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Market Power of the German Beer Industry on Export Markets - An Empirical Study -

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- An Empirical Study -

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Abstract

In this paper the existence and magnitude of market power for the German beer exporters is tested. Two theoretical approaches to model incomplete competition on international markets are employed, the 'pricing to market' (PTM) model the 'residual demand elasticity' (RDE) approach. Estimations for both models over the period from 1991 to 1998 reveal incompatible results regarding the underlying theoretical models and with respect to the approach that is used. While significant market power is indicated in the PTM model, the RDE approach signalizes perfect competition. This leads to the conclusion that the underlying theoretical models have to be extended to consistently match the observed market solutions in this case.

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1 Introduction

Utilization of market power has significant implications for the profitability of firms, the pricing of goods, and the allocation of resources. In this paper we estimate the existence and the magnitude of market power for the German beer industry on international markets. We employ two theoretical approaches to model incomplete competition on international markets. The first approach is the 'pricing to market' (***PTM***) model which was developed by Krugman (1987). The second approach, which is essentially based on the derivation and estimation of the 'residual demand elasticity' (***RDE***), was introduced by Baker and Bresnahan (1988). Both approaches allow to identify the existence of market power, but the extent of market power can only be estimated by the ***RDE*** approach. The advantage on an analysis of the pricing behavior of firms on international markets is that we do not need information on marginal production costs to test for market power. Variations of currency values work as cost or profit shifters to reveal the pricing behavior of the exporter. In the empirical analysis, we use monthly data for German beer exports to four important export destinations within the period from 1991 till 1998. Due to the number of observations available (n=86) the time series properties of the processes can be analyzed and considered in the estimation, which is important as prices and exchange rate often behave non-stationary. The paper is structured as follows: First, we start with a brief presentation of the theoretical models. Second, we explain the empirical specification of the two theoretical and empirical approaches. Third, we present the empirical results, and finally, we draw some conclusions and summarize our results.

2 Theoretical Background

The ***PTM*** model assumes an exporter that has monopolistic power on his export markets[1]. The international markets are completely separated and the monopolistic exporter utilizes price discrimination between these markets to maximize his profits. In the case of 'normal' demand curves, the exporter sets prices above his marginal production and transaction costs[2]. The mark ups on each market might differ depending on the price elasticity of demand. With regard to less elastic demand curves, the markup increases. Changes in the real exchange rate can cause an adjustment of the geographical price structure under the assumption of profit maximization. Normally, when the exporter's currency is depreciated against a destination's currency, then export prices in the exporter's currency ought to increase, but less than the currency is depreciated. In that case exchange rate fluctuations are incompletely transmitted to prices in the exporter's currency which indicates the utilization of market power[3]. To illustrate the PTM we assume that a monopolistic exporter faces 'normal' demand curves on each international market.

(A-1) $$Q_i = Q_i\left(e_i P_i, Z_i\right)$$

P_i is the price (unit value) of the good measured in the exporter's currency, e_i is the exchange rate between destination's and exporter's currency, e_iP_i is the price in the destination's market currency, and Z_i is a vector of demand shifters on the destination market (e.g. income)[4]. The supply relation of the exporter follows from the stationary solution of the profit maximization

1 This could be a pure monopoly or a market with monopolistic competition.

2 Transaction costs have to be considered, but are assumed to be equal for each destination market for simplicity.

3 Complete competition would lead to a complete transmission of exchange rate changes to the price in the destination market currency as long as changes in the destination market currency have no impact on the world market.

4 The demand function can be the excess or the residual demand function on the respective market, or the demand function for the product the exporter offers which is significantly different to other products in the same category. The function can be interpreted as the reactions of sales to changes in the supply price which is the by the monopolist that we look at.

problem $\underset{P_i}{MAX} \quad \Pi_i = P_i Q_i(.) - C\left(Q_i(.), W\right)$, which leads to the first order condition $Q_i + \frac{\partial Q_i}{\partial P_i} P_i - \frac{\partial C}{\partial Q_i}\frac{\partial Q_i}{\partial P_i} = 0$. C(.) indicates the cost function of the exporter, which depends on the quantity produced and various cost shifters, such as input prices. The exporter maximizes his profits when the marginal revenue MR=$Q_i + P_i(\partial Q_i / \partial P_i)$ is equal to the marginal costs MC=$(\partial C / \partial Q_i)(\partial Q_i / \partial P_i)$. After some rearrangements follows[5]

(A-2) $$P_i = MC\left(\frac{\eta_i(e_i p_i, Z)}{\eta_i(e_i p_i, Z) - 1}\right).$$

If we take logarithms and derive (A-2) with respect to the exchange rate, we deduce the following expression, which is the basis for the empirical specification:

(A-3) $$\frac{\partial \ln P_i}{\partial \ln e_i} = -\frac{\partial \ln \eta_i / \partial \ln(e_i p_i)}{\eta_i - 1 + (\partial \ln \eta_i / \partial \ln(e_i p_i))}.$$

The ratio of relative change in the exporter's price and the relative change of the exchange rate (exchange rate transmission elasticity) depends on the demand elasticity on the destination market (η_i) and its relative change with respect to the price level $(\partial \ln \eta_i / \partial \ln(e_i P_i))$. For complete competitive markets the exchange transmission elasticity tends to zero (A-4a). For a demand elasticity of minus one the transmission elasticity would be minus one. The latter case could only occur when marginal costs of the monopolist are zero, which makes it extemely unprobable. Thus, the utilization of market power is indicated if the transmission elasticity is greater than minus one and smaller than zero (A-4b).

(A-4a) $$(\partial \ln \eta_i / \partial \ln(e_i P_i)) = 0 \Rightarrow (\partial \ln P_i / \partial \ln e_i) = 0$$

(A-4b) $$(\partial \ln \eta_i / \partial \ln(e_i P_i) > 0) \wedge (\eta_i > 1) \Rightarrow (\partial \ln P_i / \partial \ln e_i) \in \left]-1, 0\right[$$

(A-4c) $$(\partial \ln \eta_i / \partial \ln(e_i P_i)) < 0 \wedge (1 - \eta)_i > \left|\partial \ln \eta_i / \partial \ln(e_i P_i)\right| \Rightarrow (\partial \ln P_i / \partial \ln e_i) > 0$$

Two other special cases occur when the demand curve is isoelastic or when the demand elasticity is decreasing with increasing price level. For isoelastic demand curves the profit maximizing relative markup is independent from exchange rate variations. Therefore, the transmission elasticity is zero when the demand on the destination market is isoleastic (A-4a). If the demand elasticity declines with the price level, the transmission elasticity can appear to be even positive (A-4c). Apart from the latter two cases, the PTM model allows us to interpret the exchange rate transmission elasticity as an indicator for the existence of market power. However, the extent of market power cannot be estimated without further assumption.

The ***RDE*** model is a more general approach based on either pure monopolistic or oligopolistic competition (e.g. Cournot or Stackelberg). The aim is to estimate the residual demand elasticity which the individual competitors face. Market power is characterized by a falling residual demand curve or a residual demand elasticity of less than infinity in absolute terms. The residual demand elasticity also indicates the extent of market power as its reciprocal absolute value is equal to the Lerner index $((P - MC)/P)$. To illustrate the generality of this approach, let us assume two competitors. Both face an inverse residual demand function which depends on

5 The demand elasticity is defined η_i indicates the absolute value of $\frac{\partial Q_i}{Q_i} \Big/ \frac{\partial e_i P_i}{e_i P_i}$

their own supply, the supply of the competitor, and other determinants of demand *(Z)*, such as income.

(B-1) $$P^{ex1} = P^{ex1}\left(Q^{ex1}, Q^{ex2}, Z\right)$$

(B-2) $$P^{ex2} = P^{ex2}\left(Q^{ex2}, Q^{ex1}, Z\right)$$

Based on the residual demand and the individual cost functions, the maximization problem of the two competitors can be written as follows:

$$\underset{Q^{ex1}}{MAX} \quad \Pi^{ex1} = Q^{ex1}P^{ex1}\left(Q^{ex1}, Q^{ex2}, Z\right) - e^{ex1}C^{ex1}\left(Q^{ex1}, W^{ex1}\right) \text{ and}$$

$$\underset{Q^{ex2}}{MAX} \quad \Pi^{ex2} = Q^{ex2}P^{ex2}\left(Q^{ex2}, Q^{ex1}, Z\right) - e^{ex2}C^{ex2}\left(Q^{ex2}, W^{ex2}\right) \text{ with the first}$$

order conditions $P^{ex1} + Q^{ex1}\underbrace{\left(\frac{\partial P^{ex1}}{\partial Q^{ex1}} + \frac{\partial P^{ex1}}{\partial Q^{ex2}}\frac{\partial Q^{ex2}}{\partial Q^{ex1}}\right)}_{q^{ex1}} = e^{ex1}MC^{ex1}$ and $P^{ex2} + Q^{ex2}\underbrace{\left(\frac{\partial P^{ex2}}{\partial Q^{ex2}} + \frac{\partial P^{ex2}}{\partial Q^{ex1}}\frac{\partial Q^{ex1}}{\partial Q^{ex2}}\right)}_{q^{ex2}} = e^{ex2}MC^{ex2}$.

q indicates the conduct parameter and determines the market solution. From the stationary solutions of these optimization problems, we obtain the competitor's supply or pricing behavior (supply relations):

(B-3) $$e^{ex1}MC^{ex1}\left(Q^{ex1}, W^{ex1}\right) = MR^{ex1}\left(Q^{ex1}, Q^{ex2}, Z\right)$$

(B-4) $$e^{ex2}MC^{ex2}\left(Q^{ex2}, W^{ex2}\right) = MR^{ex2}\left(Q^{ex2}, Q^{ex1}, Z\right)$$

To quantify the extent of market power, Goldberg und Knetter (1999) and Baker and Bresnahan (1988) have proposed to estimate a reduced form of the system (B-1) to (B-4) to result the inverse residual demand function of one of the competitors, for instance exporter 1. In the first step we solve (B-2) and (B-4) for the quantity supplied by exporter 2. In the second step we substitute the quantity supplied by exporter 2 into (B-1), which indicates the basis for the empirical specification:

(B-5) $$P^{ex1} = P^{ex1}\left(Q^{ex1}, Q^{ex2}\left(Q^{ex1}, Z, e^{ex2}W^{ex2}\right), Z\right).$$

The residual demand function of exporter 1 is determined by his own supply, by demand shifters, and by shifters for the competitor's production costs, which are assumed to be mostly determined by the exchange rate between exporter 2 and the destination market currency. The coefficient of the Q^{ex1} in the residual demand function (B-5) consists of two effects $\left(q^{ex1}\right)$, the price reaction to variations of the supply by exporter 1 and the corresponding conjectural reaction of exporter 2. To circumvent the problem of simultaneous equation bias, the supply of exporter 1 is instrumented as proposed by Goldberg and Knetter (1999) who estimate the following inverse residual demand specification:

(B-6) $$P^{ex1} = D^{ex1}\left(\hat{Q}^{ex1}, e^{ex2}, Z\right).$$

If we estimate (B-5) in log-linear from, the coefficient for the estimated export volume gives us the residual demand elasticity, by which the market power can be identified and quantified. The extent of market power increases with decreasing absolute values of the residual demand elasticity. However, the absolute value of the residual demand elasticity cannot be smaller than one because this would not be compatible with imperfect competition under profit maximization. If the residual demand elasticity is zero, perfect competition cannot be rejected.

3 Empirical Analysis

Data and stylized facts

Data for German beer exports to the USA, Canada, France, and the United Kingdom (US, CA, FR, UK) are analyzed here, which is, except for the time frame and the frequency, the same data basis used by Goldberg and Knetter (1999)[6]. Goldberg and Knetter used annual data from 1973 to 1988, for this study we collected monthly data from 1991 to 1998. Monthly data are favored here to increase the number of observation and to increase the frequency of observation which allows us to analyze and consider the time series properties of the variables. Furthermore, we can study the short term reactions to exchange rate changes.

Germany exports about 44 percent of its beer exports to US, CA, FR, and UK. The beer is made of barley malt and is packed in containers of less than 10 liters. World beer demand is steadily increasing; however, in industrial countries the demand is about stagnant. Germany produces 115 mio. hl of beer per year which is about 8.7 percent of the world production. Roughly 5 percent of the world production is traded internationally. The import shares of German beer on the US, CA, FR, and UK markets range from 7 (CA) to 30 (UK) percent. The unit values of these exports differ significantly during the observation period and between the destinations. While the average unit value (fob basis) from 1991 to 1998 of German beer exports to FR is 1.11 DM per L, exports to UK yielded 1.86 DM L. The unit values for US and CA are 1.47 and 1.65 DM per L respectively.

Model Specifications and Estimation Procedures[7]

For the ***PTM*** approach Knetter (1993) used the following specification, which can either be estimated by single equations (OLS or SUR procedure) or by a fixed effects panel model. The latter approach is often used to increase the degrees of freedom by grouping all destinations with the same fixed effects (Falk and Falk, 1999).

(A-5) $$\ln P_{i,t}^{ex1} = \sum \delta_i D_i + \sum \lambda_i T_i + \alpha_i \ln\left(e_{i,t}^{ex1} / PPI_{i,t}\right) + \beta_i \ln\left(GDP_{i,t} / CPI_{i,t}\right) + u_{i,t}$$

P^{ex}: export unit values in the currency of the export origin (German Mark, DM) *D*: Destination specific dummy; *T*: Trend term for every destination market; *PPI*: producer price index for the destination market; *GDP*: gross domestic product in the destination market. *CPI*: consumer price index for the destination market; *e*: exchange rate between destination market and country of origin (e.g. $US/DM). Compared with the theoretical model the empirical specification shows several adjustments. Instead of the nominal exchange rate, the real exchange rate is used because changes of the nominal exchange rate that would be caused by inflation on the destination market should not lead to price adjustments. The real GDP is added to the specification to account for income-driven demand shifts. The constant term and the time dummy for each destination account for possible changes of marginal transaction costs between markets and over time. This specification is further simplified here. As the real GDP on a monthly basis follows nearly a linear trend which can also be reflected by the trend term, the variable is omitted here. Further, price changes and exchange rate changes due to inflation should be corrected also for the endogenous price in the exporter's market currency. However, as inflation rates are very low in all countries that are analyzed here, we decided to use the nominal exchange rate and not to calculate real export unit values. We compared this simplified empirical specification with the Knetter model and found that the results were very similar.

(A-6) $$\ln P_{i,t}^{ex1} = \sum \delta_i D_{i,t} + \sum \lambda_i T_i + \alpha_i \ln e_{i,t}^{ex1} + u_{i,t}$$

As the same argument holds for the ***RDE*** approach, we also estimate a simplified version of the Goldberg und Knetter (1999) specification:

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[6] A similar data set is used by Knetter (1989, 1993).

[7] All results that are here not documented in detail can be obtained from the authors upon request.

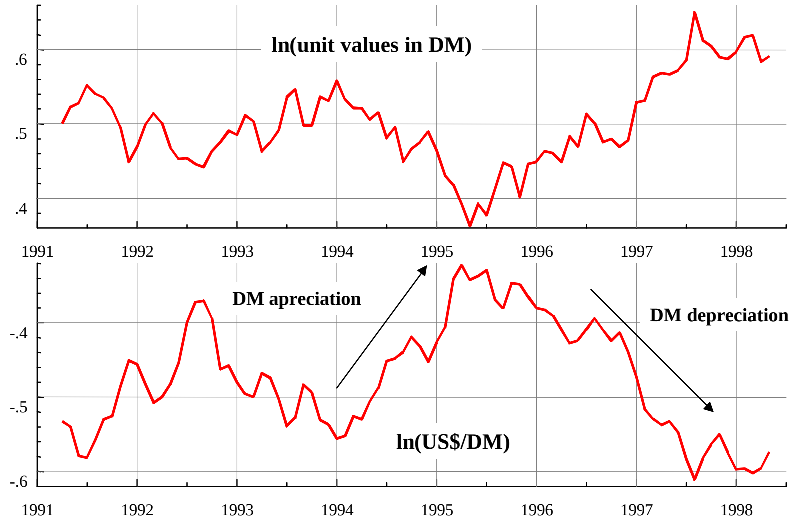
(B-7) $$\ln P^{ex1*}_{i,t} = \sum \delta_i D_{i,t} + \sum \lambda_i T_{i,t} + \phi_i \ln \hat{Q}^{ex1}_{i,t} + \sum \alpha^{j}_{i,t} \ln e^{exj}_{i,t} + u_{i,t}$$

P^{ex1*}_{i} is the price (unit value) of German beer exports to the respective destination market measured in the destination market currency. e^{exj}_{i} are the exchange rates between all the other competitors' and the destination's currencies. All other variables are defined as above. The model can be estimated as a single equation by IV-OLS or by SUR procedure. Both methods are applied here.

Estimation Results

For the unit values from April 1991 to May 1998 and for the exchange rate series over the same period, the null hypothesis that the processes behave non-stationary could not be rejected. All first differences are stationary[8]. Following Engle and Granger (1987), the series are treated as integrated processes of order one, which makes testing of cointegration necessary. Cointegration is tested by a parameter restriction in the error correction model (ECM) (see Hansen, 1993; Kremer, Ericsson and Dolado, 1992). In Figure 1 the unit values of German beer exports to US and the exchange rate between Germany and the US are shown.

Fig. 1: Unit values in DM per L for German beer exports to US and exchange rates (US$/DM) from April 1991 to May 1998



Source: SAEG, various issues, Deutsche Bundesbank, various issues.

Figure 1 demonstrates that a currency depreciation is accompanied with price decreases and vice versa. For the estimation of this relationship (***PTM*** model) we obtained the following parameters. The endogenous variable is the export unit value of German beer exports to US in DM (German Mark) per L *($\ln P^{ex}$)*:

Variable	Coefficient	Std. Error	t-value	t-prob	Part.R^2
Constant	0.10340	0.019218	5.380	0.0000	0.2657
$\ln P^{ex}$ (lag 1)	-0.72562	0.10590	-6.852	0.0000	0.3698
$\ln e^{US/DM}$ (lag 1)	-0.50794	0.077047	-6.593	0.0000	0.3520
$d \ln e^{US/DM}$	-0.58698	0.074732	-7.855	0.0000	0.4354
Trend	0.00045	9.8819e-005	4.605	0.0000	0.2096

R^2=0.57; F(4,80)=26.69 [0.000]; s = 0.01637; DW = 1.98
RSS = 0.0214 for 5 variables and 85 observations[9]

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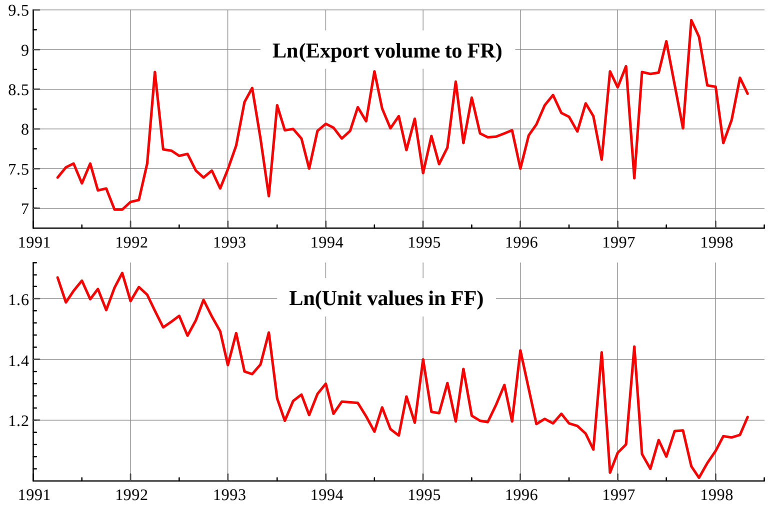
[8] We applied the procedures by Dickey und Fuller (ADF-Test), Phillips und Perron (1998) and by Kwiatkowski et al. (1993), which over all revealed compatible results. Trend-stationarity was also rejected for the original series. All series were transformed by taking logarithms.

[9] AR 1-2 F(2, 78)=1.2622 [0.2887]; ARCH 6 F(6, 68)=0.34629 [0.9097]
Normality Chi^2(2)=2.1872 [0.3350]; Xi^2 F(8, 71)=1.0466 [0.4102]

The results for the ECM indicate that in the long run a depreciation of on e percent leads to price increase of 0.7 percent. The model shows a strongly reduced dynamic structure, only one lag is significant, which implies that the short term reactions appear only in the concurrent and in the following period. The markup elasticity is negative, significantly different from zero, and absolute smaller than one. Thus, we can conclude the existence or utilization of market power of German beer exporters on the US market. In the case of CA a long run markup elasticity of –0.6 is obtained, for FR and UK the coefficients are not significantly different from zero. In all cases, cointegration is indicated and the single equation estimations revealed results that are hihgly similar to the results of the SUR estimation procedure[10].

Fig. 2: Volumes and unit values for beer exports to FR in French Franc from April 1991 to May 1998



Quelle: SAEG, various issues, Deutsche Bundesbank, various issues.

All series for the export volumes in logarithms are stationary, except the series for exports to FR. The same holds for the estimated (intrumented) series. As all price series are non-stationary, we have to reject the existence of long-run relationships between quantities and prices (***RDE*** model). Although exchange rate vary significantly in the observation period, the quantities do not show a corresponding reaction. For FR we obtain such a relationship as volumes and unit values are cointegrated, but exchange rates do not vary significantly in the same direction as it would be necessary to explain the increase of exports to FR. Thus, for all cases the existence of market power has to be rejected.

The results for the ***RDE*** approach contradict the results by Goldberg and Knetter (1999) who foundsignificant coefficients for the residual demand elasticities for these markets. This could be explained by the use of monthly instead of annual data and by the difference in the observation period. The use of data of higher frequency could be inappropriate in this case because export unit values might be determined (negotiated) annually. Then, the seasonal pattern of exports might be predetermined, and therefore not related to exchange rate variations in the short-run. Also, the results of Goldberg and Knetter (1999) could indicate spurious regression problems as time series properties were not tested. The results for FR indicate that non-cooperative strategies might prevail on this market.

Xi*Xj F(14, 65)=0.95697 [0.5056]; RESET F(1, 79)= 2.0643 [0.1547]

10 Cointegration was also tested by using the Johansen-procedure (Johansen, 1988 and 1995). The results support the findings for the ECM. In addition, it could be shown that underlying causality assumptions could not be rejected.

4 Summary and Conclusions

In this paper we applied two empirical approaches to identify and quantify market power on international markets for German beer. For the pricing to market approach, we identified market power for German exports on the US and the Canadian market, while on the French and the UK market exporters had no market power. However, the residual demand elasticity approach did not reveal a falling residual demand curve for the export markets, which is a necessary condition for the utilization of market power. These results contradict the findings of Goldberg and Knetter (1999) who found significant residual demand elasticity for all markets that are investigated here. Thus, not only the two different approaches applied here reveal inconsistent results, but deviating results are also obtained for the same approach for a different period of observation and a different data frequency. This leads to the conclusion that the underlying theoretical models have to be extended to consistently match the observed market solutions. The explicit consideration of competitors' behavior on the international markets might be worthwhile to enhance the understanding of the pricing process on these markets.

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