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International trade and firms' attitude towards risk

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ABSTRACT

This paper examines the optimal production and trade decisions of the domestic firms facing uncertainties owing to the exchange rate volatility under mean-variance preferences. The impact of uncertain exchange rate fluctuations on trade is evaluated in a partial equilibrium framework, using the concept of risk-aversion elasticities. These elasticities measure how sensitive the firms are towards substituting between return and risk at the margin, with respect to changes in the distribution of the spot exchange rate. This simplest possible analytical framework is useful for explicit empirical estimation of risk-aversion elasticities in the literature of international economics.

1. Introduction

One of the most contentious issues in international economics is the effect of the uncertainties associated with the exchange rate fluctuations on the international firms, and therefore, on the entry and exit into export market (extensive margin) as well as on the volume of international trade (intensive margin). There is relatively little evidence on the responses of exports, due to the exchange rate volatilities, at the level of firms or individual producers. Exceptions include Cheung and Sengupta (2013), Berman et al. (2012), Broll and Eckwert (2009), Arize et al. (2008), Greenaway et al. (2007), Cheung (2005), Bernard and Jensen (2004a, 2004b), Forbes (2002), and Franke (1991). Among these, Cheung and Sengupta (2013) examined the impact of exchange rate changes on the volume of exports of the Indian manufacturing firms, i.e. at the intensive margin. They have found negative and significant effects on firm's export shares of exchange rate appreciation. Cheung and Sengupta (2013) have also noted, for their sample of Indian firms from 2000 to 2010, that the exchange rate fluctuations have differential firm–specific effects on the export shares, with an asymmetric response towards the exchange rate movement.

However, these empirical studies fail to explain how and why should uncertainties associated with the distribution of foreign exchange rate contribute towards the individual firms decisions on diversifying productions into domestic and export sales, at the intensive margin. The study of an exporting firm under exchange rate uncertainty has been the subject of considerable research in decision making under uncertainty.[1] These papers examined the production and export decisions of the exporting firm using the standard von Neumann–Morgenstern expected utility representation. But, in all of these theoretical contributions, the exporting firm under consideration cannot simultaneously serve both domestic and foreign markets. Given this, this paper applies the two–moment decision model,[2] which is based on the utility of the expected value and the standard deviation of the uncertain final profit in order to examine the optimal production decision for an international firm that serves simultaneously both domestic and foreign markets. Risk preferences only contribute to alter the allocation of production between these two activities, keeping the total production unchanged. Therefore, we do not impose any specific *a priori* assumption about the firm, for the sake of simplicity and ease of interpretation.

In order to characterise the attitude towards risk, various concepts of risk aversion have been introduced; such as standard risk aversion, prudence, risk vulnerability, and shifts in the first–order stochastic dominance. Two–moment decision making (i.e., mean–standard deviation) model is an alternative and simple technique to analyse decisions to participate in the international market in the presence of external shocks. Albeit this modelling technique sometimes is misperceived as the special case of the expected utility framework, the

latter is completely different from the two-moment decision making modelling approach. This is due to the fact that when the random variables under some choice set differ only in terms of the scale (standard deviation) and location (mean) parameters of the distribution, then an expected utility ranking of these random variables can be based on the means and standard deviations of the alternatives' risky outcomes, if uncertainty represented by a stochastic variable and the decision maker's decision variable interact in a linear way (Meyer, 1987).

The decision problem of a risk–averse firm can also be characterised by such a linear interaction between random influence of the (spot) foreign exchange rate and the production decision using mean–standard deviation modelling approach. This approach allows us to model the firm being linked to both domestic and the world market simultaneously, in contrast to the existing theoretical contributions.

Therefore, this paper examines the optimal production and export decisions of a risk–averse firm facing exchange rate uncertainty under mean–variance preferences, where the revenue risk is stemmed from the uncertain movements in foreign (spot) exchange rate.[3]

Recent literature,[4] supports the fact that the export intensity of the firms, even at the intensive margin, often depends on the different specific characteristics (such as product–quality differences, cost advantages, market transparency) among the firms, which will contribute to the mark–up adjustments by these firms in response to the exchange rate volatilities in the international market.[5] Hence, the attitude towards risks owing to the uncertainties associated with the distribution of foreign exchange rate should be worthy to study. Therefore, while the increase in such risks arising from the external shock leads to unambiguous substitution effect (the decision maker reacts by switching to less risky alternative), and an ambiguous income effect (Davis, 1989). Both effects should matter for a risk–averse exporter at the intensive margin. Using the concept of risk aversion elasticity we show how changes in the mean or the standard deviation of the exchange rate distribution affect an individual firm's decisions on domestic production and trade, i.e. exports. In fact, our paper shows that the substitution and income effects together may induce a risk–averse firm to optimally export more, depending on the magnitude of the risk–aversion elasticity.

As demonstrated in Goldberg et al. (2010), for a large developing country like India, expansion in the sales of domestic products by the Indian manufacturing firms during the liberalised regime, even at the intensive margin, can be attributed largely to the increased imports of intermediate inputs from abroad by the domestic firms. Therefore, an immediate subsequent question that should arise in our mind is how far the uncertainties in the distribution of foreign exchange rate at the import market would affect domestic production* This paper, for the first time, also devotes itself to the analysis of the risk–taking behaviour (i.e. the optimal import decision) for a representative risk–averse competitive domestic firm that imports intermediate input from abroad for domestic production and facing external shocks in the import market, using mean–standard deviation model. Hence, the firm in this case, is facing uncertainties surrounding the cost of production due to the volatilities in (spot) foreign exchange rate of the import market. This is analysed in Section 4 of this paper.

We aim at systematic analyses of economic response in the mean–variance framework. All comparative static effects are described in relative terms, i.e. risk–aversion elasticities. Elasticities measure how sensitive risk aversion of the firm is with respect to changes in the distribution of the random variable.

The rest of this paper is organised as follows. Section 2 delineates the model for a firm, serving both domestic and export markets, with some monopoly power under revenue risk, owing to the uncertain movements in foreign (spot) exchange rate. Section 3 demonstrates how risk–aversion elasticity affects optimal production allocation decision for such exporting domestic firm. In Section 4, we examine the effect of cost uncertainties, owing to the exchange rate volatilities in the import market, on the optimal import decision for a domestic firm that uses imported inputs for its production. We bring in the empirical relevance of our results in Section 5. The final Section 6 concludes.

2. The firm serving both domestic and export markets

Let us consider a firm that serves both the domestic market and a foreign country market under exchange rate uncertainty, facing a downward sloping residual demand curve at home and abroad. There is a single period horizon with two dates, i.e. t=0 and t=1. To start with, let us assume at t=0, the firm produces a single product in the home country according to a known cost function, $C(q)$, with $C'(q) > 0$, and $C''(q) > 0$, i.e. marginal costs are increasing (i.e. the firm's production technology exhibits decreasing returns to scale). We suppress the riskless interest rate by compounding all operating profits to their future values at the end of the period. We assume that the firm chooses different prices in home and abroad: the firm faces $p(x)$ as the price schedule of the exportable x in units of foreign currency; while $p(y)$ is the price schedule of the product y sold in domestic market, in units of domestic currency, faced by the firm. Revenue functions $R(x)$, $R(y)$ in both home and foreign markets (in units of their respective currencies) are concave; i.e. $R'(y) > 0$, $R''(y) < 0$, and $R'(x) > 0$, $R''(x) < 0$. The firm regards the spot exchange rate, $\tilde{e}$, as a random variable that is distributed according to a know cumulative distribution function (CDF), over support $[\underline{e}, \bar{e}]$.[6] The exchange rate, $\tilde{e}$, is expressed in units of the home currency per unit of foreign currency. With total output $q = x + y$, the random operating profit of the firm reads

$$\tilde{\pi} = \tilde{e}R(x) + R(y) - C(x + y).$$

The domestic firm's preferences are given by a two-parameter utility function:

$$V = V(\mu, \sigma), \tag{1}$$

where $\mu = \mu_e R(x) + R(y) - C(x + y)$ and $\sigma = \sigma_e R(x)$ denote, respectively, the expected value and the standard deviation of random profit π. We require the following properties to be satisfied for all μ, σ: $V_\mu(\mu, \sigma) > 0$, $V_\sigma(\mu, \sigma) < 0$. The marginal rate of substitution (MRS) between risk and return is defined by

$$S = -\frac{V_\sigma(\mu, \sigma)}{V_\mu(\mu, \sigma)} > 0. \tag{2}$$

The marginal rate of substitution between risk and return, $S(\mu, \sigma)$, is the two–parameter equivalent to Arrow-Pratt measure of absolute risk–aversion. Indifference curves in (σ, μ)-space are upward-sloping, with their slopes measuring risk–aversion.

The domestic firm's ex-ante decision problem as such is given by

$$\max_{x \geq 0,\ y \geq 0} V(\mu(x, y), \sigma(x, y)). \tag{3}$$

When we consider interior solutions of this decision problem,[7] the optimum is then determined by

[3] It should be worthwhile to mention that Broll and Wong (2015) explicitly model ambiguity for an exporting firm that sells in both the home country and a foreign country under smooth ambiguity aversion. However, our paper uses the simplest possible analytical framework without modelling ambiguity aversion using simple portfolio theory to illustrate the risk–taking behaviour, not only for the similar type of exporting firm, but also for another type of risk–averse firm that produces for the domestic market, using imported input from abroad.

[4] Wong (2003), Mallick and Marques (2016a, 2016b), Wagner (2016) and Mukherjee (2016).

[5] We are grateful to the Editor of this journal to point us out this.

[6] All random variables are denoted by a tilde, while their realisations are not.

[7] Corner solution would have been relevant only if we would allow for zero exports. This point is illustrated after Eq. (6).

$$V_\mu(\mu^*, \sigma^*)(\mu_e R'(x^*) - C'(x^* + y^*)) + V_\sigma(\mu^*, \sigma^*)\sigma_e R'(x^*) = 0, \quad (4)$$

$$V_\mu(\mu^*, \sigma^*)(R'(y^*) - C'(x^* + y^*)) = 0, \quad (5)$$

where an asterisk (*) signifies an optimal level. The second-order condition is satisfied due to the quasi–concavity of $V(\mu, \sigma)$, concavity of domestic and foreign revenue functions and the convexity of the cost function. In the optimum, since $V_\mu(\mu^*, \sigma^*) > 0$, we obtain from Eq. (5) that

$$C'(x^* + y^*) = R'(y^*).$$

Hence, we establish our first result.

Proposition 1. *The firm optimally chooses its total output level, $q^* = x^* + y^*$, at which the marginal cost of production $C'(x^* + y^*)$, is equated to the domestic marginal revenue, $R'(y^*)$. Total output does not depend on the firm's attitude towards risk and on the exchange rate distribution.*

An interesting implication of Proposition 1 is that the *total* amount of production of the firm is independent of the firm's attitude towards risk and of the probability distribution of the random marginal export revenue. This result is equivalent to the celebrated separation theorem derived in the risk management and hedging literature. However the decision to allocate production into domestic supply and exports depends on the firm's risk preferences and the distribution. The purpose of the next section is to demonstrate the comparative static properties of the firm's allocation problem in relative terms. We show that comparative static results depend on how sensitively the firm's risk–aversion responds to changes in expected final profit and profit risk.

3. The economic impact of changes in the distribution

We are interested in how optimal risk–taking behaviour of the exporting firm responds to changes in the world market. Our first result deals with the comparative statics for changes in the distribution of the foreign spot exchange rate. Before analysing a change in exchange rate risk and its impact upon trade and domestic sales, let us introduce the concept of risk–aversion elasticity.

Definition 1. The elasticity of the marginal rate of substitution between risk and return with respect to the standard deviation of the firm's end of period profit is

$$\varepsilon_\sigma(\mu, \sigma) = \frac{\partial S(\mu, \sigma)}{\partial \sigma}\frac{\sigma}{S(\mu, \sigma)},$$

with $\sigma > 0$.

The elasticity ε_σ indicates the percentage change in risk–aversion over the percentage change in final profit standard deviation, keeping the mean of the end-period profit constant. By using the marginal rate of substitution, $S(\mu, \sigma)$, and Eq. (4), the decision problem of the firm on how much should it diversify towards the international market and the domestic market boils down to

$$\frac{\mu_e R'(x^*) - C'(x^* + y^*)}{\sigma_e R'(x^*)} = S(\mu(x^*, y^*), \sigma(x^*, y^*)). \quad (6)$$

The left hand side of Eq. (6) is merely the expected change in the mark-up. It is easily verifiable that if $\mu_e R'(x^*) - C'(x^* + y^*) < 0$, then the optimum export is zero. Therefore, when the expected change in the mark-up is non–positive, the firm will never export some of its production. Since in this paper we focus on intensive margin of trade, we do not consider this possibility and always assume that expected change in the mark-up for our exporting firm is always positive. This is why we have focused on interior solution only of the maximisation problem.

Proposition 2. *A risk–averse exporting firm reduces its optimal export x^* upon an increase in risk, if and only if risk–aversion elasticity is greater than −1, i.e. $\varepsilon_\sigma(\mu^*, \sigma^*) > -1$.*

Proof. Implicit differentiation of Eq. (6) with respect to σ_e leads to

$$\operatorname{sgn}\frac{\partial x^*}{\partial \sigma_e} = -\operatorname{sgn}\left(S(\mu^*, \sigma^*) + \sigma_e \frac{\partial S}{\partial \sigma}\frac{\partial \sigma}{\partial \sigma_e}\right) = -\operatorname{sgn}(1 + \varepsilon_\sigma(\mu^*, \sigma^*)) \quad (7)$$

Economic intuition for our risk–aversion elasticity can be interpreted by a graphical representation. Consider the (μ, σ)-plane and Eq. (6). This defines a tangency condition where the right-hand side measures the slope of the indifference curve, whereas the left-hand side is the slope of the efficiency line, defined through the locus of (σ^*, μ^*). □

The result shows that a risk–averse firm may optimally export more when risk increases. This happens if and only if the elasticity of risk–aversion is less than −1. An increase in revenue risk (brought about by the uncertain exchange rate movements in the world financial market) leads to a direct and indirect effect. The substitution effect (direct effect) is unequivocally negative, i.e., a higher price risk implies lower exports, and higher domestic sales. The income effect however can be negative or positive, because it encompasses the possibilities that the exportable is priced at higher (lower) domestic currency per unit of foreign currency. For instance, if the income effect would be negative, then the firm would have decreasing risk–aversion: an increase in σ_e would make the firm poorer, the firm would behave in a more risk–aversion fashion and would have supplied less export. Thus, the total effect on export supply depends on the relative magnitudes of the income and substitution effects. Proposition 2 states that if and only if the elasticity of risk–aversion is less than −1, then $\partial x^*/\partial \sigma_e = -\partial y^*/\partial \sigma_e > 0$. That is, the firm then reacts to an increase in exchange rate risk by exporting more and supplying less in the domestic market.

Definition 2. The elasticity of the marginal rate of substitution between risk and return with respect to the mean of final operating profit is defined as

$$\varepsilon_\mu(\mu, \sigma) = \frac{\partial S}{\partial \mu}\frac{\mu}{S(\mu, \sigma)}.$$

The elasticity $\varepsilon_\mu(\mu, \sigma)$ indicates the percentage change in risk–version over the percentage change in expected final profit, keeping the standard deviation of the firm's end-period profit constant.

Now we examine the relationship between the firm's export and domestic sales with respect to a change in the expected foreign exchange rate, i.e., μ_e. From the optimality condition (6) applying the implicit function theorem we get

$$\operatorname{sgn}\frac{\partial x^*}{\partial \mu_e} = \operatorname{sgn}\left(1 - \sigma_e \frac{\partial S}{\partial \mu}\frac{\partial \mu}{\partial \mu_e}\right).$$

By extension the last term on the right hand side we obtain

$$\operatorname{sgn}\frac{\partial x^*}{\partial \mu_e} = \operatorname{sgn}(1 - \varepsilon_\mu(\mu^*, \sigma^*)\alpha^*). \quad (8)$$

Where $\alpha^* = S(\mu^*, \sigma^*)\frac{\sigma^*}{\mu^*}$. We arrive at our next proposition.

Proposition 3. *Owing to an increase in the expected foreign exchange rate at a given risk, a risk–averse exporting firm will increase export at the intensive margin if and only if the elasticity of the marginal rate of substitution between risk and return with respect to μ is less than 1, i.e. $\varepsilon_\mu(\mu^*, \sigma^*) < 1$.*

Proof. In the optimum risk–version elasticity $\varepsilon_\mu(\mu^*, \sigma^*)$ is less than 1, if $\alpha^* \leq 1$. We are going to show this below. With definition of the marginal rate of substitution and the first–order condition we obtain

$$\frac{\mu_e R'(x^*) - C'(x^* + y^*)}{R'(x^*)} \leq \frac{\mu_e R(x^*) + R(y^*) - C(x^* + y^*)}{R(x^*)}.$$

Hence, $\alpha^* \leq 1$, due to $R(z^*)/z^* > R'(z^*)$ with $z = x, y$ and $C(q^*)/q^* > C'(q^*)$. □

Hence, the impact on firm's optimal export behaviour depends once again on the interaction between the income and the substitution

effect. To sum up, our results can be generalised by stating that the firms enjoying comparative advantage (in terms of quality, cost and informational advantages as mentioned earlier) in the product that they are producing and selling to both local and global markets, in general, do not tend to switch out of the export market, i.e. the expected change in mark–up is always positive. However, the comparative statics of parameter changes depend on how sensitively the firm's risk–aversion, i.e., its willingness to pay for additional risks, responds to changes in expected final random profit and profit risk. Different exporting firms at the intensive margin have different willingness to pay for additional risks can be guided by the financial strength of the firms, as evidenced in Cheung and Sengupta (2013); Heriocourt and Poncet (2014). Therefore, firms with greater risk–taking capacity may not necessarily reduce exports at the intensive margin owing to the exchange rate risks. This explains the asymmetries in the responses of different firms on their export activities to the fluctuations in foreign exchange rate.

4. Import of intermediate inputs and domestic production

Let us now consider a domestic industry where each of the firms is producing identical products, by using imported intermediate inputs from abroad, to sell in the domestic market.[8] Each firm is a price-taker in both domestic and world markets and producing under constant returns to scale. Hence, we can consider such a representative firm of this domestic industry. However, the firm is facing uncertainties in the foreign exchange rate of the import market, which is modelled by a positive random variable $\tilde{e}$, having distributed according to an objective cumulative distribution function over support $[\underline{e}, \bar{e}]$. The spot exchange rate is again measured in terms of the home currency per unit of foreign currency. p_x denotes the per-unit price of imported inputs in units of foreign currency and p_y denotes the per-unit price of the domestic final output in units of home currency. The firm's random operating profit, denoted in home currency, is given by

$$\pi = p_y y - \tilde{e} p_x x. \tag{9}$$

That is, domestic production $y = f(x)$, where $f(x)$ is a concave function with $f'(x) > 0, f''(x) < 0$ and x is the amount of intermediate product imported.

The firm's preference function is $V = V(\mu, \sigma)$, where $\mu = p_y f(x) - \mu_e p_x x$ and $\sigma = \sigma_e p_x x$. The domestic firm solves the following decision problem

$$\max_{x \geq 0} V(\mu(x), \sigma(x)). \tag{10}$$

Restricting attention to interior solution, the optimal import quantity is then determined by the first–order condition

$$V_\mu(\mu^*, \sigma^*)(p_y f'(x^*) - \mu_e p_x) + V_\sigma(\mu^*, \sigma^*)\sigma_e p_x = 0. \tag{11}$$

By using the marginal rate of substitution, $S(\mu, \sigma)$, the first–order condition is

$$\frac{p_y f'(x^*) - \mu_e p_x}{\sigma_e p_x} = S(\mu^*, \sigma^*). \tag{12}$$

Since $S(\mu^*, \sigma^*) > 0$, the left hand side of Eq. (12) states that the value of marginal product is greater than the expected marginal cost of imports at the optimum, which essentially implies that the firm likes to be compensated for exchange rate risks at the import market. We are going to trace out comparative static responses for changes in the distribution of the foreign spot exchange rate, using the definitions of the risk–aversion elasticity.

By implicit differentiation of Eq. (12) w.r.t. σ_e yields

$$\operatorname{sgn} \frac{\partial x^*}{\partial \sigma_e} = -\operatorname{sgn}(1 + \varepsilon_\sigma(\mu^*, \sigma^*)), \tag{13}$$

where ε_σ is the elasticity of the marginal rate of substitution between risk and return with respect to the standard deviation of the firm's end–period profit. Hence, $\partial x^*/\partial \sigma_e < 0$ when $\varepsilon_\sigma(\mu^*, \sigma^*) > -1$. This yields the following proposition.

Proposition 4. *A risk–averse firm, importing input from abroad for domestic production, will reduce its optimal imports of intermediate inputs upon an increase in risk, σ_e, if and only if the risk–aversion elasticity is greater than –1, i.e. $\varepsilon_\sigma(\mu^*, \sigma^*) > -1$.*

Let us now focus on the change in expected exchange rate for a given exchange rate risk. Implicit differentiation of the first–order condition w.r.t. to a change in the expected exchange rate, μ_e, we have,

$$\operatorname{sgn} \frac{\partial x^*}{\partial \mu_e} = \operatorname{sgn}(\alpha^* \varepsilon_\mu(\mu^*, \sigma^*) - 1), \tag{14}$$

where ε_μ is the elasticity of the marginal rate of substitution between risk and return with respect to the mean of the firm's end–period profit.

Now, $\alpha^* = S(\mu^*, \sigma^*)\frac{\sigma^*}{\mu^*}$ can be shown as lying between 0 and 1. This is because,

$$\alpha^* = \frac{p_y f'(x^*) - \mu_e p_x}{\sigma_e p_x} \frac{\sigma_e p_x x^*}{p_y f(x^*) - \mu_e p_x x^*} = \frac{p_y f'(x^*) x^* - \mu_e p_x x^*}{p_y f(x^*) - \mu_e p_x x^*} \leq 1, \tag{15}$$

since $f'(x^*) < f(x^*)/x^*$. This yields $\partial x^*/\partial \mu_e < 0$, if and only if $\varepsilon_\mu(\mu^*, \sigma^*) < 1$.

Hence, although normal intuition suggests that an increase in the expected cost of imported inputs should lead to less demand, the firm under consideration may not necessarily respond by importing less. It will only do so if the elasticity of the marginal rate of substitution between risk and return with respect to μ is less than 1. Therefore, we have the following proposition.

Proposition 5. *A risk–averse firm, importing inputs from abroad for domestic production, will reduce its optimal imports of intermediate inputs upon an increase in the expected foreign exchange rate at a given risk, if and only if the elasticity of the marginal rate of substitution between risk and return with respect to μ, i.e. $\varepsilon_\mu(\mu^*, \sigma^*)$ is less than 1.*

An increase in the expected exchange rate leads to a direct and indirect effect. The substitution effect (direct effect) is unequivocally negative, i.e., a higher exchange rate implies less imports, and less domestic sales. The income effect however can be negative or positive. Thus, the total effect on import demand depends on the relative magnitudes of the income and substitution effects which are described by the elasticity of risk–aversion.

5. Empirical relevance

We know from the economic literature of international economics that the investigation of trade elasticity is an important task. In the theoretical and empirical literature there are different ways to identify the impact of changes in the exchange rate and exchange rate regimes. In our modelling exercise we focus on risk preferences of an international firm. We apply the following specific utility function (see, Saha 1997):

$$V(\mu, \sigma) = \mu^a - \sigma^b,$$

where a and b are parameters. Therefore the firm's risk attitude measure is

$$S(\mu, \sigma) = (b/a)\mu^{(1-a)}\sigma^{(b-1)}.$$

[8] As mentioned earlier, our focus in this section is on a representative importing firm, operating under perfect competition, and only serves the domestic market by using imported intermediate inputs. Hence, albeit interesting, we leave the case for the firm serving both home and foreign markets, using intermediate inputs from abroad, for future research in a mean–standard deviation model.

Using this condition, we can infer

$$\ln S_{it} = \ln(b/a) + (1 - a)\ln \mu_i + (b - 1)\ln \sigma_i,$$

where i denotes cross–sectional units (firms) and t represents time period (year, month, quarter, day). Hence, we obtain $\varepsilon_\sigma = b - 1$ and $\varepsilon_\mu = 1 - a$.

Propositions 2 implies if $b > 0$ then the firm's optimum export will decrease when the revenue risk increases owing to greater volatility in the foreign exchange rate. Similarly Proposition 3 implies the firm will optimally export more when expected revenue increases if $a > 0$. On the other hand, Proposition 4 implies if $b > 0$, then a risk–averse firm, importing input from abroad for domestic production, may reduce its optimal imports of intermediate inputs upon an increase in risk; while Proposition 5 implies a risk–averse firm may reduce its optimal imports of intermediate inputs upon an increase in the expected foreign exchange rate, if $a > 0$. Hence, the impact of risk preferences with respect to global allocation of production is testable via an empirical study of risk–aversion elasticity, using firm–level data.

Very recently, Broll et al. (2016) have estimated risk–aversion elasticities for different non–financial service sector exporting Indian firms (at the intensive margin) over the period of 2004–2015 for the entire conditional distribution of marginal rate of substitution using quantile regression method. They have found all the exporting firm in their sample, at the intensive margin, having exhibit decreasing absolute risk–aversion in general. However, the responsiveness of the firms' exporting behaviour to the change in the distribution of revenue risk still varies significantly across the exporting firms in their sample.

6. Concluding remarks

In this paper, we have examined the allocation decisions of an international firm under exchange rate uncertainty when the firm's preferences exhibit risk–aversion. In the first case, the firm under consideration performs domestic production and simultaneously serves the export market; while we have also considered another scenario when the firm only serves domestic market, but using imported inputs from abroad. In both cases, the firm faces international price risk owing to the uncertainties in the foreign spot exchange rate. Using a two–moment decision model, we have shown that the impact of a change in the distribution of the exchange rate on the firm's production decision is contingent upon the sensitivity of its risk–aversion, i.e. the willingness to participate in the foreign market for an increase in revenue risk.

Relative to the existing literature, the contribution of this paper is to use analytically simplest possible framework to yield deeper insights. We have directly represented the international firm's risk–taking behaviour without any specific assumptions on the higher-order and cross derivatives of the utility function. Whether or not should the firm produce more for domestic market depends on the firm's elasticity of risk–aversion with respect to the standard deviation (or the mean) of the firm's end-period random profit. This application of the robust elasticity concept explains asymmetric responses of the firms, in terms of their trade shares at the intensive margin, as the outcome of the asymmetric risk–aversion elasticities over time. As future research, one could extend the two-moment model in case of the firm that serves the domestic market as well as the foreign market, by using imported inputs from abroad.

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