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Export and benefits of hedging in emerging economies

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Export and benefits of hedging in emerging economies

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Abstract:

We study the impact of exchange rate risk upon export production within an emerging economy lacking in currency forward markets. However there exists a financial asset whose price is correlated with the relevant foreign currency. We present conditions under which export production is stimulated when the hedging device becomes more effective. In any case the exporting firm benefits from imperfectly hedging exchange rate risk.

JEL-Classification: D80, D81, F14, F31.

Keywords: Emerging markets, transition economy, export, exchange rate risk, price risk, hedging.

1. Introduction

Given the great volatility of commodity prices and foreign exchange rates firms engaged in international operations have been highly interested in developing ways to protect themselves from exchange rate risk (for a survey, see International Monetary Fund, 2007). The scenario of export revenue uncertainty attributable for example to exchange rate uncertainty is one particular case in point that is of interest in three specific contexts: that of multinational firms; that of price discriminating firms in international trade; and that of developing nations looking to manufacturing exports as a stimulus to economic growth, as a foundation for development of an industrial sector, and as a means for acquiring foreign currency.[1]

It has been shown in the literature that an international firm facing exchange rate risk can eliminate this risk altogether if it can use a currency forward market, or another financial asset which is perfectly correlated to the exchange rate in question.[2] In the absence of such markets, the firm can reduce its income risk by engaging in a cross hedging activity of assets correlated to the foreign exchange rate.[3]

In reality, not every commodity or foreign currency is traded in a futures market especially in emerging and transition economies (International Monetary Fund, 2007). In the real world hedging must often be accomplished by

[1]See, for example, Calvo, 2006.

[2]See, for example, Benninga et al., 1985, Kawai and Zilcha, 1986.

[3]Anderson and Danthine, 1981, Broll et al., 1995, Broll et al., 2001, Chang and Wong, 2003, Wong, 2007.

using futures contracts on different deliverable instruments. In general, this leads to an imperfect hedge, i.e. profit uncertainty can be minimized but cannot be fully reduced. Nevertheless, our study shows that an exporting firm can benefit from hedging profit risk even when no perfect hedge is available.

In our study of economic implications of imperfect hedging, we focus on the impact of a well-known regressibility assumption. This regressibility assumption appears by extensive statistical research on the relationship between futures and spot prices and has a long tradition in the risk management and economic literature. We analyse production and hedging decisions and also welfare consequences of a competitive exporting firm.[4] Our firm uses the foreign currency as invoicing currency.[5]

The paper is organized as follows. In section 2, the decision model of export supply under exchange rate risk and of demand for currency futures contracts is presented. Section 3.1 presents optimum production and hedging under exchange rate risk. The optimum hedge ratio satisfies the beta-hedge rule. Section 3.2 analyzes the impact of imperfect hedging upon exports with and without commodity price uncertainty. We present conditions under which production is stimulated when hedging becomes more effective. In section 3.3 we report the positive welfare effect. Section 4 concludes.

[4]For the importance of the market structure in risk management see Broll et al., 2008.

[5]Invoicing strategies are discussed in Döhring, 2008.

2. The decision model

Consider an exporting firm in an emerging economy facing the random exchange rate $\tilde{S}$.[6] Let the price of the commodity Q in the world market, denominated in foreign currency, be P and assume that this price is certain (We relax the assumption later.). The exporting firm cannot perfectly hedge its foreign exchange risk in a currency futures market, since such market does not exist. However, there is a futures market for a domestic financial asset whose price correlates with the exchange rate. This domestic futures market can be utilized by the exporting firm in order to manage foreign exchange exposure.

When the production decision takes place the firm has access to a futures market whose random spot price $\tilde{G}$ is correlated to the random foreign exchange spot rate $\tilde{S}$. We assume the regression

$$\tilde{S} = \alpha + \beta\tilde{G} + \tilde{\epsilon}, \quad \beta > 0, \tag{1}$$

where $\tilde{\epsilon}$ is a zero-mean random variable independent of $\tilde{G}$. The exporting firm can sell or buy financial futures written on the domestic financial asset at a given futures price F. The variance $\mathrm{Var}(\tilde{\epsilon}) = \mathrm{Var}(\tilde{S} - \beta\tilde{G}) = \mathrm{Var}(\tilde{S}) - \beta^2$ $\mathrm{Var}(\tilde{G})$ can be interpreted as the non-marketable exchange rate risk.

Definition 1. The futures hedge is called perfect (imperfect) if and only if $\mathrm{Var}(\tilde{\epsilon}) = 0$ ($\mathrm{Var}(\tilde{\epsilon}) > 0$).

The exporting firm chooses its production quantity Q and the contractual amount of forwards H in a way that maximizes expected utility of profits,

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

where profits are denominated in domestic currency. If $H > 0\,(H < 0)$ then the firm sells (purchases) foreign exchange forward.

Random profits $\tilde{Y}$ consist of random operational profits (from exports) and random financial profits (from forwards). Additionally there exists a non-stochastic profit Δ from domestic aktivities. Such a profit is not necessarily irrelevant to optimum export production and trade.

The firm possesses a von Neumann-Morgenstern utility function U defined over its home currency profit, where $U'(\cdot) > 0$ and $U''(\cdot) < 0$, indicating the presence of risk aversion. We denote by $C(Q)$ the firm's cost function, where $C(\cdot)$ is an increasing and convex function of production quantity Q.

The exporter's ex-ante decision problem reads:

$$\max_{Q,\,H} E[U(\Delta + \tilde{Y})], \tag{2}$$

where E is the expectation operator. The joint density of the random variables $\tilde{G}$ and $\tilde{\epsilon}$ may be a Bayesian prior, an empirically estimated density, or a posterior density that combines the two.

Random profits are given by:

$$\tilde{Y} = \tilde{S}PQ - C(Q) + (F - \tilde{G})H. \tag{3}$$

Necessary and sufficient conditions for a maximum are:

$$E[(\tilde{S}P - C'(Q^*))U'(\Delta + \tilde{Y}^*)] = 0, \tag{4}$$

$$E[(F - \tilde{G})U'(\Delta + \tilde{Y}^*)] = 0, \tag{5}$$

where $U'(\cdot)$ denotes random marginal utility and $C'(\cdot)$ marginal cost. The asterisk indicates optimum level. In the next section we use the above first order conditions in order to explore the effects of hedging on the firm's export production decision, financial commitment to forwards and ex ante expected utility, i.e. economic welfare.

3. Production, hedging and welfare

Emerging economies exhibit non-marketable risks. If the marketability of risks improves the exporting firm has an incentive to increase export production. In contrast to the literature we show that this incentive does not require unbiasedness of futures markets. Interestingly, it holds in general.

3.1 Optimum decisions

We demonstrate that the well-known separation and full-hedge properties do not hold. The marginal cost equals marginal revenue rule has to be risk-adjusted. The hedge ratio must account for the non-marketable risk $\tilde{\epsilon}$ of regression (**??**).

To characterize the optimum amount of forward contracting let us introduce the following

Definition 2. The futures price of the domestic financial asset is unbiased if and only if $F = E(\tilde{G})$. Backwardation (contango) holds if and only if $F < (>)\, E(\tilde{G})$.

Proposition 1. Consider an exporting firm in an emerging economy as described above under the regressibility assumption (**??**).

(i) The separation property does not hold: optimal export production depends upon joint density, upon domestic nonstochastic profit and upon exporting firm's attitude towards risk.

(ii) The beta-hedge property holds: The $\beta-$hedge $H^* = \beta PQ^*$ occurs if and only if the forward rate is unbiased. Backwardation (contango) implies an under-β-hedge (over-β-hedge), i.e. $H^* < (>)\, \beta PQ^*$.

Proof. Define $\hat{U}' = U'/EU'$. (i) From regression (**??**) and first order equations (**??**) and (**??**) we obtain:

$$C'(Q^*) = (\alpha + \beta F)P + \mathrm{Cov}(\tilde{\epsilon}, \hat{U}'(\Delta + \tilde{Y}^*))P, \tag{6}$$

which proves that the decision about the export production quantity cannot be separated from the firm's expectations, risk attitude and Δ.

(ii) From equation (**??**) we calculate

$$F - E(\tilde{G}) = \mathrm{Cov}(\tilde{G}, \hat{U}'(\Delta + \tilde{Y}^*)),$$

where $\tilde{Y}^* = (\beta PQ^* - H^*)\tilde{G} + \tilde{\epsilon}PQ^* + \alpha PQ^* + FH^* - C(Q^*)$. This profit equation follows from combining profit equation (**??**) and regression (**??**) and rearranging terms. The existence of a unique solution, continuity of marginal utility and independence yield the relationship: $(F - E(\tilde{G}))(H^* - \beta PQ^*) > 0$. □

Corrollary (i) Optimum export production quantity satisfies the relationship marginal cost equals risk-adjusted marginal export revenue. (ii) In no case unbiasedness secures riskless profits.

Proof. (i) Equation (**??**). (ii) $\tilde{Y}^* = (\alpha + \beta F + \tilde{\epsilon})PQ^* - C(Q^*)$. □

Note that marginal revenue $(\alpha + \beta F)P$ becomes a certain magnitude, since it is determined by the futures price of the domestic financial asset.

In the unbiased case the optimal hedge ratio equals beta, i.e. the regression parameter $\beta = H^*/PQ^*$. This hedge position of the firm has three distinctive properties. First, futures hedging leaves the producer's expected profits unchanged. Second, the optimal hedge ratio is a fixed proportion of the firm's cash position regardless of the degree of its risk aversion. Third, futures hedging miminizes profit risk.

3.2 Imperfect hedging and export production

In the following we investigate on the optimum production decision of the exporting firm when futures hedging of foreign exchange risk gradually improves. We consider the transition from an imperfect hedge to a perfect hedge of the foreign echange exposure via the domestic financial asset (see *Definition 1*).

No commodity price uncertainty

The first important result of this paper is given by the following

Proposition 2. Assume that initially the relevant currency futures market has not yet emerged and a perfect hedge is not possible. Notwithstanding, the exporting firm has access to an imperfect hedge. If a perfect hedge becomes available the exporting firm has an incentive to increase its production quantity. This incentive does not depend upon the magnitude of the futures price.

Proof. Reconsider the parity condition of optimum production (**??**) which holds for imperfect hedging:

$$C'(Q^*) = (\alpha + \beta F)P + \text{Cov}(\tilde{\epsilon}, \hat{U}'(\Delta + \tilde{Y}^*))P.$$

Perfect hedging means that $\tilde{\epsilon} = 0$, with probability 1. Hence optimum export production under a perfect hedge, Q_p^*, has to satisfy:

$$C'(Q_p^*) = (\alpha + \beta F)P. \tag{7}$$

Since the random variables $\tilde{G}$ and $\tilde{\epsilon}$ are independent, observe that $\text{Cov}(\tilde{\epsilon}, U'((\beta PQ^* - H^*)\tilde{G} + \tilde{\epsilon}PQ^* + \text{const.})) < 0$, where const.$= \Delta + \alpha PQ^* + FH^* - C(Q^*)$. Therefore, $C'(Q_p^*) > C'(Q^*)$. The convexity of the cost function then implies $Q_p^* > Q^*$. □

The economic intuition of this result is as follows: Equation (**??**) reveals the well-known separation property of a perfect futures hedge. In this case the exporting firm chooses its optimum production quantity as if under certainty, given the futures price. In the case of an imperfect futures hedge a risk effect on production occurs, for some risk always remains. This non-marketable risk induces the risk averse exporting firm to opt for lower export production.

Commodity price uncertainty

In general, exporting firms have to account for uncertain prices for final goods. In the world market there often exist commodity futures markets (see International Monetary Fund, 2007). Suppose our exporting firm can enter such a commodity futures market and assume that a perfect hedge is available. However, the domestic financial hedge in the emerging market remains still imperfect (see *Definition 1*).

The commodity price invoiced in foreign currency now is the random variable $\tilde{P}$. Let M denote the commodity futures price denominated in foreign currency and X be the quantity of the commodity sold (if $X > 0$) or purchased (if $X < 0$) in the commodity futures market.

Under additional price risk the exporter's ex-ante decision problem reads:

$$\max_{Q,\,H,\,X} E[U(\Delta + \tilde{Y})], \tag{8}$$

where random profits are now given by:

$$\tilde{Y} = \tilde{S}\tilde{P}Q - C(Q) + (F - \tilde{G})H + \tilde{S}(M - \tilde{P})X. \tag{9}$$

Necessary and sufficient conditions for a maximum are:

$$E[(\tilde{S}\tilde{P} - C'(Q^*))U'(\Delta + \tilde{Y}^*)] = 0, \tag{10}$$

$$E[(F - \tilde{G})U'(\Delta + \tilde{Y}^*)] = 0, \tag{11}$$

$$E[\tilde{S}(M - \tilde{P})U'(\Delta + \tilde{Y}^*)] = 0. \tag{12}$$

Definition 3. The financial and commodity futures prices are jointly unbiased (Kawai and Zilcha, 1986) if and only if $(\alpha + \beta F)M = E(\tilde{S}\tilde{P})$.

The following claim reports a further important result.

Proposition 3. Suppose the exporting firm has access to the relevant commodity futures market in the world market. Furthermore, assume an unbiased financial futures price (see *Definition 2*) and jointly unbiased financial and commodity futures prices (see *Definition 3.*). If domestically a currency futures market emerges such that a perfect financial hedge becomes available, then the exporting firm will increase its export production.

Proof. (i) Consider equation (**??**). Since the commodity price is uncertain we have to substitute the commodity futures price M for P. We get:

$$C'(Q^*) = (\alpha + \beta F)M + \mathrm{Cov}(\tilde{\epsilon}, \hat{U}'(\Delta + \tilde{Y}^*))M. \tag{13}$$

This result is obtained by combining regression (**??**) and first order conditions (**??**), (**??**) and (**??**).

(ii) From the definition of $\tilde{Y}^*$ in equation (**??**) and the first order equations (**??**) and (**??**), we find:

$$\begin{aligned} \mathrm{Cov}(\tilde{Y}^*, \hat{U}'(\Delta + \tilde{Y}^*)) &= (Q^* - X^*)\,((\alpha + \beta F)M - E[\tilde{S}\tilde{P}]) \\ + (F - E[\tilde{G}])\,(\beta M X^* - H^*) &+ MQ^*\,\mathrm{Cov}(\tilde{\epsilon}, \hat{U}'(\Delta + \tilde{Y}^*))] < 0. \end{aligned} \tag{14}$$

Now, suppose $F = E[\tilde{G}]$ and $(\alpha + \beta F)M = E[\tilde{S}\tilde{P}]$. Then in the optimum $\mathrm{Cov}(\tilde{\epsilon}, \hat{U}'(\Delta + \tilde{Y}^*)) < 0$ must hold.

(iii) Using the covariance result of part (ii) within part (i) we observe (see equation (**??**)) that $C'(Q_p^*) = (\alpha + \beta F)M > C'(Q^*)$. The convexity of the cost function then implies $Q_p^* > Q^*$. This proves the claim. □

Note that the result of Proposition 3 does neither require separately unbiased financial and commodity futures markets, i.e. $F = E[\tilde{G}]$ and $M = E[\tilde{P}]$, nor a specific assumption about the correlation of the uncertain commodity price and the asset price. The special case that there is no risk premium in either futures market and that $\text{Cov}(\tilde{S}, \tilde{P}) = 0$ is discussed in Benninga, Eldor and Zilcha, 1985. This set of assumptions also leads to our result but is a stronger set.

3.3 Imperfect hedging and welfare

The introduction of hedging opportunities within emerging markets can promote trade although some hedging device is imperfect. For example, the foreign exchange rate $\tilde{S}$ is not perfectly correlated with the domestic financial asset price $\tilde{G}$, where the latter underlies the futures contract. In this case unbiased futures markets does not secure riskless profits. Still the exporting firm benefits from imperfect hedging.

We denote by Y^*_{no} the firm's optimum export profit when no futures hedging is available and by Q^*_{no} the corresponding optimum export production of the firm. Comparing utility levels under imperfect hedging and no hedging, respectively, we prove the following claim:

Proposition 4. Regardless of the degree of imperfection of the financial futures hedge the exporting firm benefits from hedging profit risk.

Proof. Since $Y^* \neq Y^*_{no}$ strict concavity of the utility function implies

$$E[U(\Delta + \tilde{Y}^*) - U(\Delta + \tilde{Y}^*_{no})] > E[U'(\Delta + \tilde{Y}^*)(\tilde{Y}^* - \tilde{Y}^*_{no})] = \\ E[U'(\Delta + \tilde{Y}^*)(\tilde{S}\tilde{P}(Q^* - Q^*_{no}) - (C(Q^*) - C(Q^*_{no})) \\ + (F - \tilde{G})H^* + \tilde{S}(M - \tilde{P})X^*].$$

Since $Q^* \neq Q^*_{no}$ strict convexity of the cost function implies

$$C(Q^*) - C(Q^*_{no}) < C'(Q^*)(Q^* - Q^*_{no}).$$

Hence we can write

$$E[U(\Delta + \tilde{Y}^*)] - E[U(\Delta + \tilde{Y}^*_{no})] > E[(\tilde{S}\tilde{P} - C'(Q^*))U'(\Delta + \tilde{Y}^*)](Q^* - Q^*_{no}) \\ + E[(F - \tilde{G})U'(\Delta + \tilde{Y}^*)]H^* + E[\tilde{S}(M - \tilde{P})U'(\Delta + \tilde{Y}^*)]X^* = 0.$$

Due to first order conditions (**??**), (**??**) and (**??**) we obtain $E[U(\Delta + \tilde{Y}^*)] > E[U(\Delta + \tilde{Y}^*_{no})]$. This proves the claim. □

Propositions 2-4 yield some important economic policy implications. Suppose individual exporters and importers of tradable commodities and services do not face the opportunity to trade in futures exchange. Then the implication of economic policies that bring about results equivalent to those of introducing imperfect futures markets, are desirable to promote international trade. Futures hedging, though imperfect, stimulates production for exports and allows for gains from trade. This is consistent with the empirical research of the International Monetary Fund.

4. Conclusions

The introduction or, respectively, a deepening of hedging opportunities within emerging economies can increase trade. For this effect to hold the hedging device need not be perfect.

We present a model of a competitive risk averse exporting firm in an economy in transition. For risk management derivatives are available. We consider an imperfect futures hedge of foreign exchange exposure.

If commodity price uncertainty is absent a gradual improvement in hedging effectiveness of foreign exchange risk stimulates export production irrespectively from the risk premium in the futures price. Uncertain commodity prices do not necessarily invalidate this insight. We prove that unbiased commodity and financial futures markets are sufficient to support this assessment though the hedge of profit risk is imperfect.

There are policy and trade implications for emerging economies. Exporting firms benefit when hedging devices, though perhaps imperfect devices, are offered by risk sharing markets, governments and other institutions.

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