

# Product Differentiation on the Polish Pig Meat Market

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# **PRODUCT DIFFERENTIATION ON THE POLISH PIG MEAT MARKET**

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## **Abstract**

This study deals with horizontal product differentiation in the Polish pig meat market. Hypothesis among firms behaviour are derived from an illustrative model and tested in an empirical analysis using data from 1991-1998. The empirical analysis suggest that product differentiation is a relevant phenomenon in the polish pig meat markets. In addition we found that costs and competitions are important factors influencing price variation. However, further influences like price discrimination and vertical product differentiation are also important determinants for product price variations.

**Keywords:** pricing, market structure, product quality

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## Abstract

This study deals with horizontal product differentiation in the Polish pig meat market. Hypothesis among firms behaviour are derived from an illustrative model and tested in an empirical analysis using data from 1991-1998. The empirical analysis suggest that product differentiation is a relevant phenomenon in the polish pig meat markets. In addition we found that costs and competitions are important factors influencing price variation. However, further influences like price discrimination and vertical product differentiation are also important determinants for product price variations.

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## 1. INTRODUCTION

Product differentiation refers to a situation in which two or more products are perceived by consumer to be close, but not perfect, substitutes (GEORGE et al. 1992, p. 213ff.; HAY et al. 1991, p. 102ff.). In our paper we consider the horizontal differentiation (product range), which involves comparisons between goods that require the same quantity of resources for their manufacture, but are different in respect of their design.<sup>1</sup>

Beginning with HOTTELING's study (1929) of spatial competition, important insights into product differentiation has been provided. In spite of the extensive theoretical developments on this field, there are only a few quantitative analysis on effects of product differentiation both at the overall level of the agri-food market, and with respect to the individual processing firm. Some empirical analysis can be found mainly in marketing research, whereas cases studies dominate over the pattern identification.

The objectives of our paper is a contribution to fill the gap between the theoretical consideration and empirical analysis in industrial organisation. In a first step, we develop testable hypothesis regarding horizontal product differentiation from a simple model. The second step consists of identifying determinants of product differentiation. We applied our research to the polish pig meat industry.

The paper is organised as follows. The first step considers the relevant developments on the polish meat industry during transition. Chapter 3 is aiming at deriving comparative static results to be tested in the empirical analysis. The following chapters (4 and 5) analyse major elements which are considered to be relevant to an explanation of existing price differentials between the meat processing firms and over the time. To test these hypothesis, we used the data of the pig meat processing firms in Poland. Six commodities with different intern attributes are examined for the period spanning 1991-1998. The concluding section draws some general lessons.

## 2. THE POLISH MEAT INDUSTRY DURING TRANSITION

The transition process has changed the Polish meat market dramatically. Not only that former state-owned enterprises had been privatised, furthermore, new enterprises were founded. The

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<sup>1</sup> Vertical (or quality) differentiation, on the other hand, refers to a set of products ordered according to some quality. Two products are considered vertically differentiated if the products are differentiated over attributes over which consumers share common preferences (e.g. product quality) (BARRON et al. 2000, HAY et al. 1991, TIROLE 1988).

growing number of firms in the sector, the implementation of new efficiency oriented incentive schemes and the growing awareness of consumer sovereignty has lead to a more intense competition among the firms (PIENIADZ 2001). In addition, market transparency is expected to be relatively high, because consumers can compare prices in different location (stores) relatively easily.

**Table 1: Variance decomposition of real product prices\***

Output prices	$\sigma_T$	Share of	
		$\sigma_W$	$\sigma_B$
Pork chop	0.0364	61.9%	38.1%
Pork shoulder	0.0451	55.2%	44.8%
Hard cured sausage	0.0332	56.3%	43.7%
Frankfurter	0.0401	47.8%	52.2%
Cocked ham	0.1335	54.6%	45.4%
Cured loin	0.2238	55.0%	45.0%

Source: Own calculations based on PISiPAR-database (1998), and MENGES (1982).

Note:  $\sigma_T$ : total variance (=  $\sigma_W + \sigma_B$ );  $\sigma_W$ : variance within a firm;  $\sigma_B$ : variance between the firms;

\* Deflated by average price development, base 2<sup>nd</sup> quarter 1991. The data reflect the processors weekly quotations from 2<sup>nd</sup> quarter 1991 to 2<sup>nd</sup> quarter 1998.

Given that firms would supply homogenous goods, these characteristics would lead to similar product prices for all firms. However, the data presented in figure 1 provide that on average about 45% of the price variations is due to between firm variance. The magnitude of this phenomenon varies among products but is present in all production lines. This indicates that firms are able to use marketing practices that allow them to overcome the negative impacts of competition. In particular, we assume that horizontal product differentiation play an important role in the marketing strategies. We argue that this policy manifests itself in price variations among firms. In addition, horizontal product differentiation provides possibilities to charge a markup and thus allows firms to make extra profits.

### 3. THEORETICAL BACKGROUND

#### 3.1. Firms behaviour in competitive markets

In this chapter we present theoretical considerations. It is not the purpose to develop a closed and complex analytical model. The intention is rather to motivate the procedure in the empirical analysis. Because of this, it seems to be appropriate to use a very general model that allows us to keep the theory as simple as possible without neglecting important aspects of horizontal product differentiation.

In standard textbooks horizontal product differentiation is discussed in the tradition of HOTELLING (1929). Within this framework consumers are located in a linear city and decide, from which of the two firms they buy. Their choice depends on the product prices and their preferences revealed by their transport costs. However, extensions of the basic model are difficult to implement. The incorporation of the size of demand as done in a slightly different context by KLEMPERER (1990) would already provide large difficulties for the comparative static analysis. However, the major problem is to consider more than two firms. Thus, the analysis is restricted either to a linear or circular city (TIROLE 1988) or requires very extreme assumptions (all producers and consumers are homogeneous) to derive a spatial pattern of production (LÖSCH 1944).

In order to overcome these problems, we use an ad-hoc specification of a demand function. In particular, we assume that the sector consists of  $n$  firms and each firm produces one brand. The firm's price-demand function have the form (MARTIN 1993):

$$(1) \quad p^i = a - b \left[ x^i + \theta \sum_{j \neq i} x^j \right] \text{ for } i, j = 1, \dots, n.$$

The parameter  $\theta$  represents the degree of product differentiation. It ranges between 0 and 1. If it reaches its lower bound there is no competition among firms and they can act as monopolists. A value of one indicates that products are completely homogeneous and there is no room for brand specific pricing behaviour. Solving the price-demand functions (1) with respect to quantities provides the demand curve for brand  $i$ :

$$(2) \quad x^i = \frac{1}{1 + (n-1)\theta} \frac{1}{b} \left[ a - \frac{1 + (n-2)\theta}{1-\theta} p^i + \frac{\theta}{1-\theta} \sum_{j \neq i} p^j \right] \text{ for } i, j = 1, \dots, n.$$

Each firm operates with a constant returns to scale technology with marginal cost  $c^i$ .<sup>2</sup> There is no uncertainty and firms set their product price ( $p^i$ ) in order to maximise variable profits: Optimal profits in a **Bertrand-Nash** equilibrium are then given by:

$$(3) \quad \pi^i(p^{i*}, P^{-i*}) = \max_{p^i} \left\{ (p^i - c^i) x^i \right\}, \text{ with } x^i = x^i(p^i, P^{-i*}, n, a, \theta, b),$$

where a star behind variable denotes optimal adjusted variables and  $P^{-i}$  indicates the vector of product prices of all firms  $j \neq i$ . Performing the indicated maximisation in (3) and solving for equilibrium prices yields:

$$(4) \quad p^{i*} = \alpha(a, n, \theta) + \beta_1(n, \theta) c^i + \beta_2(n, \theta) \sum_{i \neq j} c^j, \text{ with } \alpha > 0, \beta_1 > 0, \beta_2 > 0.$$

The functions are linear in marginal costs and market size ( $a$ ). However, they are highly nonlinear in the degree of product differentiation and the number of firms as it is already indicated in (2).

From (4), it follows directly that

$$\frac{dp^i}{dc^i} = \beta_1 > 0 \quad \text{and} \quad \frac{dp^i}{dc^j} = \beta_2 > 0.$$

Higher costs lead to a raise of the product price no matter whether own costs or a competitors costs increase. With regard to own costs the reason is that a firm tends to transmit higher costs to consumers. The effect of competitor's higher costs results from the fact prices are strategic complements. Thus the increase of firm  $j$ 's price leads to an increase of firm  $i$ 's price.

In order to derive comparative static results for the other variables, we will not differentiate the price function directly but will use an alternative approach. This consists of applying CRAMER'S rule to the total differential of the first order conditions. Inspection into the resulting terms provides that the sign of the comparative static effects is given by the sign of the derivative of the respective first order condition:<sup>3</sup>

<sup>2</sup> In the following we assume that  $c^i$  includes production, transport and a firms' transactions costs.

<sup>3</sup> The procedure is as follows. A LAPLACE expansion regarding the  $i$  column is performed. Second derivatives of the  $i$ 's first order condition with regard to  $p$  is cancelled out. With condition (2) it follows that the sign of the comparative static effect is determined by the direct effect.

$$\text{sign}\left(\frac{dp^i}{dq}\right) = \text{sign}\left(\frac{\partial^2 \pi^i}{\partial p^i \partial q}\right) \text{ for } q = a, n, \theta.$$

The individual effects are

$$\text{sign}\left(\frac{dp^i}{da}\right) = \text{sign}\left(\frac{1}{b(1+(n-1)\theta)}\right) > 0 \quad \text{and} \quad \text{sign}\left(\frac{dp^i}{dn}\right) = \text{sign}\left(-\frac{(a-\bar{p})\theta}{b(1+(n-1)\theta)}\right) < 0.^4$$

Larger markets (higher  $a$ ) have a positive impact on prices, while an increase in competition (higher  $n$ ) reduces equilibrium prices. Furthermore, it follows that

$$\text{sign}\left(\frac{dp^i}{d\theta}\right) < 0,$$

where the sign is a direct consequence of (1). This formula says that the lower the possibilities of product differentiation, the lower the price.

## 4. DATA SET

### 4.1. Structure of the sample

We tested our hypothesis with data for the polish meat market. We combined information from several sources. Our main set contains data on product prices and quantities as well as purchase prices for pigs of selected meat processors in Poland. The information was provided by the governmental ‘Control Agency for Procurement and Processing of Agricultural Products’ (PISiPAR). Data from 45 firms with complete records for the whole period between the second quarter of 1991 and the second quarter of 1998 were used. Since the identity of the individual firms was known additional information from other sources could be included. These are the location of each firm, its ownership status, whether a license to export meat products into the European Union (EU) is possessed, etc.

*Firms:* The focus of the study is on the largest firms in the meat processing industry. The enterprises were considered by the control agency to be able to influence prices on the polish meat market.<sup>5</sup> Therefore, not all slaughtering and meat processing establishments are covered by the data set. Hence, due to the selection procedure the investigated sample is neither random, nor representative for the polish meat industry. In 1991 the 45 analysed firms accounted for around 70% of the total sales and around 75% of employment in the meat sector. The corresponding figures for 1997 are 40% and 53%, respectively. All of these firms were state-owned until 1989, and have been almost completely privatised until the end of 1998. A typical firm in the sample processes pork (around 70 percent) and beef (30 percent). Another feature of the firms is their high degree of horizontal and vertical integration. The technological process embraces slaughter, partition and production of meat products. Moreover, upstream relationships are being developed through involvement of meat processors in livestock production (contractual control over livestock supply) as well. A typical meat processing firm in the database is forward integrated and sells 30% of its produce

<sup>4</sup> The bar over a variable indicates the arithmetic mean. We assumed that  $n$  is a continuous variable and all firms charge consumers the same prices.

<sup>5</sup> The agency surveys these firms every week and receives firm specific information about quantities and prices of purchased inputs (livestock/carcasses) and marketed output (detailed intermediate and final products).

through its own wholesale and retail distribution system.<sup>6</sup> Despite of some common features of the firms the sample is very heterogeneous regarding the costs, and other characteristics. Some of this will be discussed in the following chapter.

*Products:* Since the beginning of the transformation process the range and quality of manufactured meat products has changed significantly. As a producer market turned into a consumer market, changes in consumer preferences and the increasing degree of competition obliged the formerly state owned enterprises to modify their production profile. As a result some of them manufacture between 300 and 500 different meat products today, whereas products that did not meet consumer preferences left the market. In our analysis we focused on products, which were present on the market in the entire period under investigation. Additionally, due to its relevance on the polish meat market, we concentrate on the pig meat products, only. We chose products, which represent three different group of categories: (1) pig fresh meat (pork chop and pork shoulder) (2), highly processed pork products with a high share of raw materials (cocked ham and cured loin), and (3) sausages that are highly processed meat products with relatively low share of pig meat (frankfurter, and a kind of hard cured sausage).<sup>7</sup>

#### **4.2. Dependent variable**

The variable going to be explained are price variations for meat products as they are weekly quoted by the processors. The series available mirrors the prices at the firm gate. These differ from those paid by consumers since margins set by wholesalers and retailers are not included. For some observations no data were available. In order to get a complete record for the processors we calculated quarterly averages of individual product prices.

Price movements on the polish hog/pork markets reflected not only the macroeconomic changes (inflation) but also dynamic changes on the whole meat market. Driven by cyclic changes of pig (and beef) supply, development of rivalry between the meat processing firms and changing consumer preferences, the development of the average purchase and the product prices diverge from the development of the common deflators, e.g. the consumer price index (CPI) (s. figure 1). For this reason, we avoid adjusting the nominal time series by using common (aggregated) deflators. Instead, we proceeded by calculating the average price in each period and using this figure for deflating the price series for each firm.

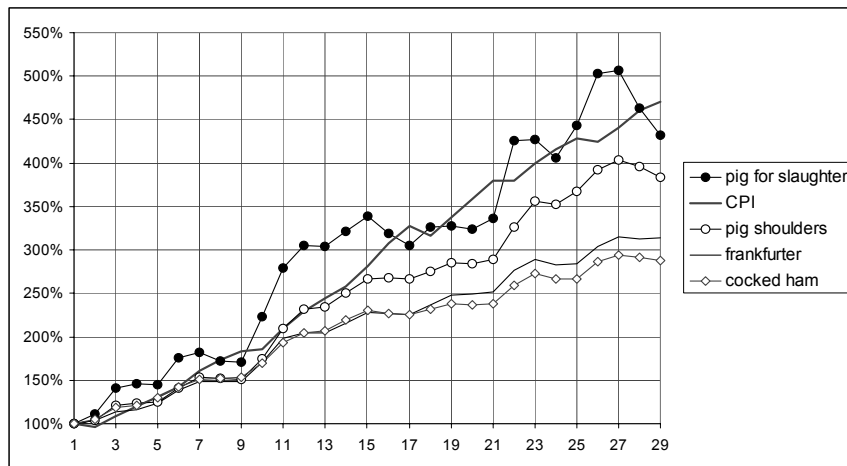
This procedure allows us to abstract from factors that are affecting simultaneously all prices through time but are the same for all cross-sectional units at a given point in time (inflation, cyclic changes of pig supply, etc.). Due to this transformation we forced the mean of the variables in the period  $t$  to equal one. Furthermore, this enables us to discuss the price variation ignoring the differences in price level between the investigated product.

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<sup>6</sup> Own calculations based on PISiPAR-database (1998), Boss (1998), MSP (1991), GUS (1992 a, 1998 b), Individual Annual Reports of the meat processing firms and information's collected at Treasury Ministry in Warsaw, Poland, and Interviews with representatives of the investigated firms.

<sup>7</sup> The traditional polish names of these two sausages are: parówki (frankfurter) and kielbasa zwyczajna (a kind of hard cured sausage). For details concerning the internal product attributes see BN-84/80144-05 (1988), PN-A-82007 (1996), FELLOWS (2000).

**Figure 1: Nominal price movements on hog/ pork markets and the development of the consumer price index (CPI) for food products in Poland between the 2<sup>nd</sup> quarter 1991 and the 2<sup>nd</sup> quarter 1998**



Source: Own calculations based on PISiPAR-database, and GUS (various issues d).

### 4.3. Independent Variables

According to the theoretical considerations higher costs are associated with higher prices. Unfortunately, the data set does not provide any accurate information about the firms costs. Thus, we have used different proxy variables to account for this effect on price variation. As mentioned in the theoretical considerations, the variable *c* contains production, transport and transaction costs.

Regarding transaction costs we concentrate to ownership structure. We presume that the privatisation of former state owned enterprises (SOE) has a positive impact on allocative efficiency, thus reduces overall costs and in turn induces lower output prices. The reasons for the efficiency gains are that, first, in privatised firms more efficient incentives schemes could be implemented and enforced. Second, owners and managers are forced to work under hard budget constrains (KORNAI 1979). Because the requirements regarding human capital a. o. varies among privatisation strategies, differences among the methods can be expected. For this reason we classified the privatised firms into three categories according to the applied privatisation method.<sup>8</sup> The dummy variable **Indirect privatisation** denotes that a firm was converted first from a SOE into a wholly state owned joint stock company. After that the shares were distributed by initial public offering, public tenders, or other methods. The variable **Direct privatisation** indicate that a firms has been privatised by leasing and/or by selling.<sup>9</sup> The membership in one of the National Investment Funds represent the third main privatisation strategy in Poland: This method is represented by the variable **Mass privatisation**.<sup>10</sup>

<sup>8</sup> For more details on privatisation methods in the Polish food industry see PIENIADZ (2001), BORNSTEIN (1999) and selected papers in FAULKNER et al. (1999).

<sup>9</sup> The ownership change through direct privatisation in Poland is similar to management and employee buy-outs strategy (MEBO), which could be found in the western countries. In Poland this kind of privatisation consists on the liquidation of a solvent SOE by leasing, selling or otherwise 'contributing' its assets to a new company. Although its assets remain and its operation continues, the enterprise's legal status changes from an SOE to a private firm. According to this dummy variable in the data base there are only firms, which have been privatised or 'liquidated' by leasing and by selling.

<sup>10</sup> The NIF-program involving 512 companies from different branches consisted in setting 15 investment trusts called National Investment Funds (NIFs) managed mainly by various international and domestic



Differences in fixed costs of production are approximated by two dummy variables, **Affiliation with a capital group** and **Possession of an export licence**. An **Affiliation with a capital group** is expected to be relevant for two reasons. On the one hand firms that belong to a capital group have better access to investment capital either from sources within the group or from commercial banks.<sup>11</sup> In the long run, additional investment rises productivity and hence reduces the costs. Furthermore, firms within a group can exploit economies of scale and scope and thus can reduce R&D and marketing expenditure even further. Furthermore, because these groups operate nationally, competition between them is intense. Their members are continuously searching for new promotional and advertising strategies for domestic and export markets, developing of trade marks, etc. However, in the short run (e.g. the investigated period) investment expenditure will have a positive influence on production costs. We assume that the short run effects dominate.

The **Possession of an export licence** indicates whether a company has licenses to export meat and meat products into the EU. Possession of an export licence is assumed to have a positive effect on individual firms' costs for two separate reasons: Firstly, an export licence is an indicator of superior product quality of a firm. The ability to meet the sanitary and quality standards required for a EU licenses makes it likely that the investment, and subsequently the (fixed) costs of these firms' are above average. Secondly, an access to an additional (foreign) market rises the distribution and marketing costs.

The impact of variable costs is also captured by two determinants. The first, **Factor prices**, are the meat processors specific purchase prices for pigs. Again, we normalised the purchase prices to an average in the period, to abstract from time specific effects. Corresponding to the comparative statics, a higher price of hog will increase product prices. However, there are further influences. Due to differences in the degree of processing and the share of raw materials in the final product it is likely that quality requirements regarding purchased inputs (livestock/carcasses) will vary between the investigated products. Fresh products (pork chop, pork shoulder) are characterised by a direct relation between the internal attributes of the final products and those of the primary products. For instance, for fresh meat products the quality of the animals, e.g. the carcasses sets the benchmark for the quality attainable of the final fresh product. In fact, after primary production internal quality can only deteriorate (OUDEN et al. 1996).

In recent years we observed in Poland a shift of consumer demand towards high quality products. However, supplying sufficient quality needs high quality carcasses, which in turn will only be provided when the farmers receive prices that account for quality differentials. This implies that (changing) consumer demands have to be converted directly to primary producers and a correlation between the quality of pork and input prices can be expected (HOCKMANN et al. 2001). Correlation should also be significant in the group of highly processed meat products as pork ham and pork loin. The production of high quality sausages requires a corresponding quality of inputs, as well. However, harmonising inputs characteristics to consumer demands can take place largely in the processing stage through mixing (fresh) products, adding additives such as spices, and firm's specific recipes. In

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financial firms, insurance and/or industrial firms, whose remuneration was closely linked to their ability in successfully turning around and eventually selling the enterprises in their portfolio. After the allocation of the firms to the 15 NIF (1995), freely tradable master share certificates representing proportional ownership in the 15 (NIFs) were distributed under the polish adult citizen. Subsequently, the certificates could have been exchanged for one separate freely tradable share in each of the NIFs. The mass privatisation has been fully implemented by the end of 1997.

<sup>11</sup> Commercial banks are often more interested in extending loans to big groups than to individuals, particularly small firms.

general, high quality sausage products cannot be obtained without at least some minimal quality of raw materials. Thus, if a positive correlation exists, it may be not so much reflected in the coefficients as for the other products.

A part of the between-firm variation of output prices may also be caused by different access to the resource base or indirectly by different amount or quality of pigs raised in the vicinity of a slaughterhouse. These effects are captured by the variable **Local Supply of Raw Materials**. The variable is defined as the supply of pigs in the region (voivodship) in which a firm is located.<sup>12</sup> It was constructed by splitting annual statistical information about regional pig production homogeneously to the quarters. On the one hand sufficient supply of pigs in a given area reduce the transaction and /or transport costs of hog procurement.<sup>13</sup> On the other hand there is evidence of a positive correlation between the intensity of animal production and the specialisation on high quality animals in a region. However, higher quality is normally awarded with higher prices. Which of these counteracting effects dominates can only be assessed empirically.

A further set of variables is defined to capture the impact of competition on the prices. A first, **Regional Demand**, is used as an indicator of demand size in the region in which a meat processor is located. This variable is defined by real wages multiplied by rate of employment within the region and thus, approximates average per capita income in a region. The annual statistical data had to be split to quarters again. It could be argued that this variable is an indicator for a processor's market size. This effect is present, undoubtedly. However, the argument neglects the fact that there is plenty of regional trade of meat products. Although, we observe import and export movements in all regions, the main direction of trade is towards urban centres. Moreover, there is a strong correlation between a region with a high income and the population density. Thus, the higher average income, the more firms are present on the market and the lower the price a firm can charge. We argue that the effect resulting from competition dominates the demand effect.<sup>14</sup>

The variable **Regional market power** is also an indicator of regional competition. The degree of concentration on the output markets of the Polish meat processing industry seems to be low at the national level.<sup>15</sup> However, at the regional level firms can exercise some monopolistic power and hence require higher prices for their products. This can partly cause the variation of output prices across firms and should also be taken into consideration. Some authors use the distance to each firm closest rival as a proxy for the degree of competition in the defined regional market area (e.g. BARRON et al. 2000). Since there is a great number of firms with different size in each voivodship we found it more appropriate to approximate the regional degree of competition or market power by regional market shares. Thus, we define regional

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<sup>12</sup> In thousands tons of meat equivalent per a hectare agricultural area.

<sup>13</sup> Because of the severely fragmented resource base of hog farming in Poland, transaction costs there might have been higher than in other regions of Poland.

<sup>14</sup> Some studies mention (e.g. WEI et al. 1995) the major share of sales of a meat processing firm goes to retailing firms within a vicinity of less than 100 km. Therefore, proximity to urban centres might have been a factor that is conducive for firms' price setting strategy (s.a. HOTELING-Model). Hence, the regional population density could have been used as an alternative approximation of the regional demand for the products of the firm located within that region. However, we could not utilise this variable because of its very small variation during the investigated period (fixed effect model).

<sup>15</sup> The market price and each firm's profit decrease with the number of firms. When the number of firms becomes very large, the market price tends to the competitive price  $c$ . Consequently, each firm has only a small influence on the price and thus acts almost like a price taker (TIROLE 1988).

market power as a share of highly processed meat products (sausages, ham, other smoked and cured meat) of each firm in total sales (of these products) of the appropriate voivodship.<sup>16</sup>

So far competition is only considered through approximations of the number of firms. However, the model provides that prices are not only influenced by own costs but also by those of the rivals. This effect is captured by **Competitors' costs** which reflects average labour productivity of the rivals. It was constructed by dividing a firm's total quarterly sales in meat equivalents by its labour force. Since labour input at a firm level was only available for 1991 and 1996-1998, we estimated a series by approximation with a related time series (FRIEDMAN 1962). The time series used in the calculation was annual labour input in the meat processing sector in Poland. Our suggestion is that the higher labour productivity of the competitors, the lower their average costs, the lower the price a firm can charge. However, the variable is not exogenous in the short run, because a firm's price affect the quantities sold and thus labour productivity. The relationship is the reason why we did not consider the variables as the cost determinant an individual firm. However, it can be expected that average labour productivity of all competitors is affected less than an individual firms' productivity. Moreover, we had no other variable that could capture the competitiveness of the rivals.<sup>17</sup>

Demand in physical terms changes annually as well as seasonally. During the period under investigation, Poland experienced economic growth and thus an increase of average per capital income. Because income elasticity for food is relatively low only a small impact on meat consumption and thus on prices could be expected. Furthermore, there is a pronounced seasonal pattern in meat consumption in so far as in December demand for fresh meat and highly processed products in the high price segment is up to two times higher than in other months. This development is accompanied by a significant increase in prices (see figure 1). However, we were not able to discover these influences by our estimations. The main reasons is that through the transformation of the dependent variable we erased all temporal effects from price adjustments.

## **5. ANALYTICAL PROCEDURE**

In this section we describe the empirical model in order to estimate a relationship between the presented variables.

### **5.1. Motivation of regression procedure**

According to the model outlined in chapter 3, product differentiation affects prices nonlinearly. This concern the absolute term as well as the slope coefficients in (4). Furthermore, because it is to be expected that the substitution possibilities differ among the brands and that the number of competitors depends on location and marketing strategies. This suggests, that the heterogeneity manifests itself in a variation of all parameters among the firms. Such an econometric model could have been estimated when the data have suitable characteristics. In particular, the explanatory variables need to posses an interval scale (GREENE 2000). Unfortunately, most of the data used in the estimation were dummy variables. Thus, this very general procedure could not be applied. Instead, we chose more restrictive assumptions: slope coefficients are constant and the intercept varies over firms. This model can be estimated depending upon whether the variable intercept is assumed to be random or fixed (BALTAGI 1995, GREENE 2000, HSIAO 1996, JUDGE et al. 1985).

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<sup>16</sup> As denominator we applied a quarter of the respective annual date.

<sup>17</sup> An alternative would be to take concentration measures. Doing this would cause even larger exogeneity problems.

Due to the construction of the dependent variable, we have eliminated price variations resulting from common trends like increases in demand, inflation and general improvements of the supply conditions. Thus, the absolute terms are not affected by time specific but only by firm specific effects. Under perfect competition and without product differentiation there is no room for price variations, since the market price is determined by the production costs of the least efficient firm. This in turn provides that absolute terms significantly greater than zero can be used as an indicator of product differentiation. Furthermore, firm specific intercepts provide that the importance of product differentiation varies among enterprises which means that they are differently positioned to benefit from special recipes, brand figures, or informative labelling.

Each processors supplies a wide range of products. The production bundle is influenced by price relations as well as technological restrictions. Thus, there are strong linkages to the amount of production in the different product categories. In addition, it can be expected that this in turn has consequences for a firm's pricing behaviour. Principally, this would have required an econometric model in which the prices of the different products are estimated simultaneously. The interdependencies between products would be explicitly considered in the variance co-variance matrix of the error terms. However, in order to keep the estimation simple, we assume that the covariance among error terms is zero. This allows us to estimate each product separately.

## 5.2. Estimation and inference

As mentioned above, the heterogeneity across the firms is captured by assuming firm-specific intercepts  $\alpha_i, \forall_t$  but constant slope coefficients  $\beta, \forall_{i,t}$  with  $i=1,..N, t=1,..T$ . Hence, the model to be considered is:

$$y_{it} = \alpha_i + \beta'x_{it} + v_{it}, \quad \text{with} \quad \alpha_i = \bar{\alpha} + \mu_i \quad \text{and} \quad v_{it} = u_{it} - \mu_i,$$

where  $\bar{\alpha}$  is the „mean“ intercept and  $\mu_i$  represents the differences from this mean for the  $i$ -th firm. The stochastic term  $v_{it}$  is assumed to have a mean zero and constant variance (s. BALTAGI 1995, S.9; HSIAO 1996, S.32). This model can be estimated depending upon whether  $\mu_i$  is assumed to be random or fixed. The random-effect estimator requires that  $\mu_i$  and  $v_{it}$  and hence  $\mu_i$  and  $x_{it}$  be uncorrelated. We checked the appropriateness of this specification (for all products) using a HAUSMANN (1978) test. The statistics suggested links between  $\mu_i$  and  $x_{it}$  and we rejected the null hypothesis for all products. Consequently, a fixed effect regression was fitted. The results are shown in table 2.

Table 2 provides evidence that private ownership increases allocative efficiency by reducing a firm's cost. However, the effect depends on the privatisation method: **Indirect Privatisation** seems to reduce the firm's specific costs, and hence, allows c. p. lower output prices. The coefficient estimated for this variable is negative and highly significant for all investigated products. **Direct Privatisation** is also found to be associated with an decrease of firm's specific output prices. In most cases the results are significant at a relatively high significance level. In opposite to this, private ownership due to **Mass Privatisation** exhibits no clear effects on the firms' product prices. Overall, the findings confirm our expectation of costs asymmetries due to disparities in the governance structures, access to capital and human recourses, etc. after implementing one of the privatisation strategies.

We argued that firms which are affiliated with a capital group and which possess an export licence to the EU have higher fixed costs than the average firm. Generally, these results support our view. We found the variable **Affiliation with a capital group** to have a positive effect for almost all highly processed pork products on a relatively high significance level. In

addition, the signs of the significant coefficients of the variable **Possession of an export licence** complies with expectation.

**Table 2: Estimated coefficients and standard errors: Fixed Effect Model**

Final products		Pork chop	Pork shoulder	Hard cured sausage	Frankfurter	Cooked ham	Cured loin
<b>adj. R<sup>2</sup></b>		0.41	0.46	0.42	0.54	0.46	0.47
<b>F-Statistic</b>		96.7 [10,1172]	121.4 [10,1172]	93.8 [10,1033]	163.4 [10,1172]	120.9 [10,1172]	116.9 [10,1064]
Costs asymmetries	Indirect privatisation	-0.025*** (0.007)	-0.020** (0.009)	-0.022** (0.010)	-0.028** (0.011)	-0.038*** (0.008)	-0.039*** (0.009)
	Direct privatisation	-0.003 (0.009)	-0.037*** (0.013)	-0.039*** (0.015)	-0.048*** (0.013)	-0.018** (0.009)	-0.070*** (0.011)
	Mass privatisation	0.022** (0.009)	0.009 (0.008)	-0.012* (0.007)	-0.025*** (0.009)	-0.001 (0.007)	0.003 (0.007)
	Affiliation with a capital group	0.005 (0.008)	-0.018 (0.012)	0.039*** (0.010)	-0.034*** (0.013)	0.016** (0.008)	0.041*** (0.011)
	Possession of an export licence	0.009 (0.009)	-0.008 (0.013)	0.021* (0.012)	0.032** (0.013)	-0.007 (0.009)	0.032*** (0.010)
	Factor prices/ hog procurement prices	0.080*** (0.029)	0.167*** (0.054)	0.074 0.046	-0.062 (0.104)	0.149** (0.073)	0.039** (0.018)
	Local supply of raw materials	0.044 (0.062)	0.049 (0.089)	0.232*** (0.082)	0.198** (0.090)	0.159*** (0.063)	0.291*** (0.073)
Intensity of competition	Regional market power	0.032*** (0.015)	0.049** (0.022)	0.022 (0.020)	0.034* (0.020)	-0.015 (0.014)	-0.014 (0.016)
	Regional demand	-0.062** (0.031)	-0.131*** (0.045)	0.003 (0.041)	-0.012 (0.046)	-0.002 (0.032)	-0.073* (0.037)
	Competitor's costs of labor	0.002 (0.008)	0.023* (0.012)	0.001 (0.012)	0.031*** (0.012)	0.013* (0.007)	0.009 (0.010)

Note: \*\*\* Significant at the 1% level, \*\* Significant at the 5% level Significant at the 10% level. Values in round brackets denote standard deviation. The values in square brackets denotes degrees of freedom.

Source: own computations on the base of PISiPAR- Database (1998), GUS (various issues a, b, c) and BOSS (1998, 1999).

Finally, as expected, the importance of the internal quality of purchased inputs and hence their prices vary according to the internal attributes of the final product: An increase in **hog procurement prices** significantly raises the output prices for fresh products (pork chop and pork shoulder) and for highly processed meat products with a high share of raw materials (ham and loin). The coefficients estimated for pork and for ham/loin are positive and significantly different from zero at the 1% and 5% level, respectively. Since the production of sausages is a process that inherently leads to a wide range of slightly modified final products, it is not surprising that we found no correlation between the input and output prices.

The intention of the variable **Local supply of raw materials** was to assess empirically which of the counteracting effects (transaction costs of hog procurement versus specialisation on high quality animals in the region) dominates. The coefficients estimated for all processed

meat products is positive and highly significant. It suggests that for these products the quality effect of inputs dominates. However, higher quality is rewarded with higher prices only in the case of highly processed pork products with a large share of raw materials (ham, loin). In regions which are specialised on high quality animals, backward integration may allow the firm to obtain specialised inputs through which it may improve or at least distinguish its final products by price differentiation (regional origin). This could partly explain the significant parameter by **Local supply of raw materials** accompanied by insignificant coefficients by the variable **Factor prices** by sausages.

In principle, the influence of the variable **Regional demand** corresponds to the theoretical findings. The variable was found to be significantly negative for fresh pig meat. The prices of highly processed pork products seem to be not affected by regional demand. Estimated coefficients of the variable **Regional market power** were in general positive and significant for low processed goods. This means that in this market segment a dominant firm may use its position to charge a markup.<sup>18</sup> In contrast, market-power-based price differences seem to be generally unimportant for processed meat products. The general development of wholesale and retail, increasing scales and shares of supermarket stores and a higher durability of highly processed meat products may better the market integration (between regions), and hence counterbalance the regional market power of the dominante firms. These findings correspond basically with the conclusions regarding the variable regional demand, and underline the statements about a low integration degree of the markets for fresh meat.

The theory suggested a positive relationship between the i-th firm's price and the **Competitors' Costs**. This relationship is principally confirmed by the estimates. However, the significance level of the estimated coefficients is relatively low and refers to only a half of the products. It can be concluded that this variable, which reflects average labour productivity of the rivals do not capture all relevant cost/productivity asymmetries between the firms. Other possible interpretation of these results is that firms which we assume to be potential competitors, do not stay in a direct rivalry: On the one hand the analysis focused on the largest firms in the meat processing industry, which were considered to dominate the polish market and hence to be able to influence prices. On the other hand the investigated firms covered only a part of the meat processing establishments and are distributed all over the national market.

**Table 3: Characteristic of the estimated fixed effects**

	Average	Variance
Pork chop	0.99487	0.00231
Pig shoulder	0.96442	0.00518
Hard cured sausage	0.88772	0.00404
Frankfurter	1.02447	0.00662
Cocked ham	0.86449	0.00274
Cured loin	1.04301	0.00425

Source: own computations.

<sup>18</sup> Due to limited storage possibilities of fresh meat, the existence of assured market is important to the processors. Because of some shortages in this area on the polish market the suppliers of perishable products prefers to sell their products through its own wholesale and retail distribution system or to distribute the products on the local markets to reduce the time /risk/ of transportation. It is likely, that this prevent a local dominating firms to entry other /distant/ regional market for fresh meat.

Selected statistics of the fixed effects are presented in table 3. The coefficients are positive for all enterprises and for all products and significantly different from zero at the 1% level. The average ranges between 0.864 for cooked ham and 1.043 for cured loin. According to the model outlined in chapter 3, the fixed effects depend on the number of firms and the degree of product differentiation. Hence, the dissimilar and highly significant firm specific intercepts indicate that product differentiation is important and that firms are differently suited to make use of this policy. This means, that the firms are differently positioned to benefit from special recipes, brand figures, or informative labelling. It can be assumed that there are further factors like differences in capital costs, vintage of equipment, as well as management quality and efficiency which play a predominant role in explaining the variation of the fixed effects. However, it would go beyond the power of the model to explain all variations by product differentiation.

The estimates presented so far confirmed the hypothesis mentioned above. However, when we take a look at the  $R^2$  we see that we were only able to explain a small part of the price variations. Because we used a fixed-effect estimator which removes between-firms variance from the error-term, our adjustment regarding within-firms variance is very small. Neglecting the variance absorbed by the fixed effects provides that on the average not more than 10% of the total price variation can be explained by the considered exogenous variables. This means that besides horizontal differentiation, prices are affected by other determinants. These include long run affect as well as complementary firm policies like vertical product differentiation and price discrimination.

Long run effects manifest themselves in investment behaviour and decisions on market entry and exits. In those areas where profits are high, we can expect market entry, thus the number of firms has to be endogenous in the model and the estimation. That long effects are important is already revealed by the regression results for **Regional demand**.

The influence of vertical product differentiation may be to some extent captured in the equation that explain prices of fresh meat, especially in the high price segment. In this market it is important for a firm, to attract and keep consumers by providing constantly high quality. Charging the same price for a low quality good would destroy consumers confidence in the product and would be associated with a considerable loss of market share. However, high quality of final products requires corresponding quality of the raw materials. Since average quality of hogs is relatively low in Poland, the meat processors must provide incentives for high quality production. One mechanism would be to pay higher prices for low fat pig, like being conducted in the EU. This discussion suggests a positive relationship between costs of slaughtered pigs and the prices of the final products. However, the higher processed the products, the less important is the quality of the raw material for the internal attributes of the final goods. Especially for goods with a relative low share of pork and where the ingredients could not be identified individually – like frankfurter – it is not surprising, that the price of slaughtered pigs were found to have no significant impact on product prices. An indicator for the relevance of this argument is provided by the sign and the magnitude of the variable **Factor prices**.

Another determinant of price variation is price discrimination. This effect occurs when processors charge different prices for the same product quality. Regarding the subject under investigation, price discrimination can occur in several ways. The first are special marketing offers for a given period. Second, firms may discriminate buyers insofar as wholesalers and retailers are charged differently. A third possibility are discounts when purchasers take higher quantities than other buyers. A last possibility to be mentioned is spatial price discrimination. The latter may occur when the processors are in a poor market position and they have to bear the transport costs. Another reason is that firms react to differences in the amount of final demand and ask for higher prices when they deliver their products to highly populated areas

with high per capita income.<sup>19</sup> Because of the lack of data we could not capture these potential influences in our estimation.

## 6. CONCLUDING REMARKS

Product differentiation is a common feature of imperfectly competitive markets in food industries. Hence, in spite of the extensive theoretical literature on product differentiation, only a few quantitative analysis have been conducted on its reasons and effects both at the overall level of the agri-food market, and with respect to the individual processing firm. One of the objectives of our paper was to contribute to fill the gap between theoretical consideration and empirical analysis in industrial organisation. Since we have focused in particular on horizontal differentiation the second objective was to identify its determinants on the polish market for pig meat products.

The theoretical model generated a number of predictions with respect to the effects of asymmetries in costs between firms, market size, etc. on the output price variations. To test these hypothesis, we used a sample of firms considered to be able to influence prices on the polish market for pig meat products during the transition (1991-1998). We have chosen products, which represent three different group of categories: pig fresh meat (e.g. pork chop), and highly processed pork products with a high (e.g. ham) and a low (sausages) share of raw materials.

A fixed effect regression was fitted and a number of determinants has been identified that have influenced the output prices of the individual firms. The results of econometric analyses support our hypothesis and provide also that horizontal product differentiation is a relevant phenomenon in the market under investigation. Our analysis may appear limited due to the low explanation power of the exogenous variables. This points to a serious lack in specification as far as the aim of presenting a complete model would have been pursued. We can follow this argument in such a way that our proxy-variables are rather rough and in some cases may not be well suited to capture the effect mentioned in the discussion in chapter 4.2. However, on the other hand we argue that the low  $R^2$  is something we have expected. In the model, we have looked at horizontal price differentiation only, and, we considered mainly short run effects. Other influences concern long run effects, vertical product differentiation and price discrimination, etc. are neither covered in our model nor in the empirical application.

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<sup>19</sup> This effect should be distinguished from the effect we have estimated. The estimates consider the location of production, while our argument in this context stresses the location of the product market. Because of intraregional trade, these markets will not match perfectly.



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