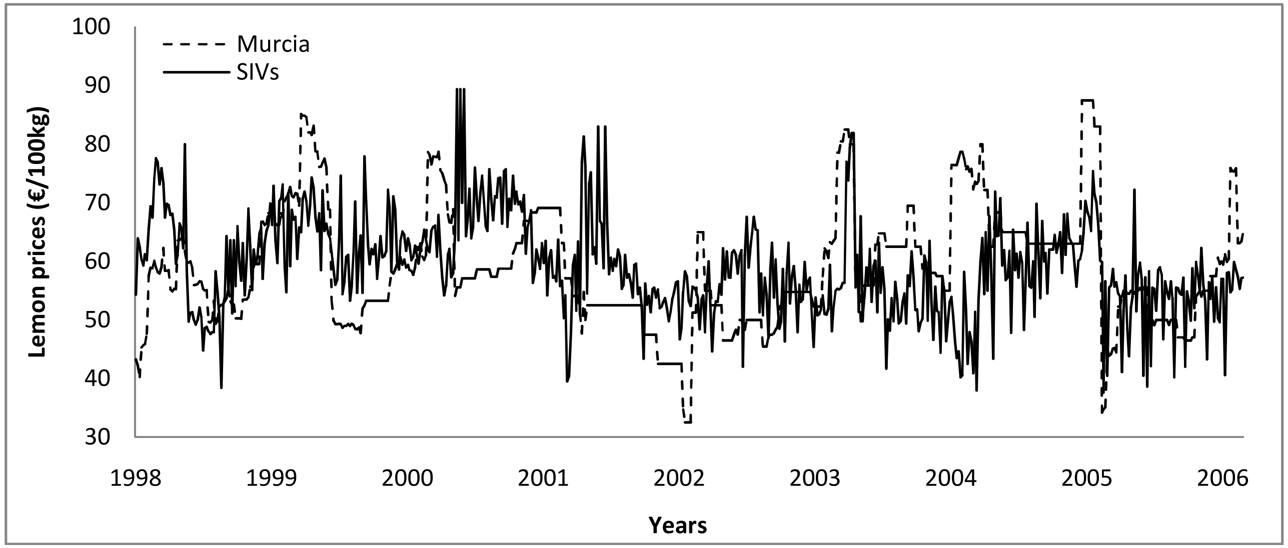

*Case a: Almeria and Moroccan SIVs*




*Case b: Chateau Renard prices and Turkish SIVs*




*Case c: Murcia prices and Turkish SIVs*




*Case d: Murcia prices and Argentinean SIVs*

**Table 3 - DF-DLS$_u$ and KPSS test statistics**

| | Tomatoes | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Spain - Morocco** | | | | | **France - Turkey** | | | |
| | DF-DLS$_u$ (1) | DF-DLS$_u$ (2) | KPSS (3) | KPSS (4) | | DF-DLS$_u$ (1) | DF-DLS$_u$ (2) | KPSS (3) | KPSS (4) |
| Almeria | *1.248* | *2.739* | *0.192* | *0.194* | Chateau-Renard | 2.854 | 3.299 | 0.058 | 0.048 |
| Morocco | *0.437* | *1.621* | *0.458* | *0.062* | Turkey | 2.315 | 4.046 | 0.095 | 0.079 |
| | **Lemons** | | | | | | | | |
| | **Spain - Turkey** | | | | | **Spain - Argentina** | | | |
| Murcia | *1.789* | *4.640* | *0.377* | *0.136* | Murcia | 2.342 | 3.621 | 0.139 | 0.131 |
| Turkey | *2.663* | *4.551* | *0.248* | *0.016* | Argentina | 0.729 | 2.339 | 1.056 | 0.108 |

(1) Intercept. Test critical value (10%) = 4.48; (2) Intercept and trend. Test critical value (10%) = 6.89

(3) Intercept. Test critical value (10%) = 0.347 ; (4) Intercept and trend. Test critical value (10%) = 0.119

**Table 4 - Model results for tomato markets**

| | Almeria (ES) - Morocco | | Chateau-Renard (FR) - Turkey | |
|---|---|---|---|---|
| | I regime (SIV > Trig) | | I regime (SIV > Trig) | |
| | ***Almeria*** | ***Morocco*** | ***Chateau Renard*** | ***Turkey*** |
| $\alpha$ | 2.451** (1.152) | 2.661 (1.669) | 9.581*** (3.427) | 22.186 (4.194) |
| $P_{t-1}$ | 0.898*** (0.026) | 0.121*** (0.027) | 0.892*** (0.035) | 0.203*** (0.038) |
| $SIV_{t-1}$ | 0.081*** (0.025) | 0.831*** (0.025) | | 0.531*** (0.044) |
| $D_1$ | | -2.073*** (0.756) | | |
| $D_2$ | | -2.131** (0.921) | | |
| | II regime (SIV <= Trig) | | II regime (SIV <= Trig) | |
| $\alpha$ | 2.531 (9.366) | 5.611 (8.286) | 5.946*** (19.806) | 2.062 (14.823) |
| $P_{t-1}$ | 0.966*** (0.177) | | 0.942*** (0.223) | 0.418*** (0.133) |
| $SIV_{t-1}$ | | 0.893*** (0.235) | | 0.636*** (0.191) |
| $D_1$ | | | | |
| $D_2$ | | | | |
| $R^2$ | 0.93 | 0.90 | 0.80 | 0.61 |

Significant: *** at 0.01 ; ** at 0.05 ; * at 0.1

**Table 5 - Model results for lemon markets**

| | Murcia (ES) - Turkey | | Murcia (ES) - Argentina | |
|---|---|---|---|---|
| | **I regime (SIV > Trig)** | | **I regime (SIV > Trig)** | |
| | ***Murcia*** | ***Turkey*** | ***Murcia*** | **Argentina** |
| $\alpha$ | 0.224 (1.028) | 3.736 (2.679) | 5.142*** (1.534) | 11.560*** (3.366) |
| $P_{t-1}$ | 0.963*** (0.013) | 0.093*** (0.028) | 0.913*** (0.020) | 0.101*** (0.032) |
| $P_{t-2}$ | | | | |
| $P_{t-3}$ | | | | |
| $SIV_{t-1}$ | 0.027*** (0.012) | 0.466*** (0.041) | | 0.386*** (0.048) |
| $SIV_{t-2}$ | | 0.248*** (0.037) | | 0.316*** (0.033) |
| $SIV_{t-3}$ | | 0.119*** (0.033) | | |
| | **II regime (SIV <= Trig)** | | **II regime (SIV <= Trig)** | |
| $\alpha$ | 2.202 (2.315) | 4.801 (4.626) | 1.091 (1.247) | 33.128*** (3.717) |
| $P_{t-1}$ | 0.969** (0.049) | | 0.984*** (0.026) | |
| $P_{t-2}$ | | | | |
| $P_{t-3}$ | | | | |
| $SIV_{t-1}$ | | 0.380*** (0.105) | | |
| $SIV_{t-2}$ | | 0.365*** (0.070) | | 0.388*** (0.067) |
| $SIV_{t-3}$ | | 0.230*** (0.064) | | |
| $R^2$ | 0.932 | 0.561 | 0.876 | 0.426 |

Significant: *** at 0.01 ; ** at 0.05 ; * at 0.1

**Table 6 - Changes in means and standard deviations under the two scenarios**

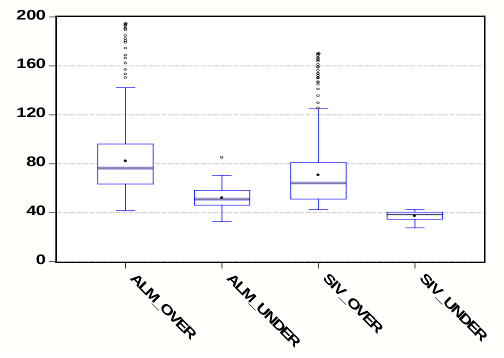
| ***Tomato markets*** | **(1)** | **(2)** | **Δ% (1-2)** | **(3)** | **(4)** | **Δ% (3-4)** | | **(1)** | **(2)** | **Δ% (1-2)** | **(1)** | **(2)** | **Δ% (1-2)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **EU price** (Almeria) | 78.32 | 78.22 | -0.12% | 26.48 | 26.52 | 0.12% | **SIVs** (Morocco) | 66.44 | 66.40 | 0.00% | 25.46 | 25.47 | 0.04% |
| *Nov* | 72.74 | 72.49 | -0.34% | 21.44 | 21.57 | 0.60% | | 60.51 | 60.53 | 0.04% | 24.06 | 24.03 | -0.12% |
| *Dec.* | 81.86 | 81.77 | -0.10% | 16.85 | 16.96 | 0.65% | | 67.94 | 67.94 | -0.00% | 18.40 | 18.39 | -0.05% |
| *Jan.* | 73.49 | 73.46 | -0.03% | 21.15 | 21.16 | 0.08% | | 64.34 | 64.26 | -0.12% | 19.87 | 19.97 | 0.53% |
| *Feb.* | 72.85 | 72.86 | 0.01% | 22.35 | 22.34 | 0.07% | | 60.69 | 60.60 | -0.15% | 19.60 | 19.69 | 0.44% |
| *Mar.* | 92.21 | 92.20 | -0.02% | 37.25 | 37.27 | 0.05% | | 79.15 | 79.15 | 0.01% | 34.87 | 34.87 | -0.03% |
| **EU price** (Chateau-Renard) | 93.41 | 93.20 | -0.23% | 34.36 | 34.29 | -0.17% | **SIVs** (Turkey) | 89.43 | 88.76 | -0.76% | 22.83 | 22.09 | -3.23% |
| *Apr* | 123.07 | 122.75 | -0.26% | 32.61 | 32.70 | 0.28% | | 113.57 | 111.36 | -1.94% | 21.33 | 21.60 | 1.30% |
| *May* | 88.30 | 88.30 | 0.01% | 22.45 | 22.42 | -0.15% | | 91.46 | 91.42 | -0.04% | 13.97 | 13.57 | -2.89% |
| *Jun* | 72.27 | 72.32 | 0.07% | 18.33 | 18.27 | -0.29% | | 72.52 | 72.38 | -0.19% | 9.02 | 9.01 | -0.05% |
| *Jul* | 57.75 | 58.27 | 0.90% | 15.61 | 14.94 | -4.30% | | 60.13 | 62.13 | 3.33% | 13.50 | 10.43 | -22.69% |
| *Aug* | 63.94 | 63.94 | -0.00% | 14.39 | 14.39 | -0.00% | | 68.87 | 68.87 | -0.00% | 8.03 | 8.03 | -0.00% |
| *Sep.* | 96.16 | 96.17 | 0.01% | 45.54 | 45.35 | -0.42% | | 86.72 | 86.25 | -0.54% | 23.47 | 22.92 | -2.36% |
| *Oct* | 93.48 | 93.43 | -0.06% | 23.05 | 22.96 | -0.39% | | 86.32 | 85.89 | -0.49% | 14.23 | 14.13 | -0.69% |
| **EU price** (Murcia) | 55.44 | 55.28 | -0.28% | 12.46 | 12.54 | 0.64% | **SIVs** (Turkey) | 58.06 | 57.47 | -1.02% | 9.16 | 9.48 | 3.50% |
| *Oct* | 66.50 | 66.40 | -0.15% | 12.10 | 12.16 | 0.50% | | 64.83 | 64.31 | -0.80% | 9.57 | 9.77 | 2.10% |
| *Nov* | 59.11 | 59.04 | -0.13% | 9.03 | 9.09 | 0.62% | | 61.37 | 61.09 | -0.45% | 9.28 | 9.55 | 2.93% |
| *Dec.* | 53.07 | 53.01 | -0.11% | 6.50 | 6.47 | -0.49% | | 58.50 | 58.27 | -0.40% | 7.33 | 7.40 | 0.97% |
| *Jan.* | 49.32 | 49.23 | -0.18% | 6.08 | 6.06 | -0.34% | | 55.93 | 55.52 | -0.75% | 6.39 | 6.51 | 1.78% |
| *Feb.* | 48.16 | 48.06 | -0.22% | 9.06 | 9.07 | 0.08% | | 54.54 | 54.01 | -0.96% | 4.71 | 4.78 | 1.47% |
| *Mar.* | 49.74 | 49.19 | -1.10% | 14.37 | 14.54 | 1.16% | | 51.13 | 49.50 | -3.20% | 8.77 | 9.09 | 3.65% |
| *Apr* | 61.49 | 61.25 | -0.38% | 18.50 | 18.66 | 0.89% | | 55.29 | 54.37 | -1.66% | 8.92 | 9.22 | 3.45% |
| **EU price** (Murcia) | 58.97 | 58.99 | 0.04% | 9.61 | 9.40 | -2.24% | **SIVs** (Argentina) | 58.71 | 59.09 | 0.65% | 5.68 | 5.59 | -1.61% |
| *May* | 57.69 | 57.74 | 0.08% | 12.64 | 12.48 | -1.27% | | 59.57 | 59.72 | 0.25% | 6.86 | 6.83 | -0.55% |
| *Jun* | 55.41 | 55.49 | 0.13% | 5.49 | 5.41 | -1.47% | | 58.68 | 58.99 | 0.53% | 5.38 | 5.51 | 2.44% |
| *Jul* | 55.26 | 55.33 | 0.12% | 5.46 | 5.25 | -3.95% | | 57.92 | 58.65 | 1.25% | 4.92 | 4.67 | -5.12% |
| *Aug* | 55.80 | 55.97 | 0.31% | 7.90 | 7.67 | -2.95% | | 59.41 | 59.51 | 0.16% | 5.23 | 5.27 | 0.66% |
| *Sep.* | 59.17 | 59.20 | 0.06% | 7.83 | 7.67 | -2.01% | | 59.31 | 59.66 | 0.59% | 5.62 | 5.46 | -2.94% |
| *Oct* | 67.23 | 67.06 | -0.24% | 11.11 | 10.85 | -2.34% | | 58.27 | 58.64 | 0.64% | 6.38 | 6.28 | -1.49% |

**(1)** = $E[\boldsymbol{X}|\Omega^I,\Omega^{II}]$ ; **(2)** = $E[\boldsymbol{X}|\Omega^I]$ ; **(3)** = $Std.dev.[\boldsymbol{X}|\Omega^I,\Omega^{II}]$ ; **(4)** = $Std.dev.[\boldsymbol{X}|\Omega^I]$

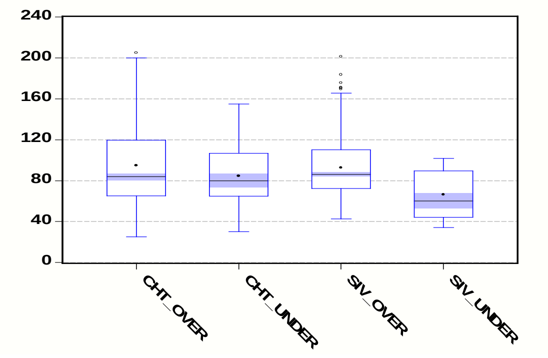
*$\boldsymbol{X}$ = P or SIVs; $\boldsymbol{\Omega^I}$ and $\boldsymbol{\Omega^{II}}$ are the information sets containing, respectively, the estimated coefficients of the first and second regime.*

## Data appendix

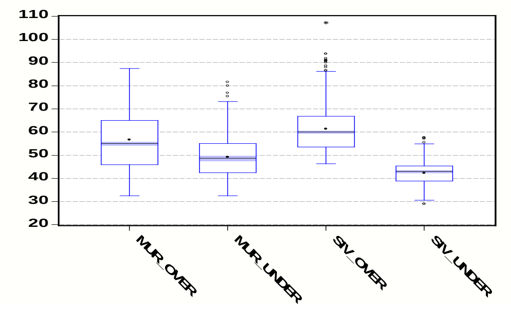
### Graph A.1. Box plot per regimes



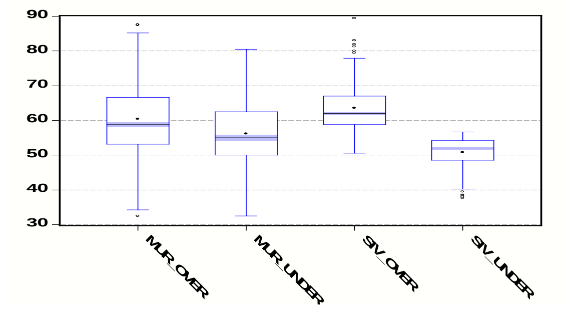

*Case a: Almeria prices and Moroccan SIVs*




*Case b: Chateau Renard prices and Turkish SIVs*



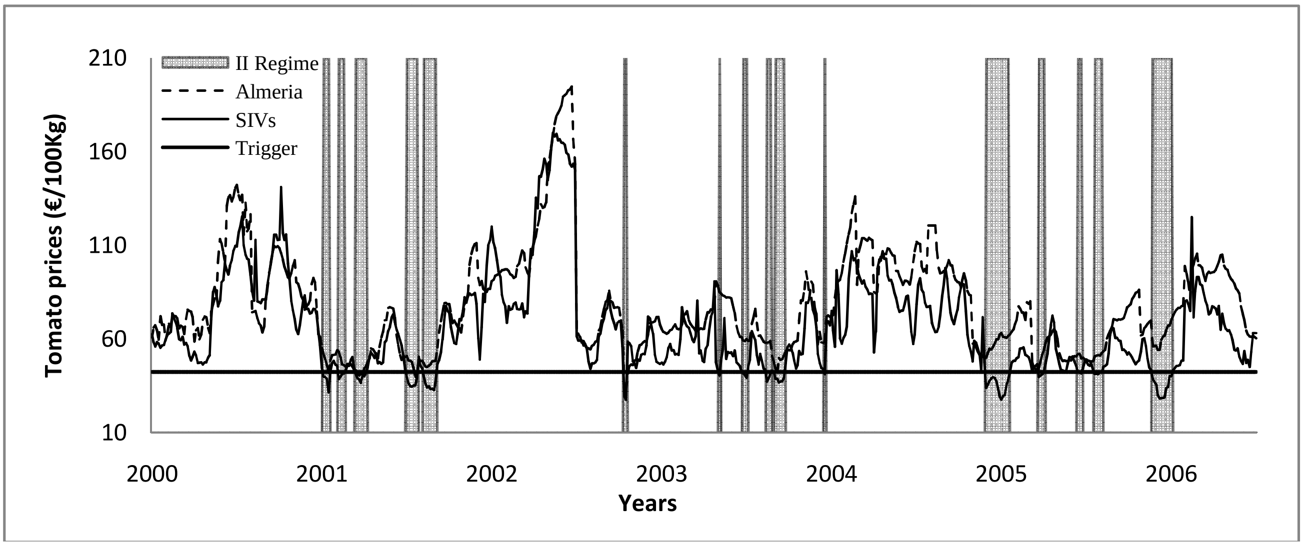

*Case c: Murcia prices and Turkish SIVs*



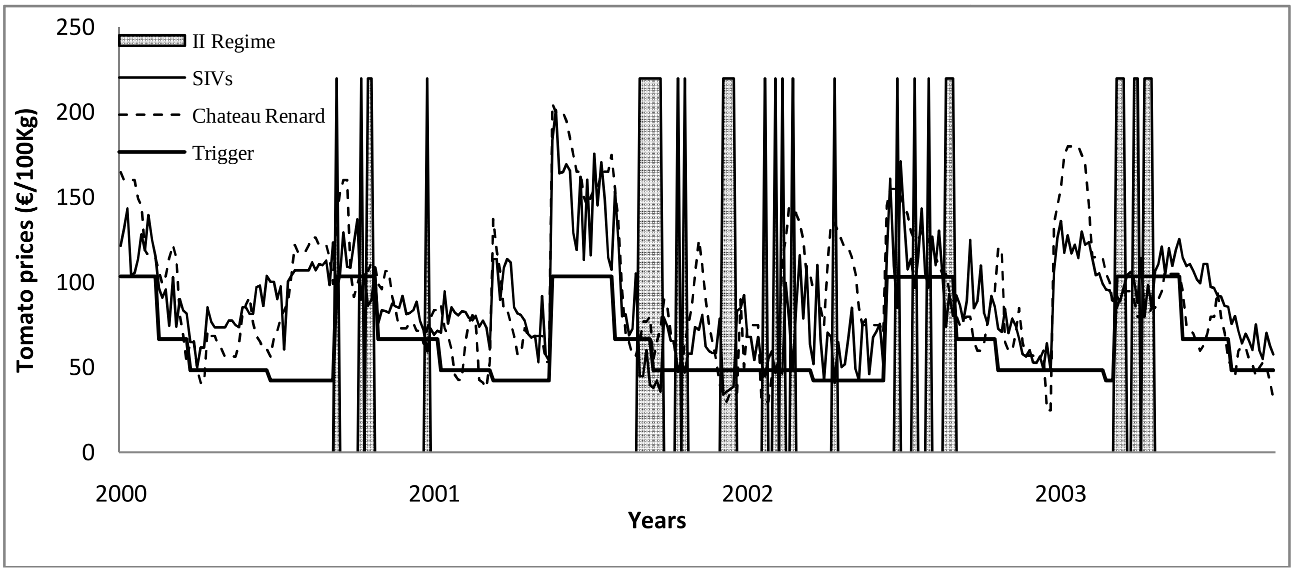

*Case d: Murcia prices and Argentinean SIVs*

The suffix “over” and “under” indicate, respectively, the first regime and the second regime.

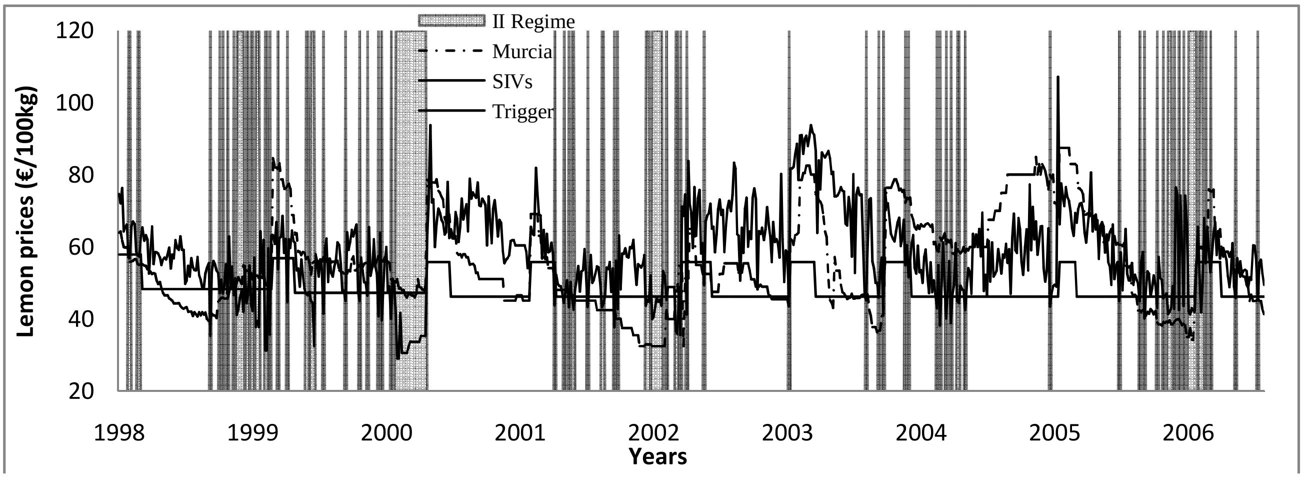
**Graph A.2. Prices and SIVs time series with TEP threshold and II regime** (SIV ≤ 0.91*TEP)



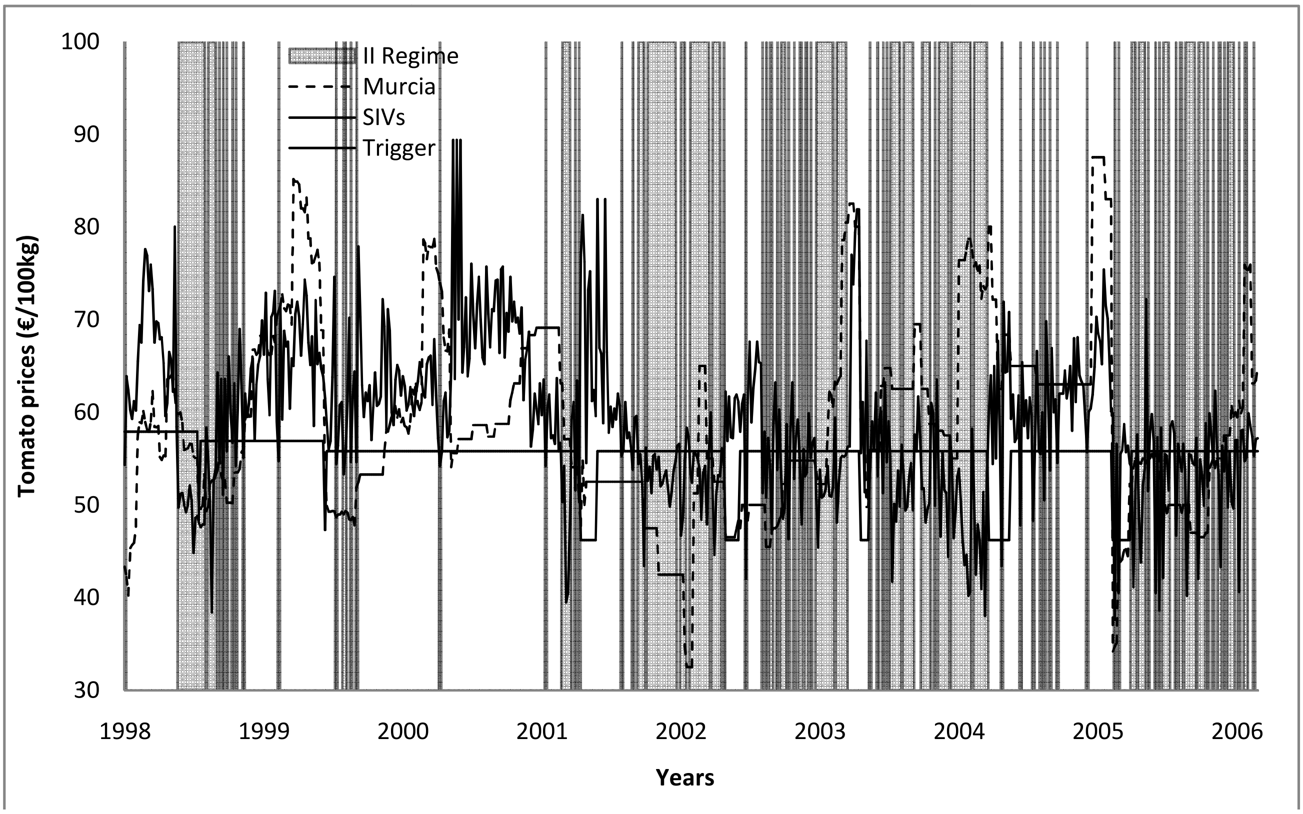

*Case a: Almeria and Moroccan SIVs*




*Case b: Chateau Renard prices and Turkish SIVs*




*Case c: Murcia prices and Turkish SIVs*




*Case d: Murcia prices and Argentinean SIVs*

**Table A.1 Cross-correlogramms**

| | Case a<br>Almeria prices and Moroccan SIVs | | Case b<br>Chateau Renard prices and Turkish SIVs | |
|---|---|---|---|---|
| | $P_t$ | $SIV_t$ | $P_t$ | $SIV_t$ |
| $P_{t-1}$ | 0.111 | 0.061 | 0.160 | 0.092 |
| $P_{t-2}$ | 0.138 | 0.027 | 0.011 | -0.120 |
| $P_{t-3}$ | 0.035 | 0.061 | -0.004 | -0.063 |
| $P_{t-4}$ | 0.018 | 0.048 | -0.087 | 0.059 |
| $P_{t-5}$ | 0.045 | -0.048 | -0.001 | 0.065 |
| $SIV_{t-1}$ | 0.068 | 0.041 | 0.070 | -0.054 |
| $SIV_{t-2}$ | 0.048 | 0.035 | -0.022 | 0.001 |
| $SIV_{t-3}$ | 0.058 | 0.042 | 0.102 | 0.191 |
| $SIV_{t-4}$ | 0.057 | 0.039 | 0.044 | 0.130 |
| $SIV_{t-5}$ | 0.015 | -0.077 | -0.062 | -0.007 |
| *2 st.dev.* | 0.0784 | | 0.1099 | |

| | Case c<br>Murcia prices and Turkish SIVs | | Case d<br>Murcia prices and Argentinean SIVs | |
|---|---|---|---|---|
| $P_{t-1}$ | -0.005 | -0.016 | 0.016 | 0.052 |
| $P_{t-2}$ | 0.047 | 0.067 | 0.017 | 0.037 |
| $P_{t-3}$ | 0.040 | -0.055 | 0.045 | 0.017 |
| $P_{t-4}$ | -0.003 | 0.023 | 0.020 | -0.012 |
| $P_{t-5}$ | -0.053 | -0.037 | -0.027 | -0.075 |
| $SIV_{t-1}$ | 0.066 | -0.205 | 0.028 | -0.177 |
| $SIV_{t-2}$ | -0.069 | 0.162 | -0.006 | 0.183 |
| $SIV_{t-3}$ | 0.028 | 0.075 | -0.006 | 0.112 |
| $SIV_{t-4}$ | -0.043 | 0.140 | 0.015 | 0.202 |
| $SIV_{t-5}$ | -0.101 | 0.022 | -0.056 | 0.088 |
| *2 st.dev.* | 0.0741 | | 0.0809 | |

**Table A.2 TVAR(1) models with and without time dummies**

| | Almeria (ES) - Morocco | | Chateau-Renard (FR) - Turkey | |
|---|---|---|---|---|
| | ***Almeria*** | ***Almeria*** | ***Chateau Renard*** | ***Chateau Renard*** |
| $\alpha^{I}$ | 2.441** | 2.183** | 8.325* | 8.787* |
| | (1.147) | (1.247) | (4.176) | (4.158) |
| $P_{t-1}^{I}$ | 0.899*** | 0.902*** | 0.876*** | 0.875*** |
| | (0.026) | (0.026) | (0.048) | (0.049) |
| $SIV_{t-1}^{I}$ | 0.081*** | 0.081*** | 0.029 | 0.028 |
| | (0.025) | (0.025) | (0.065) | (0.065) |
| $\alpha^{II}$ | 5.654 | 5.448 | 6.182 | 6.262 |
| | (21.254) | (21.754) | (19.938) | (19.857) |
| $P_{t-1}^{II}$ | 0.956*** | 0.956*** | 0.945*** | 0.942*** |
| | (0.235) | (0.234) | (0.293) | (0.295) |
| $SIV_{t-1}^{II}$ | -0.070 | -0.062 | -0.007 | -0.003 |
| | (0.521) | (0.525) | (0.343) | (0.344) |
| | ***Morocco*** | ***Morocco*** | ***Turkey*** | ***Turkey*** |
| $\alpha^{I}$ | 1.410 | 1.139 | 21.672*** | 22.215*** |
| | (1.561) | (1.584) | (4.336) | (4.324) |
| $P_{t-1}^{I}$ | 0.099*** | 0.103*** | 0.197*** | 0.201*** |
| | (0.027) | (0.027) | (0.043) | (0.044) |
| $SIV_{t-1}^{I}$ | 0.860*** | 0.860*** | 0.543*** | 0.536*** |
| | (0.023) | (0.023) | (0.057) | (0.056) |
| $\alpha^{II}$ | 8.320 | 7.275 | 2.156 | 2.135 |
| | (10.040) | (10.185) | (14.874) | (14.801) |
| $P_{t-1}^{II}$ | -0.021 | -0.017 | 0.419** | 0.422** |
| | (0.198) | (0.201) | (0.143) | (0.142) |
| $SIV_{t-1}^{II}$ | 0.851* | 0.875* | 0.633** | 0.631** |
| | (0.428) | (0.436) | (0.206) | (0.204) |
| | | ***Dummies*** | | |
| $D_{101}$ | | 1.740 | | -6.131 |
| | | (3103.3) | | (1578.6) |
| $D_{102}$ | | -4.758 | | -22.182 |
| | | (9455.5) | | (1538.4) |
| $D_{103}$ | | -15.711 | | -0.574 |
| | | (4270.4) | | (1509.5) |
| $D_{104}$ | | 0.505 | | -1.533 |
| | | (3171.7) | | (1505.7) |
| $D_{105}$ | | -0.573 | | |
| | | (3032.5) | | |
| $D_{106}$ | | -3.046 | | |
| | | (3069.2) | | |
| $D_{107}$ | | 1.202 | | |
| | | (3143.2) | | |

The apexes I and II indicate, respectively, the first and second regime.
In parenthesis are reported standard errors.
Significant: *** at 0.001 ; ** at 0.01 ; * at 0.05

**Table A.3 TVAR(*n*) models with and without time dummies**

| | Murcia (ES) - Turkey | | Murcia (ES) - Argentina | |
|---|---|---|---|---|
| | ***Murcia*** | ***Murcia*** | ***Murcia*** | ***Argentina*** |
| $\alpha^{I}$ | 0.894 | 1.112 | 4.661* | 5.830* |
| | (1.139) | (1.145) | (2.442) | (2.445) |
| $P_{t-1}^{I}$ | 0.944*** | 0.941*** | 0.936*** | 0.935*** |
| | (0.030) | (0.029) | (0.117) | (0.119) |
| $P_{t-2}^{I}$ | 0.057 | 0.122 | -0.023 | -0.024 |
| | (0.113) | (0.072) | (0.113) | (0.115) |
| $P_{t-3}^{I}$ | -0.033 | -0.096 | | |
| | (0.101) | (0.062) | | |
| $SIV_{t-1}^{I}$ | 0.059*** | 0.076*** | 0.030 | 0.016 |
| | (0.013) | (0.013) | (0.044) | (0.044) |
| $SIV_{t-2}^{I}$ | -0.045*** | -0.060*** | -0.023 | -0.025 |
| | (0.012) | (0.011) | (0.045) | (0.045) |
| $SIV_{t-3}^{I}$ | 0.003 | 0.001 | | |
| | (0.015) | (0.015) | | |
| $\alpha^{II}$ | 2.569 | 2.240 | -1.291 | -1.426 |
| | (3.998) | (4.631) | (6.779) | (6.787) |
| $P_{t-1}^{II}$ | 1.083*** | 1.116*** | 0.987*** | 0.959*** |
| | (0.142) | (0.161) | (0.294) | (0.315) |
| $P_{t-2}^{II}$ | -0.023 | -0.008 | -0.003 | 0.028 |
| | (0.214) | (0.208) | (0.297) | (0.319) |
| $P_{t-3}^{II}$ | -0.088 | -0.127 | | |
| | (0.154) | (0.149) | | |
| $SIV_{t-1}^{II}$ | 0.050 | 0.040 | 0.064 | 0.067 |
| | (0.117) | (0.124) | (0.101) | (0.101) |
| $SIV_{t-2}^{II}$ | -0.022 | -0.009 | -0.015 | -0.019 |
| | (0.078) | (0.079) | (0.073) | (0.072) |
| $SIV_{t-3}^{II}$ | -0.022 | -0.039 | | |
| | (0.078) | (0.081) | | |
| | ***Turkey*** | ***Turkey*** | ***Murcia*** | ***Argentina*** |
| $\alpha^{I}$ | 4.256 | 5.186* | 12.082*** | 12.801*** |
| | (2.691) | (2.712) | (3.556) | (3.599) |
| $P_{t-1}^{I}$ | 0.175* | 0.171* | 0.268*** | 0.177*** |
| | (0.076) | (0.077) | (0.059) | (0.049) |
| $P_{t-2}^{I}$ | 0.061 | 0.158 | -0.179** | -0.090 |
| | (0.098) | (0.094) | (0.058) | (0.048) |
| $P_{t-3}^{I}$ | -0.154*** | -0.248*** | | |
| | (0.084) | (0.075) | | |
| $SIV_{t-1}^{I}$ | 0.464*** | 0.451*** | 0.387*** | 0.380*** |
| | (0.044) | (0.044) | (0.049) | (0.049) |
| $SIV_{t-2}^{I}$ | 0.239*** | 0.246*** | 0.319*** | 0.316*** |
| | (0.040) | (0.040) | (0.034) | (0.033) |
| $SIV_{t-3}^{I}$ | 0.132*** | 0.125*** | | |
| | (0.036) | (0.037) | | |
| $\alpha^{II}$ | 7.430 | 7.296 | 31.877 | 32.056 |
| | (6.271) | (6.374) | (8.783) | (8.790) |
| $P_{t-1}^{II}$ | -0.004 | -0.038 | -0.036 | -0.023 |
| | (0.407) | (0.419) | (0.219) | (0.226) |
| $P_{t-2}^{II}$ | 0.757* | 0.868* | -0.017 | -0.028 |
| | (0.434) | (0.442) | (0.217) | (0.223) |
| $P_{t-3}^{II}$ | -0.795*** | -0.871*** | | |
| | (0.210) | (0.213) | | |
| $SIV_{t-1}^{II}$ | 0.408*** | 0.440*** | 0.116 | 0.125 |
| | (0.115) | (0.116) | (0.119) | (0.119) |
| $SIV_{t-2}^{II}$ | 0.337*** | 0.336*** | 0.357*** | 0.343*** |
| | (0.079) | (0.079) | (0.075) | (0.079) |

| | | | | |
|---|---|---|---|---|
| $SIV_{t-3}^{II}$ | 0.217*** | 0.189*** | | |
| | (0.067) | (0.066) | | |
| | | ***Dummies*** | | |
| $D_{101}$ | | -2.836 | | -1.005 |
| | | (1276.5) | | (167.7) |
| $D_{102}$ | | -1.481 | | -4.504 |
| | | (723.4) | | (245.6) |
| $D_{103}$ | | 0.464 | | -0.431 |
| | | (671.1) | | (214.7) |
| $D_{104}$ | | -7.762 | | 1.334 |
| | | (16.994) | | (443.4) |
| $D_{105}$ | | -3.208 | | 0.081 |
| | | (1075.7) | | (254.4) |
| $D_{106}$ | | 3.667 | | 3.432 |
| | | (668.6) | | (270.7) |
| $D_{107}$ | | 0.313 | | -3.014 |
| | | (68.461) | | (249.6) |
| $D_{108}$ | | 8.647 | | 0.987 |
| | | (74.397) | | (274.9) |

The apexes I and II indicate, respectively, the first and second regime.
In parenthesis are reported standard errors.
Significant: *** at 0.001 ; ** at 0.01 ; * at 0.05