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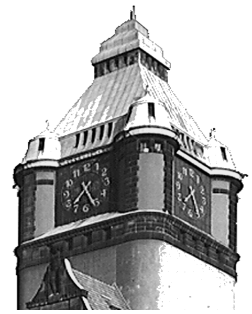

International trade and the role of market transparency

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Abstract:

The paper examines the economic role of market transparency on the decision problems of an international firm. Transparency is described in terms of the informativeness of a publicly observable signal. With higher transparency, the signal conveys more precise information about the random foreign exchange rate. We analyze the interaction between market transparency, ex ante expected production, domestic sales, and exports of the fi rm. Furthermore, we discuss the welfare implications of more transparency in the foreign exchange market for the firm and domestic consumers.

JEL-Classification: F11, F23, G14, G15

Keywords: Blackwell theorem, information system, transparency, hedging, international trade

International trade and the role of market transparency

The paper examines the economic role of market transparency on the decision problems of an international firm. Transparency is described in terms of the informativeness of a publicly observable signal. With higher transparency, the signal conveys more precise information about the random foreign exchange rate. We analyze the interaction between market transparency, ex ante expected production, domestic sales, and exports of the firm. Furthermore, we discuss the welfare implications of more transparency in the foreign exchange market for the firm and domestic consumers.

1. Introduction

The complexity and dynamics of financial systems as well as the increasing risk of failures calls for a higher level of transparency on global markets, especially in the banking sector, to foster a solid and smoothly functioning financial system. Primarily, regulatory authorities and central banks aspire to more transparent markets. Transparency is usually associated with the level of disclosure and the public dissemination of information to market participants. The policy oriented literature stresses the role of transparency for a functioning economy.

In our study the market transparency is linked to the informativeness of a publicly observable signal that is correlated with the random foreign exchange rate. The signal conveys some noisy information about the unknown foreign exchange rate and, therefore, allows firms to update their beliefs in a Bayesian manner. This paper deals with transparency in financial markets and its role for the decision problems of an international firm under exchange rate uncertainty. The risk-averse firm has access to a foreign exchange futures market in which it can hedge its net exposure connected with its export activities.[1] Prices and contracts traded on the foreign exchange futures market depend upon market transparency.

The uncertainty to which the international firm is exposed when it decides about its resource allocation for production to the domestic and international

[1]See, for example, Kawai and Zilcha (1986), Broll, Chow, and Wong (2001), Wong (2003a,b).

markets 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 unknown foreign exchange rate. Thus, more transparency means that the exchange rate uncertainty is reduced through the disclosure of more reliable information.

In the literature, there are different analytical concepts measuring the degree of informativeness and proposing an order of the underlying information systems. The concepts proposed by Blackwell (1953), Lehmann (1988), and Kim (1995), among others, are widely used. The notion of transparency used in our study is adopted from the work by Drees and Eckwert (2003) and Broll and Eckwert (2009). They characterize market transparency by using a criterion which is conceptually related to the literature that emerged from the seminal work by Blackwell (1953).[2] More transparency or more reliable information means that market participants can make better economic decisions. When the information is of public nature, rather than privately owned by some individuals, it will be used by other agents, too. Under such circumstances the information may affect endogenous market mechanisms (see, for example, Morris and Shin, 2002).

There is a large body of literature that analyzes the welfare effects of public information. When individuals make decisions in isolation from others, more reliable information is generally beneficial (Blackwell, 1953). Yet, more information can have detrimental effects if the information affects risk sharing arrangements in the economy (Hirshleifer, 1971, 1975; Schlee, 2001) or if agents interact strategically using private information and public information simultaneously. In this paper we abstract from informational asymmetries but we allow for some risk sharing through a competitive foreign exchange futures market. While market transparency does not affect the risk premium on this market, it does have implications for the amount of risks that will be shared in equilibrium.

We demonstrate that the impact of more precise information on the firm's ex ante expected allocation of production to domestic and foreign markets critically depend on the production technology of the international firm and on the demand conditions in the home market. More transparency, however,

[2]For other concepts of transparency that have been used in the economic literature, see Heinemann and Illing (2002) and Krebs (2005).

always leads to an increase in the expected profit of the international firm. We also offer reasonable conditions under which the ex ante expected utility of the international firm and the ex ante expected domestic consumers' surplus are both improved by making the foreign exchange market more transparent. Our results thus suggest the need for economic policy design that can convert the potential benefit of market transparency into actual economic benefit.

The rest of the paper is organized as follows. Section 2 develops a two-period model of an international firm under exchange rate uncertainty. In section 3, we introduce the concept of market transparency that underlies the analysis. Section 4 and 5 derives the main results. The final section 6 concludes.

2. The model

Consider a risk-averse international firm that makes decisions under exchange rate uncertainty in a one-period horizon with two dates (indexed by $t = 0$ and 1). At $t = 0$, the firm produces a single homogeneous good in the home country according to a strictly increasing and convex cost function, $c(q)$, where q is the level of output and $c(0) = c'(0) = 0$. The firm sells its output at $t = 1$. Specifically, the firm sells s units of its output in the home market and exports the rest, $x = q - s$, to a foreign country, where $0 \leq s \leq q$.

We assume that the firm enjoys some monopoly power in the home market such that the revenues from domestic sales are governed by a strictly increasing and concave function, $r(s)$, with $r(0) = 0, r'(0) = \infty$, and $r'(\infty) = 0$. On the other hand, we assume that the firm is a price taker in the foreign market in which the selling price of the good is fixed at p per unit and is denominated in the foreign currency, where $0 < p < \infty$. The firm faces exchange rate uncertainty in that the spot exchange rate at $t = 1$, denoted by $\tilde{e}$ and expressed in units of the home currency per unit of the foreign currency, is not known at $t = 0$.[3] The random spot exchange rate, $\tilde{e}$, has a prior probability density function, $f(e)$, over support $[\underline{e}, \overline{e}]$, where $0 < \underline{e} < \overline{e} < \infty$.

There is a public signal, $\tilde{y}$, released by the government or the central bank at $t = 0$ before the firm makes its decisions. Let $n(y)$ be the prior probability density function of $\tilde{y}$ over support $[\underline{y}, \overline{y}]$, where $-\infty < \underline{y} < \overline{y} < \infty$. The signal, $\tilde{y}$, is correlated with the random spot exchange rate, $\tilde{e}$, and thus

[3]Throughout the paper, random variables have a tilde while their realizations do not.

contains valuable information about $\tilde{e}$. Let $\nu(e|y)$ be the posterior probability density function of $\tilde{e}$ conditioned on $\tilde{y} = y$ over support $[\underline{e}, \overline{e}]$. At $t = 0$, the firm makes its decisions using the conditional expectation operator, $\mathrm{E}(\cdot|y)$, with respect to $\nu(e|y)$. The firm updates its belief in a Bayesian manner.

The firm has access to a foreign exchange futures market for hedging purposes. The foreign exchange futures market opens at $t = 0$ after the public signal has been revealed. Let e_f be the futures exchange rate that is determined at $t = 0$ and is expressed in units of the home currency per unit of the foreign currency. The firm sells (purchases if negative) h units of the currency futures at $t = 0$, which are settled at $t = 1$ at the then prevailing spot exchange rate, $\tilde{e}$. Thus, the firm's profit at $t = 1$, denominated in the home currency, is given by

$$\tilde{\pi} = r(s) + \tilde{e}px - c(s + x) + (e_f - \tilde{e})h. \tag{1}$$

We assume that the foreign exchange futures market is unbiased, i.e.,

$$e_f = E(\tilde{e}|y) = \int_{\underline{e}}^{\overline{e}} e\nu(e|y)de, \tag{2}$$

for all $y \in [\underline{y}, \overline{y}]$. Hence, Eq. (2) implies that the futures exchange rate, e_f, is a function of the signal, y, in general and a linear function of the posterior probability density function, $\nu(e|y)$, in particular.

The firm possesses a von-Neumann Morgenstern utility function, $u(\pi)$, defined over its home currency profit at $t = 1$, π, with $u'(\pi) > 0$ and $u''(\pi) < 0$, indicating risk aversion. At $t = 0$, the firm chooses a level of domestic sales, s, a level of exports, x, and a futures position, h, so as to maximize the expected utility of its random home currency profit at $t = 1$:

$$\max_{s,\,x,\,h} E[u(\tilde{\pi})|y] = \int_{\underline{e}}^{\overline{e}} u[r(s) + epx - c(s + x) + (e_f - e)h]\nu(e|y)de, \tag{3}$$

where $\tilde{\pi}$ is defined in Eq. (1). The first-order conditions for program (3) are given by

$$E\{u'(\tilde{\pi}^*)[r'(s^*) - c'(s^* + x^*)]|y\} = 0, \tag{4}$$

$$E\{u'(\tilde{\pi}^*)[\tilde{e}p - c'(s^* + x^*)]|y\} = 0, \tag{5}$$

and

$$E[u'(\tilde{\pi}^*)(e_f - \tilde{e})|y] = 0, \tag{6}$$

where an asterisk (*) signifies an optimal level.

The solution to Eqs. (4)-(6) can be characterized by the following system of equations:

$$
\begin{aligned}
h^* &= px^* &(7)\\
r'(s^*) - c'(s^* + x^*) &= 0, &(8)\\
e_f p - c'(s^* + x^*) &= 0, &(9)
\end{aligned}
$$

In fact (7) implies that $\pi^* = r(s^*) + e_f p x^* - c(s^* + x^*)$, which is non-stochastic. Eqs. (4)-(6) are therefore satisfied because with non-stochastic $\tilde{\pi}^*$, (6) reduces to (2), and (4),(5) reduce to (8),(9).

Eq. (9) implies that the firm's optimal output, $q^* = s^* + x^*$, is uniquely determined by equating the marginal cost of production, $c'(q^*)$, to the foreign market price, p, converted into the home currency using the futures exchange rate, e_f. Eqs. (8) and (9) imply that the optimal allocation of output between the home and foreign markets is uniquely determined by equating the marginal revenue in the home market, $r'(s^*)$, to that in the foreign market, p, converted into the home currency using the futures exchange rate, e_f. Thus, we have established for our model the separation and full-hedging hypotheses.[4] These hypotheses claim that, in the presence of a currency exchange forward market, production and export decisions are independent on attitudes towards risk and, for the special case of an unbiased forward market, that exchange rate risks will be fully hedged.

3. Market transparency: The information system

We follow Drees and Eckwert (2003) and Broll and Eckwert (2009) (see also Eckwert and Zilcha, 2001, 2003) to describe transparency in the foreign exchange market by means of the informativeness of the signal, $\tilde{y}$, that is publicly observable. The signal's informativeness depends on the information system within which one would interpret the signal. An information system, denoted by g, specifies for each state of the nature, e, a conditional probability density function, $g(y|e)$, over the set of signals, $[\underline{y}, \overline{y}]$. The function, $g(y|e)$, which generates the signal for a given spot exchange rate at $t = 1$,

[4]See, for example, Kawai and Zilcha, 1986; Friberg, 1998; Wong, 2003a,b.

e, is common knowledge. Using Bayes' rule, the firm revises its expectations and maximizes its expected utility on the basis of the updated beliefs.

Given the information system, g, the prior probability density function, $n(y)$, of $\tilde{y}$ can be written as

$$n(y) = \int_{\underline{e}}^{\overline{e}} g(y|e)f(e)de, \tag{10}$$

for all $y \in [\underline{y}, \overline{y}]$. By Bayes' rule, the posterior probability density function, $\nu(e|y)$, of $\tilde{e}$ conditioned on $\tilde{y} = y$ is given by

$$\nu(e|y) = \frac{g(y|e)f(e)}{n(y)}, \tag{11}$$

for all $y \in [\underline{y}, \overline{y}]$, where $n(y)$ is given by Eq. (10). Blackwell (1953) suggests the following criterion that ranks different information systems according to their informational contents.

Definition 1. *Let g^1 and g^2 be two information systems for the random spot exchange rate at $t = 1$, $\tilde{e}$. We say that g^1 is more informative than g^2, expressed by $g^1 \succ_{inf} g^2$, if there exists an integrable function, $\lambda(y', y)$, such that*

$$\int_{\underline{y}}^{\overline{y}} \lambda(y', y)dy' = 1, \tag{12}$$

for all $y \in [\underline{y}, \overline{y}]$, and

$$g^2(y'|e) = \int_{\underline{y}}^{\overline{y}} g^1(y|e)\lambda(y', y)dy, \tag{13}$$

for all $e \in [\underline{e}, \overline{e}]$.

According to Definition 1, $g^1 \succ_{inf} g^2$ holds if g^2 can be obtained from g^1 through a process of randomization. Eq. (12) states that $\lambda(y', y)$ is a probability density function that transforms the signal, y, into a new signal, y'. It is evident from Eq. (13) that the information system, g^2, can be interpreted as being obtained from the information system, g^1, by adding random noise. Since $\lambda(y', y)$ does not depend on the realization of $\tilde{e}$, the signals under the information system, g^2, cannot convey any information about the random spot exchange rate at $t = 1$, which is not conveyed by the signals under the information system, g^1. As a result, g^1 must contain more information about $\tilde{e}$ than g^2.

Our notion of transparency in the foreign exchange market is based on the informational content of the signal, y, about the random spot exchange rate at $t = 1$, $\tilde{e}$. We describe the foreign exchange market as more transparent if y conveys more precise information about $\tilde{e}$.

Definition 2. *Let g^1 and g^2 be two information systems for the random spot exchange rate at $t = 1$, $\tilde{e}$. We say that the foreign exchange market is more transparent under g^1 than under g^2 if $g^1 \succ_{inf} g^2$.*

The following lemma formulates an alternative transparency criterion that is equivalent to the condition stated in Definition 2, which is useful in our subsequent analysis.

Lemma 1. *Let g^1 and g^2 be two information systems for the random spot exchange rate at $t = 1$, $\tilde{e}$. The foreign exchange market is more transparent under g^1 than under g^2 if, and only if*

$$\int_{\underline{y}}^{\overline{y}} F[\nu^1(\cdot|y)]n^1(y)dy \geq \int_{\underline{y}}^{\overline{y}} F[\nu^2(\cdot|y)]n^2(y)dy, \tag{14}$$

for any given convex function, $F(\cdot)$, defined on the set of probability density functions over support $[\underline{e}, \overline{e}]$.

A proof of Lemma 1 can be found in Kihlstrom (1984). Since $\nu^1(\cdot|y)$ and $\nu^2(\cdot|y)$ are the posterior beliefs under the two information systems, g^1 and g^2, respectively, Lemma 1 implies that more transparency in the foreign exchange market (weakly) raises the expectations of any convex functions of posterior beliefs. If $F(\cdot)$ is any given concave function defined on the set of probability density functions over support $[\underline{e}, \overline{e}]$, inequality (14) is reversed.

4. National and international allocations

The key variable of interest in the comparative static exercise is e_f since the futures exchange rate is a function of the signal, y, in general and a linear function of the posterior probability density function, $\nu(e|y)$, in particular, as is evident from Eq. (2). Rewrite Eqs. (8) and (9) as

$$r'(s^*(e_f)) - c'(q^*(e_f)) = 0 \tag{15}$$

$$e_f p - c'(q^*(e_f)) = 0 \tag{16}$$

Differentiating Eqs. (15) and (16) with respect to e_f yields

$$s^{*\prime}(e_f) = \frac{p}{r''(s^*(e_f))} < 0, \tag{17}$$

and

$$x^{*\prime}(e_f) = \frac{p}{c''(q^*(e_f))} - \frac{p}{r''(s^*(e_f))} > 0. \tag{18}$$

Eqs. (17) and (18) imply that an increase in the futures exchange rate, e_f, makes exports more attractive relative to domestic sales, thereby lowering the amount of domestic sales, $s^*(e_f)$, and raising the level of exports, $x^*(e_f)$. The firm's total output, $q^*(e_f) = s^*(e_f) + x^*(e_f)$, is unambiguously larger as e_f rises because

$$q^{*\prime}(e_f) = s^{*\prime}(e_f) + x^{*\prime}(e_f) = \frac{p}{c''(q^*(e_f))} > 0, \tag{19}$$

where the second equality follows from Eqs. (17) and (18). The firm's profit is given by

$$\pi^*(e_f) = r(s^*(e_f)) + e_f p x^*(e_f) - c(q^*(e_f)). \tag{20}$$

Proposition 1. *Let $\overline{q^*}$ be the expected level of output before observing the signal, y:*

$$\overline{q^*} = \int_{\underline{y}}^{\overline{y}} q^*(e_f) n(y) dy. \tag{21}$$

More transparency in the foreign exchange market leads to a higher (lower) expected level of output, $\overline{q^*}$, if the marginal cost function, $c'(q)$, is concave (convex).

Proof. By Eq. (2), e_f is linear in the posterior belief, $\nu(\cdot|y)$. It then follows from Eq. (21) and Lemma 1 that $\overline{q^*}$ increases (decreases) with more transparency if $q^*(e_f)$ is convex (concave) in e_f. Differentiating Eq. (19) with respect to e_f yields

$$q^{*\prime\prime}(e_f) = -\frac{p^2 c'''(q^*(e_f))}{c''(q^*(e_f))^3}. \tag{22}$$

The desired results then follow from Eq. (22). $\square$

The intuition of Proposition 1 is as follows. Let us say that signal y' is 'better' than signal y, if it corresponds with a higher conditionally expected exchange rate, i.e., $e_f(y') > e_f(y)$. The firm's output is increasing in e_f and, hence, is higher for 'good' signals than for 'bad' signals. Now, with more transparency, a 'good' signal becomes even better because it is more reliable. As a consequence, production rises. For the same reason, a 'bad' signal becomes worse in a more transparent foreign exchange market and, consequently, production declines. If the marginal cost of production is increasing at a decreasing (an increasing) rate, the transparency-induced increase in output for good signals is larger (smaller) than the transparency-induced decrease in output for bad signals. As such, the expected level of output goes up (down) if the marginal cost function is concave (convex).

To gain further insight, suppose that the firm has a Cobb-Douglas production function, $q(K, L) = K^\alpha L^\beta$, where K is the capital stock, L is the labor input, and α and β are positive constants such that $\alpha + \beta < 1$.[5] If the unit-cost of capital and that of labor are i and w, respectively, the firm's cost function, $c(q)$, is given by

$$c(q) = (\alpha + \beta)\Big(\frac{i}{\alpha}\Big)^{\frac{\alpha}{\alpha+\beta}}\Big(\frac{w}{\beta}\Big)^{\frac{\beta}{\alpha+\beta}} q^{\frac{1}{\alpha+\beta}}. \tag{23}$$

It is evident from Eq. (23) that $c'(q)$ is concave or convex, depending on whether $\alpha + \beta$ is higher or lower than 1/2, respectively. In this example, more transparency in the foreign exchange market reduces or enhances the expected level of output, depending on whether the firm's production technology exhibits sufficient decreasing returns to scale or not.

Proposition 2. *Let $\overline{s^*}$ be the expected level of domestic sales before observing the signal, y:*

$$\overline{s^*} = \int_{\underline{y}}^{\overline{y}} s^*(e_f)n(y)dy. \tag{24}$$

More transparency in the foreign exchange market leads to a higher (lower) expected level of domestic sales, $\overline{s^*}$, if the marginal revenue function, $r'(s)$, is convex (concave).

Proof. By Eq. (2), e_f is linear in the posterior belief, $\nu(\cdot|y)$. It then follows from Eq. (24) and Lemma 1 that $\overline{s^*}$ increases (decreases) with more transparency if $s^*(e_f)$ is convex (concave) in e_f. Differentiating Eq. (17) with respect to e_f yields

$$s^{*\prime\prime}(e_f) = -\frac{p^2 r'''[s^*(e_f)]}{r''[s^*(e_f)]^3}. \tag{25}$$

[5] We require $\alpha + \beta < 1$ to ensure that the firm's cost function, $c(q)$, is convex.

The desired results then follow from Eq. (25). □

The mechanism generating the result in Proposition 2 is similar to the one in Proposition 1: if the marginal revenue in the home market is decreasing at a decreasing (an increasing) rate, the transparency-induced decrease of domestic sales for 'good' signals is smaller (larger) than the transparency-induced increase for 'bad' signals. The expected level of domestic sales therefore goes up or down if the marginal revenue function is convex or concave.

Let $p_D(s)$ be the inverse demand for the homogeneous good in the home market, where s is the amount of domestic sales. Since $r(s) = p_D(s)s$, the marginal revenue function is convex or concave, depending on whether $3p''_D(s) + p'''_D(s)s$ is positive or negative, respectively. Suppose that $p_D(s) = s^{-\eta}$, where $1/\eta \in (0, 1)$ is the constant elasticity of demand.[6] In this example, the marginal revenue function is convex so that more transparency in the foreign exchange market increases the expected level of domestic sales. On the other hand, if the inverse demand function is linear, the marginal revenue function is also linear. In this example, making the foreign exchange market more transparent has no effect on the expected level of domestic sales.

Corollary 1. *Let $\overline{x^*}$ be the expected level of exports before observing the signal, y:*

$$\overline{x^*} = \int_{\underline{y}}^{\overline{y}} x^*(e_f)n(y)dy. \tag{26}$$

More transparency in the foreign exchange market leads to a higher (lower) expected level of exports, $\overline{x^*}$, if both the marginal revenue function, $r'(s)$, and the marginal cost function, $c'(q)$, are concave (convex).

Proof. Since $\overline{x^*}=\overline{q^*} - \overline{s^*}$, the claim is implied by propositions 1 and 2. □

If the firm has a Cobb-Douglas production function such that the production technology exhibits sufficient decreasing returns to scale, we know from Proposition 1 that the expected level of output decreases with more transparency. If the inverse demand function, $D(s)$, either has a constant elasticity of demand or is linear, we know from Proposition 2 that the expected domestic sales cannot go down in response to more transparency. Hence, in this case, the expected level of exports must be smaller. In contrast, if the firm's production technology does not exhibit severe decreasing returns to scale,

[6] We require $1/\eta < 1$ to ensure that the revenue function, $r(s)$, is concave.

the expected level of output increases with more transparency. If the inverse demand function is linear, the expected domestic sales is unaffected by the degree of transparency. Hence, in this case, the expected level of exports must be larger.

Proposition 3. *Let $\overline{\pi^*}$ be the firm's expected profit before observing the signal, y:*

$$\overline{\pi^*} = \int_{\underline{y}}^{\overline{y}} \pi^*(e_f)n(y)dy. \tag{27}$$

More transparency in the foreign exchange market leads to an increase in the expected profit of the firm.

Proof. By Eq. (2), $e_f(y)$ is linear in the posterior belief, $\nu(\cdot|y)$. It then follows from Eq. (27) and Lemma 1 that $\overline{\pi^*}$ increases with more transparency if $\pi^*(e_f)$ is convex in e_f. Differentiating Eq. (20) with respect to e_f and using the envelope theorem yields

$$\pi^{*\prime\prime}(e_f) = px^{*'}(e_f). \tag{28}$$

The desired result then follows from Eq. (18). □

To see the intuition of Proposition 3, note that

$$\pi^{*\prime}(e_f) = px^*(e_f). \tag{29}$$

An increase in e_f has a first-order effect on the firm's maximum profit through the export revenues, $px^*(e_f)$. Since the firm exports more when e_f increases, this first-order effect on $\pi^*(e_f)$ is stronger for larger e_f and weaker for lower e_f. As a result, the firm's profit function is unambiguously convex in e_f. A more transparent foreign exchange market makes e_f more sensitive to changes in the public signal. Thus, the firm benefits from increased transparency in that its expected profit is always higher.

5. Market transparency and welfare implications

The firm's optimal utility level for a given futures exchange rate, e_f, conditional on the observed signal, y, is given by $U[\pi^*(e_f)]$, where $\pi^*(e_f)$ is given by Eq. (20). Define ex ante expected utility, $\overline{U^*}$, by

$$\overline{U^*} = \int_{\underline{y}}^{\overline{y}} U[\pi^*(e_f)]n(y)dy. \tag{30}$$

With more transparency, from an ex ante perspective the forward rate becomes more risky as it reacts more sensitively to random signal changes. Higher transparency therefore imposes welfare costs on the risk-averse firm. This risk effect is sometimes called the 'Hirshleifer-effect'. On the other hand, the greater informational content of the signal permits better production and export decisions which result in welfare gains. The total impact of higher transparency on the ex ante welfare of the firm consists of these two opposing effects.

By Lemma 1, $\overline{U^*}$ increases (decreases) with more transparency if $U[\pi^*(e_f)]$ is convex (concave) in e_f. Differentiating $U[\pi^*(e_f)]$ twice with respect to e_f yields

$$\frac{\partial^2 U[\pi^*(e_f)]}{\partial e_f^2} = \frac{px^*(e_f)}{e_f} U'[\pi(e_f)] \Big\{ e_f p x^*(e_f) \frac{U''[\pi^*(e_f)}{U'[\pi^*(e_f)]} + \frac{e_f x^{*\prime}(e_f)}{x^*(e_f)} \Big\}, \quad (31)$$

where we have used Eqs. (14), (15), and (20). The first term inside the curly brackets on the right-hand side of Eq. (31) captures the negative risk effect. This effect vanishes if the firm is risk-neutral and is otherwise increasing in the firm's aversion towards risk. The second term in the curly brackets captures a positive trade effect which results from the firm's improved allocation of production between the domestic and the foreign market. From this we conclude

Proposition 4. *More transparency in the foreign exchange market increases the firm's ex ante expected utility if the firm is risk-neutral or if risk aversion is sufficiently small. If the firm is highly risk-averse, the transparency-induced negative risk effect may dominate the positive trade effect and, hence, ex ante expected utility may decline with higher transparency.*

The (negative) risk effect is stronger the more risk-averse the firm is; and the (positive) trade effect is stronger the more elastic the amount of exports is to changes in the forward exchange rate. Hence, we can conclude that the international firm is made better off with more transparency in the foreign exchange market if the firm is not too risk averse and/or the amount of exports is sufficiently elastic to changes in the forward exchange rate.

We now turn to the domestic consumption sector. Denote by $CS(e_f)$ the consumers' surplus,

$$CS(e_f) = \int_0^{s^*(e_f)} p_D(s) ds - p_D[s^*(e_f)] s^*(e_f). \quad (32)$$

Proposition 5. *Let $\overline{CS}$ be the expected level of the consumers' surplus before observing the signal, y:*

$$\overline{CS} = \int_{\underline{y}}^{\bar{y}} CS(e_f)n(y)dy.$$

More transparency in the foreign exchange market leads to a higher expected level of the domestic consumers' surplus if the inverse demand function, $p_D(s)$, either has a constant elasticity or is linear.

Proof. Using Leibniz's rule to differentiate Eq. (32) with respect to e_f yields

$$CS'(e_f) = -D'[s^*(e_f)]s^*(e_f)\frac{p_D}{r''[s^*(e_f)]}, \tag{33}$$

where we have used Eq. (17). Differentiating Eq. (33) with respect to e_f yields

$$CS''(e_f) = -\frac{p_D^2 p_D'[s^*(e_f)]}{r''[s^*(e_f)]^2}\left\{1 - s^*(e_f)\frac{r'''[s^*(e_f)]}{r''[s^*(e_f)]} + s^*(e_f)\frac{p_D''[s^*(e_f)]}{p_D'[s^*(e_f)]}\right\}. \tag{34}$$

Since $r(s) = p_D(s)s$, Eq. (34) can be written as

$$CS''(e_f) = -\frac{p_D^2}{r''[s^*(e_f)]^3}$$

$$\times\{2p_D'[s^*(e_f)]^2 - s^*(e_f)^2 p_D'[s^*(e_f)]p_D'''[s^*(e_f)] + s^*(e_f)^2 p_D''[s^*(e_f)]^2\}. \tag{35}$$

If $p_D(s)$ is linear, we have $p_D''(s) = 0$ so that the expression inside the curly brackets in Eq. (35) becomes $2p_D'[s^*(e_f)]^2 > 0$. If $p_D(s) = s^{-\eta}$, where $1/\eta \in (0, 1)$ is the constant elasticity of demand, the expression inside the curly brackets in Eq. (35) becomes $\eta^2(1-\eta)s^*(e_f)^{-2(\eta+1)} > 0$. Hence, in either case, $CS(e_f)$ is convex in e_f. The desired results then follow from Lemma 1. □

If the inverse demand function, $p_D(s)$, has a constant elasticity of demand, we know from Proposition 2 that the expected level of domestic sales increases with more transparency, thereby rendering a higher expected consumers' surplus in the home market. Even in the case that $p_D(s)$ is linear so that the expected level of domestic sales is unaffected by the degree of transparency, Proposition 5 shows that the expected domestic consumers' surplus is improved with more transparency.

It follows from Propositions 4 and 5 that making the foreign exchange market more transparent is potentially beneficial to all (the international firm and domestic consumers). This suggests the need for policy design that can convert the potential benefit into actual benefit.

6. Conclusion

Our paper develops a theoretical framework to examine the interaction between market transparency, risk sharing opportunities, production and allocation of goods in an open economy under exchange rate uncertainty. The aim of our study is to discuss the economic implications of more transparency in the foreign exchange market. Transparency is described by the precision of information signals that are correlated to the random foreign exchange rate. We show that the effects of more transparency in the foreign exchange market on production and exports critically depend on the production technology of the international firm and on the demand conditions in the home market. More transparency, however, always leads to an increase in the expected profit of the international firm. We also offer reasonable conditions under which the ex ante expected utility of the international firm and the ex ante expected domestic consumers' surplus are both improved by making the foreign exchange market more transparent. Our results thus suggest the need for economic policy design that can convert the potential benefit of market transparency into actual economic benefit.

References

Blackwell, D., 1953, Equivalent comparison of experiments, Annals of Mathematics and Statistics 24, 265–272.

Broll, U. and B. Eckwert, 2009, Modelling information and hedging: The exporting firm, Economic Modelling 26, 974–977.

Broll, U., Chow, K.W. and K.P. Wong, 2001, Hedging and nonlinear risk exposure, Oxford Economic Papers 53, 281–298.

Eckwert, B. and I. Zilcha, 2001, The value of information in production economies, Journal of Economic Theory 100, 172–186.

Eckwert, B. and I. Zilcha, 2003, Incomplete risk sharing arrangements and the value of information, Economic Theory 21, 43–58.

Friberg, R., 1998, In which currency should exporters set their prices? Journal of International Economics 45, 59–76.

Heinemann, F. and G. Illing, 2002, Speculative attacks: unique equilibrium and transparency, Journal of International Economics 58, 429–450.

Hirshleifer, J., 1971, The private and social value of information and the reward to incentive activity, American Economic Review 61, 561–574.

——, 1975, Speculation and equilibrium: information, risk and markets, Quarterly Journal of Economics 89, 519–542.

Kawai, M. and I. Zilcha, 1986, International trade with forward–futures markets under exchange rate and price uncertainty, Journal of International Economics 20, 83–98.

Kihlstrom, R.E., 1984, A 'Bayesian' exposition of Blackwell's theorem on the comparison of experiments, in: M. Boyer and R. E. Kihlstrom (eds.), Bayesian Models of Economic Theory, Amsterdam: Elsevier, 13–31.

Kim, S.K., 1995, Efficiency of an information system in an agency model, Econometrica 63, 89–102.

Krebs, T., 2005, Fundamentals, information, and international capital flows: a welfare analysis, European Economic Review 49, 579–598.

Lehmann, E.L., 1988, Comparing location experiments, Annals of Statistics 16, 521–533.

Morris, S. and H.S. Shin, 2002, Social value of public information, American Economic Review 92, 1521–1534.

Schlee, E., 2001, The value of information in efficient risk sharing arrangements, American Economic Review 91, 509–524.

Wong, K.P., 2003a, Export flexibility and currency hedging, International Economic Review 44, 1295–1312.

——, 2003b, Currency hedging with options and futures, European Economic Review 47, 833–839.

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