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Buyer Power and Product Innovation:
Empirical Evidence from the German Food Sector[1]

Christoph R. Weiss and Antje Wittkopp

Abstract: Substantial increases in retail concentration (particularly in Europe) raise concerns about the welfare implications for consumers. In a formal model, we argue that retailer market power reduces upstream firms incentives to introduce new products. On the basis of a survey of firms in German food manufacturing, the results of a negative binomial regression model supports the proposition of a detrimental effect of retailer market power on product innovations. This effect is mitigated if manufacturing firms also have some market power (countervailing power). Innovations are positively related to firm's market share in food manufacturing.

Keywords: Retailer market power, product innovation, food manufacturing

JEL-Code: L1, O31, L66

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1. Introduction

The last couple of decades have seen an increased retail concentration around the world, particularly in Europe. In 1992, the top ten grocers in Europe accounted for 27.8 per cent of the market, but for 36.2 per cent only five years later (Clarke, et al., 2002). Views on the welfare implications of this severe change are controversial. Consumers might benefit because larger stores (owned by larger retailer chains) offer more product choices under more convenient conditions. Further, they could use their buying power to obtain lower prices from suppliers which could then be passed on to consumers. On the other hand, there is concern that powerful retailers might exert their market power in the product market and raise consumer prices. In addition, it has repeatedly been hypothesized that buyer power may force manufacturers "to reduce investment in new products or product improvements, advertising and brand building" (EC, 1999, p.4). Similarly, a recent FTC report suggests that consumers "could be adversely affected by the exercise of buyer power in the long run, if prices to suppliers are reduced below the competitive level and if the suppliers respond by under-investing in innovation or production" (FTC, 2000, p. 57 and Footnote 190).

This paper focuses on the last issue and aims at analysing whether buyer power affects upstream incentives to invest in product innovation. Particular emphasis will be given to the food sector for three reasons. Firstly, as Clarke et al. (2002) emphasize, among all areas of retailing, food retailing stands out to have experienced the most significant changes in market structure during the last decades. Secondly, because of the size and importance of food retailing, these changes will have the greatest impact on consumers. Finally, the food sector is particularly interesting because of the large number of innovations per year. According to Madakom (2001) 32.478 new products have been introduced into the German food market in year 2000, whereas innovative activity is heterogeneously among food industry sectors.

The paper is organized as follows. We discuss the relationship between buyer power and innovation incentives in a theoretical model in Section 2. Data and the empirical evidence is reported in Section 3. Section 4 summarizes and concludes.

2. The model

The impact of retailer power on the rate of product innovation in manufacturing can most easily be investigated in a model based on Sullivan (1997). The author develops a model of product innovation in a vertically related market by investigating separately the behaviour of retailers and manufacturers. In the following, we do not discuss the full model in detail but focus on retailers only and modify Sullivan's model by introducing imperfect competition.

We assume retailers to act competitively on the product market but to have monopsonistic power with respect to input markets (manufacturers). The retailer's problem is to decide how many new products to accept (X) from manufacturers and to determine the quantity of each product (q) and thus the total store quantity ($Q = qX$). In period t, the retailer decides to take X_t new products without knowing, whether or not this product will be successful in the market. If the product is successful, it can be sold for two periods, if it is not successful, it can only be sold in the first period but will not be accepted by consumers in the second period. The fraction of successful products, ρ, is treated as deterministic. The total number of products offered by a retailer in period t thus is, $X_t^T = \rho X_{t-1} + X_t$ but only $\hat{X}_t = \rho(X_{t-1} + X_t)$ are products attractive to consumers. If the retailer offers a large number of attractive products, consumers are willing to pay a higher price for products at a store. Formally, consumer demand is represented by the inverse demand function $P(\hat{X})$, with $P_{\hat{X}} > 0$ and $P_{\hat{X}\hat{X}} < 0$, where $P_{\hat{X}}$ and $P_{\hat{X}\hat{X}}$ represent the first and second derivative of $P(\hat{X})$, respectively.[2]

A retailer faces two sorts of costs: operating costs K and costs associated with purchasing the product from the manufacturer W. Operating costs are increasing in the number of new products accepted as well as in the total store quantity: $K_X > 0, K_Q > 0, K_{XX} > 0, K_{QQ} > 0$.[3]

Due to monopsonistic market power, input prices are not given but vary with the quantity of products purchased: $W_Q > 0$.

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2 Shopping at a store with a small number of products increases the chance that one of the desired products is not available, in which case the consumer must either buy a less-than-optimal brand or visit another store. Offering a larger number of products may further satisfy consumer's taste for variety. $P_{\hat{X}\hat{X}} < 0$ implies that the reduction in search costs from an additional product is declining in the number of products. Note that the probability that an additional product will be in the consumer's optimal bundle is smaller when the number of products is large. Secondly, adding another products to a fixed amount of shelf space makes it more difficult for a consumer to find the product in the store ("in store search costs").

3 When many new products are added to the store, it is more difficult to rearrange the shelves and manage additional products, which implies $K_{XX} > 0$.

The retailers profit function for the two periods t and t+1 is:

$$\pi = [P(\hat{X}_t) - W_t(Q_t)] - K(X_t, Q_t) + [P(\hat{X}_{t+1}) - W_{t+1}(Q_{t+1})] - K(X_{t+1}, Q_{t+1}) \qquad (1)$$

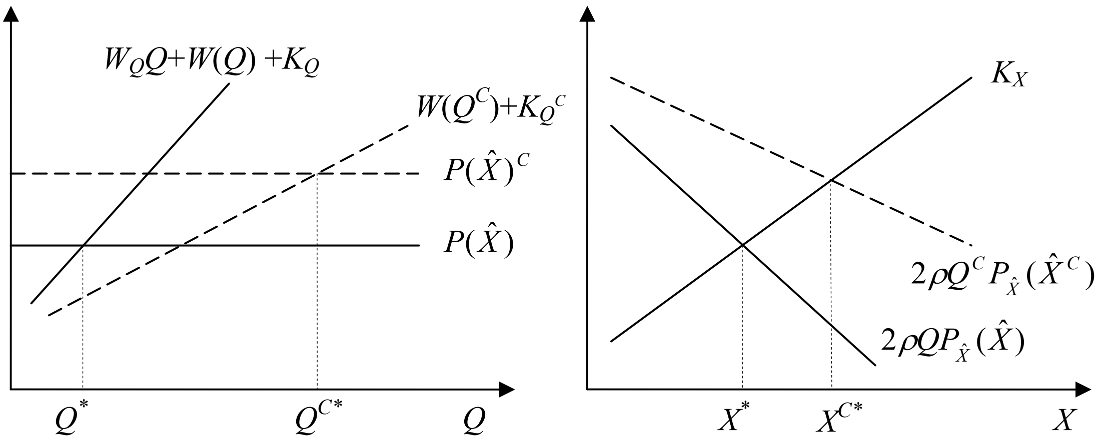
Profit maximisation implies choosing X and Q such that the following first order conditions must be satisfied:

$$\frac{\partial \pi}{\partial X_t} = \rho Q_t P_{\hat{X}}(\hat{X}) - K_X + \rho Q_{t+1} P_{\hat{X}}(\hat{X}_{t+1}) = 0 \qquad (2)$$

$$\frac{\partial \pi}{\partial Q_t} = P(\hat{X}_t) - W_{Q_t} Q_t - W_t(Q_t) - K_Q = 0 \qquad (3)$$

The following diagram illustrates this choice of X and Q in a steady state situation ($\hat{X}_t = \hat{X}_{t+1},\quad Q_t = Q_{t+1}$).

Diagram 1: The retailer's optimal X and Q



With respect to the total store quantity, the retailer will choose Q such that output price $P(\hat{X})$ equals total marginal costs. Total marginal costs include marginal operation costs K_Q as well as marginal costs associated with purchasing products from manufacturers ($W_Q Q + W(Q)$). Similarly, the optimal number of products chosen is also determined by the intersection of marginal costs K_X and marginal revenue ($2\rho Q P_{\hat{X}}(\hat{X})$). The marginal revenue curve is downward sloping since $P_{\hat{X}\hat{X}} < 0$.

Diagram 1 also allows to compare Q^* and X^* with a situation where the retailer does not have monopsonistic power (Q^{C*} and X^{C*}). In a competitive market, the marginal costs of total store quantity will be lower (since $W_Q = 0$) which increases the optimal quantity ($Q^{C*} > Q^*$). An increase in Q shifts the marginal revenue curve in the second part of diagram 1, which again raises the optimal number of products ($X^{C*} > X^*$). This process in reinforced by the fact that an increase in X further raises the consumers willingness to pay ($P(\hat{X})^C > P(\hat{X})$).

Modelling the manufacturer's behaviour does not add anything important to the model. We can conclude that retailer market power reduces the demand for new products compared to a competitive retailer market. The basic argument is that concentration among buyers leads to a strategic reduction in purchases with the aim of reducing prices. This lowers manufacturers profits and reduces incentives for product innovation.[4]

Increasing unit costs are the primary source of buyer power in this model. Additional arguments supporting a relationship between buyer power and suppliers profits and innovation have been suggested. Katz (1987) stresses that larger buyers can more credibly threaten to integrate backwards thereby exerting more pressure on a supplier. Scherer and Ross (1990) argue that a large buyer's purchasing order is more likely to break up potential collusion between suppliers. Within the framework of bilateral negotiations between suppliers and downstream firms, Inderst and Wey (2002) consider a large buyer's ability of threatening to withdraw his demand. If negotiations fails, suppliers with a fixed capacity in the short run will have difficulties in selling their output. Finally, market power of downstream firms might also allow them to force upstream firms into contractual arrangements such as signing exclusive supply contracts. Stefanides (1997) has shown that these contracts will reduce upstream innovation in that the foreclosed suppliers incur the disadvantages of low-scale production and are discouraged from innovating. These effects, although not explicitly integrated in the formal model, will have to be considered when interpreting the results of the following empirical model.

3. Data and Empirical Evidence

In spring 2002 we conducted a survey among food industry firms in Germany. Aim was to consider the companies' competitive environment as well as the determinants of their innovation activities. Special attention was given to changes in retailers' market power and its influence on manufacturers' product innovative activity. According to convention of Eurostat and OECD (1997) product innovation is defined as new or noticeably improved products the company has introduced within the last three years, thus it is not necessarily a radical innovation.

We mailed questionnaires to 539 companies in food manufacturing listed in the „Presse-Taschenbuch Ernährung", a handbook on food industry which is published by the Federation

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4 For a recent summary of the empirical literature linking market concentration to buyer and supplier profitability see Ellison and Snyder (2001).

of German Food and Drink Industries (BVE). From the 539 questionnaires, 119 (22 %) were returned. For further analysis only 87 questionnaires could be used due to missing data. Dataset consists of companies of all sectors of food industry, federal states and size categories. The majority of respondents belong to bakery, meat processing, brewery and dairy sector. Least companies are from malthouse, condiments or sugar industry. Most of the respondents are small- and medium-sized companies (66 per cent), however firm size ranges from 3 persons employed up to 8500. Thus, sample is a good representation of the German food industry.

As endogenous variable and indicator for innovative activity we use the number of new products (*NNP*) the companies' have introduced into the market within the period 1999 to 2001. The definition and descriptive statistics of all variables used is reported in Table 1.

Table 1: Definition and descriptive statistics of variables used

	Mean (Std.Dev.)	Minimum Maximum
Number of new products introduced between 1999 and 2001 (*NNP*)	13.057 (18.490)	0 120
Number of products in the product assortment in 2001 (*#PROD*)	226.873 476.248	1 3,500
Retailer market power (RMP). Respondents were asked to evaluate retailers' pricing pressure on a scale from 1 (very low) to 5 (very high).	3.471 (1.150)	1 5
Market share of the firm in its primary product market in 2001 (*MAS*).	3.161 (1.430)	1 5
Dummy variable for the degree of competition in food manufacturing (*COMP*). Respondents were asked to rank the degree of competition in their own industry on a scale from 1 (very low) to 5 (very high). The dummy variable is set equal to 1 if the respondent characterizes competition to be high or very high and is 0 otherwise.	0.195 (0.399)	0 1
Advertising to sales ratio (ASR). Respondents were asked to classify firm's advertising to sales ratio on the following scale: (1) if ratio is < 1 %; (2) if ratio is between 1 and <2.5%; (3) if ratio is between 2.5 and <5% (4) if ratio is between 5 and <7.5 %; (5) if ratio is between 7.5 and <10%; (6) if ratio is between 10 and <12.5%; (7) if ratio is between 12.5 and <15%; (8) if ratio is ≥ 15%.	2.943 (1.673)	1 8
Ratio of expenditures for R&D in total sales (R&D). Respondents were asked to classify firm's ratio of R&D to sales on the following scale: (0) if ratio is 0; (1) if ratio is between 0 and <0.25%; (2) if ratio is between 0.25 and <0.5% (3) if ratio is between 0.5 and <0.75 %; (4) if ratio is between 0.75 and <1%; (5) if ratio is between 1 and <1.5%; (6) if ratio is between 1.5 and <2%; (7) if ratio is ≥ 2%.	2.241 (1.941)	0 7

Share of exports in total sales (*EXP*) * 100.	10.205 (13.564)	0 74
Size class of firm sales (*SIZE*). Respondents were asked to classify firm sales on the following scale: (1) if sales are < 1 Mio. €/year (2) if sales are between 1 and < 5 Mio. €/year; (3) if sales are between 5 and < 25 Mio. €/year; (4) if sales are between 25 and < 50 Mio. €/year; (5) if sales are between 50 and < 100 Mio. €/year; (6) if sales are between 100 and < 250 Mio. €/year; (7) if sales are between 250 and < 500 Mio. €/year; (8) if sales are ≥ 500 Mio. €/year	4.172 (1.838)	1 8
Market growth (*GROWTH*) * 100. Average growth rate of industry real sales between 1995 and 1999.	8.664 (35.543)	-39.027 154.089

Given the specific nature of our dependent variable (non-negative, discrete observations), count data models will be used for estimation purposes. The bench-mark model for count data, the Poisson regression model, specifies that y_i is drawn from a Poisson distribution with parameter λ_i, which is related to regressors $\boldsymbol{x_i}$: $\Pr(Y = y_i|\mathbf{x}_i) = \frac{e^{-\lambda_i}\lambda_i^{y_i}}{y_i!}$ where $\ln \lambda_i = \mathbf{x}_\mathbf{i}'\beta_i$.[5] The expected number of events per time period (innovations within the three-year-period) is given by $E[y_i|\mathbf{x_i}] = Var[y_i|\mathbf{x_i}] = \lambda_i = e^{\mathbf{x_i}'\beta_i}$. This implicit assumed equality of the conditional mean and variance functions ($E[y_i|\mathbf{x_i}] = Var[y_i|\mathbf{x_i}]$) in the Poisson model (Poisson assumption) is typically taken to be the major shortcoming of this methods. Cameron and Trivedi (1990) have suggested a number of tests to evaluate, whether the Poisson assumption has to be rejected on the basis of the available data (tests for over- or underdispersion). In cases where the H_0-hypothesis of no over- or underdispersion has to be rejected, the most commonly used alternative to the Poisson model is the Negative Binomial model. The results of the Poisson– and the Negative Binomial Regression Model for analysing the innovation activities of 87 enterprises in German food industry in 2002 are reported in Table 2.

[5] An extensive recent survey of specification and estimation of models of counts is available in Winkelmann (2000)

Table 2: Regression results of the Poisson- and the Negative Binomial Regression Model

Explanatory Variables	Symbol	Parameter	(t-value)	Parameter	(t-value)
		Poisson Model [1]		*Neg. Bin. Model* [2]	
Constant		2.4401	(16.244)***	1.6611	(2.791)***
Number of Products	*#PROD*	0.0006	(12.026)***	0.0009	(2.613)*
Retailer Market Power	*RMP*	-0.3665	(-11.979)***	-0.2668	(-2.311)**
Market Share	*MAS*	0.2513	(10.265)***	0.3076	(3.687)***
Competitive Pressure	*COMP*	-0.0192	(-0.211)	-0.0874	(-0.232)
Advertising to Sales Ratio	*ASR*	-0.1065	(-5.206)***	-0.0468	(-0.645)
R&D Share	*R&D*	0.2048	(12.989)***	0.1986	(2.708)***
Export Ratio	*EXP*	-0.0225	(-7.648)***	-0.0194	(-1.684)*
Firm Size	*SIZE*	0.0751	(3.912)***	0.0615	(0.620)
Market Growth	*GROWTH*	-0.0106	(-10.596)***	-0.0036	(-0.771)
Dispersion Parameter	*ALPHA*			0.7809	(5.301)***
Log Likelihood Function	LL(β)	-560.5233		-285.8627	
Restr. Log Likelih. Funct.	LL(0)	-912.0861		-560.5233	
Likelihood Ratio Test	LRT (DF)	703.1256 (9)		549.3214 (1)	
Deviance	G^2	819.0054			
R^2 Cameron /Windmeijer	R^2_D	0.4619			
Overdispersion Test 1	t_1	12.4911			
Overdispersion Test 2	t_2	0.8721			

Remarks: ** significance level = 1%; * significance level = 5%; LL(β) (and LL(0)) are the log of the (restricted) likelihood function. DF refers to the degrees of freedom. Deviance is defined as $G^2 = 2\sum_{i=1}^{n} y_i \ln(y_i / \hat{\lambda}_i)$. The calculation of R^2_D is described in detail in Cameron and Windmeijer (1993) and the overdispersion tests 1 and 2 are reported in Cameron and Trivedi (1990).

Column [1] reports the results of the Poisson model. The t-tests of overdispersion (Cameron and Trivedi, 1990) however clearly reject the assumption of equality of the conditional mean and variance functions in the Poisson model. The negative binomial regression model in column [2] has an additional parameter to estimate, which accounts for any difference in the conditional mean and variance functions $Var[y_i|\mathbf{x_i}] = E[y_i|\mathbf{x_i}](1+\alpha E[y_i|\mathbf{x_i}])$. The parameter α in column [2] is positive and significantly different from zero suggesting some degree of overdispersion, the variance exceeds the mean. The following discussion thus refers to the results reported in column [2] on the basis of the Negative Binomial Model.

Table 2 suggests a positive and significant impact of firm's assortment size on new product introductions. With a larger number of products (*#PROD*) in a firm's assortment, the necessity to replace specific (old) products in a given time period with new products increases.

Study's main attention is to investigate the impact of German food retailer's market power on product innovations. Therefore we asked interviewed companies to give an evaluation of the retailers' pricing pressure on a scale from 1 (retailer pricing pressure is very low) to 5 (retailer pricing pressure is very high). Nearly two-third of the respondents (32.18 per cent) affirm that retailer pricing pressure is high and very high, only 10.35 per cent report retailer pricing pressure to be low and very low. The theoretical model described in section 2 suggests a negative relationship between retailer market power and innovation activity in the upstream industry. The present study actually reveals an innovation reducing effect, which implies that retailers' market power impedes new product introductions. The parameter estimate of *RMP* is negative and significantly different from zero at the 5%-level.

Is this negative impact of market power in the downstream market mitigated if manufacturing firms also are concentrated and powerful (countervailing power)? According to Neo-Schumpeter-hypothesis II, there is a high innovative potential of powerful firms because these firms a) have sufficient financial resources and accumulation of human capital, b) can realize economies of scale in producing innovations as well as c) have a strong incentive to establish market barriers to entry due to product innovation ('efficiency effect'). Conversely it can be argued that firms with low market power undertake innovation to withstand the pressure of competition and "steal consumers" from competitors. Increasing competitive intensity forces to react quickly in order to remain competitive whereas firms with market power deter from product innovation since the new product would partially "steal consumers" from their own (profitable) old product ('replacement effect'). Finally, a number of authors argue, that innovation is discouraged by both, too much or too little competition, and occurs when the degree of competition in an industry is in an intermediate range (Kantzenbach, 1966; Raider, 1998; Baldwin et al., 2002; Dubey and Wu, 2002). The existing empirical literature reports mixed results. Whereas Gayle (2001) as well as Cabagnols and Le Bas (2002) find a positive relationship, Acs and Audretsch (1990), Geroski (1994), Röder et al. (2000) as well as

Gottschalk and Janz (2001) suggest a negative relationship between different measures of market power and innovative activity.

This study uses different proxies for firm's market power. Table 2 suggests that firms with a large market share (*MAS*) report significantly higher numbers of product innovations, the parameter estimate of *MAS* is positive and significantly different from zero. Firms have also been asked to evaluate the "degree of competition" in their primary product market. Again, firm's response patterns are indicated from 1 (intensity of competition in industry is very low) to 5 (intensity of competition in industry is very high). For those firms reporting a high and very high intensity of competition (19.54 per cent), a dummy variable (*COMP*) is set equal to 1. Including this variable, however, does not contribute to the explanatory power of the model. No significant relationship can further be observed between a variable indicating the existence of predatory pricing strategies or 'price wars' and innovation. We finally matched our data set with industry data to introduce aggregate (industry) concentration ratios as proxies for market structure. No significant effect of aggregate concentration ratios on the number of product innovations can be observed. Summarizing, there is al least some evidence in favour of the argument that product innovations are more frequent in firms with a larger market share. Their market power restrains the negative effect of retailer market power.

Similar arguments have also been suggested with respect to the impact of entry barriers on innovation activities. Marketing activities can act as a barrier to entry as the potential entrant has to incur higher marketing expenditures than the established firm to convince the customer to buy his product instead of the incumbent's product. In Table 2, the advertising to sales ratio (*ASR*) shows a negative impact on companies' innovative activity, which is, however, not significantly different from zero. Similarly, a number of studies suggest that increasing R&D expenses imply a higher number of new product introductions (Galizzi and Venturini, 1996; Cabagnols and Le Bas, 2002). The results in Table 2 confirm these studies. The ratio of R&D expenditures to firm sales (*R&D*) exerts a significant positive influence on innovative activity. Firms have also been asked to directly evaluate the importance of entry barriers as well as to comment on the importance of fixed costs in their industry. Both measure however did not contribute significantly to the explanatory power of the model and are thus not reported in Table 2.

To control for international competition, we include the ratio of exports to firm sales (*EXQ*). A strong international orientation might allow firms to flee competitive pressure on domestic markets as well as generate larger demand for new and different products thereby increasing incentives to innovate. Conversely, a strong international orientation of German firms might also be an indication of a strong international competition on the local product market which would reduce incentives to develop new products. The parameter estimate for *EXQ* in Table 2 is negative and significantly different from zero at the 10%-level, giving some support to the second interpretation.[6] Including a variable, that aims at directly measuring the respondent's evaluation of foreign competitive pressures on a scale from 1 (foreign competitive pressure is very low) to 5 (foreign competitive pressure is very high) did not contribute to the explanatory power of the model.

According to Neo-Schumpeter-hypothesis I, it is to emanate from a positive relationship between firm size and innovative activity due to better accouterment for introducing new products. Large companies, it is argued, would have an advantage in raising funds for risky innovation projects as they can cover capital requirements to a considerable proportion from own funds due to higher liquidity and have easier access to loans. Also large firms can spread fix costs over a large sales volume, thus reduce unit costs of production. Innovations would thus be more profitable in big companies. Further, large firms can undertake several innovation projects at the time and thereby spreading R&D-risk (Schumpeter,1942; Kamien and Schwartz,1982; Cohen and Levin,1989). The parameter estimates reported in column [2] of Table 2 do not support this argument though. Firm size, measured as sales per year (*SIZE*), did not show a significant impact on innovation activity.

Finally, the theoretical model suggests the number of product innovations to increase with aggregate market size. On the basis of aggregate industry data, empirical support for the supposed positive relationship between market size and innovative activity is reported in Galizzi and Venturini (1996), Gayle (2001) as well as Baldwin et al. (2002), whereas Acs and Audretsch (1990) as well as Rothwell and Dogson (1994) find the opposite result. The present study uses past industry growth between 1995 and 1999 (*GROWTH*) as a proxy for future demand potentials. The parameter estimate of this variable reported in Table 2 however is not significantly different from zero. Other measures of market size (such as industry sales) also did not show any significant relationship with innovation activities in German food industries.

4. Summary

Rapidly growing concentration ratios in European food retailing raise concerns about the welfare implications for consumers. On the one hand, consumers might gain if lower input prices for retailers are passed on to consumers. In the long run, however, retailer power might

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6 A negative relationship between foreign trade and innovation has also been found by Traill and Meulenberg (2002).

force manufacturers to reduce investment in new products which would reduce consumer welfare. The relationship between downstream (retailer) market power and upstream (food manufacturing) product innovation is the focus of this paper. On the basis of a formal model, we find that retailer market power reduces upstream firms incentives to introduce new products. This proposition is then tested empirically.

In contrast to much of the existing literature on product innovation, which is based on cross-section (aggregate) industry data, we use firm level data from a survey of food manufacturing firms carried out in 2002 in Germany. The results of a negative binomial regression model supports the proposition of a negative effect of retailer market power on product innovation in food manufacturing. This negative impact of market power in the downstream market is mitigated if manufacturing firms also have some market power (countervailing power). Innovations are positively related to firm's market share in food manufacturing. Further, we find firm's expenditures in R&D to be significantly and positively related to product innovation.

There has been considerable debate over the appropriate policy treatment towards buyer power. Our results underline the necessity to incorporate the long-run implications with respect to product innovation into competition policy considerations.

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