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Abstract

Gravity and pricing to market (PTM) models have been used to elaborate determinants of bilateral trade and export pricing for different countries and branches. Typically, only one of the two methods was chosen. We show in a stepwise approach that a combination of both methods yields novel results on the determinants of exports and export pricing behaviour. For the case of German beer exports, we show that structural differences exist between markets on which exporters apply either PTM or non-PTM strategies. German beer exporters apply PTM strategies, in particular local-currency stabilization, on those markets where imports are very sensitive to exchange-rate changes. Non-PTM strategies, i.e. full exchange-rate transmission, occur on export markets with insensitive reactions. Apart from PTM strategies, German beer exports are strongly dependent on policy variables such as the introduction of the Euro and the partner country's membership in the EU.

Keywords

Incomplete pass-through, gravity equation, pricing to market, export behaviour, German beer

1 Introduction

Beer brewing and consumption dates back to ancient times (Poelmans and Swinnen, 2011) and the determinants of beer production, consumption and trade have been fascinating economists for a long time. Major issues have been the optimal taxation of alcoholic beverages (Smith, 2005) and, in this context, the price elasticity of demand (Fogarty, 2010) as well as the industrial organization of major beer markets (Sutton, 1991; Tremblay and Tremblay, 2005). In an international context, determinants of foreign direct investment (Mehta, 2012) and trade of the brewing sector have been studied. Beer export pricing and exports have been analysed with pricing to market and gravity models. The two methods have been used extensively in trade analyses and in some studies of agricultural exports, but always separately for different types of questions. We will use both concepts in a stepwise approach to elaborate determinants of export pricing and exports of German beer in the period 1991-2011.

Gravity-type studies for the food industry (Raimondi and Olper, 2011) as well as for total external trade (e.g. Berger and Nitsch, 2008; Baldwin, 2006) investigated how export values react to distance between trading partners, their income, openness and policy variables. There is one gravity-type study on the beer and wine markets across 15 (old) member states of the European Union (EU) in the period 2000 – 2009. This study by Olper et al. (2012) concentrated on the existence and magnitude of a home bias in beer as opposed to wine consumption. The authors concluded that the home bias in beer consumption is clearly stronger than for wine, but it is mainly due to firms' decisions to locate close to consumers rather to consumer preferences as in the case of wine. There is no gravity analysis for German beer trade and generally no gravity application to European beer trade that incorporates major policy variables like being a member of the EU or the Eurozone apart from the standard gravity variables of bilateral trade.

A separate branch of the literature on export behaviour, that is surveyed by Goldberg and Knetter (1997) and Goldberg and Hellerstein (2008), refers to PTM and exchange-rate transmission. Pricing decisions of exporters on various destination markets are analysed in PTM models in order to test for imperfect competition. Some of these studies incorporated German beer exports and showed that PTM strategies existed on some but not on other markets (Knetter, 1989; Glauben and Loy, 2003). Beer exporters apply price discrimination and, in particular, local currency price stabilization (LCPS). LCPS is a special form of PTM, when the exchange rate changes are partially absorbed by the markup of producers in order to avoid large price fluctuations in local currency on the destination markets in order to protect market shares.

The available pass-through and PTM studies of German beer exports refer to data in the 1980s and 1990s and do not cover the period after the Euro introduction. However, there are more recent empirical industrial organization (NEIO) approaches in which the intensity of competition in export markets were addressed and applied to beer exports. Goldberg and Knetter (1999, p. 28), in an influential paper, argue that the pass-through and PTM literature allows to reject the "hypothesis of integrated world markets" but there is "no direct link between pass-through or pricing-to market and the level of the mark-up, the standard measure of the degree of market power". They suggest the residual demand elasticity (RDE) along the lines of Baker and Bresnahan (1988) as a measure of market power on export markets and derive for German beer exporters that their market power is limited and "inversely related to the presence of the Netherlands in each market" (Goldberg and Knetter, 1999, p. 59). In their analysis of German exports for beer, cocoa powder, chocolate, and sugar confectionary, Glauben and Loy (2003) find "partly inconsistent results" (ibid., p. 18) of PTM and RDE results: They reject the market-power hypothesis with the RDE model for all markets, but find significant pricing to market coefficients in various markets including the US and Canadian beer market.

We argue here that an insignificant market-power coefficient and a significant PTM coefficient might well be consistent. One reason is that, although testing for imperfect competition, the PTM approach captures two different aspects of export pricing: (i) the destination-specific price level as measured by the intercept, the country and the time influence in the Knetter model; (ii) the price adjustment as measured by the coefficient of the exchange-rate variable. It is dynamic pricing of the second type, which is the core of the PTM model and of LCPS. It may well be that on competitive export markets, where a market-power coefficient is not significantly different from zero, exporters are cautious with regard to price changes in order to keep their market shares. There are indications that this might be very realistic for beer exports. Large beer export markets, like the US, are very competitive (Tremblay and Tremblay, 2005). Moreover, there is increasing evidence of a general price stickiness, e.g. in the US (Blinder et al., 1998), and for food and beverages in different countries such as Germany and the U.S. (Herrmann, Möser and Weber, 2005; Nakamura and Steinsson, 2008). Blinder et al. (1998) identify in their survey results a "coordination failure" as the most important reason for sticky prices. It means that managers hold back on price adjustment and rather wait for competitors to go first. They refrain from antagonizing consumers and losing market shares. This reason may well be crucial for PTM, in particular LCPS, at least if exporters decide themselves on prices in the destination markets. Interestingly, the study by Goldberg and Hellerstein (2013, p. 208) reports findings which confirm the relevance of sticky prices for the US beer market: "… we observe many periods during which prices remain completely unchanged; this complete inertia can only be accounted for by nominal price rigidities".

Additionally, individual studies of German beer marketing describe that firms distinguish between their major and important export destinations and less important export markets. Schmid and Luber (2013), e.g., report for the case of Bitburger that the firm is much more involved in marketing efforts on the markets of their major destinations: Cooperations with foreign wholesalers do exist and own service activities are performed by own sales representatives abroad. On less important export markets, importers buy beer from the firm in Germany and manage sales on the export market on their own initiative. Under such conditions, differential pricing strategies for important or large destinations and for less important and small destinations are very likely.

Given these findings in different branches of the literature, the question arises whether pricing behaviour of German beer exporters differs across market segments according to the sensitivity of bilateral trade with regard to exchange-rate variations. PTM and, in particular, LCPS seems much more likely on markets where exchange-rate induced price variations would lead to strong changes in market shares. It could also be that LCPS prevails more on the more important beer export markets than on less important ones as distinguished by Schmid and Luber (2013). We will test this hypothesis in the following by applying PTM and gravity analyses within a stepwise approach.

It is the objective of this article to show that a combination of gravity and PTM models may yield novel and consistent insights into the dynamics of export pricing behaviour. We show for the case of German beer exporters: (i) what determines bilateral trade in a general gravity model with recent data including the introduction of the Euro; (ii) that PTM applies in the period 1991-2011 for German beer exports to some but not to other market segments; (iii) a differential gravity approach for the PTM and non-PTM markets showing that imports from Germany are particularly exchange-rate elastic on PTM but not on non-PTM markets.

In the implementation of the analysis, we contribute to the related literature in a number of ways: (i) To our knowledge, this is the first article where PTM and gravity models are utilized in a complementary form. (ii) As we will derive an incomplete exchange-rate pass-through, the exchange rate has to be integrated in the gravity model as derived by Anderson, Vesselovsky and Yotov (2013). Earlier gravity models on agricultural, food and beer exports have used specifications excluding the exchange rate. (iii) Unlike earlier gravity models of beer trade, impacts of the Euro and of participation in the Eurozone are captured in the gravity analysis. (iv) We provide the first PTM analysis of German beer exports including the period after the Euro introduction.

The article is organized as follows. We start by briefly addressing the beer sector development in Germany and analyze how beer production, consumption and exports have evolved over time. Then we concentrate on the major determinants of beer trade by estimating a gravity model including all German trade partners for the period after Germany's reunification, and introduce the exchange rate to this model. We then switch to the PTM model and empirically test whether strategic price discrimination is taking place in German trade with its partners outside the Eurozone and form two groups of countries based on the empirical results. We return to the gravity model with these outcomes, and re-estimate it for both traded values and quantities to see whether our hypothesis about different reaction between and within groups of countries is supported. Finally, we summarize the major outcomes, put them into the context of the existing literature and draw some conclusions.

2 German beer sector: a brief overview

There are around 1300 breweries in Germany, which produce between 5000 and 7000 sorts of beer. Most of the breweries are small- or medium-scaled and are located in Bavaria, while in the North of Germany the beer sector is historically more concentrated. The German beer industry is the most fragmented in Europe (BM, 2012), with the four largest companies (Radeberger, ABI Germany, Oettinger and Bitburger) capturing around 40 percent of the market[1]. With a production of around 96 mio hl, Germany was in 2011 the fifth largest beer producer after China, the US, Brazil and Russia. In 2014, Germany overcame Russia and became the world's fourth largest beer producer. About 86 of the brewed 95 mio hl were also consumed within the country in the same year (Beer Statistics, 2015). There has been a strong decline in domestic beer consumption over the last two decades, as Figure 1 shows, and per-capita consumption is still falling.

[Figure 1 around here]

The decrease in beer consumption and production since the 1990s drastically increased the role of exports. In the last five decades, exports increased from a negligible number to over 15 mio hl in 2014 (Beer Statistics, 2015), making Germany the third largest beer exporter after Mexico and the Netherlands. Major shares of German beer exports go to Italy (15 percent), followed by France, the UK, the US, the Netherlands, Spain, Switzerland, China and Canada (UNComtrade, 2016). While European countries had always been important destination markets for German beer, their role sharply increased with the enlargement of the European Union and with the

[1] For instance, in the US the share of the largest four companies were 95 % already in 2000 (as in Adams, 2006).

introduction of the Euro (Fig.2). We try to capture these effects within the gravity approach. On the other hand, China became an important beer importer very recently. We will incorporate these factors, when choosing our sample for the PTM analysis. In order to take time-series properties of the data into account we will choose countries outside of the Eurozone, where exports are frequent and stable over time, including Australia, Canada, Denmark, Japan, Sweden, Switzerland, the UK and the US. China will be excluded, as constant shipments appeared from 1998 only. The development of German beer exports to these countries relatively to the EU and the rest of the world over time is depicted in the Figure 2.

[Figure 2 around here]

3 Gravity model and incomplete pass-through

This section first presents the theoretical model of the gravity equation mainly based on Anderson and van Wincoop (2003) and then introduces incomplete exchange rate pass-through as done by Anderson, Vesselovsky and Yotov (2014). Afterwards, the econometric specification for our case of German beer exports is shown and important trade-hampering and facilitating covariates are identified based on a literature review. The last subsection introduces the data used in more detail.

3.1 Theoretical derivation

Since its empirical introduction by Tinbergen (1962), the gravity model that is based on Newton's law of universal gravitation became a workhorse of trade analysis. The gravity equation was derived from different models of international trade by several authors (Anderson, 1979; Helpman, 1987; Deardorff, 1998; Bergstrand, 1985, 1989, 1990; Anderson and van Wincoop, 2003). However, Anderson's (1979) derivation from a full expenditure system that was resumed by Anderson and van Wincoop's (2003), has become the major reference in many studies applying the gravity model. They established the following specification[2]:

(1) $$T_{od} = Y_o\, E_d \left(\frac{\tau_{od}}{\Pi_o P_d}\right)^{1-\sigma},$$

[2] For the analytical derivation, see Anderson (1979) and Anderson and van Wincoop (2003). The presentation of Baldwin and Taglioni (2006) might also be helpful.

where T_{od} is the value of bilateral exports of a good from origin county o to destination country d. Y_o is o's total sales to all destinations (including country o itself) and, thus, equals country o's output.[3] E_d is the destination country's expenditure on tradable goods. In empirical studies, countries' GDPs are usually used as proxies for both Y_o and E_d. τ_{od} are all kind of man-made and natural bilateral trade costs. Distance between o and d and various other measures (see below) that make the gravity equation to a widely applicable tool are used to capture trade costs. σ is the elasticity of substitution that is assumed to be above unity.

The major novelty of this derivation was the introduction of the "relative-prices-matter terms" Π_o and P_d that capture the so-called 'multilateral resistance'. These relative prices depend on all bilateral trade resistances and, additionally, are a function of bilateral trade costs. To solve this problem of circular references the authors assume bilateral trade costs (e.g. $\tau_{od} = \tau_{do}$) and estimate a special non-linear system of equations. By now, some other methods to determine the price terms Π_o and P_d have been developed (e.g. Baier and Bergstrand, 2009). However, a widespread and easy-to-implement method to account for multilateral resistance is to include fixed effects in panel analysis (Anderson and van Wincoop, 2003).

The major elements in all gravity equations are trade costs. These have easily been introduced in Anderson and van Wincoop's (2003) derivation by a pass-through equation that enters in a step in that the price of a traded good is converted from producer price in the exporting country to a consumer price in the destination country. The landed price in country d of a good produced in country o (p_{od}) is linked to the production costs in country o (p_o), the bilateral markup (μ_{od}) and trade costs (τ_{od}):

$$p_{od} = \mu_{od}\, p_o\, \tau_{od} \tag{2}$$

For simplicity, μ is often assumed to be one and, thus, neglected in the presentation. This assumption holds, for example, in the Dixit-Stiglitz monopolistic-competition case or in a trade model with Armington goods.

As both prices, p_o and p_{od}, are denominated in the same currency, exchange rates are not considered in standard gravity research. Anderson, Vesselovsky and Yotov (2013, p. 2) argue that the ignorance of exchange rates is justified "…because previous literature assumed constant returns trade technology and most researchers implicitly assumed complete pass-through

[3] To simplify we skip the time subscript in most parts of the gravity models.

obtained in the static gravity model setting." However, Anderson, Vesselovsky and Yotov (2013; 2014) prove theoretically and show empirically that incomplete pass-through of exchange rate changes and non-uniform scale effects are two channels through which exchange rates have real effects on trade patterns. Taking into account both, incomplete pass-through and scale effects, as a part of border-related trade costs the authors formulate the *adjusted* trade costs τ^{*}_{od} as given by:

$$(3) \qquad \tau^{*}_{od} = \tau_{od} \left(\frac{r_o}{r_d}\right)^{\rho_d} V_{od}^{\varphi_{od}} ,$$

where r_o/r_d is the appreciation of the bilateral exchange rate of *o* with *d* that is raised (in a constant elasticity form) to the power of the pass-through elasticity ρ. Thus, the second multiplier of Eq. 2 is the pass-through to prices paid by *d* for goods of *o*. Note that the pass-through elasticity is destination-specific. V_{od} is the volume shipped from *o* to *d* and ϕ is the elasticity of scale effects in trade. The exchange rate pass-through elasticity is the parameter of our interest. Due to the small size of the beer-exporting sector compared to the whole economy we can take exchange rate changes as exogenous.

Anderson, Vesselovsky and Yotov (2013) note that there is no evidence of pricing to market in their industry-level data for inter provincial Canadian trade and cross-border trade with the US. However, in the empirical literature it has often been proven that firms do price discriminate so that exchange rate pass-through is incomplete (e.g. Goldberg and Knetter, 1997). Furthermore, the evidence of pricing to market has often been found in beer exports (e.g. Knetter, 1989; Goldberg and Knetter, 1999; Hellerstein, 2008).

Replacing τ_{od} in Eq. 1 by τ^{*}_{od} Anderson, Vesselovsky and Yotov (2014) obtain the following theoretical specification of the gravity equation:

$$(4) \qquad T_{od} = Y_o E_d \left(\frac{\tau_{od} \left(\frac{r_o}{r_d}\right)^{\rho_d} V_{od}^{\varphi_{od}}}{\Pi_o P_d}\right)^{1-\sigma}$$

As soon as a complete exchange rate pass-through on the market is doubted it is necessary to include the exchange rate in the gravity model. Thus, we estimate a gravity model for all German trade partners where we also include the exchange rate, in order to account for an incomplete pass-through due to pricing-to-market strategies in the different markets. A significant effect of the exchange rate on exports would be a signal, that the exchange rate changes affect exports and might result in application of pricing strategies (e.g. PTM). Furthermore, for the PTM group the reaction of quantities exported is expected to be less pronounced as the reaction of the export values, while for the non-PTM group both the values and quantities might be found insensitive to the exchange rate changes. However, before turning to differences in PTM and non-PTM countries we will estimate a gravity model in a standard setting for all German trading partners. We will return to the incomplete pass-through in Sections 4 and 5. The empirical specification is presented in the next sub-section.

3.2 Econometric specification

Rewriting Eq. 4 in a reduced and log-linearized form while substituting Y_o and E_d by countries' GDPs and taking distance (*Dist*) as a proxy for trade costs yields

$$\text{(5)} \qquad \ln(T_{Gd,t}) = \alpha + \beta_1 \ln\left(GDP_{G,t}\right) + \beta_2 \ln\left(GDP_{d,t}\right) + \beta_3 \ln(Dist_{Gd}) + \rho \ln\left(ER_{Gd,t}\right) + Z_{Gd,t} + \mu_d + \varepsilon_t + u_{Gd,t}\,.$$

$T_{Gd,t}$ is the value of German beer exports to partner country *d* in year (or month) *t*. The subscript *G* indicates Germany as being the origin country of beer exports.[4] *Z* is a vector of a comprehensive number of additional variables that capture trade-driving factors we identify below and *ER* is the bilateral exchange rate.

μ and ε are a full set of country- and time-specific fixed effects that are supposed to capture the multilateral resistance terms as well as all other unobserved country- and time-specific effects. Some variables are dropped in the fixed-effect estimation in order to avoid perfect correlation with country-specific effects (e.g. *Dist*) or time-specific effects (e.g. GDP_G). Finally, *u* is an error term assumed to be *iid*.

Of particular interest are the variables that are summarized in the vector *Z.* Variables included in our analysis are summarised in Table 1[5]. Annex 1 provides an overview of the descriptive statistics of these variables.

[Table 1 around here]

[4] Often in the gravity literature both countries' GDPs are multiplied as in most studies exports from *o* to *d* are averaged with exports from *d* to *o* and, thus the information on the direction of trade *gets lost* in the data. This implies that $\beta_1 = \beta_2$. However, as we consider German exports only, we are able to observe exporter- and importer-specific coefficients.

[5] We also take into account excise taxes as well as value-added taxes in the importing country. However, data on the first are incomplete and hardly available and there is little variation over time in both excise taxes and value-added taxes. Estimations for both variables are less promising so we skip them in the estimations and forego a further presentation.

As we have seen above, the effect of the European market integration on German beer exports is a major factor driving Germany's trade. With the foundation and enlargement of the European Union, a large Single European Market has been created. Integration was fostered by establishing of the European Economic and Monetary Union (EEMU) and by introducing of the Euro in 1999. The related elimination of transaction costs[6] should have led to an increase of member countries' trade. There is a large body of theoretical and empirical literature concerning the trade-increasing effects of a common currency. In his seminal work, Rose (2000) elaborated that monetary unions triple trade. The lively debate initiated by this work is summarized by Rose and Stanley (2005) in a meta-regression analysis concluding that currency unions increase trade by 30 to 90 %. Baldwin (2006) analyses the effect of the Euro on member countries' trade and the existing literature most comprehensively. He substantiates, e. g., his view that aggregate estimations of relationships between monetary unions and trade flows are unsound. Thus, later studies concentrate on sectoral trade flows (as this study does) and investigate a trade-increasing effect within a microeconomic framework. Among these studies are Baldwin et al. (2008), Nitsch and Pisu (2008), Berger and Nitsch (2008), Flam and Nordström (2006) and others. In summarizing this strand of the literature, one may conclude that the Euro has a trade-increasing effect between 5 and 20 %. We include two dummy variables that capture the effects of European integration.

The variable of a common religion not just captures a trade-increasing effect of cultural similarities in our case. In terms of exporting alcoholic beverages, the variable also includes that some religions, especially the Islam, do not allow their adherents to drink alcohol. Thus, exports to Muslim-dominated or non-Christian-dominated countries should be considerably smaller.

We include the exchange rate (ER_{Gd}) in indirect quotation (units of local currency per Euro). An appreciation of the Euro would make German exports more expensive for the trading partners and, hence, one would expect the exported quantity and export value noted in Euro to decrease.

Like all other monetary variables, the dependent variable is measured in Euro.

Existing empirical literature provides important insights concerning the influence of trade determinants. The coefficient of GDP is different from zero but not significantly different from

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[6] One type of transaction costs to mention here is the exchange rate risk that occurs due to the uncertainty about the future development of exchange rates in the trade of countries with different currencies. Intuitively, the elimination of the risk within a monetary union reduces trade costs and leads to an increase of trade. However, there are theoretical contributions as well as empirical findings suggesting that exchange rate risk could also have positive effects on trade. Clark, Tamirisa and Wei (2004) and Bahmani-Oskooee and Hegerty (2007) give a comprehensive overview on this topic. We assume that German beer exporters hedge the occurring risk on forward exchange markets and, thus, are not vulnerable to exchange rate risk and related costs other than (negligible) hedging costs. However, besides elimination of exchange rate risk, other trade-facilitating facts exist in a currency union.

one and the population which is often included as an additional variable has an elasticity of -0.4 (Anderson, 1979). In a meta-analysis concerning the effect of distance, Disdier and Head (2008) found that the elasticity is -0.91 (see also van Bergeijk and Brakman, 2010). Olper et al. (2012) provided some results for bilateral exports of wine and beer for 15 old EU member states. By concentrating on the home bias, the authors found an elasticity of trade with respect to relative distance in the magnitude of -0.7 to -0.9. Additionally, the trade of adjacent states was found to be 140 to 230 % higher, while no trade-increasing effect of a common language could be proved.

Comprehensive studies addressing all the above-mentioned determinants of food and agricultural trade jointly are not available for German beer exports. We estimate a gravity model for an annual panel from 1991 to 2010 including all destination countries for German beer exports, as a first step of this study[7]. In total 216 possible trading partners are listed in the UNComtrade database and included in our panel. This results in 4320 observations in total (20 years * 216 countries). However, as not all countries exist during the whole period the number of possible trade flows reduces to 3996. Positive trade flows of German beer exports are actually observed in 2822 (71 %) cases.[8]

3.3 Estimation outcomes of the gravity approach

Results shown in Table 2 suggest that the estimated gravity equation explains the variation in export values successfully. The adjusted coefficients of determination are for 7 of 8 equations above 0.80. The estimations reveal that economic growth in the partner country by one percent, e.g. a rising GDP, leads to an increase of exports to those countries by 0.60 to 0.96 % what is in line with literature concerning other products. Growth in Germany significantly reduces German beer exports. An increase of distance as an indicator for transport costs leads to a decrease of exports by roughly 0.40 up to 0.56 %. Thus, transport costs are three times as important for exports as trade partners' import tariffs whose increase by one percent reduces exports only by 0.23 %. However, compared to other gravity literature on different products and countries and compared to the outcomes of Disdier and Head (2008), German beer exports are not that heavily

[7] Annual data on exports are available back to 1962 whereas monthly data from Eurostat only exist as from 1988. Hence, to keep results from different estimates comparable and to avoid distortion associated with German reunification, the sample was reduced to data from 1991 on.

[8] The gravity model was usually estimated in log-linearized form using ordinary-least-squares techniques (OLS). However, Silva and Tenreyro (2006) show that under heteroskedasticity, which is widespread fact in gravity estimations, the use of OLS techniques results in biased estimates. They concluded that the Poisson Pseudo Maximum Likelihood (PPML) should be used instead. Additionally, PPML-estimators better address the frequently occurring zero values in trade flows (i.e. no trade occurs). In order to check for robustness we present outcomes from PPML estimates and least-squares techniques.

affected by distance or transport costs even though transporting beer primarily means transporting water. However, this might well be explained by the popularity of German beer all over the world. Contrary to the existing literature which regularly finds an enhanced trade between contiguous countries, exports to neighbouring countries are by roughly 100 % ($e^{0.72}$-1) to 150 % ($e^{0.91}$-1) lower. This might to some extent be explained by the home-bias effect (e.g. Olper et al., 2012), which suggests that producers tend to localize their plants near to consumers. Having in mind that most of Germany's neighbouring countries (Belgium, Denmark, the Netherlands, and the Czech Republic) have a strong beer industry and a pronounced home production, such outcomes are conceivable. An appreciation of the Euro seems to negatively affect export values. However, this result does not hold robustly for different estimation techniques. The PTM behaviour of exporters in different markets in the next section will shed more light on this pattern.

Coefficients on the European Union variable tell us that apart from a reduction of tariffs to zero within the EU, which is captured by the tariff variable, there is an additional trade-increasing effect of the European Union. Exports to EU members countries in the case of least square estimates with fixed effects is 48 to 57 % higher compared to non-members or compared to the situation before the foundation of the EU in 1993. This finding is theoretically consistent with a broad literature concerning free-trade agreements, but interesting evidence on the magnitude of the impact can be provided here. However, in PPML estimates with fixed effects no significant trade increasing effect is observed. Moreover, if a member introduces (has introduced) the Euro as its currency, German beer exports to this country rise across all models presented in Table 2 from 42 to 112 %. In our preferred specifications, numbered 3 and 4, a trade-increasing effect in the amount of 72 and 67 %; respectively, can be observed. Compared to the existing literature that finds a trade-increasing effect of the Euro in the range from 5-20 % this impact is substantially higher. The structure of our data suggests that the trade increasing effect of the EU is particularly driven by enlargement of the EU in the East. The outcomes of the estimations, thus, lead us to the conclusion that the German beer industry substantially benefits from the EU enlargement, especially towards the East, and from the introduction of the Euro.

Complementary to Table 2, Annex 2 shows that the results are rather robust with regard to zero trade flows. In the estimates of Table 2 zero observations were dropped, in Annex 2 zero flows were included[9].

[Table 2 around here]

4 Incomplete pass-through and pricing to market

The decreasing domestic beer consumption, an increasing role of exports and a very high competition in both domestic and foreign markets make exporters search for instruments of gaining and protecting their market shares. Pricing to market, introduced by Krugman (1987), is one instrument of such strategic behaviour. PTM implies setting destination-specific adjustments of the markups as a response to the exchange rate changes. Theoretically, a situation in which PTM might occur can be derived from a profit-maximization problem of the producer, who exports his goods to different destinations, analogous to Krugman (1987) and Knetter (1989)[10]:

(6) $$P_{dt} = MC_t\left(\frac{\varepsilon_{dt}}{\varepsilon_{dt}-1}\right),$$

where P is the free-on-board (fob) export price, set for destination market d, MC are the marginal costs of production in period t and ε_{dt} is the elasticity of demand with respect to the local currency price in destination market d.

Here, PTM arises when the elasticity of demand with respect to the local currency price is not constant, making price setting in the source country's currency a strategic decision, which might depend on a development of the exchange rate. In the absence of the destination-specific price adjustment related to an exchange rate change, price setting for the case of perfect competition and for the case of imperfect competition with constant elasticity of demand can be derived from this equation. To test whether German beer exporters exploit PTM strategies, as suggested by previous empirical studies, we adapt a static Knetter model (1989, 1994). In the model that the exporter‘s price is influenced by marginal costs of production, exchange rates and income factors of both home and foreign countries:

[9] Interested readers may note that the coefficient of the distance variable is much higher in the least-squares estimates including zero trade flows compared to the estimates without zero trade flows. This seems consistent, as zero flows are more likely to occur for more distant trade flows. Moreover the different in the PPML estimates is much smaller, suggesting that PPML estimates are a better way to deal with zero trade flows as stated by Silva and Tenreyro (2006).

[10] Here we skip the complete derivation part. It can be found, e.g., in Knetter (1989).

(7) $\ln(P_{d,t}) = a_d + b_d \ln(E_{d,t}) + c_d \ln(GDP_{d,t}) + d_d \ln(GDP_{G,t}) + e_d \ln(MC_t) + u_{d,t},$

where $P_{d,t}$ is the export unit value[11], expressed in terms of the exporter's currency and $E_{d,t}$ is the exchange rate in units of destination country's currency per unit of exporter's currency adjusted by the consumer price index (CPI) of the destination market to control for the impact of the inflation on foreign markets ($E_{d,t} = \frac{ER_{Gd,t}}{CPI_{d,t}}$). $GDP_{d,t}$ is included as a demand shifter in the destination markets. Cost shifters are presented in the model by two variables: marginal costs and German GDP, which is included in order to account for possible input quality changes (as in e.g. Manova and Zhang, 2012). As marginal costs (MC) are not observed, they are approximated analogously to Silvente (2005) by the estimated time-specific effect from the Knetter (1989) fixed-effects panel estimation, as they capture changes in prices, similar across all destinations and show a better fit than barley prices or the PPI in German food manufacturing[12]. In order to account for time-series properties of the data, we estimate a dynamic form of the equation individually for each destination market:

(8) $\Delta \ln(P_{d,t}) = a_0 + a_1[\ln(P_{d,t-1}) - a_2 \ln(E_{d,t-1}) - a_3 \ln(GDP_{d,t-1}) - a_4 \ln(GDP_{G,t-1}) - a_5 ln\,(MC_{t-1})] +$
$+ \sum_{q=1} \rho_q \Delta \ln(P_{d,t-q}) + \sum_{q=0} \phi_q \Delta \ln(\mathrm{E}_{d,t-q}) + \sum_{q=0} \chi_q \Delta \ln(GDP_{d,t-q}) + \sum_{q=0} \psi_q \Delta \ln(\mathrm{GDP_{G,t-q}}) +$
$+ \sum_{q=0} \omega_q \Delta \ln(MC_{t-q}) + u_{d,t}$

Such an autoregressive distributed lag (ARDL) specification can be estimated with OLS and allows us to apply the bounds-testing approach by Pesaran, Shin and Smith (2001) to test for the long-run relationship between variables irrespective of their order of integration[13]. The appropriate lag structure is chosen according to the Schwarz criterion with 12 being the maximal

[11] We are well aware of potential problems introduced by the use of average unit values (see, e.g., Lavoie and Liu, 2007). No alternative data are available and it seems reasonable that mostly premium-quality beer is exported, especially to far-away destinations (see, e.g., Görg, Halpern and Muraközy, 2010). The price difference between different beer sorts is hopefully not so large, and exchange rate changes do not lead to a substitution between the premium and "normal" beer in the composition of exports. Besides that, the recently discovered evidence of a collusive behavior of German beer producers on domestic market during the last 20 years, lets us assume, that such agreements could have taken place in the international market as well, as Germany faces even stronger competition there.

[12] It is possible that those time effects capture not only marginal costs changes, but some other factors. Still, those are the changes in export prices (fob) similar between all the destinations under consideration. Thus, the inclusion of time-specific effects, similar across destinations, as cost proxies, implies accounting for potential correlation between cross-sectional units. As an inclusion of this parameter shows a better fit than the model where other possible cost shifters are considered, we stick to using the time-specific effects as a proxy of marginal costs. Outcomes from the fixed-effects estimation might be obtained from the authors on request.

[13] This is very appealing, as standard tests fail to come to a consistent conclusion regarding some variables. As e.g. when the ADF test reject the H_0 of a unit root and the KPSS reject the H_0 of stationarity for some price variables. Still, none of our variables is of order two, which makes bounds-testing applicable.

number of lags as we use monthly data. When the problem of autocorrelation was still present in the selected model, the lags of ΔP were added to overcome the problem. The long-run elasticity of price with respect to the exchange rate is obtained using the Delta method as:

$$Z = -\frac{a_2}{a_1}. \tag{9}$$

We concentrate on exports to eight destination countries outside of the Eurozone, most of which are found among the twenty main importers of German beer in value terms in 2011 (UNComtrade, 2011). Figure 3 shows how exports to these eight destinations were evolving over the twenty years covered by our sample period.

[Figure 3 around here]

The complete estimation outcomes are reported in Appendix 3. The overall quality of the estimated models is quite good. The explanatory power for the estimated ARDL models is between 0.29 and 0.63. All the models passed diagnostic tests, including the LM correlation, Ramsey Reset (beside Denmark and Sweden) and are stable over time according to the CUSUM outcomes (beside Denmark). For most of the markets the bounds-testing approach confirmed the long-run relationship between the variables in the model. The bounds-testing results for Sweden and the US fell in the "uncertain" area. For these countries no clear conclusion can be made and we treat the outcomes with caution[14].

Marginal costs affect the prices positively as expected. Still, cost transmission differs across countries. For most of the destination countries transmission is immediate (Australia, Denmark, Japan, Sweden, the UK), while in others the cost pass-through is incomplete even in the long run. This can be explained to some extent by overcapacity on the market, which prevents producers from full cost transmission as significant discounts are necessary to slow down the decrease in sales (BM, 2012)[15]. As for the income shifters in the destination markets, the coefficients we obtained were mostly negative. This might be due to a very high competition on the premium beer markets, where higher incomes are associated with a larger variety of high-quality products

[14] For the US, where bounds testing could not reveal any clear outcomes, it might be a sign that the PTM behavior to the US is changing over time. Here, we appeal to the previous studies, which found PTM in exports to the US very persistently. Besides, the US model reveals a pronounced short-run relation between the price and the exchange rate, which remains, when we reestimate the model in differences only. The outcomes of this estimation might be obtained upon request. As for Sweden, such an outcome might be a result of a spurious regression.

[15] The failure to explain beer prices with the barley prices is caused by the same reasons: Despite increasing prices of raw materials and energy, beer prices have not changed accordingly as producers had to protect their sales volumes on very competitive markets via markup correction, which was captured by the estimated time effects.

available. On the other hand, most statistically significant coefficients related to the German GDP were found to be positive. This supports the assumption of Manova and Zhang (2012) that with an increasing home country income higher quality inputs are used for the production of goods, which results in the increasing of their prices. The only outlier from this pattern is Australia, for which increasing income has a positive effect on prices, while German GDP is negatively related to the export price. The long-run elasticities of the exchange rate are presented in Table 3.

[Table 3 around here]

Despite the fact that the coefficients are evenly distributed between positive and negative, only negative coefficients are of high statistical significance. Thus, the outcomes suggest than local currency price stabilization as a form of PTM is prevailing in our sample markets. This is the case for Canada (-0.65), Switzerland (-0.22), UK (-0.65) and the US (here we obtain the long-run coefficient of -0.93 and the short-run coefficient of -0.30). For those destinations a part of the Euro appreciation is absorbed by German exporters via markup adjustment in the long run. The inverse happens as the Euro depreciates, if we assume a symmetric PTM reaction. Positive, though mostly insignificant, long-term coefficients were found for Australia, Denmark, Japan and Sweden.

PTM outcomes revealed two groups of countries: Canada, Switzerland, the UK and the US, where short- or long-term (or both) LCPS was found, and Australia, Denmark, Japan and Sweden, where no LCPS could be found, neither in the long nor in the short run. This implies a complete pass-through of changes in exchange rate to the prices in local currency on the markets of the second country group.

The size of the market and the destination markets' importance for the exporters seem to be a decisive factor for the application of PTM. Aggregate exports to non-PTM countries did not exceed 3 percent of total German beer exports in 1991 and 3.5 percent in 2011. In the meantime, PTM countries hosted around 40 percent of German beer exports in 1991 and 25 percent in 2011, with a decrease over time caused by a diminishing consumption by the UK and the US in relative terms. This decline, though, was not that pronounced in export values or quantities and was driven by an increasing role of the EU countries and new emerging export markets (e.g. China and Russia). Furthermore, the PTM countries are to be found among top-12 destinations for German beer exports with the US on the 2nd rank, the UK on the 4th, Switzerland on the 7th and Canada on 12th position. Non-PTM countries appear lower in this list, with Australia being 15th, Sweden 17th, Denmark 19th and Japan 32nd export destination in terms of value. Figure 4 depicts the distribution of German beer exports between the PTM and the non-PTM group over the sample period.

[Figure 4 around here]

The size of the market might affect pricing decisions through e.g. menu costs, as monitoring of the exchange rate fluctuations and adjusting prices should be perceived by exporters as reasonable, once costs and benefits of PTM are compared. The organization of exports also depends on the size of producer and the destination market, as large breweries tend to organize exports to the key-destinations themselves, while little breweries or the exports to less important markets are given away to some export company[16]. That might lead to the case where PTM is reasonable on large and important markets, especially if it is known that the imports of those destinations are very sensitive to price changes. Another factor influencing PTM application might be the intensity of competition in the destination market and related to it price sensitiveness of its consumers. One could think of the US or Canada for instance. Apparently, Germany is facing a very severe competition from the Mexican beer sector in these markets, and the changes in the local prices might shift consumer preferences away from German beer.

On the other hand, this might be much less the case for another group of countries. Despite the full pass-through of exchange rate changes on the non-PTM group, their share in German beer exports did not change much. Having in mind constantly increasing exports of German beer, it seems that the beer consumption in those countries does not suffer from exchange rate volatility. One might think that there is a certain constant (or even increasing) demand from consumers in those countries, who tend to appreciate the quality of German beer irrespective of its price, while in the countries of the PTM group consumers are more sensitive to changes in the local currency price.

If that is the case, export values and quantities in the PTM group might be affected by the changes in the exchange rates to a larger extent, while for the non-PTM group those changes seem rather negligible. If our hypothesis is correct, reestimation of the gravity equation, based on the outcomes from the PTM study, might provide some additional insights in the sensitivity of exports toward exchange rate fluctuations in the PTM and non-PTM groups. The local currency price stabilization mechanism would suggest that German exporters price to market exactly on the large and important markets, where exports are very sensitive to price changes and,

[16] Such distinguishing between export strategies applied to large and small markets is e.g. the case of Bitburger (Schmid and Luber, 2013).

consequently, to currency fluctuations. If this is the case, we are expecting to see a pronounced difference in reactions of exports between the two groups (as export values to the PTM-group should react more negatively to the exchange rate change) and within groups (between export values and quantities, as for PTM group we assume that the quantities are reacting less than the values due to the price adjustments).

5 Returning to the gravity model: what a split sample tells us

The evidence from the PTM estimates suggests that between 22 and 93 % of Euro appreciations are offset by German exporters for Canada, Switzerland, the UK and the US and are not passed through to prices in the importers' currencies. Such pricing behaviour might indicate that German beer exporters hesitate to adjust prices on destination markets if imports are sensitive towards price changes and, thus, to Euro appreciations. In order to investigate this possibility further and to look at differences in exporting behaviour on different export markets we re-estimated the gravity model for the two sub-samples and show the results in this section. Gravity estimates of this section are based on the same monthly export values and prices as in the pricing-to-market section. All other variables were introduced in Section 3.

Splitting the sample into PTM (Canada, Switzerland, the UK and the US) and non-PTM countries (Australia, Denmark, Japan, Sweden) results in outcomes presented in Table 4.

[Table 4 around here]

The table only covers the panel-least-squares estimations including fixed effects; full results are available from authors upon request. As one would expect, the explanatory power is high in fixed-effects models. However, the coefficient of determination in the non-PTM sample is by 30 percentage points lower. Exports to these countries are much more sensitive to random factors and are only insufficiently explained by traditional variables. German exporters and foreign importers do not seem to follow classical patterns. It might well be that, e.g., Japanese consumers drink German beer under each and even unfavourable circumstances, if they can afford it, making exports to these counties independent and maybe even unpredictable.

For the PTM group we obtain a significantly negative effect of the exchange rate on German exports, which proves our initial idea of the factors driving PTM behaviour. A negative sign of the variable is consistent with theory, as an appreciation of the Euro, i.e. an increase of the exchange rate, results in a decrease of exports. The price estimates are in line with the outcomes from the PTM section. A 1 % Euro appreciation causes a decline of the fob export price by

0.35 %. Hence, on average German exporters seem to offset around one third of the Euro appreciation by lowering export prices denoted in Euro for the destination countries from the PTM group. For the non-PTM countries, there is neither an effect of the exchange rate on export values nor on quantity. Thus, exporters and importers do not seem to perceive exchange rate changes as an important factor determining their decisions.

As a check of robustness, results shown in Annex 4 reveal that estimates on monthly data for all eight countries are widely in line with the annual panel for all trading partners in Section 3. However, there are some differences in the estimations concerning the contiguity and the EU variable. Whereas the contiguity variable was highly significant and negative in the earlier estimates, they turn positive now on German beer export values. Regression coefficient of the EU variable in Table 4 suggests a notably smaller effect compared to results from the full sample. However, one should not overstate these differences as each of the variables in the small sample captures characteristics for only two or three countries e.g. Denmark and Switzerland (Contiguity) and the UK, Denmark and Sweden (EU), respectively. There is a remarkable difference between the coefficient of importers' GDP in the PPML estimates and the panel-least-squares. In the latter an increase of GDP by one would increase beer imports by more than 3 %.

6 Summary and Conclusions

It was shown in this article that a combination of gravity and PTM models may yield novel and consistent insights into the dynamics of export pricing and export behaviour. The analysis revealed for German beer exports (i) how bilateral trade can be explained in a general gravity model for the periods before and after the Euro introduction; (ii) that PTM occurred in the period 1991-2011 for German beer exports to the non-Euro markets Canada, Switzerland, United Kingdom and the US, but not to Australia, Denmark, Japan and Sweden; and (iii) that beer imports from Germany show a differential reaction to changes in the exchange rates on PTM as opposed to non-PTM markets. On non-Euro destination markets, on which German beer exporters do (do not) utilize PTM strategies, beer imports are sensitive (insensitive) to changes in the exchange rate, i.e. to changes in the local-currency price. This pattern derived from the complementary use of PTM and gravity analysis provides a rationale for observed export pricing decisions. Apparently, beer exporters transmit exchange-rate changes only imperfectly to those markets where a declining market share is most likely with appreciations of the Euro.

Which conclusions can be drawn from this major finding? Our results allow to draw a more comprehensive picture of export pricing. It is evident that a cautious dynamic pricing strategy of German beer exporters exists on some markets. As exchange rate changes are not fully transmitted to prices on destination markets, price stabilization in local currency takes place and a destabilization of exporters' margins is the consequence. In the Knetter model, this is the case of $b_j < 0$, i.e. one of the two possible forms of PTM. This behaviour seems consistent with the fear (i) to antagonize customers and (ii) to move first in raising prices, i.e. arguments which were identified as major causes of price rigidity (Blinder et al., 1998: 85). The finding in the earlier literature, where existing PTM behaviour and lack of market power according to the RDM approach have been viewed as being "inconsistent" (Glauben and Loy, 2003: 17), has then to be questioned. Certainly, the PTM approach is supposed to identify imperfect as opposed to perfect competition. But it is not the objective of the concept to provide a market-power coefficient as in explicit market-power models. The dynamic pricing pattern shown above reveals that German beer exporters do not use potential market power on important export markets in terms of price adjustments to exchange-rate variations. It may well be that they do not use potential market power in terms of the price level either in order to remain competitive on those markets. It seems absolutely consistent that PTM behaviour with $b_j < 0$ coincides with insignificant market-power coefficients.

Some conclusions can be derived for future research. Firstly, it seems worthwhile to combine gravitation and PTM approaches on other German export markets or for other exporting countries. Similar evidence on other export markets would strengthen the argument we worked out here. Secondly, our interpretation of the complementary use of gravitation and PTM concepts is based on theoretical reasoning and econometric analysis and tests. It seems necessary to add expert surveys in order to contrast results of multivariate analysis with insider knowledge on export markets. Thirdly, if incomplete exchange-rate transmission emerges as the rule rather than the exception, it seems important to include exchange-rate effects regularly in gravity models.

Apart from the findings on our main research question, some of our results deviate from those of earlier studies and additional interpretation is needed. Some striking differences refer to the gravity estimates. While Disdier and Head (2008) find in a meta-analysis that distance has an effect of -0.91 on trade, German beer exporters suffer only half as strong under increasing distance, i.e. rising transport costs (-0.4 to -0.5). We find a significant effect of European market integration, i.e. the foundation of the EU and the introduction of the Euro, on German beer exports. While exports to EU countries are about 50 % higher compared to other countries, trade with countries of the Eurozone additionally increases by 60 to 70 %. Compared with recent literature on the Euro's effect on trade which concludes that the common currency increases trade by 5 to 20 % (e.g. Baldwin et al., 2008; Nitsch and Pisu, 2008; Berger and Nitsch, 2008; Flam and Nordström, 2006), German beer exports increased by much more due to the introduction of the Euro. Exports to neighbouring countries, which are also characterized by a significant beer production and consumption, are clearly smaller. These results suggest the existence of a home-bias effect as described by Olper et al. (2012).

Our PTM results are complementary and explainable, too, in the context of related earlier literature. In our econometric analysis, short- or long-term PTM is found in trade with Canada, Switzerland, the UK and the US, implying that for those destinations German exporters partly offset the Euro appreciation. Outcomes suggest that in the long run around 65 % of Euro appreciations are absorbed via markup adjustment of German exporters for Canada and the UK. For Switzerland, PTM adjustment is around 22 %. The long-run coefficient for the US is 93 %. But as we were not able to confirm the long-run relationship between the prices and the exchange rates for the American market, we discuss only contemporaneous adjustments for the US (around 30 %). These coefficients are somewhat higher than in Knetter (1989), whose coefficients for the UK, the US and Canada are -0.305, -0.288 and -0.205 respectively. An increasing competition on these markets over time seems very likely. A comparison with the findings of Glauben and Loy (2003) reveals some further differences. In their study, the long-run elasticity of price with respect to the exchange rate is reported to be -0.65 for the US, -0.71 for Canada and not significantly different from zero for the UK. Our findings regarding exports to the US are much lower and are only contemporaneous, while no long-term relation between price and the exchange rate could be found. This might be explained by a partial loss of interest from the side of small- and medium-sized brewers to compete with exports of Mexican brewers who now dominate the US beer import market (Tremblay and Tremblay, 2005: 110) and supply more than 50% on this market segment. The US are one of the countries where German beer is actually brewed (e.g. Paulaner) and, thus, trade was partly replaced by foreign direct investments. In this case the argumentation of Olper et al. (2012) comes into play, which also contributes to the changing price strategies. The UK is the 4th main destination of the German beer exports, so PTM is rather expectable, and the difference in the outcomes might be simply due to different time spans analysed.

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Table 1: Overview on variables of the estimated gravity model

Name	Description	Exp. sign	Source	Selected literature
GDP	Gross domestic product (€)	+	World Bank WDI	
Dist	Direct distance between Berlin and the main cities of trading partner (km)	-	Calculated with great-circle formula	Disdier and Head (2008)
Open	Openness captures a country's general openness to trade and is calculated as a sum of a country's total exports and imports divided by its GDP, i.e. $Open_{d,t} = \frac{EX_{d,t}+IM_{d,t}}{GDP_{d,t}}$. Thus, *Open* measures a countries' overall protection.	+	Calculated with UNComtrade and World Bank data	
Rem	Remoteness measures a country's relative distance to potential markets/ trade partners. It is the average distance of a country to all possible trading partners k, using partners' share of the world's GDP as weights, i.e. $Rem_{d,t} = \sum_{k}^{n,k\neq d} Dist_{dk} * \frac{GDP_{k,t}}{GDP_{W,t}}$.	-	Calculated with World Bank data	Frankel, (1997: 143), Wei (1996)
TR	Tariff rate (ad valorem; %) applied by importing country on beer imports from Germany. One is added to avoid taking logs in the case of no tariff is applied or missing data.	-	World Integrated Trade Solution (WITS)	
Christian	Dummy; 1 indicating that at least 40 % of the inhabitants in the respective trading country are Christians.	+	compiled on information of CIA World Factbook	
Contiguity	Dummy; 1 indicating that countries share a common land border.	+	CEPII gravity database	
Landlocked	Dummy; 1 indicating that country is landlocked.	-	CEPII gravity database	
EU	Dummy; 1 indicating that both trading partners are members of the EU (since 1993).	+	Own compilation	
Euro	Dummy; 1 indicating that both trading partners are members of the Euro zone and use the Euro as currency.	+	Own compilation	Baldwin (2006), Baldwin et al. (2008), Berger and Nitsch (2008), Flam and Nordström (2006), Nitsch and Pisu (2008)
ER	Exchange rate in indirect quotation (units of local currency per Euro)	-	IMF IFS	

Source: Own compilation.

Table 2. Gravity results for an annual panel of German beer exports, 1991-2010

	PPML				Panel least squares			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
c	33.2***	21.3***	2.81	2.52	21.1**	20.8**	-5.45	-3.30
	6.41	5.83	4.45	4.01	9.66	9.93	3.70	3.73
ln GDP_d	0.91***	0.96***	0.68***	0.74***	0.60***	0.61***	0.81***	0.73***
	0.02	0.02	0.15	0.13	0.02	0.02	0.15	0.15
ln GDP_G	-1.06***	-0.62***			-0.42	-0.42		
	0.24	0.21			0.34	0.35		
ln $Dist_{Gd}$	-0.40***	-0.45***			-0.56***	-0.55***		
	0.05	0.05			0.06	0.06		
ln $Open_d$	-0.01	0.03	0.18	0.42**	-0.08	-0.04	-0.25**	-0.27**
	0.08	0.08	0.20	0.21	0.07	0.07	0.11	0.13
ln Rem_d	-1.04***	-1.23***	-0.37	-0.27	-0.81***	-0.78***	0.21	0.21
	0.21	0.22	0.27	0.23	0.21	0.21	0.18	0.18
ln $(TR+1)$	-0.23***	-0.23***	-0.08**	-0.08**	-0.07**	-0.07**	0.00	0.00
	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02
EU_{Gd}	0.34**	0.13	0.09	0.07	1.09***	1.09***	0.45***	0.39***
	0.11	0.08	0.08	0.09	0.12	0.12	0.13	0.13
$Euro_{Gd}$	0.70***	0.35***	0.54***	0.51***	0.65***	0.64***	0.75***	0.66***
	0.10	0.09	0.09	0.09	0.14	0.14	0.14	0.14
$Contiguity_d$	-0.91***	-0.72***			-0.08	-0.07		
	0.10	0.09			0.13	0.13		
$Religion_d$	1.00***	1.19***			0.35***	0.37***		
	0.14	0.15			0.09	0.09		
ln ER_{Gd}		0.10***		-0.43***		0.01		-0.17***
		0.01		0.10		0.02		0.06
Country F.E.	N	N	Y	Y	N	N	Y	Y
Time F.E.	N	N	Y	Y	N	N	Y	Y
N	2089	2054	2089	2054	2089	2054	2089	2054
adjusted R^2	0.966	0.971	0.990	0.919	0.570	0.835	0.821	0.823

All variables are explained in the text or in table 1. Robust standard errors are shown below the coefficients. *, **, *** denotes significance at 10, 5 and 1 % error term level. Source: Own estimations.

Table 3. Exchange rate long run elasticities

	AU	CA	CH	DK	JP	SE	UK	US
Z	0.26*	-0.65***	-0.22**	0.55	0.13	1.04*	-0.65***	-0.93***
	0.14	0.16	0.10	0.64	0.08	0.56	0.23	0.12

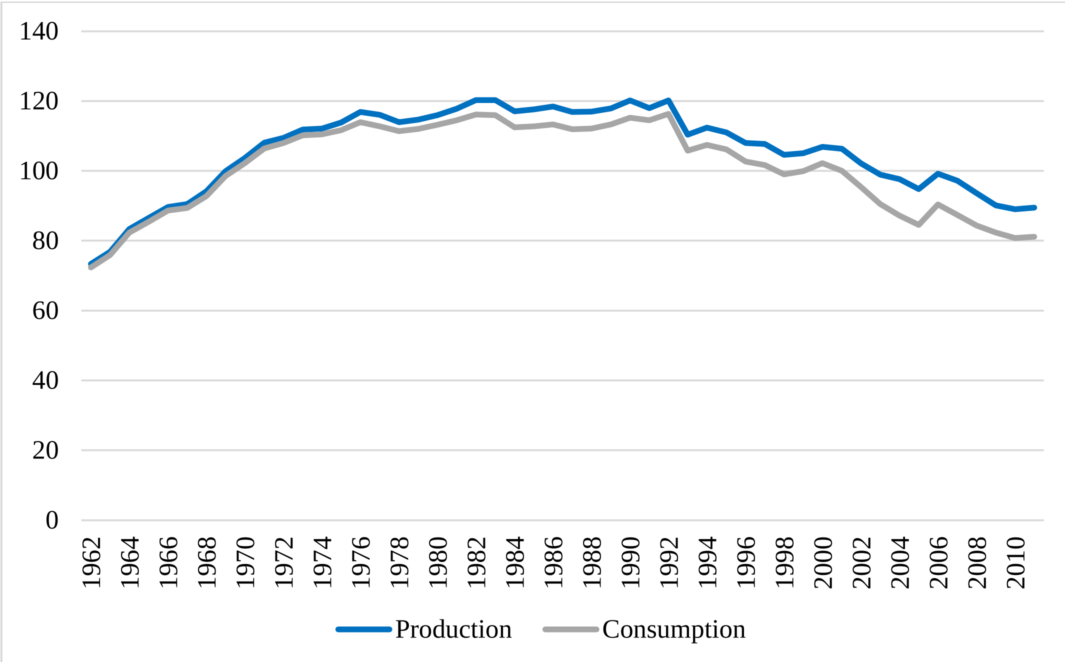
Notes: Calculated from the ARDL models using Delta method. Delta method robust standard errors are shown below the coefficients. *, **, *** denote significance at 10, 5 and 1% error term level. AU: Australia, CA: Canada; CH: Switzerland; DK: Denmark; JP: Japan; SE: Sweden; UK: United Kingdom; US: United States.
Source: Own estimations.

Table 4. Gravity results for PTM and non-PTM countries (monthly)

	PTM (Canada, Switzerland, UK, US)		**non-PTM** (Australia, Denmark, Japan, Sweden)	
	Value (ln $T_{Gj,t}$)	Quantity (ln $q_{Gj,t}$)	Value (ln $T_{Gj,t}$)	Quantity (ln $q_{Gj,t}$)
c	-17.98 ***	-17.25 ***	-58.08 ***	-62.64 ***
	4.97	4.95	8.41	8.99
ln GDP_d	2.52 ***	2.15 ***	5.86 ***	5.88 ***
	0.39	0.39	0.74	0.79
ln $Open_d$	0.34 *	0.4 *	-1.35 **	-1.46 **
	0.19	0.19	0.46	0.49
ln $(TR_{Gd}$+1)	0.29 ***	0.26 ***	0.14 **	0.13 *
	0.07	0.06	0.05	0.05
EU_{Gd}			-0.23 *	0.2
			0.13	0.14
$ln\ ER_{Gd,}$	-1.43 ***	-1.07 ***	-0.25	-0.43
	0.17	0.17	0.37	0.4
Country F.E.	Y	Y	Y	Y
Time F.E.	Y	Y	Y	Y
N	960	960	948	948
Adj. R^2	0.86	0.85	0.55	0.58

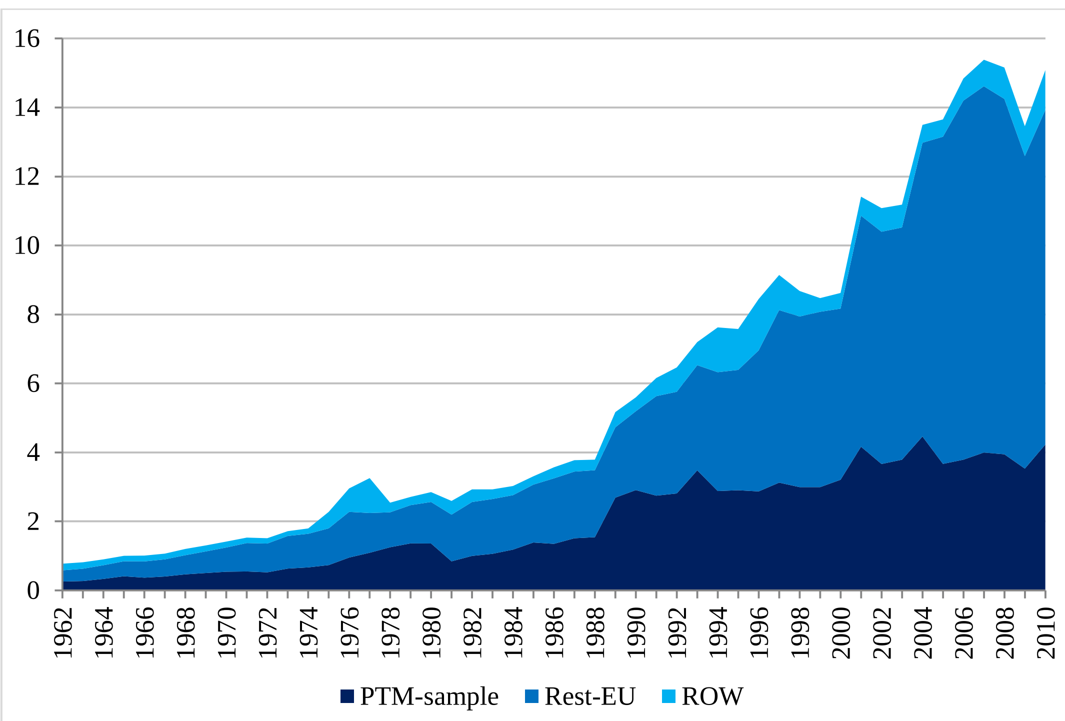
All variables are explained in the text. Results are from panel-least-squares estimations. Robust standard errors are shown below the coefficients. *, **, *** denotes significance at 10, 5 and 1 % error term level.
Source: Own estimations.

Figure 1. Production and consumption of German beer, mln kg



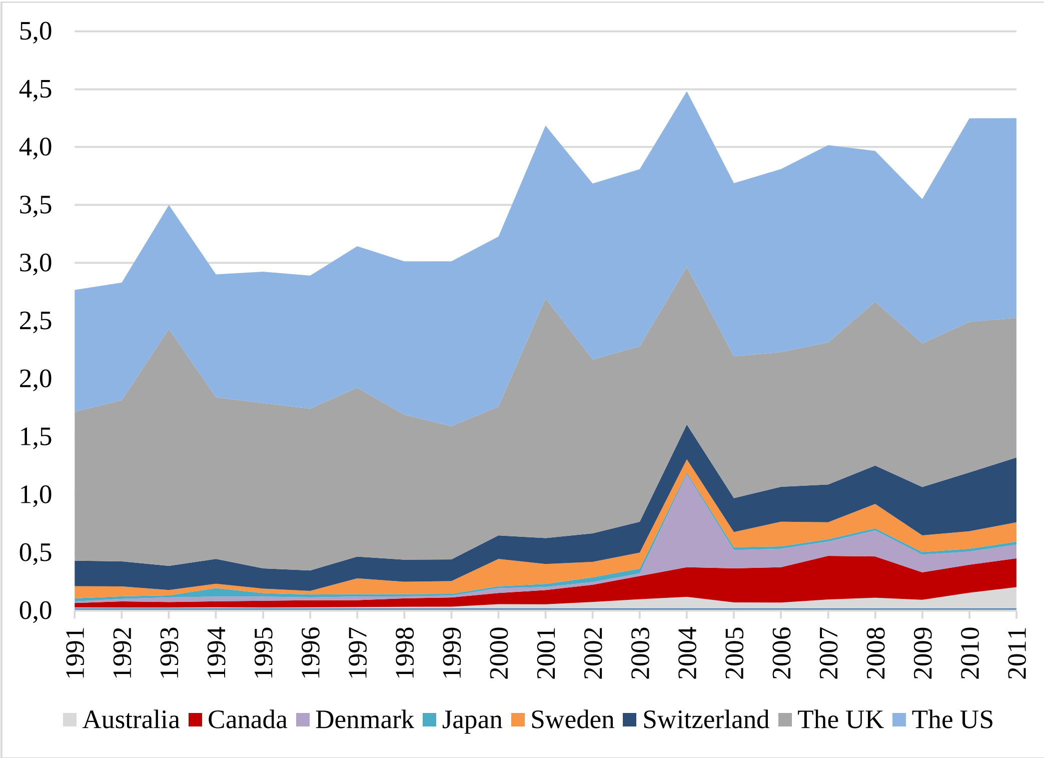
Note: Own presentation with data from FAOstat (2016)

Figure 2. Development of German beer exports to European countries, countries of PTM sample and rest of the world, mln kg.



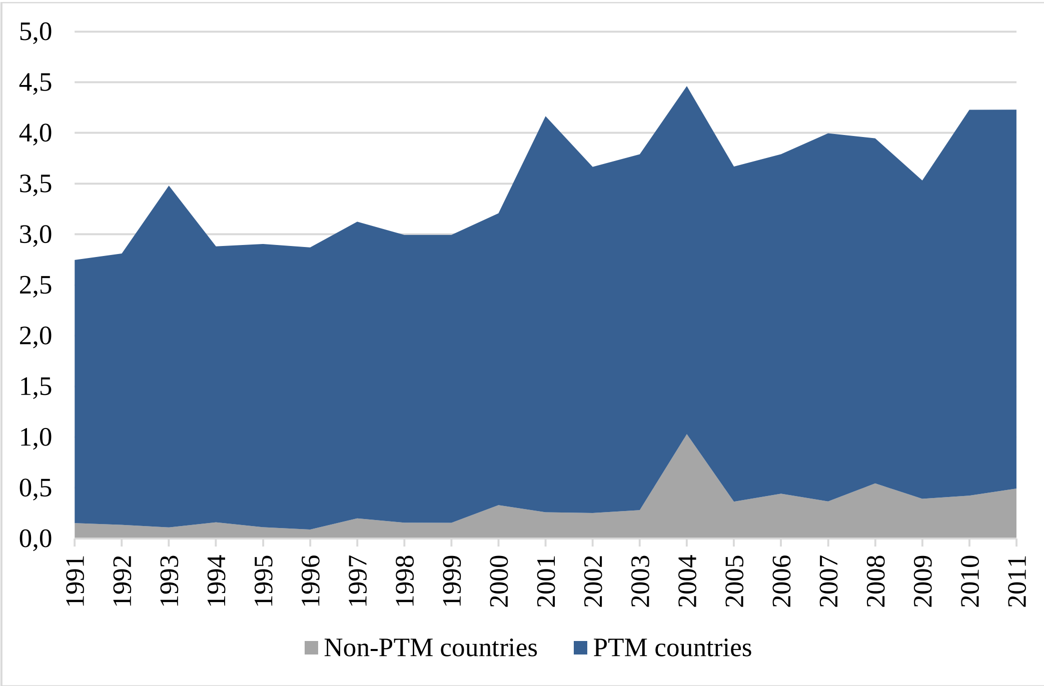
Note: Own presentation with data from FAOstat (2016)

Figure 3.German beer exports to sample countries, mln kg



Note: Own presentation with data from FAOstat (2016)

Figure 4.Distribution of German beer exports between PTM and non-PTM groups



Note: Own presentation with data from FAOstat (2016)

Annex 1. Descriptive statistics for the gravity variables

		mean	median	min	max	std. dev.	missing obs.
GDP_d	€	1.69E+11	8.59E+09	7.51E+06	1.14E+13	7.58E+11	308
GDP_G	€	2.07E+12	2.10E+12	1.46E+12	2.48E+12	2.75E+11	0
$Dist_{Gd}$	km	6274	6187	166	18588	3996	20
$Open_d$		0.6305	0.5486	0.0052	3.6822	0.4066	1171
Rem_d		8023.2	7899.0	0.3	13950.0	2286.5	163
TR	%	29.1	20.0	0.0	1200.0	84.8	2896
ER_{Gd}	LCU/Euro	2.69E+06	11.208	6.44E-08	9.85E+09	1.63E+08	336
Export Value	€	4.81E+06	1.74E+05	508	2.44E+08	2.00E+07	1174
Export quantity	kg	7.57E+06	2.29E+05	100	4.07E+08	3.02E+07	1174

Annex 2. Gravity results for an annual panel of German beer exports, 1991-2010. Zero trade flows included

	PPML (incl. zeros)				Panel least squares +1			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
c	33.9***	21.9***	2.52	2.42	26.0	32.5*	-14.6**	-17.4**
	6.41	5.81	4.46	4.05	17.74	17.91	7.18	7.09
ln GDP_d	0.92***	0.97***	0.68***	0.74***	1.39***	1.43***	1.02***	1.15***
	0.02	0.02	0.15	0.13	0.03	0.03	0.28	0.27
ln GDP_G	-1.10***	-0.65**			-1.11*	-1.38**		
	0.24	0.21			0.62	0.62		
ln $Dist_{Gd}$	-0.39***	-0.45***			-1.69***	-1.65***		
	0.05	0.05			0.11	0.11		
ln $Open_d$	0.01	0.05	0.17	0.38*	0.23	0.37**	-0.26	-0.06
	0.08	0.07	0.20	0.21	0.17	0.16	0.29	0.28
ln Rem_d	-1.06***	-1.26***	-0.35	-0.27	-0.42	-0.43	0.63	0.65
	0.21	0.22	0.27	0.23	0.39	0.39	0.40	0.40
ln (TR+1)	-0.22***	-0.22***	-0.08**	-0.08**	0.49***	0.49***	0.14**	0.14**
	0.03	0.03	0.03	0.03	0.05	0.05	0.05	0.05
EU_{Gd}	0.35**	0.14*	0.09	0.07	0.85***	0.87***	0.13	0.11
	0.11	0.08	0.08	0.08	0.18	0.18	0.17	0.17
$Euro_{Gd}$	0.70***	0.35***	0.54***	0.51***	0.42**	0.40***	0.48**	0.39**
	0.10	0.09	0.09	0.09	0.20	0.21	0.35	0.22
$Contiguity_d$	-0.91***	-0.73***			-1.87***	-1.85***		
	0.10	0.09			0.19	0.19		
$Religion_d$	1.01***	1.21***				-0.09		
	0.14	0.15				0.18		
ln ER_{Gd}		0.10***		-0.39***	-0.06	0.02		0.03
		0.01		0.10	0.18	0.03		0.12
Country F.E.	N	N	Y	Y	N	N	Y	Y
Time F.E.	N	N	Y	Y	N	N	Y	Y
N	2688	2641	2708	2661	2688	2641	2708	2661
adjusted R^2	0.972	0.976	0.991	0.992	0.556	0.556	0.800	0.799

All variables are explained in the text or in table 1. Robust standard errors are shown below the coefficients. *, **, *** denotes significance at 10, 5 and 1 % error term level. Source: Own estimations.

Annex 3. Outcomes of the estimated ARDL models, 1991-2011

	AU	CA	CH	DK	JP	SE	UK	US
$Const$	1.24	-0.51	-0.07	-1.56	-0.87	-0.93**	0.38	-0.39
	0.97	0.47	0.43	1.98	1.17	0.42	0.74	0.24
$\ln P_{d,t-1}$	-0.66***	-0.37***	-0.89***	-0.45***	-0.82***	-0.22***	-0.32***	-0.16***
	0.09	0.09	0.08	0.08	0.10	0.06	0.08	0.05
$\ln E_{d,t-1}$	0.17*	-0.24***	-0.20**	0.26	0.10	0.23	-0.20**	-0.15***
	0.10	0.07	0.10	0.53	0.07	0.14	0.09	0.05
$\ln GDP_{d,t-1}$	0.31**	-0.30***	-0.25**	0.63	-0.36	-0.19**	0.05	-0.17***
	0.15	0.11	0.10	0.48	0.24	0.08	0.16	0.06
$\ln GDP_{G,t-1}$	-0.61*	0.39**	0.16	-0.35	0.54***	0.37**	-0.17	0.24**
	0.34	0.19	0.13	0.64	0.09	0.16	0.32	0.11
$\ln MC_{t-1}$	0.21	-0.06	0.28***	1.92***	1.00***	0.22	0.52**	0.04
	0.18	0.12	0.10	0.39	0.23	0.22	0.21	0.06
$\Delta\ln E_d$	0.10	-0.03*	-0.52*	-1.12	0.26	0.34	-0.22	-0.06
	0.29	0.15	0.30	1.62	0.32	0.49	0.25	0.07
$\Delta\ln GDP_d$	0.41	0.32	-0.26	1.78	0.33	-0.18	-3.88***	-0.70
	1.12	0.61	0.96	2.30	1.55	0.29	1.28	0.43
$\Delta\ln GDP_G$	0.48	-0.54	-0.21	-1.32	0.31	-0.13	4.30***	1.16***
	1.71	0.82	0.68	2.32	1.58	0.90	1.20	0.41
$\Delta\ln MC$	1.08***	0.24***	0.28***	2.33***	1.68***	1.16***	1.02***	0.13**
	0.16	0.08	0.07	0.32	0.23	0.19	0.15	0.05
$\Delta\ln E_{d,(1)}$	-0.48**	-0.29**				0.58	0.22	-0.30***
	0.22	0.15				0.38	0.25	0.09
$\Delta\ln MC_{(1)}$	0.56**	0.34***				0.45**	0.33*	0.10**
	0.17	0.13				0.19	0.20	0.04
$\Delta\ln E_{d,(2)}$		-0.10					0.09	
		0.14					0.32	
$\Delta\ln MC_{(2)}$		0.18*					0.29*	
		0.09					0.16	
$\Delta\ln P_{d,(1)}$	-0.12*	-0.43***		-0.29***	-0.10*	-0.43***	-0.61***	-0.31***
	0.06	0.07		0.09	0.06	0.07	0.09	0.07
$\Delta\ln P_{d,(2)}$		-0.27***		-0.17**			-0.59***	
		0.06		0.08			0.10	
$\Delta\ln P_{d,(3)}$				-0.01			-0.21**	
				0.07			0.09	
$\Delta\ln P_{d,(4)}$							-0.09	
							0.06	
Adj. R^2	0.49	0.44	0.44	0.54	0.63	0.50	0.56	0.29
LM-Cor.	0.42	0.16	0.57	0.10	0.09	0.27	0.06	0.05
Ramsey	0.53	0.07	0.29	0.03	0.05	0.01	0.80	0.25
Cusum	+	+	+	-	+	+	+	+
Bounds	12.79[a]	4.51[a]	29.44[a]	8.90[a]	14.64[a]	2.56[c]	3.34[b]	2.37[c]

Notes: Robust standard errors are shown below the coefficients. *, **, *** denote significance at 10, 5 and 1% error term level. [a] Long-run relationship between the level variables is confirmed at 1% level according to test statistics tabulated by Pesaran, Shin and Smith (2001), Table C1(ii). [b] Long-run relationship between the level variables is confirmed at 10% level according to test statistics tabulated by Pesaran, Shin and Smith (2001), Table C1(ii). [c] Long-run relationship between the level variables cannot be confirmed, while the absence of a long-run relationship between those variables cannot be rejected at the 10% level. AU: Australia, CA: Canada; CH: Switzerland; DK: Denmark; JP: Japan; SE: Sweden; UK: United Kingdom; US: United States.

Annex 4. Gravity results from a monthly panel for German beer exports to 8 non-Euro countries, 1991-2011

	PPML		Panel least squares	
	Value ($T_{Gj,t}$)	Quantity ($q_{Gj,t}$)	ln Value (ln $T_{Gj,t}$)	ln Quantity (ln $q_{Gj,t}$)
c	20.03 ***	18.49 ***	-34.2 ***	-34.92 ***
	1.23	1.3	4.98	5.41
ln GDP_d	0.90 ***	0.99 ***	3.70 ***	3.44 ***
	0.06	0.06	0.34	0.37
ln GDP_G	-0.58 ***	-0.92 ***		
	0.13	0.13		
ln $Dist_{Gd}$	-0.27 ***	-0.36 ***		
	0.05	0.05		
ln $Open_d$	0.08	0.48 ***	0.32 *	0.15
	0.13	0.12	0.15	0.17
ln Rem_d	-0.84 ***	-0.63 ***	0.38 *	0.28
	0.15	0.14	0.2	0.21
ln $(TR_{Gj}+1)$	0.04	0.07 *	-0.19 ***	-0.21 ***
	0.03	0.03	0.03	0.03
EU_{Gd}	0.30 *	0.38 **	-0.41 ***	-0.09
	0.12	0.12	0.10	0.12
$Contiguit_d$	0.52 ***	0.56 ***		
	0.15	0.16		
ln ER_{Gd}	-0.46 ***	-0.39 ***	-1.19 ***	-0.86 ***
	0.01	0.02	0.17	0.19
Country F.E.	N	N	Y	Y
Time F.E.	N	N	Y	Y
Std. Errors	PML (Huber/White) standard errors & covariance		White cross-section standard errors & covariance (d.f. corrected)	
N	1884	1884	1884	1884
Adj. R^2	0.80	0.78	0.87	0.86

All variables are explained in the text. Robust standard errors are shown below the coefficients. *, **, *** denotes significance at 10, 5 and 1 % error term level.

Source: Own estimations.