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Invoicing under exchange rate risk: the exporting firm

Abstract: The basis for our analysis is a monopolistic risk neutral exporting firm searching for optimum invoicing under exchange rate risk. The exporting firm exposes itself to various risks depending on the selection of the invoicing currency, namely a transaction risk while selecting the currency of the importer (local currency pricing) and an economic risk while selecting the currency of the exporter (producer currency pricing). The resulting risk is different in both cases and can therefore be influenced by the selection of the invoicing currency.
Keywords*:* invoicing, trade, exchange rate risk.
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Introduction

Globalization can be described by foreign trade, international capital movements, in particular foreign direct investments, and labour migration (Feenstra & Taylor 2008; Krugman & Obstfeld 2009). The global development of price and exchange rate risks deserves particular attention (see, for example, ECB 2009). Due to significant exchange rate fluctuations and incomplete international financial markets, entrepreneurial risk policy is becoming increasingly important for the shareholder value (Froot et al. 1993; Elliott et al. 2003; Wong 2003). The foreign trade literature points to an additional aspect, namely the question in which currency an internationally active firm should set the price for its exported goods and services.

The majority of papers explain the price setting decision from the viewpoint of an exporter with market power (Friberg 1998; Bacchetta & Wincoop 2005; Fendel et al. 2008; Goldberg & Tille 2008). Some authors take bargaining considerations

into account (Donnenfeld & Zilcha 1995; Amann & Römmich 1999). Besides pure microeconomic (rational) reasons one can think of more abstract (but equally important) factors, such as tradition, which leads to inertia. Macroeconomic repercussions of invoicing also play an important role (Melvin & Sultan 1990; Lane 2001). It is therefore important to highlight the fact that there is no single invoicing theory considering all the relevant factors which influence the price setting decision. Furthermore, in the finance literature it is shown that exchange rate risk management of the multinational firm has direct impacts on its international capital structure decision and on its currency of denomination decision (Broll & Wong 2006; Broll et al. 2006).

An empirical perspective offers interesting insights: 67.8 percent of German exports to states outside the European Union (EU) were invoiced in euro and 21.5 percent in US dollar in 2006. Approximately 60 percent of aggregate German imports from non-EU member states were invoiced in euro and about 34 percent in US dollar. An additional observation is the invoicing behaviour of firms in the European Union member states in Eastern Europe. In 2006 nearly 60 percent of exports were invoiced in euro (for example Poland 74.2 percent and Estonia 55.2 percent). At the same time the export share to the European Monetary Union (EMU) is above 50 percent in these countries (ECB 2008). What explanation does the invoicing theory of international trade provide for this? In our study we demonstrate (see section 4) that setting prices in the currency of the importing country cannot lead to a lower expected profit than setting prices in home currency. A precondition for this result is a profit function that is concave in the exchange rate when invoicing in home currency. Whether the profit is concave or convex in the exchange rate when setting price in home currency depends on how foreign demand reacts to exchange rate fluctuations. This can explain the invoicing behaviour of EU member states in Eastern Europe due to the fact that foreign demand is sensitive to foreign exchange rate changes.

The basis for our analysis is a monopolistic exporting firm striving for optimum invoicing along the lines of Friberg (1998) and Bacchetta & Wincoop (2005). If price parity generally applies, then there is indifference when selecting the invoicing currency. If the parity is violated, the exporting firm exposes itself to various risks depending on the selection of the invoicing currency, namely a transaction risk while selecting the currency of the importer (Local Currency Pricing LCP) and an economic risk while selecting the currency of the exporter (Producer Currency Pricing PCP). The resulting risk is different in both cases and can therefore be influenced by the selection of the invoicing currency.

This is also significant for a risk-neutral exporter with monopolistic price setting power. With the optimum selection of the invoicing currency, the monopolistic exporter may further increase its expected profit from the optimum price policy. As long as transaction and economic risk do not coincide, the exporter is not indifferent with regard to the selection of the invoicing currency.

As already mentioned above, the invoicing decision, which is a microeconomic one at the level of the exporting firm, has important macroeconomic implications. This has also been one of the messages from the recent New Open Economy Macroeconomics (NOEM) literature (Lane 2001). This literature has introduced nominal rigidities in an open economy macro context. The invoicing choice affects both exchange rate volatility and the impact of the exchange rate on the economy. It has been found to play a critical role for optimal monetary policy and the choice of an exchange rate regime. A key channel through which the invoicing choice affects the economy is its impact on the pass-through of exchange rate changes to import prices.

In empirical terms, the effects of exchange rate uncertainty on the price of export goods are not clear (Faruqee 2006; Flodén & Wilander 2006). The theory on the invoicing policy of exporting firms contributes to explaining the incomplete exchange rate pass-through of exchange rate changes to demand by clarifying the incentives of the exporting firm on the basis of which it decides for home currency (PCP) or foreign currency (LCP).

In the following part we analyze the economic relation between exchange rate risk and invoicing (Section 2) – first invoicing in the currency of the importing firm (LCP), which results in a transaction risk (Section 3.1), and then invoicing in the currency of the exporting country (PCP), which leads to an economic risk (Section 3.2). Section 4 then deals with the optimum selection of the invoicing currency. The advantages of invoicing in the currency of the importing country or the exporting country are evident in view of the maximization of the expected firm profit. Section 5 summarizes the results.

1. Invoicing under exchange rate risk: the model

In general, exchange rate uncertainty has an impact on the success of internationally active firms. Under certain market conditions cash-flow risks can be avoided with the use of financial derivatives (Broll & Eckwert 2009). Besides using derivative markets, international firms may also use internal approaches to manage their profit risk. Among these strategic alternatives is the selection of the currency for invoicing, as the cash-flow risk can be traced back to a transaction risk or economic risk depending on the invoicing currency. When the firm's profit is concave in the exchange rate, an exporter has an incentive to invoice in foreign currency. The profit risk can thereby be reduced to the transaction risk. Furthermore, the expected firm profit grows. Accordingly, a hedging aspect is inherent to optimum invoicing.

Our model analysis is based on a domestic monopoly firm that serves an international market and sets the price $p^\star$ (in foreign currency) or p (in home currency)

for its product. The random exchange rate, expressed in units of home currency per unit of foreign currency, is denoted by e. As the exchange rate e is uncertain, the firm generally must decide on how high the price is and in which currency. The foreign demand x depends on the price in home currency and amounts to $x(p^\star)$ when invoicing in foreign currency or $x(p/e)$ when invoicing in home currency.

The production costs (in domestic currency) of the exporting firm amount to $C(x)$. The marginal costs are positive and increasing. The exporting firm maximizes its expected profit, which turns out to be the following when invoicing in foreign currency

$$\mathrm{E}\left[\Pi\left(p^\star, e\right)\right] = \mathrm{E}[e]p^\star x(p^\star) - C\left(x(p^\star)\right).$$

When invoicing in home currency

$$\mathrm{E}\left[\Pi\left(p, e\right)\right] = p\mathrm{E}\left[x\frac{p}{e}\right] - E\left[C\left(x\frac{p}{e}\right)\right].$$

The firm's profit in home currency is stochastic, because the exchange rate is stochastic. The symbol E represents the expected value operator.

For the sake of simplicity it will be assumed for the further analysis that the expected exchange rate $\mathrm{E}[e] \equiv \overline{e}$, which applies to cases of uncertainty, agrees with the exchange rate in cases of certainty e_c. The exporting firm must decide on the price and the currency denomination of the price. If the firm maximizes its (deterministic) profit in the case of a certain exchange rate e_c and if $p = p^\star e_c$ applies, this results in identical profits in the case of an optimum price policy $p^\star = p^\star_{opt}$ and $p = p_{opt}$. Therefore

$$\Pi\left(p^\star_{opt}, e_c\right) = \Pi\left(p_{opt}, e_c\right). \tag{1}$$

In cases of exchange rate certainty, the domestic firm prefers neither the home nor the foreign currency for invoicing. It is indifferent with regard to the selection of the currency. The monopolistic domestic firm initially opts for its profit-maximizing price. However, it cannot further increase this profit by selecting the invoicing currency. The exporting firm is thus indifferent with respect to the currency denomination of the price of its product.

2. Invoicing in the currency of the importer or exporter?

In the case of exchange rate uncertainty, the domestic firm maximizes its expected profit. In the following we demonstrate, if the international price parity is valid only on the basis of the expected exchange rate, i.e. $p = \overline{e}p^{\star}$, the exporter is not neutral with regard to the invoicing currency. The following sections 3.1 and 3.2 explain two possible currencies for invoicing and its impact on expected firm profit.

2.1. Invoicing in the currency of the importer

If the domestic firm selects the currency of the foreign market to invoice its exports, the expected profit of the exporter is $\mathrm{E}\left[\Pi\left(p^{\star}_{opt}, e\right)\right] = \overline{e}p^{\star}x(p^{\star}) - C\left(x(p^{\star})\right)$. Because every realization of the uncertain exchange rate has a linear impact on the export profit, the exporter is exposed to a transaction risk. Transaction risk means that the exporting firm enters a currency exchange risk through its export transaction.

Optimum pricing by the exporter requires the marginal revenue from the export transaction equals marginal cost of the export activity. Thus, the following applies for the maximum expected profit:

$$\mathrm{E}\left[\Pi\left(p^{\star}_{opt}, e\right)\right] = \Pi\left(p^{\star}_{opt}, \overline{e}\right) = \Pi\left(p^{\star}_{opt}, e_c\right). \tag{2}$$

The result of the assumption made for expected profit comparisons $\overline{e} = e_c$ is that the price policy stipulated in equation (2) is also optimum in the case of a certain exchange rate e_c.

Proposition 1: (Transaction risk) Since the exchange rate has a linear impact on the firm's profit when price is set in the currency of the importing country, a transaction risk results in the case of an uncertain exchange rate.

The analytical relationship between profit and exchange rate in the form of linearity is of particular significance for how revaluations and devaluations of the home currency against the foreign currency influence the expected profit of the domestic firm. Moreover, the structure of the profit function – as will become evident later – is decisive for the optimum selection of the invoicing currency.

2.2. Invoicing in the currency of the exporter

If the domestic exporting firm decides to set the price of the product in home currency, foreign demand is influenced by changes in the exchange rate. The expected profit of the exporter when invoicing in the domestic currency takes on the following structure $\mathrm{E}\left[\Pi\left(p, e\right)\right] = p\mathrm{E}\left(x\frac{p}{e}\right) - \mathrm{E}\left[C\left(x\frac{p}{e}\right)\right]$.

Realizations of the uncertain exchange rate now have a non-linear impact on the firm's profit. The reason lies in the currency denomination of the export price. Thus the exporter is exposed to a so-called economic risk when invoicing its export transaction in home currency, which takes on the form of a demand risk here. One should bear in mind that the production costs are also uncertain at the time of invoicing. Optimum price setting by the exporter requires that marginal revenue equals marginal cost of the international activity. If the resulting expected profit is concave in the exchange rate, then the following relation applies:

$$\mathrm{E}[\Pi(p_{opt}, e)] \leq \Pi(p_{opt}, \bar{e}). \tag{3}$$

A profit function that is convex in the exchange rate changes the unequal sign.

Proposition 2: (Economic risk) If the exchange rate has a non-linear impact on the firm's profit when it invoices in the currency of the exporter, an economic risk emerges in the case of an uncertain exchange rate.

Non-linearity of the profit function means that revaluations and devaluations of the home currency have an asymmetric impact on the expected profit of the firm. If the profit function is concave in the exchange rate, the losses in profit from a revaluation will turn out to be greater than the gains from a devaluation of the home currency. If the exchange rate remains unchanged on average, the overall expected profit will decrease when exchange rate risk rises (see Figure 1).

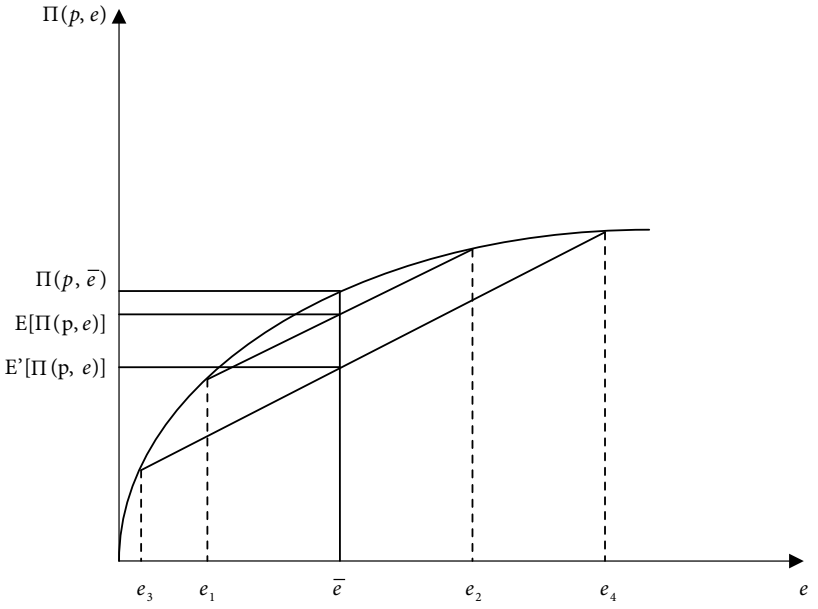

Figure 1. Concavity of profit function in e and higher exchange rate risk

If we define the expected exchange rate as $\overline{e} = qe_1+(1-q)e_2$ with $q=(1-q)=0{,}5$ as probabilities and e_1 and e_2 as realizations of e, the initial expected profit is $E[\Pi(p, e)]$. A rise in exchange rate risk is described as a mean preserving spread (MPS), which means here $qe_3 + (1-q)e_4 = \overline{e}$. The expected profit $E'[\Pi(p, e)]$ corresponding with higher exchange rate risk is lower than the initial expected profit $E[\Pi(p, e)]$.

Figure 2 shows the relationship between a convex profit function and higher exchange rate risk. An MPS in this case leads to an increase in expected profit from $E[\Pi(p, e)]$ to $E'[\Pi(p, e)]$.

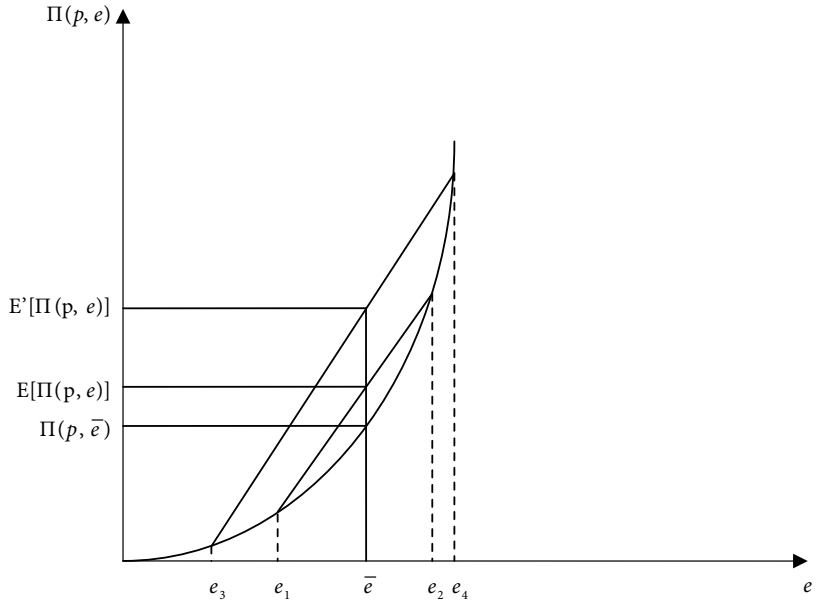

Figure 2. Convexity of profit function in e and higher exchange rate risk

The extent to which the currency denomination influences the exporting firm's profit expectations therefore crucially depends on the analytical relationship between profit and exchange rate. Depending on the invoicing currency, various profit risks may emerge for the exporter: when invoicing in the currency of the importer a transaction risk, when invoicing in the currency of the exporter an economic risk, which differs from the transaction risk. The first case involves a currency exchange risk and the second case an economic risk due to the stochastic foreign demand. In other words: the different risk exposure resulting from the selection of the currency has the effect that the exporter will not be indifferent with respect to the invoicing currency. However in which currency should the exporting firm set prices? This will be discussed in the next section.

3. The optimum invoicing currency

As mentioned in the previous sections if the international price parity applies, the exporting firm is indifferent with regard to the selection of the invoicing currency in the case of a certain exchange rate. This does not automatically apply to uncertain exchange rates. If the exporter maximizes its expected profit, the firm will select the currency for invoicing with which the expected profit can be further increased by currency selection with optimum price policy. As already mentioned, one must bear in mind for the profit comparison whether the respective profit is linear or non-linear in the exchange rate.

When invoicing in the foreign currency, equation (2) applies and when invoicing in the domestic currency, equation (3) applies. If the international price parity holds on the basis of the expected exchange rate, then $p = \overline{e}p^{\star}$. We can infer from (2) and (3) in view of (1) that

$$\Pi(p_{opt}, \overline{e}) = \Pi\,(p^{\star}_{opt}, \overline{e}). \tag{4}$$

If we take the uncertain exchange rate into account, the left hand side profit contains an economic risk and the right hand side profit contains a transaction risk, because $\Pi\,(p^{\star}_{opt}, \overline{e}) = \mathrm{E}\,[\Pi\,(p^{\star}_{opt}, e)$ from equation (2) applies. In the case of a concave profit function, $\Pi\,(p_{opt}, \overline{e})\ \mathrm{E}\,[\Pi(p_{opt}, e)]$ from equation (3) applies.

To summarize, we obtain the following equation:

$$\mathrm{E}\,[\Pi\,(p^{\star}_{opt}, e) \geq \mathrm{E}\,[\Pi\,(p_{opt}, e)]. \tag{5}$$

Equation (5) states that setting prices in the currency of the importing country cannot lead to a lower expected profit than setting prices in home currency. However, a precondition for this result is a profit function that is concave in the exchange rate when invoicing in home currency. When the profit function is convex, the importing country's currency cannot be advantageous, though.

Whether the profit is concave or convex in the exchange rate when setting the price in home currency decisively depends on how foreign demand reacts to exchange rate fluctuations. If our monopolist has non-decreasing marginal costs and if the foreign demand is concave in the exchange rate, then we are also dealing with a concave profit function.

Proposition 3: (Producer currency pricing vs. local currency pricing) When the profit function is concave in the exchange rate the exporter selects the currency of the importer when invoicing. Thus, the economic risk is taken away and only a transaction risk applies. Consequently, the expected profit of the firm increases.

Home currency pricing (PCP) implies that the price and hence foreign demand fluctuate. If demand is convex (concave) then price fluctuations increase (decrease) average foreign demand. If marginal cost is constant, PCP this would raise expected profits of the firm. However, fluctuating demand implies frequent contractions and expansions of the output, which raises average costs if the cost function is convex. This result gives an advantage of LCP over PCP and will dominate as long as costs increase sufficiently when firms expand production.

In the following example we consider a given linear foreign demand function. The second derivative of $\Pi = px\,(p/e) - C\,(x\,(p/e))$ is $\partial^2\,\Pi/\partial e^2 = (p - \partial C/\partial x)\,\partial^2 x/\partial e^2 - - \partial^2 C/\partial x^2\,(\partial x/\partial e)^2$. In case of a linear foreign demand function $x = a - b\,(p/e)$ with $a > 0$ and $b > 0$ and constant marginal costs $\partial C/\partial x = c > 0$, a concave profit function results. If the profit function is concave in the exchange rate e, surprising devaluations of the exporter's currency have a smaller impact on profit than surprising revaluations. A devaluation of the home currency increases profit less than a revaluation reduces it. If the expected exchange rate remains unchanged, the overall expected profit will decrease when exchange rate volatility rises.

Conclusions

Using the example of a monopolistic international firm we have examined optimum invoicing policy in the case of exchange rate uncertainty. The risk-neutral exporter has the incentive to select the currency denomination for invoicing which maximizes its expected profit. The structure of the cash-flow risk due to risky exchange rates depends on the selection of the currency. A transaction risk emerges when the exporting firm selects the currency of the importing country, and an economic risk emerges when it prefers the home currency. The functional relationship between profit and exchange rate is ultimately decisive for optimum invoicing in our model. Our analysis shows that setting prices for exports in the home currency is not always in the interest of the exporting firm due to demand risk. A similar analytical result occurs in finance theory, i.e. hedging is value increasing if the profit function is concave. Hedging is driven by an interaction between financing and investment aspects (Froot et al. 1993, p.1635).

The prominence of the euro as invoicing currency among the Central and Eastern European Countries can be explained first with the strong international trade ties of these countries with the EMU and secondly with the tough price competition in the euro area which implies high demand volatility.

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