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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 those of imports from Morocco, the main competing country on the EU domestic markets. 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 when prices of tomato imports are below the trigger entry prices the EU tomato market becomes isolated. However, the contribution of the import regime on price stabilization is rather limited. Since tomato imports from Morocco are granted zero tariff if their price is higher than the trigger entry price within a yearly quota that is completely filled, the largest contribution to market stabilization may well come from the size of the quota.

1. Introduction

The EU import regime for fresh fruit and vegetables (F&V) was modified in 1995 after the signing of the Uruguay Round Agreement on Agriculture, shifting from the old reference price system to the entry price system (EPS) that protected the most important products, while imports of other F&V products were only subject to duties. The reasons why the EPS was introduced and the way it worked in comparison with the old import regime were thoroughly discussed by Ritson and Swinbank (1995). The authors found that the architecture of the EPS was rather restrictive on trade and were sceptical about its ability to create a more open EU market of F&V.

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 (Cioffi and dell'Aquila, 2004). 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).

This paper concerns with the analysis of the effectiveness of the EPS as a tool able to contribute to the stabilization of the EU domestic prices of F&V, in the sense of reducing the lower tail of their distribution. This was one of the main objectives of the reference price system introduced in the 1972 Common Market Organization of F&V, that is also pursued by the EPS. The stabilization effect of the EPS may arise from the avoidance of imports from a country when their market price or, as we will see in the following pages, an index built on it called Standard Import Value (SIV), is below the trigger entry price (TEP).

The analysis is carried out on tomatoes imported by the EU from Morocco, whose SIVs have often been below the TEP and it is built around identifying the relationships between the tomato SIVs and the price of tomatoes observed on production markets in Spain, i.e. the main competitors of Moroccan tomatoes on the EU market.

Our empirical analysis hinges on the idea that if the EPS affects price series they cannot be described by a random walk. We will show that since price behaviour is constrained by the EPS, specification of linear models is unable to ascertain price relationships. Therefore we estimate and test a nonlinear threshold model as proposed by Tong (1978, 1990) and generalized in the multivariate case in Tsay (1998). By means of this nonlinear specification we will be able to identify price relationships on different markets.

In our analysis we discuss the workings of the EU import regime as applied to tomatoes and the preference system granted to tomatoes imported from Morocco. The discussion will show that the case of tomatoes particularly fits to understand the effects played by the EPS on the stabilization of EU market prices. Relationships between Spanish tomato prices and the SIVs of Morocco imported tomatoes are then identified. The last part of the paper is devoted to an econometric analysis of price behaviour, testing the effects of the import regime on prices using a multivariate threshold model.

2. The EU tomato import regime

Council Regulation (EEC) 1035/72 laid down rules for the common organization of the market, establishing in 1972 an EU import regime for fruit and vegetables. It was based on tariffs and on the reference price system that was applied only to the most important products including tomatoes. The reference price system was aimed to stabilizing prices on the internal market and avoiding disturbances arising from low-price imports. Under this system, when the entry price of a product imported from one country was below the reference price, a countervailing levy was charged on those imports in addition to the most favoured nation customs duty. The countervailing charge was equal to the difference between the reference price and the recorded wholesale price of that product net of all import charges (Ritson and Swinbank, 1995). The removal of the countervailing charge was subject to a wholesale price of the products imported from that origin country higher than the reference price for at least two consecutive market days. Since all charges were deducted from the wholesale price, for its removal it was necessary to have a wholesale price higher than the reference price at least by the customs duty and the countervailing charge. Ritson and Swinbank (1995) showed that its removal was quite difficult to obtain while very often the countervailing charge was increased continuously until imports from that country were no longer profitable.

The EPS was introduced in 1995 as a result of the tariffication of the previous reference price system. It was applied to the products already covered by the reference price except a few products whose imports after the enlargement of the EU to include Spain and Portugal had become negligible. The functioning of the EPS is based on the daily calculation of the SIV of produce imported from a country. The SIV is the average market price of that product on the main EU markets minus deductions to allow distributive margins[1]. SIVs are published on the OJ the working day following calculation. If the published SIV of a product imported from a country is less than 8%

[1] SIVs are a weighted sum of average representative prices collected on the import markets within the EU by member states with reference to the importer-wholesaler or wholesaler-retailer stage; in the latter case they are reduced by 9% to account for wholesaler margin and by € 0,7245 per 100 Kg for handling and market taxes and charges. Representative prices are reduced by a percentage varying from 8 to 15% according to the different markets on which they are surveyed, in order to take account of distributive margins. The Commission reduces representative prices by a fixed amount of €5 per 100 Kg and of import duties.

lower than the EP of that product, imports from that country, besides the tariff, are also charged a specific duty that is roughly equal to the difference between the EP and the SIV. If the SIV is below 92% of the EP, the trigger entry price (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 (Table 1 reports TEP and MTE appled to tomato imports).

Both the reference price system and the EPS calendars were scheduled in such a way as to increase protection in the season when EU products are sold on the market, while it is lowered in other periods. For many products, protection is granted only in periods of the year in which EU production is marketed.

The main difference in the EPS from the previous import regime is the possibility to apply the system on a consignment basis. While the countervailing charges of the reference price system had to apply to all imported products from a country, the EPS offers the possibility to avoid the MTE being charged, showing that the final sale price was high enough to make the MTE unenforceable on that consignment, giving more flexibility to traders (Grethe and Tangerman, 1998). This is not the only way to avoid the MTE. For example, a trader who on one day would be supposed to pay the MTE to clear customs, could wait conditions making the MTE inapplicable.

2.1 The enforcement of the EPS

Some of the studies made on the EPS have compared the daily SIVs with the TEP identifying the conditions making the MTE applicable (Cioffi and dell'Aquila, 2004; Agrosynergie, 2008; Goetz and Grethe, 2009). Since, data on the daily imported quantities of F&V cleared by EU custom and the amount of specific duty collected by EU customs offices are not available, to investigate the effects of the EPS the distribution of SIVs below the TEP has been compared with the Eurostat data on monthly imports (Cioffi and dell'Aquila, 2004; Agrosynergie, 2008).

These studies have shown that the relevance of the EPS is not homogeneous among the different products. Tomatoes and lemons are the two products with the largest number of daily SIVs below the TEP (Agrosynergie, 2008; Goetz and Grethe, 2009). Generally, the relevance of the EPS is also higher for EU neighbouring partner countries, while is lower for farther countries, particularly of Southern Hemisphere. This is because the high transportation costs boost the exports of higher quality produce (Hummel and Skiba, 2004) that more rarely have prices below the TEP. Moreover the relevance of the EPS is lower for storable products that have wider opportunity to legally circumvent the payment of the specific duty (Cioffi and dell'Aquila, 2004).

2.2 Preferential agreements in the EU tomato import regime

The external protection of EU F&V is modified by preferential trade agreements. Preferences agreed with Southern Mediterranean countries (SMCs) are particularly relevant to EU imports of F&V. Such preferences were first introduced in the 1970s within the Cooperation Agreement signed by the former EEC with Algeria, Egypt, Israel, Jordan, Morocco and Tunisia, and generally granted a zero tariff treatment within an import quota. Such quotas were increased several times, partly to compensate for the preference erosion effects linked to EU enlargement in the 1980s to Greece, Portugal and, particularly, Spain. In the periods in which the reference price was in force, the zero tariff was subject to the fulfilment of the reference price system. Ritson and Swinbank (1995) showed that countervailing charges were rather infrequently applied to F&V imports from SMCs. It was probably also due to the modulation of calendars in which preferences were granted as well as of the calendars in which the reference price system was enforced. These two factors modelled the EU import flows of F&V from SMCs that were concentrated in the periods in which either the reference price was not applied or preferences were in operation.

Before the EPS was introduced, the reference price was enforced on tomato imports in the period from April 1st to December 20th. With the introduction of the new import regime, the EPS was enforced on tomato imports all year round. The agreement in the form of an exchange of letters between the EU and the Kingdom of Morocco established that starting from January 1st 1995 the imports of tomatoes from Morocco in the EU were granted a zero tariff quota subject to a reduced preferential TEP. The quota was agreed in 130,000 tons of tomatoes distributed in monthly quotas from November to March (Council Decision, 1994). It was also agreed that the quota system would be managed by Morocco, while the EU reserved the right to introduce a system of import licenses to insure the proper functioning of the agreement. Licenses were introduced in 1999, after several exceedances of the monthly quotas, and were fairly effective at controlling imports of tomatoes from Morocco working as a non-trade barrier (Garcia-Alvarez-Coque, 2002). In this framework the reduced TEP granted to Morocco may be seen as a kind of compensation for extending the EPS to periods in which the previous reference price was not operating[2] .

Despite the reduced TEP, SIVs of tomatoes imported from Morocco have often been lower than the TEP. In certain months it is quite usual to observe SIVs below the TEP. However, this does not seem to have prevented the flow of imports and the import quotas have always been binding. This situation has been the norm since the EPS came into operation. 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[3]. Table 1 summarizes the main features of the EPS as applied to tomatoes and the preferences granted to Morocco. Fulfilment of the monthly quota requires strict management of tomato imports from Morocco. These are subdivided into roughly constant daily shipments (Agrosynergie, 2008).

<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

[2] Chemnitz and Grethe (2005) estimated for the period 2000-2003 a total rent from the quota of €24-36.5 million per year, roughly 25-26% of the total export value of Moroccan tomatoes to the EU, which is largely captured by Moroccan operators including agricultural producers.

[3] The quota was set at 150.676 tons from October to March in 2000. It was increased at 175.000 tons from October to May by 2003/04 with a further conditional quota of 45.000 tons by 2006/07, that can be subdivided at a maximum of 30% per month from November to May under the condition that the tariff quota was not exceeded in the previous year (Regulation 37/2004, Official Journal of the European Union; 2004).

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 is from October to March, when imports from Morocco have zero tariffs if SIVs are above the preferred entry price and the volume of imports does not exceed the monthly quota.

As mentioned above, the EU Commission calculates Moroccan SIVs with a daily frequency. Hence to assess the effectiveness of the EU tomato import regime from Morocco daily prices have to be considered. In our analysis we used prices of round fresh tomatoes from two Spanish markets, Almería and Murcia, respectively the first and second largest tomato exporting provinces. Their export seasons differ: Almería concentrates its exports in January and February while Murcia shows a more stable and longer season (de Pablo Valenciano and Perez Mesa, 2004). In our analysis we considered the period from October to May, that is the period in which there are import flows of tomatoes from Morocco to the European Union.

3. Methodology and results

3.1 A model of price behaviour in the EU tomato market

Analysis of the tomato preferential trade agreements between the EU and Morocco and of the relationships between EU supply and Moroccan imports in the previous sections would suggest the hypothesis that the behaviour of prices on the EU tomato market, at least for round tomatoes, is governed by the Spanish supply, being daily imports from Morocco roughly constant to stay within the monthly quotas (Agrosynergie, 2008). If we consider the high substitutability between Spanish and Moroccan tomatoes, being in practice their quality the same, we can assume that in the EU wholesale markets the prices of the latter would not greatly differ from the prices of Spanish tomatoes. Therefore, under the assumption of a perfectly competitive market, farm gate prices of tomatoes in Spain and Morocco would only differ for transportation cost. An increase of Spanish supply would cause a decrease in the price of both Spanish and Moroccan tomatoes on the EU markets. In this situation, if the EPS were effective, when the SIV of Moroccan tomatoes becomes lower than the TEP, imports from Morocco would decrease due to the levying of the MTE, contributing to avoid a further reduction in Spanish tomato prices.

Given this hypothesis on tomato price behaviour in the EU markets, since there aren't data on the price of Moroccan tomatoes, the first part of our empirical analysis aimed to assess the relationships between Spanish tomato prices and the SIVs of Moroccan imports, that can be considered a proxy of the price of those tomatoes, although the criteria for their calculation has remained the same since 1995, while distributive costs may have changed[4]. This part of the analysis seeks to understand how Spanish and Moroccan supply influence one another in market price behaviour. The second part of the analysis consists in the identification and estimation of an econometric model for Spanish tomato prices. This model, as well as the analysis of

[4] A detailed analysis on the administrative procedures of the EPS scheme is available in the Evaluation report (Agrosynergie, 2008).

relationships, is subsequently modified to test the effects of the EPS.

3.2 The econometric analysis

The daily prices data used to carry out the analysis were extracted from the Agriview database of the European Commission, which also includes daily prices of F&V collected on EU markets of different countries. Data on daily SIVs are those calculated by the EU Commission. All prices are reported in euro and expressed in current terms. Time series of daily prices and SIVs refer to weekdays from Monday to Friday and contain data from October to May which corresponds to the season in which tomatoes are imported in the EU from Morocco. Prices from the different years are combined to obtain a unique sample that covers the period from 10 January 2000 to 13 February 2004. Missing observations (less than 11%) were replaced using linear interpolation at nearby points.

The analysis was carried out in four sequential steps:

(i) first ADF (Augmented Dickey and Fuller) and PP (Philips and Perron) tests were performed to verify the presence of unit roots in the price series and their non-stationarity that affects econometric model inference;

(ii) a linear Vector Auto-Regressive (VAR) model was estimated to assess the relationships between Spanish and Moroccan prices, in order to understand how Spanish and Moroccan supply influence each other in market price behaviour;

(iii) a threshold autoregressive (TAR) model (Tong, 1978, 1990) was used to test whether Spanish prices time series change their behaviour when Moroccan SIVs go below the TEP and, hence, if time series could be split up into two different regimes: the first that occurs when Moroccan SIVs are above the TEP, the second when SIVs are below and extra duty on Moroccan imports to EU is then applied;

(iv) finally, a Threshold Vector Auto-Regressive (TVAR) model (Tsay, 1998) was estimated taking into account the presence of the threshold to ascertain the "true" relationships among Spanish and Moroccan prices.

In order to carry out the analyses some preliminary tests and transformations of time series were applied. Nelson and Plosser (1982) showed a vast majority of economic series could be better characterized by a unit root process than by a deterministic trend. Furthermore, according to other authors (Fama, 1995), price series are likely to follow a random walk process, this 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 the unitary root of the price series was tested through different tests (Table 2): the augmented Dickey-Fuller (ADF) (Dickey and Fuller, 1979) and the Philips-Perron (PP) (Philips and Perron, 1988) unit root tests were applied on the prices and SIV series, both in levels and differences. These tests do not allow us to accept the null hypothesis of non-stationarity and we can analyze them through standard regression inference.

Note that the two tests were derived for the null hypothesis of unit roots in linear time series. On the other hand, if series are non-linear and the number of observations is large, as in our analysis, Kapetanios et al (2003) show, through Montecarlo simulations, that these tests continue to have the prefixed size and a high power. Kapetanios and

Shin (2006) derive specifically tests suited for TAR models that are slightly more powerful than ADF, when observations are lower than 200 (see also Bec et al, 2004), and equivalent for larger samples. Moreover, the alternative proposed tests and their power is strongly linked to the threshold constant that in our analysis is a variable (the TEP). This implies that these tests are not directly applicable to our analysis.

< TABLE 2 ABOUT HERE >

3.3 Linear VAR system

Among EU members, Spain is the main exporter of tomatoes, while Morocco is the main non-EU partner country. Production seasons, target markets, technologies and varieties adopted by the two countries are very similar; furthermore, both Spain and Morocco supply the French market. As a consequence, competition between Spain and Morocco is fierce (de Pablo Valenciano and Perez Mesa, 2004). Nevertheless, their export volumes are quite different: Spain's volume is over five times greater than Morocco's. This could imply a dependence of Moroccan SIVs, the *proxy* for Moroccan tomato prices in the EU, on Spanish tomato prices. In order to test this assumption and ascertain the existence and direction of spatial and time relationships between Spanish and Moroccan prices for fresh tomatoes a Vector Auto-Regressive system (VAR) may be specified. Such specification is justified on the ground of a stochastic supply of Spanish tomato, while daily storage, that is possible also for a perishable product such as tomato, may introduce an autoregressive pattern in prices (Deaton, Laroque, 1992). Therefore the following VAR system was estimated:

(1) $$\mathbf{\Phi}(\mathrm{B})\mathbf{X}_t = \mathbf{c} + \boldsymbol{\varepsilon}_t$$

where $\mathbf{X}_t' = (\mathrm{ALM}_t, \mathrm{MUR}_t, \mathrm{SIV}_t)$, $\mathbf{\Phi}(\mathrm{B})$ is a polynomial matrix (3, 3) of degree k:

$$\mathbf{\Phi}(\mathrm{B}) = \mathrm{I} - \mathbf{\Phi}_1\mathrm{B} - \mathbf{\Phi}_2\mathrm{B}^2 - \ldots - \mathbf{\Phi}_k\mathrm{B}^k;$$

with **I** an identity matrix, $\mathbf{\Phi}_i$ matrices of parameters to be estimated, B the back-shift operator: $\mathrm{B}\mathbf{X}_t=\mathbf{X}_{t-1}$, ε_t a vector of white noise processes independently and identically distributed with zero mean and covariance matrix $\mathbf{\Sigma}_\varepsilon$ to be estimate.

As the simultaneous full information maximum likelihood estimation (Green, 1997) was carried out considering only statistically significant lagged variables, the final specification is as follows:

$$\hat{\mathbf{\Phi}}(\mathrm{B}) = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} - \begin{bmatrix} 1.197 & 0 & 0 \\ 0 & 1.178 & 0 \\ 0 & 0 & 1.048 \end{bmatrix} \mathrm{B} - \begin{bmatrix} -0.226 & 0 & 0 \\ 0 & -0.270 & 0 \\ 0 & 0 & 0 \end{bmatrix} \mathrm{B}^2 +$$

$$-\begin{bmatrix} 0 & 0 & 0 \\ 0.119 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} B^3 - \begin{bmatrix} 0 & 0 & 0 \\ -0.062 & 0 & 0 \\ 0 & 0 & -0.098 \end{bmatrix} B^4; \quad \hat{\mathbf{c}} = \begin{bmatrix} 2.120 \\ 2.074 \\ 3.644 \end{bmatrix}$$

or in explicit form (in parenthesis the estimated standard errors):

$$(2) \quad \begin{cases} \mathrm{ALM}_t = \underset{(.713)}{2.120} + \underset{(.024)}{1.197}\,\mathrm{ALM}_{t-1} - \underset{(.023)}{0.226}\,\mathrm{ALM}_{t-2} \\ \mathrm{MUR}_t = \underset{(.830)}{2.074} + \underset{(.016)}{1.178}\,\mathrm{MUR}_{t-1} - \underset{(.018)}{0.270}\,\mathrm{MUR}_{t-2} + \underset{(.026)}{0.119}\,\mathrm{ALM}_{t-3} - \underset{(.025)}{0.062}\,\mathrm{ALM}_{t-4} \\ \mathrm{SIV}_t = \underset{(.861)}{3.644} + \underset{(.017)}{1.048}\,\mathrm{SIV}_{t-1} - \underset{(.016)}{0.098}\,\mathrm{SIV}_{t-4} \end{cases}$$

with N=725; $\mathrm{adj}-R^2$, respectively, 0.96; 0.96; 0.94; and the estimate residual covariance and correlation matrices given by

$$\hat{\boldsymbol{\Sigma}}_{\boldsymbol{\varepsilon}} = \begin{pmatrix} 31.13 & 15.29 & 12.47 \\ 15.29 & 30.25 & 11.56 \\ 12.47 & 11.56 & 47.32 \end{pmatrix}; \quad \hat{\mathbf{R}}_{\boldsymbol{\varepsilon}} = \begin{pmatrix} 1 & 0.50 & 0.32 \\ 0.50 & 1 & 0.30 \\ 0.32 & 0.30 & 1 \end{pmatrix}$$

where ALM, MUR, SIV are the series of prices on Almería and Murcia markets and the SIVs of tomatoes imported from Morocco.

If $|\boldsymbol{\Phi}(B)|$ is the determinant of the matrix $\boldsymbol{\Phi}(B)$, the VAR(k) model (1) is stationary if all roots (characteristic roots) in B^{-1} of $|\boldsymbol{\Phi}(B)| = 0$ are, in modulus lower than one. If any of these roots is equal to one the VAR is not stationary and has a random walk component. In our case it is straightforward to verify that:

$$|\boldsymbol{\Phi}(B)| = (1 - 1.197B + 0.22B^2)(1 - 1.178B + 0.270B^2)(1 - 1.048B + 0.098B^4)$$

allowing the eight, in decreasing order, characteristic roots:

B_1=0.96, B_2=0.92, B_3=0.87, B_4=0.60,

B_5=-0.24-i0.34, B_6=-0.24+i0.34, B_7=0.31, B_8=0.23

with $|B_5| = |B_6| = 0.42$. It is therefore possible to say that:

- $|\boldsymbol{\Phi}(B)| = (1\text{-}0.96B)(1\text{-}0.92B)(1\text{-}0.87B)(1\text{-}0.60B)\ (1\text{+}0.48B\text{+}0.1732B^2)$
  it is quite evident that there is a strong inertia in our series but the VAR is still stationary confirming the evidence from the ADF and PP tests;

- prices in the two Spanish markets are not directly affected by the Morocco SIVs and vice versa. However this result may be due to the specification of the model: using a linear model while we have non linear phenomena;
- the existence of two conjugate complex roots imply a pseudo-periodical wave with period P = 6.57, very close to a week. This result could be also accounted to the misspecification of the model. In the next section we assess the change in behaviour that Spanish prices show when Moroccan SIVs exceed the TEP.

3.4 Univariate TAR model

In this section, we test whether Spanish price behaviour changes when SIVs fall below the TEP, i.e. the condition under which the MTE would be applied to Moroccan imports, reducing the volume of tomatoes exported to the EU. We analyze the presence of two different regimes in Spanish prices, due to the applicability of the MTE when SIVs fall below the TEP which in our sample occurs 117 times over a total of 725 observations. Descriptive statistics show that, for all the tree analyzed series, the two regimes differ substantially in mean, variance and asymmetry (figures 1 and 2): compared to the second regime, the first has a higher mean, larger variability and stronger positive asymmetry. The threshold model allows us to better investigate how these regimes differ.
The use of non linear threshold auto regressive models (TAR) is aimed at the assessment of the effects of the EPS on the tomato market. These models were first 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). In TAR models nonlinearity is due to the continuous mixing to whom phenomena undergo through a stochastic variable of switching called threshold process. The standard TAR model with two regimes and k lagged variables in each regime is given by:

(3) $$\left[I_{t-d}\phi_1(B)+(1-I_{t-d})\phi_2(B)\right] X_t = I_{t-d}\alpha+(1-I_{t-d})\beta+\varepsilon_t$$

with $I_{t-d}=\begin{cases}1 \text{ if } X_{t-d}>\lambda\\ 0 \text{ if } X_{t-d}\le\lambda\end{cases}$ and $\phi_i(B)$, i=1, 2, polynomial in B of degree k.

In our analysis d=1, while the index variable is different from the one in the standard model and is given by:

$$I_{t-1}=\begin{cases}1 \text{ if } SIV_{t-1}>TEP_{t-1}\\ 0 \text{ if } SIV_{t-1}\le TEP_{t-1}\end{cases}$$

The TAR model (3) is meaningful if:

- $0<E(I_{t-1})=p<1$ and therefore has observations in both regimes;
- $\phi_1(B)\ne\phi_2(B)$ and the autoregressive structure of the two regimes is different in each of one.

If the two stated conditions introduced are both verified, the EU import regime on tomatoes really affect prices and it can be assessed through the p value and the differences between the two polynomials $\phi_1(B)$ and $\phi_2(B)$. From (3) it is straightforward to ascertain that X_t has a unit root if both regimes have a unit root. If only one regime has a unit root, X_t is globally stationary but locally non-stationary for that specific regime.
The maximum likelihood estimate of (3) for ALM_t, MUR_t and SIV_t are reported in (4)-(6).

FIGURE 1 AND 2 ABOUT HERE

The models, in which the variables have been lagged up to five lags (one week), were estimated with OLS but reported only statistically significant lagged variables. In the first time, the estimations were carried out without restrictions on model parameters. The results implied a characteristic root not significantly different from one in the first regime. Therefore we made a new estimation imposing a unit root in the first regime of each model. Also, three different dummies were introduced to consider the seasonal discontinuity in time series, which were all statistically not significant and were omitted in the final specification. Residual auto-cross correlation and partial correlation up to 20 lags showed that there are no significant auto-cross correlation in the residuals[5].

(4)
$$\begin{aligned} ALM_t &= I_{t-1}\Big(\underset{(.037)}{1.242}\,ALM_{t-1} - \underset{(.037)}{0.242}\,ALM_{t-2}\Big) + \\ &+ (1 - I_{t-1})\Big(\underset{(1.332)}{4.372} + \underset{(.137)}{1.349}\,ALM_{t-1} - \underset{(.135)}{0.423}\,ALM_{t-2}\Big) \end{aligned}$$

with N=723; adj-R^2=0.96; DW=2.055; $\hat{\sigma}_\varepsilon = 5.58$

(5)
$$\begin{aligned} MUR_t &= I_{t-1}\Big(\underset{(.038)}{1.213}\,MUR_{t-1} - \underset{(.038)}{0.213}\,MUR_{t-2}\Big) + \\ &+ (1 - I_{t-1})\Big(\underset{(1.283)}{4.197} + \underset{(.126)}{1.368}\,MUR_{t-1} - \underset{(.123)}{0.437}\,MUR_{t-2}\Big) \end{aligned}$$

with N=723; adj-R^2=0.96; DW=1.995; $\hat{\sigma}_\varepsilon = 5.59$

(6)
$$SIV_t = I_{t-1}SIV_{t-1} + (1 - I_{t-1})\Big(\underset{1.694}{5.391} + \underset{(.029)}{0.940}SIV_{t-1}\Big)$$

with N=724; adj-R^2=0.94; DW=1.900; $\hat{\sigma}_\varepsilon = 6.95$

[5] The relevant graphs were omitted for reasons of space and are available upon request from the authors.

More specifically, for Almería we obtain:

$$\phi_1(B) = 1 - 1.242B + 0.242B^2\ ;\quad \phi_2(B) = 1 - 1.349B + 0.423B^2$$

whose characteristic roots for each regime are:

$$B_1^{(1)} = 1,\ B_2^{(1)} = 0.24\ ;\quad B_1^{(2)} = 0.85,\ B_2^{(2)} = 0.50\ .$$

For Murcia we obtain:

$$\phi_1(B) = 1 - 1.213B + 0.213B^2\ ;\quad \phi_2(B) = 1 - 1.368B + 0.437B^2$$

whose characteristic roots are for each regime are:

$$B_1^{(1)} = 1,\ B_2^{(1)} = 0.21\ ;\quad B_1^{(2)} = 0.86,\ B_2^{(2)} = 0.51\ .$$

For the SIV series we obtain:

$$\phi_1(B) = 1 - B\ ;\quad \phi_2(B) = 1 - 0.940B$$

whose characteristic roots for each regime are:

$$B_1^{(1)} = 1\ ;\quad B_1^{(2)} = 0.94\ .$$

From those estimates we can say that:

- the first regime for ALM, MUR and SIV are all non stationary and ALM and MUR show an almost identical structure in boot regimes;
- the structure of the second regime is stationary and different from the first; it has a moderate inertia for ALM e MUR and stronger for SIV;
- the effect of the EU import regime can be evaluated from $1 - \hat{p} = 0.162$ and therefore is rather small;
- the three price are globally stationary, but locally (in the first regime) non stationary.

3.5 Threshold Vector Auto-Regressive model

In the previous section the influence of the trigger threshold on Spanish prices was highlighted. As a consequence, trigger price policy should be considered in the simultaneous equation system model estimated in section 3.1.

In order to control the effect that a change in price behaviour could have on the relationship between Spanish prices and Moroccan SIVs, the following simultaneous trivariate TVAR equation system was estimated:

$$(7)\qquad \left[I_{t-1}\boldsymbol{\Phi}_1(B) + (1 - I_{t-1})\boldsymbol{\Phi}_2(B)\right]\mathbf{X}_t = I_{t-1}\boldsymbol{\alpha} + (1 - I_{t-1})\boldsymbol{\beta} + \boldsymbol{\varepsilon}_t$$

In the first time, the estimations were carried out without restrictions on model parameters. The results implied a characteristic root not significantly different from one in the second regime. Therefore we made a new estimation imposing a unit root in the second regime.
The estimation parameters of model (7) up to five lags with the full information maximum likelihood method, considering only the parameters statistically significant, are:

$$\hat{\mathbf{\Phi}}_1(B) = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} - \begin{bmatrix} 1.182 & 0 & 0.034 \\ 0.044 & 1.137 & 0 \\ 0.036 & 0 & 1.072 \end{bmatrix} B - \begin{bmatrix} -0.216 & 0 & 0 \\ 0 & -0.238 & 0.147 \\ 0 & 0 & -0.115 \end{bmatrix} B^2$$

$$\hat{\mathbf{\Phi}}_2(B) = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} - \begin{bmatrix} 1.329 & 0 & 0 \\ 0 & 1.427 & 0 \\ 0 & 0 & 1 \end{bmatrix} B - \begin{bmatrix} -0.329 & 0 & 0 \\ 0 & -0.427 & 0 \\ 0 & 0 & 0 \end{bmatrix} B^2; \quad \hat{\boldsymbol{\alpha}} = \hat{\boldsymbol{\beta}} = \mathbf{0};$$

or explicitly

$$\begin{aligned} ALM_t = I_{t-1}\Big(&\underset{(.028)}{1.182}\,ALM_{t-1} - \underset{(.023)}{0.216}\,ALM_{t-2} + \underset{(.013)}{0.034}\,SIV_{t-1}\Big) + \\ &+ (1 - I_{t-1})\Big(\underset{(.096)}{1.329}\,ALM_{t-1} - \underset{(.096)}{0.329}\,ALM_{t-2}\Big) \end{aligned}$$

$N = 723;\ adj - R^2 = 0.97;\ DW = 1.989;$

$$\begin{aligned} MUR_t = I_{t-1}\Big(&\underset{(.017)}{0.044}\,ALM_{t-1} + \underset{(.019)}{1.137}\,MUR_{t-1} - \underset{(.018)}{0.238}\,MUR_{t-2} + \underset{(.013)}{0.047}\,SIV_{t-2}\Big) + \\ &(1 - I_{t-1})\Big(\underset{(.079)}{1.427}\,MUR_{t-1} - \underset{(.079)}{0.427}\,MUR_{t-2}\Big) \end{aligned}$$

$N = 723;\ adj - R^2 = 0.96;\ DW = 1.973$

$$\begin{aligned} SIV_t = I_{t-1}\Big(&\underset{(.017)}{0.036}\,ALM_{t-1} + \underset{(.028)}{1.072}\,SIV_{t-1} - \underset{(.028)}{0.115}\,SIV_{t-2}\Big) + \\ &+ (1 - I_{t-1})SIV_{t-1} \end{aligned}$$

$N = 723;\ adj - R^2 = 0.943;\ DW = 1.992$

and

$$\hat{\mathbf{\Sigma}}_{\boldsymbol{\varepsilon}} = \begin{pmatrix} 30.99 & 15.10 & 13.54 \\ 15.10 & 30.23 & 11.76 \\ 13.54 & 11.76 & 48.90 \end{pmatrix}; \qquad \hat{\mathbf{R}}_{\boldsymbol{\varepsilon}} = \begin{pmatrix} 1 & 0.49 & 0.35 \\ 0.49 & 1 & 0.30 \\ 0.35 & 0.30 & 1 \end{pmatrix}$$

For the first regime it is:

$$\left|\mathbf{\Phi}_1(B)\right| = (1-1.137B+0.238B^2)(1-1.82B+0.216B^2)(1-1.072B+0.115B^2)$$

with characteristic roots

$$B_1^{(1)} = 0.86,\ B_2^{(1)} = 0.28,\ B_3^{(1)} = 0.96,\ B_4^{(1)} = 0.23,\ B_5^{(1)} = 0.95,\ B_6^{(1)} = 0.12.$$

All roots in the first regime are real and positive and therefore imply the simultaneous existence of six components with agreeing signs. Moreover, the first regime is stationary but with a strong inertia close to the non stationary unit region.
For the second regime it is:

$$\left|\mathbf{\Phi}_2(B)\right| = (1-1.329B+0.329B^2)(1-1.427B+0.427B^2)(1-B)$$

with characteristic roots:

$$B_1^{(2)} = 1,\ B_2^{(2)} = 0.33,\ B_3^{(2)} = 1,\ B_4^{(2)} = 0.43,\ B_5^{(2)} = 1,\ B_6^{(2)} = 0$$

therefore the second regime is not stationary, even though the process is still globally stationary (Niglio and Vitale, 2008). More precisely:

- the roots of the two regimes differ substantially each other: the first is stationary while the second is not. These differences justify the use of the two regimes and therefore of the threshold TVAR model;
- taking into account the univariate TAR analysis, the variables ALM, MUR and SIV are, as expected, cointegrated only in the first regime;
- Spanish prices are affected explicitly by the Morocco SIVs only in the first regime that has a high probability to happen $\hat{p} = 0.839$;
- Almería price affect Murcia price only in the first regime, while the opposite is not true. It must be recalled that Almería is the most important Spanish exporting region for tomatoes;
- Morocco SIVs are affected only by Almería price and only in the first regime.

Our results reinforce the idea that EPS influences the relationship between Spanish prices and Moroccan SIVs. More particularly, Almería prices follow an AR(2) structure in both regimes, albeit with different parameters. It is worth noting that the Moroccan SIVs affect Almería prices on the day after they are higher than the TEP. By contrast, in the second regime when the Moroccan SIVs are below the TEP, they show no relationship with Almería prices.

Murcia prices follow an AR(2) structure and are also influenced by Almería prices and by lagged Moroccan SIVs during the first regime. In the second regime Murcia prices are also unaffected by lagged SIVs, only showing an AR(2) behaviour. Finally, Moroccan SIVs show an AR(2) structure while are influenced by Almería prices during the first regime. The lack of an SIV effect on Almería and Murcia prices in the second regime highlights the contribution of the EPS to the stabilization of tomato prices on the EU markets. This effect is synthesized in the isolation of the EU market when Moroccan prices are particularly low. However such effect is rather small given the low but statistically significant parameters shown by the SIVs in the first regime of both price series.

4. Final remarks

This paper sought to analyze the stabilization effects of the EPS on the prices of EU F&V. It focuses on the case of tomatoes, since for this product the prices of imports from Morocco, the main EU partner country, frequently fall below the TEP. The following hypothesis was tested: when the price of imports falls below that level is there a reaction in the level of the prices of EU domestic (Spanish) produce?

The analysis showed that a standard VAR model was unable to take into account the effects played by the EPS on tomato price behaviour. Econometric analysis was therefore carried out through threshold vector autoregressive specification in which the threshold is represented by a SIV of Morocco tomato imports below the TEP.

The results of threshold vector autoregressive specification show that when Moroccan SIVs are below the TEP the Spanish prices follow a pattern different from the one shown when SIVs are higher. Moreover, while the price of Moroccan tomatoes affects the Spanish prices when the SIVs are higher than the TEP this does not hold when SIVs are below this level. Econometric analysis thus showed that at least in the case of tomatoes, the EPS contributes to stabilizing EU domestic prices through the neutralization of the effects that low import prices could exert.

Our analysis also showed that although a stabilization effect exists, it is rather limited probably because of the relatively small size of Moroccan tomato imports compared to Spanish production. Imports from Morocco amount to roughly 20% of Spanish exports to the EU market and are distributed in the period from October and May according to the zero tariff quotas.

A stronger stabilization effect of the EU domestic tomato market is probably provided by the import quota regime in which the imports of tomatoes from Morocco are granted zero tariff. The size of such quotas has often been the subject of bilateral negotiations that brought about a gradual increase. Since the yearly quota is distributed in monthly quotas from October to May that cannot be overcome, the system is carefully managed by Moroccan exporting firms which seek to make uniform daily shipments capable of staying within the monthly zero tariff quotas.

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Tables

Table 1 – Preferential EP and TRQ granted to Morocco in 2006/07 and monthly imports.

	Tariff	Entry price	MTE	Pref. Tariff	Pref. Entry price	MTE	TRQ	Import 06/07
	(%)	*(€/t)*	*(€/t)*		*(€/t)*	*(€/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	

Table 2 –ADF and PP tests

Variable	ADF		PP	
	(1)	(2)	(1)	(2)
ALM	-3.762	-3.774	-3.732	-3.746
MUR	-3.769	-3.830	-3.798	-3.858
SIV	-4.678	-4.772	-4.678	-4.772

(1) Intercept. Test critical value (5%) = -2.865;
(2) Intercept and trend. Test critical value (5%) = - 3.416.

Figures

Figure 1 – Regimes box – plot of ALM, MUR, SIV

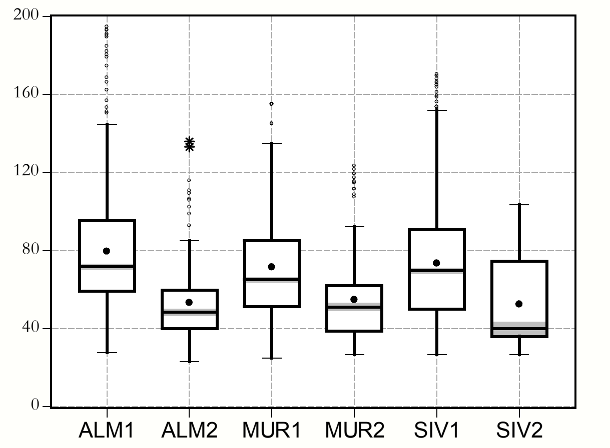
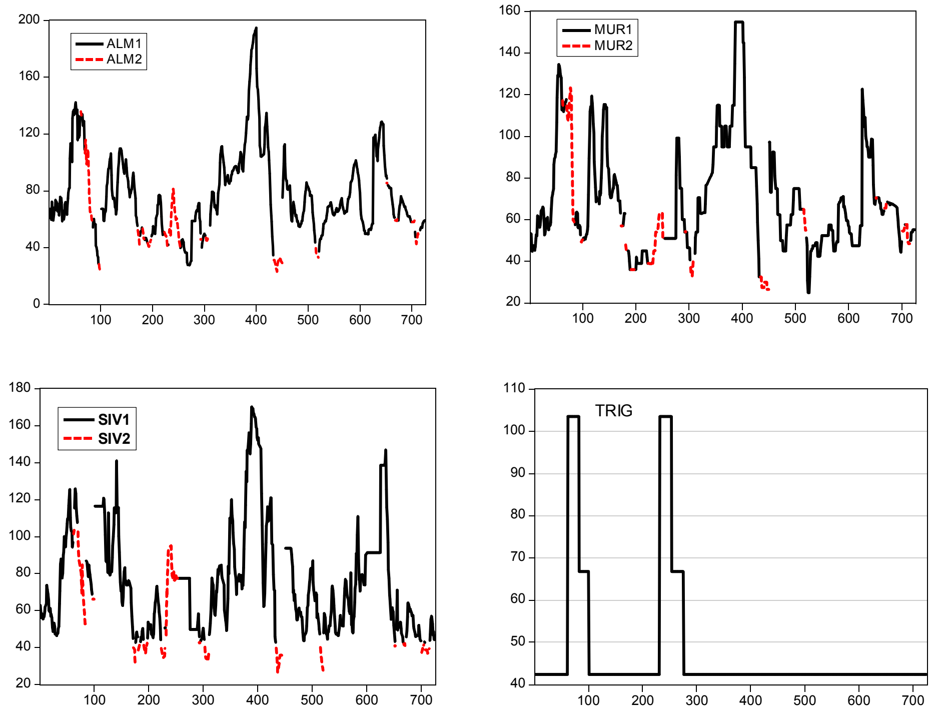


Figure 2 – Series ALM, MUR, SIV and their regimes



Key words*: Fruit and vegetables, Entry price system, Preferential trade agreement, Tomato, price stabilisation, VAR, TVAR.*