No. 63

Linkages Between Marketing Levels in the German Meat Sector: A Regional Price Transmission Approach with Marketing-Cost Information*

by

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Giessen, May 2001

* The article was written while the author was at the Institute of Agricultural Policy and Market Research, University of Giessen, Senckenbergstr. 3, D-35390 Giessen, Germany. Thanks are due to Deutsche Forschungsgemeinschaft for financial support of the project "Wettbewerbsnachteile für die Landwirtschaft in der Untersuchungsregion? Theoretisches Konzept und empirische Messung" (Sonderforschungsbereich 299).

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The "Discussion Papers in Agricultural Economics" are edited by: Institut für Agrarpolitik und Marktforschung, University of Giessen, Senckenbergstr. 3, D-35390 Giessen, Germany.
Tel.: +49 (0)6 41/99-3 70 20, Fax: +49 (0)6 41/99-3 70 29.

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1 Introduction

The share of producer revenues in consumer expenditures for food has declined by 24 percentage points since 1970 and accounts nowadays for only about 26% (BMELF, 2000). One part of this reduction can be explained by the greatly increased importance of complementary goods and services in the transformation process of food. But also the growth in market power at higher stages of the market chain[1], particularly at the retail level, is suspected (AGRA-EUROPE 46/98).

The problem in analysing price relations empirically is to split the product-specific marketing margin correctly into complementary services and a supplement that can be traced back to market power. It is also difficult to assess whether there exists input substitution between agricultural raw product and other inputs across time[2]. Insufficient knowledge about the extent and variation of added services as well as the observable market structure can, therefore, easily lead to a misinterpretation of empirical results.

In view of these difficulties, the purpose of this study is to deduce a clear picture of the predominant market situation at all three marketing levels for a market segment of the German meat sector. The empirical focus is on a vertical price transmission analysis for pig meat to get evidence about the extent and speed of price transmission. The methodology of PALASKAS (1995) is chosen, because all three prices under consideration are integrated of order one, but the methodology is extended in four important points. First, the wholesale level is considered separately and second, a cost variable for slaughtering is implemented. Third, single farm data are used and not the usual aggregated data for producer prices at the wholesale level. Fourth,

[1] GOHIN/GUYOMARD (1998) calculated that on the French market prices for meat products are 21% higher than they would be under perfect competition.

the causal relationships are interpreted in the sense of HOLLOWAY/HERTEL (1996) and the overall results are judged in the light of the observable market situation.

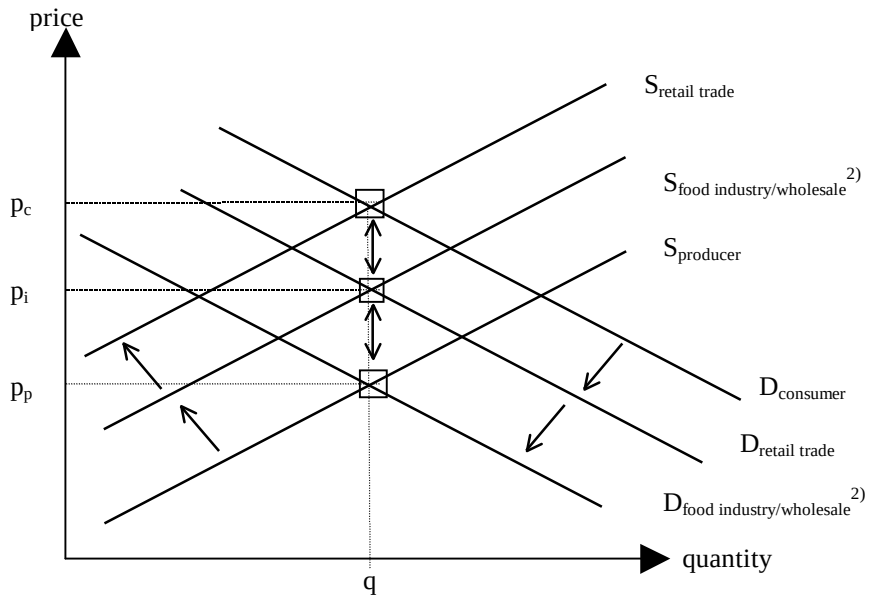
The article starts by illustrating the theoretical linkage between price transmission, competition and market power. The third section gives a brief description of the market situation in the German meat sector. A short outline of existing approaches and the methodology of the extended PALASKAS approach follows in the fourth section. In the fifth section the data are described and the empirical results are presented and discussed. The article closes with a summary of the results and concluding remarks.

2 The price structure in the market chain

Assuming perfect competition on input and output markets in the market chain, the marketing margin at each level corresponds to the respective marginal costs of complementary goods and services (APPEL, 1992). Arbitrage is then the reason why changing prices at one level, no matter at which level or from which side they are released, must be transmitted completely and within the same period to the other levels (Diagram 1). In this case the market is called efficient. But even when retaining the assumption of perfect competition, the time-consuming transformation process (harvest/slaughter, storage, transportation and transformation of the raw material) creates natural time lags and makes the supposition of contemporaneous price transmission unrealistic (KINNUCAN/FORKER, 1987). However, product-specific perishability plays an important role in this context. In an empirical model, this fact must be reflected by a suitable number of time lags. But also the definition of market efficiency must be broadened: under the condition of full information, arbitrage will ensure that price differences in related spatial and temporal markets correspond to the marketing margins (CHANG/GRIFFITH, 1998).

[2] WOHLGENANT (1998) demonstrates that, with such substitution, mark-up pricing can be shown statistically, but in this case the result should not be interpreted as market power.

Diagram 1: Pricing in perfect competition[1)]



p_c = equilibrium price at the consumer level; p_i =equilibrium price at the industry level; p_p = equilibrium price at the producer level; q = equilibrium quantity.

1) Simplified presentation.
2) Food industry and wholesale are here combined in one level. In principle, a wholesale level can be operating before and/or after the transformation process.

Source: Own presentation.

A lagged price transmission in the food sector is thus no indication of market power if it happens in a 'reasonable'[3] period of time. In contrast, information lags can lead to imperfect competition and so to long-term disturbances of price transmission. If the relevant information arrives only lagged but not distorted, one has to cope with market imperfections but not necessarily with market power. In this case, perfect and imperfect competition can only be distinguished with a model incorporating a special market-power term[4]. An extreme case of market power means that the price at one level - referring to Diagram 1 - is not formed at the intersection of the supply and demand curve, but only one curve is relevant for pricing (HOLLOWAY/HERTEL, 1996).

Another point to consider is the causal relationships between prices at different levels. In a lot

[3] Must be defined for each product.
[4] Some examples for the meat sector are to be found in AZZAM/PAGOULATOS, 1990; SCHROETER/AZZAM, 1990; MUTH/WOHLGENANT, 1999.

of studies, price transmission from the producer to the consumer level is assumed. This implies that the importance of the demand side is eliminated. HOLLOWAY/HERTEL (1996) show, nevertheless, that conclusions about the market structure can be drawn particularly from the causal relationships. Using an enlarged GARDNER model, they demonstrate that under perfectly competitive behaviour prices and quantities are determined simultaneously at each level. Under the assumption that there is an oligopoly in the retail-product market but price-taking in the farm commodity market, there is a one-way causality from the producer to the retail level. Retailers take some market parameters, among them the producer price, as given and choose their quantity decisions accordingly. Having an oligopsony in the factor market and price-taking behaviour in the product market reverses the direction of causality from retailers to producers.

3 Market structure in the German meat sector

At the moment, the retail trade in Germany is going through a very dynamic process of concentration and is turning more and more into a tight oligopoly (HERDZINA, 1999). While the Monopoly Commission classified the degree of competition in 1996/97 as 'tending to improve', FISCHLER, the Commissioner for Agriculture, suspected the opposite and asked the Consumer Commission to analyse retail pricing in detail (afz, 37/98; FAZ, 248/98). The shopping environment is changing in favour of big hypermarkets and discount shops. In 1997, only 28.5% of all consumed meat was bought in butchers' shops. The annual average consumption per person decreased to 60 kg (LZ, 41/98; LZ, 47/98). This change is being encouraged by the growing demand trend for self-service goods, which, according to the *CMA: Centrale Marketinggesellschaft der deutschen Agrarwirtschaft* will continue in future (HOFFMANN, 1997).

Small units survive longer the lower the levels of the market chain. The regional distribution of slaughterhouses in terms of their capacity varies greatly. Whereas in the north of Germany by

far the biggest plants are in use, only very small plants (<10,000t slaughter weight) exist in central Hesse. Here, approximately 50% of the slaughter is carried out by small businesses and butchers (KERN, 1994; HLRL, Statistik 96). One thing they all have in common, irrespective of their size, is the problem of unused capacity. In Germany as a whole, 40-50% of the capacity for pig slaughtering and 60% in the case of beef is not being utilised (LZ, 26/98). Apart from some large-scale enterprises the meat industry in Germany is still dominated by medium-sized businesses. However, at the moment a lot of money is being invested in adaptation of plant to changing consumer demands (BREITENACHER/TRÄGER, 1995). Simultaneously, the growing number of self-service meat providers is increasing the competition of products listed in retail stores. Altogether, this level can be characterised as oligopolistic in the centre with a large polypolistic fringe. However, agriculture is still characterised by a mainly polypolistic structure. The average farm size in Germany is 31.5 ha and 20 ha in central Hesse (PFAFF, 1998). Here, structural change is taking place at the slowest rate. One major reason is the Common Agricultural Policy, which hampers structural change.

4 Methodology

As the term 'price-transmission analysis' is very broad, a multitude of studies and methods could be cited here. The first empirical models belong to the group of static or dynamic single-equation or multi-equation *equilibrium models* (WEIß, 1995; GARDNER, 1975). A basic assumption is perfect competition at all levels in the market chain. Although mark-up pricing is mostly presumed, special tests, called *causality tests*, have been developed to establish the direction of price transmission (HEIEN, 1980). In the 1990s, a growing interest in the *New Empirical Industrial Organisation* (NEIO) changed the focus of the analysis. Thus, inclusion of pricing on imperfect markets and the question of market power came to the fore (MCCORRISTON/MORGAN/RYNER, 1998; MCCORRISTON, 1997; TRAILL/HENSON, 1994). Other authors try to model the marketing margin in order to derive explanations of price

transmission (WEI/GUBA/BURCROFF, 1998; AZZAM, 1992; SCHROETER/AZZAM, 1991). As all these models are static, dynamic NEIO-models were developed in the framework of game theory and the knowledge that rivals' reactions on oligopolisic markets create new reactions (SEXTON/LAVOIE, 1997).

The method which has been chosen for this study does not fit into any of the mentioned branches. To be able to conduct the usual statistical tests in any model sketched above, one has to assume stationarity of the data, but especially price series are often non-stationary. For this reason, the methodology of this study is based on cointegration analysis, which is specially designed to handle non-stationary data.

The variables p_t^l and p_t^k, which represent product prices at different levels of the market chain, are integrated of order one [I(1)]. First of all, one has to test whether a cointegrating regression exists to be able to get inference about price transmission between those two prices. PALASKAS (1995) uses a static cointegrating regression which, as STOCK (1987) has affirmed, gives super-consistent estimates and incorporates all dynamic elements. Nevertheless, BANERJEE et al. (1993) have shown with a Monte-Carlo study that in a substantial majority of cases the dynamic regression estimates of the long-run coefficient are more accurate than the static estimates. For this reason a dynamic cointegrating regression is used here. Another expansion of PALASKAS' work is the inclusion of a marketing variable K_t which depicts an important part of the complementary goods and services between the different levels. The dynamic and expanded cointegrating regression is indicated by equation (1):

$$(1)\quad p_t^l = a + bp_t^k + cK_t + d_i p_{t-i}^l + f_i p_{t-i}^k + u_t$$

The optimal number of time lags is determined by three information criteria: Hannan-Quinn, Final-Prediction Error and the Schwarz-Criterion. Cointegration exists if the residuum u_t is stationary, which means I(0). If the rank is not reduced, there is no statistically proven price

connection[5]. For these cointegration tests, the method of KIVIET and PHILLIPS[6] is common practice. u_t indicates the disequilibrium in period t, which is released by the incomplete reaction of price p_t^l after a change in price p_t^k.

To get the long-run price coefficient b, one has to transfer the dynamic regression into its static counterpart. This is done with the general formula (2):

(2) $a(L)y_t = b(L)x_t + \varepsilon_t$

with

(3) $y_t = \frac{b(1)}{a(1)} x_t = Kx$.

If the long-run price coefficient is unity, a perfect long-run relationship exists between the two prices. b converges not only with the normal asymptotic rate $T^{1/2}$ towards its true value, but also with rate T.

The problem in using cointegration analysis is to define proper critical test statistics, as estimates do not usually follow a limiting normal distribution. Instead, the distribution is a function of a Wiener process (BANERJEE et al., 1993).

PALASKAS, therefore, uses the maximum-likelihood three-step estimator of the cointegrated system approach to test hypotheses relating to the long-run price coefficient. These estimators have the advantage of t-ratios with limiting normal distributions. To determine the three-step estimator, the cointegrating regression is the first step; the next step is to derive the error-correction model (ECM) belonging to (1) as proposed by ENGLE and GRANGER (1987):

(4) $\Delta p_t^l = \alpha_0 + \beta\left(a - p^l - bp^k - cK\right)_{t-1} + \alpha_1 \Delta p_t^k + \alpha_2 \Delta K_t + \sum_{i=1}^{n}\left(\delta_i \Delta p_{t-i}^l + \varphi_i \Delta p_{t-i}^k\right) + \varepsilon_t$

[5] One of the theoretical implications of cointegration is that Granger-causality must exist at least in one direction. The opposite cannot be concluded (GRANGER, 1988, pp. 202-204).

[6] The test is described in BANERJEE/HENDRY, 1992.

They proved that consistent parameters with limiting normal distributions can be calculated with the derived ECM. Both steps require only ordinary least squares. The error-correction term $\beta(p^l - bp^k)_{t-1}$ evens out each disequilibrium in period t between the variables in the following period. β acquires values between -1 and 0; the closer it gets to -1, the faster the system converges to its equilibrium. The parameter α_1 is called the immediate or short-run effect.

a) Test for perfect price transmission in the long run

The hypothesis *ß = 1* must be examined. If it can not be rejected, perfect price transmission in the long run can be assumed. The third step to evolve the three-step estimator consists of the two-step estimator of *ß* and the results of the additional regression (5):

(5) $\hat{\varepsilon} = \alpha_1 + \gamma(\hat{\beta} p_{t-1}^k) + v_t$.

$\hat{\varepsilon}$ are the estimated residuals and $\hat{\beta}$ is the estimated parameter of β, both from the ECM. The three-step estimator of *b* can now be calculated:

(6) $\tilde{b} = \hat{b} + \hat{\gamma}$.

The standard deviation from (6) is the one from parameter $\hat{\gamma}$, $\hat{p}$ is the estimator of *ß* from the first step and $\hat{\gamma}$ is the estimator of γ from regression (5). The critical values for $\tilde{b}$ can be calculated with the formula:

(7) $t = (\tilde{b} - 1) / s.e.$

s.e. is the standard deviation from $\hat{\gamma}$.

b) Test for perfect price transmission in the short run

To analyse the question of perfect price transmission in the short run, the following restrictions are tested using regression (4):

(8) $-\beta = \alpha_1 = b = 1$ and

(9) $\sum_{i=1}^{n} (\delta_{1i} \Delta p_{t-i}^{k} + \Delta_{1k} p_{t-i}^{l}) = 0$

In cases where the hypothesis of perfect price transmission in the long run is rejected, restriction (8) can be replaced by restriction (10):

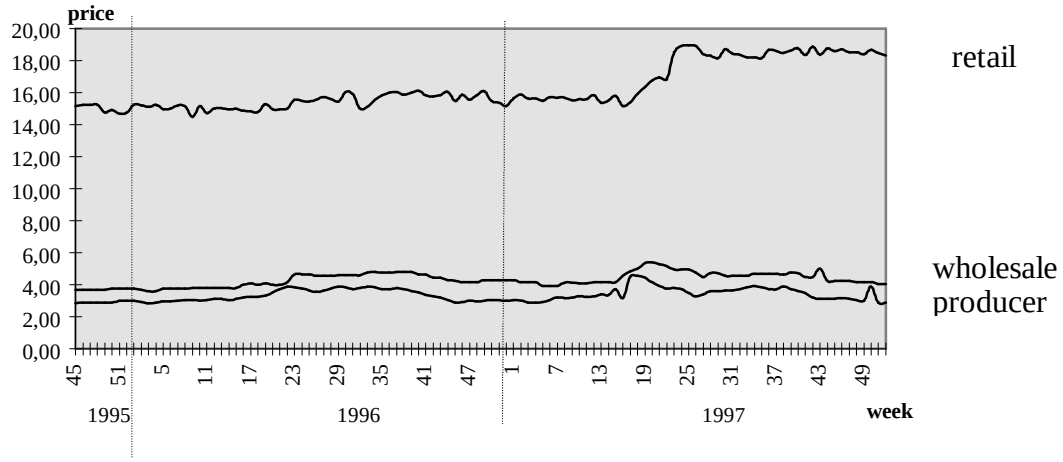
(10) $-\beta = \alpha_1 = 1$

5 Data and empirical results

The empirical analysis is based on weekly prices per kg pig meat for the time period 45/1995 to 52/1997. At the producer level, prices per kg for highest quality pigs from six slaughterhouses in Hesse are used, which reflect representatively the structure in the middle of Germany. Those prices were made available to the author by the '*Hessische Landesamt für Regionalentwicklung und Landwirtschaft (HLRL) Wetzlar*'. Because of the widespread spatial trade in cut meat, regional data for the whole of Hesse is taken for the wholesale and consumer levels. To establish the specific costs of slaughtering per pig for each plant[7] as a basis for the marketing variables, the plant directors were interviewed by telephone in the spring of 1998. Afterwards, from these statements a price series was derived using the cost-of-living index (BMELF, Stat. Monatsbericht 1/1998 and earlier issues). The price per kg at the wholesale level comes from the '*Marktbericht Hessen*', which is published by the *HLRL Kassel*. To obtain a comparable price at the consumer level, a weighted average of five pieces, which are documented by the '*Zentrale Markt- und Preisberichtstelle'* (ZMP), was derived according to the proportional share of each piece in relation to the whole animal.

[7] They consist of proportional flat rates for energy, repairs, meat inspection, cleaning, refuse disposal and wages. The different statements are only comparable to a limited extent, as especially the flat rates do not take into account the same components all the time.

Diagram 2: Weekly prices at the retail, wholesale and producer level in DM per kg



Source: Data as mentioned above.

As the marketing variable plays an important role in the empirical approach, the following table provides an overview of the ratio of the costs for slaughtering and the marketing margins.

Table 1: Ratio of respective costs and marketing margin between producer and wholesale level in per cent

	Minimum	**Maximum**	**Average**	**Standard deviation**	**Maximum without 15/16/17-97**
S1	25.2	116.9	41.3	12.4	58.8
S2	22.3	252.5	42.6	24.8	79.2
S3	37.4	219.3	66.4	25.1	93.4
S4	19.3	72.7	33.2	9.1	55.5
S5	12.3	57.6	20.6	6.8	33.7
S6	12.6	52.0	21.4	6.7	38.9

S: slaughterhouse.

Source: Own computations.

The minimum and maximum values differ greatly between the six plants as well as within the time period. In weeks 15/16 and 17/97, plants S1, S2, S3 even had to cope with a situation where stated costs exceeded the margin. If those weeks are taken out of the price series, because they seem to be exceptional, the picture gets better. S5 and S6 achieve by far the best results. One thing which has to be borne in mind is that not all the costs - e.g. capital costs - are incorporated in the cost variable, so total costs exceed the costs specified here. The first impression concerning the market situation is somewhat indistinct. The plants do not seem to operate competitively (there is no visible fixed or proportional mark-up reflecting the costs),

but they do not react in an oligopolistic way either (at least some plants have only limited power to fix their price).

The results of the price transmission analysis are demonstrated in Table 2[8]. All variables are in logarithms, as the misspecification tests indicated a better performance.

Table 2: Results of the price transmission (PT) analysis

	b	$\tilde{b}$	t [1)]	**perfect PT in the long run**	α_1	**Perfect PT in the short run**	**ß**
G←S1	0.860	0.761	2.47	no	0.114[a]	no	-0.166[c]
G←S2[2)]	0.980	0.874	0.869	yes	0.138[b]	no	-0.114[b]
G←S3	0.846	0.793	2.152	no	0.061[b]	no	-0.174[c]
G←S4[3)]	1.188	1.231	1.464	no	0.254[c]	no	-0.096[c]
G←S5	0.869	0.737	2.256	no	0.052	no	-0.133[c]
G←S6	0.875	0.758	2.475	no	0.005	no	-0.159 [c]
V⇔G	no cointegration						

S: single slaughterhouse; G: wholesale level; V: consumer level.
a. significant at the 95% level, b: significant at the 99% level, c: significant at the 99.9% level.
1) $t = (\tilde{b} - 1) / s.e.$
2) Cointegrating regression without cost variable, otherwise no cointegration.
3) Cointegrating regression without cost variable and without constant term, otherwise no cointegration.
Source: Own computations with PcGive 9.0.

First of all, the existence of a cointegrating regression between the producer and the wholesale level confirms an equilibrium in the long run, but only in the case of mark-up pricing. For all plants, two time lags in the dynamic specification are optimal. All models, with the exception of S2, reject perfect price transmission both in the long run and in the short run. The three-step estimator $\tilde{b}$ takes, with one exception, values smaller than unity and lies in the narrow range between 0.73 and 0.87. This implies that between 73% and 87% of the producer price is transmitted to the wholesale price. However, the system approaches its equilibrium quite slowly, as can be seen from the error-correction term ß. This impression is corroborated by α_1,

[8] The empirical data do not support the assumption that agricultural raw material and other input costs sum up additively to marketing costs. Rather, marketing costs seem to be calculated as an irregular percentage surcharge on agricultural raw material costs. Therefore the hypothesis for perfect price transmission is specified to equal 1 and not to equal the share of agricultural raw materials in the wholesalers' cost function.

the parameter which identifies price transmission in the short run. From one week to the next, only a price change of between 0.5% and 25.4% is transmitted. Both α_1 and ß are highly significant for the most part.

According to HOLLOWAY/HERTEL, mark-up pricing is a sign of price-taking in the farm commodity market and an oligopsony at higher levels of the market chain. The observable market structure, described in Section 3, indicates a rather polypolistic structure. The results of Table 1 do not really help to decide which situation is more plausible. Both results can be explained and make sense, but only - as will now be shown - when they are seen and interpreted within the framework of the whole market chain.

The cointegration test rejects a relationship between the wholesale and the consumer levels in either direction. This means, as cointegration is the necessary condition for the second and third step, the price transmission analysis cannot be continued. No price relationship at all is theoretically not possible, because exactly the same product is traded at both levels. Probably for this reason, HOLLOWAY/HERTEL do not consider the case of no relationship. The only explanation that makes sense is that retailers, when fixing their price, judge other parameters to be more important than the wholesale price. So, without detailed data about those other parameters, for instance wages or prices of substitutes, the empirical analysis cannot be restarted. Regarding the wholesale price as of minor importance, together with the information of a high concentration rate at the retail level, leads to the very likely conclusion that retailers operate with market power. In this situation where retailers exercise market power, wholesalers might have the function of a buffer between producers and retailers. With this function they have to keep their prices more or less stable for the retailers, e.g. by having special contracts. On the other hand, slaughterhouses in Hesse are small and compete for live animals. Consequently, they are forced to act competitively towards each other and towards

the farmers. This would explain why the empirical results indicate an oligopsony at the wholesale product market whereas the observable structure is fairly competitive.

6 Conclusions

The objective of this study was to establish distinct information about the relationship between the producer, wholesale and retail levels for the Hesse meat sector. Awareness of the difficulty in assessing correctly the magnitude of complementary goods and services in empirical models led to a different approach in analysing vertical price transmission. Though not yet standard in empirical analysis because of difficulties in testing hypotheses, cointegration analysis was chosen as the empirical methodology. It is still very common to use the asymptotic theory for integrated data series as well, thus risking the danger of getting spurious regressions and inferring wrong interpretations. The framework of PALASKAS (1995) has been used and extended in four directions. First, a dynamic cointegrating regression was constructed to derive the static long-run parameter. As shown in Section 2, time-lags are a natural consequence of the transformation process and do not necessarily indicate a lack of competition. Second and third, a wholesale level and a cost variable reflecting marketing costs at the wholesale level have been implemented in the regressions. Instead of aggregated data, data at farm level for producer prices and costs of slaughtering at the wholesale level have been used. This has the advantage of minimising the black-box share of the marketing margin between the producer and wholesale levels. And fourth, causal relationships have been interpreted as additional indicators for the market situation.

The results of the empirical price transmission analysis are clear: though an equilibrium exists in the long run, the hypothesis of perfect price transmission in both the long and the short run must be rejected for the producer - wholesale levels. No statistical relationship can be proved for the wholesale - retail level. Taking the observable market structure into account, it seems that the wholesale level has to act like a buffer between the producer and the retail levels. The

linkage between farmers and slaughterhouses would be quite competitive without the influence of the retail level. But retailers' market power forces the slaughterhouses to act sometimes oligopsonistically.

This research applies only to a small area in Germany and the conclusions are not valid for Germany in its entirety. But since there are very different structures at the producer and the wholesale levels throughout Germany, especially in the meat sector, working with disaggregated data seems to be an interesting approach. In particular, it has the advantage of minimising faults arising from complementary goods and services. Further research would benefit from comparable analyses covering other areas. It would also be beneficial to construct a marketing variable for the wholesale-retail levels in the same detail as for the producer-wholesale levels.

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