Market Dynamics in Supply Chains: The impact of globalisation and consolidation on food companies' mark-ups

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Paper prepared for presentation at the EAAE 2011 Congress
Change and Uncertainty
Challenges for Agriculture,
Food and Natural Resources

August 30 to September 2, 2011
ETH Zurich, Zurich, Switzerland

Market Dynamics in Food Supply Chains: The impact of globalisation and consolidation on firms' mark-ups

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Abstract

This paper examines whether ownership and increased competitive pressure affect food retailers' market power, analysing whether all actors involved in the food supply chain deviate from the pricing behaviour that exists under perfect competition. A method proposed by Roeger (1995) is used to estimate price-cost margins, relaxing the assumptions of perfect competition and constant returns to scale. The obtained results show that foreign investments and consolidation have a positive and significant impact on the market power of food processors and retailers. Food processors, agricultural producers and wholesalers have lower price-cost margins than retailers, which suggests that these actors price closer to marginal costs being more concerned with maximising social welfare or that the former have higher costs than retailers. The results are robust to various estimation techniques and specifications.

JEL Classification: F23, L13, L81
Keywords: Price-cost mark-ups, multinational firms, retailing

1. INTRODUCTION

The nature of the food supply chain has been substantially affected by the widespread consolidation and globalisation of retail and procurement markets. Processors may traditionally have driven food distribution by implementing intensive brand policies and then using a network of wholesalers and retailers to sell and distribute goods to consumers, though currently retailers have strengthen their position. The balance of power in the food system is effectively shifting from processors to global retailers, due to fundamental factors such as increased concentration and the development of sophisticated information technology. The associated structural changes that are occurring along the food supply chain have though broad socio-economic impacts, as they undoubtedly affect not only consumers, but also agricultural producers, food processors and wholesalers.

Global retailers experience economies of scale, lower costs and higher profits, so that a competitive price cutting behaviour as well as improved efficiency and service can be considered potential benefits. However, there may be cause for concern that consolidation and globalisation can facilitate retailers' ability to exercise market power as buyers and sellers, dictating higher prices and less variety for the consumers, and lower prices for food suppliers. Agricultural producers are forced to cut margins both from retailers, who directly buy food products, and from processors, who intend on sharing the burden raised by retailers' buying power. Processors and retailers impose also separately their mark-ups, increasing profits by raising prices under competitive pressures. The rising trend of food prices may further affect consumers' welfare, increase government expenditure and limit economic growth. The analysis of retailers' mark-ups has, therefore, received enormous attention in the economic literature.

According to McKinsey (2003), the entry of global retailers has a positive impact on consumers' prices, though this is not necessarily the case for all products (e.g. Schwentesius and Gomez, 2002). Concentration may be associated with increased

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prices, whereas the presence of global retailers has dampened the performance of local retailers by introducing higher competitive pressures (Durand, 2007). Moreover, various case studies conclude that there may be a strong relationship between the presence of global retailers and the performance of food suppliers, though the direction of such a relationship is still an open question (e.g. Chavez, 2002; Javorcik et al., 2006). Overall, the conventional wisdom that retailers have grown more powerful relative to all other actors involved in the food supply chain has not been supported by empirical analyses of their relative profitability (Ailawadi, 2001). The impact of consolidation and shifts of power on firm performance and market structure is not clear a priori, and as a result, there has been considerable debate over the appropriate policy treatment towards retailers' market power.

Previous research has examined whether ownership and increased competitive pressure affect food retailers' market power, measuring firm performance either by sales growth, labour productivity or total factor productivity. The potential problem of endogeneity related to the explanatory variables may though arise in the models used to analyse these effects. For instance, unobserved productivity shocks may have an impact both on the input factors and the output that can result in biased estimates of total factor productivity. The approaches proposed to overcome this problem by Olley and Pakes (1996) and Levinsohn and Petrin (2003) require the inclusion of exogenous instruments (e.g. investment or material inputs), that are difficult to select; whereas the methods introduced by Berry et al. (1999) and Verboven (2002) require data for prices in order to estimate demand functions. In this paper, firm performance is measured as the price-cost margins, that are estimated using a method proposed by Roeger (1995), based on which endogeneity problems and data requirements are avoided.

To analyse then whether all actors involved in the food supply chain deviate from the pricing behaviour that exists under perfect competition, the properties of the primal and dual Solow residuals are exploited, estimating consistently firms' mark-ups without instrumentation. In addition, the nominal values of the input and output variables are used, without having to find good deflators, and the assumption of constant returns to scale is relaxed following Dobrinsky et al. (2004). The firm-level data are retrieved from the *Amadeus* database, which is compiled by a commercial data provider, *Bureau van Dijk*, and contains actual company account data. The sample consists of 2,910 firms of the food supply chain for the case of Greece and data are available for the period 1998-2007.

The paper is organised as follows. Section 2 documents and analyses the substantial restructuring of the food market in Greece over the last years, giving emphasis on the increased competitive pressure due to the expansion of global food processors and retailers. Section 3 describes the empirical model used in the analysis; whereas Section 4 provides details in terms of the firm-level data and their descriptive statistics. The empirical estimates are presented in the following section, and Section 6 concludes and outlines some possible directions for policy responses and future research.

2. THE FOOD SUPPLY CHAIN IN GREECE

Food actors operate in an integrated supply chain that is subject to considerable changes. A change in one of the different elements of the food supply chain affects inevitably the other elements. For instance, performance in the agricultural and

retailing sectors as well as new trends in consumer preferences can affect food processors. Global changes may also exert pressure on all elements of the supply chain, but due to fragmentation, certain actors are more affected by shifts in power than others. In this framework, agriculture, food processing and retailing have always been of great importance to the Greek economy (Table 1).

The agricultural sector has experienced an important restructuring over the last few years, leading to an increase in average farm sizes. The number of persons employed is relatively high, though the sector remains highly fragmented, while the share of farming in gross value added is declining. The food industry sector is ranked first in the manufacturing sector, as it accounts for about 25% in terms of turnover and total value added. The sector employs about 22% of the manufacturing labour force and processing firms account for more than 20% of total industrial firms. The food industry is a rather competitive sector, having as key characteristics its structure and size. About 200 large firms produce 85% of total output, while 16,000 small processors produce the remaining output. Global processing firms (multinationals) mostly invest on new production methods, new products and logistics; whereas smaller firms located in rural areas focus mainly on traditional and biological food products. Finally, the retail and wholesale sectors account for a large portion of the economic activity relative to other services, as they contribute about 20% to total employment and 16% to the value added of the economy.

Table 1
Food supply chain

	Agriculture		**Food processing**		**Wholesale**		**Retail sale**	
	2000	*2008*	*2000*	*2008*	*2000*	*2008*	*2000*	*2008*
% of total employment	15.2	10.0	2.5	2.5	5.6	7.3	11.2	11.8
% of total gross value added	6.0	3.3	2.7	3.3	7.3	9.6	4.8	6.5

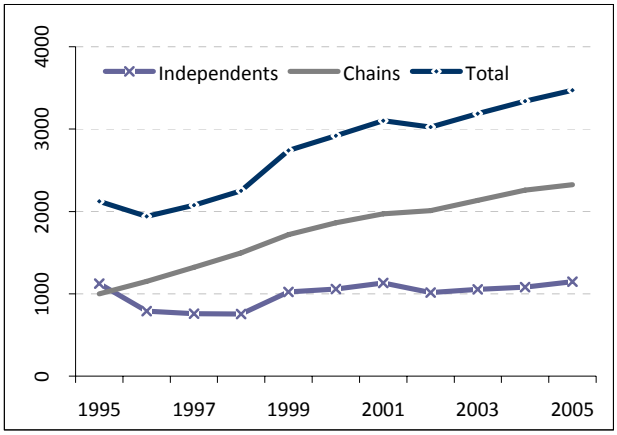
Source: Eurostat.

In particular, the food retailing sector has been defragmented over the last two decades, as global retailers have accelerated the growth of the hypermarkets portion at the expense of traditional and specialist retailers. Distinguishing food retailing between chains (firms with more than 10 stores) and independents, there are about 3,500 supermarkets in Greece; of which 2,325 belong to chains (Figure 1). The percentage of total sales captured by the top five chains has increased from 11 to 27 and 54% for the years 1993, 1999 and 2005, respectively. The number of small independent retailers remains relatively stable, though these retailers have been marginalised and act as convenience stores. Restrictive planning regulations that limit new hypermarket store openings have also stemmed their decline, though it is argued that such regulations have potentially allowed for monopolies to be created. In any case, for a market to be considered competitive, the top four firms must maintain less than a 40% market share. The food retail sector has clearly exceeded this benchmark.

Well-known multinationals, such as Nestlé, Coca-Cola, Vivartia, Campina Friesland, Pepsico, Cadbury, etc., manufacture in Greece for decades, as major food processors have sought to expand their operations internationally. Naturally, the Greek market follows international trends in the field of retailing as well. Multinational chains have already established a very strong presence in the Greek market, while concentration has been rather high during the last decade. The share of total sales for five chains controlled by foreign interests is about 45% (i.e. Carrefour-

Marinopoulos, AB-Vassilopoulos, Makro, Dia and Lidl). The Europe's largest and the world's second largest retailer, Carrefour, operates in Greece since 1999; whereas four out of the five largest European discount chains are also present (i.e. Dia since 1995, Lidl since 1999, Plus since 2006 and Aldi since 2008).

Figure 1
Development of the Greek food retailing



Source: Panorama of Greek Supermarkets, various years.

A sharp increase in the number of mergers and acquisitions has been also observed in the retail sector, as consolidation allows for improved efficiency gains and lower investment costs, in order to achieve profitability (Table 2). If cost savings from improved efficiency passes on to consumers via lower prices, it is likely that consumers benefit from the restructuring of retailing. However, as already mentioned, the consolidation of food retailing has reached such a pitch that it has raised concerns about monopoly conditions. It seems that retailers have grown so powerful that they are able to dictate prices and terms to their suppliers who, with no alternative, have little choice but to comply. Moreover, consolidation is expected to continue due to the resulting efficiency gains and maintenance of profitability, while competitive pressure is likely to increase further as the world's largest retailer, Wal-Mart, has already established an office in Athens to study the Greek market.

Table 2
Mergers and acquisitions in food retailing

Retailer	Firms acquired
Carrefour-Marinopoulos	Niki (2000); Continent Hellas (2000); Xynos (2005); OK! (2005)
AB-Vassilopoulos	Trofo (2000); Ena (2001)
Veropoulos	Panemporiki (2001); Trofino (2007)
Massoutis	Mpiska (1999); Alfa-Delta (2001); Maios (2006)
Atlantic	Galinos/Laoutaris (2001); Arista (2002)
Arvanitidis	Galaxias (2001); Enosi (2002); Lada (2003)
Market In	Alimenta Nova (2006)
Sklavenitis	Papageorgiou (2007)

Source: IOBE, 2005 & Panorama of Greek Supermarkets, various years.

Overall, retailers have added new products as well as services (e.g. ready-meals departments, home delivery via online or telephonic orders, shop-in-shop arrangements selling electronic equipment or travel agencies, financial services via special credit cards, etc.), and they have built larger stores in order to offer consumers 'one-stop shopping' convenience for more than 20,000 product lines. At the same

time, certain chronic problems have been solved, such as the problem of shopping hours, along with the amendments to the labour regime, which facilitate part-time employment and the optimum arrangement of working hours. Nevertheless, retailers have incurred significant procurement, labour and capital investment costs.

Consequently, retailers' behaviour has been affected by the changing patterns of retail competition, leading to their so-called *defensive* and *strategic restructuring* (Grosfeld and Roland, 1997). As their immediate survival can be guaranteed taking measures such as reducing costs and scaling down unprofitable stores, the degree of gross job creation and destruction may indicate retailers' defensive restructuring. Their long-run viability can be further guaranteed via investment and innovation decisions. Strategic restructuring refers then to new technology, new products and services. In this paper, defensive restructuring is measured by the real sales variable, that captures the extent to which retailers may have faced demand shocks. Having higher real sales, the need for defensive restructuring is presumably less stringent, as retailers can keep their position in the market without cutting costs. Strategic restructuring is measured by the net investment rate at the firm-level, defined as the growth rate in the book value of real intangible assets. The number of stores is also examined, as food retailers increase sales by opening new stores. Finally, retailers' profitability is compared with the one of processors, as it is generally argued that retailers' profits increase faster than processors' profits.

Table 3 presents the level of real sales, the growth rate of investment and the number of stores for the top ten retailers, as well as for all retailers included in the sample. Data shows that retailers controlled by foreign investors have increased their sales levels, whereas local retailers have experienced a lower increase in their sales, with the exception of Massoutis, whose growth rate of sales appears to be the highest among those reported. In terms of investments, two retailers controlled by foreign interests (Carrefour-Marinopoulos and Dia) have the highest growth rates in 2007, whereas two local retailers (Arvanitidis and Atlantic) have experienced a reduction in their investments growth. Nevertheless, all top ten retailers have increased the number of their stores reflecting the level of sales growth.

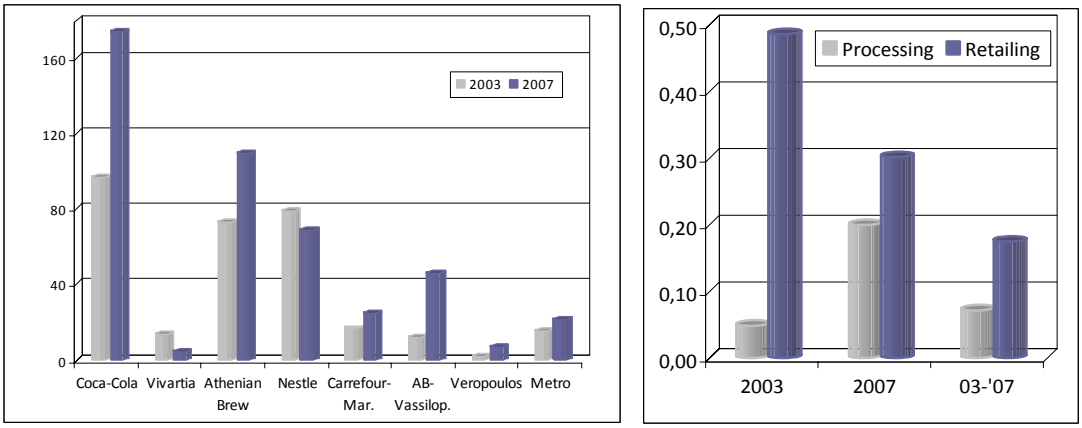
Table 3
Retailers' sales, investment and number of stores

	Sales			**Investment growth**		**Number of stores**		
	2003	*2007*	*%'03-'07*	*2003*	*2007*	*2003*	*2006*	*%'03-'06*
Carrefour-Marinopoulos⋆	1,458	1,899	0.30	..	1.48	162	228	0.41
AB-Vassilopoulos⋆	789	1,141	0.45	-0.96	0.01	96	108	0.13
Sklavenitis	..	912	..	..	..	36	38	0.06
Veropoulos	536	647	0.21	-0.05	0.61	131	164	0.25
Metro⋆	423	601	0.42	-0.52	-0.01	63	70	0.11
Atlantic	523	586	0.12	-0.28	-0.68	172	177	0.03
Massoutis	290	541	0.87	0.60	0.11	88	171	0.94
Dia⋆	269	381	0.42	-0.19	1.07	278	395	0.42
Pente	283	381	0.35	-1.00	..	85	110	0.29
Arvanitidis	196	226	0.15	0.56	-1.00	118	125	0.06
TOTAL	6,288	9,443	0.50	1.23	1.70	2,133	2,449	0.15

Note: ⋆ Retailers controlled by foreign interests.
Source: Amadeus & Panorama of Greek Supermarkets, various years.

Concerning profitability, it is expected that the average growth rate of profits in concentrated markets (i.e. retailing) will be higher than in less concentrated markets (i.e. food processing). However, higher profitability growth may not be due to market power, but to lower costs as concentrated markets entail larger, more efficient firms. Figure 2 further indicates that food retailers experience higher growth profitability than their suppliers. Some food processors have managed to increase their profits, though even large multinationals such as Vivartia and Nestlé have to face a reduction in their profitability over the examined period. It should be also noted that factors such as slotting allowances, retroactive discounts, exclusive rights, promotional expenses and display fees compose a significant share of retailers' profits, supporting the differences in food actors' profitability.

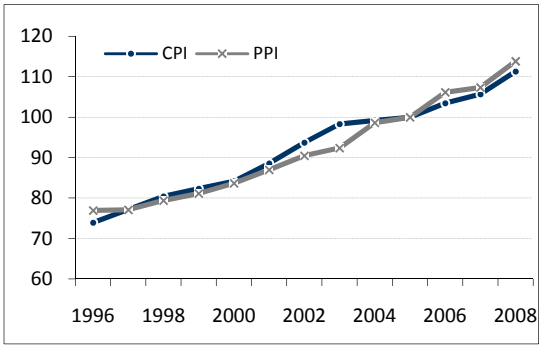
Figure 2
Food processors' and retailers' profitability (Mio € & growth rates)



Source: Amadeus.

In this framework, food prices have increased whereas food expenditure relative to income has fallen. The level of price increases varies among products, while the share of disposable income devoted to food products fell from 18% to 16.3% from 2003 to 2007. As shown in Figure 3, after 2005 producer food prices rise faster than consumer food prices, implying that producer price increases are currently fully transmitted to consumer food prices and that they are not partially absorbed by the food retail sector through a reduction in profit margins (that they have increased). It should be, finally, noted that significant price dispersion is observed among food retailers, whereas product quality is heterogeneous. Retailers may also provide the same product, service levels though vary considerably.

Figure 3
Producer and harmonised consumer price indices



Source: Eurostat.

3. METHODOLOGY

As the changing patterns of retail competition may affect food suppliers' competition and economic welfare, this section builds upon previous empirical research methods and insights from new industrial organization studies to analyse market dynamics in the food supply chain.[2] In particular, a method proposed by Roeger (1995) for the price-cost margins estimation is employed, which is based on Hall's (1988) method of estimating mark-ups and on exploiting the properties of the primal and dual Solow residuals. The difference between the two residuals is essentially explained as a result of imperfect competition and by subtracting the two residuals from each other; the unobservable productivity term cancels out avoiding the problem of endogeneity.

The main intuition is that the mark-up term is embodied in the measurement of total factor productivity growth, which is the output growth not accounted for by the growth in input factors. Using this method, the price-cost margins can be estimated consistently avoiding potential correlations between the unobserved productivity shocks and the input factors of production. Consider a log-linear homogenous production function $Q_{it} = F\left(K_{it}, L_{it}, M_{it}\right)\Theta_{it}$, for output Q_{it}, where K_{it}, L_{it} and M_{it} are capital, labour and material inputs, and Θ_{it} is a shift variable representing changes in productivity efficiency of firm *i* at time *t* (a Hicks neutral technological progress). If price exceeds marginal cost, the input shares per unit of output do not sum to one, but are lower because of the existence of a mark-up factor. This mark-up as well as the technology components can be decomposed from the Solow residuals.

Based on the aforementioned production function and assuming imperfect competition, the primal Solow residual is derived after log-differentiation as follows:

$$SR_{Pit} = \Delta q_{it} - \left(1 - \alpha_{Lit} - \alpha_{Mit}\right)\Delta k_{it} - \alpha_{Lit}\Delta l_{it} - \alpha_{Mit}\Delta m_{it} = \left(1 - \beta_{it}\right)\Delta \vartheta_{it} + \beta_{it}\left(\Delta q_{it} - \Delta k_{it}\right) \quad (1)$$

where $\alpha_{(L,M)it}$ is the revenue share of the respective factor and β_{it} is the Lerner index, which is closely related to the price-cost mark-up μ_{it}, as $\beta_{it} = 1 - 1/\mu_{it}$, assuming constant returns to scale. Dobrinsky *et al.* (2004) further show that in the case of variable returns to scale, the Lerner index can be denoted by $\beta_{it} = 1 - \lambda_{it}/\mu_{it}$, where λ_{it} is the returns to scale index.

The dual or priced-based Solow residual is derived by a general cost function associated with the production function, assuming that the change in marginal cost is a weighted average of changes in input prices with respect to their relative cost shares, minus the effect of technological innovation. That is defined as:

$$SR_{Dit} = \left(1 - \alpha_{Lit} - \alpha_{Mit}\right)\Delta r_{it} + \alpha_{Lit}\Delta w_{it} + \alpha_{Mit}\Delta p_{mit} - \Delta p_{it} = \left(1 - \beta_{it}\right)\Delta \vartheta_{it} - \beta_{it}\left(\Delta p_{it} - \Delta r_{it}\right) \quad (2)$$

where r_{it} is the growth rate of the rental price of capital, w_{it} is the growth rate of wages, and p_{mit} and p_{it} are the growth rates of material prices and output, respectively.

Subtracting equation (2) from (1) and adding an error term, ε_{it}, the unobservable productivity term $\left(1 - \beta_{it}\right)\Delta \vartheta_{it}$ cancels out. The following equation can be, therefore, estimated to yield consistent estimates of the price-cost mark-up:

$$\left[\left(\Delta p_{it} + \Delta q_{it}\right) - \left(\Delta r_{it} + \Delta k_{it}\right)\right] =$$
$$= \mu_{it}\left\{\alpha_{Lit}\left[\left(\Delta w_{it} + \Delta l_{it}\right) - \left(\Delta r_{it} + \Delta k_{it}\right)\right] + \alpha_{Mit}\left[\left(\Delta p_{Mit} + \Delta m_{it}\right) - \left(\Delta r_{it} + \Delta k_{it}\right)\right]\right\} + \varepsilon_{it} \quad (3)$$

[2] Tybout (2003) provides an overview of the methods used to estimate mark-ups using firm-level data.

where the right-hand side is, in fact, the Solow residual measuring all variables in nominal terms.

To estimate equation (3), a simplified version of this expression can be denoted by:

$$\Delta y_{it} = \alpha_i + \mu_{it}\Delta x_{it} + \varepsilon_{it} \quad (4)$$

where y_{it} can be interpreted as the growth rate in output per value of capital in firm *i*; and x_{it} as a composite variable that represents the growth rates in the various input factors weighted by their respective shares in total output. A white noise error term is also included due to a possible mis-measurement of labour input or of the rental price of capital. The average price-cost margin is captured by μ_{it}, and α_i stands for an unobservable firm-level fixed effect that captures firm heterogeneity.

In this framework, sales are used as the output variable, whereas capital is denoted by tangible fixed assets and labour input is measured as the number of employees. The rental price of capital is calculated using the following equation:

$$r_{it} = \left(e_{it} + \delta_{it}\right) \times p_I \quad (5)$$

where p_I stands for the index of investment goods prices, measured at a country-level[3], e_{it} is the interest paid at a firm-level, and δ_{it} is the depreciation ratio measured at a firm-level as well. The industry-specific wage expenditure is used for wages, due to the lack of the wage expenditure variable.[4] The variable called cost of goods sold is also used for the material inputs. Following Levinsohn (1993), it is further assumed that the mark-ups are the same for all firms within the same sector. The estimation of a separate mark-up for each firm is not possible, as there would not be available enough degrees of freedom. Deflation of variables using price indices is no longer needed; whereas the use of company account data implies that the financial flows associated with individual food products cannot be traced, though food actors may be multi-product firms. It is, therefore, assumed that if a firm has market power over one of its products, it is likely to have market power over its other products as well. Alternatively, the estimates of mark-ups can be reviewed as an average firm effect, assessing whether global food actors affect the average market power of the different elements in the supply chain.

Consequently, the estimated mark-ups will reflect competitive pressures in the food market, though increased competition may partially stem from conduct rules imposed by policy makers and other sources such as foreign direct investments (FDI) and consumer preferences. If global retailers achieve cost savings without reducing food prices, this would result in a higher price-cost margin. The relative performance of the food actors will be, therefore, examined as a function of the ownership structure, where performance is measured as the firms' price-cost margin. The effect of increased competitive pressure on market power will also be examined, as the pricing behaviour of firms is affected. According to Sutton (1991), a negative relationship exists between the number of firms in an industry and the price-cost margin, there is though evidence that concentration can be positively related to mark-ups (Domowitz, et al., 1988). The following model is effectively estimated:

$$\Delta y_{it} = \alpha_i + \mu_1\Delta x_{it} + \mu_2\left[\Delta x_{it} \times FDI_{it}\right] + \mu_3\left[\Delta x_{it} \times H_{jt}\right] + b_1 FDI_{it} + b_2 H_{jt} + b_3 d_t + u_{it} \quad (6)$$

where the dependent variable represents the difference between the Solow residuals; FDI_{it} is a dummy equal to one if the firm is owned for more than 10% by foreign

[3] From the AMECO database, European Commission.
[4] From the STAN database, OECD.

shareholders in year *t*; and H_{jt} stands for the three digit Herfindahl index of concentration in sector *j* in year *t*. The coefficients μ_2 and μ_3 refer to changes in price-cost margins associated with globalisation and competition pressure, so that for instance the total mark-up of global food actors is equal to $\mu_1 + \mu_2$. The ownership and competition variables are also included separately to capture any difference between the primal and dual Solow residuals that is not explained by market power. A white noise error term is, finally, included as above, as well as year dummies, d_t, to control for common aggregate shocks. Equation (6) is estimated using OLS and fixed effects estimators. Random effects were also estimated, though, the Hausman test rejected this model in favour of the fixed effect model.[5] The latter may then capture any unobserved firm-level heterogeneity and measurement error that is constant over time.

4. DATA AND DESCRIPTIVE STATISTICS

The firm-level data used in this paper are retrieved from the *Amadeus* database that consists of company accounts reported to national statistical offices for European firms in 35 countries. This dataset essentially contains firms' balance sheets, the profit and loss accounts, and information on stocks, shareholders, subsidiaries and activities. Table 4 presents the summary statistics of the variables used in the empirical estimations for each element of the food supply chain. After deleting firms with missing information, the full sample includes the unbalanced panel data on 2,910 firms for the period 1998 to 2007. In particular, the sample is composed of 199 agricultural firms, 1,361 food and beverage processing firms, 1,113 wholesalers of food products and 237 food retailers.[6]

The majority of the firms were established after 1990, although the dates of establishment for the overall sample range between 1915 and 2006. In terms of firm size, small firms comprise the clear majority of the sample (about 46 %), with an almost equal proportion of medium firms along the various elements of the supply chain (8 %). The retail sector has the highest shares of large and very large firms (10 and 12 %, respectively), whereas there are no wholesalers with more than 250 employees. Concerning foreign investments, it should be noted that about 74 % of these originate from other EU countries, and 11 % of the reported investments are from the United States. The Netherlands and the United Kingdom are the first two European countries from where foreign investments originate, followed by France. Switzerland appears to have the majority of the investments in the sample for countries of the rest of the world. Moreover, the average Herfindahl index in 1998 is 0.242 in the processing sector, and in 2007, it appears to be reduced at a rate of 0.116. This compares to an average Herfindahl index of 0.363 and 0.079 for the agricultural and wholesale sectors over the examined period. The retailing sector though is becoming more competitive over time, with an exception of the last two years, whereas the average index is much higher than for the rest of the food actors (0.868).

It should be, finally, noted that the sample contains a significant share of the entire population of medium and large firms in the Greek food supply chain over the period

[5] An F-test indicated that fixed effects were significant in all specifications.

[6] Wholesale of agricultural raw materials, live animals, food, beverages and tobacco; Retail sale in non-specialised stores with food, beverages or tobacco predominating and retail sale of food, beverages and tobacco in specialised stores.

1998-2007. In particular, the firm-level data for the food processing sector account on average for about 85 % of the total employment and 77 % of total gross turnover as compared to the aggregated data retrieved from Eurostat. The data cover also most of the total employment and turnover in the retail sector (54 % and 45 %, respectively). In terms of the wholesale and agricultural sectors, these shares appear to be lower as expected, due to the fact that the majority of firms operating in the local market are not obliged to publish account data. Nevertheless, the *Amadeus* data are quite representative as 33 % and 11 % of total turnover is covered in the wholesale and agricultural sectors.

Table 4
Summary statistics

	Mean	Std Dev	Min	Max	No.Obs.
		Agricultural firms			
Sales	5,857	12,420	51	141,069	1,520
Tangible fixed assets	2,531	5,008	37	65,669	1,509
Employment	44	122	1	1,070	1,508
Material cost	4,891	10,807	41	129,453	1,450
Herfindahl index	0.363	0.118	0.233	0.695	1,520
Years of operation	17	13	1	84	1,520
		Food processing			
Sales	8,004	31,012	56	686,600	10,634
Tangible fixed assets	3,017	11,262	48	342,621	10,612
Employment	50	137	1	2,850	10,564
Material cost	5,336	18,643	53	336,316	10,015
Herfindahl index	0.151	0.039	0.114	0.242	10,634
Years of operation	15	12	1	92	10,634
		Wholesale			
Sales	6,618	15,281	63	281,006	7,746
Tangible fixed assets	669	2,037	34	37,133	7,551
Employment	14	22	1	232	7,680
Material cost	5,334	12,093	58	217,063	7,534
Herfindahl index	0.079	0.017	0.059	0.118	7,746
Years of operation	14	9	1	81	7,746
		Retail sale			
Sales	30,797	130,503	157	1,899,111	1,701
Tangible fixed assets	6,734	42,238	40	729,342	1,687
Employment	193	815	1	11,500	1,698
Material cost	22,499	93,532	72	1,349,756	1,692
Herfindahl index	0.868	0.966	0.731	0.989	1,701
Years of operation	14	8	1	67	1,701

Note: Values are expressed in thousands of €.

5. EMPIRICAL RESULTS

In Table 5, the results of equation's (4) estimation are presented. The average market power is reported for the entire food supply chain and for each actor separately. The average market power in the food supply chain, with an estimated Lerner index of 10.1 %, is much higher than the estimated market power of 3.8 % obtained when assuming variable returns to scale.[7] In any case, as the Lerner index is bounded between 0 and 1 with lower values representing a higher degree of competition, food retailers appear to have a rather high market power in comparison to the other actors

[7] The average returns to scale are computed at the three digit sector-level from the production function.

of the supply chain. The regression results also show that imperfect competition explains more than 95 percent of the difference between the primal and dual productivity measures with significant mark-ups for all elements of the food supply chain. The generally excellent fit of these equations suggest then that imperfect competition might be the cause of this discrepancy.

The estimated mark-ups are also reported year by year to trace their evolution over time. The panel estimation results are similar to those obtained for a single-year estimation. The estimated mark-up ratios though range from 1.01 in 2001 to 1.28 in 2003 for the case of retailing. Using price-cost margins as a measure of market power, it is obvious that competition has increased significantly more in the retailing sector. This becomes evident by comparing columns (2) to (5). The results further indicate that the firms' mark-ups based on single year estimates tend to display some time variability, which may be attributed to cyclical factors or to a changing level of competitive pressure within the sectors.

Overall, the results support the general view that prices exceed marginal cost in food retailing more than in food processing, whereas there is no perfect competition in any of the sectors of the food supply chain. The estimates also suggest substantially lower mark-ups for agricultural producers and wholesalers. Another interesting result concerns the magnitude of the mark-up ratios in the regressions over time. All actors apart from retailers appear then to price closer to marginal costs being more concerned with maximising social welfare. An alternative interpretation may be that the food suppliers and wholesalers have higher costs than retailers.

Table 5
Firms' mark-ups

	Food Supply Chain **(1)**	*Agricultural firms* **(2)**	*Food processing* **(3)**	*Wholesale* **(4)**	*Retail Sale* **(5)**
β_{VRS}	0.038	0.047	0.128	0.122	0.202
β_{CRS}	0.101	0.003	0.102	0.095	0.169
μ	1.112	0.997	1.113	1.105	1.203
	(0.003)	(0.015)	(0.005)	(0.005)	(0.007)
$\overline{R}^2$	0.863	0.774	0.834	0.872	0.950
No.Obs.	19,084	1,369	9,574	6,650	1,491
μ_{1999}	1.185	1.120	1.163	1.194	1.218
	(0.010)	(0.031)	(0.019)	(0.013)	(0.014)
μ_{2000}	1.104	0.840	1.074	1.135	1.195
	(0.011)	(0.065)	(0.017)	(0.016)	(0.017)
μ_{2001}	1.048	1.087	1.154	0.984	1.007
	(0.012)	(0.049)	(0.016)	(0.021)	(0.041)
μ_{2002}	1.126	0.959	1.138	1.115	1.236
	(0.009)	(0.038)	(0.014)	(0.015)	(0.046)
μ_{2003}	1.117	1.012	1.036	1.151	1.277
	(0.010)	(0.045)	(0.016)	(0.015)	(0.015)
μ_{2004}	1.139	1.117	1.185	1.122	1.128
	(0.009)	(0.042)	(0.013)	(0.015)	(0.032)
μ_{2005}	1.106	0.937	1.217	1.087	1.263
	(0.009)	(0.043)	(0.014)	(0.015)	(0.012)
μ_{2006}	1.079	0.881	1.112	1.058	1.265
	(0.009)	(0.041)	(0.015)	(0.015)	(0.017)
μ_{2007}	1.076	0.985	0.963	1.113	1.259
	(0.009)	(0.042)	(0.016)	(0.013)	(0.010)

Values in the parentheses are standard errors. All estimations are statistically significant at 0.01.

Concerning the impact of globalisation and competitive pressure on market power, it appears in Table 6 that the estimate of the mark-up ratio for the entire food supply chain is about the same estimate. In the second column, the average mark-up is estimated at 1.10. However, the price-cost margin varies with the level of foreign interest and concentration in the various sectors. Sectors with higher Herfindahl index of concentration are characterised by high market power, as expected. For instance, the coefficient of 0.29 for the retail sector suggests that a reduction in product market concentration of a percentage point is equivalent to a reduction in the average price-cost margin of 2.9 percentage points. It is also indicated that domestically owned firms have lower price-cost margins relative to foreign-owned firms, captured by μ_2. The point estimate of 0.013 for the processing sector suggests that foreign ownership is associated with an average price-cost margin of 1.076. Consequently, foreign-owned firms have better performance measured in terms of their price-cost margins, as they are better in cutting costs relative to domestic firms. Moreover, the fixed effects estimations suggest that sales are positively and significantly related to globalisation, though market concentration does not have a significant impact.

Table 6
Empirical Results

	Food supply chain		*Agricultural firms*	*Food processing*	*Wholesale*	*Retail sale*
	OLS	*Fixed-effects*	*Fixed-effects*			
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
μ_1	1.087	1.101	0.742	1.063	0.976	0.947
	(0.006)***	(0.006)***	(0.066)***	(0.023)***	(0.029)***	(0.066)***
μ_2	0.013	0.012		0.013		0.007
	(0.004)***	(0.004)***		(0.005)***		(0.007)
μ_3	0.138	0.110	0.758	0.362	1.719	0.288
	(0.014)***	(0.015)***	(0.185)***	(0.147)**	(0.371)***	(0.076)***
FDI	-0.004	0.171		0.179		0.103
	(0.003)	(0.090)*		(0.097)*		(0.269)
Herfindahl index	-0.003	-0.009	0.144	-0.121	0.763	0.449
	(0.002)	(0.015)	(0.163)	(0.212)	(0.613)	(0.519)
Constant	0.074	0.063	-0.617	0.287	-0.697	-3.358
	(0.022)***	(0.057)	(0.800)	(0.439)	(0.615)	(3.977)
R^2	0.863	0.825	0.776	0.790	0.873	0.943
No.Obs.	11,065	11,065	1,369	9,574	6,650	1,491

Values in the parentheses are standard errors. Significance levels: 0.01***, 0.05**, 0.1*. Year dummies were also included in the estimations.

Taking into account the possibility of measurement errors in the input factors, concern arises related to the potential endogeneity of Δx_{it} in equation (6). The *general methods of moments* estimator (GMM), proposed by Arellano and Bond (1991), is therefore employed to account for this problem estimating equation (6) with instrumental variables. All lagged values of Δx_{it} starting from t-2 and before are used as instruments and estimation is made in first differences to control for unobserved fixed effects. Table 7 shows the results obtained for this case. The estimated coefficients are quite different compared to those already reported, though a significant increase in mark-ups is still found due to globalisation, and concentration. The Sargan test confirms the instrument validity in all cases and the second order serial correlation test does not reject the model.

To further control for any dynamics in the mark-ups, an alternative approach to measuring market power is used following Tybout (2003). The so-called *observed firm-level price-cost margin* (*PCM*) is defined as sales net of expenditures on labour and materials over sales. That is:

$$PCM_{it} = \frac{P_{it}Q_{it} - P_{Lit}L_{it} - P_{Mit}M_{it}}{P_{it}Q_{it}} \quad (7)$$

so that the following equation can be estimated:

$$PCM_{it} = \gamma_i + \gamma_1 PCM_{it-1} + \gamma_2 \left(K_{it}/P_{it}Q_{it}\right) + \gamma_3 FDI_{it} + \gamma_4 H_{jt} + \gamma_5 d_t + \varphi_{it} \quad (8)$$

where γ_i is the unobserved firm-level fixed effect and φ_{it} is a white noise error term. The lagged dependent variable is included to control for the possibility that price-cost margins are mean-reverting. As additional controls, the capital to sales ratio is included, as well as the globalisation and concentration variables and the year dummies. Equation (8) is estimated in first differences using GMM as in the previous case. The results are shown in columns (6) to (10) of Table 7. The point estimates suggest that the firm-level PCM is on average 11.1 percentage points higher due to globalisation, whereas concentration affects also positively the firm-level PCM for the overall case of the food supply chain. Similar conclusions can be derived when examining separately all elements of the supply chain, though both factors appear to have a larger impact for the case of food processing. These provide then evidence of a positive effect on firm mark-ups due to globalisation and consolidation, irrespectively of the method used.

6. CONCLUSIONS

The industrialisation of agriculture, the globalisation of food processing and distribution as well as the continued consolidation of the retailing sector are all connected. An important factor to address the socio-economic problems in the food system is to understand these supply chain dynamics. For instance, the buying power of retailers may have adverse economic effects on the viability and efficiency of food suppliers, whereas such power may go hand in hand with increased selling power and thus potentially have adverse effects on consumer welfare. As competition may be considerably distorted, Roeger's (1995) method was used in this paper that allows to derive an expression for the difference between the primal and dual productivity measures under imperfect competition, to estimate firms' mark-ups in the food supply chain. Firm-level data were used for a period of ten years for actors involved in the Greek food supply chain to estimate price-cost margins and to analyse how these are affected by foreign ownership and increased competitive pressure.

The food retail sector is the most dynamic one in Greece, as it is rapidly changing with the emergence of global retailers and mergers of existing firms. It is in fact increasingly concentrated, offering opportunities for firms to exert market power on both the output and input markets. The obtained results show that the concentration of food retailers increases firms' profits, and the retailing sector has become relatively more profitable and powerful than the food processing sector. Moreover, processors, agricultural producers and wholesalers have lower price-cost margins than retailers. To check the robustness of the results, the importance of correcting mark-up estimates by the returns to scale factor was also highlighted, as the measurement bias induced by the assumption of constant returns to scale was also taken into consideration. Firms' mark-ups were further examined using GMM estimators and the observed firm-level PCM. The results are robust to various estimation techniques and

specifications that control for firm-specific attributes inherent to the food supply chain.

As far as the policy implications are concerned, the results of the analysis point that increased concentration in food retailing has resulted in food prices increases, as retailers get their products at lower prices but they do not pass those cost savings on to consumers. If consolidation is then allowed to continue further, food prices are likely to increase in the long-term because competition among top retailers will decrease. Appropriate policies should be developed ensuring that retailers do not exchange price information, while tackling anti-competitive behaviour of individual dominant actors involved in the food supply chain. For example, regulations concerning planning and zoning restrictions, shop opening hours and retail pricing policy might affect the increasing power of retailers.

In this paper, the impact of foreign investors' expansion in the Greek food supply chain was considered in the sense that a mark-up increase is likely to reflect an increase in food prices affecting negatively consumer welfare. The impact of globalisation and consolidation on employment and wages could also be empirically analysed. This is open to future research.

Table 7. Empirical Results

	Food supply chain	*Agricultural firms*	*Food processing*	*Wholesale*	*Retail sale*
	GMM				
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
μ_1	0.943 (0.032)***	0.392 (0.089)***	1.133 (0.058)***	1.111 (0.059)***	0.990 (0.024)***
μ_2	0.331 (0.088)**		0.061 (0.058)		0.168 (0.119)
μ_3	0.502 (0.131)***	1.436 (0.255)***	-0.365 (0.437)	0.095 (0.732)	0.227 (0.028)***
b_1	-0.083 (0.038)**		0.107 (0.046)**		-0.020 (0.019)
b_2	-0.031 (0.018)*	-0.215 (0.056)***	-0.888 (0.297)***	2.217 (0.880)**	0.029 (0.009)***
Constant	0.046 (0.045)	0.651 (0.158)***	1.444 (0.492)***	-1.949 (0.779)**	-0.225 (0.076)***
Sargan test	0.055	0.060	0.141	0.324	0.154
Autocorre-lation test	0.150	0.262	0.289	0.739	0.054
No.Obs.	9,465	1,167	8,209	5,560	1,256
	PCM-GMM				
	(6)	**(7)**	**(8)**	**(9)**	**(10)**
γ_1	0.235 (0.027)***	0.291 (0.015)***	0.245 (0.028)***	0.364 (0.018)***	0.010 (0.003)***
γ_2	-0.039 (0.009)***	-0.019 (0.004)***	-0.033 (0.009)***	-0.020 (0.004)***	-0.120 (0.001)***
γ_3	0.111 (0.048)**		0.105 (0.049)**		0.016 (0.013)
γ_4	0.027 (0.008)***	0.006 (0.003)**	0.028 (0.012)**	0.049 (0.017)***	-0.017 (0.004)***
Constant	0.057 (0.026)**	0.093 (0.009)***	0.076 (0.029)***	0.059 (0.017)***	0.294 (0.029)***
Sargan test	0.094	0.372	0.075	0.168	0.177
Autocorre-lation test	0.259	0.548	0.212	0.763	0.765
No.Obs.	10,707	1,311	9,249	6,600	1,458

Values in the parentheses are standard errors. Significance levels: 0.01***, 0.05**, 0.1*. Year dummies (not reported in this table) were also included in the estimations.

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