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Questioning Pricing-to-Market Linearity: Partial Sum Decomposition Approach Applied to Beer Export

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Abstract

Pricing decisions of exporters, who are facing imperfect competition in their destination markets, might depend on exchange rate changes. While empirical literature often assumes that the impact of the exchange rate on the exporters' prices is linear and the markup adjustment does not depend on magnitude or direction of the exchange rate, we question this statement and test for hysteresis and asymmetry of pricing-to-market (PTM). By means of the partial sum decomposition approach of Shin et al. (2013) using the beer market as an example, we show that both types of nonlinearities play an important role in PTM decisions.

Keywords

Asymmetry, beer exports, hysteresis, NARDL, pricing-to-market

1. Introduction

Pricing-to-market (PTM) is a destination-specific markup adjustment, made by an exporter to avoid large price changes in the local currency of a destination market, caused by exchange rate fluctuations. PTM was first introduced by Krugman (1987) as "the phenomenon of foreign firms maintaining or even increasing their export prices to the United States when the dollar rises…" (p. 49). Knetter (1993) defined PTM when the dollar falls as the situation when the "sellers reduce markups to buyers whose currencies have depreciated against the seller, thereby stabilizing prices in the buyer's currency relative to a constant markup policy" (p. 473). These two definitions, which show how PTM in the form of a local-currency price stabilization (LCPS)[1] mechanism emerges in cases of currency appreciation and depreciation, do not make any assumptions about the extent of the markup adjustment towards exchange rate changes of different direction or magnitude. Even though it was found that "prices rise faster than they fall" (e.g., Peltzman, 2000) and that the prices are sticky to nominal shocks (e.g., Delgado, 1991), PTM is often regarded empirically as symmetric and linear.

The studies, that consider different effects of appreciations and depreciations on price-setting decisions, are very scarce (e.g., Knetter, 1994; Bussière, 2013) and focus on the short-run dynamics, neglecting the underlying long-run relationships beyond PTM. Still, even in the short run, separation of different changes in exchange rates is proved to be important. E.g., Bussière (2013) concluded that asymmetries in the exchange rate pass-through cannot be ignored, especially on the export side. There are even fewer studies, which consider a different price reaction towards small and large exchange rate changes. The only attempt to model long-run asymmetries and nonlinearities implicitly within PTM framework that we are aware of is done by Fedoseeva (2013), who used an example of the sugar confectionery exports to show that PTM can be regarded neither as linear, nor as symmetric. Still, the study did not try to quantify PTM, focusing on symmetry testing.

We fill the gap in the empirical literature by addressing both the hysteresis and the asymmetry in the underlying long-run relationship between exporters' prices and the exchange rates. This is done using the example of German beer exports, as beer has been an especially popular object of

[1] And leave another side of PTM – the amplification of the exchange rate change effect on the markup/price – out of the focus.

PTM studies. Knetter (1989) was the first to include beer in the sample of investigated exported products. As PTM models grew more complicated, beer consistently remained within the group of studied products. Along with Knetter, who often returned to beer exports (e.g., Knetter, 1994; Goldberg and Knetter, 1999), there are numerous studies, where strategic pricing of (often German) beer exports is addressed (e.g., Kasa, 1992; Hellerstein, 2008; Goldberg and Hellerstein, 2013). With some variation in coefficients empirical studies often find evidence of strategic pricing in beer exports, which makes it a perfect market to test for PTM nonlinearities.

As the German domestic beer market stagnates, exports become more and more important for the beer industry. According to Schmid and Luber (2013), around one hundred out of more than a thousand German breweries are active internationally and export their beer[2]. As the destination market entry requires sunk investments (e.g., Campa, 2004) related to, e.g., marketing researches, advertisement, and establishment of the distribution channels, exporters might wish to stay in the market, once entered, and, thus, protect their market shares. This might lead to a cautious pricing policy, where the exporter partially absorbs, e.g., non-favorable exchange rate changes by the means of his markup and shifts the pass-through in time to assure that the price in the local currency of the destination market does not change that much. A nonlinear price adjustment, driven by a "wait-and-see" strategy of the exporter and neglecting the minor changes until some pain threshold is passed, describes hysteresis in prices. In this case, the minor changes are passed through to the local currency price of the destination market, while larger changes of the exchange rate result in a markup adjustment. From the asymmetric perspective we expect that especially large Euro appreciations are partially offset in order to protect the market shares, while depreciations might be used to compensate for those offsets (in sense of LCPS) or might be fully passed-through (as a tool of expansion). On the other hand, an amplification of the exchange rate appreciations on prices might indicate a market power realization on some markets.

To address the (a)symmetry and hysteresis of PTM we apply a partial-sum decomposition approach and a nonlinear autoregressive distributed lag (NARDL) framework by Shin et al. (2013) to test whether assuming the price reaction to be invariant to the type of the exchange rate change and, hence, PTM to be linear and symmetric is too restrictive. For this test we concentrate on a large sample of destination countries (which covers more than 80 percent of German beer exports outside of the Eurozone), which allows us to analyze pricing behavior of German beer exporters also outside of typically considered markets.

The remainder of the paper is as follows. Section II briefly introduces the theoretical model and describes the empirical specification in more detail. Section III provides information on the data. Section IV presents the results and Section V concludes.

2. Theoretical Model and Empirical Solution

For the theoretical framework we stick to a classical model of Krugman (1987) and Knetter (1989). We assume a producer, exporting his product to a number of destinations and maximizing his profit. The free-on-board (fob) price in the exporter's currency depends on marginal cost of production and the elasticity of demand with respect to the local currency price in the destination market[3]. In the perfect competition case export price equals marginal costs of production. In case of market segmentation with constant elasticity of demand, a fixed country-specific markup over costs is added to the price. PTM in this framework arises when the elasticity of demand with respect

[2] Opposite to, e.g., foreign direct investments, which are a less popular mean of internationalization among German brewers than among other large beer producing nations.

[3] For the details of the derivation please address, e.g., Knetter (1989).

to local currency price is not constant, making price setting in source country's currency a strategic decision:

$$P = f(MC, ER, \mathrm{Z}), \tag{1}$$

where the export fob price (*P*) is a function of marginal costs of production (*MC*), exchange rate between trading countries (*ER*), and the vector of various demand and supply shifters (*Z*). The aim of this study is to assess potential nonlinearity of the exchange rate in this function.

In order to achieve this goal we follow Shin et al. (2013), who propose a decomposition of the independent variable into a partial sum of its positive and negative changes, which allows the introduction of nonlinearity and asymmetry into a standard ARDL framework. For the PTM study such a decomposition allows to model all kinds of asymmetry (between, e.g., positive/negative, small/big changes in short and long run) and to estimate a nonlinear asymmetric model by means of linear estimation technics, including a simple testing of hidden cointegration[4] (Granger and Yoon, 2002) directly within the model.

To correctly specify the model and account for the (possibility of the) presence of hysteresis, we extend the variable decomposition from the one-threshold case (where only positive and negative changes are separated) to the two-threshold decomposition:

$$ER_t = ER_0 + ER_t^- + ER_t^{\pm} + ER_t^+, \tag{2}$$

where ER_t^- is a partial sum process of large negative changes, ER_t^+ is a partial sum process of large positive changes and $ER_t^{\pm}$ is partial sum process of all small changes. As the magnitude of the exchange rate changes differs between currencies, we fix the threshold at the level of one standard deviation (STD) of the *ΔER* so that:

$$ER_t^- = \sum_{j=1}^{t} \Delta ER_j^- = \sum_{j=1}^{t} \Delta ER_j I\{\Delta ER_j \leq -STD\}; \tag{3}$$

$$ER_t^+ = \sum_{j=1}^{t} \Delta ER_j^+ = \sum_{j=1}^{t} \Delta ER_j I\{+STD \leq \Delta ER_j\}; \tag{4}$$

$$ER_t^{\pm} = \sum_{j=1}^{t} \Delta ER_j^{\pm} = \sum_{j=1}^{t} \Delta ER_j I\{-STD < ER_j < +STD\}, \tag{5}$$

[4] As we deal with a variable decomposition, standard cointegration tests might be not applicable. Thus, we apply a bound test approach by Pesaran et al. (2001) to test for a long-term relationship between level variables irrespective of their being I(0), I(1) or of a mixed nature.

where I{Z} denotes an indicator function which takes the value of 1 if the condition is satisfied and 0 otherwise.

Decomposing the log of the original exchange rate series will enable us to estimate the entire model in a log-log form and overcome the problem of taking logs of negative numbers, noted by Fedoseeva (2013), and Shin et al. (2013). This will later let us interpret our outcomes as elasticities.

The empirical specification of the model specified in Equation (1) for the case of two-threshold exchange rate decomposition can be extended to the following NARDL-form:

$$\begin{aligned}\Delta P_t = {} & \alpha_0 + \eta\left(P_{t-1} - \kappa_1 ER^{-}_{t-1} - \kappa_2 ER^{\pm}_{t-1} - \kappa_3 ER^{+}_{t-1} - \kappa_4 MC_{t-1}\right) + \\ & + \sum_{\tau=0} \lambda_\tau \Delta ER^{-}_{t-\tau} + \sum_{\tau=0} \mu_\tau \Delta ER^{\pm}_{t-\tau} + \sum_{\tau=0} \pi_\tau \Delta ER^{+}_{t-\tau} + \\ & + \sum_{\tau=0} \varphi_\tau \Delta MC_{t-\tau} + \sum_{\omega=1} \chi_\omega \Delta P_{t-\omega} + u_t \end{aligned} \quad (6)$$

where η is an error-correction term, which shows the speed of adjustment towards the long- run equilibrium, the κ-coefficients refer to the long-run relations, and the coefficients referring to variables in first differences capture the contemporaneous adjustments. The upper bound for τ is chosen according to the Schwarz criterion of lag selection. A maximum of 12 lags is tested as we work with monthly data. If in the selected model the problem of autocorrelation is still present, lags of ΔP are added to overcome it.

Equation 6 is estimated with OLS. The long-run elasticities of price with respect to nominal exchange rates then are:

$$e^{-} = -\frac{\kappa_1}{\eta};\ e^{\pm} = -\frac{\kappa_2}{\eta};\ e^{+} = -\frac{\kappa_3}{\eta} \quad (7)$$

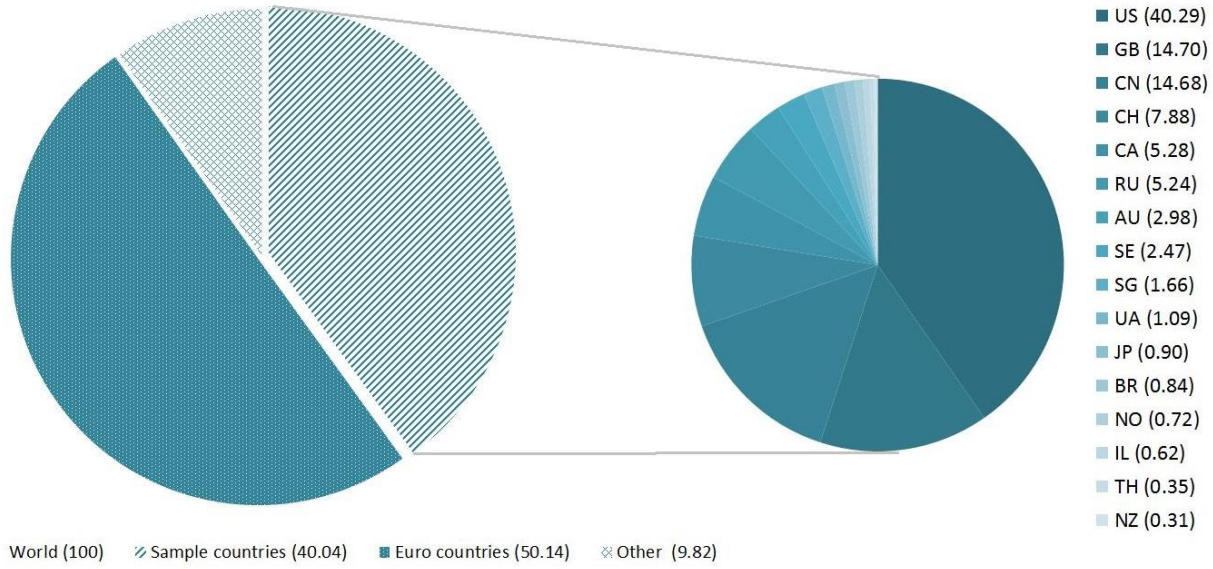
for large depreciations, the inner regime and large appreciations, respectively. Standard errors for long-run elasticities are calculated using the Delta method. Asymmetry is tested by means of a Wald test.

As PTM allows for both effects (amplification of the effect of the exchange rate change on prices and the local currency price stabilization), coefficients of both signs can be obtained. No significant coefficients would indicate a complete pass-through of the Euro fluctuations to the price in local currency (hence, no PTM). Significant coefficients would signal the presence of some pricing strategy. LCPS is reported when the coefficients are negative; implying that a part of the exchange rate change is absorbed through the exporter's price. This is valid for both, appreciation and depreciation. A higher rate of the offset is expected for depreciations, as it allows exporters to extract extra profits, while keeping the local currency price stable. A partial offset of Euro appreciation would suggest that the exporters cut the Euro prices to offset a part of change in price in local currency. Such behavior supports a cautious pricing policy of the exporter in an attempt to protect sales volumes. A positive coefficient related to the Euro appreciation might be a sign of market power realization on the destination market, when the exchange rate appreciation is used

as a reason for an additional increase of prices. Earlier studies suggest LCPS to be found for large important markets, while for little markets there might be no effect. As for the inner regime, no significant estimates are expected, due to hysteresis in prices. If any are obtained, it could be a sign that persistent changes of the same sign can trigger a price adjustment as well.

3. Data

The study concentrates on German beer exports to sixteen non-Euro destination countries, to which more than 40 percent of beer exports were sent in 2012. Around fifty percent of total beer exports do not go further than to neighboring countries, which have introduced the Euro and hence cannot be included in a PTM study. Hence, we cover around 80 percent of all exports, where PTM might potentially arise. Figure 1 shows the role of these countries in German beer exports.



Source: Own computation based on the Eurostat data (2013)

Figure 1. Distribution of German Beer Exports

Beer is defined according to Standard International Trade Classification (SITC) classification (product group code 11230). Prices are constructed as unit values, which are calculated from Eurostat's export values and quantities[5]. Exchange rates are measured as units of local currencies per one Euro. Exchange rates series are obtained from the IMF database or from national banks. In both cases nominal exchange rates are monthly averages. Non-observable marginal costs are proxied analogously to Silvente (2005) as estimated time-specific effect from the original Knetter (1989) model[6].

[5] We are well aware of potential problems we introduce into the estimation by concentrating on average unit values (see, e.g., Lavoie and Liu, 2007). Still there seems to be no better alternative so we follow the previous researches (as, e.g. above mentioned studies of Krugman and Knetter) and use unit values as a measure of export prices. We assume, however, that it is mostly premium quality beer being exported, especially to far-away destinations (see, e.g., Goerg et al., 2010). Then the price difference between different sorts is hopefully not so large, and as the exchange rate changes there is no product substitution between the premium and "cheap" beer.

[6] Knetter (1989) estimated a fixed-effect model, where export price was explained by a set of country-specific effects, time-specific effects and the exchange rate. He argued that the time-specific effects can be regarded as a measure of marginal cost changes

Whenever it was possible, the estimation period was chosen from January 1991 to December 2012. For some destinations the information was not available for the entire time span and the sample was adjusted for these countries[7].

4. Results

Table 1 presents the long-run elasticities of prices with respect to the exchange rate[8].

Table 1. The long-run elasticities of price with respect to exchange rates changes

Country	e^-		$e^{\pm}$		e^+	
AU[a]	0.50***	(0.16)	-0.12	(0.21)	0.36***	(0.14)
BR[a]	-0.20	(0.16)	0.27**	(0.12)	0.16**	(0.07)
CA[a]	-0.77***	(0.12)	-0.27*	(0.16)	-0.67***	(0.11)
CN[b,c]	0.27	(0.49)	0.56	(0.97)	0.99***	(0.34)
GB[a]	-0.93***	(0.32)	-0.02	(0.52)	-0.79***	(0.25)
IL[a]	-0.19	(0.25)	1.32*	(0.71)	-0.33*	(0.17)
JP[a]	0.08	(0.13)	-0.00	(0.21)	0.17	(0.15)
NZ[a]	0.04	(0.29)	0.27	(0.34)	0.03	(0.26)
NO[c]	-1.05	(1.66)	-3.47*	(2.07)	-1.51	(1.51)
RU[a]	-0.23	(0.65)	-0.55	(0.35)	0.32	(0.23)
SG[b,c]	1.71**	(0.72)	-2.07**	(0.90)	1.56**	(0.64)
SE[a]	0.30	(0.31)	1.84*	(0.94)	-0.36**	(0.24)
CH[a]	-0.10	(0.13)	-0.36	(0.26)	-0.27	(0.21)
TH[a]	-0.57	(0.67)	0.36	(0.41)	-1.14	(0.71)
UA[a]	0.07	(0.29)	-0.20	(0.12)	0.21***	(0.04)
US[c]	-1.46***	(0.25)	-0.19	(0.26)	-0.65***	(0.11)

Notes: Delta method standard errors are in parentheses.

[a] Hypothesis of no long-run relationship is rejected according to Pesaran et al. (2001) for both k=2 and k=5.

[b] Hypothesis of no long-run relationship could not be rejected for k=2.

[c] Hypothesis of no long-run relationship could not be rejected for k=5.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Source: Own computation.

Results suggest that German exporters often stabilize prices in local currencies, as the number of negative coefficients is prevailing. The magnitude of such adjustment varies for different types of exchange rate changes. Negative coefficients are obtained for nine out of sixteen countries in the depreciation (e^-) regime. This implies that in exports to these destinations Euro depreciation is followed by a price increase in Euro, so that the price paid in local currency changes only slightly, while the exporter extracts extra profits. LCPS related to Euro depreciation is found to be highly

over time, as they capture changes in export price, similar between all the destination countries. The more countries are added to the model, the more trustable the outcome is. That is why (despite the fact that this estimate can capture other than marginal cost changes factors) Silvente (2005) used the estimated time-specific effect of the Knetter model to proxy marginal costs in a residual demand elasticity study. Being aware that the estimated time-specific effect is not a perfect proxy for not observable marginal costs, we treat the outcomes with caution. Details of this estimation can be obtained upon a request.

[7] More information on data availability is gathered in the Appendix A.

[8] The outcomes of originally estimated NARDL models are skipped here in order to save the space.

significant for markets including Canada (77.3 percent) and Great Britain (92.6 percent). As for the US, a coefficient of 146 percent suggests overshooting and a more than proportional price increase as the Euro depreciates. For those markets such price increases during a Euro depreciation is a source of smoothing of the Euro appreciation effect on the destination market prices, when the appreciation is offset via markup reduction.

A positive coefficient in the case of a Euro depreciation would imply an additional price decrease, which is more difficult to explain from the theoretical point of view. Most of the positive coefficients we obtained in our sample are not statistically significant at any reasonable probability level.

Inner regime outcomes in general support the necessity of implicit introducing hysteresis into the model. Most of the coefficients are only of a very low statistical significance or are found for equations, for which we could not reject the hypothesis of no long-run relationship.

The coefficients referring to the Euro appreciation tell us two stories, as different as the signs of the coefficients obtained. A negative coefficient suggests a case of LCPS, when an exporter offsets a part of the appreciation via a reduction of the markup. This leads to a decrease in profits the exporter would normally receive, if the price and quantity sold remained unchanged. Without price adjustment the price paid by the partner country will rise, as the Euro appreciates, which might lead to a decrease in the quantity demanded. LCPS in this situation assures that the price in the local currency does not change too much and exporter is able to keep his market share on the destination market.

A positive coefficient related to a Euro appreciation means that the exporter uses a change in the exchange rate to additionally increase the price. This would be possible only in markets where exporters are able to realize market power, as they are sure that the demand stays constant, no matter what happens to the price. A 50/50 distribution of positive and negative coefficients was found for our sample. Negative coefficients seem to appear more often for countries which contribute the most to the total exports of German beer (e.g., the US, Great Britain, Switzerland, Canada and Sweden). This proves the idea of cautious policy of German exporters on important markets, where protecting of the market share is of high priority. Among those destination markets, Canada, Norway, Great Britain and the US tend to be the destinations with the most pronounced LCPS policy, as all exchange rate changes, irrespective of their sign are at least partially offset.

Euro appreciations are estimated to be offset up to 67.1 percent for Canada, 32.6 percent for Israel, 36.3 percent for Sweden, 78.8 percent for Great Britain and 64.7 percent for the US. The amplification of the Euro appreciation is recorded for Australia (36.4 percent), Brazil (16.2 percent), and Ukraine (21.1 percent). Positive coefficients found for China (98.7 percent) and Singapore (156.1 percent) cannot be trusted as no long run relation was found for these models and the estimates lie beyond reasonable expectations.

Table 2 presents the outcomes of symmetry testing. In most cases the hypothesis of a long-run symmetry between all regimes is rejected. Few exceptions are New Zealand, Norway and Great Britain. While in the first two countries pricing seems to be rather independent of exchange rate fluctuations, the UK shows a very pronounced but symmetric LCPS. For most of the sample, symmetry was rejected for large appreciation and depreciation regimes, while the asymmetry between appreciations/depreciations and inner regime is not so pronounced. The short-run dynamics do not seem to play an important role in our sample. This is also reflected in symmetry test results, most of which support symmetry in the short run.

Table 2. Symmetry testing results

	$ER^{-}=ER^{\pm}=ER^{+}$	$ER^{-}=ER^{+}$	$ER^{-}=ER^{\pm}$	$ER^{\pm}=ER^{+}$	$\Delta ER^{-}=\Delta ER^{\pm}=\Delta ER^{+}$
AU	0.09	0.03	0.04	0.05	0.83
BR	0.00	0.00	0.08	0.53	0.51
CA	0.02	0.08	0.01	0.01	0.00
CN	0.05	0.02	0.77	0.63	0.45
GB	0.46	0.31	0.22	0.21	0.08
IL	0.00	0.16	0.05	0.02	0.23
JP	0.02	0.01	0.75	0.52	0.40
NZ	0.47	0.93	0.63	0.51	0.04
NO	0.63	0.40	0.34	0.36	0.41
RU	0.00	0.19	0.72	0.10	0.68
SG	0.06	0.17	0.02	0.02	0.25
SE	0.00	0.00	0.10	0.02	0.16
CH	0.07	0.04	0.44	0.85	0.11
TH	0.00	0.00	0.32	0.13	0.52
UA	0.01	0.57	0.39	0.00	0.10
US	0.00	0.00	0.01	0.12	0.38

Notes: Wald test results of equality of the coefficients are reported (p-values).

5. Summary and conclusion

In this study we relaxed the assumption of linear and symmetric PTM and allowed the exporter's price reaction to exchange rate fluctuations to differ. To test the nonlinearity of PTM we concentrated on German beer exports, for which empirical studies often find evidence of strategic pricing. Furthermore, we increased the number of considered trade partners up to sixteen in order to test if some special patterns can be found for rarely (or never) considered destinations.

Our findings reveal different pricing strategies in destination markets and show that price reactions of exporters towards the exchange rates of different direction and magnitude are not the same. There are clearly markets where German exporters offset exchange rate changes in order to keep local currency prices relatively unchanged (e.g., Canada, Great Britain, the US, Israel). Still, the reaction of export prices to Euro appreciations and depreciations is different. There are markets, where German exporters exploit market power and use Euro appreciations as an exogenous reason to raise the export prices (e.g., Australia, Brazil, and Ukraine). There are also markets, where the exchange rate changes are fully passed-through, as no relation between export prices and exchange rates could be found (e.g., Japan, New Zealand, Thailand). Other, than exchange rate fluctuations, factors must be important for the export strategies for these destinations. For some destination countries (e.g., China, Singapore) we were not able to identify any clear pattern or derive any conclusions due to time-series issues. We also failed to come up with consistent outcomes for Sweden. A proper analysis for those destinations would require, e.g., a longer time span. Still, nearly for all countries, where PTM was found, both types of nonlinearities were revealed.

The size of the market and its importance for exporters seem to play a decisive role in pricing decisions[9]. LCPS was found for exports to countries which host a large share of German beer exports and where the competition with other countries' brands is very strong (e.g., the US, Great Britain or Canada, which are the main trade partners of German beer exporters outside the Euro zone). Those markets require high sunk costs of market entry and keeping the market share is a challenge for an exporter. To protect their market shares on these destination markets, the exporters partially offset Euro appreciations by means of their markups, which allows smoothing the local-

[9] Some industry case-studies also prove this point (see, e.g., Schmid and Luber (2013), for the case of Bitburger).

currency price change. During Euro depreciations, exporters were often found to adjust the prices in a similar manner to keep the price in local currency stable. In this case, LCPS implies the increase of the Euro price and accumulation of the extra profits, which are then used to partially offset Euro appreciations. A complete pass-through of depreciations might be a sign of expanding policy on the market. For countries with a minor role in German total beer exports, a complete pass-through of all kinds of exchange rate changes is often found. An amplification of the Euro appreciation on prices might be a sign of a market power realization on some markets.

Although in general our outcomes support the findings of previous empirical studies on PTM in the beer sector, as we found the price adjustment in those markets, where PTM is typically recorded, they clearly show, that the markup adjustments heavily depend on the sign and the magnitude of the exchange rate changes. This lets us conclude that the outcomes of the linear PTM model provide only very little information on the price adjustments due to the exchange rate changes and cannot be used to derive any conclusions about the market power realization on the export markets. More detailed information can only be found out, once both types of PTM nonlinearities are taken into account.

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Appendix A. Data related information

Destination	Country code	Data availability		Number of observations
Australia	AU	1991-01	2012-12	264
Brazil	BR	1995-09	2012-12	208
Canada	CA	1991-01	2012-12	264
China	CN	1998-03	2012-12	178
Great Britain	GB	1991-01	2012-12	264
Israel	IL	1993-11	2012-12	230
Japan	JP	1991-01	2012-12	268
New Zealand	NZ	1998-03	2012-12	178
Norway	NO	1998-03	2012-12	178
Russia	RU	1999-01	2012-12	168
Singapore	SG	1991-01	2012-12	264
Sweden	SE	1991-01	2012-12	264
Switzerland	CH	1991-01	2012-12	264
Thailand	TH	2001-06	2012-12	139
Ukraine	UA	1994-11	2012-12	218
United States	US	1991-01	2012-12	264