

Berner, Eike

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Department of Economics

Economics Working Paper
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exchange rate pass-through: new evidence from german micro data

by Eike Berner



Exchange rate pass-through: New evidence from German micro data

Eike Berner*

Abstract

This paper examines exchange rate pass-through into German import unit values over the last 20 years. I find incomplete pass-through to be the predominant characteristic for German imports with an average rate of 42% over three months. This result holds when considering monthly 8-digit data, the most disaggregated German import data available. Furthermore, I distinguish 16 German trading partners and estimate substantial cross-country differences in the pass-through to import unit values. Imports coming from European countries generally exhibit statistically zero pass-through. By contrast, non-European trading partners are characterized by statistically significant incomplete pass-through rates. I also study whether there are differences in the pass-through rates for appreciations and depreciations, as well as for small and large exchange rate shocks. Moreover, I test for a negative correlation between the goods' quality and its pass-through rate.

Key words: Exchange rate, pass-through, import prices, Germany

JEL codes: F42, F31, F14

*Department of Economics, Christian-Albrechts-Universität Kiel, Ohlshausenstraße 40, 24098 Kiel, Germany. Email: berner@economics.uni-kiel.de. I would like to thank my supervisors, Horst Raff and Holger Görg, the participants at the RIEF Doctoral Meetings in Kiel, and two anonymous referees for helpful comments and suggestions.

1 Introduction

This paper uses highly disaggregated German data to study exchange rate pass-through (ERPT) into import unit values. I am particularly interested in potential differences in ERPT across goods and countries. Therefore, I consider German imported goods at the 8-digit level and distinguish between different trading partners. Additionally, I try to measure the impact of quality on ERPT and analyze whether there are differential effects for appreciations of the Euro compared to depreciations, as well as for small and large exchange rate shocks.

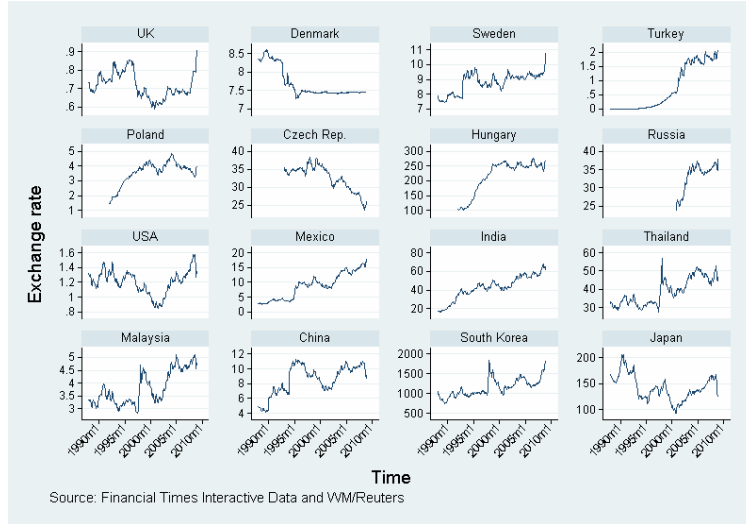
The pass-through of exchange rate shocks and trade shocks through the elimination or imposition of tariffs and non-tariff barriers has important economic effects¹. On a macroeconomic level, the extent of this pass-through is crucial for optimal monetary policy as it directly affects domestic prices and thus inflation rates (see, for instance, Devereux (2001), McCarthy (2007) or Engel (2009)). On a microeconomic level, the degree of pass-through determines how firms and households are affected by external shocks. This is especially true for Germany since its share of imports to total GDP increased in the last twenty years from 21% in 1991 to 32% in 2008².

Surprisingly, there still is little empirical evidence regarding potentially different ERPT effects across trading partners and products. Studies focus either on one or two countries with their specific bilateral trade relation (Gosh and Rajan (2009) or Bergin and Feenstra (2009)), or on single countries and all their trading partners at once (Feinberg (2000), Gust et al. (2006), Olivei (2002), McCarthy (2007)). In the latter case, effective exchange rates are used which comprise several currencies. An aggregated view suppresses a lot of information and can lead to a sectoral estimation bias, as found by Mumtaz et al. (2006). There is also a large heterogeneity in the movements of exchange rates, as Figure 1 shows. For instance, in the last years the euro experienced a substantial appreciation versus the Mexican Peso or the Indian Rupee. On the other hand, the German exchange rate versus the Czech

¹For the equivalent impact of these effects see, for example, Feenstra (1987).

²Values calculated with data from the online database of the German Federal Statistical Office.

Figure 1: Exchange rates with respect to the Euro (Euro/foreign currency)



Koruna depreciated strongly and it remained rather stable with respect to the Danish Krone. By adding 16 different German trading partners - among others the United States, China and the United Kingdom - my analysis is, thus, useful to further distinguish country-specific pass-through rates into German import prices. A lot of studies analyze ERPT into price indices (see also Campa and Goldberg (2005), Campa and Minguez (2006), or Ihrig et al. (2006)), while some consider more disaggregated sectors and price indices (Yang (1997), Mumtaz et al. (2006), Francois et al. (2010)). However, relatively few studies try to estimate ERPT into highly disaggregated unit values for a broader set of products (for instance, Gaulier et al. (2008) for 4-digit data and a large set of up to 100 countries, Auer and Chaney (2009) for 10-digit U.S. import data, and Gopinath et al. (2010) for 10-digit U.S. data at the firm-level)³.

This paper is closely related to the work by Gaulier et al. (2008) and Gopinath et al. (2010). Gaulier et al. (2008) measure ERPT at an annual rate at the 4-digit level for about 100 countries, among which are Germany, the U.S., and Japan. While they find considerable cross-sectional heterogene-

³Knetter (1989, 1993, 1997) also uses 7-digit data but estimates pass-through rates for a rather narrow set of up to 37 industries.

ity, they do not consider potential differences concerning one destination and its several trading partners which this study does. Furthermore, their use of annual data limits the analysis to long-run pass-through rates. By contrast, I apply monthly data and distinguish short and long-run pass-through rates. Gopinath et al. (2010) provide rich evidence on differences in ERPT concerning the currency in which U.S. imports are invoiced. Using monthly U.S. import data, they find that Dollar priced goods exhibit much lower ERPT rates compared to non-dollar priced goods. Additionally, they show substantial differences in ERPT rates regarding the specific U.S. trading partner. For instance, the average pass-through rate for German imports into the U.S. is 63% (17%) higher for dollar priced (non-dollar priced) goods compared to imports from the United Kingdom. I carry out a similar analysis using German data. In addition, I consider possible non-linearities of ERPT stemming from appreciations and depreciations as well as large and small exchange rate movements.

The analysis is conducted as follows. Exchange rate pass-through into import unit values at the 8-digit level is calculated for the period January 1988 to December 2008. While other studies look at pass-through for Germany as a whole, one of the main contributions of this analysis is to extend it to 16 German trading partners separately. That is, it will be possible to measure the pass-through of, say, changes of the Yuan vis-à-vis the Euro for a selection of 8-digit products. The chosen partner countries cover on average 46% of German imports for these products. Given the fact that Euro-currency countries such as the Netherlands and France cannot be included, the countries in my sample cover a large share of relevant imports. I estimate pass-through with different time horizons to check the consistency of definitions of short and long-run pass through rates. I also test whether estimated ERPT rates differ for appreciation periods compared to depreciation periods, that is, whether ERPT to import unit values is uniform. Afterwards, I define "large" and "small" exchange rate changes and test whether unit values react equally to both types of exchange rate fluctuations. Finally, I make use of the highly disaggregated 8-digit data to consider product specific determinants. That is, I test for a negative correlation of the goods' quality and its exchange rate

pass-through rate.

ERPT is incomplete with a rate of 42% in the short-run of three months when I use 8-digit level data in a pooled analysis. That is, a 10% increase in the exchange rate leads to a 4.2% decrease in the import unit value. These adjustments mainly occur within the short-run of three months. Further disaggregation by German trading partner shows substantial differences among countries. Imports coming from European countries generally exhibit statistically zero pass-through in the short as well as the long-run. By contrast, non-European trading partners are characterized by statistically significant incomplete ERPT rates with full pass-through for imports from the U.S. and Mexico. This strongly suggests that local currency pricing for German imports from Europe prevails. Further disaggregating by product reveals large product heterogeneity, although I observe a low significance of the estimates.

I check whether the estimated ERPT rates differ for periods of appreciation. Appreciations, for instance, could refer only to periods where in all months an appreciation occurred. I estimate no significant difference, whether in the short or in the long-run. However, this result changes if I consider longer phases of appreciation. Then, ERPT is substantially lower in periods of appreciation and the order of magnitude is 57 to 92 *percentage points*. Additionally, large exchange rate changes indeed induce larger ERPT rates at a rate of about 3 percentage points. The point estimates are, however, not significantly different from zero. Finally, I do not find support for the Auer and Chaney prediction of a negative influence of quality on ERPT rates. In particular, my results point in the opposite direction: goods with higher quality are characterized by higher pass-through rates. The statistical evidence, however, is limited.

This paper contributes to three strands of the pass-through literature⁴. First, studies, such as Gaulier et al. (2008) or Auer and Chaney (2009),

⁴A comprehensive overview of how the empirical research questions on exchange rates and prices evolved is provided by Goldberg and Knetter (1997). They summarize that research started with trying to validate the law of one price. Then, ERPT, and pricing-to-market behavior of firms was investigated, generally based on the same empirical framework. Among other things, they conclude that incomplete pass-through can be interpreted as evidence for imperfect competition.

analyze pass-through with yearly data. The current paper differs from these papers by considering pass-through at a disaggregated level and at a monthly frequency. It reveals strong variations in pass-through rates across products and country of origin. I show that pass-through is a short-run phenomenon and occurs within three months, which is in line with the findings of Gopinath et al. (2010).

Second, as outlined by Marazzi et al. (2005), little is known about whether ERPT really is a linear phenomenon. Dramatic decreases of exchange rates might influence a firm's costs more intensively. In the presence of standard menu costs of price changes, import prices could react differently depending on the size of the exchange rate change. This also includes the question of whether ERPT is uniform for appreciations and depreciations. Firms might tend to pass-through cost increases at a different rate than cost-reducing effects of exchange rate fluctuations. My findings suggest that large exchange rate changes indeed are passed-through to a larger extent than small changes.

Third, in a recent article Auer and Chaney (2009) set out a new theoretical framework that considers a good's quality as an explanation for pass-through. Their model predicts that lower quality goods are more sensitive to exchange rate movements than higher quality goods. Auer and Chaney empirically test this hypothesis with 10-digit US import data for 1991 to 2001. The empirical evidence supporting their theory, however, is statistically not significant. Applying the same methodology to German import unit values yields a comparable conclusion. I find no evidence for a negative correlation of quality and ERPT, whether in a pooled regression or on a by-country basis.

The rest of the paper is organized as follows. In section 2, the estimation strategy is outlined and discussed. Section 3 describes the data and presents the empirical findings for ERPT into German import prices at an aggregated level, across countries, and for different non-uniform specifications. Section 4 concludes. The appendix provides details on the data used.

2 Estimation strategy

This section provides a brief discussion of the estimation strategy and the theoretical background that motivates the estimation equation.

If exporting firms increase prices by 1% following a 1% increase in the exchange rate, this is named complete exchange rate pass-through. However, there are several channels which might explain why firms will not adjust prices one-to-one. In a perfectly competitive market, a firm's price equals its marginal cost. If, however, the competitive environment is such that a firm is able to charge positive mark-ups over prices, it might choose to preserve its price in order to maintain or even increase its market share in a specific country. Since the work by Krugman (1986), this behavior is generally named "pricing-to-market". Second, additional local distribution or transportation costs an exporting firm has to bear may not be influenced by the exchange rate. This implies that the exchange rate pass-through is incomplete, even if the firm does not charge a positive mark-up. Third, the frequency of price adjustment determines pass-through as found by Gopinath and Itskhoki (2010). The more often prices are changed, the better a firm is able to adjust the price to any exogenous change. Additionally, classic menu costs might prevent the immediate change of prices and imply differences in pass-through rates in the short- and long-run. Finally, a flexible production structure allows a firm to switch its source of imported inputs to countries where the exchange rate remained stable or even depreciated. Campa and Goldberg (2010) show that the use of imported inputs is indeed important and can account for up to 48% of the final price. All these channels not only give rise to incomplete exchange rate pass-through. They also imply that, besides the sectoral heterogeneity bias observed by Mumtatz et al. (2006), there might be country and product-level heterogeneities in pass-through rates.

According to Campa and Goldberg (2005) a useful starting point is the pricing decision of an exporting firm. For a given country, the import price of product j from its trading partner i , P_t^{ij} , can be written as export price,

$P_t^{x,ij}$, multiplied with the inverse of the bilateral exchange rate⁵, E_t^i , that is

$$P_t^{ij} = \frac{1}{E_t^i} P_t^{x,ij}. \quad (1)$$

Decomposing exporter prices into markup ($MKU P_t^{x,i}$) and marginal cost ($MC_t^{x,i}$) and taking the logarithm of all variables yields

$$\ln P_t^{ij} = \ln MKU P_t^{x,i} + \ln MC_t^{x,i} - \ln E_t^i. \quad (2)$$

Marginal costs of exporters are assumed to be increasing in the exporter's wage ($\ln W_t^{x,i}$) and the demand in the destination market ($\ln Y_t$)^{6,7}. The logarithm of mark-ups on the other hand, is a function of fixed industry-specific conditions (ϕ) and the macroeconomic environment ($\Phi \ln E_t^i$) which is simply expressed as a function of the exchange rate. Therefore, the import price can be written as

$$\ln P_t^{ij} = \phi - (1 - \Phi) \ln E_t^i + c_0 \ln Y_t + c_1 \ln W_t^{x,i}. \quad (3)$$

The literature considers several transformations of (3)⁸. For the analysis of monthly 8-digit data I transform (3) according to Gopinath et al. (2010) into the general estimation equation

$$\begin{aligned} \Delta \ln P_t^{ij} = & \sum_{k=0}^n \alpha_k^{ij} \Delta \ln E_{t-k}^i + \sum_{h=1}^3 \beta_h^{ij} \Delta \ln P_{t-h}^{ij} \\ & + \gamma_1^j trend^j + \gamma_2^{ij} fix^{ij} + \delta' D + \epsilon_t^{ij}. \end{aligned} \quad (4)$$

Here, P_t^{ij} denotes the unit value of an 8-digit good j imported into Germany from country i at time t , E_t^i is the bilateral exchange rate between Germany

⁵Throughout the rest of my analysis exchange rates are expressed in quantity notation.

⁶That is, increasing marginal costs in the production for exporters are assumed.

⁷This implicitly assumes that marginal costs are invariant to exchange rate fluctuations. However, if firms rely on imported inputs (see, for instance, Feenstra (1998) and Hummels et al. (2001)) then exchange rate shocks affect a firm's cost. Hence, one cannot rule out the possibility that the estimated ERPT coefficient also captures the sensitivity of marginal costs to currency adjustments.

⁸See, for instance, Campa and Goldberg (2005) for non-stationary variables and no cointegration or Gosh and Rajan (2009) for a dynamic ordinary least square specification.

and country i , and $trend^j$ is a product j -specific time trend. This time trend captures an average influence of time on product j , e.g., the average impact of worldwide technological shocks⁹. fix^{ij} is a product-country fixed effect that captures, for instance, cost increases or changes in export legislation specific to product j and country i . Additionally, the vector D covers a full set of fixed effects for the three dimensions of the data (time (fix_t), partner country (fix^i), and product (fix^j)) and other dummies¹⁰. ϵ_t^{ij} is the error term. All but one exchange rate are non-stationary time series. In order to make the data stationary, I consider first differences in logarithms of the exchange rate and the import unit value. I refrain from using country-level variables, such as German GDP or the producer price index, to measure the influence of demand or exporter costs, respectively, and consider fixed effects instead. There are considerable differences in the variation of aggregate variables and 8-digit unit value data. This suggests that the use of fixed effects is more appropriate for the data.

I estimate (4) with monthly dummies in order to correct for seasonal influences and to preserve the time dimension of the data. The error terms might be correlated within a country but not across countries. Therefore, I cluster the data by trading partner to correct for the potential problem of contemporaneous correlation (confer, for instance, Moulton (1990)). The literature generally assumes pass-through to occur within a year after the initial exchange rate movement. Accordingly, I allow for $n = 12$ lags of the exchange rate in equation (4). The short-run pass through is defined as occurring within the first three months. Long-run pass-through rates are the sum of the contemporaneous difference of the exchange rate and 8 or 11 lags, respectively. This guarantees comparability with studies using quarterly or annual data. Three lagged terms of the difference of the unit value on the right hand side correct for autocorrelation in the sample. A crucial assumption in the ERPT literature is that a change in the exchange

⁹Although product-time fixed effects control for effects at any point in time, for reasons of data parsimony I chose the time trend specification.

¹⁰These include dummies for the German reunification in 1990, the beginning of the financial crisis in mid 2008, the introduction of the Euro, and the replacement of the Multifiber Arrangement starting in 1995.

rate is considered as an exogenous shock¹¹. While this assumption may seem strong for macroeconomic import price indices, it is of less concern for detailed product data. A price change of a specific 8-digit product does not affect a country's exchange rate. Hence, my analysis is less sensitive to endogeneity problems. All regressions are weighted ordinary least square with weights based on the trade volume¹².

3 Empirical Evidence

3.1 Data

The monthly data in this analysis covers the period from January 1988 to December 2008 and is obtained from two different sources. I use data on import unit values from Eurostat, classified up to 8 digits by the combined nomenclature (CN)¹³. Mainly, I consider CNs covering textile and electronic categories for this study. These selected CNs provide a so-called supplementary unit which shows in numbers the quantity traded in this CN. This allows me to calculate unit values. To further increase the reliance of the data, I consider CNs that were traded for more than a minimal number of periods. Finally, CNs need to pass a threshold with respect to their variation which is described in the appendix section 5.2.

Due to data limitations I was not able to capture all non-Euro trade of Germany. However, the chosen 16 partner countries cover on average 40% of German imports for these products. Including imports from Euro-countries such as France or the Netherlands increases this share to 90%. That is, my data covers a large share of relevant imports.

¹¹That is, they do not influence a firm's pricing decision and neither are exchange rates affected by firm pricing (see Gopinath et al. (2010)).

¹²Similar to Gaulier et al. (2008), I use three-period weights, that is $w_t^{ij} = 0.5 \left(\frac{V_t^{ij}}{V_{t-1}} + \frac{V_t^{ij}}{V_t} + \frac{V_t^{ij}}{V_{t+1}} \right)$. Here, w_t^{ij} is the weight for product j from country i at time t . Total world trade at time t is $V_t = \sum_{i,j} V_t^{ij}$, the sum over the 16 German trading partners and all products. I chose three periods to minimize the influence of a relative high import volume in one month.

¹³For more details on data collection and its methodology confer Eurostat (2006).

Data on bilateral exchange rates come from Financial Times Interactive Data and WM/Reuters and were extracted from Thomson Datastream. I calculated the arithmetic mean per month and used a Euro/US-Dollar exchange rate to convert all other currencies into Euro/foreign currency exchange rates over the entire sample period.

Checks on stationarity lead to the conclusion that the exchange rates are non-stationary, i.e. integrated of order one ($I(1)$). According to the results of Fisher's unit-root test for unbalanced panels, unit values are stationary ($I(0)$). Hence, the existence of a cointegration relation between the exchange rates and the import unit values is not considered as being relevant¹⁴.

At an 8-digit level, data on import unit values still exhibit significant variation. In what follows a crucial assumption is that an 8-digit CN is defined as a relatively homogeneous product. That is, changes in the unit value in this category will be interpreted as price changes of this product¹⁵. Therefore, there is no need to further construct a price index and variables are considered as log differences due to their non-stationary characteristic. In order to estimate an average ERPT rate into German import prices, I ran a pooled regression on equation (4) and use each country-CN combination as the panel variable. Thus, the coefficients α_k do not have a country or product dimension. Then, I estimate (4) by country and product. Accordingly, country-specific ERPT rates (α_k^i) are estimates for each country i , and product-specific pass-through rates are α_k^j .

¹⁴For a more detailed overview of the unit root tests see the appendix.

¹⁵There is another caveat. Any change inside an 8-digit-level in the relative quantity of imported goods is not observable. To illustrate this point think of two goods x and y belonging to the hypothetical CN 10000001. The combined imported quantity of x and y be 10 units. 6 of these units are y goods priced at 10, 4 are x goods with a price of 5. Thus, in the data I observe a quantity of 10 and a value of 80 for this CN. This yields an unit value of 8. The next period Germany still imports 10 units in this CN, 5 y goods and 5 x goods, and prices remain constant. I now would calculate a decreased unit value of 7.5 which is totally due to changes in quantity but not in prices. Since it is not possible to control for this effect, I assume that it can be neglected in the sense that an 8-digit-CN represents one final good.

3.2 Exchange rate pass-through to import unit values

Table 1 shows the results for a pooled regression with different specifications. Estimates are sensitive to the weighting scheme, but to a much less extent to the number of included fixed effects. In the short-run, defined as the first difference of the exchange rate and two lags, a statistically significant incomplete ERPT is estimated at a rate of about 42%, as can be seen in the lower part of the table for the weighted regressions. In other words, a 10% increase in the exchange rate leads to a 4.2% decrease in the import unit value¹⁶. The long-run includes eight lags of the exchange rate and the pass-through increases only slightly to 42%–46%. If I consider eleven lags of the exchange rate as the long-run pass-through, Table 1 shows a substantial decrease of the pass-through rate for all specifications, for instance down to 34% in column 4. That is, pass-through is sensitive to the number of lags included in its definition. In order to define short and long-run effects more precisely, I therefore estimate equation 4 and increase the number of lags stepwise to $n = 20$. The respective cumulative ERPT is presented in Figure 2 and it reveals that ERPT is predominantly a short-run phenomenon with little adjustments after the first three months. It also justifies the definition of long-run as occurring within nine months which is equivalent to a period of three quarters. These results are close to the findings of Campa and Goldberg (2005), who estimated ERPT to be 34% in the short-run and 42% in the long-run for manufactured goods using quarterly data up to 2003. Other studies found larger ERPT rates. Gaulier et al. (2008) report a median long-run pass-through of 68% for Germany, Warmedinger (2004) obtains 56%, and Campa and Minguez (2006) present 76%. Nevertheless, these studies cover a different set of industries. For instance, reducing Campa and Minguez' (2006) data to a comparable set of industries decreases their ERPT to 66%.

Now, I further disaggregate by country and run a regression of equation (4) for each country. This eliminates the geographical dimension of the data and shows whether there are country-specific differences in German import

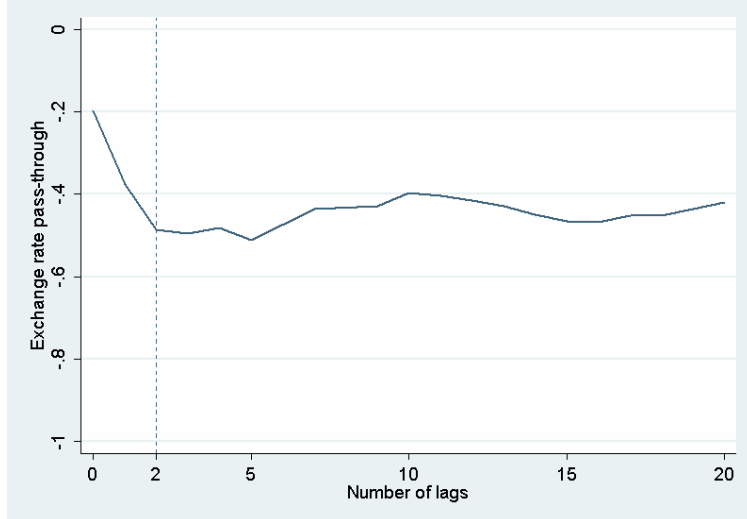
¹⁶Note, that exchange rates are used in quantity notation. Thus, estimated ERPT coefficients will be negative numbers and a coefficient closer to zero represents a decline in the pass-through rate.

Table 1: Exchange rate pass-through in the short and long-run

Variables	1	2	3	4	5	6	7
	Dependent variable: Δ_t Unit value						
Δ_t Exchange rate	0.003	-0.041	-0.053	-0.102***	-0.106***	-0.104***	-0.108***
	-0.018	-0.024	-0.040	-0.028	-0.028	-0.028	-0.028
Δ_{t-1} Exchange rate	-0.202***	-0.170***	-0.175***	-0.173***	-0.175***	-0.173***	-0.176***
	-0.050	-0.040	-0.041	-0.041	-0.042	-0.041	-0.043
Δ_{t-2} Exchange rate	-0.126*	-0.147**	-0.097	-0.138**	-0.143**	-0.139**	-0.144**
	-0.062	-0.063	-0.064	-0.055	-0.056	-0.055	-0.057
Δ_{t-1} Unit value	-0.648***	-0.558***	-0.649***	-0.563***	-0.566***	-0.566***	-0.568***
	-0.017	-0.029	-0.016	-0.028	-0.027	-0.028	-0.027
Product-, country-, and time fixed effects	no	no	yes	yes	yes	yes	yes
Product-specific time trend	no	no	no	no	yes	no	yes
Product-country fixed effect	no	no	no	no	no	yes	yes
Weighted by trade volume	no	yes	no	yes	yes	yes	yes
Observations	216427	213979	216427	213979	213979	213979	213979
Adj. R2	0.306	0.251	0.306	0.256	0.257	0.255	0.256
Root MSE	0.347	0.181	0.347	0.180	0.180	0.180	0.180
Short-run ERPT	-0.325	-0.357	-0.325	-0.413	-0.425	-0.416	-0.427
Prob > F	0.060	0.002	0.014	0.000	0.000	0.000	0.006
Long-run (8 lags) ^a ERPT	-0.528	-0.386	-0.602	-0.421	-0.460	-0.422	-0.463
Prob > F	0.009	0.029	0.007	0.002	0.006	0.002	0.000
Long-run (11 lags) ^a ERPT	-0.430	-0.368	-0.470	-0.343	-0.396	-0.345	-0.400
Prob > F	0.007	0.008	0.001	0.006	0.003	0.006	0.003

(Weighted) ordinary least square regression, standard errors in parentheses, ** p<0.01, * p<0.05, * p<0.1.
All regressions are clustered by trading partner. ^aSum of the coefficients of 8 and 11 lagged exchange rates, respectively.
All regressions include: dummies for the financial crisis, Germany's reunification, the introduction of the Euro and the replacement of the Multi Fibre Arrangement.

Figure 2: Exchange rate pass-through with different number of lags



pass-through rates. As Table 2 shows, the mean of ERPT rates over all countries is 36% in the short-run. However, there is considerable variation between countries. Imports coming from European countries, such as Denmark, Sweden or Poland, exhibit statistically zero pass-through in the short as well as the long-run with the exception of Hungarian imports. All of these countries are close to Euro-currency states and also small economies relative to Germany. By contrast, non-European trading partners are characterized by statistically significant incomplete ERPT rates with complete pass-through rates for imports from the U.S. and Mexico. This strongly suggests that local currency pricing is prevalent for German imports from Europe. In the long-run, pass-through increases to a mean across countries of 69% after 9 month and 80% after a year. The aforementioned observed drop in pass-through rates in the pooled regression when including 11 instead of 8 lags seems to be driven by the European countries. All other countries show a steady increase of pass-through rates with an increasing number of lags.

In order to estimate pass-through rates by products I now focus on 8-digit goods regardless of where they were imported from. In other words, I drop the country dimension and estimate α_k^j for each product j . At this high

Table 2: Exchange rate pass-through estimates by country (first part)

	1	2	3	4	5	6	7	8
Variables	UK	Denmark	Sweden	Turkey	Poland	Czech Rep.	Hungary	Russia
	Dependent variable: Δ_t Unit value							
Δ_t Exchange rate	-0.0728	-0.306	-0.027	-0.0327	0.134*	-0.523***	0.253***	1.658***
Δ_{t-1} Exchange rate	-0.105	-0.547	-0.311	-0.023	-0.073	-0.143	-0.088	-0.595
Δ_{t-2} Exchange rate	-0.0104	0.141	-0.675**	-0.0205	-0.12	0.0178	0.0591	-0.18
	-0.111	-0.571	-0.320	-0.025	-0.074	-0.141	-0.088	-0.594
	-0.189*	-0.155	0.101	0.0352	-0.122	0.169	0.0603	-1.051*
	-0.112	-0.575	-0.319	-0.025	-0.077	-0.141	-0.096	-0.610
Δ_{t-1} Unit value	-0.626***	-0.666***	-0.705***	-0.517***	-0.533***	-0.611***	-0.534***	-0.776***
	-0.008	-0.008	-0.017	-0.007	-0.006	-0.008	-0.008	-0.029
Observations	14492	13699	3327	22218	23190	15086	15599	1163
Adj. R2	0.284	0.318	0.355	0.233	0.249	0.272	0.225	0.394
F-Statistic	31.1	37.02	25.39	26.11	23.63	20.67	18.09	9.594
Short-run ERPT	-0.272	-0.320	-0.601	-0.018	-0.107	-0.336	0.373	0.427
Prob > F	0.088	0.594	0.180	0.131	0.192	0.145	0.004	0.349
Long-run (8) ^a ERPT	0.036	-0.681	-1.051	-0.155	-0.529	-0.523	0.828	-0.408
Prob > F	0.889	0.753	0.186	0.591	0.019	0.125	0.011	0.792
Long-run (11) ^a ERPT	0.582	-0.485	-0.861	-0.101	-0.338	-0.481	0.636	-1.531
Prob > F	0.043	0.690	0.331	0.011	0.338	0.283	0.000	0.636
Root MSE	0.189	0.245	0.224	0.143	0.203	0.204	0.153	0.231

Weighted ordinary least square regression, standard errors in parentheses, ** p<0.01, *** p<0.001, * p<0.1.
All regressions include: product fixed effects, a product specific time trend, dummies for the financial crisis, Germany's reunification, the introduction of the Euro and the replacement of the Multi Fibre Arrangement.
^aSum of the coefficients of 8 and 11 lagged exchange rates, respectively.

Table 2 (cont'd): Exchange rate pass-through estimates by country (second part)

Variables	9	10	11	12	13	14	15	16
	USA	Mexico	India	Thailand	Malaysia	China	S. Korea	Japan
	Dependent variable: Δ_t Unit value							
Δ_t Exchange rate	-0.282***	-0.331**	-0.209***	0.0522	-0.0332	-0.0583*	-0.039	-0.0147
Δ_{t-1} Exchange rate	-0.084	-0.150	-0.067	-0.078	-0.140	-0.031	-0.072	-0.055
Δ_{t-2} Exchange rate	-0.299***	0.0248	-0.086	-0.246***	-0.363**	-0.277***	-0.205***	-0.172***
Δ_{t-1} Unit value	-0.087	-0.161	-0.070	-0.080	-0.144	-0.032	-0.079	-0.057
	-0.526***	-0.780***	-0.0819	0.0334	-0.409***	-0.179***	-0.148*	-0.214***
	-0.090	-0.147	-0.071	-0.080	-0.144	-0.032	-0.080	-0.058
	-0.674***	-0.650***	-0.542***	-0.526***	-0.668***	-0.503***	-0.576***	-0.637***
	-0.007	-0.042	-0.009	-0.010	-0.015	-0.005	-0.011	-0.008
Observations	17800	614	11174	10376	4060	38174	7934	15073
Adj. R2	0.328	0.311	0.271	0.23	0.333	0.22	0.255	0.29
F-Statistic	41.46	7.749	27.84	21.75	26.05	26.64	23.87	34.95
Short-run ERPT	-1.106	-1.086	-0.377	-0.160	-0.805	-0.514	-0.392	-0.401
Prob > F	0.000	0.000	0.000	0.155	0.000	0.000	0.000	0.000
Long-run (8) ^a ERPT	-1.053	-2.039	-0.578	-0.351	-2.196	-0.851	-1.067	-0.403
Prob > F	0.000	0.000	0.003	0.101	0.000	0.000	0.000	0.001
Long-run (11) ^a ERPT	-1.693	-2.117	-0.642	-0.593	-2.406	-1.007	-1.153	-0.514
Prob > F	0.000	0.000	0.003	0.031	0.000	0.000	0.000	0.004
Root MSE	0.233	0.14	0.17	0.22	0.218	0.196	0.197	0.159

Weighted ordinary least square regression, standard errors in parentheses, ** p<0.01, * p<0.05, * p<0.1.
All regressions include: product fixed effects, a product specific time trend, dummies for the financial crisis, Germany's reunification, the introduction of the Euro and the replacement of the Multi Fibre Arrangement.
^aSum of the coefficients of 8 and 11 lagged exchange rates, respectively.

level of disaggregation only 25% of the estimated coefficients are statistically significant from zero. For the significant estimates I obtain a much higher density around the complete pass-through rate of -1 . Nevertheless, a fraction of estimates lies outside this interval, is not statistically different from zero, and even some coefficients exceeding -2 or $+2$ are obtained. Other studies present comparable results, for instance Auer and Chaney (2009), who report pass-through into US import unit values at the 6-digit level within a similar interval of -2.5 to $+2.5$. This seems to be due to the variation in disaggregated unit value data and does not seem to be a German phenomenon.

What explains such a spread? A possible explanation is that 8-digit-levels do not describe a specific good in all cases. This would contradict my basic assumption and implies that quantity effects and other unobservable determinants of goods are persistent in the data. As outlined above, this critique cannot be negated unless real product data is used. On the other hand, the proposed theoretical model underlying the estimation equation may not be appropriate for such disaggregated data. Although I include a full set of fixed effects in the estimation equation, other forces that influence prices may not be captured by this specification, for example competition effects in the transportation sector or within an industry. Additionally, Hellerstein's (2008) findings suggest that the strategic behavior of firms is another important channel to be considered. Hence, firm-level information on how they adjust their mark-ups and to which extent they are willing to bear some part of the costs seems to be crucial to understand and measure pass-through at this disaggregated level.

In summary, I obtain strong statistical evidence for incomplete pass-through occurring within three months in a pooled analysis. Refining by country and product reveals large heterogeneity. There are substantial differences in ERPT rates for German import unit values across Germany's trading partners. All but one European countries exhibit zero ERPT while non-European countries exhibit statistically significant incomplete ERPT rates.

3.3 Nonlinearities of exchange rate pass-through rates

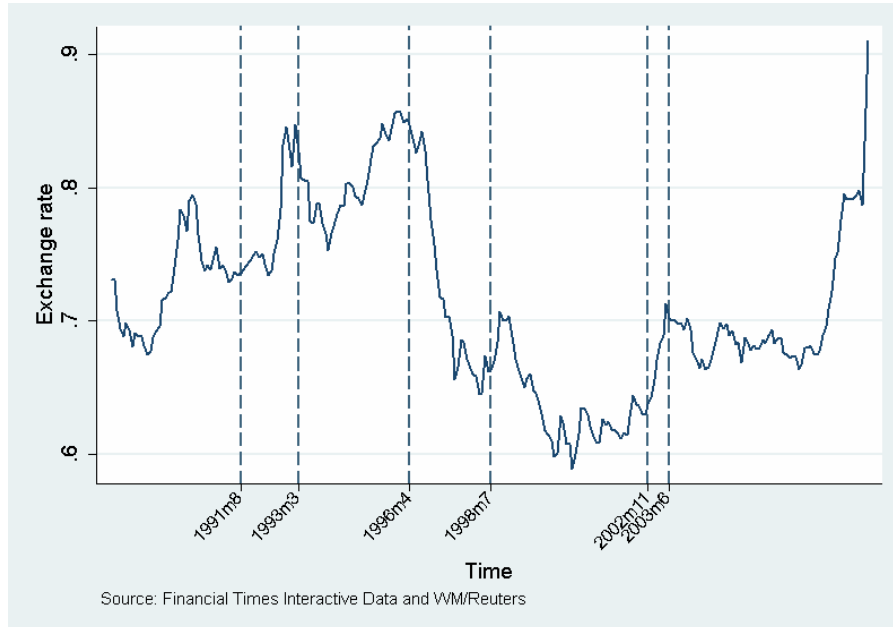
The literature generally considers ERPT to be a linear phenomenon. In this section, I first test whether German import unit values react similarly when differences in the direction and size of exchange rate movements are taken into account. I consider appreciations compared to depreciations and define small and large changes of an exchange rate. Second, following the idea of Auer and Chaney (2009), I analyze whether a product's quality determines the degree of pass-through.

3.3.1 Appreciation and large exchange rate change effects

Generally, ERPT is estimated with first-differences specifications which implicitly assume appreciations and depreciations to influence prices equally, and neither is the actual size of exchange rate changes considered. Early work on this topic by Knetter (1994) did not show significant differences for 7-digit data on German and Japanese exports. By contrast, Webber's (2000) study on countries across the Asia-Pacific region finds asymmetric behavior for six out of seven countries. Khundrakam (2007) confirms this result for India. Theoretically, there are good reasons to think of differential effects. Consider again the classic menu costs of price changes. Confronted with a slight devaluation of a currency an importer should not change his prices as long as the cost for changing is higher than his expected income increase through higher prices. On the other hand, periods of substantial appreciation of a currency might be induced by an overall economic upswing. As this process takes time, firms could anticipate the appreciation and hedge against the consequences. As a consequence, the pass-through of these changes could be smaller. Additionally, firms with market power pass through cost increases at a higher rate than cost-reducing effects of exchange rate fluctuations.

First, I check whether the estimated ERPT rates differ for periods of appreciation. Given my definition of short-run and long-run pass-through rates, several specifications are possible. Appreciations, for instance, could refer only to periods where in all months an appreciation occurred. By contrast, I assume that a general appreciating trend is decisive. I define an appreciation

Figure 3: Exchange rate with periods of appreciation and depreciation (Euro/Pound)



phase as a phase that starts with at least three successive months of appreciations and where there are no more than two consecutive depreciations. Thus, if over a longer time period an exchange rate appreciates, all months within this period are considered as an appreciation period. I use a dummy variable which is "1" in this case. This definition seems reasonable, as the following example of the Euro and the British Pound indicates. By this definition the exchange rate of the Euro with respect to the British Pound is characterized by a total of 9 appreciation periods. Figure 3 shows three examples for this criterion. From August 1991 to March 1993 the Euro appreciated compared to the Pound. By contrast, all the periods from April 1994 to June 1998 are classified as belonging to a depreciation phase, although not every single month is characterized by a depreciation. Finally, from November 2002 to June 2003 there is a period of consecutive appreciations.

Furthermore, for each country I define an exchange rate change of greater than one standard deviation above or below the mean of all changes over time as a "large change". That is, I calculated the mean and standard deviation of

each exchange rate. If any monthly growth rate of the exchange rate exceeds a value of more than one standard deviation above or below the mean, this change is considered a "large change". All others changes are referred to as a "small change". This should shed some light on the question whether import prices react uniformly. These nonlinearities are generated as dummy variables and incorporated in the estimation equation as an interaction with the exchange rate. In order to be consistent with the definition of short and long-run pass-through, I include the interaction term as the sum of lagged values. Equation (4) then reads

$$\begin{aligned} \Delta \ln P_t^{ij} = & \sum_{k=0}^{12} \alpha_k \Delta \ln E_{t-k}^i + \sum_{k=0}^{12} \theta_k \Delta \ln E_{t-k}^i * Dummy \\ & + \sum_{h=1}^3 \beta_h^{ij} \Delta \ln P_{t-h}^{ij} + \gamma_1^j trend^j + \gamma_2^{ij} fix^{ij} + \delta' D + \epsilon_t^{ij} \quad (5) \end{aligned}$$

where the definition of the variables is the same as above. The variable *Dummy* equals 1 if there is an appreciation or a large change. I perform a weighted least square regression and restrict coefficients to be equal across trading partners and products. If appreciations or large changes of the exchange rate imply a higher pass-through rate, the respective short and long-run sum of θ_k should be negative.

Table 3 provides the results of a pooled analysis for different specifications. $\Delta_t NL$ is a synonym for the first difference of the respective interaction effects and the squared exchange rate variable ($\Delta_{t-1} NL$ stands for the lagged first difference, accordingly). In columns 1 and 2 I test whether an appreciation leads to a significantly different ERPT rate.

Column 2 shows the results when I interact with all positive monthly growth rates of the exchange rate. The sum of the interaction terms is statistically not different from zero, whether in the short or in the long-run. However, this result changes if I apply the above described criterion to discern periods of appreciation. As column 1 shows, ERPT is substantially lower in periods of appreciation and the order of magnitude is 57 to 92

*percentage points*¹⁷. The coefficients are statistically significant in the short and long-run. Appreciations of the Euro represent cost reducing effects for the importers. If these effects were passed-through at a substantially lower rate than other changes, this would be a strong indicator for market power of the importers.

The interaction terms in column 3 and 4 suggest that large exchange rate changes indeed induce larger ERPT rates at a rate of about 3 percentage points. These results are, however, not significantly different from zero. Apart from column 1, the estimated ERPT rates in the short and long-run are in line with the reference estimation in column 5.

3.3.2 Exchange rate pass-through and quality

There are a lot of product-specific features that influence pass-through rates. However, the adjustment of a firm's mark-up or changes in the input composition of production require additional firm-level data which is hard to obtain. By contrast, the available unit value data may be used to approximate the quality of products. The model of Auer and Chaney (2009) predicts pass-through to depend negatively on quality. In their model, an appreciation of, e.g., the Euro allows households in the Euro-zone to increase consumption of an international numéraire good. This raises domestic wages in the numéraire sector and all other sectors and thus marginal costs of European firms. Faced with a fixed cost of exporting, this wage increase forces the exit of the lowest quality firms that were exporting before. On average, quality valuation of consumers and prices go up. Since firms have identical technology, this cost shock leads all firms to reduce their production and prices increase once more. Firms at the exporting threshold are affected more by the first effect, and prices for lower quality products move almost equally with the exchange rate. On the other hand, high quality goods are solely influenced by the second effect. Thus, they predict lower quality products to be more sensitive to exchange rate movements than higher quality products.

¹⁷These results are robust to alternative definitions. In particular, whether I define appreciation phases as a phase that starts with at least two or four successive months of appreciations, respectively, does not qualitatively change the result.

Table 3: Appreciations and large change effects on ERPT

Variables	Appreciation effect		Large changes		5 Reference estimation
	1 Appreciation phase	2 $\Delta_t E > 0$	3 $Mean \pm sd$	4 $\Delta_t E^2$	
Dependent variable: Δ_t Unit value					
Δ_t Exchange rate	-0.212	-0.112	-0.011	-0.142***	-0.108***
	-0.127	-0.11	-0.071	-0.031	-0.028
Δ_{t-1} Exchange rate	-0.253**	-0.183***	-0.186***	-0.165***	-0.176***
	-0.102	-0.054	-0.040	-0.038	-0.043
Δ_{t-2} Exchange rate	-0.422***	-0.190*	-0.185***	-0.120**	-0.144**
	-0.103	-0.096	-0.044	-0.054	-0.057
$\Delta_t NL$	0.130	0.008	-0.122	0.010**	
	-0.132	-0.118	-0.079	-0.004	
$\Delta_{t-1} NL$	0.098	0.008	0.030	-0.004	
	-0.135	-0.082	-0.069	-0.004	
$\Delta_{t-2} NL$	0.342**	0.100	0.064	-0.008	
	-0.131	-0.078	-0.056	-0.006	
Δ_{t-1} Unit value	-0.569***	-0.568***	-0.568***	-0.568***	-0.568***
	-0.027	-0.027	-0.027	-0.028	-0.027
Observations	213979	213979	213979	213979	213979
Adj. R2	0.256	0.256	0.256	0.256	0.256
Root MSE	0.18	0.18	0.18	0.18	0.18
F-Test					
Interactions (joined)	6.603	20.08	57.59	40.53	
Prob > F	0.000	0.000	0.000	0.000	
NL Short-run	0.570	0.100	-0.029	-0.004	
Prob > F	0.091	0.601	0.870	0.868	
Short-run ERPT	-0.888	-0.484	-0.382	-0.427	-0.427
Prob > F	0.004	0.005	0.000	0.002	0.006
NL Long-run (8) ^a	0.920	0.164	0.200	-0.026	
Prob > F	0.046	0.426	0.142	0.222	
Long-run (8) ^a ERPT	-1.206	-0.578	-0.502	-0.443	-0.463
Prob > F	0.008	0.013	0.000	0.001	0.000
NL Long-run (11) ^a	0.785	0.177	-0.033	-0.031	
Prob > F	0.078	0.322	0.756	0.121	
Long-run (11) ^a ERPT	-1.028	-0.517	-0.359	-0.372	-0.400
Prob > F	0.014	0.004	0.002	0.004	0.003

Weighted ordinary least square regression, standard errors in parentheses, ** p<0.01, * p<0.05, * p<0.1.
All regressions include: product fixed effects, a product specific time trend, dummies for the financial crisis, Germany's reunification, the introduction of the Euro and the replacement of the Multi Fibre Arrangement.
Note: Variable NL is a synonym for the respective interaction effects and the squared exchange rate variable.
^aSum of the coefficients of 8 and 11 lagged exchange rates, respectively.

Besides their explanation, there is another quite straightforward possibility to interpret this correlation. In a market with perfect competition and homogeneous goods, producers are not able to charge positive mark-ups over prices. Consequently, any cost shock needs to be transferred to buyers and ERPT will be complete. The higher the quality of a product, the more differentiated a good might be and the harder it seems to assume perfect competition. That is, the higher the quality of goods the lower might be the competition in this market. Any differences in ERPT across products or sectors could thus be interpreted as an indicator for market power of firms, i.e. imperfect competition¹⁸. This section empirically tests the hypothesis that lower quality goods are characterized by higher pass-through rates compared to higher quality goods.

Since no official measure of quality is covered by the data, it needs to be approximated in some way. Auer and Chaney (2009) suggest to consider differences across unit values within specified sectors. Across all countries, the data allows me to define 103 sectors at the 4-digit-level denoted by Ω . Within each sector Ω , differences in the unit values of corresponding 8-digit-products j are assumed to reflect differences in quality of otherwise comparable goods. Consider as an example the sector 6201¹⁹ with the subcategories 62011100²⁰ and 62011210²¹. The first category covers coats made out of wool while the latter includes coats made from cotton. I assume that this is a difference in quality of relatively similar products.

Unit values are normalized by standard deviations from the mean of a sector in order to make results comparable across sectors. That is, I calculate

¹⁸Note, however, that imperfect competition does not necessarily imply incomplete ERPT. In particular, a model with Dixit-Stiglitz monopolistic competition generates constant mark-ups, no pricing-to-market and therefore complete ERPT. I thank an anonymous referee for pointing this out.

¹⁹With the official description: "Men's or boy's overcoats, car coats, capes, cloaks, anoraks, incl. ski jackets, windcheaters, wind-jackets and similar articles (excl. knitted or crocheted, suits, ensembles, jackets, blazers, and trousers)".

²⁰With the official description: "Men's or boy's overcoats, car coats, capes, cloaks, anoraks, incl. ski jackets, windcheaters, wind-jackets and similar articles of wool or fine animal hair".

²¹With the official description: "Men's or boy's overcoats, car coats, capes, cloaks, anoraks, incl. ski jackets, windcheaters, wind-jackets and similar articles of cotton, of a weight per garment of ≤ 1 kg".

$$Q_t^{ij} = \frac{P_{t-1}^{ij} - E_{t-1}[P_{t-1}^{ij}|j \in \Omega]}{\sigma_{t-1}[P_{t-1}^{ij}|j \in \Omega]} \quad (6)$$

for each good j from each country i at time t . I then extend equation (4) by this quality measure (Q_t^{ij}) and a sum of lagged interaction terms of quality and the exchange rate ($\Delta \ln E_t^i * Q_t^{ij}$), which yields

$$\begin{aligned} \Delta \ln P_t^{ij} = & \sum_{k=0}^{12} \alpha_k \Delta \ln E_{t-k}^i + \sum_{k=0}^{12} \theta_k \Delta \ln E_t^i * Q_t^{ij} + \mu Q_t^{ij} \\ & + \sum_{h=1}^3 \beta_h^{ij} \Delta \ln P_{t-h}^{ij} + \gamma_1^j trend^j + \gamma_2^{ij} fix^{ij} + \delta' D + \epsilon_t^{ij}. \quad (7) \end{aligned}$$

Finally, I run a regression of equation (7) for each 4-digit sector Ω separately and on the pooled data. Since unit values are normalized, a sum of estimated coefficient θ_k larger than zero implies that lower quality goods have a higher ERPT in sector Ω . Table 4 summarizes the results for the 103 sectors in the data and for a pooled regression. In column two, the estimated coefficients of the exchange rate variable ($\alpha_k(\Omega)$) have a median of -0.255 over all sectors Ω . The estimated influence of the interaction term ($\theta_k(\Omega)$) has a median of -0.044 in the short-run. That is, a good with a quality two standard deviations below (above) the mean of its sector has a short-run ERPT of -0.167^{22} (-0.343). This difference vanishes in the long-run. The pooled analysis provides a comparable picture. The effect of quality is significant and reduces the short-run pass-through rate for lower quality goods. These results exactly point in the opposite direction of the Auer and Chaney prediction and, thus, do not support the hypothesis of a negative effect of quality on ERPT rates.

²²For a good two standard deviations *below* the mean of its sector I therefore *subtract* the median of the interaction term. Thus I calculate $-0.255 - 2 * (-0.044) = -0.167$.

Table 4: Exchange rate pass-through and quality

	1	2
	Pooled Regression ^a	All sectors ^b Median
Short run		
Exchange rate * Quality	-0.102	-0.044
Prob > F	0.047	
ERPT	-0.345	-0.255
Prob > F	0.000	
Long-run (8) ^c		
Exchange rate * Quality	-0.099	0.000
Prob > F	0.139	
ERPT	-0.804	-0.593
Prob > F	0.000	

^aWeighted ordinary least square regression.
^bNumber of sectors: 103.
^cSum of the coefficients of 8 and 11 lags, respectively.

4 Conclusion

Until recently, exchange rate pass-through has been analyzed mainly at an aggregated level. Although the microeconometrics of ERPT have increasingly gained in importance, few studies analyze the bilateral exchange rate relations for one country and a set of its specific trading partners. This study tries to bridge this gap for Germany and presents broad empirical evidence for incomplete pass-through into monthly German import data at the 8-digit-level. In a pooled analysis I estimate ERPT to be incomplete at a rate of about 42% in the short run of three months and 46% in the long run of 9 months. I find that ERPT differs substantially across German trading partners as well as across products, being highest and complete for goods imported from the US and Mexico. The European countries generally exhibit zero pass-through, strongly indicating local currency pricing with respect to the German market.

Additionally, I test whether ERPT is linear with respect to the size and direction of exchange rate movements. My findings suggest that appreciations of the Euro are passed through to a much lesser extent than depreciations. Large changes of the bilateral exchange rates are passed-through by about 3

percentage point more with the point estimates being not significantly different from zero. Following Auer and Chaney (2009), I also test for a negative correlation of the ERPT and the relative quality of a product, but do not find empirical support for their theory. In effect, my results point in the opposite direction of higher quality goods having higher pass-through rates.

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5 Appendix

5.1 Data

Data on import unit values from January 1988 to December 2008 comes from Eurostat and is published as "Intra- and extra-EU trade data". According to the combined nomenclature (CN), it covers trade at an 8-digit level²³. In order to reduce the complexity, some threshold for the declaration of imports and exports exist. For example, transactions with a value less than 200€ may be summarized to one reported product code for Intra-EU trade. In the case of Extra-EU trade, transactions with value less than 1000€ or weight less than one ton do not have to be provided. Since 2002 all member states have to adjust their data for these omitted transactions. Generally, roughly 1% of trade is not captured due to this threshold. The statistical values of imported goods are CIF (cost, insurance, and freight) which are collected in the respective national currency. Eurostat's publication is in multiples of euros. In addition to import values, the CNs selected for this study provide a so-called supplementary unit which shows the quantity traded in this CN in terms of pieces. As unit values are an approximation for prices, unit value per piece instead of ton or kilo seems to be a more reasonable approach for this approximation. This reduces the number of available CNs. To further increase the reliance of the data, I only consider CNs that were traded for more than a minimum time period. In particular, the duration of a trade relation with Germany covered by the data differs by country. For instance, imports from Poland start in January 1992 which yields a total of 204 periods. I then keep all CNs that are traded for at least 154 (= maximum time coverage minus 50) periods. Finally, CNs need to pass a threshold with respect to their variation described in the next section. This should further support the approximation of prices with unit values.

Data on bilateral exchange rates come from Financial Times Interactive Data and WM/Reuters and were extracted from Thomson Datastream at a daily rate. I calculate the arithmetic mean per month and use a Euro/US-

²³An example is 61041300 "Women's or girl's suits of synthetic fibres, knitted or crocheted (excl. ski overalls and swimwear)"

Dollar exchange rate to convert the other currencies into Euro/foreign currency exchange rates over the entire sample period.

Generally, my data captures the period from January 1988 to December 2008. However, for some countries, e.g., Russia or Poland, I do not have an exchange rate over the entire sample period. One shortcoming of the Eurostat CN system is that it does not explicitly differentiate between consumer goods and industrial goods. Descriptions for CNs covering textile and electronic categories seem most appropriate to exclude industrial goods. Therefore, the analysis is mainly restricted to these CNs. Furthermore, concordance tables offered by the Statistical Office to classify industry and consumption purposes were integrated, but still this caveat needs to be kept in mind.

5.2 CN selection criterion

CNs are selected according to their dispersion. Following the methodology outlined in WTO, UNCTAD and ITC (2007), the interquartile range ratio (*IRR*) and Bowley's skewness coefficient (*BSC*) are useful instruments. I calculate the mean and quartiles ($Q_i, i \in 1, 2, 3$) of the unit value of each CN in each country over time. The *IRR* then is $IRR = Q_1/Q_3$. The smaller the *IRR* the higher is the variation in this CN. In order to check whether the median of this CN is well located, I calculate the *BSC* according to $BSC = ((Q_3 - Q_2) - (Q_2 - Q_1)) / (Q_3 - Q_2)$. The closer to zero the *BSC* is, the closer is the mean of this CN to the exact middle of the interquartile range. CNs satisfying $IRR > 0.5$ and $-0.5 < BSC < 0.5$ are considered as stable and properly centered. In other words, the less volatile an 8-digit CN and the more centered the median, the more likely it is that this CN represents a relatively homogeneous product. This constraint reduces the total of different CNs from 753 to 487.

5.3 Unit-root test for stationarity

I tested for unit-roots with the Augmented-Dickey-Fuller test (ADF-test). The number of included lags has been chosen according to the Akaike information criterion provided by Stata. The results for the exchange rates are

given in Table 5. All exchange rates are tested to be integrated of order one with the exception of the Polish Zloty. Import unit values, on the other hand, are tested with Fisher's unit-root test for unbalanced panels using both, the ADF and the Phillips-Perron test. As Table 6 indicates, the null hypothesis that all unit value series are non-stationary is clearly rejected.

Table 5: ADF-Tests on stationarity

Country	no. of lags ^a	test statistic	cr. values			order of integration
			1%	5%	10%	
UK	4	-1.009	-3.461	-2.88	-2.57	I(1)
Denmark	4	-1.637	-3.461	-2.88	-2.57	I(1)
Sweden	5	-1.225	-3.461	-2.88	-2.57	I(1)
Turkey	3	-2.702	-3.461	-2.88	-2.57	I(1)
Poland	3	-3.482	-3.476	-2.883	-2.573	I(0)
Czech Rep.	2	-0.427	-3.48	-2.884	-2.574	I(1)
Hungary	3	-2.953	-3.476	-2.883	-2.573	I(1)
Russia	3	-1.896	-3.518	-2.895	-2.582	I(1)
USA	3	-1.737	-3.461	-2.88	-2.57	I(1)
Mexico	2	-0.926	-3.46	-2.88	-2.57	I(1)
India	3	-2.222	-3.461	-2.88	-2.57	I(1)
Thailand	9	-1.563	-3.463	-2.881	-2.571	I(1)
Malaysia	3	-1.472	-3.461	-2.88	-2.57	I(1)
China	3	-2.176	-3.461	-2.88	-2.57	I(1)
South Korea	3	-1.331	-3.461	-2.88	-2.57	I(1)
Japan	2	-1.901	-3.46	-2.88	-2.57	I(1)

^achosen according to Akaike information criteria in Stata

Table 6: Import unit values: Unit-root tests on stationarity

Country	ADF-Test		Phillips-Perron Test	
	p-value	Test statistic	p-value	test-statistic
UK	0	3715.815	0	6466.508
Denmark	0	3519.873	0	6486.69
Sweden	0	1038.557	0	1748.656
Turkey	0	5163.857	0	9004.582
Poland	0	5066.479	0	9368.225
Czech Republic	0	3277.219	0	6828.678
Hungary	0	3489.939	0	6950.986
Russia	0	469.5029	0	1060.843
USA	0	4847.172	0	8128.96
Mexico	0	114.4351	0	344.5228
India	0	2464.346	0	4313.462
Thailand	0	2415.629	0	4142.424
Malaysia	0	1029.745	0	2055.048
China	0	6827.915	0	12693.25
South Korea	0	1905.395	0	3229.822
Japan	0	2998.916	0	5603.54

5.4 Country information

Additional information on the trade volume and exchange rates used in this study are given in Table 7. In the reference year 2008 the selected countries cover on average 46% of the total import value over all CNs. This amount is explained by the restriction to specific CNs as well as by the exclusion of all other EU countries belonging to the Euro-currency zone, e.g. France, the Netherlands and Italy. Including all Euro-currency countries increases the share to 90%. However, as unit values are an approximation of prices I constrain the data twice. First, CNs that are traded over a time period of less than the maximum time range minus 50 periods are not considered. Second, as mentioned above, the *IRR* and *BSC* are applied, which reduces the number of CNs. In so doing I reduce the data to a set of relatively stable and continuing observations which should provide a more reliable approximation of prices.

Table 7: Import volume and share by country

German Trading Partner	Exchange rate		Year: 2008, (volume in 1000€)		
	Mean	St. Dev.	Volume	Trade	
				Share	No. of CNs
UK	0.716	0.069	1522720	9.68%	65
Denmark	7.686	0.393	681399	4.33%	61
Sweden	8.780	0.654	292623	1.86%	18
Turkey	0.710	0.772	1108947	7.05%	106
Poland	3.560	0.765	630582	4.01%	134
Czech Rep.	32.646	3.443	854812	5.44%	101
Hungary	216.217	55.049	1860906	11.84%	98
Russia	33.205	3.688	28128	0.18%	27
USA	1.202	0.157	1043973	6.64%	75
Mexico	8.773	4.265	519615	3.30%	4
India	42.532	12.388	709392	4.51%	57
Thailand	38.851	7.239	156862	1.00%	53
Malaysia	3.809	0.643	106295	0.68%	22
China	8.567	1.943	5372396	34.17%	173
South Korea	1145.853	221.379	118856	0.76%	36
Japan	141.774	24.003	715036	4.55%	50
Total:			15722541	100.00%	

Notes:
Selected countries cover on average 46% of German imports over all CNs.
Including imports from Euro-countries increases this share to 90%.