TRANSMISSION OF MARKET CRISES IN THE EUROPEAN VEGETABLES SECTOR

JEL classification: F13, Q17, Q18

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Abstract. *The paper analyses the problem of transmission of crises in European fruit and vegetable markets. The analysis is performed on the prices of tomatoes and cauliflowers on some important markets of the European Union close to production or consumption areas. The methodological approach consists in estimating a two regime error correction model capable of capturing the main aspects of price transmission in the absence or presence of market crises. The analysis shows that the transmission of market crises differs according to the characteristics of the markets analysed, their proximity to production or consumption areas, as well as to the products considered. The work has allowed the identification of relevant insights for planning policies for crisis management in the fresh vegetables sector.*

Keywords: *Market crises, vegetables, price transmission.*

1. Introduction

According to the European Commission (EC, 2005), a crisis occurs when "*there is an unforeseen situation that threatens the survival of farms, both locally and through the entire production sector or a broader geographical level*". Such a definition is very close to the concept of natural disaster: however, despite its similarity to disasters, a different definition is required as companies can resume normal activities after the crises are over.

Within such a framework, a peculiarity of market crises is that they are mainly linked to sudden price falls due to an unforeseen decline in consumer demand provoked by concerns arising from outbreaks such as BSE, or environmental disasters (*e.g.* Chernobyl). The economic losses of these crises can be amplified by import bans issued by trading partners that further reduce the market demand for products. The European Commission (EC, 2007) has further differentiated market crises into structural and economic crises. The former requires the adaptation of enterprises to the changing market conditions, while the latter are short-term crises.

Although unexpected, market crises can be considered as one of the risks that companies usually incur in their business activities. In order to cope with such risks firms can implement different management strategies. Among them, preventive strategies are very relevant: they consist in transferring the risks to third parties, or in avoiding losses by savings or credit. The new Common Agricultural Policy (CAP) might – and should - play a relevant role in helping farmers to manage these risks (De Castro *et al.*, 2011, 2012b).

The fresh fruit and vegetables (F&V) sector is often involved in market crises due to the sensitivity of supply to climatic variables and to the perishability of many products. The fresh

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F&V sector is particularly sensitive to structural crises, due to the high incidence of fixed costs on total production costs, which reduce the ability of companies to adapt quickly to market crises. On the other hand, vegetables are very sensitive to economic crises, due to the reduced shelf-life and to the high incidence of transport costs on retail prices. The reform of the Common Market Organization (CMO) for F&V in 2007 has reduced the role of existing measures to stabilize markets: it introduced the possibility of adopting new tools to deal with market crises. In particular, the CMO has established the so-called security funds that are intended to assist firms through financial instruments and/or insurance (Cafiero *et. al.*, 2007). However, a correct planning of risk and crisis management cannot ignore the spatial dimension of market crises: more precisely, understanding the degree and speed of price transmission and therefore the spread of market crises, is important for efficient management of potential market losses.

The term *contagion* indicates the phenomenon of transmission and spread of economic crises in spatially separated countries/areas. On one hand the economic literature on the transmission of financial crises (and the concept of contagion) is large and newly developed (*e.g.* Rigobon, 2003, Bekaert *et al.*, 2005; Dungey *et al.*, 2005; Dungey *et al.*, 2007; Ahlgren and Antell, 2010), on the other, the international economic and agricultural literature has devoted much space to the study of the mechanisms and degree of price transmission using different econometric approaches: threshold auto regressive models (TAR) (Ejrnaes and Persson, 2000, Goodwin and Piggott, 2001; Abdulai, 2000, Serra *et al.*, 2006; Balcombe, Bailey, Brooks, 2007; Ben-Kaabia1, Gil, 2007), switching regimes models (SR) (Ihle, Von Cramon -Taubadel, Zorya, 2009; Hassouneh, Serra, Gil, 2010) and threshold vector error correction models (TVECM) (Meyer, 2004; Brümmer, von Cramon-Taubadel, Zorya, 2009)[1]. However, agricultural economics literature appears to lack works aimed at studying the transmission of price during market crises[2].

Our paper aims to contribute to this issue by analyzing whether, and to what extent, the degree and the mechanism of price transmission of fresh vegetables are influenced by the occurrence of market crises. Our study considers prices of tomatoes and cauliflowers collected on several European markets close to production or consumption areas. The products are two of the main vegetables per volume of production. In addition, tomatoes and cauliflowers are widely affected by market crises. Therefore, the present work highlights aspects of interest for correct planning of policies for market crisis prevention and management.

The article is organized in six sections: Section 2 presents a summary of the main features of the European fruit and vegetables sector with particular emphasis on the products to be analysed; the issue of market crises is explored in the subsequent section; the fourth paragraph describes the methodology, while results are presented in section 5; conclusions and final remarks are developed in the last paragraph.

2. The European fruit and vegetables sector

The European Union (EU) is one of the world's largest producers of fruits and vegetables: its production accounts for more than 8 percent of the total (in particular, the EU produces 12 per cent and 7 per cent of global fruits and vegetables respectively).

[1] See Listorti and Esposti (2012) for a recent survey.

[2] To the best of our knowledge, one of the most appropriate works in agricultural economics literature related to the transmission of market crises has been published in Journal of Economic History (Madsen, 2001).

Tab. 1 - Main European producers of F&Vs (1000 tonnes)			
State	**Annual average production**		
	2000-2002	**2005-2007**	**2005-2007 (share)**
Italy	32.523	32.653	25.3%
Spain	28.179	28.515	22%
France	19.638	16.366	12.7%
Poland	7.391	7.383	6.2%
Greece	8.325	7.472	5.8%
Source: own calculations on EUROSTAT data.			

Grapes are the main item in the sector for volume of production, although they are mainly for the wine industry. Tomatoes are the second product and account for 30 percent of the European production of vegetables.

Italy (38 percent) and Spain (20 percent) are the main EU producers of fresh tomatoes, followed by Greece, Portugal and France. The Spanish fresh tomatoes are directed mainly to Northern Europe, particularly to France, United Kingdom, Germany and Netherlands. In other words, Spain plays an important role as a major producer and as main intra-EU exporter of fresh tomatoes. Almeria and Murcia are respectively the first and second Spanish provinces for export volume: the former concentrates its exports during the winter, while the latter has a wider and more stable export season (Valenciano de Pablo and Perez Mesa, 2004).

Tab. 2 - Main vegetables – EU volumes of production (1000 tonnes)			
State	**Annual production**		
	2001	**2003**	**2005**
Tomatoes	16.204	15.780	15.579
Carrots	5.079	5.088	5.057
Cabbages	5.434	4.635	4.940
Onions	4.795	4.559	4.906
Lettuce	3.275	3.224	3.804
Cauliflowers	2.114	2.190	2.105
Source: : own calculations on EUROSTAT data.			

Italy, Spain and France provide almost 70 percent of European cauliflower production. Italian production occurs in several geographical areas and is particularly relevant in Campania, Tuscany, Sicily, Marche. The main production areas in Spain are located close to Murcia, Navarra, Valencia and LaRoja: the volume produced in those areas accounts for 85 percent of total Spanish production. Germany is the main partner for Italian exports, while Spanish exports are mainly traded to United Kingdom (40 percent), Germany (15 percent), France (13 percent) and Netherlands (13 percent).

3. Market crises in the European fruit and vegetables sector

According to the definition of the European Commission "[...] *a crisis is understood to be an unforeseen situation that endangers the viability of agricultural holdings, either at a* ***localized*** *level, across a whole sector of production or at a* ***wider geographical level***" (emphasis added) (EC,

2005)". Economic events can cause short-term but intense market crises which may give rise to long-term structural problems. Although the management of risks and uncertainty at a time of economic choices is generally due to individual skills and preferences, the emergence of market crises - by definition unpredictable - has two main effects: firstly it leads to lower profits, secondly it affects several agents simultaneously (Cafiero *et al.*, 2007). In general, market crises cannot be managed by a single firm, while they can lead to considerable damage to the whole industry. For the these reasons both a correct prevention and a proper management of market crises at different levels (regional, national or European) is not only desirable but essential. The level of intervention should be chosen depending on the size of the crisis and the level of contagion[3]: the greater the degree and speed of transmission of crises, the higher will be the level of intervention necessary (*e.g.* if market crises are spread internationally, an intervention at Common level is required).

Market crises may be caused by several factors such as disasters, health problems, economic dynamics, and, in particular, they are caused by market disequilibria (*e.g.* over-production, sudden changes in demand, excess of imports, *etc.*).

In an era of volatile prices, food insecurity and market instabilities (De Castro *et al.*, 2012a), the European Commission intervenes with specific agricultural policies aimed at prevention and management of market crises - wine distillation, publicly supported storage, market withdrawals, *etc.*.

The F&Vs sector is particularly exposed to market crises due to the perishability of the produce, and due to the sensitivity of production and consumption to climatic variations (EC, 2007a). In particular, the perishability of the produce prevents storage as a form of temporal arbitrage and might force producers to sell the ready produce during periods of low price. A second side effect of perishability is the strong seasonality in consumption. The sensitivity to climatic conditions influences both consumption and production (EC, 2007a). The last reform of the fruit and vegetables CMO has introduced a new tool to help in stabilizing the markets, the Operating Fund, aimed at transferring risks to other economic agents (EC, 2007b). It is important, however, to emphasize that the effectiveness of such a policy tool is strongly linked to the spatial dimension of market crises, and more precisely, it is affected by their speed and degree of transmission. The European Union aims to stabilize farmers' revenues also through trade policy measures such as the entry price The latter was introduced to stabilize the domestic price and prevent market crises, but its effectiveness is still unclear (Swinbank and Ritson, 1995; Cioffi and dell'Aquila, 2004, Goetz and Grethe, 2009). Recent analyses on the stabilization effects of the entry prices seems to indicate a rather modest effectiveness (Cioffi *et al.*, 2011; Santeramo and Cioffi, 2012). Price dynamics and market crisis transmission are key issues also in the correct planning of stabilization policies: for products whose markets are isolated the relevance of the entry price scheme could be quite limited, while the contrary is true for more integrated markets with fast price transmission.

To sum up, market crises are quite frequent in the European fruit and vegetable sector, and their size depends crucially on the degree of market integration: market crises occurring in poorly integrated markets tend to be localized, while market crises occurring in highly integrated markets lead to global crises. In this latter case despite the fact that it spreads the phenomenon, spatial arbitrage helps to reduce the intensity of the crises.

[3] In particular, the World Bank adopts three definitions of contagion: the first, a very general one, indicates the degree of price transmission between countries; the second definition links the concept of contagion to the transmission of shocks which are not explained by economic fundamentals; the third definition, most often adopted, defines contagion as a change in the price transmission mechanisms during periods of market crises (Ahlgren and Antell, 2010).

The present study focuses on two products particularly relevant in the EU as they represent the main vegetables for volume of production and are strongly affected by crises: cauliflowers and tomatoes (Cafiero *et al.*, 2009). They permit a limited degree of preservation, and differ by degree of perishability and unit costs of transport. As shown in Santeramo (2012), those features play a relevant role in spatial price transmission, therefore they will be taken into account for the interpretation of results.

Santeramo and Cioffi (2010) provided preliminary evidence on the degree of spatial price transmission in the tomato and cauliflower sectors, pointing out that market crises might be rapidly transmitted within *regions* whilst they tend to be confined to them rather than be transmitted to spatially separated *regions*. Such a result seems to be clearly demonstrated for cauliflowers as the low degree of integration and price transmission on the relevant markets suggests a low tendency towards the cross-regional transmission of market crises.

4. Methodology and data

As a preliminary step to the analysis of the effects of market crises on price transmission, we defined *crisis* the event occurring when the observed price, in a certain period of the year, is more than 25 percent below the five-years average price recorded in the same market. In analytical terms, the event "*crisis*" is defined as follows: $P_t < 0.25 * MM_{5t}$, where P_t is the market price at time t, MM_{5t} indicates the moving average of prices recorded for the same period in the previous 5 years. Our data-set includes daily prices - collected at wholesale level - and it covers the period from January 2001 to December 2006. The original data, extracted from the Agriview database of the European Commission, have been temporally aggregated to obtain weekly frequency. Prices have been collected on main EU vegetables markets by volume of trade. The data-set, in fact, includes the following markets for the tomato sector[4]: Almeria (Spain), Chateau-Renard (France), Dublin (Ireland), London (United Kingdom), Den Bosch (Netherlands). As regards the prices of cauliflower, the data-set includes the following markets: La-Roja (Spain), London (United Kingdom), Den Bosch (Netherlands), Sint Katelijne Waver (Belgium). We analysed price transmission among Spanish markets (Almeria or La Roja), which are close to the large production areas, and the other European markets, relevant for volume of consumption. Market crises have been identified in several of the main Spanish markets for volume of production: such a selection procedure allowed the investigation of the transmission of market crises from production Regions to consumption Regions. The selected markets in Spain are as follows: Almeria, Malaga and Murcia for tomatoes, and Barcelona, La Rioja, Navarra, Valencia for cauliflowers.

The analysis is conducted in two steps: firstly we evaluate the degree of market integration; secondly we estimate an econometric model able to take into account the event of *market-crisis*, that is we allow spatial price dynamics to differ under the *normal* regime and the *market-crisis* regime. The first econometric specification is as follows:

$$\Delta X_t = \alpha + \sum_{i=1}^{n} \beta_i \Delta X_{t-i} + \rho X_{t-1} + \varepsilon$$

[4] For sake of simplicity, we omitted results related to markets for which we cannot find price relationships.

where X_t represents the prices difference ($P_t^A - P_t^B$), ρwill indicate the coefficient degree of transmission, and $\varepsilon \sim \mathbf{N}(\mathbf{0}, \sigma_I^2)$.

As far as the second step, we adopted a vector autoregressive error correction model (TVECM) in which the *market crisis* regime is deterministically determined by the occurrence of a market crisis in the Spanish markets. The econometric specification is as follows:

$$\Delta X_t = (1 - I_t)\left\{\alpha_I + \sum_{i=1}^{n} \beta_{i,I} \Delta X_{t-i} + \rho_I X_{t-1} + \varepsilon_I\right\} + I_t \left\{\alpha_{II} + \sum_{i=1}^{n} \beta_{i,II} \Delta X_{t-i} + \rho_{II} X_{t-i} + \varepsilon_{II}\right\}$$

where X_t represents the prices difference ($P_t^A - P_t^B$), while I_t is the *switching variable* assuming value 0 in the normal regime and 1 in the *market crisis* regime, $\varepsilon_I \sim \mathbf{N}(\mathbf{0}, \sigma_I^2)$ and $\varepsilon_{II} \sim \mathbf{N}(\mathbf{0}, \sigma_{II}^2)$ are the error terms.

According to the above mentioned specification, the coefficients ρ_I and ρ_{II} represent the degree of transmission in the first and second regimes.

5. Results

The model is estimated through OLS, which allow consistent estimates under regularity conditions (Tsay, 1989). The number of autoregressive lags of our econometric specification has been chosen by minimizing the values of information criteria (AIC, BIC, SIC).

The analysis of the price transmission shows that market prices are correlated and price transmission occurs (Tables in appendix).

As far as cauliflowers are concerned, the coefficients ρ are respectively equal to -0.20, -0.45 and -0.21 for Den Bosch, London and St. Kateljine Waiver, highlighting a sufficient degree of price transmission (Table A.1). The degree of price transmission is larger for tomatos: the values of ρ are respectively equal to -0.43, -0.64, -0.40 and -0.37 for Chateau Renard, Den Bosch, Dublin and London (Table A.2). It should be emphasized that our estimates might be subject to upward bias as we do not take into account transaction costs and the consequent *inactivity band*.

The second step of the analysis dealt with the effects of market crises on price transmission. As regards cauliflowers, we found that price transmission for Den Bosch and Saint Kateljine Waiver occurs only in the first (normal) regime, and not in the second (crisis) regime. On the contrary, price transmission between LaRoja and London occurs under both regimes (Table A.3). The latter case is probably due to the large volume of cauliflowers traded from Spain to the United Kingdom (about 40 percent of total exports to countries in the EU-25). Tomato prices are indeed transmitted both in the first and in the second regimes only for Den Bosch and London. Our findings suggest that market crises are transmitted from Spain to areas of net consumption (*e.g.* Netherlands and United Kingdom). In contrast, the transmission of market crises across production areas (*e.g.* Chateau Renard in France) or towards countries with small import volumes from Spain (*e.g.* Ireland) is absent.

To sum up, our analysis shows that price shocks in the vegetable sector are weakly transmitted during market crises, therefore market crises occurring in production areas tend to be localized and do not affect distant European markets. A plausible explanation would be that the perishability of vegetables and the high unit costs of transport reduce arbitrage opportunities in international markets. Results from the tomato sector also suggest that market crises tend to spread from production areas to net-importer areas: the limited shelf life of tomatoes does not prevent arbitrage in international markets and price adjustments tend to be fast and consistent.

6. Concluding remarks

Due to the sensitivity of supply to climatic variables and to the perishability of many products, the fresh fruit and vegetables sector is often involved in market crises. The relevance of these crises led the European Union to introduce, in the reform of the Common Market Organization for fruits and vegetables, new tools to deal with market crises, such as the so-called security funds., In order to plan crisis management efficiently, however, it is crucial to take into account both the frequency and the spatial dimension of market crises. The latter feature has been addressed in the present paper, through the estimation of a non-linear time series econometric model.

A preliminary analysis on the degree of spatial integration of European fruit and vegetables markets shows a strong price transmission between markets close to production and consumption areas, while the phenomenon is less evident among markets located in the production area. The findings lead to interesting empirical and policy implications: market crises occurring in production areas have negligible effects on market prices of other production areas, implying that market crises determined by a temporary and unexpected surplus in production, tend to be localized. From a policy perspective, the crisis management tools should be planned on the basis of the peculiarities of each production area and its market structure. In other terms, policy-makers should implement the market regulatory tools most efficient at local level.

A further result of our analysis consists in having detected the changes in the mechanisms of price transmission during *market crises*. In particular we found that the occurrence of market crises tends to interrupt price transmission among markets at a distance from each other or located in the same production area. A second implication of our work is therefore that market crises in production areas tend to be localized and intense, lowering local prices for long periods. Under this scenario, the social planner should be aware that market crises in perishable markets would strongly affect producers' welfare. As the perishability of vegetables makes it impossible to adopt stabilization tools such as public or private storage, it seems appropriate to plan policy intervention that compensates producers' losses – e.g. relying on market crises funds might be a feasible approach.

Despite the fact that our results may be weakened by data limitations – in particular our results may be specific for the two products under analysis - we provide relevant insights for policymakers aimed at planning policies for market crisis management.

A further limitation could be due to the definition of market crisis as exogenously determined. The adoption of a simple time series model might bias our results and hide further changes in the price dynamics during market crises. In reality market crises are a smooth process that might be better captured by highly non-linear models (e.g. STVECM).

Future research should take into account recent trends in the European fruit and vegetables sector. The increasing volume of contracts among sellers and buyers and the declining role of the wholesale fruit and vegetable markets in particular, have two important implications: firstly, prices collected on the traditional fruit and vegetable markets are less informative on the relationships between demand and aggregate supply; secondly, it would be important to take into account vertical price transmission.

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ESTIMATION RESULTS

Tab. A.1 - Price transmission in the cauliflower sector –La Roja vs other European markets

	Den Bosch Linear model		London Linear model		St. Kateljine Waiver Linear model	
α	6.06 *	*(2.62)*	5.15 ***	*(0.89)*	15.81***	*(3.76)*
β_1	-0.80	*(0.07)*	0.11 *	*(0.05)*	0.07	*(0.05)*
β_2	-0.11	*(0.07)*			-0.03	*(0.05)*
β_3	0.1 ***	*(0.07)*			-0.11 *	*(0.05)*
ρ	-0.2 ***	*(0.05)*	-0.45 ***	*(0.05)*	-0.21 ***	*(0.04)*

, **, * indicate statistical significance at 10%, 5% and 1% level*

Tab. A.2 - Price transmission in the tomato sector –Almeria vs other European markets

	Chateau Renard Linear model		Den Bosch Linear model		Dublin Linear model		London Linear model	
α	6.89 *	*(4.02)*	22.29 ***	*(7.75)*	13.62***	*(4.19)*	16.37 ***	*(5.81)*
β_1	-0.12	*(0.11)*	0.01	*(0.13)*	0.12	*(0.11)*	0.02	*(0.09)*
β_2	-0.30 ***	*(0.10)*	0.11	*(0.11)*			0.28 ***	*(0.09)*
ρ	-0.43 ***	*(0.13)*	-0.64 ***	*(0.15)*	-0.40 ***	*(0.09)*	-0.37 ***	*(0.09)*

, **, * indicate statistical significance at 10%, 5% and 1% level*

Tab. A.3 - Cauliflower price transmission in *normal* and *market crisis* regimes

	Den Bosch		London		St. Kateljine Waiver	
	Regime I	**Regime II**	**Regime I**	**Regime II**	**Regime I**	**Regime II**
α	6.92 ** *(3.07)*	3.78 *(6.22)*	4.98 *** *(0.95)*	7.03 ** *(3.29)*	5.96 *** *(4.09)*	12.85 *(9.89)*
β_1	-0.80 *(0.07)*	-0.04 *(0.31)*	0.12 ** *(0.05)*	-0.12 *(0.24)*	0.04 *(0.06)*	0.23 *(0.15)*
β_2	-0.12 *(0.07)*	-0.07 *(0.42)*			-0.05 *(0.06)*	-0.02 *(0.17)*
β_3	0.1 *(0.07)*	0.7 *(0.22)*			0.12 * *(0.06)*	0.07 *(0.14)*
ρ	-0.21 *** *(0.05)*	-0.17 *(0.23)*	-0.45 *** *(0.05)*	-0.35 ** *(0.24)*	-0.21 *** *(0.04)*	-0.13 *(0.12)*

, **, * indicate statistical significance at 10%, 5% and 1% level*

Tab. A.4 - Tomato price transmission in *normal* and *market crisis* regimes.

	Chateau Renard		Den Bosch		Dublin		London	
	Regime I	**Regime II**	**Regime I**	**Regime II**	**Regime I**	**Regime II**	**Regime I**	**Regime II**
α	7.57 *(4.65)*	5.15 *(9.46)*	14.45 *** *(9.04)*	37.48 ** *(14.66)*	15.73 *** *(4.71)*	3.52 *(9.91)*	14.33 *** *(6.37)*	27.72 ** *(15.57)*
β_1	-0.10 *(0.13)*	-0.19 *(0.28)*	0.21 *(0.19)*	0.11 *(0.23)*	0.13 *(0.11)*	0.13 *(0.26)*	-0.01 *(0.11)*	0.16 *(0.22)*
β_2	-0.32 *** *(0.12)*	-0.22 *(0.21)*	-0.19 *(0.18)*	-0.03 *(0.17)*			-0.33 *** *(0.10)*	-0.11 *(0.21)*
ρ	0.46 *** *(0.15)*	-0.34 *(0.29)*	0.44 ** *(0.17)*	-1.07 *** *(0.31)*	-0.44 *** *(0.10)*	-0.22 *(0.21)*	-0.33 *** *(0.10)*	-0.57 ** *(0.24)*

, **, * indicate statistical significance at 10%, 5% and 1% level*