International Network for Economic Research

Working Paper 2014.02

Asymmetry and Hysteresis: Two Perspectives on Pricing-to-Market Nonlinearity

by

Svetlana Fedoseeva & Laura M. Werner

(University of Giessen)

Asymmetry and Hysteresis: Two Perspectives on Pricing-to-Market Nonlinearity

Svetlana Fedoseeva (corresponding author)

University of Giessen
Center for International Development and Environmental Research
Institute for Agricultural Policy and Market Research
Senckenbergstr. 3, 35390 Giessen, Germany
Email: svetlana.fedoseeva@zeu.uni-giessen.de

Laura M. Werner

University of Giessen
Center for International Development and Environmental Research
Senckenbergstr. 3, 35390 Giessen, Germany
Email: laura.m.werner@zeu.uni-giessen.de

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 change, we question this statement and test for hysteresis and asymmetry of pricing-to-market (PTM). Using the German export beer market as an example, we show that both types of nonlinearities play an important role in PTM decisions.

Keywords: Asymmetry, beer exports, hysteresis, local currency price stabilization, pricing-to-market

JEL-Codes: C22, D40, F12, F14

Acknowledgements: Work on this paper is based on the project "What Explains Agricultural Trade of the EU and Germany? Theoretical and Econometric Analyses on Liberalization, Macro Effects and Hysteresis" (HE 1419/12-1) financed by Deutsche Forschungsgemeinschaft. The Authors would like to thank the organizers and participants of the INFER Annual Conference 2014 in Pescara, WIEM 2014 in Warsaw and MURPHYS-HSFS-2014 in Berlin for their valuable comments and intensive discussions. All remaining errors are ours and only ours.

The final version of the paper can be found in:

Fedoseeva, S. and Werner, L. M. (2015). How linear is pricing-to-market? Empirical assessment of hysteresis and asymmetry of PTM. Empirical Economics. DOI: 10.1007/s00181-015-0957-4

I. 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, p. 49) as "the phenomenon of foreign firms maintaining or even increasing their export prices to the United States when the dollar rises…" Knetter (1993, p. 473) 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". 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 for sugar confectionery exports by Fedoseeva (2013), who showed that PTM can be regarded neither as linear, nor as symmetric and suggested that price hysteresis needs to be taken into account as it influences exporters' price decisions in the long run.

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

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

is done using the example of German beer exports, as beer has been an especially popular object of 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, 1995; 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., Baldwin, 1989; 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.

[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.

To address the symmetry and hysteresis of PTM, we apply two different approaches, which allow us to capture both types of PTM nonlinearities and shed more light on the reasons behind the exporters' price decisions. First, we fit the hysteresis model of Belke et al. (2013) into a PTM framework. This model allows us to separate the effects of small and large exchange rate changes on prices and lets us test whether PTM is hysteretic and whether there is some band of inaction, within which all exchange rate changes are ignored. Second, 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.

This paper contributes to the existing literature by extending the PTM analysis through a) addressing nonlinearity and asymmetry of the exporter pricing both in the long and the short run, b) testing for hysteresis of PTM, and c) focusing 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 outside of typically considered markets.

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

II. Theoretical Model and Empirical Solution(s)

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

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

the elasticity of demand with respect to local currency price is not constant, making price setting in source country's currency a strategic decision:

$$P = f(MC, ER, \boldsymbol{Z}), \quad (1)$$

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

A. Hysteresis

The first approach searches for hysteresis. The idea of hysteresis is that the current state of an output variable depends not only on the current value of an input variable but on the former local extreme values of it. So, there results a path dependent nonlinear system which reacts only to large variations of the input variable. Originating in physics, this concept is applicable to the study of various economic problems, such as modeling labor markets (e.g., Belke and Goecke, 2001; Mota et al., 2012) or exporter behavior (e.g., Baldwin, 1989; Campa, 2004; Kannebley, 2008). Here, we apply the hysteresis approach to assess the nonlinearity of PTM. As sunk costs are required to enter foreign markets and high competition in those often involves implementing pricing strategies to keep market shares, PTM might turn out to be hysteretic as well.

Hysteresis in our context is associated with a price reaction, which follows large exchange rate changes but ignores small ones. Every exporter is expected to have two individual thresholds. One, which causes price adjustments when the exchange rate increases and the other, lower one, which leads to price changes in case the exchange rate declines. The area between these two thresholds is called the band of inaction. In this band of inaction the past movements of the exchange rate determine the actual price level. This behavior corresponds to the (mechanical) theory of a non-ideal relay, as described in, e.g., Krasnoselskii and Pokrovskii (1989) or Mayergoyz (2003).

The non-ideal relay (Figure 1) sketches the behavior of an exporter who uses the LCPS mechanism. If the exchange rate is increasing and the initial price level is rather high, the exporter will keep this price until a threshold is passed. To stabilize the price in local currency the exporter will at some point react and change his price to a lower level. If the exchange rate decreases after the exporter changes his price, he will not alter his price level immediately, but wait until he has more certain expectations about the future behavior of the exchange rate as every price change involves costs. Does the exchange rate increase once more, he will keep the low price level, but if the exchange rate decreases there will be a second threshold where the exporter will raise his price again. Analogously, as long as the exchange rate stays low, the exporter will keep his high price level and although the exchange rate may rise again, he will not alter his price until the first threshold is passed.

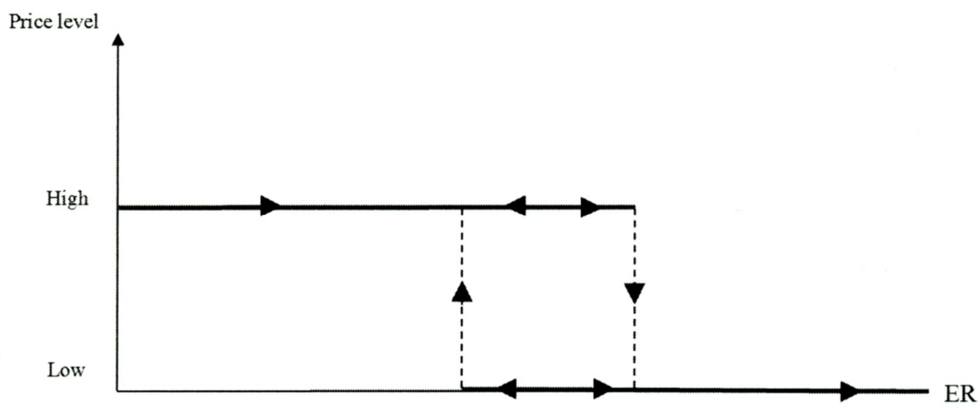

Figure 1. Non-ideal relay

The aggregation of the exporters with individual thresholds gives a hysteresis loop as every change of the exchange rate direction, that is from decreasing to increasing, for example, triggers first a few exporter thresholds and, when the increase of prices continues, causes more and more exporters to adjust their prices. That is, every change of direction of the exchange rate, and therefore every local extreme value, results first in slight adjustment processes, called play, and if the change continues, in strong reactions, called spurt (see, e.g., Goecke, 2002 or Mayergoyz, 2003). The model of Belke and Goecke (2001) linearizes the classic hysteresis loop.

Figure 2 shows the aggregated hysteresis loop in case of LCPS. If the exchange rate is low and the exporters' price in Euro is rather high, a first increase of the exchange rate will result in only slight or no adjustments. But, if the exchange rate increases further more and more thresholds of individual exporters will be passed and a strong price reaction on the spurt line will follow. After a local maximum, the exchange rate will decrease and the exporters will keep their low prices as long as the exchange rate stays within this band of inaction. If the exchange rate decreases further, the exporters will raise their prices again. The drawn play lines in Figure 2 are not fixed. They will be shifted as soon as a movement on a spurt line changes its direction.

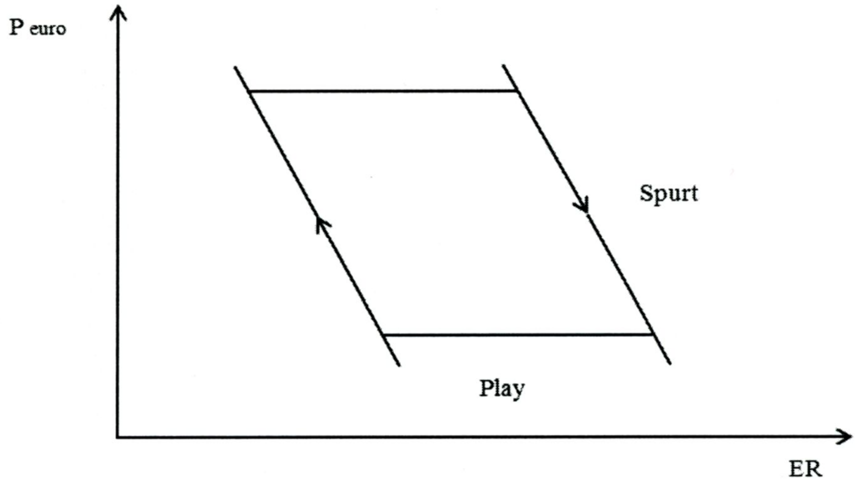

Figure 2. Spurt and play in case of LCPS hysteresis

To test for this behavior a filtered version of the input variable (spurt), is added to a standard linear model. This spurt variable is constant as long as the underlying variable, the exchange rate, stays within a play area, and follows the movement of the exchange rate as soon as it leaves it. After a local extreme value and a following change of the direction of the exchange rate, the spurt stays again constant as long as the exchange rate stays within the play range. Therefore the model analyses if there is a difference of the slope of the play line and the spurt line.

To test whether this is the case, two models, a linear and a nonlinear one (including spurt) are estimated, using both OLS and FMOLS estimation methods to account for cointegration issues[4].

(2) $$P_t = \gamma_1 c + \alpha_1 ER_t + \delta_1 MC_t,$$

(3) $$P_t = \gamma_2 c + \alpha_2 ER_t + \beta Spurt_t + \delta_2 MC_t.$$

Here, the fob export price in Euro is the dependent variable. The aim is to examine if there is any influence by the exchange rate on the price. First, the additional spurt variable has to be computed, which is done by means of the algorithm provided by Belke and Goecke (2001). The play width used by the algorithm represents the necessary change of the exchange rate which causes an adjustment in price. As the actual play width is unknown it is estimated with a grid search. The models for all reasonable play values are estimated and the results of the one with the highest explanatory power are presented in the outcomes section.

The coefficients of the exchange rate and the spurt are our primary interest. The coefficient α_1 of the first equation represents the influence of the exchange rate on prices and, therefore, captures PTM behavior in the static linear model. In the second equation, the coefficient α_2 of the exchange rate represents the slope of the play area, that is the area with no or only slight reactions to the exchange rate movements. The coefficient β of the spurt variable is the amount of slope to add to α_2 outside the play area (Figure 3). If β is significant, the relationship between exchange rate and price is nonlinear and there is hysteresis. Due to the indirect quotation of the exchange rate, we interpret a negative sign of the coefficient of the exchange rate $\alpha_{1,2}$ and the spurt β as an application of LCPS mechanisms. In this case exporters tend to offset the effect of the exchange rate change on prices in local currencies through adjustment of their own export prices in Euro. Positive signs mean amplification of the exchange rate effects on the price.

[4] Equations are estimated in a double-log form. Here and further in the country-specific index as well as the log notation are omitted to simplify notations.

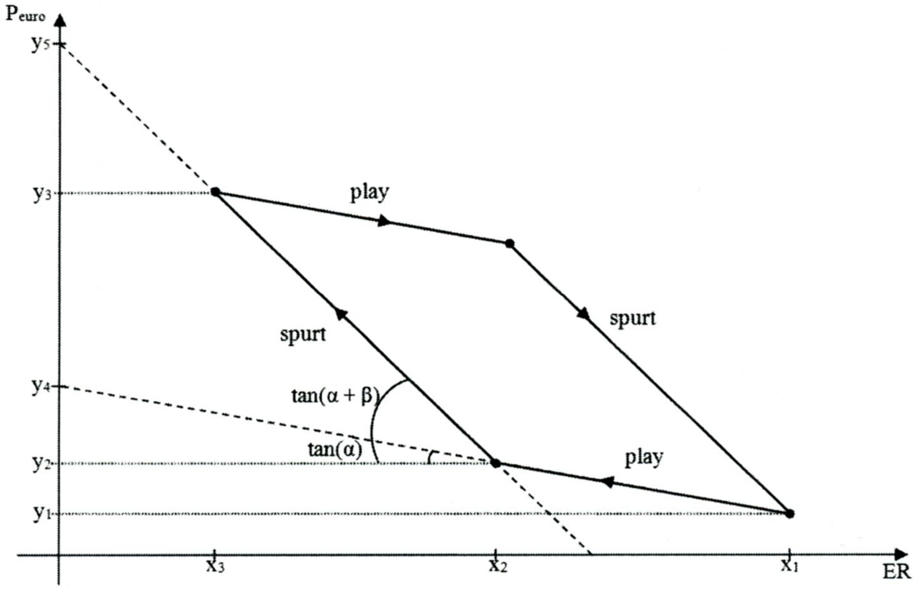

Figure 3. Spurt and play in the hysteresis model

Hysteretic behavior of exporters which use PTM strategies would be to adjust their Euro prices to large changes of the exchange rate. Small changes would have no significance and therefore would be ignored. Therefore, a negative and significant *β* coefficient indicates hysteresis in the case of LCPS.

If the exporters do not wait to apply LCPS mechanisms there would be no hysteresis and so, the coefficient *β* would not be significant. But, the coefficients $\alpha_{1,2}$ of the exchange rate are expected to be negative and significant to indicate LCPS.

The amplification of the exchange rate change effect on prices will be revealed by positive signs of the exchange rate coefficients. Such amplification might be driven by the ability of the exporter to exploit market power on some destination markets.[5] However, in case the exporters do not use every small exchange rate movement to amplify their prices they behave hysteretically again. So, the coefficient of the spurt variable is expected to be positive and significant. Figure 4 illustrates hysteresis for the case of amplification of the exchange rate effect on prices.

[5] In case of Euro appreciation, see the following chapter where this is discussed in some more detail.

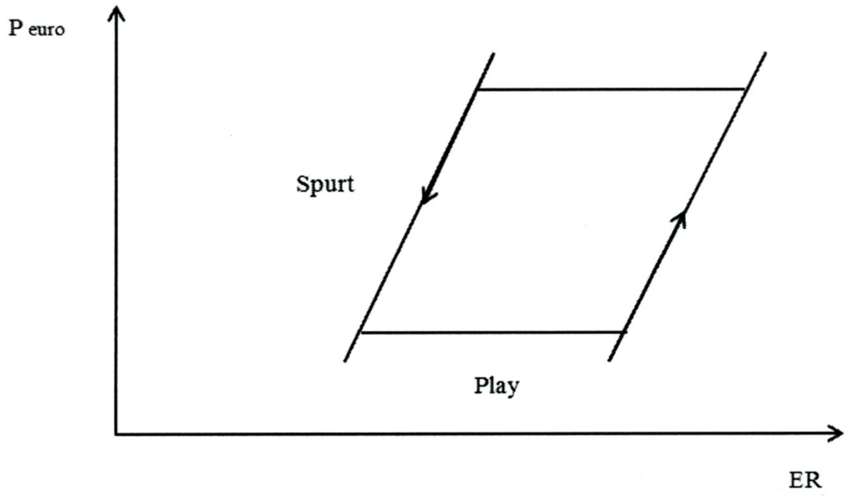

Figure 4. Spurt and play in case of price amplification hysteresis

Prices which are amplified without delay will be driven by a positive exchange rate influence but not by a spurt influence. The *β* coefficient is not significant in this case.

If neither $\alpha_{1,2}$ nor *β* are significant the exchange rate has no influence on the price. There is no PTM in this case. Table 1 summarizes the interpretations of the coefficients.

Table 1. Interpretation of coefficients in hysteresis analysis

$\alpha_{1,2}$	β	PTM		Hysteresis
		(LCPS)	(Amplification)	
Not significant	Not significant			
Not significant	Significant, negative	+		+
Significant, negative	Not significant, negative	+		
Not significant	Significant, positive		+	+
Significant, positive	Not significant, positive		+	

B. Asymmetry: Partial Sum Decomposition

The second approach allows us to test, whether currency appreciations and depreciations influence the price adjustment similarly. To do so 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[6] (Granger and Yoon, 2002) directly within the model.

To correctly specify the model and account for the presence of hysteresis, for which we test implicitly by means of the hysteresis analysis introduced in the previous subsection, we extend the variable decomposition from the one-threshold case (where only positive and negative changes are separated) to the two-threshold decomposition. A similar decomposition was applied by Verheyen (2013) to the study on exchange rate nonlinearities in EMU exports in order to test whether especially large changes affect exports:

(4) $$ER_t = ER_0 + ER_t^- + ER_t^{\pm} + ER_t^+,$$

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*[7] so that:

(5) $$ER_t^- = \sum_{j=1}^{t} \Delta ER_j^- = \sum_{j=1}^{t} \Delta ER_j I\{\Delta ER_j \leq -STD\};$$

(6) $$ER_t^+ = \sum_{j=1}^{t} \Delta ER_j^+ = \sum_{j=1}^{t} \Delta ER_j I\{+STD \leq \Delta ER_j\};$$

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

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

[6] 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.

[7] Descriptive statistics for *ΔER* is provided in Appendix A.

estimate the entire model in a log-log form and overcome the problem of taking logs of negative numbers, noted by Shin et al. (2013) and Verheyen (2013).

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:

$$(8)\ \Delta P_t = \alpha_0 + \eta\left(P_{t-1} - \kappa_1 ER^{-}_{t-1} - \kappa_2 ER^{\pm}_{t-1} - \kappa_3 ER^{+}_{t-1} - \kappa_4 MC_{t-1}\right) + \\ + \sum_{\tau=0} \lambda_\tau \Delta ER^{-}_{t-\tau} + \sum_{\tau=0} \mu_\tau \Delta ER^{\pm}_{t-\tau} + \sum_{\tau=0} \pi_\tau \Delta ER^{+}_{t-\tau} + + \sum_{\tau=0} \varphi_\tau \Delta MC_{t-\tau} + \\ + \sum_{\omega=1} \chi_\omega \Delta P_{t-\omega} + u_t$$

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

$$(9) \qquad e^{-} = -\frac{\kappa_1}{\eta};\ e^{\pm} = -\frac{\kappa_2}{\eta};\ e^{+} = -\frac{\kappa_3}{\eta}.$$

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.

III. 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 5 shows the role of these countries in German beer exports.

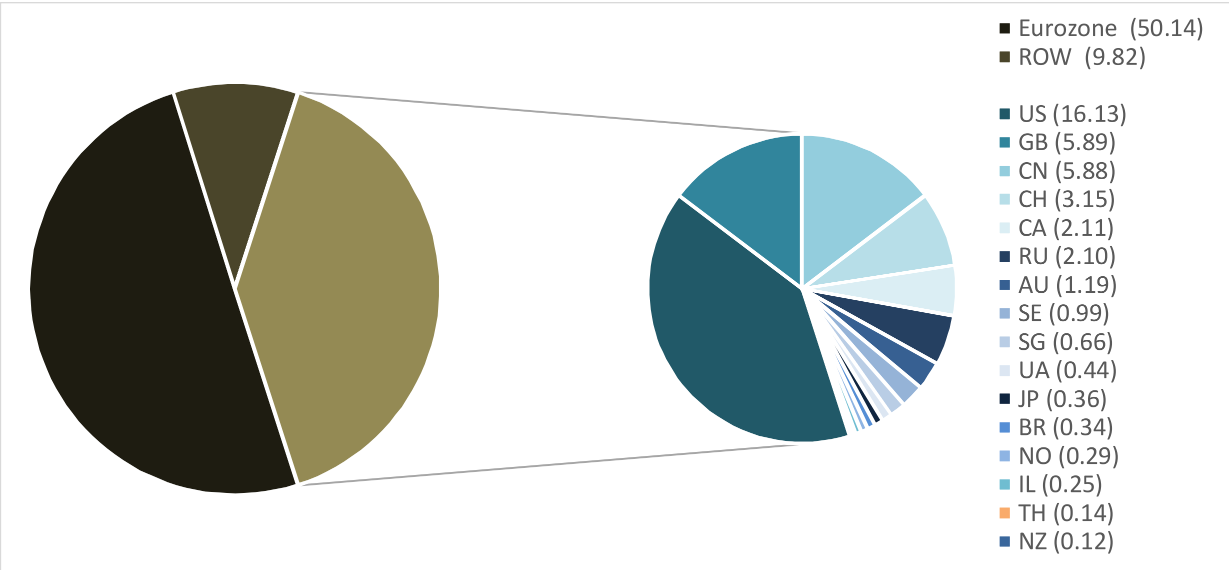

Figure 5. Distribution of German beer exports (based on the Eurostat data, 2013)

Beer is defined according to SITC classification (product group code 11230). Prices are constructed as unit values, which are calculated from Eurostat's export values and quantities[8]. 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[9].

Whenever it was possible, the estimation period was chosen from January 1991 to December 2012. For some destinations though the information was available only for a part of the sample for all or some required series. Because the spurt variable computation requires starting at a local maximum or minimum of the exchange rate, the samples for the hysteresis analysis had to be additionally adjusted. Due to these adjustments some countries had to be dropped from the hysteresis analysis, as we did not have enough data. Those were only a few cases though. Appendix B gathers the information on data availability for each destination of our sample.

IV. Results

We report our outcomes in two subsections, which correspond to approaches that we applied in order to address the nonlinearity of pricing-to-market.

A. Hysteresis

In Table 2 the outcomes of the estimated hysteresis model are presented. In Panel A the results of the model without the spurt variable (linear model) are presented and in Panel B the coefficients of the nonlinear model with the spurt variable. Appendix C presents the results

---

8 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.

9 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 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.

Table 2. Hysteresis outcomes (OLS)

	Panel A. Linear model	Panel B. Nonlinear model	
	ER (α_1)	*ER*(α_2)	*Spurt* (β)
AU	0.22***	-0.31*	0.81***
	(0.08)	(0.17)	(0.22)
BR	0.16***	0.02	4.27***
	(0.05)	(0.05)	(0.86)
CA	-0.52***	0.14	-0.70***
	(0.05)	(0.15)	(0.15)
CN	0.81***		
	(0.15)		
GB	-0.41***	-0.49***	0.24
	(0.09)	(0.12)	(0.22)
IL	-0.51***	-0.21	-0.68**
	(0.10)	(0.17)	(0.32)
JP	0.07		
	(0.08)		
NZ	0.10		
	(0.15)		
NO	-0.28	2.49***	-4.38***
	(0.34)	(0.47)	(0.59)
RU	0.18***	0.07	0.11
	(0.06)	(0.09)	(0.07)
SG	0.41***	0.96***	-1.81***
	(0.14)	(0.17)	(0.35)
SE	0.36*	-0.11	1.24***
	(0.21)	(0.24)	(0.34)
CH	0.04	-0.68***	0.78***
	(0.06)	(0.12)	(0.12)
TH	-0.27		
	(0.22)		
UA	0.18***		
	(0.02)		
US	-0.76***	3.21***	-4.02***
	(0.05)	(0.87)	(0.88)

Notes: Standard errors presented in parenthesis.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

obtained with the FMOLS estimation. For some countries (e.g., China, Japan, New Zealand) it was not possible to estimate the model with the spurt due to the zero playwidth. There are no results for Ukraine because the remaining sample was too short.

The outcomes suggest that exporters' reaction to the exchange rate changes differs between destination countries. The coefficients of the linear static model indicate by negativism LCPS behavior for five countries, Canada, Israel, Norway, Great Britain and the US and give hint to price amplification for eleven countries, including Australia, China, Brazil, Japan, New Zealand, Russia, Singapore, Sweden, Switzerland, Thailand and Ukraine.

This coarse assignment can be specified by a closer examination of the β coefficients. Hysteresis in the local currency price stabilization mechanism is expected if the β coefficient is negative and significant. This is found for Canada, Israel, Norway and the US. The negative α_1 coefficients of the model without spurt support the LCPS interpretation. For Canada, Norway, and the US the α_2 coefficient is positive and β is negative but as $\alpha_2+\beta<0$, there is no contradiction to the linear model.

A special case is Great Britain. Here, the spurt coefficient is not significant and the exchange rate coefficients of both models are negative. Therefore, we conclude that German beer exporters adjust their Euro prices without delay. That is, the LCPS, but no hysteresis is found for the UK.

On the other hand there seem to be some countries where beer exporters use exchange rate fluctuations to raise prices excessively. In this case we find also hysteresis strategies. A positive, significant spurt coefficient indicates hysteretic price amplification in Australia, Brazil, and Sweden. The positive exchange rate coefficients of the model without spurt support this interpretation. Like above, a conflicting sign of the α_2 coefficient to β is no problem especially when it is not significant. Similar reactions to exchange rate fluctuations are expected for China, Thailand (and Ukraine). But in these countries no hysteresis occurs.

Switzerland seems to be a special case of pricing because on the one hand the spurt coefficient is positive and significant but on the other hand the exchange rate coefficient is negative and significant as well. Besides, α_1 of the model without spurt is not significant and the sum α_2+β of the model with spurt is, like α_2, close to zero. As the coefficients or the sum of them are nearly zero we conclude that there are other factors involved that determine the price for Switzerland.

As mentioned above, we could not estimate a spurt model for Japan and New Zealand. However, the linear model suggests no relation between prices and exchange rates for those destinations. Hence, we conclude that the exchange rate is fully passed through to the prices of these two markets, which is further tested within NARDL approach.

B. Asymmetry

Table 3 presents the long-run elasticities of prices with respect to the exchange rate. The outcomes of the originally estimated NARDL model are reported in Appendix D. 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 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 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. 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 significant for markets including Canada (77.3 percent) and Great Britain (92.6

Table 3. The long run elasticities of price with respect to exchange rates changes

	e^{-}	$e^{\pm}$	e^{+}
AU[a]	0.50***	-0.12	0.36***
	(0.16)	(0.21)	(0.14)
BR[a]	-0.20	0.27**	0.16**
	(0.16)	(0.12)	(0.07)
CA[a]	-0.77***	-0.27*	-0.67***
	(0.12)	(0.16)	(0.11)
CN[b,c]	0.27	0.56	0.99***
	(0.49)	(0,97)	(0.34)
GB[a]	-0.93***	-0.02	-0.79***
	(0.32)	(0.52)	(0.25)
IL[a]	-0.19	1.32*	-0.33*
	(0.25)	(0.71)	(0.17)
JP[a]	0.08	-0.00	0.17
	(0.13)	(0.21)	(0.15)
NZ[a]	0.04	0.27	0.03
	(0.29)	(0.34)	(0.26)
NO[c]	-1.05	-3.47*	-1.51
	(1.66)	(2.07)	(1.51)
RU[a]	-0.23	-0.55	0.32
	(0.65)	(0.35)	(0.23)
SG[b,c]	1.71**	-2.07**	1.56**
	(0.72)	(0.90)	(0.64)
SE[a]	0.30	1.84*	-0.36**
	(0.31)	(0.94)	(0.24)
CH[a]	-0.10	-0.36	-0.27
	(0.13)	(0.26)	(0.21)
TH[a]	-0.57	0.36	-1.14
	(0.67)	(0.41)	(0.71)
UA[a]	0.07	-0.20	0.21***
	(0.29)	(0.12)	(0.04)
US[c]	-1.46***	-0.19	-0.65***
	(0.25)	(0.26)	(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.

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 4 presents the outcomes of symmetry testing.

Table 4. 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).

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.

V. Summary and conclusions

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, depending on the characteristics of the latter. To address the nonlinearity of PTM we applied the hysteresis framework (to test if there is a difference in the exporter's price reactions towards small and large exchange rates fluctuations) and the partial sum decomposition approach (to test if those price responses are symmetric for currency appreciations and depreciations). This makes the study the first attempt at combining these different methods to obtain more information on the exporters' pricing behavior. 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. Hysteresis in LCPS was found for Canada, Israel, Norway and the US (for the case of Great Britain we also found LCPS, which, however, turned out to be not hysteretic), while hysteresis in amplification of the exchange rate change effects on prices – for Australia, Brazil and Sweden. This implies that for some countries there is a certain band of inaction, within which exporters do not adjust their prices (due to, e.g., menu costs) and wait for the following development of the exchange rate. This band is country-specific and it heavily depends on the volatility of the exchange rate between the trading partners.

As price hysteresis might be asymmetric, we conducted the analysis based on an exchange rate decomposition and showed that pricing decisions of exporters depend not only on the magnitude, but also on the direction of the exchange rate change. 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. Table 5 summarizes the information regarding hysteresis and asymmetry in our sample.

Table 5. Summary of hysteresis and asymmetry results

No PTM	PTM (LCPS)	PTM (Amplification)	Ambigous
Russia	Canada[b)]	Australia[b)]	China[c)]
Switzerland	Israel[b)]	Brazil[b)]	Norway[c)]
Japan[a)]	Great Britain	Ukraine[a)]	Singapore[c)]
New Zealand[a)]	US[b)]		Sweden
Thailand[a)]			

Notes:

[a)] No hysteresis model could be estimated for the destination country.

[b)] Hysteresis in found in pricing of exports to the corresponding country.

[c)] Hypothesis of no long-run relationship could not be rejected by means of the bounds testing.

The size of the market and its importance for exporters seem to play a decisive role in pricing decisions[10]. 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

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

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-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. Similarly to Fedoseeva (2013) only for very few countries symmetry and linearity could not be rejected. 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. We also revealed few other markets, where strategic pricing might take place. Our main contribution, still, is in proving the hypothesis of nonlinearity of PTM. The application of two approaches revealed consistent results regarding the markets where strategic pricing is present, which allowed us to better interpret pricing behavior of German beer exporters. For all of the destinations, where PTM was found, we also concluded that the markup adjustments heavily depend on the sign and the magnitude of the exchange rate changes. Hysteresis in prices turned out to play an important role in the exporters' price adjustments, as it was found nearly for all the countries, where PTM was revealed. 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. More detailed information can only be found out, once both types of PTM nonlinearities are taken into account.

REFERENCES

Baldwin, R. (1989). Sunk-cost hysteresis. Working Paper 291, National Bureau of Economic Research.

Belke, A., Goecke, M. & Guenther, M. (2013). Exchange rate bands of inaction and play-hysteresis in German exports – sectoral evidence for some OECD destinations. Metroeconomica, 64(1), 152–79.

Belke, A. & Goecke, M. (2001). Exchange rate uncertainty and employment: An algorithm describing „Play“. Applied Stochastic Models in Business and Industry, 17, 181-204.

Bussière, M. (2013). Exchange rate pass-through to trade prices: The role of non-linearities and asymmetries. Oxford Bulletin of Economics and Statistics, 75(5), 731-58.

Campa, J. M. (2004). Exchange rates and trade: How important is hysteresis in trade? European Economic Review, 48, 527-48.

Delgado, F. A. (1991). Hysteresis, menu costs and pricing with random exchange rates. Journal of Monetary Economics, 28, 461-84.

Fedoseeva, S. (2013). (A)symmetry, (non)linearity and hysteresis of pricing-to-market: Evidence from German sugar confectionery exports. Journal of Agricultural and Food Industrial Organization, 11, 69-85.

Goecke, M. (2002). Various concepts of hysteresis applied in economics. Journal of Economic Surveys, 16(2), 167-88.

Goerg, H., Halpern, L. & Murakoezy, B. (2010). Why do within firm-product export prices differ across markets? Discussion Paper 7708, Center for Economic and Policy Research.

Goldberg, P. K. & Knetter, M. M. (1999). Measuring the intensity of competition in export markets. Journal of International Economics, 47(1), 27-60.

Goldberg, P. K. & Hellerstein, R. (2013). A structural approach to identifying the sources of local-currency price stability. Review of Economic Studies, 80(1), 175-210.

Granger, C. W. J. & Yoon, G. (2002). Hidden cointegration. Economics Working Paper No. 2002-02, University of California.

Hellerstein, R. (2008). Who bears the cost of a change in the exchange rate? Pass-through accounting for the case of beer. Journal of International Economics, 76, 14–32.

Kannebley Jr., S. (2008). Tests for the hysteresis hypothesis in Brazilian industrialized exports: A threshold cointegration analysis. Economic Modelling, 25(2), 171-90.

Kasa, K. (1992). Adjustment costs and pricing-to-market: Theory and evidence. Journal of International Economics, 32, 1-30.

Knetter, M. M. (1989). Price discrimination by U.S. and German exporters. The American Economic Review, 79(1), 198-210.

Knetter, M. M. (1993). International comparisons of pricing-to-market behavior. The American Economic Review, 83(3), 473-86.

Knetter, M. M. (1994). Is export price adjustment asymmetric? Evaluating the market share and marketing bottlenecks hypotheses. Journal of International Money and Finance, 13, 55-70.

Knetter, M. M. (1995). Pricing to market in response to unobservable and observable shocks. International Economic Journal, 9(2), 1-25.

Krasnoselskii, M. A. & Pokrovskii, A.V. (1989). Systems with hysteresis. Berlin: Springer.

Krugman, P. (1987). Pricing to market when the exchange rate changes. In S. W. Arndt & J. D. Richardson (Eds.), Real-financial linkages among open economies (pp. 49-70). Cambridge: MIT Press.

Lavoie, N. & Liu, Q. (2007). Pricing-to-market: Price discrimination or product differentiation? American Journal of Agricultural Economics, 89(3), 571-81.

Mayergoyz, I. (2003). Mathematical models of hysteresis and their applications. New York: Elsevier.

Mota, P. R., Varejão, J. & Vasconcelos, P.B. (2012). Hysteresis in the dynamics of employment. Metroeconomica, 63(4), 661-92.

Peltzman, S. (2000). Prices rise faster than they fall. Journal of Political Economy, 108(3), 466-502.

Pesaran, M. H, Shin, Y. & Smith, R.J. (2001). Bounds testing approaches to the analysis of level relationships. Journal of Applied Econometrics, 16, 289-326.

Schmid, S. & Luber, A. (2013). Internationalisierung als Randaktivität. In S. Schmid (Ed.), Strategien der Internationalisierung: Fallstudien und Fallbeispiele (pp. 113-23). München: Oldenbourg.

Shin, Y., Yu, B. & Greenwood-Nimmo, M.J**.** Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework. In W.C. Horrace & R. C Sickles (Eds.), Festschrift in Honor of Peter Schmidt. New York: Springer Science & Business Media (forthcoming).

Silvente, F. R. (2005). Price discrimination and market power in export markets: The case of the ceramic tile industry. Journal of Applied Economics, 8(2), 347-70.

Verheyen, F. (2013). Exchange rate nonlinearities in EMU exports to the US. Economic Modelling, 32, 66-76.

Appendices

Appendix A. Descriptive statistics $\Delta \ln ER$

	Mean	Median	Maximum	Minimum	Std. Deviation
AU	-0.001	-0.003	0.093	-0.071	0.028
BR	0.004	-0.001	0.210	-0.130	0.043
CA	-0.001	-0.002	0.070	-0.077	0.025
CN	0.000	0.000	0.065	-0.076	0.025
GB	0.001	-0.001	0.087	-0.053	0.019
IL	0.002	-0.001	0.126	-0.051	0.025
JP	-0.002	0.000	0.087	-0.138	0.029
NZ	-0.001	-0.003	0.069	-0.062	0.026
NO	-0.001	-0.001	0.068	-0.048	0.016
RU	0.002	-0.002	0.120	-0.109	0.027
SG	-0.001	-0.002	0.048	-0.057	0.021
SE	0.001	0.000	0.105	-0.058	0.017
CH	-0.001	-0.001	0.076	-0.048	0.012
TH	0.000	0.000	0.053	-0.072	0.021
UA	0.010	0.003	0.293	-0.069	0.046
US	0.000	0.001	0.065	-0.079	0.026

Appendix B. Data-related information

Destination	Country code	Data availability		Total number of observations	Start point for hysteresis analysis
Australia	AU	1991-01	2012-12	264	1995-01
Brazil	BR	1995-09	2012-12	208	2000-01
Canada	CA	1991-01	2012-12	264	1995-01
China	CN	1998-03	2012-12	178	1998-04
Great Britain	GB	1991-01	2012-12	264	1995-01
Israel	IL	1993-11	2012-12	230	1996-01
Japan	JP	1991-01	2012-12	268	1995-01
New Zealand	NZ	1998-03	2012-12	178	1998-04
Norway	NO	1998-03	2012-12	178	2000-01
Russia	RU	1999-01	2012-12	168	2001-01
Singapore	SG	1991-01	2012-12	264	1995-01
Sweden	SE	1991-01	2012-12	264	1995-01
Switzerland	CH	1991-01	2012-12	264	1995-01
Thailand	TH	2001-06	2012-12	139	2001-07
Ukraine	UA	1994-11	2012-12	218	1994-12
United States	US	1991-01	2012-12	264	1995-01

Notes: Available number of observations for the hysteresis analysis differs from the total size of the sample due to computational procedure requirements. Last column indicates the start period for the hysteresis analysis.

Appendix C. Hysteresis Outcomes (FMOLS)

	Panel A. Linear model	Panel B. Nonlinear model	
	ER (α_1)	*ER(α_2)*	*Spurt (β)*
AU	0.21*	-0.49**	0.94***
	(0.11)	(0.22)	(0.29)
BR	0.15**	-0.00	7.51***
	(0.06)	(0.06)	(1.48)
CA	-0.55***	0.16	-0.74***
	(0.08)	(0.23)	(0.24)
CN	0.93***		
	(0.22)		
GB	-0.48***	-0.56***	0.28
	(0.13)	(0.16)	(0.30)
IL	-0.54***	-0.12	-0.90**
	(0.13)	(0.23)	(0.43)
JP	0.05		
	(0.10)		
NZ	0.17		
	(0.16)		
NO	-0.25	3.18***	-4.69***
	(0.55)	(0.75)	(0.93)
RU	0.13	-0.05	0.18*
	(0.09)	(0.13)	(0.10)
SG	0.41**	1.08***	-1.76***
	(0.19)	(0.22)	(0.43)
SE	0.31	-0.29	1.13**
	(0.34)	(0.41)	(0.57)
CH	0.06	-0.77***	0.88***
	(0.08)	(0.12)	(0.12)
TH	-0.44		
	(0.32)		
UA	0.19***		
	(0.02)		
US	-0.86***	3.95**	-4.85***
	(0.09)	(1.63)	(1.65)

Notes: Standard errors presented in parenthesis.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Appendix D. NARDL Outcomes

	P(-1)	$ER^{-}(-1)$	$ER^{\pm}(-1)$	$ER^{+}(-1)$	*MC(-1)*	ΔER^{-}	$\Delta ER^{\pm}$	ΔER^{+}	ΔMC
AU[a]	-0.70***	0.35***	-0.08	0.25**	0.34*	0.31	0.02	-0.22	0.78***
	(0.10)	(0.12)	(0.15)	(0.10)	(0.18)	(0.69)	(0.52)	(0.48)	(0.18)
BR[a]	-0.80***	-0.16	0.21**	0.13**	0.50	-0.36	0.41	0.26	0.77***
	(0.09)	(0.14)	(0.10)	(0.06)	(0.35)	(0.53)	(0.43)	(0.40)	(0.28)
CA[a]	-0.49***	-0.38***	-0.13	-0.33***	0.08	-0.68***	0.57*	0.19	0.24***
	(0.10)	(0.08)	(0.08)	(0.08)	(0.08)	(0.24)	(0.34)	(0.33)	(0.08)
CN[b,c]	-0.37***	0.10	0.21	0.37**	-0.72	-0.40	-0.97	-2.28**	1.22***
	(0.12)	(0.19)	(0.37)	(0.17)	(0.56)	(0.97)	(1.33)	(1.04)	(0.34)
GB[a]	-0.40***	-0.37***	-0.01	-0.31***	0.63***	-1.58**	0.88	0.26	0.41**
	(0.08)	(0.14)	(0.20)	(0.11)	(0.24)	(0.79)	(0.90)	(0.40)	(0.19)
IL[a]	-0.59***	-0.11	0.79*	-0.19*	1.74***	0.55	0.46	-1.50**	1.84***
	(0.09)	(0.15)	(0.41)	(0.11)	(0.34)	(1.26)	(1.13)	(0.68)	(0.27)
JP[a]	-0.76***	0.06	-0.00	0.13	0.54**	-0.17	1.05	0.30	1.61***
	(0.09)	(0.10)	(0.16)	(0.11)	(0.21)	(0.41)	(0.94)	(0.52)	(0.25)
NZ[a]	-0.92***	0.04	0.25	0.03	1.40***	-2.00	1.15	-1.32	1.34***
	(0.09)	(0.26)	(0.32)	(0.24)	(0.38)	(1.22)	(0.87)	(0.69)	(0.34)
NO[c]	-0.31***	-0.32	-1.07*	-0.47	0.46	-1.53	-0.89	1.60	1.48***
	(0.08)	(0.47)	(0.62)	(0.40)	(0.50)	(1.63)	(1.56)	(1.69)	(0.35)
RU[a]	-0.52***	-0.12	-0.29	0.17	-0.06	0.29	0.79	-0.03	0.14
	(0.12)	(0.33)	(0.20)	(0.13)	(0.22)	(0.54)	(0.77)	(0.46)	(0.19)
SG[b,c]	-0.33**	0.56***	-0.68**	0.51**	0.22	1.29	-1.25	0.64	0.86***
	(0.15)	(0.25)	(0.30)	(0.24)	(0.22)	(1.17)	(1.18)	(0.66)	(0.29)
SE[a]	-0.43***	0.13	0.79**	-0.16	1.33***	-1.18	1.40	0.14	1.12***
	(0.08)	(0.14)	(0.40)	(0.10)	(0.31)	(0.97)	(1.01)	(0.67)	(0.21)
CH[a]	-0.85***	-0.08	-0.30	-0.24	0.32***	0.02	-1.68**	-0.57	0.30***
	(0.08)	(0.12)	(0.23)	(0.18)	(0.12)	(0.38)	(0.76)	(0.40)	(0.09)
TH[a]	-0.69***	-0.40	0.25	-0.79	1.53**	0.55	1.30	-0.89	1.75***
	(0.09)	(0.46)	(0.28)	(0.48)	(0.67)	(1.42)	(1.64)	(1.17)	(0.43)
UA[a]	-0.91***	0.06	-0.18	0.19***	0.21	-0.83	0.79**	0.60**	0.59**
	(0.07)	(0.26)	(0.11)	(0.04)	(0.30)	(0.65)	(0.37)	(0.24)	(0.27)
US[c]	-0.14***	-0.20**	-0.03	-0.09***	0.09*	-0.21	0.24	-0.18	0.11
	(0.04)	(0.05)	(0.04)	(0.02)	(0.05)	(1.18)	(0.28)	(0.16)	(0.07)

Notes: Heteroscedasticity robust standard errors presented in parentheses. Not reported here results might be obtained upon request.

[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.