International comparison of product supply chains in the agri-food sector: determinants of their competitiveness and performance on EU and international markets

COMPETE

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Market Imperfections in the European Food Processing Industry

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Abstract

The paper analyzes the degree of market imperfections in the input and output food processing markets using the derived mark-down and mark-up models and employing stochastic frontier methodology. The research was based on data drawn from the Amadeus database. The estimated mark-down model revealed some degree of non-competitive behaviour in the input food processing market for all analysed sectors (slaughtering, fruit and vegetables, dairy and milling) with different degree of market imperfections among the sectors. The EU slaughtering common market is characterised by significantly greater market imperfections as compared to the dairy and milling sectors. The results of the fitted mark-up model suggest that market imperfections on the output market are not so pronounced for the slaughtering sector. The degree of market imperfections is higher for the output market in the dairy and milling sectors as compared to the input market. The fruits and vegetables sector has almost the same level of market imperfections for the output as for the input market.

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1 Introduction

The food processing industry, an important part of the agri-food chain, creates the demand for food in general, and agricultural raw materials in particular, and has the potential to substitute the incentives implemented by agricultural policy for incentives resulting from the demand for food. In this respect, at least two requirements have to be met so that the processors can incur this function. First, market power must not be a crucial factor in the exchange transactions of raw materials, so that processors are not able to extract rents from farmers. Second, food processors must be highly productive, and thus competitive, so that they can create a high demand which can be met by the domestic agricultural sector.

In this working paper, we focus on the first requirement and analyse the market imperfections in the EU food processing industry. Our aim is to conduct a comparative analysis among the different EU countries and different industries, and identify the degree of market imperfections in both the input and output food processing markets. That is, based on the derived mark-down and mark-up model and using stochastic frontier methodology, we will identify the degree of non-competitive behaviour in the slaughtering, fruits and vegetables, dairy and milling sectors in 24 EU member states (only Croatia, Cyprus, Luxemburg and Malta are missing).

This study extends the research on the analysis of market imperfections. Since 1980 there have been numerous studies based on a New Empirical Industrial Organization theoretical background focused on detecting market power or, in general, market imperfections in the agricultural and food processing market, as the case may be. Most of these studies are based on market-level data. There is evidence of the oligopsonistic market power of food processors (e.g. Schroeter and Azzam, 1990, Morrison Paul, 2000), but there are also studies which failed to find any evidence of oligopsonistic power (e.g. Weliwita and Azzam, 1996, Muth and Wohlgenant, 1999, Perekhozhuk and Grings, 2006) or found only weak oligopsonistic power (Scalco and Brage, 2014). Moreover, McCorriston (2002) concluded that food markets are now more typically oligopolistic. Studies using firm-level data are not so numerous and include, for example, Hockmann and Vöneki (2009), Bakucs et al. (2009), Perekhozhuk et al. (2011) and Acharya et al. (2011).

In this working paper, we use firm-level data to complement the research on market imperfections by identifying the degree of non-competitive behaviour in the food processing industries of the 24 EU member states. In particular, the paper addresses the following research questions:

1. The first question relates to market imperfections in the input food processing market. The aim is to identify the degree of non-competitive behaviour of the food processors with respect to farmers.
2. The second question concerns market imperfections in the output food processing market. The aim is to identify the degree of oligopolistic market power.
3. The last question relates to the country specifics, especially whether the input and output processing markets differ significantly among countries, and whether the EU processing market is becoming increasingly competitive or whether an idiosyncratic development of market power can be observed.

The working paper is organized as follows: Chapter 2 contains the theoretical framework and presents the estimation strategy; Chapter 3 describes the data set; Chapter 4 presents the results of the mark-down and mark-up model, compares the estimated market imperfections and their development, and discusses their causes and consequences. Chapter 5 contains concluding remarks and policy recommendations.

2 Theoretical framework and estimation strategy

The research questions will be dealt with (1) estimation of country specific input distance function with inter- and intra-sectoral heterogeneity using the Amadeus database and (2) Based on the parameters the efficient output level will be calculated. These will be used in a metafrontier estimate of sectoral input distance functions to determine the TFP level of the analysed sectors (slaughtering, fruits and vegetables, dairy and milling) and TFP development.

In order to produce coherent results, all models (the country-specific models in (1) as well as the metaproduction models in (2) will make use of the same procedure: The models are formulated as a special case of input distance functions with sector dummies in (1) for capturing the intersectoral differences in technology. Moreover, in all models it is explicitly considered that food processing production possibilities are affected by firm (intrasectoral) heterogeneity, which influences the level as well as shape of the production possibilities.

2.1 Theoretical framework

The research questions will be addressed by estimating the derived mark-down and mark-up model and employing stochastic frontier methodology. The stochastic frontier approach for detection of the degree of monopoly power was first applied by Kumbhakar et al. (2012). The novelty of our study is the derivation of a mark-down model using stochastic frontier methodology for detection of the abuse of oligopsonistic/monopsonistic behaviour. Moreover, we extend the theoretical backgrounds of the mark-up model and discuss the static versus dynamic (game theory) interpretation of results.

2.1.1 Mark-down model

The mark-down model is derived using the conjectural variation approach. First, we introduce the firm optimization problem, which is followed by the identification and estimation of the mark-down.

A) Firm optimization

We follow the methodology developed by Bresnahan (1982 and 1989) and Muth, Wohlgenant (1999) to test for oligopsonistic market power. The profit of a processor (*i*) is given by:

(1) $\pi_i = R(\mathbf{p}, \cdot x_i, \mathbf{z}_i, t) - w_X \cdot x_i \; - \; \mathbf{w_z}' \mathbf{z}_i$

where **p** is a vector of product prices, R(**p**, x_i, $\mathbf{z_i}$, t) represents the revenue function depending in addition on the agricultural raw materials (x), other inputs (**z**) and a time trend (t) as an indicator of technical change. The symbol w is used for the corresponding factor prices. The supply function of raw materials is:

(2) $x = g(w_x, \mathbf{s})$ or $w_x = g^{-1}(x, \mathbf{s})$

Here, **s** is a vector of supply shifters and x is the total supply of raw material. However, for analysing the optimal demand of the processor it is more convenient to use the inverse supply function $w_x = g^{-1}(x, \mathbf{s})$. Given (1) and (2), the first order condition for profit maximisation is:

(3) $$\frac{\partial R(\mathbf{p}, x_i, \mathbf{z})}{\partial x_i} - w_X - \frac{\partial g^{-1}(x, \mathbf{s})}{\partial x}\frac{\partial x}{\partial x_i}x_i = 0,$$

where $\partial x / \partial x_i$ represents the increase in total farm supply induced by an increase in processor *i*'s demand for milk. After rearrangement of (3):

(4) $$w_X\left(1+\frac{\Theta}{\varepsilon}\right) = \frac{\partial R(\mathbf{p}, x, \mathbf{z}, t)}{\partial x},$$

where $\varepsilon_x = \frac{\partial x}{\partial g^{-1}(x, \mathbf{s})}\frac{g^{-1}(x, \mathbf{s})}{x} = \frac{\partial \ln x}{\partial \ln w_x} < 0$ denotes the price elasticity of the raw milk supply and $\Theta = \frac{\partial x}{\partial x_i}\frac{x_i}{x}$ is an elasticity capturing the degree of oligopsonistic market power (Bresnahan, 1989). The parameter range is $0 < \Theta < 1$. $\Theta = 0$ corresponds to perfect competition, while $\Theta = 1$ characterizes a monopsonistic market.[1]

From (4) it follows that:

$$w_x < MRP_x = \frac{\partial R}{\partial x}$$

This relationship can furthermore be expressed as:

(5) $$w_x \frac{x}{R} < MRP_x \frac{x}{R} = \frac{\partial \mathrm{R}}{\partial \mathrm{x}}\frac{x}{R} = \frac{\partial \ln R}{\partial \ln x} = \frac{\partial \ln D^o}{\partial \ln x}$$

Where the last equality comes from the duality of the revenue (*R*) and output distance (D^o) functions.

B) Estimation and identification of the mark-down

Inequality in (5) can be transformed into equality by adding a non-negative one-sided term, u:

(6) $$\frac{w_x x}{R} = \frac{\partial \ln D^o}{\partial \ln x} - u,\ u \geq 0.$$

Assuming that the output distance function has a translog form:

(7) $$\begin{aligned}\ln D^o = {} & ß_0 + ß_t t + \frac{1}{2}ß_{tt}t^2 + ß_x \ln x + ß_{xt}\ln xt + \frac{1}{2}ß_{xx}(\ln x)^2 \\ & + \mathbf{ß}_z{}'\ln \mathbf{z} + \mathbf{ß}_{zt}{}'\ln \mathbf{z}t + \frac{1}{2}\ln \mathbf{z}'\mathbf{B}_{zz}\ln \mathbf{z} + \ln \mathbf{z}'\mathbf{ß}_{zx}\ln x \\ & + \mathbf{ß}_{\mathbf{y}}{}'\ln \mathbf{y} + \mathbf{ß}_{\mathbf{y}t}{}'\ln \mathbf{y}t + \frac{1}{2}\ln \mathbf{y}'\mathbf{B}_{\mathbf{yy}}\ln \mathbf{y} + \ln \mathbf{y}'\mathbf{ß}_{yx}\ln x \\ & + \ln \mathbf{y}'\mathbf{B}_{\mathbf{yz}}\ln \mathbf{z}\end{aligned}$$

[1] Since prices of other inputs are assumed to be constant, their optimal level is given when the factor price is equal to the value of marginal revenue: $w_Z = \frac{\partial R(\mathbf{p}, x, \mathbf{z}, t)}{\partial \mathrm{z}}$.

With the corresponding differential and addition of statistical noise (v), (6) becomes:

(8) $$\frac{w_x x}{R} = ß_x + ß_{xt}t + ß_{xx}\ln x + \mathbf{ß}_{zx}'\ln \mathbf{z} + \mathbf{ß}_{yx}'\ln \mathbf{y} - u + v\,.$$

For one output, (8) reduces to (*homogeneity of degree 1 requires that $ß_{yx} = 0$*):

(9) $$\frac{w_x x}{R} = ß_x + ß_{xt}t + ß_{xx}\ln x + \mathbf{ß}_{zx}'\ln \mathbf{z} - u + v\,.$$

Since we define the relative mark-down by:

(10) $$\sigma = \frac{MRP_x\text{-}w_x}{MRP_x}$$

It can be estimated via (*expanding by x/R and using the duality relationship*):

(11) $$\sigma = \frac{u}{\partial \ln D^o / \partial \ln x}$$

That is,

(11´) $$\hat{\sigma} = \frac{\hat{u}}{ß_x + ß_{xt}t + ß_{xx}\ln x + \mathbf{ß}_{zx}'\ln \mathbf{z}}\,.$$

2.1.2 Mark-up model

The mark-up model can be derived in the same manner as the mark-down model.

A) Firm optimization

The optimization problem for the output market is analogous to the input market. In this case, the profit function of processor (i) is given by:

(12) $$\pi_i = p \cdot y_i - C(\mathbf{w}, y_i, t)$$

where p is a price of output, y_i is the output of processor (i), **w** is a vector of input prices, and $C(w,y_i,t)$ is a cost function of processor (i) and time trend (t) for capturing technical change.

The demand or inverse demand function, respectively, is:

(13) $$y = f(p, \mathbf{d}) \text{ or } p = f^{-1}(y, \mathbf{d})$$

where **d** is a vector of demand shifters and y is the total demand for food.

Given (12) and (13), the first-order condition for profit maximisation is:

(14) $$\frac{\partial f^{-1}(y,\mathbf{d})}{\partial y} \cdot \frac{\partial y}{\partial y_i} \cdot y_i + p - \frac{\partial C(\mathbf{w}, y_i, t)}{\partial y_i} = 0$$

Relation (14) can be rearranged as:

$$(15) \quad p \cdot \left(1 + \frac{\Omega}{\varepsilon_p}\right) = \frac{\partial C(\mathbf{w}, y_i, t)}{\partial y_i} \quad ,$$

where $\varepsilon_p = \frac{\partial y}{\partial f^{-1}(y, \mathbf{d})} \cdot \frac{p}{y} < 0$ is a demand elasticity of the final product and $\Omega = \frac{\partial y}{\partial y_i} \cdot \frac{y_i}{y}$ is a conjectural elasticity capturing the degree of oligopolistic market power. The parameter is in the interval $\Omega \in [0;1]$. $\Omega = 0$ indicates competitive behaviour and $\Omega = 1$ characterizes monopolistic power. That is, a positive value of $\Omega \in (0;1)$ indicates the presence of non-competitive behaviour in the output market. In particular, the higher is Ω, the greater is the degree of oligopolistic market power, or the degree of non-competitive behaviour in general.

It follows from (15) that:

$$p \geq \frac{\partial C(\mathbf{w}, y_i, t)}{\partial y_i} \quad \text{for} \quad \Omega \in [0;1].$$

This relation can be expressed as:

$$(16) \quad \frac{p \cdot y}{C} \geq \frac{\partial C(\mathbf{w}, y_i, t)}{\partial y_i} \cdot \frac{y}{C} = \frac{\partial \ln C}{\partial \ln y} = \frac{\partial \ln D^I}{\partial \ln y} \quad ,$$

where the last equality comes from the duality of the cost (C) and input distance (D^I) functions.

B) Estimation and identification of the mark-down

Inequality in (16) can be transformed into equality by adding a non-negative one-sided term, u:

$$(17) \quad \frac{p \cdot y}{C} = \frac{\partial \ln D^I}{\partial \ln y} + u \quad , \quad u \geq 0 .$$

Assuming that the input distance function has a translog form:

$$(18) \quad \begin{aligned} \ln D^I = {} & \alpha_0 + \alpha_t t + \frac{1}{2}\alpha_{tt} t^2 + \alpha_y \ln y + \alpha_{yt} \ln yt + \frac{1}{2}\alpha_{yy} (\ln y)^2 \\ & + \boldsymbol{\alpha}_x' \ln \tilde{\mathbf{x}} + \boldsymbol{\alpha}_{xt}' \ln \tilde{\mathbf{x}} t + \frac{1}{2} \ln \tilde{\mathbf{x}}' \mathbf{A}_{xx} \ln \tilde{\mathbf{x}} + \ln \tilde{\mathbf{x}}' \mathbf{A}_{xy} \ln y \end{aligned}$$

where $\tilde{x}_j = x_j / x_J$ for j = 1,…,J.

Then

$$\frac{\partial \ln D^I}{\partial \ln y} = \alpha_y + \alpha_{yt} t + \alpha_{yy} \ln y + \boldsymbol{\alpha}_{xy}' \ln \tilde{\mathbf{x}} + u + v \quad .$$

Consequently, it follows from (17) and (18) that the function to be estimated has the form:

(19) $$\frac{p \cdot y}{C} = \alpha_y + \alpha_{yt} t + \alpha_{yy} \ln y + \boldsymbol{\alpha}_{xy}' \ln \tilde{\mathbf{x}} + u + v \quad .$$

Since we define the relative mark-up as:

(20) $$\varphi = \frac{p - MC}{MC} \quad .$$

It can be estimated via:

(21) $$\varphi = \frac{u}{\partial \ln D^I / \partial \ln y}$$

That is,

(21´) $$\hat{\varphi} = \frac{\hat{u}}{\alpha_y + \alpha_{yt} t + \alpha_{yy} \ln y + \boldsymbol{\alpha}_{yx}' \ln \mathbf{x}} \quad .$$

2.2 Static vs. dynamic setting[2]

Conjectural elasticities derived in the mark-down and mark-up models in the preceding section might be misleading as an indicator of market power. Moreover, their theoretical consistency is rather poor. In this section, a different approach will be presented. No functional relationship between an indicator and market power will be derived, but the various factors facilitating and hampering collusion in the food processing industry will be discussed. That is, the different reasons or interpretations for the identified non-competitive behaviour or market imperfections using the derived mark-down (8) and mark-up (19) models will be presented, respectively.

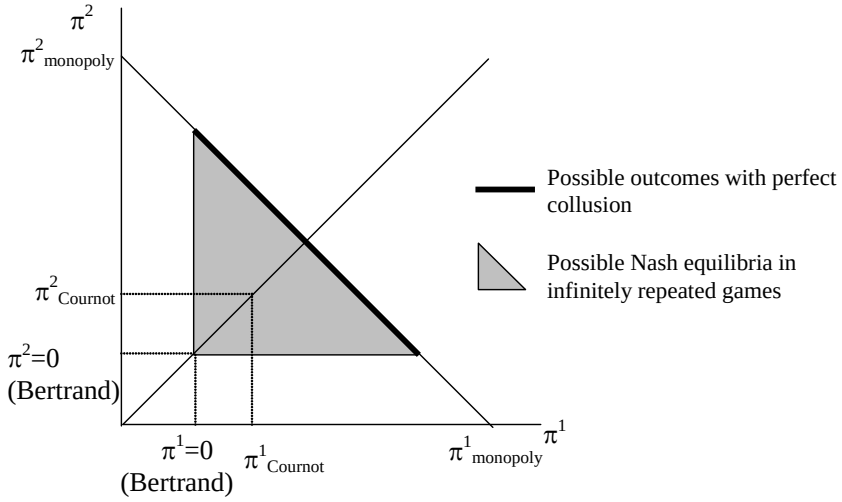
Firm behaviour in a dynamic setting: Repeated games

While theory provides unambiguous results regarding a firm's behaviour in a static setting (e.g. Cournot equilibrium for full capacity utilisation, Bertrand equilibrium for underutilised capacities), a firm's behaviour in a dynamic framework is far from unambiguous. Game theory results exist for finitely and infinitely repeated games. In the first case, backward induction suggests that firms behave as in a simultaneous-shot game. The solution becomes more complex when the game is repeated indefinitely.

[2] In this section, we focus our attention on the output market since it is usually found in the literature. However, the corresponding interpretation for the input market is straightforward.

According to the Folk theorem, every outcome that is better than the worst Nash equilibrium can be reached by an equilibrium strategy (Figure 1). This implies that there exist plenty of equilibrium solutions, and no definite answer regarding the behaviour of a firm in the industry is possible (Fudenberg, Tirole, 1990). It may be argued that the assumption of an indefinitely repeated game is artificial; however, this requirement may be weakened by the assumption that the probability of continuation from one stage to the next is strictly positive.

Figure 1: Equilibrium solution in a duopoly under different behavioural assumptions



Source: Tirole (1988)

Factors hindering and facilitating collusion

Having defined the principle solution set for a situation with dynamic interactions, it remains to discuss the determinants that may hinder and facilitate a solution. Possible influences on collusion will be discussed with an illustrative model. We assume a homogeneous good industry with n firms. Furthermore, demand growth with rate g.[3]

When firms coordinate their pricing behaviour, prices will be larger than marginal costs (p>MC) and industry profits π^C will be realized, which are divided by a predefined key that consists of the profit shares received by the individual firms (s_i).[4] A firm deviating from this (implicit) agreement sets a price slightly lower than p and receives profits $\varepsilon_i \pi^C$ in the deviating period and $\delta_i \pi^C$ thereafter, with $\varepsilon_i > \delta_i$. In addition, we assume that $\varepsilon_i > s_i > \delta_i$ since otherwise there would be no incentive to deviate (the first inequality) and no incentive to cooperate (the second inequality).

The parameters ε_l and δ_l reflect the production capacities of the firms. The larger ε_l, i.e. the less the capacity of the deviating firm is constrained, the easier the firm can serve the whole market. By contrast, higher δ_l indicate large capacity constraints of the competitors. The discount factor is given by ρ. The frequency with which transactions occur is given by α. The higher the α, the higher the frequency, i.e. $\alpha = 1$ corresponds to an annual transaction while $\alpha = 365$ indicates daily transactions.

[3] We follow the procedure usually found in the literature, where collusion is discussed with regard to output markets. However, a corresponding interpretation for input or procurement markets is straightforward.

[4] The s_i can be thought of as the initial market shares or shares of the production capacities of the firms.

Next, we will apply the following strategy. Firms agree to cooperate in the first stage. As long as there is no deviation from the agreed process, cooperation will continue. However, if one firm deviates, the agreement will break down and firms will begin to apply competitive pricing. Formally, this strategy is sustainable, when the following condition holds:

$$(22) \qquad s_i \pi^C \sum_{j=0}^{\infty} \left[(1+g)\rho\right]^{\frac{j}{\alpha}} > \varepsilon_i \pi^C + \delta_i \pi^C \sum_{j=1}^{\infty} \left[(1+g)\rho\right]^{\frac{j}{\alpha}},$$

Thus, collusion is a viable strategy when firms put more weight on future than on present profits. Moreover, (22) can be transformed to present a threshold at which collusion is sustainable:

$$(23) \qquad \rho^* > \frac{(\varepsilon_i - s_i)^{\alpha}}{(1+g)(\varepsilon_i - \delta_i)^{a}},$$

Generally, collusion is easier to sustain when the threshold is lower, because in that case even an impatient firm with a low discount factor regards collusion as a beneficial strategy. Condition (23) provides that the threshold is increasing in ε_i and δ_i, but decreasing in s_i, g and α.

The potential for collusion in the food industry

If the *frequency* of transactions (α) is high it makes collusion more likely (Buigues and Rey, 2004, p. 93). Moreover, this situation implies that *market transparency* is also relatively high (Ivaldi et al., 2003, p. 22). Processors can detect possible deviation from an agreement relatively easily from a change in deliveries or negotiations with farmers. In addition, price information systems are available that provide information about recent price developments without serious delays. These suggest that deviation may be detected immediately, and the competitors can react quickly. Thus a high degree of market transparency reduces the incentives to deviate from a collusive agreement.

A further characteristic of food production is the perishableness of the raw material. Raw material usually cannot be stored for a long time without being processed. This puts farmers in a poor bargaining position, because the opportunities to adjust production immediately to changing market conditions are rather limited. From this it follows that processors possess distinct possibilities of gaining from *opportunistic behaviour*, i.e. of extracting large parts of the producer rents associated with production (Ivaldi et al., 2003, p. 50).

Moreover, condition (23) provides that *market growth* facilitates collusive behaviour, because deviation would lead to higher foregone future profits. In general, the costs of capacity underutilisation determine a firm's behaviour. An increase in the costs of capacity underutilisation increases the incentives to switch to competitive behaviour over time.

Furthermore, the incentives for large and small firms to deviate from collusion, as well as the consequences of deviation, will vary by firm size (Compte, et al., 2002). In condition (23), these forces find their expression in s_i, ε_i and δ_i. *Small firms* will have little s_i and ε_i. On the one hand, the first reduces while the second increases the incentives to collude. However, it can be expected that, due to capacity constraints, ε_i is not much larger than s_i. Corresponding to condition (23), the threshold will be relatively low, i.e. together the two parameters facilitate collusion. In addition, if a small firm deviates, the larger competitors may

react with severe competition. This would result in an increase in the procurement price, which in turn – because of the low economies of scale in small firms – suggests a rather low δ_i or even a market exit ($\delta_i = 0$). Summarizing these arguments suggests that small firms may have few incentives to deviate from a collusive agreement. On the other hand, even if the firms deviate, the sanctions may be less severe than those which occur when a large firm or firms deviate. Since small firms usually have low capacities, their additional demand when deviating will be low, possibly without a noticeable impact on market prices. This argument holds as long as not too many small companies try to deceive. In *large firms* where collusion may lead to high unused capacities, ε_i can be expected to be significant larger than s_i, which implies a high threshold. However, these low incentives to collude can be compensated by the threat of intense competition on the raw materials market (low δ_i), which in turn requires that large firms possess sufficient underutilised capacities to make the threat credible.

This discussion of the various determinants of collusion shows that there is no unambiguous answer to the question of whether the situation in the food processing industry facilitates or hinders collusion. However, in our view, the points in favour of collusion (high degree of market transparency, high frequency of interaction, small number of large firms which could actually influence market prices, threat of severe sanctions due to low capacity utilisation, opportunistic behaviour) make collusive behaviour more likely than competitive behaviour.[5]

2.3 Estimation strategy

The derived mark-down model (8) and mark-up model (19) will be estimated using the stochastic frontier methodology. Since we respect both the heterogeneity in production structures and possible time-varying mark-down or mark-up component, we employ the Fixed Management model (Álvares et al., 2003 and 2004).

Fixed Management model

Álvarez et al. (2003 and 2004) specified the Fixed Management model as a special case of the Random Parameters model in the following form:

Mark-down model (for one output):

$$\frac{w_x x}{R} = \beta_x + \beta_{xt} t + \beta_{xx} \ln x_{it} + \boldsymbol{\beta}_{zx}' \ln \mathbf{z}_{it} + \beta_m m_i^* + \frac{1}{2}\beta_{mm} m_i^{*2} + \beta_{tm} m_i^* t + \beta_{xm} m_i^* x_{it} + \boldsymbol{\beta}_{zm} m_i^{*\prime} \ln \mathbf{z}_{it} - u_{it} + v_{it} \tag{24}$$

with

$$u_{it} = \ln f\left(\mathbf{x}_{it}, \mathbf{z}_{it}, t, m_i; \boldsymbol{\beta}\right) - \ln f\left(\mathbf{x}_{it}, \mathbf{z}_{it}, t, m_i^*; \boldsymbol{\beta}\right) \geq 0$$

[5] Since the dataset consist of large companies (see chapter 3) in majority of cases we can expect that some large companies may exercise market power.

Mark-up model:

$$\frac{p \cdot y}{C} = \alpha_y + \alpha_{yt} t + \alpha_{yy} \ln y_{it} + \boldsymbol{\alpha}_{xy}' \ln \tilde{\mathbf{x}}_{it} + \alpha_m m_i^* + \frac{1}{2}\alpha_{mm} m_i^{*2} + \alpha_{tm} m_i^* t + \alpha_{ym} m_i^* y_{it} + \boldsymbol{\alpha}_{xm} m_i^{*\prime} \ln \tilde{\mathbf{x}}_{it} + u_{it} + v_{it} \quad (25)$$

with

$$u_{it} = \ln g\left(y_{it}, \tilde{\mathbf{x}}_{it}, t, m_i; \boldsymbol{\alpha}\right) - \ln g\left(y_{it}, \tilde{\mathbf{x}}_{it}, t, m_i^*; \boldsymbol{\alpha}\right) \geq 0 \quad ,$$

The mark-down or mark-up component, $u_{it} \geq 0$, captures the deviations from competitive behaviour. $m_i^* \sim \bullet(0,1)$ represents unobservable fixed management. The symbol $\bullet$ expresses that m_i^* could possess any distribution with zero mean and unit variance. The difference between real (m_i) and optimal (m_i^*) management determines the degree of market imperfections exercised by the i-th producer.

Álvarez et al. (2004) showed that u_{it} can be estimated according to Jondrow at al. (1982) as (26), with simulated m_i^* according to (27).

$$E\left[u_{it} \middle| \varepsilon_{it}, m_i^*\right] = \frac{\sigma\lambda}{\left(1+\lambda^2\right)}\left[\frac{\phi\left(-\left(\varepsilon_{it}\middle|m_i^*\right)\lambda/\sigma\right)}{\Phi\left(-\left(\varepsilon_{it}\middle|m_i^*\right)\lambda/\sigma\right)} - \frac{\left(\varepsilon_{it}\middle|m_i^*\right)\lambda}{\sigma}\right], \quad (26)$$

where $\lambda = \frac{\sigma_u}{\sigma_v}$, $\sigma^2 = \sigma_u^2 + \sigma_v^2$ and $\varepsilon_{it} = v_{it} + u_{it}$.

$$\hat{E}\left[m_i^* \middle| \frac{w_{x,i}x_i}{R_i}, x_i, \mathbf{z}_i, \boldsymbol{\beta}\right] = \frac{\frac{1}{R}\sum_{r=1}^{R} m_{i,r}^* \hat{f}\left(\ln\frac{w_{x,i}x_i}{R_i}\middle| x_{it}, \mathbf{z}_{it}, t, m_{i,r}^*; \boldsymbol{\beta}\right)}{\frac{1}{R}\sum_{r=1}^{R} \hat{f}\left(\ln\frac{w_{x,i}x_i}{R_i}\middle| x_{it}, \mathbf{z}_{it}, t, m_i^*; \boldsymbol{\beta}\right)} \quad \text{or} \quad (27)$$

$$\hat{E}\left[m_i^* \middle| \frac{p_i y_i}{C_i}, y_i, \tilde{\mathbf{x}}_i, \boldsymbol{\alpha}\right] = \frac{\frac{1}{R}\sum_{r=1}^{R} m_{i,r}^* \hat{g}\left(\ln\frac{p_i y_i}{C_i}\middle| y_{it}, \tilde{\mathbf{x}}_{it}, t, m_{i,r}^*; \boldsymbol{\alpha}\right)}{\frac{1}{R}\sum_{r=1}^{R} \hat{g}\left(\ln\frac{p_i y_i}{C_i}\middle| y_{it}, \tilde{\mathbf{x}}_{it}, t, m_i^*; \boldsymbol{\alpha}\right)} \quad \text{, respectively.}$$

The Fixed Management model is fitted by maximum simulated likelihood with NLOGIT 5.0.

3 Data

The data we use in the analysis is drawn from the Amadeus database, created and produced by Bureau van Dijk. The database contains financial information for public and private companies across Europe.[6] The database provides detailed information about (standardised) annual accounts, financial ratios, sectoral activities and ownership information.[7]

Table 3.1 Structure of the data set

EU member country	Slaughtering	Fruit & Vegetable	Dairy	Milling
Austria	69	31	39	1
Belgium	539	318	276	167
Bulgaria	200	64	83	32
Czech Republic	381	68	282	110
Germany	375	186	414	115
Denmark	41	31	15	38
Estonia	58	10	43	9
Spain	2031	835	570	329
Finland	159	52	84	32
France	1887	462	623	351
United Kingdom	837	546	450	266
Greece	223	468	206	118
Hungary	226	111	79	60
Ireland	72	0	17	19
Italy	2211	1321	1666	868
Lithuania	125	19	99	31
Latvia	58	19	70	18
Netherlands	55	71	64	20
Poland	1189	521	754	207
Portugal	279	97	75	106
Romania	676	126	317	219
Sweden	393	143	27	110
Slovenia	66	18	27	9
Slovakia	89	24	87	36

Source: Amadeus database and our own calculations

The panel data set that we use in our analysis contains companies whose main activity is food processing according to the NACE classification (NACE 10 – manufacture of food products – groups from 10.1 to 10.9). It is an unbalanced panel data set which represents the period from 2003 to 2012 and contains 9,885 food processing companies from 24 EU countries. Since not all companies in the database have complete information, we exclude those companies with negative and zero values of the variables of interest. Thus, we were

[6] The dataset consists of the companies who are obliged to publish a balance sheet and a profit loss account (cooperatives, joint stock companies, etc.). That is, the dataset contains mainly large (and often successful) companies that might be able to exercise market power (see chapter 2). In other words, the sample of companies is biased with respect to the companies that might be able to exploit their bargaining power.

[7] More information on the Amadeus database is provided at: http://www.bvdinfo.com.

constrained to using an unbalanced panel data set containing 8,110 companies with 52,682 observations covering the period from 2003 to 2012. Moreover, we concentrated on the analysis of four food processing sectors: slaughtering (12,239 observations), fruits and vegetables (5,541 observations), dairy (6,367 observations) and milling (3,271 observations). Table 1 presents the structure of the data set.

The following variables were used in the analysis:

Mark-down model:
Cost share = Material costs/Revenue, Material, Capital and Labour. Material costs were used in the form of the total costs of materials and energy consumption per company. Revenue is represented by operating revenue (Turnover) of the company. Material is the total costs of materials and energy deflated by the index of producer prices in the industry (country level; 2010 = 100). Labour is represented by the total number of employees and Capital is the book value of fixed assets deflated by the index of producer prices in the industry (country level; 2010 = 100).

Mark-up model:
Revenue share = Revenue/Costs, Output, normalized Material and Labour. Revenue is represented by operating revenue (Turnover) of the company. Costs are the sum of Labour costs, Material costs and Capital costs. Labour costs are represented by the costs of employees, Material costs are the total costs of materials and energy consumption per company, and Capital costs are calculated as the book value of fixed assets multiplied by the interest rate according to convergence criteria. Output is represented by operating revenue (Turnover) of the company and is deflated by the sectoral index of food processing prices (EU level – 27 countries or country level if it was disposable, respectively; 2010 = 100). Material and Labour are normalized by Capital. As in the case of the mark-down model, Material is the total costs of materials and energy deflated by the index of producer prices in the industry (country level; 2010 = 100). Labour is represented by the total number of employees and Capital is the book value of fixed assets deflated by the index of producer prices in the industry (country level; 2010 = 100).

Moreover, we rejected producers with fewer than three observations (on average) to decrease the problem associated with the entry and exit of producers from the database.

4 Results

4.1 Mark-down model

Table 4.1 provides the parameter estimate of the mark-down model for the slaughtering, fruits and vegetables, dairy and milling sectors in 24 EU member states (only Croatia, Cyprus, Luxembourg and Malta are missing). Since we assume both heterogeneity in technology and time-varying market imperfections, we employ the Fixed Management model, which allows us to capture unobservable heterogeneity and has a time-varying, one-sided error component (see Chapter 2). We estimated models separately for the slaughtering, fruits and vegetables, dairy and milling sectors. As could be expected, all the fitted parameters are highly significant, in the majority of cases even at a 1 % significance level. This holds for all sectors. Moreover, the high significance of the coefficients on unobservable fixed management suggests that the chosen specification approximates well the estimated relationship, and that heterogeneity among firms is an important characteristic of the food processing sector.

The fitted parameters show that Capital and Labour have a negative impact on the material cost share. This also holds for the time variable in the slaughtering and dairy sectors. That is, the cost share decreases over time in the slaughtering and dairy sectors and increases in the milling sector. The time variable is not significant in the fruits and vegetables sector. The negative impact of capital and labour inputs on the material cost share and, on the other hand, the positive contribution of the material inputs implies that the larger companies produce with smaller relative value added.

The unobservable heterogeneity component (management) contributes positively to the cost share in slaughtering and dairy and negatively in the fruits and vegetables and milling sectors. Moreover, the positive impact is decelerating, and the negative accelerates over time. The increase in management has a different effect in each sector. Slaughtering is characterized by the positive contribution of management on the impact of capital, as well as labour on the material cost share. The opposite holds true for the time component and material inputs. The heterogeneity component negatively determines the impact of capital on the material cost share, whereas it positively determines the labour and material impact in fruits and vegetables. In the dairy sector, the increase in the heterogeneity component contributes positively to the impact of capital and labour on the material cost share and negatively to the impact of material. Finally, the milling sector is characterized by a negative contribution of the heterogeneity component to the impact of labour inputs on the material cost share, and a positive contribution on the impact of capital and material. In terms of the relationship between the heterogeneity component and mark-down component or, in general, market imperfections, as the case may be, an increase in the heterogeneity component leads to an increase in the mark-down component or market imperfections in the fruits and vegetables and milling sectors and a decrease in slaughtering and dairy, respectively. Moreover, higher capital leads to an increase in the mark-down component in the slaughtering, dairy and milling sectors for a given level of management. The opposite holds true for fruits and vegetables. Higher labour determines positively the mark-down in slaughtering, fruits and vegetables and dairy, and negatively in the milling sector. Finally, the higher the material inputs, the smaller the market imperfections

for a given level of management in slaughtering and dairy, and the higher they are in the fruits and vegetables and milling sectors.

Table 4.1 Parameter estimates

Slaughtering							
Means for random parameters				**Coefficient on unobservable fixed management**			
Variable	**Coeff.**	**SE**	**P [|z|>Z*]**	**Variable**	**Coeff.**	**SE**	**P [|z|>Z*]**
Const.	0.5317	0.0030	0.0000	**Alpha_m**	0.5963	0.0033	0.0000
Time	-0.0012	0.0001	0.0000	**Time**	-0.0003	0.0001	0.0267
Capital	-0.0209	0.0003	0.0000	**Capital**	0.0043	0.0004	0.0000
Labour	-0.0417	0.0004	0.0000	**Labour**	0.0395	0.0005	0.0000
Material	0.0791	0.0004	0.0000	**Material**	-0.0750	0.0004	0.0000
				Alpha_mm	-0.3635	0.0011	0.0000
Sigma	0.0707	0.0002	0.0000	**Lambda**	2.2733	0.0288	0.0000
Fruits and vegetables							
Means for random parameters				**Coefficient on unobservable fixed management**			
Variable	**Coeff.**	**SE**	**P [|z|>Z*]**	**Variable**	**Coeff.**	**SE**	**P [|z|>Z*]**
Const.	0.3520	0.0057	0.0000	**Alpha_m**	-0.6157	0.0058	0.0000
Time	-0.0002	0.0002	0.4384	**Time**	-0.0004	0.0002	0.0483
Capital	-0.0211	0.0005	0.0000	**Capital**	-0.0060	0.0006	0.0000
Labour	-0.0227	0.0006	0.0000	**Labour**	0.0012	0.0008	0.1173
Material	0.0853	0.0007	0.0000	**Material**	0.0653	0.0006	0.0000
				Alpha_mm	-0.3737	0.0019	0.0000
Sigma	0.0610	0.0006	0.0000	**Lambda**	0.9308	0.0387	0.0000
Dairy							
Means for random parameters				**Coefficient on unobservable fixed management**			
Variable	**Coeff.**	**SE**	**P [|z|>Z*]**	**Variable**	**Coeff.**	**SE**	**P [|z|>Z*]**
Const.	0.3779	0.0044	0.0000	**Alpha_m**	0.3264	0.0050	0.0000
Time	-0.0018	0.0002	0.0000	**Time**	-0.0012	0.0002	0.0000
Capital	-0.0193	0.0004	0.0000	**Capital**	0.0016	0.0004	0.0000
Labour	-0.0439	0.0005	0.0000	**Labour**	0.0207	0.0006	0.0000
Material	0.0782	0.0005	0.0000	**Material**	-0.0293	0.0006	0.0000
				Alpha_mm	-0.0475	0.0010	0.0000
Sigma	0.0702	0.0004	0.0000	**Lambda**	1.9872	0.0434	0.0000
Milling							
Means for random parameters				**Coefficient on unobservable fixed management**			
Variable	**Coeff.**	**SE**	**P [|z|>Z*]**	**Variable**	**Coeff.**	**SE**	**P [|z|>Z*]**
Const.	0.3092	0.0076	0.0000	**Alpha_m**	-0.1886	0.0074	0.0000
Time	0.0008	0.0002	0.0023	**Time**	0.0017	0.0003	0.0000
Capital	-0.0232	0.0007	0.0000	**Capital**	0.0041	0.0007	0.0000
Labour	-0.0498	0.0009	0.0000	**Labour**	-0.0216	0.0009	0.0000
Material	0.0885	0.0010	0.0000	**Material**	0.0128	0.0008	0.0000
				Alpha_mm	-0.0290	0.0014	0.0000
Sigma	0.0729	0.0007	0.0000	**Lambda**	2.0917	0.0720	0.0000

Source: own calculations

These estimate correspond to our expectations only partially. The heterogeneity (management) component can be viewed as a measure of the quality of inputs as well as a measure of good practises. That is, higher quality and better practises (management, strategy) can be a source of non-competitive behaviour. Moreover, higher inputs are associated with the larger size of a food processor, and with larger size (or market share in general) we should expect a higher relative mark-down – either due to the higher market power or, in terms of game theory, the higher probability of collusion.

The first assumption is met in the fruits and vegetables and milling sectors. That is, the higher heterogeneity component is a source for higher non-competitive behaviour in these sectors. Moreover, the signs of unobservable fixed management on inputs are also only partially in line with the second assumption for a given level of management. But if we regress the relative mark-down on the input quantities we can find a significant positive relationship. To sum up, the hypothesis about the positive relationship between market power or market imperfections and size cannot be rejected; however, it is significantly determined by the sources of non-competitive behaviour (see the discussion in Chapter 5).

The impact of time on the relative mark-down is negative in the slaughtering, fruits and vegetables and dairy sectors and positive in the milling sector. This could be a sign of increasing competitiveness on the EU common market in the slaughtering, fruits and vegetables and dairy sectors.

Finally, the parameter λ is highly significant and is greater than one in the slaughtering, dairy and milling sectors, and approximately one in fruits and vegetables. This means that the variation in the mark-down component u_{it} is more pronounced than the variation in the random component v_{it} in slaughtering, dairy and milling. That is, the estimates indicate that differences in non-competitive behaviour among food processors are important characteristics of these sectors.

Table 4.2 provides statistical characteristics of the relative mark-down for slaughtering. The relative mark-down is in the interval zero to one. Zero indicates no market imperfections or generally competitive behaviour, as the case may be, i.e. the situation where marginal revenue product equals the price of the material inputs (especially agricultural raw material, which dominates the material inputs in the analysed food processing sectors). Then, the positive value of the relative mark-down represents non-competitive behaviour. In particular, an increasing relative mark-down is associated with increasing market imperfections or, in general, increasing abuse of market power, i.e. the food processor has a greater degree of oligopsonistic power (e.g. due to the higher bargaining power) to charge mark-down ($MRP_x > P_x$) with respect to suppliers (in this case farmers). Another interpretation of the $MRP_x > P_x$ is in terms of game theory, i.e. coordination of the firms' pricing behaviour – collusion. With respect to the different interpretation of the surplus of marginal revenue product over the input price, we will relate the increase in relative mark-down to an increase in the degree of non-competitive behaviour, which is more general compared to the increase in oligopsonistic power interpretation.[8]

[8] The interpretation in terms of oligopsonistic power can be misleading; see the discussion in Chapters 2.2 and 5.

The estimated overall mean of the relative mark-down for the EU slaughtering common market, 0.1578, indicates non-competitive behaviour in the EU slaughtering industry. The distribution of the relative mark-down is relatively narrow, with standard deviation of 0.11, and also slightly skewed toward smaller values. The first decile indicates that 10 % of producers have a rather low mark-down. On the other hand, the last 10 % of producers reach a relative mark-down higher than 0.28, indicating a considerably large relative mark-down and thus a degree of non-competitive behaviour.

Table 4.2 Relative mark-down - Slaughtering

Country	Statistical characteristics of relative mark-down								
	Mean	Std.Dev	Min.	Max.	1st Decile	9th Decile	1st Quartile	3rd Quartile	Cases
Total	0.1578	0.1069	0.0067	0.9787	0.0483	0.2874	0.0840	0.2028	11715
Austria	0.2202	0.0582	0.0671	0.3435	0.1420	0.2885	0.1806	0.2541	57
Belgium	0.1969	0.0929	0.0253	0.6564	0.0920	0.3171	0.1419	0.2400	503
Bulgaria	0.1353	0.1401	0.0067	0.8924	0.0231	0.3054	0.0468	0.1657	174
Czech Republic	0.1127	0.0674	0.0169	0.5524	0.0437	0.1770	0.0732	0.1342	377
Germany	0.2321	0.0988	0.0173	0.9778	0.1426	0.3268	0.1661	0.2887	344
Denmark	0.1157	0.0675	0.0205	0.3696	0.0359	0.1879	0.0618	0.1406	40
Estonia	0.1086	0.0543	0.0124	0.2296	0.0360	0.1813	0.0709	0.1556	58
Spain	0.1551	0.1042	0.0072	0.9605	0.0617	0.2703	0.0965	0.1886	1956
Finland	0.2729	0.1516	0.0194	0.8447	0.1047	0.4077	0.1711	0.3419	158
France	0.2100	0.0982	0.0215	0.9787	0.1128	0.3171	0.1555	0.2442	1735
United Kingdom	0.0990	0.0460	0.0127	0.2906	0.0471	0.1621	0.0655	0.1300	834
Greece	0.0851	0.0543	0.0080	0.2754	0.0258	0.1604	0.0502	0.1113	215
Hungary	0.1607	0.1245	0.0152	0.7343	0.0602	0.2792	0.0931	0.1825	191
Italy	0.1862	0.0950	0.0223	0.9629	0.0832	0.3129	0.1210	0.2385	2143
Ireland	0.0909	0.0433	0.0174	0.2095	0.0361	0.1385	0.0616	0.1228	68
Latvia	0.0547	0.0368	0.0085	0.1975	0.0158	0.1003	0.0260	0.0739	58
Lithuania	0.0560	0.0441	0.0097	0.2363	0.0139	0.1104	0.0195	0.0833	123
Netherlands	0.1487	0.0871	0.0236	0.3062	0.0412	0.2606	0.0551	0.2292	47
Poland	0.0931	0.0795	0.0071	0.6695	0.0288	0.1534	0.0493	0.1121	1171
Portugal	0.1344	0.0962	0.0218	0.9664	0.0671	0.1910	0.0882	0.1589	268
Romania	0.1386	0.1573	0.0068	0.9062	0.0183	0.3918	0.0299	0.1970	652
Sweden	0.1638	0.0792	0.0157	0.4298	0.0643	0.2660	0.1143	0.2007	392
Slovenia	0.1324	0.0396	0.0455	0.2176	0.0783	0.1786	0.1052	0.1584	64
Slovakia	0.0914	0.0666	0.0107	0.4910	0.0413	0.1373	0.0539	0.1140	87

Source: own calculation

The overall means of the relative mark-down differ among the individual member states, and the differences are quite large. The means of the relative mark-down can be found in the interval 0.05 to 0.27. Bulgaria (0.14), the Czech Republic (0.11), Denmark (0.12),

Estonia (0.11), United Kingdom (0.10), Greece (0.09), Ireland (0.09), Latvia (0.05), Lithuania (0.06), Poland (0.09), Portugal (0.13), Romania (0.14), Slovenia (0.13) and Slovakia (0.09) have a lower mean compared to the EU average. That is, we can find smaller market imperfections in these countries. In particular, farmers may face a lower degree of non-competitive behaviour in these countries as compared to Austria (0.22), Belgium (0.19), Germany (0.23), Finland (0.27), France (0.21) and Italy (0.18), which are the countries with a mean of relative mark-down higher than the EU average.

The distribution of the relative mark-down is narrow in all countries and slightly skewed toward small values. That is, despite the small standard deviations, significant differences between the 1st and 9th deciles are pronounced in the majority of EU countries. Large differences can be found primarily in Austria, Belgium, Bulgaria, Germany, Spain, Finland, France, Hungary, Italy, the Netherlands, Romania and Sweden. Whereas the 1st decile contains slaughtering processors with a relative mark-down close to zero, indicating almost competitive behaviour, the last decile comprises the food processors with a relatively high degree of non-competitive behaviour.

Table 4.3 provides estimates of the relative mark-down for the fruits and vegetables sector. The overall mean of the relative mark-down for the EU is 0.10, indicating small deviations from competitive behaviour. The distribution is narrow and skewed toward smaller values. Moreover, the differences between the first and last deciles are not so pronounced as compared to slaughtering. That is, the estimate indicates some degree of market power for fruits and vegetables processors; however, market imperfections are quite small as compared to the slaughtering sector.

Table 4.3 Relative mark-down – Fruits and vegetables

Country	Statistical characteristics of relative mark-down								
	Mean	Std.Dev	Min.	Max.	1st Decile	9th Decile	1st Quartile	3rd Quartile	Cases
EU	0.1054	0.0726	0.0102	0.9434	0.0366	0.1862	0.0558	0.1385	5337
Austria	0.1441	0.0353	0.0718	0.1988	0.0900	0.1808	0.1287	0.1743	29
Belgium	0.1681	0.0980	0.0217	0.8630	0.0804	0.2374	0.1071	0.2022	290
Bulgaria	0.0906	0.0656	0.0162	0.3299	0.0221	0.1796	0.0440	0.1207	59
Czech Republic	0.1182	0.0424	0.0420	0.2284	0.0737	0.1963	0.0914	0.1352	68
Germany	0.1299	0.0491	0.0409	0.2479	0.0624	0.1939	0.0899	0.1653	176
Denmark	0.1113	0.0443	0.0297	0.1915	0.0459	0.1777	0.0799	0.1371	31
Estonia	0.0447	0.0238	0.0171	0.1017	0.0248	0.0745	0.0320	0.0497	10
Spain	0.1101	0.0872	0.0104	0.9141	0.0416	0.1943	0.0616	0.1316	819
Finland	0.1087	0.0705	0.0205	0.3594	0.0459	0.2149	0.0592	0.1388	51
France	0.1512	0.0752	0.0197	0.9434	0.0788	0.2299	0.1047	0.1816	447
United Kingdom	0.0712	0.0382	0.0198	0.2149	0.0324	0.1282	0.0436	0.0880	546
Greece	0.0514	0.0343	0.0132	0.2228	0.0232	0.0882	0.0301	0.0590	453
Hungary	0.0981	0.0431	0.0269	0.2225	0.0450	0.1593	0.0623	0.1284	88
Italy	0.1138	0.0605	0.0127	0.6052	0.0491	0.1807	0.0696	0.1484	1282
Ireland	NA	NA	NA	NA	NA	NA	NA	NA	NA
Latvia	0.0706	0.0345	0.0341	0.1994	0.0464	0.0913	0.0491	0.0787	19
Lithuania	0.0509	0.0116	0.0369	0.0772	0.0386	0.0667	0.0419	0.0576	19
Netherlands	0.1601	0.1515	0.0188	0.6508	0.0316	0.3254	0.0502	0.1964	67
Poland	0.0746	0.0409	0.0133	0.2361	0.0310	0.1257	0.0430	0.0961	519
Portugal	0.1161	0.0610	0.0316	0.4539	0.0496	0.1706	0.0726	0.1486	88
Romania	0.0957	0.1027	0.0102	0.5912	0.0219	0.2518	0.0340	0.1256	95
Sweden	0.1019	0.0412	0.0261	0.2960	0.0618	0.1563	0.0788	0.1104	140
Slovenia	0.1207	0.0380	0.0179	0.1607	0.0634	0.1574	0.1096	0.1509	18
Slovakia	0.0701	0.0219	0.0249	0.1121	0.0435	0.0968	0.0570	0.0839	23

Source: own calculation

The market environment in individual member countries differs slightly. The overall mean of the relative mark-down is in the interval 0.04 to 0.17. However, country differences are more pronounced if we take into consideration the distribution of the relative mark-down. It holds for all countries that the first decile comprises companies with nearly competitive behaviour, where the relative mark-down is close to zero. On the other hand, the last decile is characterized by considerable non-competitive behaviour or degree of market power, as the case may be. This holds true primarily for Belgium, Finland, France, the Netherlands and Romania.

Table 4.4 Relative mark-down – Dairy

Country	Statistical characteristics of relative mark-down								
	Mean	Std.Dev	Min.	Max.	1st Decile	9th Decile	1st Quartile	3rd Quartile	Cases
EU	0.0663	0.0504	0.0064	0.7219	0.0308	0.1109	0.0406	0.0751	6254
Austria	0.0575	0.0176	0.0285	0.1083	0.0383	0.0842	0.0450	0.0630	37
Belgium	0.0615	0.0315	0.0162	0.3363	0.0379	0.0939	0.0439	0.0691	272
Bulgaria	0.0946	0.0894	0.0069	0.4593	0.0190	0.1936	0.0405	0.1228	79
Czech Republic	0.0811	0.0763	0.0085	0.4726	0.0213	0.1742	0.0345	0.1016	281
Germany	0.0589	0.0433	0.0145	0.4668	0.0322	0.0896	0.0413	0.0640	387
Denmark	0.0626	0.0349	0.0247	0.1683	0.0318	0.0964	0.0438	0.0664	15
Estonia	0.0616	0.0333	0.0095	0.1497	0.0272	0.1042	0.0362	0.0886	42
Spain	0.0695	0.0415	0.0105	0.4050	0.0323	0.1186	0.0431	0.0865	557
Finland	0.0568	0.0233	0.0250	0.1230	0.0326	0.0820	0.0399	0.0678	84
France	0.0748	0.0507	0.0080	0.3488	0.0361	0.1314	0.0446	0.0849	616
United Kingdom	0.0546	0.0447	0.0064	0.7219	0.0296	0.0830	0.0370	0.0624	442
Greece	0.0569	0.0306	0.0121	0.2242	0.0279	0.0965	0.0360	0.0690	203
Hungary	0.0630	0.0283	0.0233	0.1665	0.0352	0.1053	0.0401	0.0774	64
Italy	0.0653	0.0450	0.0085	0.5319	0.0335	0.1027	0.0424	0.0737	1665
Ireland	0.0419	0.0182	0.0191	0.0715	0.0201	0.0684	0.0226	0.0587	17
Latvia	0.0591	0.0435	0.0090	0.2617	0.0290	0.0905	0.0375	0.0571	70
Lithuania	0.0564	0.0311	0.0119	0.1504	0.0246	0.0982	0.0340	0.0736	99
Netherlands	0.0621	0.0282	0.0232	0.1793	0.0349	0.0927	0.0432	0.0757	60
Poland	0.0555	0.0303	0.0099	0.2731	0.0291	0.0889	0.0377	0.0649	745
Portugal	0.0781	0.0472	0.0219	0.2342	0.0324	0.1415	0.0481	0.0869	75
Romania	0.1047	0.1052	0.0074	0.5213	0.0211	0.2635	0.0340	0.1384	305
Sweden	0.0620	0.0297	0.0227	0.1464	0.0274	0.0874	0.0395	0.0763	26
Slovenia	0.0571	0.0246	0.0273	0.1173	0.0326	0.0945	0.0381	0.0687	27
Slovakia	0.0575	0.0299	0.0161	0.1598	0.0310	0.0939	0.0353	0.0675	86

Source: own calculation

Table 4.4 presents the relative mark-down for the EU dairy sector. As opposed to the slaughtering and fruits and vegetables sectors, the overall mean of the relative mark-down for the EU common market is quite small. The mean, 0.07, together with the narrow distribution and skewness toward small values indicate that the behaviour of dairy processors is almost competitive with respect to farmers. In other words, we found only minor market imperfections. The last decile suggests that there are only a few companies with a considerable degree of non-competitive behaviour.

The differences among EU member states are marginal. The mean of the relative mark-down is, in the majority of cases, in the interval 0.05 to 0.07. A higher mean can only be found in the Czech Republic (0.081), France (0.075), Portugal (0.078) and Romania (0.105). The first decile in all countries is very close to zero. The last decile in the majority of countries is around 0.10, indicating that the majority of dairy companies have a small degree of non-competitive behaviour. Bulgaria (0.19), the Czech Republic (0.17) and Romania (0.26) can be considered exceptions, with a higher relative mark-down

in the last decile. That is, we can find severe market imperfections in these countries as compared to other EU member states.

Table 4.5 Relative mark-down – Milling

Country	Statistical characteristics of relative mark-down								
	Mean	Std.Dev	Min.	Max.	1st Decile	9th Decile	1st Quartile	3rd Quartile	Cases
EU	0.0697	0.0511	0.0087	0.6890	0.0302	0.1182	0.0413	0.0817	3224
Austria	NA	NA	NA	NA	NA	NA	NA	NA	NA
Belgium	0.0652	0.0303	0.0169	0.2025	0.0341	0.0996	0.0426	0.0797	166
Bulgaria	0.0840	0.0570	0.0181	0.2226	0.0307	0.1902	0.0444	0.1061	26
Czech Republic	0.0849	0.0542	0.0108	0.2491	0.0255	0.1672	0.0453	0.1151	110
Germany	0.0718	0.0280	0.0158	0.2207	0.0416	0.1013	0.0547	0.0873	110
Denmark	0.0701	0.0612	0.0125	0.2607	0.0278	0.1262	0.0408	0.0675	38
Estonia	0.0567	0.0229	0.0282	0.0847	0.0310	0.0835	0.0347	0.0814	9
Spain	0.0610	0.0332	0.0128	0.3087	0.0302	0.0948	0.0410	0.0699	329
Finland	0.0775	0.0345	0.0342	0.1586	0.0464	0.1380	0.0531	0.0927	31
France	0.0799	0.0445	0.0189	0.2653	0.0386	0.1259	0.0508	0.0955	349
United Kingdom	0.0622	0.0473	0.0127	0.2876	0.0275	0.0965	0.0363	0.0678	265
Greece	0.0622	0.0344	0.0127	0.1781	0.0261	0.1103	0.0365	0.0819	117
Hungary	0.0680	0.0355	0.0199	0.1992	0.0329	0.1017	0.0440	0.0759	59
Italy	0.0628	0.0338	0.0089	0.3502	0.0327	0.0981	0.0419	0.0755	859
Ireland	0.0652	0.0314	0.0346	0.1420	0.0352	0.1059	0.0380	0.0859	17
Latvia	0.0566	0.0258	0.0188	0.1145	0.0273	0.0968	0.0398	0.0676	18
Lithuania	0.0678	0.0466	0.0145	0.2382	0.0212	0.1191	0.0369	0.0812	31
Netherlands	0.0821	0.0746	0.0160	0.3448	0.0180	0.1085	0.0403	0.0846	20
Poland	0.0673	0.0486	0.0087	0.3810	0.0301	0.1249	0.0380	0.0774	207
Portugal	0.0655	0.0397	0.0130	0.2280	0.0302	0.1100	0.0402	0.0780	101
Romania	0.1034	0.1224	0.0111	0.6890	0.0220	0.2716	0.0298	0.1301	207
Sweden	0.0777	0.0551	0.0180	0.4017	0.0342	0.1306	0.0473	0.0928	110
Slovenia	0.0741	0.0310	0.0348	0.1426	0.0436	0.1077	0.0566	0.0926	9
Slovakia	0.0636	0.0323	0.0230	0.1691	0.0323	0.0969	0.0409	0.0791	36

Source: own calculation

Finally, Table 4.5 provides statistical characteristics of the estimated relative mark-down for the milling sector. As in the case of the dairy sector, the overall mean is small, 0.07. The distribution, which is narrow and skewed toward smaller values, suggests that the market environment is not far from competitive behaviour on the EU common market.

The differences among EU member states are also marginal, as in the case of the dairy sector. The mean of the relative mark-down is around 0.06 in the majority of cases. Only Romania has a slightly higher overall mean of the relative mark-down, 0.10. The first decile is very close to zero in all countries. The last decile is around 0.11 in the majority of countries, indicating that the majority of dairy companies have a low degree of non-competitive behaviour. Romania is again an exception, with the milling companies in the last decile having a substantial degree of market power. That is, we cannot find severe market imperfections in the milling sector in the majority of EU member countries.

The development of the relative mark-down inslaughtering sector has a rather stochastic trend. The relative mark-down for the EU did not change significantly between 2003 and 2012. The fitted trend function shows a weak positive trend for 12 countries. However, the changes are marginal in the majority of cases. The same holds true for the other 12 member states with an estimated negative trend. The negative trend is weak in the majority of cases, except for Estonia. That is, the results suggest that the slaughtering producers did not significantly change the degree of non-competitive behaviour during the analysed period.

The estimated trend functions of the relative mark-down in the fruits and vegetables sector suggest a rather constant trend for the entire EU as well as for Bulgaria, the Czech Republic, Denmark, France, Latvia, Lithuania and Slovakia. The other countries experienced either a weak positive or a negative trend in the majority of cases. A significant increase in relative mark-down can only be observed in Slovenia. On the other hand, Belgium, the Netherlands and Sweden experienced a significant decrease in the relative mark-down.

For the dairy and milling sectors we cannot observe any significant change in the relative mark-down on the EU level. The same holds true for the majority of EU member states. However, some exceptions can be found. In the dairy sector, the Czech Republic and Slovakia experienced a significant increase in the relative mark-down (except for 2012, where we have a small number of observations). On the other hand, a significant decrease in the relative mark-down can be observed in France and Lithuania. A significant increase followed by a decrease almost to the initial values took place in Estonia, Portugal and Romania. In the milling sector, a significant increase in the relative mark-down can be observed in Bulgaria, Estonia and Latvia, and a decrease in United Kingdom, Ireland and Lithuania.

4.2 Mark-up model

Table 4.6 provides a parameter estimate of the mark-up model for the slaughtering, fruits and vegetables, dairy and milling sectors in the 24 EU member states. As in the case of the mark-down model, all the fitted parameters are highly significant. Moreover, the high significance of the coefficients on unobservable fixed management suggests that the chosen specification approximates well the estimated relationship, and that heterogeneity among firms is an important characteristic of the food processing sector.

Table 4.6 Parameter estimates

Slaughtering							
Means for random parameters				**Coefficient on unobservable fixed management**			
Variable	**Coeff.**	**SE**	**P [|z|>Z*]**	**Variable**	**Coeff.**	**SE**	**P [|z|>Z*]**
Const.	1.0716	0.0059	0.0000	**Alpha_m**	0.2650	0.0047	0.0000
Time	-0.0017	0.0002	0.0000	**Time**	-0.0013	0.0002	0.0000
Output	0.0278	0.0006	0.0000	**Output**	0.0042	0.0004	0.0000
Labour	0.0408	0.0006	0.0000	**Labour**	0.0192	0.0005	0.0000
Material	-0.0532	0.0005	0.0000	**Material**	-0.0393	0.0005	0.0000
				Alpha_mm	0.0308	0.0008	0.0000
Sigma	0.1493	0.0003	0.0000	**Lambda**	3.5090	0.0371	0.0000
Fruits and vegetables							
Means for random parameters				**Coefficient on unobservable fixed management**			
Variable	**Coeff.**	**SE**	**P [|z|>Z*]**	**Variable**	**Coeff.**	**SE**	**P [|z|>Z*]**
Const.	0.7913	0.0118	0.0000	**Alpha_m**	-0.3887	0.0099	0.0000
Time	-0.0055	0.0004	0.0000	**Time**	0.0038	0.0004	0.0000
Output	0.0671	0.0012	0.0000	**Output**	0.0000	0.0009	0.9792
Labour	0.0458	0.0014	0.0000	**Labour**	-0.0237	0.0012	0.0000
Material	-0.0704	0.0014	0.0000	**Material**	0.0469	0.0012	0.0000
				Alpha_mm	0.0474	0.0017	0.0000
Sigma	0.1795	0.0008	0.0000	**Lambda**	3.0544	0.0666	0.0000
Dairy							
Means for random parameters				**Coefficient on unobservable fixed management**			
Variable	**Coeff.**	**SE**	**P [|z|>Z*]**	**Variable**	**Coeff.**	**SE**	**P [|z|>Z*]**
Const.	1.1384	0.0069	0.0000	**Alpha_m**	0.9056	0.0081	0.0000
Time	0.0001	0.0003	0.6680	**Time**	-0.0025	0.0003	0.0000
Output	0.0122	0.0007	0.0000	**Output**	-0.0832	0.0008	0.0000
Labour	0.0454	0.0009	0.0000	**Labour**	-0.0167	0.0009	0.0000
Material	-0.0490	0.0009	0.0000	**Material**	0.0006	0.0009	0.5184
				Alpha_mm	0.2986	0.0018	0.0000
Sigma	0.1252	0.0005	0.0000	**Lambda**	1.8631	0.0213	0.0000
Milling							
Means for random parameters				**Coefficient on unobservable fixed management**			
Variable	**Coeff.**	**SE**	**P [|z|>Z*]**	**Variable**	**Coeff.**	**SE**	**P [|z|>Z*]**
Const.	0.9270	0.0117	0.0000	**Alpha_m**	-0.2422	0.0118	0.0000
Time	-0.0046	0.0004	0.0000	**Time**	0.0004	0.0004	0.3346
Output	0.0455	0.0012	0.0000	**Output**	-0.0095	0.0012	0.0000
Labour	0.0365	0.0013	0.0000	**Labour**	-0.0280	0.0015	0.0000
Material	-0.0524	0.0013	0.0000	**Material**	0.0502	0.0011	0.0000
				Alpha_mm	0.0339	0.0018	0.0000
Sigma	0.1690	0.0007	0.0000	**Lambda**	6.3711	0.2910	0.0000

Source: own calculation

The fitted parameters show that the output and labour inputs have a positive impact on the revenue share in all sectors. On the other hand, material inputs determine negatively the revenue share. This result corresponds with the estimates of the mark-down model. The time variable has a negative sign in slaughtering, fruits and vegetables and milling and is not statistically significant in the dairy sector. That is, the revenue share decreases over time in slaughtering, fruits and vegetables and milling.

The unobservable heterogeneity component (management) contributes positively to the revenue share in slaughtering and dairy, and negatively in the fruits and vegetables and milling sectors. Whereas the positive impact in slaughtering and dairy is accelerating, the negative impact in fruits and vegetables decelerates over time. If we focus only on the relation between management and the mark-up component, then an increase in the heterogeneity component leads to an increase in the mark-up component or non-competitive behaviour in fruits and vegetables, and to a decrease in the mark-up component in the slaughtering and dairy sectors, respectively. Moreover, higher output leads to a larger mark-up component in slaughtering and to a smaller mark-up component in the dairy and milling sectors for a given level of management. The coefficient on unobservable fixed management for output is not significant in the fruits and vegetables sector. Labour determines positively the mark-up component in slaughtering and negatively in other sectors for a given level of management. Finally, the material inputs have a negative impact on the mark-up component in slaughtering and a positive impact in other sectors, except for dairy, in which it is not statistically significant.

As in the case of the mark-down model, these results correspond to our expectations only partially. The heterogeneity (management) component as a measure of the quality of output and inputs, as well as a measure of good practises, was found to be a source of non-competitive behaviour in the fruits and vegetables and milling sectors. The estimates revealed a positive relation between the heterogeneity component and mark-up component in these sectors. Moreover, the assumption about the positive relation between greater size (or market share in general) and market imperfections or non-competitive behaviour are not met by all coefficients on unobservable management, as the case may be. However, the positive relation generally holds. If we regress the relative mark-up on the output or input quantities, we can find a significant positive relationship. To sum up, the hypothesis about the positive relationship between the degree of non-competitive behaviour and company size cannot be rejected; however, it is significantly determined by the sources of market power.

The impact of time on market imperfections is positive in fruits and vegetables and negative in slaughtering and dairy. It is not significant in the milling sector. As we concluded for the mark-down model, this could be a sign of increasing competitiveness on the EU food processing common market in the slaughtering and dairy sectors.

Finally, the parameter λ is highly significant, and greater than one in all sectors. This means that the variation in the mark-up component u_{it} is more pronounced than the variation in the random component v_{it}. That is, the estimates indicate that differences in non-competitive behaviour among food processors are important characteristics of the analysed sectors in the EU.

Table 4.7 provides the estimated relative mark-up for the EU and its 24 member states. Since the relative mark-up (MU) is in the interval MU ϵ (0,1), where 0 indicates competitive behaviour and market imperfections increase with increasing MU, the estimated overall mean of the relative mark-up for the EU slaughtering common market, 0.09, indicates some degree of non-competitive behaviour in the EU slaughtering output market. The distribution of the mark-up is relatively narrow, with standard deviation of 0.08, and also a little skewed toward smaller values. The first decile indicates that 10 % of producers have a rather low mark-up. On the other hand, the last 10 % of producers reach a relative mark-up greater than 0.14, indicating considerable non-competitive behaviour.

Table 4.7 Relative mark-up – Slaughtering

Country	Statistical characteristics of relative mark-up								
	Mean	Std.Dev	Min.	Max.	1st Decile	9th Decile	1st Quartile	3rd Quartile	Cases
Total	0.0892	0.0750	0.0040	0.9892	0.0415	0.1413	0.0572	0.0941	11986
Austria	0.0746	0.0183	0.0380	0.1326	0.0576	0.0933	0.0640	0.0822	57
Belgium	0.0828	0.0438	0.0078	0.3263	0.0376	0.1393	0.0537	0.1003	532
Bulgaria	0.1259	0.1388	0.0155	0.7993	0.0259	0.2510	0.0421	0.1571	175
Czech Republic	0.0887	0.0533	0.0136	0.3977	0.0436	0.1538	0.0576	0.1015	377
Germany	0.0765	0.0304	0.0139	0.2607	0.0467	0.1069	0.0609	0.0871	347
Denmark	0.0852	0.0597	0.0273	0.4139	0.0483	0.1210	0.0569	0.1019	41
Estonia	0.0819	0.0453	0.0233	0.2821	0.0425	0.1349	0.0517	0.0959	58
Spain	0.0975	0.0882	0.0059	0.8236	0.0428	0.1607	0.0585	0.1023	2011
Finland	0.0870	0.0495	0.0092	0.2367	0.0355	0.1643	0.0486	0.1131	158
France	0.0810	0.0465	0.0065	0.5855	0.0430	0.1275	0.0577	0.0893	1865
United Kingdom	0.0788	0.0424	0.0155	0.5732	0.0488	0.1059	0.0603	0.0835	837
Greece	0.0832	0.0447	0.0261	0.3271	0.0438	0.1367	0.0592	0.0908	223
Hungary	0.1001	0.0771	0.0092	0.6329	0.0394	0.1899	0.0583	0.1217	199
Italy	0.0818	0.0461	0.0065	0.4922	0.0416	0.1286	0.0565	0.0924	2168
Ireland	0.0740	0.0202	0.0459	0.1324	0.0535	0.1034	0.0600	0.0819	68
Latvia	0.0864	0.0456	0.0259	0.2568	0.0424	0.1525	0.0541	0.1080	58
Lithuania	0.0917	0.0642	0.0138	0.3614	0.0477	0.1637	0.0580	0.0952	125
Netherlands	0.1081	0.0773	0.0303	0.3534	0.0444	0.2129	0.0640	0.1201	47
Poland	0.0832	0.0570	0.0040	0.6719	0.0471	0.1200	0.0595	0.0866	1182
Portugal	0.0782	0.0470	0.0155	0.6588	0.0450	0.1092	0.0590	0.0864	269
Romania	0.1527	0.1918	0.0113	0.9892	0.0271	0.4417	0.0393	0.1684	643
Sweden	0.0797	0.0363	0.0199	0.3032	0.0456	0.1199	0.0589	0.0911	393
Slovenia	0.0801	0.0405	0.0226	0.2363	0.0417	0.1427	0.0513	0.0939	64
Slovakia	0.0847	0.0625	0.0126	0.4717	0.0412	0.1085	0.0578	0.0933	89

Source: own calculation

The overall means of the relative mark-up differ among the individual member states. However, the differences are small. The means of the relative mark-up can be found in the interval 0.07 to 0.15. Producers in Austria (0.08), Germany (0.08), Estonia (0.08), France (0.08), United Kingdom (0.08), Greece (0.08), Italy (0.08), Ireland (0.07), Poland

(0.08), Portugal (0.08), Sweden (0.08) and Slovenia (0.08) exercise less market power, on average, compared to producers in Bulgaria (0.13), Hungary (0.10), the Netherlands (0.11) and Romania (0.15). The distribution of relative mark-up is narrow in all countries, and a little skewed toward small values. However, significant differences between the 1st and 9th deciles are seen in most EU countries. The largest differences can be found in Bulgaria, Hungary, the Netherlands and Romania. The high value of the relative mark-up in these countries indicates the existence of large market imperfections.

Table 4.8 provides the estimated relative mark-up for European processors of fruits and vegetables. In this sector, the estimated overall mean of the relative mark-up is 0.11. Similarly to slaughtering, this indicates the existence of market imperfections or some degree of non-competitive behaviour. The distribution of the mark-up is relatively narrow, with standard deviation of 0.08, and also a little skewed toward smaller values. The first decile indicates that 10 % of producers have a rather low mark-up (lower than 0.05). On the other hand, the last 10 % of producers reach a relative mark-up greater than 0.18. That indicates a considerable degree of non-competitive behaviour.

Table 4.8 Relative mark-up – Fruits and vegetables

Country	Statistical characteristics of relative mark-up								
	Mean	Std.Dev	Min.	Max.	1st Decile	9th Decile	1st Quartile	3rd Quartile	Cases
EU	0.1061	0.0818	0.0100	0.9506	0.0451	0.1755	0.0641	0.1217	5428
Austria	0.0850	0.0257	0.0485	0.1769	0.0608	0.1123	0.0663	0.0949	29
Belgium	0.0969	0.0705	0.0112	0.5570	0.0374	0.1788	0.0565	0.1155	315
Bulgaria	0.2042	0.2218	0.0151	0.9223	0.0218	0.4032	0.0457	0.2926	60
Czech Republic	0.0984	0.0476	0.0259	0.2115	0.0405	0.1745	0.0626	0.1228	68
Germany	0.0930	0.0452	0.0306	0.3890	0.0522	0.1357	0.0679	0.1042	176
Denmark	0.0907	0.0309	0.0430	0.1664	0.0492	0.1280	0.0652	0.1117	31
Estonia	0.1357	0.1044	0.0296	0.3832	0.0494	0.2793	0.0637	0.1469	10
Spain	0.1172	0.0890	0.0108	0.6414	0.0429	0.2139	0.0665	0.1374	824
Finland	0.1065	0.0871	0.0312	0.6186	0.0415	0.1639	0.0661	0.1116	51
France	0.0948	0.0656	0.0149	0.8485	0.0445	0.1606	0.0604	0.1081	456
United Kingdom	0.0950	0.0504	0.0250	0.4517	0.0502	0.1502	0.0663	0.1097	546
Greece	0.1131	0.0821	0.0105	0.9506	0.0476	0.1920	0.0682	0.1297	466
Hungary	0.1112	0.0778	0.0164	0.4388	0.0507	0.2081	0.0645	0.1324	84
Italy	0.0982	0.0624	0.0100	0.7641	0.0467	0.1590	0.0636	0.1153	1306
Ireland	NA	NA	NA	NA	NA	NA	NA	NA	NA
Latvia	0.1078	0.0865	0.0218	0.4414	0.0443	0.1481	0.0702	0.1170	19
Lithuania	0.0917	0.0369	0.0399	0.1715	0.0516	0.1438	0.0671	0.1135	19
Netherlands	0.0989	0.0493	0.0318	0.2342	0.0444	0.1814	0.0657	0.1202	66
Poland	0.1030	0.0589	0.0132	0.4718	0.0462	0.1787	0.0659	0.1275	521
Portugal	0.1078	0.0713	0.0191	0.4219	0.0428	0.1982	0.0590	0.1429	94
Romania	0.2102	0.2466	0.0141	0.9442	0.0264	0.6195	0.0607	0.2648	102
Sweden	0.0987	0.0591	0.0221	0.4476	0.0460	0.1638	0.0637	0.1119	143
Slovenia	0.1742	0.1128	0.0134	0.3807	0.0466	0.3453	0.0852	0.2672	18
Slovakia	0.1414	0.1192	0.0184	0.4579	0.0565	0.3373	0.0735	0.1375	24

Source: own calculation

The overall means of the relative mark-up differ among the individual member states. The lowest mean value of the relative mark-up can be found in Austria (0.09), while the highest value was reached in Romania (0.21). Nonetheless, a relative mark-up with a value lower than the EU mean can be found in Belgium (0.10), the Czech Republic (0.10), Germany (0.09), Denmark (0.09), France (0.10), United Kingdom (0.10), Italy (0.10), Lithuania (0.09), the Netherlands (0.10), Poland (0.10 and Sweden (0.10). The distribution of the relative mark-up is quite narrow in the analysed states and slightly skewed toward small values. However, significant differences between the 1st and 9th deciles exist in most EU countries, especially in Bulgaria, Estonia, Romania, Slovenia and Slovakia. In these countries, market imperfections are stronger as compared to other EU countries.

Table 4.9 presents the relative mark-up for European dairy processors. In this sector, the estimated overall mean of the relative mark-up is 0.12. This is the highest value of the relative mark-up EU mean as compared to other sectors. Comparing with the results of the mark-down analysis, we can conclude that producers in the dairy sector have

Table 4.9 Relative mark-up – Dairy

Country	Statistical characteristics of relative mark-up								
	Mean	Std.Dev	Min.	Max.	1st Decile	9th Decile	1st Quartile	3rd Quartile	Cases
EU	0.1210	0.0735	0.0043	0.8748	0.0467	0.2103	0.0731	0.1506	6287
Austria	0.1517	0.0455	0.0756	0.2912	0.1064	0.2112	0.1171	0.1758	37
Belgium	0.1339	0.0559	0.0138	0.3231	0.0738	0.2261	0.1029	0.1576	274
Bulgaria	0.0882	0.0819	0.0174	0.4413	0.0253	0.2140	0.0329	0.1014	79
Czech Republic	0.1029	0.0618	0.0071	0.4425	0.0438	0.1810	0.0608	0.1287	278
Germany	0.1269	0.0564	0.0089	0.3279	0.0564	0.1990	0.0924	0.1568	404
Denmark	0.1203	0.0441	0.0671	0.2551	0.0768	0.1530	0.0950	0.1343	15
Estonia	0.1050	0.0481	0.0266	0.2310	0.0481	0.1647	0.0623	0.1381	43
Spain	0.1259	0.0766	0.0077	0.5519	0.0455	0.2254	0.0744	0.1627	569
Finland	0.1498	0.0528	0.0676	0.3000	0.0959	0.2336	0.1063	0.1853	84
France	0.1383	0.0691	0.0043	0.4629	0.0540	0.2257	0.0951	0.1760	619
United Kingdom	0.0768	0.0435	0.0082	0.3080	0.0336	0.1277	0.0458	0.0982	447
Greece	0.1120	0.0586	0.0134	0.3319	0.0520	0.1915	0.0735	0.1440	203
Hungary	0.1616	0.1151	0.0504	0.5436	0.0761	0.3035	0.0871	0.1927	64
Italy	0.1357	0.0771	0.0070	0.6457	0.0545	0.2278	0.0882	0.1657	1656
Ireland	0.0760	0.0250	0.0440	0.1209	0.0469	0.1138	0.0551	0.0897	17
Latvia	0.1082	0.0504	0.0119	0.2771	0.0610	0.1651	0.0732	0.1308	70
Lithuania	0.0864	0.0438	0.0209	0.2055	0.0411	0.1623	0.0500	0.1121	99
Netherlands	0.1821	0.0795	0.0408	0.4961	0.1119	0.2691	0.1315	0.2269	60
Poland	0.0973	0.0557	0.0085	0.4270	0.0511	0.1542	0.0666	0.1079	749
Portugal	0.1567	0.0720	0.0053	0.3343	0.0780	0.2593	0.1033	0.2059	75
Romania	0.1191	0.1233	0.0099	0.8748	0.0244	0.2381	0.0481	0.1412	305
Sweden	0.0836	0.0448	0.0135	0.2172	0.0356	0.1400	0.0459	0.1054	27
Slovenia	0.1250	0.0403	0.0674	0.2096	0.0796	0.1818	0.0978	0.1494	27
Slovakia	0.0999	0.0436	0.0319	0.2627	0.0491	0.1506	0.0667	0.1212	86

Source: own calculation

a stronger position or non-competitive behaviour in the output market than in the raw materials input market, i.e. in price negotiations with retailers than with farmers.

The distribution of the mark-up is relatively narrow, with a standard deviation of 0.07. However, significant differences between the 1st and 9th deciles can be found. The first decile indicates that 10 % of producers have rather low market power (lower than 0.05). On the other hand, the last 10 % of producers reach a relative mark-up higher than 0.21. That is, the results again indicate a considerable degree of non-competitive behaviour on the dairy output market.

The overall means of the relative mark-up differ among the individual member states. The means of the relative mark-up can be found in the interval 0.08 to 0.18. Producers in Bulgaria (0.09), United Kingdom (0.08), Lithuania (0.09) and Sweden (0.08) exercise a lower degree of non-competitive behaviour, on average, as compared to producers in Austria (0.15), Finland (0.15), Hungary (0.16) and Portugal (0.16). The first decile is very close to zero in Bulgaria and Romania. However, it is much higher in Austria (0.11) and the Netherlands (0.11). It indicates the existence of significant market imperfections in the dairy market in these countries. The spread between the first and last deciles is more pronounced in the dairy sector as compared to the slaughtering and fruits and vegetables sectors. Greater differences can be found primarily in Bulgaria, Spain, France, Hungary, Italy, Portugal and Romania.

Finally, Table 4.10 contains the estimated relative mark-up for the milling sector. The overall mean is 0.10, which also indicates the existence of some degree of non-competitive behaviour in this sector on the EU common market. The distribution is again narrow and a little skewed toward the left. The first decile suggests that 10 % of producers have a rather low mark-up. On the other hand, the last 10 % of producers reach a relative mark-up higher than 0.18, indicating a considerable degree of non-competitive behaviour.

The overall means of the relative mark-up differ among the individual member states. However, the differences are small. The means of the relative mark-up can be found in the interval 0.07 to 0.14. Producers in Belgium (0.09), Germany (0.08), Estonia (0.08), Spain (0.09), Finland (0.08), France (0.09) and Slovakia (0.09) exercise smaller market imperfections, on average, compared to producers in Bulgaria (0.14), the Czech Republic (0.13), Denmark (0.12), Greece (0.12) and the Netherlands (0.14). There are significant differences between the 1st and 9th deciles in most EU countries. The largest differences can be found in Bulgaria, the Czech Republic, Denmark, Greece, Lithuania, the Netherlands, Poland and Romania. Similarly to the dairy sector, the spread between the 1st and 9th deciles is more pronounced as compared to slaughtering and fruits and vegetables processing.

The majority of EU member countries experienced a rather stochastic trend of the relative mark-up in the slaughtering sector. The relative mark-up for the EU does not change significantly between 2003 and 2012. The fitted trend function show a weak positive trend for 11 countries. However, the changes are marginal in the majority of cases, except for Finland and Latvia. The same holds true for the other 13 member states with an estimated negative trend. The negative trend is weak in the majority of cases. That is, the results suggest that the slaughtering producers did not change significantly the degree of non-competitive behaviour during the analysed period.

Table 4.10 Relative mark-up – Milling

Country	Statistical characteristics of relative mark-up								
	Mean	Std.Dev	Min.	Max.	1st Decile	9th Decile	1st Quartile	3rd Quartile	Cases
EU	0.1016	0.0815	0.0080	0.6685	0.0345	0.1839	0.0530	0.1190	3231
Austria	NA	NA	NA	NA	NA	NA	NA	NA	NA
Belgium	0.0858	0.0426	0.0175	0.2041	0.0379	0.1551	0.0578	0.1081	166
Bulgaria	0.1402	0.1078	0.0092	0.3695	0.0313	0.3335	0.0566	0.2138	28
Czech Republic	0.1319	0.1083	0.0080	0.4807	0.0290	0.3135	0.0510	0.1725	110
Germany	0.0840	0.0464	0.0182	0.3455	0.0408	0.1360	0.0507	0.1081	110
Denmark	0.1169	0.1169	0.0128	0.4787	0.0386	0.2469	0.0528	0.1290	38
Estonia	0.0757	0.0293	0.0367	0.1251	0.0442	0.1097	0.0480	0.0984	9
Spain	0.0925	0.0584	0.0087	0.4672	0.0373	0.1607	0.0545	0.1092	329
Finland	0.0781	0.0423	0.0324	0.2370	0.0380	0.1046	0.0447	0.0901	31
France	0.0933	0.0620	0.0115	0.4412	0.0317	0.1609	0.0546	0.1176	342
United Kingdom	0.0965	0.0853	0.0086	0.4423	0.0291	0.1752	0.0449	0.1110	266
Greece	0.1213	0.1107	0.0117	0.6212	0.0301	0.2490	0.0504	0.1476	118
Hungary	0.1041	0.0714	0.0174	0.3965	0.0407	0.1672	0.0597	0.1225	59
Italy	0.0958	0.0681	0.0088	0.6685	0.0404	0.1550	0.0582	0.1130	864
Ireland	0.1086	0.0552	0.0525	0.2218	0.0546	0.1878	0.0628	0.1727	17
Latvia	0.0950	0.0587	0.0243	0.2339	0.0460	0.1910	0.0540	0.1318	18
Lithuania	0.1186	0.0827	0.0102	0.3901	0.0347	0.2524	0.0712	0.1322	31
Netherlands	0.1346	0.1287	0.0148	0.4757	0.0262	0.2891	0.0363	0.2323	20
Poland	0.1064	0.0812	0.0093	0.4593	0.0369	0.2015	0.0578	0.1220	207
Portugal	0.1030	0.0778	0.0119	0.4205	0.0406	0.1874	0.0541	0.1200	102
Romania	0.1425	0.1454	0.0098	0.5901	0.0259	0.4473	0.0431	0.1787	211
Sweden	0.1020	0.0739	0.0128	0.4402	0.0289	0.1759	0.0486	0.1222	110
Slovenia	0.0706	0.0219	0.0308	0.1059	0.0424	0.0916	0.0577	0.0844	9
Slovakia	0.0863	0.0525	0.0194	0.2499	0.0383	0.1633	0.0505	0.1079	36

Source: own calculation

The estimated trend functions of the relative mark-up in the fruits and vegetables sector suggest a rather constant trend for the entire EU. A positive trend was estimated for 16 EU member states. However, the changes in the relative mark-up are again rather small. Belgium, Estonia, Hungary, Portugal and Slovenia are exceptions. Whereas Belgium, Portugal and Slovenia experienced a significant increase in the relative mark-up, Estonia and Hungary were characterized by a decrease in the degree of non-competitive behaviour in the fruits and vegetables output processing market.

We cannot observe any significant change in the relative mark-up in the dairy sector on the EU level. The same holds true for the majority of EU member states. However, some exceptions can be found. Hungary and Sweden experienced a significant increase in the relative mark-up. On the other hand, a significant decrease in the relative mark-up could be observed in Portugal.

The developments of the relative mark-up in the milling sector are characterized by a stochastic trend in many member states. On the EU level, we cannot observe any significant changes. The fitted trend function suggests a weak positive trend. The same holds true for 17 EU member states, where we estimated a weak positive trend in the relative mark-up. Hungary and Latvia are exceptions, with a significant increase in the relative mark-up.

5 Conclusions

The estimated mark-down model revealed some degree of non-competitive behaviour in the input food processing market for all analysed sectors, i.e. slaughtering, fruits and vegetables, dairy and milling. The degree of market imperfections differs among the sectors. Whereas the overall mean of the relative mark-down for the EU slaughtering common market is 0.1578, for fruits and vegetables it is 0.1054, for dairy 0.0663 and for milling 0.0697. That is, the EU slaughtering common market is characterised by significantly greater market imperfections as compared to the dairy and milling sectors, in particular. Moreover, since the relative mark-down is in the interval zero to one (zero indicating no market imperfections or in general competitive behaviour, as the case may be, and a positive value of the relative mark-down representing non-competitive behaviour), the estimated overall means show quite small market imperfections on the EU input food processing markets. This especially holds true for the dairy and milling sectors.

The distribution of the relative mark-down is relatively narrow in all sectors, and skewed toward smaller values. Significant differences between the first and last decile were revealed in slaughtering, indicating low market imperfections for the first 10 % of producers, but a considerable degree of non-competitive behaviour for the last 10 % of slaughtering producers. The differences among the producers in fruits and vegetables, and especially in the dairy and milling sectors, are not so pronounced.

Furthermore, there were significant differences among EU member countries. In slaughtering, the means of the relative mark-down could be found in the interval 0.05 to 0.27. Bulgaria, the Czech Republic, Denmark, Estonia, United Kingdom, Greece, Ireland, Latvia, Lithuania, Poland, Portugal, Romania, Slovenia and Slovakia are characterised by lower market imperfections as compared to the EU average. On the other hand, Austria, Belgium, Germany, Finland, France and Italy are countries having a mean of the relative mark-down higher than the EU average.

The overall means of the relative mark-down in fruits and vegetables are in the interval 0.04 to 0.17. Belgium, Finland, France, the Netherlands and Romania are countries with a relatively high degree of market imperfections.

The differences among EU member states are marginal in the dairy and milling sectors. In dairy, the mean of the relative mark-down is in the interval 0.05 to 0.07 in the majority of cases. The mean of the relative mark-down in the milling sector is around 0.06 in the majority of cases; only Romania is an exception, with a mean of the relative mark-down of 0.10.

Finally, the development of the relative mark-down is characterised by a rather stochastic trend. This holds for the majority of countries in all analysed sectors. However, the relative mark-down for the EU does not change significantly between 2003 and 2012.

The results suggest that the slaughtering producers did not change significantly the degree of non-competitive behaviour during the analysed period. Only marginal changes can be found in other sectors. However, some exceptions can be found. In fruits and vegetables, a significant increase in the relative mark-down can be observed in Slovenia. On the other hand, Belgium, the Netherlands and Sweden experienced a significant decrease in the relative mark-down. In the dairy sector, the Czech Republic and Slovakia are characterised by a significant increase in the relative mark-down, and France and Lithuania by a decrease in the relative mark-down. In the milling sector, a significant increase in the relative mark-down can be observed in Bulgaria, Estonia and Latvia, and a decrease in United Kingdom, Ireland and Lithuania.

The results of the fitted mark-up model suggest that market imperfections on the output market are not so pronounced for the slaughtering sector, with an overall mean of 0.0892. However, the degree of market imperfections is higher for the output market in the dairy (0.1210) and milling (0.1016) sectors as compared to the input market. The fruits and vegetables sector has almost the same mean for the output as for the input market (0.1061).

The distribution of the relative mark-up is again relatively narrow in all sectors and skewed toward smaller values. Moreover, significant differences between the first and last decile in all sectors were revealed by the estimate. However, the differences among producers in the slaughtering sector are not so pronounced.

The overall means of the relative mark-up differ among the individual member states in slaughtering. However, the differences are small. The means of the relative mark-up can be found in the interval 0.07 to 0.15. Producers in Austria, Germany, Estonia, France, United Kingdom, Greece, Italy, Ireland, Poland, Portugal, Sweden and Slovenia exercise less market power, on average, as compared to producers in Bulgaria, Hungary, the Netherlands and Romania. The largest differences among the slaughtering producers can be found in Bulgaria, Hungary, the Netherlands and Romania. The high value of the relative mark-up in these countries indicates the existence of strong market imperfections.

In fruits and vegetables, the lowest mean value of the relative mark-up can be found in Austria (0.09), and the highest value was reached in Romania (0.21). Nonetheless, a value of the relative mark-up lower than the EU mean can be found in Belgium, the Czech Republic, Germany, Denmark, France, United Kingdom, Italy, Lithuania, the Netherlands, Poland and Sweden. On the other hand, strong market imperfections exist in Bulgaria, Estonia, Romania, Slovenia and Slovakia as compared to other EU countries.

The means of the relative mark-up are in the interval 0.08 to 0.18 for dairy producers. Bulgaria, United Kingdom, Lithuania and Sweden exercise a lower degree of non-competitive behaviour, on average, as compared to producers in Austria, Finland, Hungary and Portugal. The first decile is very close to zero in Bulgaria and Romania. However, it is much higher in Austria and the Netherlands. This indicates the existence of significant market

imperfections in the dairy market in these countries. The spread between the first and last deciles is more pronounced in the dairy sector as compared to the slaughtering and fruits and vegetables sectors. Greater differences can be found primarily in Bulgaria, Spain, France, Hungary, Italy, Portugal and Romania.

The differences in the overall means of the relative mark-up in the milling sector are not so pronounced among the countries. Means of the relative mark-up can be found in the interval 0.07 to 0.14. Producers in Belgium, Germany, Estonia, Spain, Finland, France and Slovakia exercise, on average, smaller market imperfections compared to producers in Bulgaria, the Czech Republic, Denmark, Greece and the Netherlands. Significant differences between the 1st and 9th deciles exist in most EU countries. The largest differences can be found in Bulgaria, the Czech Republic, Denmark, Greece, Lithuania, the Netherlands, Poland and Romania. Similarly to the dairy sector, the spread between the 1st and 9th deciles is more pronounced as compared to slaughtering and fruits and vegetables processing.

The development of the relative mark-up is again rather stochastic, and changes are only marginal in the majority of cases. That is, the results suggest that the producers did not significantly change the degree of non-competitive behaviour during the analysed period on the output market between the years 2003 - 2012. However, some exceptions can be found. In fruits and vegetables, Belgium, Portugal and Slovenia experienced a significant increase in the relative mark-up, and Estonia and Hungary are characterised by a decrease in the degree of non-competitive behaviour. Hungary and Sweden experienced a significant increase and Portugal a significant decrease in the relative mark-up on the dairy output market. In milling, a significant increase in the relative mark-up can be found in Hungary and Latvia.

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Objective:	The objective of the COMPETE project is to gain a more comprehensive view on the different elements which contribute to the competitiveness of the European agri-food supply chain in order to provide better targeted and evidence based policies on the EU as well as on the domestic level. The project investigates selected determinants of competitiveness like policy interventions and the business environment, productivity in agriculture and food processing, the functioning of domestic and international markets, the choice of governance structures, and innovative activities in food processing. The research results will enable a congruent, coherent and consistent set of policy recommendations aiming at improving competitiveness of European product supply chain.
Coordinator:	IAMO, Germany, Prof. Heinrich Hockmann
Consortium:	16 Partners from 10 European countries. COMPETE brings together academics, trade bodies, NGOs, agricultural co-operative, industry representative advisory services. In addition, the project is supported by the group of societal actors, incorporating farmer, food processing and consumer associations, providing in-depth knowledge on the agri-food sector and speeding up the achievement of the project goals.
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COMPETE
International comparison of product supply chains in the agro-food sector

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