

Broll, Udo; Eckwert, Bernhard

Working Paper

Transparency in the foreign exchange market and the volume of international trade

Dresden Discussion Paper Series in Economics, No. 14/03

Provided in Cooperation with:

Technische Universität Dresden, Faculty of Business and Economics

Suggested Citation: Broll, Udo; Eckwert, Bernhard (2003) : Transparency in the foreign exchange market and the volume of international trade, Dresden Discussion Paper Series in Economics, No. 14/03, Technische Universität Dresden, Fakultät Wirtschaftswissenschaften, Dresden

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*Dresden Discussion Paper Series
in Economics*



**Transparency in the Foreign Exchange Market
and the Volume of International Trade**

UDO BROLL

BERNHARD ECKWERT

Dresden Discussion Paper in Economics No. 14/03

ISSN 0945-4829

Address of the author(s):

Udo Broll
Dresden University of Technology
Department of Business Management and Economics
Mommsenstraße 13
01062 Dresden
Germany

e-mail : broll@iwb-dresden.de

Bernhard Eckwert
University of Bielefeld
Department of Economics
Postfach 100 131
33501 Bielefeld
Germany

e-mail : beckwert@wiwi.uni-bielefeld.de

Editors:

Faculty of Business Management and Economics, Department of Economics

Internet:

An electronic version of the paper may be downloaded from the homepage:

<http://rcswww.urz.tu-dresden.de/wpeconomics/index.htm>

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Working paper coordinators:

Michael Berlemann
Oliver Greßmann

e-mail: wpeconomics@mailbox.tu-dresden.de

Transparency in the Foreign Exchange Market and the Volume of International Trade

Udo Broll

*Dresden University of Technology
Department of Business Management and Economics
01062 Dresden
broll@iwb-dresden.de*

Bernhard Eckwert

*University of Bielefeld
Department of Economics
33501 Bielefeld
beckwert@wiwi.uni-bielefeld.de*

Abstract:

In this paper we study the impact of more transparency in the foreign exchange market on the ex ante expected volume of international trade. Transparency is measured by the informational content of publicly observable signals correlated to the random exchange rate. We find that more transparency may increase or decrease the volume of international trade. In particular, the impact of more transparency depends the curvature of the marginal cost function of the firms. Furthermore, ex ante expected profits of the firms are higher when the foreign exchange market is more transparent.

JEL-Classification: D8, D51, F21, F31

Keywords: exchange rate risk, transparency, export production, futures markets

1. Introduction

Many papers have stressed the role of uncertainty in international currency markets for the performance of the real sector of an economy and, in particular, for cross border trade flows (Cushman (1986), Kawai and Zilcha (1986), Zilcha and Eldor (1991), Gagnon (1993), Broll and Eckwert (1999), Moschini and Hennessy (2000)). These contributions study the impact of exchange rate uncertainty on international trade in a framework where distributional parameters linked to higher moments of the random future exchange rate are changed in a comparative static way. While these studies have produced a number of interesting results, they can be criticized on the grounds that the stochastic nature of the economic environment ought to be considered an exogenous structural element of the model rather than a policy tool. And it is hard to see what kind of normative conclusions or policy recommendations can be drawn from comparative static exercises focusing on shocks to parameters which are not under the control of policy institutions.

In this paper we follow a different approach. Our approach is based on the view that random exchange rate movements constitute a source of uncertainty which cannot be manipulated. Even so, the exchange rate uncertainty perceived by individual decision makers is not completely exogenous as it depends on the ‘transparency’ of the foreign exchange market. Market transparency can be characterized in terms of parameters which, at least partially, are under government control. The government may enhance transparency by making more information available about important determinants of exchange rate movements, such as the foreign exchange positions of central banks or fiscal and monetary policy rules. In our framework more transparency does *not* reduce the (ex ante) volatility of the future exchange rate per se. Instead, the (ex post) distribution of the exchange rate *after* some public information has become available involves less uncertainty if the foreign exchange market exhibits more transparency.

We consider a model of partial equilibrium where a competitive exporting firm faces risky revenues due to a random future exchange rate. The distribution of the exchange rate is given, and there exists a futures market for foreign exchange. Yet, the terms at which the firm can hedge the revenue risk through trade in currency

futures depends on the transparency of the foreign exchange market. Our notion of transparency is adopted from the work by Drees and Eckwert (2003). These authors have characterized market transparency using a criterion which is conceptually related to the literature that emerged from the seminal works by Blackwell (1953), Drèze (1960) and Hirshleifer (1971;1975). According to this criterion transparency is linked to the informativeness of an observable signal which is (imperfectly) correlated with the future exchange rate. The signal conveys some information about the unknown exchange rate and, therefore, allows the firm to update its beliefs. The uncertainty to which the firm is exposed when it decides about export production depends on the observed signal as well as on the information system within which the signal can be interpreted. We characterize the foreign exchange market as more transparent if the signal conveys more precise information about the future spot exchange rate. Thus, higher transparency implies that exchange rate risk is reduced through the dissemination of more reliable information.

How does more transparency in the foreign exchange market affect the export volume of the international firm? The answer depends on the curvature of the firm's marginal cost function: more exchange rate transparency stimulates (reduces) export production if the *marginal* cost function is concave (convex). By contrast, expected firm profits always increase with more exchange rate transparency regardless of technological parameters and of attitudes towards risk as long as the cost function is convex.

These results differ in nature from the findings in earlier studies which have adopted a simplistic approach of modeling transparency by means of exogenous changes in the distributional parameters of the exchange rate (e.g., Franke (1991), Viaene and de Vries (1992), Broll et.al. (1995)). In such a framework the forward exchange market is completely separated from the underlying transparency concept; hence, the well-known separation property implies that parameters affecting the volatility of the exchange rate have no impact on international trade. Yet, this approach misses out on an important link that exists between exchange rate transparency and the terms of contracting on the forward exchange market. Taking this link into account yields new insights into the implications of exchange rate transparency for international trade.

The paper is organized as follows. In Section 2 we present the firm's decision problem and introduce the concept of transparency which underlies our analysis. Section 3 contains the main results: we characterize the impact of more transparency on the export volume and on the firm's expected profits. Section 4 concludes the paper.

2 Export Production and Foreign Exchange Market Transparency

We consider the model of an exporting firm which extends over two periods, $t = 0, 1$. The firm produces a homogenous good in period 0 and sells its products abroad for a given price of p_1 units of foreign currency. Production costs in domestic currency, $C(x)$, are a strictly increasing and convex function of the export volume, x . The firm's random revenues, as of date 1, in domestic currency are $\tilde{e}_1 p_1 x$, where \tilde{e}_1 is the one-period-ahead spot exchange rate between the domestic currency and the foreign currency. The tilde refers to the random nature of the spot exchange rate \tilde{e}_1 which assumes values in $\Omega := [\underline{e}, \bar{e}]$, where $0 < \underline{e} < \bar{e} < \infty$.

As of date 0, when the firm decides about production, the future exchange rate, \tilde{e}_1 , is random. However, prior to choosing a production level, the firm observes a signal y . This signal is the realization of a random variable \tilde{y} which is correlated with \tilde{e}_1 .¹ The signal, therefore, contains information about the unknown future exchange rate. Thus, at the time when the production decision is made, the relevant expectation for \tilde{e}_1 is the updated (in a Bayesian way) posterior belief.

We assume that the firm has access to a futures market where it can hedge the foreign exchange risk. The futures market opens at date 0 *after* the signal has been observed. A futures contract pays 1 unit of foreign currency at date 1. Hence the payoff is worth e_1 units of domestic currency. Let h be the forward commitment of the firm, i.e., h denotes the number of futures contracts sold by the firm. We assume that the terms of forward contracting are unbiased, which implies that the futures market clears at a price $e_f(y)$ that is equal to the conditional mean of a

¹We mark random variables by a tilde; we delete the tilde when referring to a *realization* of a random variable.

contract's payoff,

$$e_f(y) = E[\tilde{e}_1|y]. \quad (1)$$

Both the payoff and the purchase price of the contract fall due in period 1. The timing of events is as follows (see Figure 1):

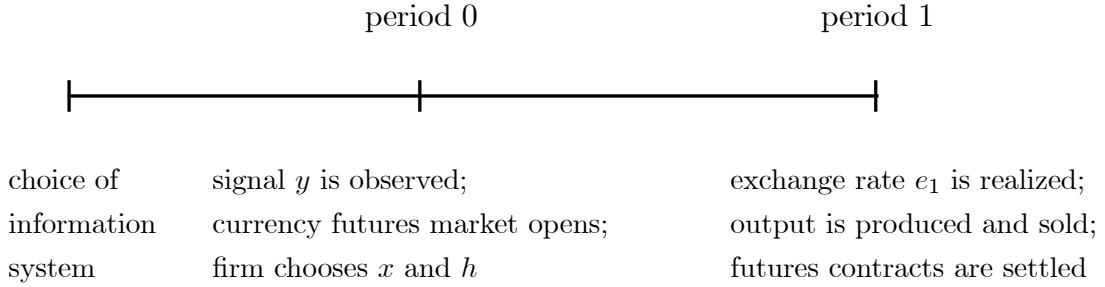


Figure 1

2.1 The Decision Problem of the Firm

We assume that the firm maximizes expected utility, defined over random profits, $\tilde{\Pi}$, where the product price in foreign currency is set equal to 1,

$$\tilde{\Pi} = \tilde{e}_1 x - C(x) + h(e_f(y) - \tilde{e}_1). \quad (2)$$

The decision maker's problem may thus be written

$$\max_{x,h} E[U(\tilde{\Pi})], \quad (3)$$

where $U : \mathbb{R} \rightarrow \mathbb{R}$ is a strictly increasing, strictly concave and twice continuously differentiable utility function. The firm maximizes (3) with respect to export production, x , and forward commitment h . The necessary first-order conditions, which are also sufficient, are

$$E[U'(\tilde{\Pi})(\tilde{e}_1 - C'(x))] = 0, \quad (4)$$

$$E[U'(\tilde{\Pi})(e_f(y) - \tilde{e}_1)] = 0. \quad (5)$$

>From (4) and (5) we obtain the optimal production level and forward commitment as²

$$C'(x) = e_f(y) \quad (6)$$

$$h = x. \quad (7)$$

Next we define our notion of exchange rate transparency. The transparency of the foreign exchange market will be linked to the informational content of the signal y .

2.2 Information Systems and Exchange Rate Transparency

Following Drees and Eckwert (2003) we identify the transparency of the foreign exchange market with the ‘informativeness’ of the signal $y \in Y \subset \mathbb{R}$, which is observed by the firm. The informativeness of the signal depends on the information system within which signals can be interpreted. An information system, denoted by g , specifies for each state of nature, e_1 , a conditional probability function over the set of signals: $g(y|e_1)$. The positive real number $g(y|e_1)$ defines the conditional probability (density) that the signal y will be observed if the true (yet unknown) state of nature is e_1 . The firm knows the function $g(y|e_1)$ by which the signals are generated, given the state of nature. Using Bayes’s rule, the firm revises its expectations and maximizes utility on the basis of the updated beliefs.

Let $\pi : \Omega \rightarrow \mathbb{R}_+$ be the (Lebesgue-) density function for the prior distribution over Ω . The density for the prior distribution over Y is given by

$$\nu(y) = \int_{\Omega} g(y|e_1)\pi(e_1) de \quad \text{for all } y. \quad (8)$$

The density function for the updated posterior distribution over Ω is³

$$\nu(e_1|y) = g(y|e_1)\pi(e_1)/\nu(y). \quad (9)$$

Blackwell (1953) suggested a criterion that ranks different information systems according to their informational contents. Suppose g^1 and g^2 are two information

²(7) follows from (5) since, according to (1), the futures market is unbiased.

³To avoid notational clutter we distinguish between the functions $\nu(y)$ and $\nu(e|y)$ only by their arguments.

systems with associated density functions $\nu^1(\cdot)$ and $\nu^2(\cdot)$. The following criterion induces an ordering on the set of information systems.

Definition 1 (Informativeness) *Let g^1 and g^2 be two information systems. g^1 is said to be more informative than g^2 (expressed by $g^1 \succ_{\text{inf}} g^2$), if there exists an integrable function $\lambda : Y^2 \rightarrow \mathbb{R}_+$ such that*

$$\int_Y \lambda(y', y) dy' = 1, \quad (10)$$

holds for all y , and

$$g^2(y'|e_1) = \int_Y g^1(y|e_1) \lambda(y', y) dy \quad (11)$$

holds for all $e_1 \in \Omega$.

According to this criterion $g^1 \succ_{\text{inf}} g^2$, holds if g^2 can be obtained from g^1 through a process of randomization. The probability density $\lambda(y', y)$ in equation (10) transforms a signal y into a new signal y' . If the y' -values are generated in this way, the information system g^2 can be interpreted as being obtained from the information system g^1 by adding random noise. Note that $\lambda(\cdot, \cdot)$ in (11) is independent of e_1 . Therefore, the signals under information system g_2 convey no information about the value of \tilde{e}_1 that is not also conveyed by the signals under information system g_1 . As a consequence, the *a priori* expected posterior exchange rate uncertainty under g_1 will be lower than under g_2 .

Our notion of exchange rate transparency is based on the informational content of the signal. A signal that conveys information about the future exchange rate affects the economic uncertainty to which the firm is exposed. We characterize the foreign exchange market as more transparent if the signal, y , conveys more precise information about the future exchange rate, e_1 . Thus, higher exchange rate transparency implies that exchange rate risk is reduced through the dissemination of more reliable information.

Definition 2 (Exchange Rate Transparency) *Let g^1 and g^2 be two information systems for the future exchange rate e_1 . The foreign exchange market is said to be more transparent under g^1 than under g^2 , if $g^1 \succ_{\text{inf}} g^2$.*

The following lemma contains a property of information systems that turns out to be a convenient tool for our analysis. The lemma formulates an alternative transparency criterion that is equivalent to the condition stated in Definition 2.

Lemma 1 *The foreign exchange market is more transparent under g^1 than under g^2 if and only if*

$$\int_Y F(\nu^1(\cdot|y))\nu^1(y) dy \geq \int_Y F(\nu^2(\cdot|y))\nu^2(y) dy$$

holds for every convex function $F(\cdot)$ on the set of density functions over Ω .

A proof of Lemma 1 can be found in Kihlstrom (1984). Note that $\nu^1(\cdot|y)$ and $\nu^2(\cdot|y)$ are the posterior beliefs under the two information systems. Thus, Lemma 1 implies that more transparency (weakly) raises the expectation of any convex function of posterior beliefs. For concave functions, F , the inequality is reversed.

3 Exchange Rate Transparency and Export Volume

We now turn to the question how the export volume of the firm is affected as the foreign exchange market becomes more transparent. The export decision, x , is contingent on the signal y . We define the export volume, X , as the average export level before the signal has been observed,

$$X = E_y[x(y)] = \int_Y x(y)\nu(y) dy \tag{12}$$

The following proposition characterizes the impact of more exchange rate transparency on the export volume in terms of the curvature of the marginal cost function.

Proposition 2 *Let g^1 and g^2 be two information systems such that the foreign exchange market is more transparent under g^1 than under g^2 . The export volume of the firm is higher (lower) under g^1 than under g^2 , if the marginal cost function $C'(x)$ is concave (convex).*

Proof: In view of (12) and Lemma 1, we have to show that the export decision, $x(y)$, is convex (concave) in the updated posterior belief $\nu(e_1|y)$ if $C'(x)$ is a concave (convex) function. By (6), $x(y)$ depends on $\nu(e_1|y)$ only via the forward rate $e_f(y)$. Since $e_f = E[\tilde{e}_1|y]$ is linear in the posterior belief $\nu(e_1|y)$, the export decision $x(y)$ will be convex (concave) in $\nu(e_1|y)$ if it is convex (concave) in $e_f(y)$. Obviously, $x(y) = (C')^{-1}(e_f(y))$ is convex (concave) in $e_f(y)$ if C' is a concave (convex) function. The proof is complete. \square

According to Proposition 1, the role of more transparency on the foreign exchange market for the export volume depends only on the curvature of the marginal cost function.⁴ In particular, under the standard specification of decreasing returns to scale, more exchange rate transparency may stimulate or depress international trade. If the cost function is quadratic and, hence, the marginal cost function is linear, the export volume will not be affected by more transparency in the foreign exchange market.

To illustrate this result, consider the extreme cases where g^1 is fully informative and g^2 is uninformative. Under the information system g^2 , the signal y does not reveal any information about \tilde{e}_1 . Thus, the forward rate is equal to the unconditional expectation $\bar{e}_1 := E[\tilde{e}_1]$, and

$$X_{g^2} = (C')^{-1}(\bar{e}_1). \quad (13)$$

By contrast, under the information system g^1 , the signal reveals the future exchange rate e_1 and, hence, the forward rate is equal to e_1 . In this case (6) reduces to $C'(x) = e_1$ which implies

$$X_{g^1} = E[(C')^{-1}(\tilde{e}_1)]. \quad (14)$$

Using Jensen's inequality, (13) and (14) imply $X_{g^1} \stackrel{(\leq)}{\geq} X_{g^2}$ if $(C')^{-1}$ is convex (concave).

⁴Convexity of the marginal cost function is a pattern often seen in agriculture and in manufacturing where the presence of some fixed input factors (land, building of fixed size) eventually constrains production. By contrast, production processes that exhibit high substitutability among input factors may give rise to concave marginal cost functions.

The result in Proposition 1 differs markedly from the role attributed to exchange rate transparency in earlier studies (e.g., Viaene and de Vries (1992), Broll et.al.(1995)). These studies have modeled lower transparency in the foreign exchange market simply by means of an exogenous mean preserving spread (MPS) of the random exchange rate. A MPS has no impact on the terms of contracting on the forward exchange market. Therefore, referring to the separation property according to which the forward exchange rate determines the export volume, those earlier studies have concluded that exchange rate transparency does not affect international trade. By contrast, our approach implies that higher exchange rate transparency affects the forward exchange rate – and, hence, the firm’s exports – through the additional information conveyed by the signals. The endogenous terms of forward contracting, therefore, constitutes an important link through which exchange rate transparency may affect international trade.

Proposition 1 might explain why the empirical evidence regarding the effect of exchange rate randomness on the volume of international trade has so far been inconclusive (Cushman (1988), Giavazzi and Giovannini (1989), Stein (1991), McKenzie (1999)): countries that differ with respect to their technologies for export production in the sense of Proposition 1 should be expected to exhibit opposing links between (ex post) exchange rate uncertainty and export volume.

Proposition 3 *Let g^1 and g^2 be two information systems such that the foreign exchange market is more transparent under g^1 than under g^2 . Expected firm profits*

$$E(\tilde{\Pi}) = \int_Y \Pi(y)\nu(y) dy \quad (15)$$

are higher under g^1 than under g^2 .

Proof: Proceeding along the same lines as in the proof of Proposition 1 we need to show that

$$\Pi(y) = e_f(y)(C')^{-1}(e_f(y)) - C\left((C')^{-1}(e_f(y))\right) \quad (16)$$

is a convex function of $e_f(y)$. Differentiating (16) with respect to $e_f(y)$ and using (6) yields

$$\frac{\partial \Pi(y)}{\partial e_f(y)} = (C')^{-1}(e_f(y)). \quad (17)$$

The convexity of the cost function implies that $(C')^{-1}(\cdot)$ is monotone increasing. Therefore, (17) yields the convexity of the profit function in the forward rate $e_f(y)$. \square

According to Proposition 2, expected firm profits increase with more exchange rate transparency regardless of attitudes towards risk and of technological parameters, as long as the cost function is convex. This result does not imply, however, that the firm will be better off – in terms of ex ante expected utility – if the foreign exchange market becomes more transparent. When the signal affects an insurable risk, like in our model, the effect of better information on ex ante expected utility depends on two opposing mechanisms. Firstly, when the firm receives more reliable information it is able to improve its decision, thereby increasing ex ante expected utility (Blackwell-effect). Secondly, as was pointed out by Hirshleifer (1971,1975), better information may interfere with the operation of risk sharing markets thereby destroying some risk sharing opportunities. Since the firm is risk-averse, ex ante expected utility declines. Due to these opposing effects the overall impact of more exchange rate transparency on the firm's welfare is ambiguous.⁵

4 Concluding Remarks

In this paper we have studied the role of transparency in the foreign exchange market for the export volume and expected profits of a competitive international firm. Exchange rate transparency was defined in terms of the informativeness of a signal that conveys some information about the future spot exchange rate. The export volume and expected firm profits were defined by means of the ex ante expected values for export production and profits. Our analysis has produced two main results: more transparency in the foreign exchange market increases expected firm profits, but does not necessarily stimulate the export volume. If the firm's marginal cost function is concave (convex), more exchange rate transparency leads to a higher (lower) export volume.

⁵In a different framework, the interaction between the Blackwell-effect and the Hirshleifer-effect has been studied in some recent papers by Schlee (2001), Drees and Eckwert (2003), and Eckwert and Zileha (2001,2003).

We have conducted our analysis in a partial equilibrium setting. Therefore the results must be interpreted with care if, as is often done in the literature on the exporting behavior of international firms, export volume is taken as a proxy for the volume of international trade. Yet, it is possible, in principle, to embed our model into a general equilibrium approach along the lines in Broll and Eckwert (1998). The key mechanisms that produce the results in this paper would equally apply in such a general equilibrium model. This observation may justify an interpretation of our findings in terms of a link between exchange rate transparency and the volume of international trade.

In deriving our results we have assumed that a futures market for foreign currency exists. In less developed economies where firms cannot use such risk sharing tools, the role of exchange rate transparency for profits and export volumes may be different. It is well known that an exporting firm may react quite differently to changes in risk exposure under various market structures (K.P. Wong (2001,2002)). The importance of the market structure for the mechanisms discussed in this paper will be the topic of future research.

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