MARKET POWER BEHAVIOURAL DYNAMICS AND PRICE VOLATILITY IN AGRICULTURAL MARKETS

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FUNDACIÓN DE LAS CAJAS DE AHORROS
DOCUMENTO DE TRABAJO
Nº 757/2014

De conformidad con la base quinta de la convocatoria del Programa de Estímulo a la Investigación, este trabajo ha sido sometido a evaluación externa anónima de especialistas cualificados a fin de contrastar su nivel técnico.

ISSN: 1988-8767

La serie **DOCUMENTOS DE TRABAJO** incluye avances y resultados de investigaciones dentro de los programas de la Fundación de las Cajas de Ahorros.
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MARKET POWER BEHAVIOURAL DYNAMICS AND PRICE VOLATILITY IN AGRICULTURAL MARKETS

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September 2014

Abstract
Market power in value chains of agricultural products is often unbalanced. Agricultural markets have been more volatile since the food crisis in 2007-2008. Markets instability should be taken into account when studying agrifood markets structure. We unravel the dynamics of market power (MP) within the agri-value chain through an innovative approach that mixes competition, industrial organisation (IO) and finance methods. We analyse the weekly prices of fifteen fruits and vegetables at three chain positions in Spain. We construct MP measures along the value chain and apply a DCC-MGARCH model. This new technique reveals how MP is conditioned by changes in prices in the value chain, revealing dynamic interactions amongst mark-ups. This affords an evaluation on the degree of collusion between market players, overcoming traditional limitations regarding static IO analyses. We find a strong role of wholesalers in the distribution chain, even greater in a dynamic context. Perishable fruits and vegetables markets are sensitive to external shocks and volatility processes, which translates into MP.

*Keywords***:** market power, agricultural prices, perishable products, MGARCH model, price volatility

JEL classification: L11, L13, Q13

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Acknowledgements: Authors acknowledge support from research project ULYSSES. ULYSSES Project has received funding from the European Commission Project 312182 KBBE.2012.1.4-05. Any information reflects only the authors' view and not that from the European Union.

1. Introduction

Are wholesalers and retailers conducting a competitive behaviour or are they in connivance? We describe the relationship and dynamics of market power (MP) within the value chain of fresh fruits and vegetables in Spain. In doing so, interactions amongst value chain links are analysed. We look for the existence of competition or collusion amongst chain links of the value chain.

Our interest is focused in how the interaction between forces in the value chain of agricultural products evolves.

The selected market is perishable fruits and vegetables. The aim of selecting the fresh fruits and vegetables market is choosing the market with the minor possible intervention (transformation and added value) from origin to consumers. We chose also one of the major fruits and vegetables markets, the Spanish[2] one.

Recent surges of price volatility have appeared in 2008 and 2012. When analysing agricultural prices, another factor hits agricultural markets: these are severely affected by volatility. Those price changes make price setting difficult and they could affect differently the levels in the value chain. So these episodes of high variance in prices must be taken into account.

Some characteristics of volatility processes are:

- Volatility clustering. It is common to observe periods of high/soft volatility in clusters. That means that periods of high volatility are commonly followed by high volatility, and similarly for low volatility processes. This means that the variance of the error is dependent from its past realizations.
- Heavy tailed distributions of errors.

When analyzing the agrifood value chain, the grade of competition in the markets shall be considered. The existence of competition in the value chain, or the lack of it, has consequences for the other players of the market: final consumers and at-origin-producers; and for the value chain itself.

In the analysis, we use the frequently-used in financial markets multivariate general autoregressive conditional heteroskedasticity model (M-GARCH). By

[2] Diop (2005) considers Spain a global leader in fresh fruit exports.

doing so, we can show the interactions between players at the value chain and, also, the sensitivity of mark-up to shocks and volatility processes.

We study the dynamics of market power (MP) when changing prices along the value chain of perishable agricultural products. We dissect the market relationships within the distribution. For the analysis, the effect of price volatility is taken into account. Our contribution to the literature is based on the application of the dynamic conditional correlation (DCC) method in a multivariate general autoregressive conditional heteroskedasticity model (M-GARCH) for the market power analysis. This new technique into Industrial Organization (IO) reveals how MP is conditioned by changes in prices in the value chain. Furthermore, dynamic interactions amongst mark-ups are also revealed. This allows an evaluation on the degree of collusion between market players.

The application of MGARCH models in agricultural markets is not very common; and, to our knowledge, this is the first time that this method is applied to the study of market power and market power behaviour. The aim of applying this new methodology is double. On one hand, our model sheds light on the responses of MP variables when changing prices in a complex data -which takes into account volatility-. This means understanding whether a mark-up is affected positively or negatively, when players change prices in the value chain. On the other hand, it provides dynamic information about the relationship amongst market power levels, at different stages of the chain. This can be seen in the dynamics of MP correlations: when wholesalers' MP diminishes, is retailer's MP diminishing also or is it reinforced instead? This analysis is done product by product. Overall, a complete picture of the market is depicted in a dynamic way.

2. Literature review

Several authors have emphasised the large transformation of the agricultural markets throughout the world. Rogers and Sexton (1994) found evidence on buyer concentration and the difficulties in assessing it due to the lack of abundant available data. Getting back to Rogers and Sexton (1994), the market of raw agricultural commodities is usually narrower and concentration is thus usually higher than in the finished products market. Sexton et al (2005) study the grocery retailers' behaviour in the US for iceberg lettuce and fresh tomatoes. They find that retailers have been able to exercise oligopsony power on lettuce market. Mixed results are found for tomatoes. Some authors have expressed their concern about the implications of the concentration process. For example, Sexton mentions the loss of farms and vitality of rural areas.

Increasing concentration processes by food manufacturers, grocery retailers (McCorriston 2002, Kinsey 2013), and new vertical contracts are some of the more crucial changes. Sexton (2013) even qualifies these trends as inexorable.

Despite this concern, empirical studies are scarce. As McCorriston (2013: 18) states, "empirical evidence on the existence of buyer power is generally lacking".

Bottlenecks are present in the food industry. Grievink (2002) showed that power imbalances are common in agricultural value chain and distribution processes in Europe. In the Grievink's market structure description, bottlenecks are present in the distribution from countryside to consumers. Grievink depicts a European market squeezed by the number of manufacturers, buying desks and supermarket formats in comparison to both extremes of the market, the number of producers and suppliers, and the number of customers and consumers. It is expected that those bottlenecks are mirrored at market behaviour, and precisely on market and buyer power. The interest in studying those markets emerges at this point.

The European picture is not far from the US strong concentration on first-handler markets for the raw agricultural commodities depicted by Rogers and Sexton (1994). From a dynamics point of view, in the food system it seems to be a consistent trend towards larger markets shares of bigger companies (Kinsey, 2013). This structure could be easily repeated in other world areas. The existence of world concentration phenomena seems possible inn food value chains and distribution.

As processing and retail markets become more and more concentrated, the balance of power between primary producers and their customers loses balance (DFID, 2004).

3. Market power in fresh agricultural products

Market power is defined as the ability of a firm to raise prices above its marginal cost. In normal conditions, it is expected that every firm has some degree of market power (Motta, 2004). For its measure, we select the index of Lerner as a relative measure of the mark-up or also understood as percentage markup of price over marginal cost (Perloff et al., 2007; Tirole, 1988). Following the Lerner (1934) definition,

$$L = \frac{p - C_i'}{p} = \frac{1}{\varepsilon} \tag{1}$$

In a generic definition like equation (1), *p* is the price, C_i' is the marginal cost and ε is the market demand elasticity[3].

In our study case, the chain is defined along three stages: first, the origin level; second, the wholesale level and third, the retailer level.

We structure our analysis following the market system shown in figure 1.

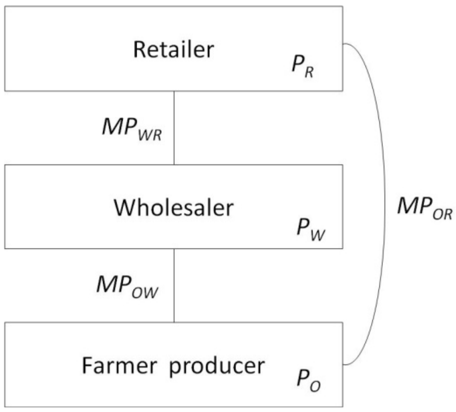

Figure 1. Market structure. “MP” represents market power and “P” is price along the 3 chain stages.

From the application of equation (1) to this price structure, we get three different Lerner indexes (two for both intermediary distribution levels and an overall distribution index). These three measures of market power represent the MP existing from the origin (farmer) to wholesaler, from the wholesaler to the retailer, and the wider index from origin to consumer. We use them as indexes signalling the presence of MP.

[3] See Lerner (1934) or Tirole (1988) for more information about the Lerner index.

$$MP_{OW} = \frac{p_W - p_O}{p_W} = \frac{1}{\varepsilon_{OW}} \quad (2)$$

$$MP_{WR} = \frac{p_R - p_W}{p_R} = \frac{1}{\varepsilon_{WR}} \quad (3)$$

$$MP_{OR} = \frac{p_R - p_O}{p_R} = \frac{1}{\varepsilon_{OR}} \quad (4)$$

Here p_O in equations (2) and (4), and p_W in (3) specify the incurred costs. We assume as constant the rest of costs. We obtain the MP_{OW}, MP_{WR} and MP_{OR} variables that are relative indexes independent from the measured units. For simplicity, it is avoid the time t subindex.

The results of the indexes MP_{OW}, MP_{WR} and MP_{OR} are shown in a synthesized way in figure 2 and detailed in figure 3.

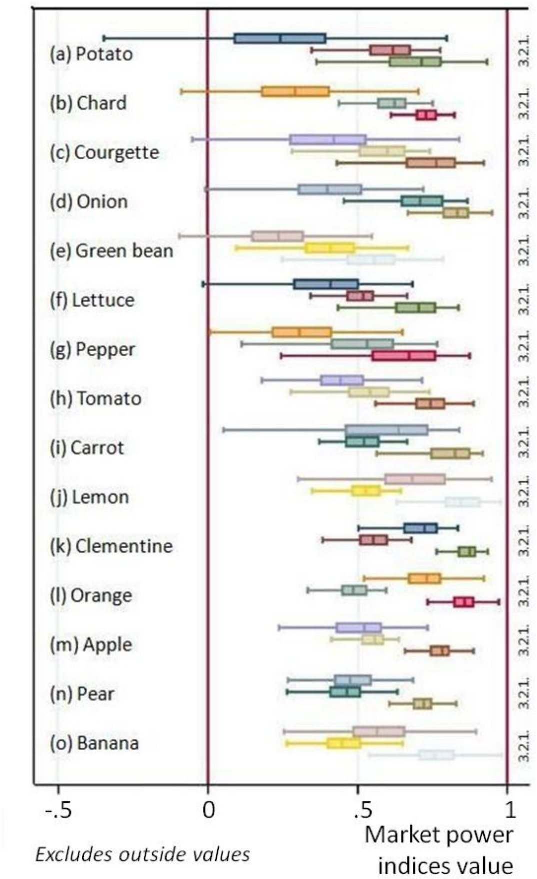

Figure 2. Market power indices distribution. Each product (*a* to *o*) has three market power indices: 1.Origin-Wholesaler; 2. Wholesaler-Retailer; 3. Overall (Origin to Retailer); top-down displayed. Data extracted from market power indices elaborated by the authors, on the basis of weekly data comprising from 2004 -1st week- to 2013 -24th week-.

In a context of pricing above marginal cost, the range of the indices goes from 0 to 1. When the index equals 0, the raise of price above marginal cost is null, no market power is exerted[4]. The index would equal 1 in a utopic extreme situation where the whole price is determined by market power, 0% of price determined by marginal costs. The higher the value of the indices, the higher the market power.

Elzinga and Mills (2011) set out the static feature of Lerner index as a weakness of the index. Elzinga and Mills said that Lerner index has the limitation of being a static measure, not encompassing dynamic effects. We reach that: the dynamic effect. This new methodology surpasses the static feature problems and criticisms traditionally released over the Lerner Index.

[4] This would hold for an ideal perfect competition situation, where price = marginal cost, and Lerner index (L)=0. Taking into account equation (1), when L = 0, market power is null and demand elasticity $\varepsilon(p) = \infty$ (as in a perfectly competitive environment) . When the demand is very elastic (high ε), margins and market power will be small, and the contrary also holds.

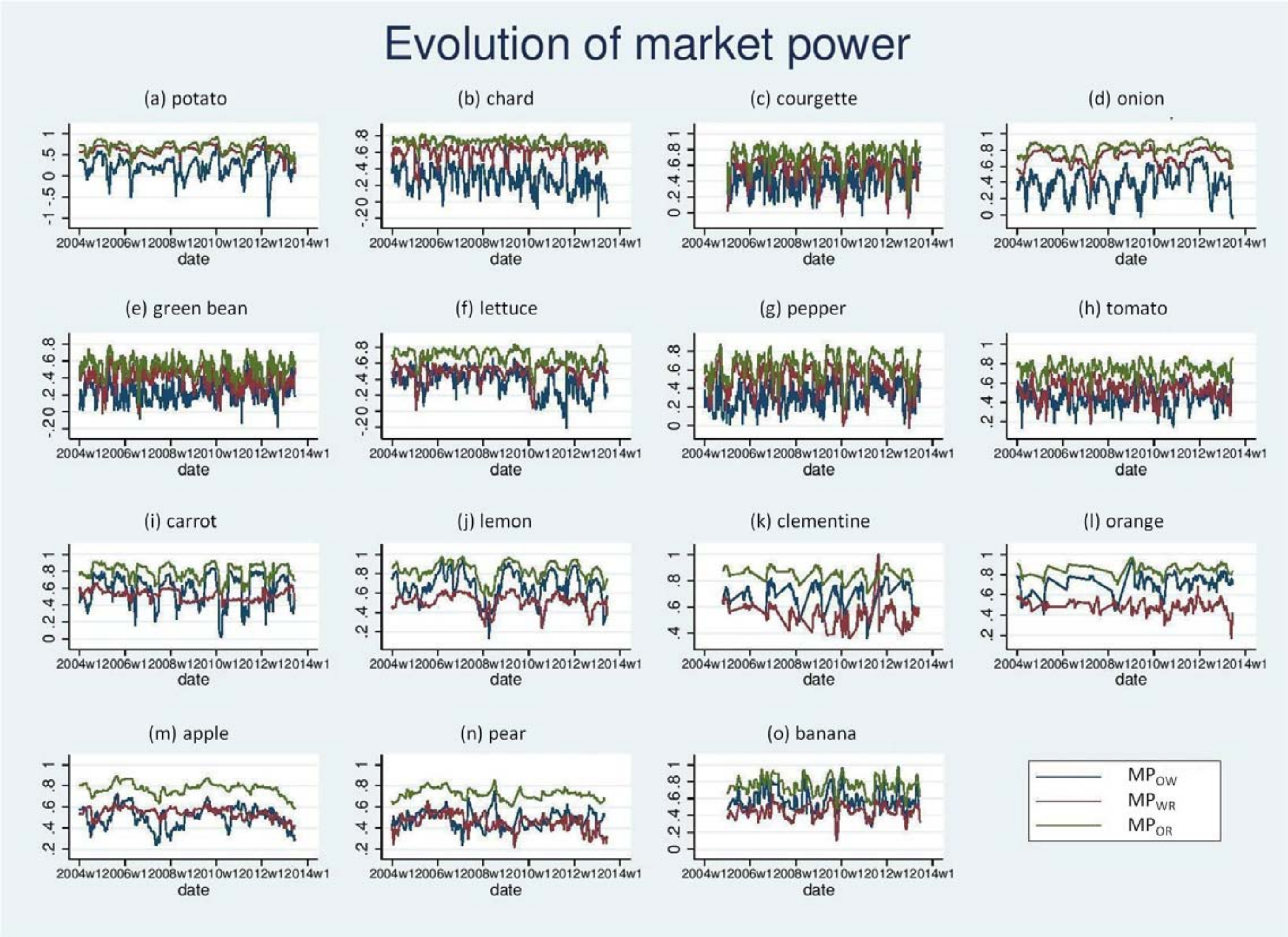

Figure 3. Evolution of market power per product (weekly observations from 2004-2013, week 24th). Data extracted from the indices elaborated by the authors.

In this value chain analysis, one previous chain link analysis is missing: the analysis of farmer margins in order to get a similar variable for fruits and vegetables producers. However, this segment becomes next to impossible to tackle given the lack of costs' information. While it is true that a mean cost could be estimated, a weekly time series for each specific product is almost impossible to obtain. So, our model would not be possible to apply. However, taking into account Grievink's (2002) considerations and the agricultural census revealing the quantity of 385,769 fruits and vegetables farm producers[5], we can assume that market power of farmers tends to negligible.

Contrasting this number of farms with the number of trading desks and further intermediaries in the chain, the depicted image is very similar to Grievink's. The number of trading desks for the whole agricultural commodities, livestock, textile commodities and semiprocessed products is 927[6]. The number of companies in the wholesale for fruits and vegetables is 9,086, and the final link in the distribution chain is divided into 15,721 minor distribution retailers of fruits and vegetables, 18,929 supermarkets and 475 hypermarkets[7].

Let's keep on mind this structural market description, shown on figure 4. It is the picture of the Spanish perishable fruits and vegetables market's actors. Also, let's add another element stated by Sexton and Zhang (2006). These authors take into account that the farm supply is inelastic (specialized production and extensive investments in sunk assets imply worthy of consideration exit barriers). Those two factors put in together: high buyer concentration, and inelastic farm supply, "represent structural conditions that are conductive to the exercise of oligopsony power by processors and handlers" (Sexton and Zhang, 2006:157).

[5] 989,796 is the number of farms for the whole country (2009 Spanish agricultural census data). The number 385.769 is the sum of the potatoes, vegetables, fruits and citrics' producers. If we would take into account vegetable gardening for family consumption (less than 500 m^2) the number would rise to 524,346.

[6] We take this number given the impossibility of decomposing it.

[7] Data extracted from the 2012 annual survey of trade from INE (Instituto Nacional de Estadística, the Spanish Official Bureau of Statistics) and data from Alimarket obtained from Toribio (2012).

Source: elaborated by the authors

Figure 4. Structure and number of actors in the Spanish value chain of perishable fruits and vegetables

Sexton and Zhang (2006) deepen the analysis of possible impacts of concentration and market power on consumers. The same stated before regarding the farmer's chain link, would apply for the other extreme of the chain: final consumers.

4. Modelling framework

In order to take into account the surges of volatility, the model used to analyse market power behaviour is a multivariate GARCH model, which adjusts to a changing conditional standard deviation and dynamic correlations.

In financial data, the assumption of constant variance of standard time series does not hold. When analysing prices it is a common fact finding periods of high volatility, clustered together. That means that independence from past variance shocks does not apply for these data. Engle (1982) was the first in proposing a model to deal with heteroskedastic variances of the error when tried to explain the volatility of the inflation rates. This kind of models allows mean and conditional covariance to be dynamic. The seminal work of Engle has nowadays multiple variations. The model that we apply is the dynamic conditional correlation (DDC) method in a multivariate general autoregressive conditional heteroskedasticity model (M-GARCH) (Engle, 2002). A GARCH is a generalization from the autoregressive conditional heteroskedasticity models (ARCH).

This model is applied in two steps. In a first step, univariate GARCH processes are modelled. We get from these the conditional variance of each individual product. In a second step, we look for nonlinear combinations of univariate GARCH processes and we get conditional covariances (and conditional correlations). The dynamic conditional correlation (DDC) method of our model allows for particularly weighted non-linear combination for obtaining the covariance matrix of the errors.

We choose this modelling approach because it allows us to study the dynamics of the different MP relationship along the levels of the agricultural distribution chain. It takes into account volatility processes in prices. It also permits determining the effect of this volatility into the market and fitting a non-linear model with multiple exogenous variables. The MP indexes ($MP_{OW,\ t}$, $MP_{WR,\ t}$, $MP_{OR,\ t}$) are the independent variables. The relative growth in prices at three levels: prices of agricultural perishable fresh products at original level (price paid to the farmer), wholesaler level, and the price paid by the consumer (retailer price) are the independent variables.

$$m_t = Cp_t + e_t \tag{5}$$

Where m_t is a m x 1 vector of dependent variables; C is the parameter matrix; the p_t vector contains the independent variables, and e_t matrix contains the innovation elements.

The relationship between innovation and volatility is defined by

$$e_t = H_t^{1/2} \cdot \varepsilon_t, \qquad \varepsilon_t \sim iid\ F(0, I_d) \tag{6}$$

The volatility matrix is given by,

$$H_t = D_t^{1/2} \cdot R_t \cdot D_t^{1/2} \tag{7}$$

And the single elements of the matrix are the following,

$$h_{ij,t} = \rho_{ij,t} \cdot \sqrt{h_{ii,t} \cdot h_{jj,t}} = \rho_{ij,t} \cdot \sqrt{\sigma_{i,t}^2 \cdot \sigma_{j,t}^2} \tag{8}$$

Where $\rho_{ij,t}$ varies with time (it is dynamic) and σ_{it}^2 are the diagonal elements.

In a first step, those elements of D_t , σ_{it}^2 (called conditional variance of each individual), are modelled by a GARCH (p,q) univariate process:

$$\sigma_{it}^2 = \omega_i + \sum_{j=1}^{p} \alpha_j \cdot e_{i,t-j}^2 + \sum_{j=1}^{q} \beta_j \cdot \sigma_{i,t-j}^2 \tag{9}$$

Where α_j is the ARCH parameter and β_j is the GARCH parameter.

If we model the univariate σ_{it}^2 GARCH (p,q) process as GARCH(1,1), we get[8]

$$\sigma_{it}^2 = \omega_i + \alpha_j \cdot e_{i,t-1}^2 + \beta_j \cdot \sigma_{i,t-1}^2 \tag{10}$$

In a second step, we look for nonlinear combinations of univariate volatility models with time-varying correlations. Those time-varying correlations are also called conditional correlations.[9]

Equations of the dynamic conditional correlation (DDC) method are:

$$D_t = diag\{\dots, \sigma_{it}^2, \dots\} \tag{11}$$

$$R_t = diag(Q_t)^{-1/2} \cdot Q_t \cdot diag(Q_t)^{-1/2} \tag{12}$$

The Q_t matrix contains the conditional correlations, with the following structure

$$Q_t = (1 - \lambda_1 - \lambda_2)R + \lambda_1 \tilde{e}_{t-1} \cdot \tilde{e}'_{t-1} + \lambda_2 Q_{t-1} \quad , \tag{13}$$

[8] It could be also understood as $\sigma_{it|t-1}^2 = \omega + \alpha \cdot e_{t-1}^2 + \beta \cdot \sigma_{t-1|t-2}^2$ regarding information availability at moment *t*, *t-1*, etc. (See *Cryer and Chan*, 2008)

[9] Those conditional correlations will be conditioned to the information set available at each moment in time.

with $\lambda_1, \lambda_2 \geq 0$ and $0 \leq \lambda_1 + \lambda_2 < 1$. λ_1 and λ_2 are the weight parameters that govern the dynamics of the conditional correlations.

$$\tilde{e}_t = D_t^{-1/2} e_t, \tag{14}$$

where $\tilde{e}_t$ is an *m x 1* vector of standard residuals.

Following Ruppert (2010), we use standardized residuals for checking the model, instead of ordinary residuals[10]. The particular parameters of the DCC structure, λ_1 and λ_2, allow the understanding and categorization of volatility effects in our dynamic multiple independent variables' relationship.

5. Data and GARCH estimation

The dataset comprises fifteen different perishable fresh fruits and vegetables: potato, chard, courgette, onion, green bean, lettuce, pepper, tomato, carrot, lemon, clementine, orange, apple, pear and banana. For each product three different prices or levels are registered: the price paid to the farmer (also origin price), the price settled in the wholesale market and the final price paid by the consumer at retailers. The time series have weekly frequency from the first week in 2004 to the 24th week in 2013. The prices are obtained from the Spanish Ministry of Agriculture, Food and Environment's statistical services.

We work with fresh and perishable products; we avoid processed goods in order to see the simplest and clearest possible relationship between the three levels of the agricultural perishable products value chain. The selection of perishable fruits and vegetables allows adopting the assumptions of constant costs for storage, inventory, transport, and handling[11]. In this way, we are able to find differences in MP attributable to the market structure.

The work is based on two different series' groups created from the dataset. The first index is a relative measure of market power per product and per level. Those are obtained from equations (2), (3) and (4). By doing so, we obtain a dynamic measure per product at three levels. For more information on the

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[10] Standardized residuals $\tilde{e}_t$ are the ordinary residuals divided by its conditional standard deviation. Residuals are useful to see if there are GARCH effects in the series, but standardized ones are best for checking the model.

[11] See Cap Gemini Ernst & Young report (2004) for the details on processes and costs for fruits and vegetables in Spanish market.

series, see table 1 and figure 2. Dynamic evolution is shown in figure 3. The second series' group is a relative growth ratio of prices, by product and by level $\left(p_{t,i,l} - p_{t-1,i,l}/p_{t,i,l}\right)$; where *t* is the time, *i* the product and *l* the level. The descriptive statistics on this series is shown in table 2. The first indexes (market power) are the dependent variables in our regression, and the second ones (relative growth in prices) are the independent variables[12].

Table 1. Mean values and standard deviation of market power indices per product and level in the value chain. Data extracted from indices elaborated by the authors, on the basis of weekly data comprising from 2004 -1st week- to 2013 -24th week-.

	Origin - Wholesaler		Wholesaler-Retailer		Overall		No. Obs.		
	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	O-W	W-R	overall
Potato	0.23	0.25	0.60	0.10	0.69	0.13	492	492	492
Chard	0.29	0.15	0.60	0.08	0.73	0.05	492	492	492
Courgette	0.40	0.16	0.55	0.16	0.72	0.15	440	440	440
Onion	0.39	0.17	0.70	0.10	0.82	0.08	457	492	457
Green bean	0.23	0.12	0.40	0.12	0.54	0.11	492	492	492
Lettuce	0.38	0.16	0.49	0.10	0.69	0.09	492	492	492
Pepper	0.31	0.13	0.50	0.15	0.65	0.14	492	492	492
Tomato	0.44	0.10	0.53	0.10	0.74	0.08	492	492	492
Carrot	0.59	0.17	0.52	0.06	0.80	0.09	492	492	492
Lemon	0.68	0.15	0.52	0.08	0.84	0.09	492	492	492
Clementine	0.70	0.09	0.55	0.08	0.86	0.05	221	275	243
Orange	0.71	0.10	0.48	0.06	0.85	0.05	305	373	305
Apple	0.50	0.10	0.54	0.05	0.77	0.06	478	492	478
Pear	0.48	0.08	0.45	0.08	0.72	0.05	385	483	385
Banana	0.58	0.13	0.45	0.08	0.76	0.10	436	440	436

Table 2. Descriptive statistics of relative growth in prices, by product and level. Weekly observations from 2004 -1st week- to 2014 -24th week-. Own-estimations based on data from the Spanish Ministry of Agriculture, Food and Environment.

	Origin - Wholesaler		Wholesaler-Retailer		Overall		No. Obs.		
	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	O-W	W-R	overall
Potato	0,07	0,07	0,47	0,08	0,53	0,10	492	492	492
Chard	0,18	0,12	0,88	0,15	1,06	0,12	492	492	492
Courgette	0,29	0,14	0,90	0,26	1,18	0,24	440	440	440
Onion	0,12	0,06	0,73	0,12	0,84	0,12	457	492	457
Green bean	0,52	0,32	1,42	0,43	1,94	0,38	492	492	492

[12] Given feasible doubts in the direction of causality in the analysis, and in order to improve the representativeness of the reality by the model, the authors preferred to run series of Granger causality test. A better explanation for reality is found from explaining MP indices from relative growth prices, not on the contrary. From the analysis, MP indices are selected as dependent variables and relative growth in prices by product and by level indices are the independent variables of our model.

Lettuce	0,17	0,08	0,43	0,08	0,60	0,08	492	492	492
Pepper	0,31	0,14	1,04	0,31	1,36	0,28	492	492	492
Tomato	0,42	0,15	1,06	0,22	1,48	0,21	492	492	492
Carrot	1,06	0,09	0,51	0,07	0,78	0,09	492	492	492
Lemon	0,48	0,13	0,76	0,13	1,24	0,19	492	492	492
Clementine	0,55	0,15	0,98	0,16	1,54	0,15	223	275	243
Orange	0,51	0,11	0,67	0,09	1,18	0,11	305	373	305
Apple	0,37	0,08	0,89	0,09	1,26	0,09	478	492	478
Pear	0,44	0,11	0,76	0,12	1,20	0,09	385	483	385
Banana	0,57	0,11	0,82	0,13	1,39	0,16	436	440	436

First of all, we run the Dickey-Fuller tests in order to check whether our variables are stationary. The test is applied to the constructed indexes with a good threshold of satisfaction for stationarity. Furthermore, the Jarque-Bera test is conducted for checking whether skewness and kurtosis are matching a normal distribution. It is checked that MP indexes present the typical trace for the presence of conditional heterocedasticity, a large value for kurtosis. In volatility processes, a normal distribution is commonly rejected. As a consequence, the model distribution is refitted as a t of Student for the error terms[13]. The existence of ARCH effects (LM test) it is also contrasted and MP variables are detailed as a GARCH (1,1) specification[14].

6. Empirical results

Applying the abovementioned specification we get three different results. The first two outputs from our model come from the responses of the causality of MP variables in complex data[15]. From this output we can extract, first, how changes in relative prices affect MP variables; and second, the effect of volatility on MP. A third outcome will come from the matrix of conditional covariances, which provides dynamic information about the interaction of market power at different stages of the chain. This is repeated product by product, along the 15 different fruits and vegetables of our study.

6.1. Causality of market power

The first output from our analysis is market power causality. Market power (MP) indices defined in equations (*2*) to (*4*) are selected as dependent

[13] However, for the onion and pear (due to computational difficulties) a normal distribution it is chosen.
[14] The selection of GARCH(1,1) specification is done following AIC and BIC criteria.
[15] Taking volatility into account.

variables; and, prices' relative growth indices -by product and by level- are the independent variables of our model.

We look for the effects of relative price movements on the MPs for wholesale, retailer and the entire distribution. MP is regressed simultaneously as a function of relative prices' growth indices. Results are shown in table 3. This calculus is made simultaneously taking into account values at the different levels: MP for wholesaler, retailer and the whole distribution; and the prices' relative growth for at origin, wholesaler and retailer's levels.

We find that the **wholesale's MP (MP_{OW})** is reduced by the growth in prices paid to the farmer. This pattern is found in a significant way ($p<0.01$) for all products. This effect was the expected, since the construction of the MP_{OW} variable is based on this assumption. Also, as expected, growth in wholesale prices, increase wholesale's MP (see the positive and significant values of *dpr_W* variable under MP_{OW} analysis in table 3). And besides, while an increase of MP_{OW} (the wholesale's market power) would be expected from growth in consumer's prices, this is not a common occurrence in our analysis. For some products (pepper, tomatoes, lemon and bananas), MP for the wholesaler is reduced when consumer prices increase ($p<0.01$). This is still more significant for bananas and tomatoes, for which we see that an increase in retailers' prices reduces wholesale MP. This could be understood under two explanations. The first explanation refers to a dispute for margins within distribution. The second, the effect of persistency of volatility; this will be explained in the second sets of results -derived from a high λ_2 parameter- (see 6.2. Volatility analysis). Changes in consumer prices could be translated into downward pressure coming from the higher level of this food chain (from retailers to wholesalers and producers).

Looking how movements in prices affect the **retailer's MP** (MP_{WR}), a reduction of retailer's MP is observed when rising of relative wholesale prices. This holds for all the group of fruits and vegetables on this study ($p<0.01$). It is, to a certain extent, an expected effect. It is clearly intuitive that margins increase when costs belittle. This effect is analogous to the diminishing MP of wholesalers when producers increased their relative prices. Nevertheless, it becomes more and more interesting when analysing the effect of retailer's price movements on the same level of market power (MP_{WR}), on retailer's MP. Here, differences between products emerge. For example, potato and carrots' retailers see their MP increased when consumer's prices growth. However, the empiric evidence suggests that the curtailing effect of the rise of consumer prices on the retailer MP is much more common and stronger (see table 3, -0.884 effect on tomatoes and -0.77 on pepper). That is, retailer's MP for courgettes, green beans, peppers and tomatoes is reduced when there are movements of increasing retailer's prices. This could seem counterintuitive because the consumer price is the one fixed at the retailer lever. However, a conceivably explanation for this occurrence is that for those particular products, volatility shocks at the consumer price level could be absorbed mainly by the retailers. This would explain the negative reaction of market power to changes in prices[16].This is consistent with the conclusion by Toribio et al. (2012) about the loyalty strategy of the retailer sector, based on few changes in consumer prices. It would imply a softening effect over consumer prices and a greater volatility in retailer's margins.

Derived from the analysis of retailer's MP evolution in the presence of consumer's prices changes, a different behaviour for potatoes and carrots is found, in front of those products highly perishable. Within perishable fresh products, potatoes and carrots are those that allow a certain stocking before shrinkage. When retailers' prices growth, retailer's market power increases for potatoes and carrots, while diminishes for tomatoes, peppers, courgettes and green beans. The supply of this latter group of products is characterized by peaks in production, highly limited storage, and inelastic supply. A hypothetical excess of supply will probably be translated into retailer's losses if the retailer has not the possibility of translating it downward, long the value chain.

Volatility in consumer prices will probably affect harder retailers for highly perishable than relatively stocking products.

Regarding the **whole distribution market power** (MP_{OR}), that is the sum from origin up to retailers, an increase in farmer's prices reduces MP for all products. The increase in retailers' price reduces distribution MP in tomato, pepper, green beans and banana. This pressure of consumers' price on market power is possibly due to final price volatility being absorbed by the distribution

[16] It is worth remembering that one characteristic of volatility processes is clustering volatility: periods of high (low) volatility followed by high (low) volatility.

sector. Potatoes behave differently: higher consumer prices are translated into more distribution MP (MP_{OR}). If we take into account that potatoes are much less perishable than the other goods, we can certainly believe that it is easier to bear volatility when certain stocking is possible.

In all the MP estimations done, the constant term has been positive and significant ($p<0.01$).

Table 3. Estimation results of MGARCH model. Multivariate results.

	potato	chard	courg	grbean	lett	pepp	tomato	carrot	lemon	clem	orang	banana	onion	apple	pear
MP_{OW} Wholesaler market power															
dpr_O	-0.255***	-0.239***	-0.176***	-0.309***	-0.198***	-0.192***	-0.209***	-0.125***	-0.118***	-0.181***	-0.0896***	-0.0724***	-0.282***	-0.242	-0.383***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(.)	(0.000)
dpr_W	0.298***	0.178***	0.205***	0.309***	0.170***	0.259***	0.208***	0.0928***	0.130***	-0.00218	0.0510**	-0.00969	0.0413	0.212	0.174***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.940)	(0.046)	(0.801)	(0.139)	(.)	(0.000)
dpr_R	-0.0459	0.0139	-0.0876	-0.164	0.0591	-0.297***	-0.659***	0.0486	-0.206***	-0.208**	-0.0977**	-0.958***	-0.0260	-0.185	-0.0852
	(0.430)	(0.912)	(0.510)	(0.118)	(0.673)	(0.005)	(0.000)	(0.419)	(0.010)	(0.022)	(0.031)	(0.000)	(0.703)	(.)	(0.374)
α_0	0.228***	0.306***	0.421***	0.227***	0.425***	0.355***	0.459***	0.601***	0.707***	0.715***	0.735***	0.542***	0.430***	0.499***	0.466***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
MP_{WR} Retailer market power															
dpr_O	0.000262	-0.0284***	0.0221**	0.00503	0.00665	0.0321*	0.0134	0.00576**	0.00378	-0.00388	0.00525	0.0166***	-0.00840	0.0137	0.0370
	(0.973)	(0.004)	(0.026)	(0.783)	(0.412)	(0.065)	(0.310)	(0.040)	(0.439)	(0.810)	(0.606)	(0.002)	(0.231)	(.)	(0.107)
dpr_W	-0.200***	-0.108***	-0.160***	-0.179***	-0.193***	-0.217***	-0.183***	-0.143***	-0.229***	-0.0817***	-0.200***	-0.158***	-0.148***	-0.233	-0.235***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(.)	(0.000)
dpr_R	0.219***	0.0644	-0.339***	-0.677***	-0.0870	-0.770***	-0.884***	0.210***	0.118**	0.0567	0.0584	-0.181*	0.0345	0.229	0.179**
	(0.000)	(0.623)	(0.004)	(0.000)	(0.232)	(0.000)	(0.000)	(0.000)	(0.011)	(0.487)	(0.304)	(0.066)	(0.250)	(.)	(0.039)
α_0	0.586***	0.626***	0.603***	0.419***	0.516***	0.553***	0.547***	0.506***	0.542***	0.539***	0.466***	0.447***	0.718***	0.550***	0.468***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
MP_{OR} Whole distribution market power															
dpr_O	-0.0947***	-0.112***	-0.0545***	-0.173***	-0.0911***	-0.0646***	-0.0880***	-0.0599***	-0.0516***	-0.0845***	-0.0443***	-0.0305***	-0.0821***	-0.102***	-0.178***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
dpr_W	-0.0398*	-0.00664	-0.0157	0.0451*	-0.0321**	-0.0307*	-0.00192	-0.00852	-0.00810	-0.0196	-0.0256*	-0.0654**	-0.0757***	-0.0144***	-0.0254**
	(0.087)	(0.465)	(0.443)	(0.056)	(0.039)	(0.092)	(0.887)	(0.552)	(0.544)	(0.117)	(0.069)	(0.023)	(0.000)	(0.001)	(0.043)
dpr_R	0.107***	0.0517	-0.257**	-0.632***	-0.00711	-0.628***	-0.792***	0.0841**	-0.0630	-0.0736	-0.0300	-0.624***	0.00508	0.0341	0.0457
	(0.000)	(0.581)	(0.013)	(0.000)	(0.924)	(0.000)	(0.000)	(0.026)	(0.134)	(0.151)	(0.360)	(0.000)	(0.869)	(.)	(0.400)
α_0	0.680***	0.742***	0.769***	0.551***	0.722***	0.711***	0.755***	0.804***	0.865***	0.869***	0.859***	0.746***	0.840***	0.775***	0.716***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
λ_1	0.700***	0.523***	0.522***	0.364***	0.493***	0.546***	0.388***	0.648***	0.730***	0.405***	0.425***	0.491***	0.585***	0.473	0.412***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(.)	(0.000)
λ_2	0.214***	0.0207	0.0978***	0.00679	0.0282	0.00140	0.110**	0.345***	0.0864***	0.0396	0.0117	0.193***	0.0602*	0.173	0.114***
	(0.000)	(0.194)	(0.008)	(0.540)	(0.361)	(0.661)	(0.013)	(0.000)	(0.000)	(0.224)	(0.457)	(0.000)	(0.071)	(.)	(0.001)
$\lambda_1 + \lambda_2$	0,914	0,544	0,620	0,371	0,521	0,547	0,498	0,993	0,816	0,445	0,437	0,684	0,645	0,646	0,526
aic	-5115.0	-6023.2	-3975.9	-4938.4	-5979.2	-4909.3	-5853.1	-6520.5	-6983.4	-3114.8	-4551.7	-5868.8	-5503.8	-7533.2	-5445.9
bic	-5001.7	-5909.9	-3865.6	-4825.1	-5865.9	-4796.0	-5739.8	-6407.2	-6870.1	-3024.2	-4452.2	-5758.9	-5396.8	-7483.3	-5344.0

p-values in parentheses

** p<0.1 ** p<0.05 *** p<0.01*

Note: *MP* is market power and *dpr_O*, *dpr_W* and *dpr_R* are the relative growth in prices, by level and by product.

6.2. Volatility analysis

In markets of perishable fruits and vegetables, the effect of volatility on market power (MP) is determined by means of the parameters λ_1 and λ_2 (see table 3). These parameters govern the dynamics of the conditional correlations.

From parameter λ_1, significant ($p<0.01$) for all products, we observe that (see table 3) the effect of previous periods' shocks is important on MP volatility processes. This is true especially for lemons, potatoes and carrots, while it is present in all products. This occurrence could be also understood as sensibility of the volatility processes to external shocks (Busse et al. 2011). Perishable fruits and vegetables MP's volatility is then highly sensitive to external shocks. From this result, we can conclude that hypothetical external shocks will probably end up in volatility processes in MP variables. Taking into account that MP is related to margins and possible benefits, this would mean a source of instability for actors being involved.

The values of the parameter λ_2 reveal certain persistency of volatility for carrots, potato, bananas and pears. We have already noticed that these particular products exhibit distinct patterns with respect the rest of the products. So the role of volatility persistency shall be taken into account when looking at MP determinants or behaviour. Following Busse et al. (2011) λ_2 parameter is also representing the impact of the own-variance on volatility development. This persistency of volatility in the market is particularly strong for carrots and potatoes (the sum of λ_1 and λ_2 is close to unity).

6.3. Market power dynamics along the value chain

The third output from the dynamic conditional correlation (DCC) method in a multivariate general autoregressive conditional heteroskedasticity model (M-GARCH) derives from the dynamic conditional covariance's matrix, containing dynamic conditional variances and correlations. We get dynamic information about the interaction of market power at different stages of the chain.

This model can be analysed statically and dynamically.

6.3.1. Static analysis

Conditional correlations between wholesaler's and all the distribution chain market power (*MP_{OW}* and *MP_{OR})* are often larger than those between retailer's and all the distribution chain's (*MP_{WR}* and *MP_{OR})*, as can be appreciated in figure 5 (figure of the differences in estimated correlations). In figure 5, a positive value represents a dominant position of wholesalers in distribution. Negative values represent a dominant position of retailers in the distribution. In addition, the estimated conditional correlations between *MP_{OW}* and *$MP_{OR,}$* -that is between wholesalers and all the distribution chain-, presents high or very high values. There is, then, a closer relationship between wholesaler's and the whole distribution MP than retailers'. This reveals a commonly larger MP of the wholesale level in comparison to the retailer level, and a dominant position of wholesalers in front of retailers for a major group of products (see figure 5, orange, apple, chard, lettuce, carrot, clementine, pear, lemon, banana and potato). This is shown by a large proportion of positive values representing a dominant position of wholesalers in the distribution.

Table 4 provides **static** information on the mean values of the correlations of market power between the different players. The correlation between *MP_{OW}* and *MP_{OR}* close to 1 at least for 6 products depicts a parallel evolution of wholesaler and all the distribution chain MPs. It could even be understood as wholesale power as being the main driver of distribution market power. It seems remarkable the different pattern of chard and pear (also green beans at a 5% significance level), regarding negative correlation between wholesalers' and retailers' MP. For the chard and pear group, this negative correlation between wholesalers' and retailers' MP, -see figure 6-, suggests the existence of competition between both distribution levels of the value chain. This fact contrasts with the rest of the analysed fruits and vegetables: for lemon, banana and potato instead, amongst others, the movements between MP of both distribution levels seem to go hand in hand. The aforementioned relationships should be understood as means in a dynamic context. For a description of the dynamics between MP variables, see figure 7.

These results are consistent with figure 3, where trading desks and wholesalers devoted to the commerce of perishable fruits and vegetables are (as wholesalers) a more concentrated level than the retailer level. The comparison becomes sharper when comparing it to the farmers' level. The highly atomized level of farmers exposes the possible existence of negligible market power in the Spanish market. The implications of this fact spread from income distribution to economic rural development.

Table 4. Estimated means of conditional correlations (MGARCH model estimation results)

Product		MP_{WR}	MP_{OR}
POTATO	MP_{OW}	0.718***	0.946***
	MP_{WR}		0.898***
CHARD	MP_{OW}	-0.631***	0.658***
	MP_{WR}		0.160**
COURGETTE	MP_{OW}	0.225***	0.779***
	MP_{WR}		0.775***
GREEN BEANS	MP_{OW}	-0.106**	0.601***
	MP_{WR}		0.725***
LETTUCE	MP_{OW}	-0.0129	0.903***
	MP_{WR}		0.415***
PEPPERONI	MP_{OW}	0.437***	0.800***
	MP_{WR}		0.882***
TOMATO	MP_{OW}	0.0490	0.698***
	MP_{WR}		0.743***
CARROT	MP_{OW}	0.307***	0.964***
	MP_{WR}		0.550***
LEMON	MP_{OW}	0.722***	0.987***
	MP_{WR}		0.814***
CLEMENTINE	MP_{OW}	0.155*	0.920***
	MP_{WR}		0.525***
ORANGE	MP_{OW}	0.0783	0.966***
	MP_{WR}		0.330***
BANANA	MP_{OW}	0.728***	0.968***
	MP_{WR}		0.876***
ONION	MP_{OW}	-0.00188	0.658***
	MP_{WR}		0.739***
APPLE	MP_{OW}	-0.277	0.835***
	MP_{WR}		0.295***
PEAR	MP_{OW}	-0.419***	0.721***
	MP_{WR}		0.322***

Source: elaborated by the author

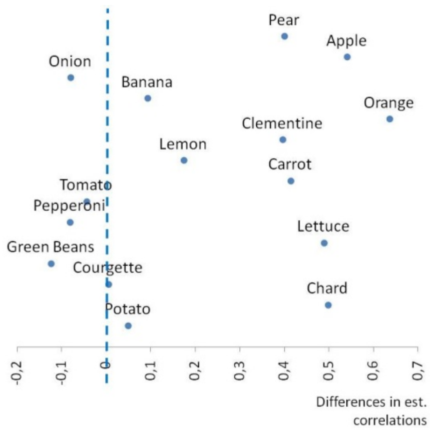

Figure 5. Differences in estimated correlations. Correlation between wholesaler's MP and whole distribution chain's is diminished by the correlation between retailer's MP and all the distribution chain's.
The positive values represent a dominant position of wholesalers in distribution. Negative values represent a dominant position of retailers in the distribution.

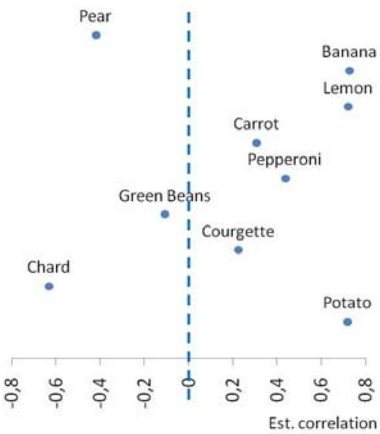

Figure 6. Estimated correlations between wholesaler's and retailer's market power (95% significance for correlations).
The positive values give traces of non-competing attitude for MP appropriation within distribution. Negative values give traces of competing attitude.

6.3.2. Dynamic analysis

From the analysis, two groups of products can be considered. We see some examples of both of them. Firstly, we take the group of fruits and vegetables in concurrence for the distribution MP (chard, pear and green beans, as already commented from figure 6). As example, the chard blue line (figure 7b) represents correlation between wholesaler and retailer MP. Red line is the MP correlation between wholesaler and all the distribution chain. It is clearly appreciable that the more concurrence for MP there is between both distributors (negative peaks of the blue line), the higher MP is for the wholesaler (positive peaks of red line). Another example of this group of products is green beans (figure 7e). The more concurrence for MP there is between both distributors (negative peaks of the blue line), the higher MP is for the retailer (positive peaks of green line). Secondly, there is the group where wholesalers and retailers go hand in hand (lemon, banana and potato, amongst others). No harmful competition is expected from this situation between distributors. For this group, all movements go in the same direction (with some exception for potato in 2008 and 2012-13, coinciding with the international crisis due to the surge in food prices, see figure 7a). Then, translation of price changes is possible to arrive to consumers or farmers, both extremes of the value chain in this group of products.

It is worth commenting on some negative peaks on MP_{OW} and MP_{WR} correlation (blue line, figure 7) during the international food prices' crisis of 2008. This could be understood as a competing attitude for MP appropriation within distribution.

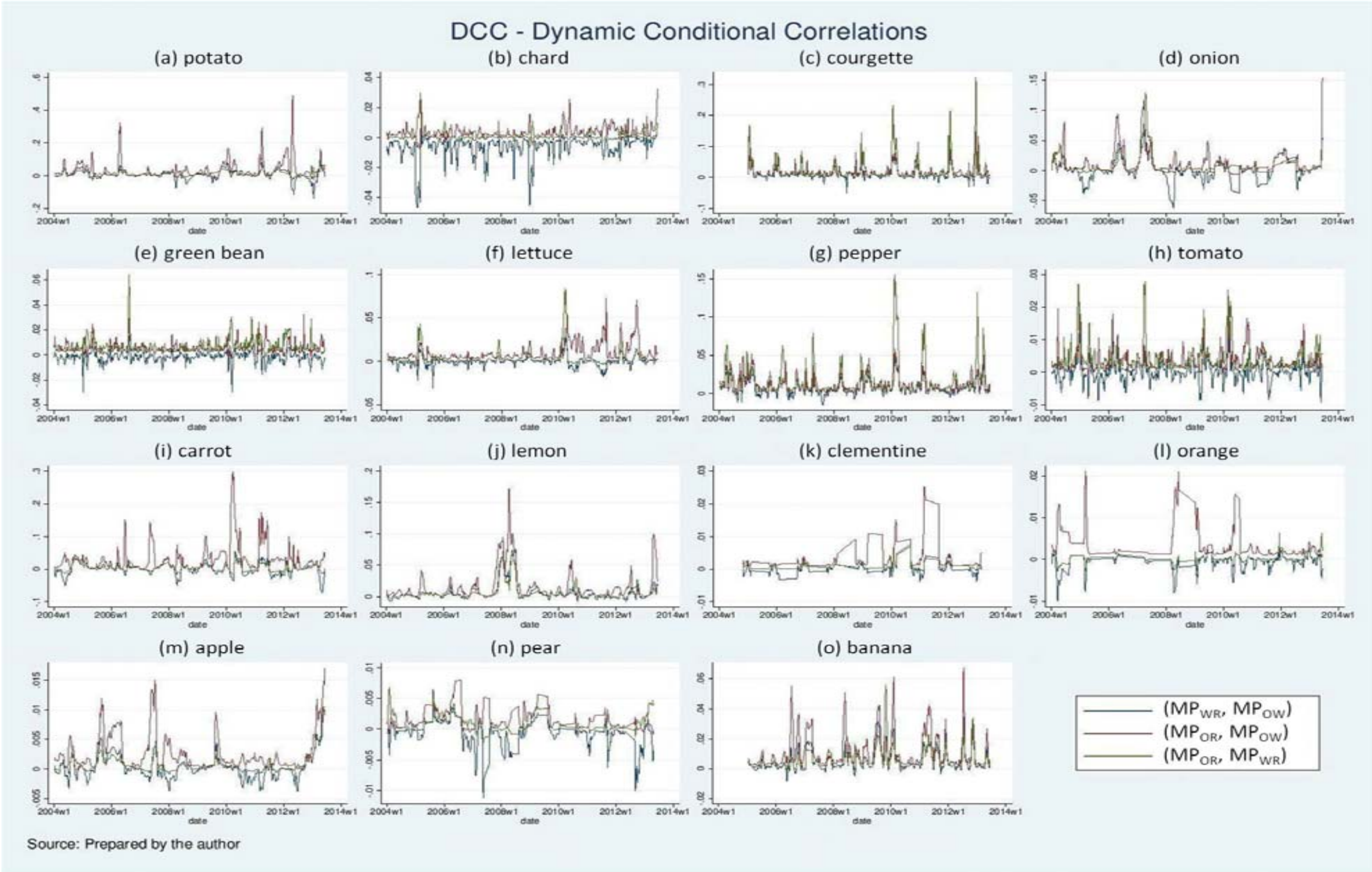

Figure 7. Evolution over time of Dynamic Conditional Correlations by product[17].

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[17] This figure is the dynamic movement of table 4, and shows MP interactions along the time, dynamic conditional correlations (DCC). Table 4 is estimated means, while figure 7 illustrates the movements and changes over time. The depicted lines are the correlations available at each moment of time. These correlations are those existing between the pair combinations of variables MP_{OW}, MP_{WR} and MP_{OR}.

7. Conclusions

As far as the determinants of different MP are concerned, MP is always (and expectably) reduced when increases the price of the input good. However, an increase in consumer price does not always increase distribution MP but rather reduces it. A defining character of volatility processes is that they tend to cluster, that is, high price changes use to follow other large price changes. In these volatility sensitive markets, increases in consumer prices could be understood as volatility that ends up affecting negatively the margins and the MP of the distribution. Downward pressures along the value chain are also translated to lower levels of the chain.

Another conclusion extracted from our analysis is that the measured market power in the agricultural market of perishable fruits and vegetables is highly sensitive to volatility and external shocks. External shocks are highly probable to end up in volatility processes for market power. This implies that an important source of instability for the margins of the value chain actors.

A persistency effect of volatility in MP is also found for some products (carrots, potato, bananas and pears). For those products, retailers' MP is harmed by consumer's price changes and the retailers' MP is gained at expenses of downstream levels of the value chain (wholesalers).

As far as market structure is concerned, there is a clear concentration on the wholesale level of the chain. We suspect that atomized farmers' sector has a minor or much minor MP.

One key finding is that in a dynamic behaviour, the role of the wholesaler's MP is often stronger than the retailer's. Although MP index' value is higher for retailer or wholesaler depending on the product market, when we do a dynamic analysis, we found a commonly larger MP of the wholesale level in comparison to the retailer level, and a dominant position of wholesalers in front of retailers for a major group of products (orange, apple, chard, lettuce, carrot, clementine, pear, lemon, banana and potato).

Regarding dynamic relationship between MP in the distribution chain, we found two different types of behaviour. On one hand, we get some products (chard, pear and green beans) for which the distributors in the value chain (wholesalers and retailers) are competing for a MP portion amongst them. This is a reasonable trace of the existence of competition between both distribution chain levels of the value chain, retailers and wholesalers. On the other hand, the other different pattern that we have found regards to a distribution chain that seems to go “hand in hand” (lemon, banana and potatoes). We suspect that no harmful competition is expected from this situation between retailers and wholesalers. It is also a reasonable trace of the existence of possible collusion between both distribution chain levels. It is likely that price changes are translated to consumers and/or farmers, both extremes of the value chain. This parallel evolution of distribution MP breaks occasionally due to the 2008 food prices’ crisis for potato.

This work opens the use of the MGARCH-DCC methodology to other commodities future MP behaviour study. Furthermore, it provides new instruments for looking for traces of collusion or competition between players of a market. It provides also a new instrument for studying the behaviour of market power from a dynamics point of view (both looking for causality and understanding the dynamics relationships between players of a market).

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