Spot Exchange Rate Volatility, Uncertain Policies and Export Investment Decision of Firms: A Mean-Variance Decision Approach[1]

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Abstract

This paper studies characteristics of optimal investment decisions of risk-averse firms who engage in exports under two types of risks: endogenous and background risks. While endogenous risk arises from the fluctuations in spot exchange rate and affects directly the profit of an exporting firm, background risk arises from uncertain changes in firm- and industry-specific domestic and foreign policies. We propose a mean-variance decision-theoretic model to trace out impact of perturbations in the distributions of these uncertainties on the optimal investment strategy. A testable empirical model is derived and applied to a panel of 840 exporting Indian manufacturing firms for the period 1995-2015. Our results suggest that Indian manufacturing exporters depict decreasing absolute risk aversion and that firms' risk preferences are prone to variance vulnerability.

Keywords: Spot exchange rate risk; Background risk; Investment decision; Mark-up estimation; Risk aversion elasticities.

JEL Codes: D22; D81; F41; L11.

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1. Introduction

Cross-border flows of goods and services are one of the key components of the globalisation process. Increasing integration to the global market has undoubtedly amplified firms' exposure to external shocks. As such, the architecture involving firms' risk management has inspired an extensive empirical and theoretical literature on investment and production under uncertainty. Recent empirical research (see, for example, Nakhoda, 2018) lays emphasis on developing countries' exporting firms regarding accumulation of long-term secured loans in the period prior to their entry into the export market. This fact implies that the exporting firms in developing countries are generally *risk averse*. But, would this tendency of risk-aversion be an outcome of embedded volatility in the financial market enhanced measurably by high degree of information asymmetry and imperfect market structure – typical of any developing country market?[1] Bloom et al. (2007) and Bloom (2009) have shown that the shocks pertaining to the volatility in the stock market reduce firm-level investment and mitigate its response to demand shocks. In a related context, Bougheas et al. (2018), showed that after a sudden currency devaluation, exporters whose foreign sales are more competitively priced under a devalued currency responds by keeping a positive premium over cost at the margin, and improve their foreign market shares. A large body of firm-level trade literature have recognized the importance of investment dynamics as a potential source of improving the firm-level export performance (e.g., Costantini and Melitz, 2007; Atkeson and Burstein, 2010). On a similar note, Fabling and Sanderson (2013) demonstrate that firm-level investment decisions play a crucial role in raising the exporter's "labor-productivity premium".[2] Handley and Limão (2015) have demonstrated the importance of trade policy uncertainty on firm-level investment to promote exporting. However, the extant literature is silent about the *behavioural responses* of a firm (in terms of export investment) under both exchange rate risk and exogenous shocks. The contribution of the present study is to fill this research gap in the literature.

To achieve this aim, we study analytically as well as empirically, the decision problem of such risk-averse domestic exporting firms in a developing country context[3]. Our main concern is how much investment is to be optimally made for exports to the international

[1] This is the reason to why we have focused ourselves considering a developing economy case.

[2] It is worth to mention about the literature on MNEs investing in emerging markets in this context, namely Ferraris (2014); Luo and Zhang (2016); Dang et al. (2020). These researches recognise the importance of firm-level investment in capital deepening, necessary for improving the firms' performance.

[3] We have taken the sample of Indian manufacturing firms as a case study to empirically demonstrate the validity of our analytical results/propositions. In this context, Figure 4.2 shows that these firms tend to keep positive risk premium, once they extract positive profits from their export markets.

markets under multiple sources of risk. As recognised in Handley and Limão (2015), this question is novel and has yet to be tackled in the context of a developing country. The primary source of uncertainty in the present context is the revenue risk, arising from the fluctuations in the (nominal/spot) exchange rate, as the randomness associated with exchange rate volatility affects both the decision to and the intensity of export (for example, see Parlaplano et al., 2015; Davies et al., 2006).[4] Consistent with the predictions for risk-averse and rational decision-makers, our results suggest that the risk preferences of the Indian manufacturing exporters are characterised by decreasing absolute risk aversion and 'variance vulnerability' (in other words, 'proper' risk aversion: see Lajeri-Chaherli, 2002; Pratt and Zeckhauser, 1987). These findings are extremely significant in the relevant domain, given that Broll et al. (2020) is by far the only contribution that has attempted to jointly estimate risk preference structure and risk aversion elasticity in the context of the non-financial service sector firms' relative willingness for exporting (relative to domestic sales) at the intensive margin.

This study is motivated not only from the class of theoretical literature that models the role of domestic financial institutions and investment on the comparative advantage and pattern of trade (such as Beck, 2003; Carlin and Mayer, 2003; Ju and Wei, 2005; 2011), but also from the papers pertaining to the literature of risk management of international trade. Majority of research in this class of literature have studied production and export decisions of exporting firms under exchange rate uncertainty using the standard expected utility (EU) representation (such as Kawai and Zilcha, 1986; Viaene and Zilcha, 1998; Broll and Eckwert, 1999; 2009; Broll et al., 2006; 2015a; 2016; to name just a few), while very few have employed the mean-variance modelling approach (Broll and Mukherjee, 2017; Broll et al., 2020). However, other than the exchange rate risks, the exporting firms also face exogenous factors beyond firm's control, such as variations in firm size, age and uncertain changes in the industry-specific policies over time (due to changes in management regimes). These factors influence the fixed costs of entering the export market, thereby aiding to the uncertainty surrounding

[4] It is important to note that our paper does not investigate the aspect of whether or not to enter the export market. Rather it takes export-investment as an indispensable factor to promote intensive margin of exporting, i.e., promoting the firm to cater greater foreign market share than what had been in the previous years. Hence, the decision problem we consider here naturally becomes how much investment a risk-averse decision-maker should make, at the margin, under the presence of both spot exchange rate uncertainty and background risk. The results we have derived are categorised as comparative static responses of how does the optimal investment decision changes, at the intensive margin of exports, due to the ceteris paribus perturbation in the moments of the distributions of exchange rate uncertainty and background risk.

the exporting prospects. We assume these effects, by their very nature, remain ***independent*** to that of *revenue risk, aroused due to the uncertainties in spot foreign exchange rate*.[5] This additional source of uncertainty can be categorised as a *background risk* (see, Eichner and Wagener, 2009; Wong, 2012; 2017; Broll and Wong, 2013), entering passively in the exporter's profit function. In this context, Topalova and Khandelwal (2011) and the references therein, substantiate the importance of firm size and age (in its non-linear form) (measured as a proxy for experience) in determining the firm's productivity, which influences the firm's decision to invest for exporting.

We consider the presence of such a *background risk*, along with the *endogenous* '*exchange rate risk'*, in the context of the export investment decision problem in a mean-variance model.[6] To the best of our knowledge, such a question has found little analytical and empirical exploration in the extant literature. In this paper, we present for the first time to the literature of risk management in international trade, the impact of both endogenous and background risk in optimal decision of firms' export investment in a developing country setting. The importance of the latter cannot be underemphasized given that there is a significant degree of volatility in the financial market in these countries beset with the typical persistence of high degree of information asymmetry and a proliferated willingness of firms to invest in exporting. The jointness of both endogenous and independent risks can have serious negative impact on the investment sentiment of the typical risk-averse firms in developing countries.

This paper, therefore, makes a distinct contribution to the literature of trade and finance (risk), by studying the impacts of perturbation in both endogenous risk (fluctuations in spot exchange rate) and background risk (*exogenous shocks*) on the firm's export investment decision at the margin. A key contribution of the paper is the characterisation of firm's optimal investment strategy, in view of the amplifying endogenous and background risks. A Mean-

[5] Given that we are considering firms of a small, open developing economy, each firm would take the world price of the exportable as exogenously given. Therefore, no firm has any price setting power in the world market. Also, no firm in our model can affect the industry-specific policies. However, it would be interesting to consider a scenario with dependent background risk where the firm can influence the industry-specific and firm-specific policies. Since the present paper is not intending to explore any external or internal policy impact on firm's export investment decisions, this is beyond the scope of the present paper. Nevertheless, it can be taken up as an exciting future research agenda.

[6] We would like to clarify that how and why fluctuations in spot foreign exchange rate ($\tilde{e}$) is termed as an *endogenous* risk, while the background risk ($\tilde{Z}$) is *exogenous* in our model. Because the impact of export investment on the distribution of end-of-year uncertain profit, $\tilde{\pi}$, directly works through $\tilde{e}$ (given the world price of the exportable, p), in line with Eichner and Wagener (2009, 1143 - 1144), we have termed $\tilde{e}$ as the *endogenous* risk.

On the other hand, background risk is purely based on firm-specific, industry-specific and domestic macroeconomic policy-specific *exogenous shocks*, *on which no firm has any influence*. Hence, the background risk purely enters the model as a *passive* random variable, weighted by a positive scale factor, β.

Variance decision-theoretic (MVD) model serves as our main vehicle for our analytical exposition.

We thus adopt two pronged strategies:

(i) For analytical design and exploration, we employ Mean-Variance decision approach and characterize risk preference structure under, for perturbations and various risks;

(ii) We derive an empirically testable model and estimate risk aversion elasticities of firms. A structural equation is estimated using a panel data of Indian manufacturing firms.

There is a certain advantage of using an MVD approach in our current context because this approach rests on trouble-free interpretation. Its effects can be instantiated in terms of both risks and returns. Moreover, irrespective of the multidimensional nature of risks or choice variables, such a model is essentially two dimensional. The Mean-Variance approach facilitates direct modelling of such decision problem without assuming anything pertaining to the higher-order and cross-derivatives of the preference functional.

It is worth noting here that the Mean-Variance (or, equivalently known as 'two-moment') modelling approach sometime is misinterpreted as the particular case of the standard von Neumann – Morgenstern expected utility (EU) representation, which is generally used to model a decision maker's attitude towards risks. But, the MVD approach is novel, as it delivers analytical simplicity with richer intuitions (see Eichner and Wagener, 2003; 2009; 2012). To realize its operational efficiency, we need to make the following two standard assumptions. Firstly, all feasible distributions of any random variable differ only with respect to the location and the scale parameters. Secondly, all sources of uncertainty must interact linearly with the decision variable (see Meyer, 1987; for the validity of this assumption). As a result, all other moments of the distributions, except mean and variance, are irrelevant in our context.

In order to provide empirical support to our theoretical predictions. Specifically, we estimate the risk preference structure of such exporting firms and the corresponding risk aversion elasticities. For this purpose, we follow Saha et al. (1994), Saha (1997), Serra et al. (2006) and Cohen and Einev (2007), among others, to directly estimate a flexible utility function in a nonlinear mean-variance framework that nests all possible risk preference structures. For our purpose, we utilise a panel of 840 Indian manufacturing exporters (firms) spanning over a period of two decades (1995-2017) and employ panel data regression[7] to obtain parameter estimates.

The motivation behind selecting the Indian manufacturing sector exporting firms (at the intensive margin of trade) for our empirical exploration stems from comparison of our work with relevant papers in the field, such as Dhasmana (2015); Nanda and Panda (2018); Srinivasan and Wallack (2003); Veeramani (2008). These contributions suggest asymmetric impacts of exchange rate fluctuations on the export performance of the Indian manufacturing firms, at the intensive margin of trade, during the liberalized regime. However, the heterogeneity in risk preference structure is important and there is little evidence in the extant literature in this regard, especially for Indian manufacturing firms catering foreign markets. In contradistinction to these studies, although Broll et al. (2020) employed the MVD modelling approach to empirically estimate risk aversion elasticities and risk preference pattern of the Indian non-financial sector exporters, the analysis of their paper was confined to only non-financial *service sector firms* at the intensive margin of trade. Therefore, it is imminent why we have claimed that such a study conducted in the present paper, namely how much investment is to be optimally made for exports to the international markets, at the intensive margin of trade, for manufacturing firms, under both exchange rate uncertainty and background cost uncertainty, has never been applied to a developing market such as India.

Regarding the suitability of Indian export market for this particular study, several points merit emphasis. Firstly, as documented in Cheung and Sengupta (2013), during 2000–2010, appreciation in Indian rupee (INR) vis-à-vis US dollar negatively affected Indian exports at the firm-level, while background uncertainty, such as unanticipated shocks in labour costs have accentuated such negative effect of such currency appreciation. Secondly, as Dhasmana (2015) pointed out, exchange rate fluctuations have a substantial impact on the performance of the Indian firms in particular, which varies significantly across different firm and industry characteristics. Given the documented evidence of such anomalies in the context of Indian markets during liberalised regime, we have taken up the Indian manufacturing sector as our case-study to exemplify the firm-specific risk preference structure and estimation of risk aversion elasticities.

[7] In our main model, we have employed static panel data regression model, using fixed-effects (FE) and Heckman's two-step estimation procedure to correct for sample-selection bias (endogeneity issues). However, for the sake of robustness of our estimated risk aversion elasticities, we have used dynamic panel data regression model, deploying the system-GMM procedure. We have explicitly talked about this in Footnote 22 and the results are available in Appendix A (Tables A.1 and A.2).

Following Dai and Chang (2018), we employ a two-step (Autocorrelation Function) ACF (Ackerberg et al., 2015) corrected LP (Levinsohn and Petrin, 2003) procedure to estimate firm-level mark-ups, so as to use them as a proxy for firms' risk-premium (in line with Broll et al., 2020). Since the mark-up adjustment is also affected by various firm-specific characteristics (such as cost advantages, market transparency etc.), this paper incorporates both firm-level controls (such as firm-size and firm-age) and firm, year and industry-year fixed effects (to control for the background risk). To mitigate potential endogeneity on firm-level mark-ups (that arise from possible sample selection bias in keeping those firms' in the dataset whose export earnings are positive), we also expand our estimation by employing Heckman's 2-step procedure.[8]

The rest of the paper is organised as follows. Section 2 discusses the modelling framework in detail. Section 3 executes the following two aspects: (i) it evaluates the optimal investment decision owing to the changes in exchange rate risk distribution, and due to the perturbation in the distribution of the independent background risk; and (ii) it presents the equivalence of our comparative static results obtained under mean-variance decision model with the EU approach and the implications of our results in the light of other measures of risk, namely prudence and temperance. Section 4 presents data characteristics and empirical results. Section 5 concludes with the implications of the main results in a broader policy context.

2. Model

This section builds a comprehensive MVD model to study the nature of optimal investment decision of an exporting firm under fluctuations in spot exchange rate and background uncertainty. Our investigation rests on the following set of assumptions: We consider an entrepreneur who invests I on a domestic exporting firm to cover the fixed overhead costs for its export production. We assume that the relationship between the invested capital (I) and export production (Q) follows (approximately) a linear production technology: $Q = AI$, with $A > 0$.[9] The firm's revenues from exports in foreign currency are pQ, with a given world price in p (owing to small open economy assumption). Therefore, the revenue in domestic

[8] The result remains robust for Heckman's estimation procedure.

[9] One can always assume any constant returns to scale (CRS) production technology for a firm using two broad inputs: a bundle of labour and intermediate goods (L) and invested capital (I). Now, it can be easily checked that any CRS production technology, viz., Cobb-Douglas, constant elasticity of substitution or trans-log production function would yield the linear relationship between Q and I for a given level of L-I ratio (say the steady-state level). We can also assume that the firm faces a pre-specified interest rate schedule, $r(I)$, with $r'(.) > 0$, $r''(.) > 0$. However, for analytical simplicity, we assume that the cost of investment is linear, viz., rI.

currency becomes $epQ = ep(AI)$, where the nominal/spot exchange rate e is defined in terms of domestic currency per unit of foreign currency. However, we assume that the spot exchange rate is uncertain at the beginning of the time-horizon, i.e. at $t = 0$, when the investment decision is made. Hence, let us denote the ex-ante revenue in domestic currency as $A\tilde{e}pI$, where $\tilde{e}$ is the random spot exchange rate, which is distributed according to a given cumulative distribution function (CDF), over support $[\underline{e}, \bar{e}]$.[10] Assuming rental return of capital as r in the domestic country, the rental cost of investment in the home country is rI.

Assume that there is an independent background risk $(\tilde{Z})$.[11] If the firm is larger and matured enough, while the firm is also blessed with an overall stable management policy, then $\tilde{Z} \to Z^*$ (Z^* can be thought of certain fixed costs of operations for matured firm). Otherwise, $\tilde{Z}$ is random and aiding to the uncertainty in firm's net profit from exports "passively". We measure $\tilde{Z}$ in domestic country's currency and characterise it as a "passive" random variable entering the firm's net profit (from exports) function additively.

$$\tilde{\pi} = A\tilde{e}pI - rI - \beta\tilde{Z} \tag{2.1}$$

where $\beta > 0$ can be used to introduce ($\beta = 0$ initially) or change background risk.

Therefore, in our decision problem, both sources of risk enter the objective function as a linear combination of two random variables, being jointly elliptically distributed for the location-scale condition, which is well-established in the literature (e.g., Chamberlain, 1983; Owen and Rabinovitch, 1983; Dalal and Alghalith, 2009; Alghalith, 2010; Alghalith et al., 2017).

For any random variable $\widetilde{W}$, the mean and variance are denoted by respectively, μ_W and v_W. The variance and mean of final profit can then be written respectively as

$$v_\pi = v_e(ApI)^2 + \beta^2 v_Z \tag{2.2}$$

$$\mu_\pi = \mu_e ApI - rI - \beta\mu_Z \tag{2.3}$$

The preference function of the firm is $U = U(\mu_\pi, v_\pi)$, with $U_\mu(\mu_\pi, v_\pi) > 0$, $U_v(\mu_\pi, v_\pi) < 0$. In other words, we are assuming that preference of the exporter satisfies non-satiation, and that the exporter is risk-averse,[12] wherein the indifference curves in (μ_π, v_π)-space are

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

[11] As already argued in footnote 5, we are considering firms operating within a small, open, developing economy in a competitive world market, where no firm has the capacity to influence the industry-specific policies/strategies to cope up with the fluctuations in the nominal effective exchange rate.

[12] See section 1, where we have already argued for this. Also see Fig. 4.2, which also gives an *a 'priori* hunch on this property for the firms in our sample.

upward-sloped. Given that all random variable(s) ($\tilde{e}$ and/or $\tilde{Z}$) is/are interacting linearly with the decision variable (I^*), all other moments of the distributions, except mean and variance, are irrelevant in our context.[13] The marginal rate of substitution (MRS) between v_π and μ_π is defined by

$$S(\mu, v) = -\frac{U_v(\mu_\pi, v_\pi)}{U_\mu(\mu_\pi, v_\pi)},$$

where $S > 0$ is the marginal willingness to pay (in terms of expected profit foregone renouncing to invest for exporting) for a reduction in the variance of the net final profit, or the "marginal rate of substitution" (MRS) between risk and return (see Broll and Mukherjee, 2017; Broll et al., 2019). The positivity of the MRS indicates upward sloping indifference curves in (v, μ)-space, with their slopes exhibiting risk aversion. It is also a two-parameter analogue to the Arrow–Pratt measure of absolute risk aversion (see Eichner and Wagener, 2012; and the references therein).

The firm solves the following problem,

$$\max_{(I \geq 0)} U(\mu_\pi, v_\pi) \text{ s.t. (2.2) and (2.3)} \quad (2.4)$$

The necessary condition for an interior solution to the firm's maximization problem is,

$$\frac{(\mu_e A p - r)}{\left(\frac{\partial v_\pi}{\partial I}\right)} = S(\mu_\pi(I^*), v_\pi(I^*)), \quad (2.5)$$

where $(\partial v_\pi / \partial I) = 2 v_e I (Ap)^2$.

The first-order condition (hereafter F.O.C.) in Eq. 2.5 then defines the marginal condition in Figure 2.1 where the slope of a (v_π, μ_π) – indifference curve (denoted by the LHS) or the marginal willingness to pay, in terms of expected returns foregone, owing to reducing the investment for exporting is equal to the slope of the so-called "efficiency frontier" (i.e. at point 0 of Figure 2.1). Note that the numerator in the LHS of Eq. 2.5, $(\mu_e A p - r)$, is nothing but the risk premium of the domestic entrepreneur for the risky activity of investing for exporting activity. If the exporting firm is risk-averse, risk-premium is positive. As we will show in Figure 4.2, our sample of Indian manufacturing firms, as they extract positive profits from exporting, are inclined to improve upon their risk premium to significantly higher values.

[13] Please see Broll et al. (2006); Broll and Mukherjee (2017); Broll et al. (2020) as only few of the many relevant contributions who have also justified the validity of this assumption in the context of exchange rate risk.

Therefore, with this presumption of modelling the preferences of risk averse firms, Eq. 2.5 suggests $(\partial v_\pi / \partial I) > 0$, implying investing on exporting activity is always risky: higher investment increases profit-risk at the margin.

Insert Figure 2.1

Before proceeding to the comparative static exercises, it is necessary to define a few concepts below.

Definition 1. The elasticity of the relative willingness-to-pay for a reduction in profit risk with respect to the variance of the random final profit is defined as,

$$\varepsilon_v(\mu_\pi, v_\pi) = \frac{\partial S(\mu_\pi, v_\pi)}{\partial v_\pi} \frac{v_\pi}{S(\mu_\pi, v_\pi)}.$$

The elasticity $\varepsilon_v(\mu_\pi, v_\pi)$ represents the proportional change in MRS over the proportional change in profit-risk, keeping the mean μ constant.

Definition 2. The elasticity of the relative willingness-to-pay for a reduction in risk with respect to the expected profit is defined as,

$$\varepsilon_\mu(\mu_\pi, v_\pi) = \frac{\partial S(\mu_\pi, v_\pi)}{\partial \mu} \frac{\mu}{S(\mu_\pi, v_\pi)}.$$

The elasticity $\varepsilon_\mu(\mu_\pi, v_\pi)$ represents the proportion change in MRS over the proportional change in expected final profit, keeping the variance constant.

With these definitions in hand, we present the first set of comparative static exercises, i.e. decision to optimally invest on trade with respect to the changes in the distribution of the nominal exchange rate.

3. Comparative static responses: changes in the distribution of nominal exchange rate

In this section, we are going to trace out how the firm-level optimal investment decision is affected owing to the changes in the distribution of spot exchange rate in the world market. In other words, we start with examining how the optimal investment changes at the margin respectively

(i) for a perturbation in the variance of the spot exchange rate (v_e), *ceteris paribus*; and

(ii) for a perturbation in the mean of the spot exchange rate (μ_e), *ceteris paribus*.

In the next subsection (section 3.1), we are going to trace out the variations in optimal investment at the margin respectively

(iii) for a perturbation in the mean of the exogenous (background) risk (μ_Z), *ceteris paribus*;

and

(iv) for a perturbation in the variance of background risk, (v_Z), *ceteris paribus*.

For this purpose, this entire section 3 takes help of the implicit partial differentiation technique. This is because of two reasons. Firstly, we are dealing with more than one parameter: the endogenous variable, I, and the other parameters $(\beta, \mu_e, \mu_Z, v_e, v_Z)$. Secondly, the F.O.C. characterizes the equation being function of $(I, \beta, \mu_e, \mu_Z, v_e, v_Z)$, from where it is impossible to isolate I and express it neatly in terms of any one of the moments $(\beta, \mu_e, \mu_Z, v_e, v_Z)$. Moreover, all our comparative static effects are in relative terms, likewise in Eichner and Wagener (2009; 2011).

Section 3.2 deals with the equivalence between the results obtained under two-moment decision theoretic setting and the vNM EU representation, along with implications for relative prudence and temperance.

With this backdrop, let us first start with Proposition 1, which discusses the first set of comparative static analyses, outlined above in (i) and (ii).

Proposition 1.

(a) Higher exchange rate volatility v_e leads to a decrease in optimum investment I^* if and only if $\varepsilon_v(I^*) > -1$,

(b) An increase in the expected exchange rate μ_e will lead to an increase in optimum investment I^* if and only if $\varepsilon_\mu(I^*) < 1$.

Proof.

(a) Applying implicit function theorem, we obtain,

$$\operatorname{sgn}\left(\frac{\partial I^*}{\partial v_e}\right) = \operatorname{sgn}\left[S(\mu_\pi(I^*), v_\pi(I^*))\frac{\partial^2 v_\pi(I^*)}{\partial I \partial v_e} + \frac{\partial v_\pi(I^*)}{\partial I}\frac{\partial S}{\partial v_\pi}\frac{\partial v_\pi}{\partial v_e}\right] \tag{3.1}$$

Where

$$\frac{\partial^2 v_\pi(I^*)}{\partial I \partial v_e} = 2I^*(Ap)^2 = (\partial v_\pi/\partial I)(1/v_e)$$

$$\frac{\partial v_\pi}{\partial v_e} = (ApI^*)^2 = v_\pi(I^*)/v_e - \beta^2(v_Z/v_e)$$

$$\left(\frac{\partial v_\pi(I^*)}{\partial I}\right)\left(\frac{I^*}{v_\pi}\right) = \frac{2v_e(ApI^*)^2}{v_\pi} = 2\left[1 - \beta\frac{\beta v_Z}{v_\pi}\right].$$

Or,

$$\frac{1}{2}\left(\frac{\partial v_\pi(I^*)}{\partial I}\right)\left(\frac{I^*}{v_\pi}\right) \in (0,1).$$

Therefore,

$$\begin{aligned}
\operatorname{sgn}\left(\frac{\partial I^*}{\partial v_e}\right) &= \operatorname{sgn}\left[S\big(\mu_\pi(I^*), v_\pi(I^*)\big)(\partial v_\pi/\partial I)(1/v_e) + \frac{\partial v_\pi(I^*)}{\partial I}\frac{\partial S}{\partial v_\pi}\left\{v_\pi(I^*)/v_e - \beta^2\left(\frac{v_Z}{v_e}\right)\right\}\right] \\
&= S.\operatorname{sgn}\left[(\partial v_\pi/\partial I)(1/v_e) + \frac{\partial v_\pi(I^*)}{v_e \partial I}\frac{\partial S}{\partial v_\pi}\frac{v_\pi(I^*)}{S(I^*)} - \frac{\partial v_\pi(I^*)}{v_e \partial I}\frac{\partial S}{S\partial v_\pi}\beta^2 v_Z\right] \\
&= \{(\partial v_\pi/\partial I)(1/v_e)S\}\operatorname{sgn}\left(\frac{\varepsilon_v\left(\frac{\partial v_\pi(I^*)}{\partial I}\right)\left(\frac{I^*}{v_\pi}\right)}{2} + 1\right) \qquad (3.2)
\end{aligned}$$

From Eq. 3.2 we obtain, $\left(\frac{\partial I^*}{\partial v_e}\right) \leq 0$, if and only if

$$\varepsilon_v(I^*) \leq -2/\left[\left(\frac{\partial v_\pi(I^*)}{\partial I}\right)\left(\frac{I^*}{v_\pi}\right)\right] \qquad (3.3)$$

Since, $\frac{1}{2}\left(\frac{\partial v_\pi(I^*)}{\partial I}\right)\left(\frac{I^*}{v_\pi}\right) \in (0,1)$, it can easily be deduced that the above inequality is satisfied if and only if $\varepsilon_v(I^*) > -1$. (Q.E.D.)

A small rise in v_e results in lower revelation to the exchange rate risk (and, thus, to a lower μ_π), provided the slope of the indifference curve (which, at the optimum, is locally proportional to S_v) becomes more sensitive to an increase in v_e than the slope of the efficiency frontier (which is locally proportional to the value of risk aversion, S). In other words, the degree of risk aversion must not significantly worsen with increase in riskiness in the external macro-environment.

In other words, increase in v_e leads to a “substitution effect” (less export, and consequently, less investment owing to higher risk), and an “income (wealth) effect” (greater variability in export prices is also associated with a possibility of higher return in terms of expected profitability).[14] The sufficiency condition $\varepsilon_v(I^*) > -1$ ensures that the substitution effect remains relatively stronger than this wealth effect, resulting less investment on exports owing to a small rise in v_e.

(b) Similarly, implicit differentiation of the F.O.C. in Eq. 2.5 yields

$$\operatorname{sgn}\left(\frac{\partial I^*}{\partial \mu_e}\right) = \operatorname{sgn}\left[1 - \frac{\partial v_\pi(I^*)}{\partial I}\frac{\partial S}{\partial \mu_\pi}\frac{\partial \mu_\pi}{\partial \mu_e}\right]$$

$$= (Ap)\operatorname{sgn}\left[1 - \frac{\mu_\pi(I^*)}{S(I^*)}\frac{\partial S}{\partial \mu_\pi}\right] = (Ap)\operatorname{sgn}\left[1 - \varepsilon_\mu\right] \tag{3.4}$$

Therefore, we have $\left(\frac{\partial I^*}{\partial \mu_e}\right) \geq 0$, under the sufficiency condition $\varepsilon_\mu \leq 1$. (Q.E.D.)

Increasing μ_e will lead to greater intention to participate in the export market, implying a higher overall risk, v_π, provided the consequential change in the slope of the indifference curve (which is proportional to $\frac{\partial S}{\partial \mu_\pi}$) is smaller than the subsequent change in the slope of the efficiency frontier (locally proportional to S).

Higher μ_e implies more exposure to the macroeconomic uncertainty by opting for more exports, pushing the decision-maker towards investing less on exports ("substitution effect"). However, given that μ_π also increases, it also entails the possibility of higher expected return ("income effect"). $\varepsilon_\mu \leq 1$ ensures that the "income effect" stands relatively stronger.[15]

The next sub-section traces out the impact of the perturbation in the distribution of the background risk.

3.1 ***Perturbation in the distribution of the background risk***.

This section deals with Proposition 2, which discusses the second set of comparative static analyses, outlined at the beginning of the section 3, in (iii) and (iv) respectively.

[14] See Davis (1989); Broll et al. (2015b); Broll and Mukherjee (2017) in this context.

[15] One very good example in this context is from Bougheas et al. (2018), who showed that exporters whose foreign sales are more competitively priced under a devalued currency responds by keeping a positive premium over cost at the margin and improve their foreign market shares.

Proposition 2.

a) *A risk-averse firm will optimally export more (less) under lower (higher) expected value of $\tilde{Z}$ if and only if the preference are DARA.*

b) *A risk-averse exporting firm may optimally export less under higher background risk if and only if its preference is 'variance vulnerable'.*

Proof.

(a) Implicit differentiation of Eq. 2.5 with respect to (w.r.t. hereafter) μ_Z, we obtain

$$\operatorname{sgn}\left(\frac{\partial I^*}{\partial \mu_Z}\right) = \operatorname{sgn}\left[-S_\mu \frac{\partial \mu_\pi^*}{\partial \mu_Z}\right] = \beta \operatorname{sgn} S_\mu(\mu_\pi^*, v_\pi^*) \tag{3.5}$$

(b) Similarly, totally differentiating Eq. 2.5 w.r.t. v_Z, we obtain

$$\operatorname{sgn}\left(\frac{\partial I^*}{\partial v_Z}\right) = \operatorname{sgn}\left[-S_v \frac{\partial v_\pi^*}{\partial v_Z}\right] = -\beta^2 \operatorname{sgn} S_v(\mu_\pi^*, v_\pi^*) \tag{3.6}$$

Therefore, as μ_Z increases, the risk-averse firm opts for optimally investing less (i.e. $\frac{\partial I^*}{\partial \mu_Z} < 0$) in order to ameliorate the possible loss, if and only if $S_\mu < 0$, which directs to the DARA ("decreasing absolute risk aversion") preference structure, which means firm's marginal willingness-to-pay for reduction in risk decreases in expected profit.

On the other hand, $\frac{\partial I^*}{\partial v_Z} < 0$, if and only if $S_v > 0$, which establishes the "variance vulnerability" property of the preferences. This implies that the optimum investment would even be lesser when the higher background risk aids to the overall riskiness of exporting. Hence, higher volatility of $\tilde{Z}$ makes the firm to invest relatively less for exporting if its willingness to accept risks intensifies when the profit-risk is escalated. One can see Eichner and Wagener (2003; 2009; 2012) in this context. In the next section we discuss the equivalence with the EU approach and the implications of our results in the light of other measures of risk, namely prudence and temperance.

3.2 Equivalence between the Mean-Variance and von-Neumann Morgenstern Expected Utility Approaches, with the Notions of Prudence and Temperance

We have already mentioned that the nature of our very problem, i.e. linear interactions of all random variable(s) ($\tilde{e}$,$\tilde{Z}$,$\tilde{\pi}$) with the decision variable (I^*), corresponds to the conformity of the location-scale conditions, so that all viable distributions vary only by location and scale parameters. We examine a choice set Y, where random variables $y \in Y$ differ only in terms of location and scale parameters. We consider x as the random variable obtained by normalization of an arbitrary $y \in Y$. Then all $y \in Y$, is symmetrical in distribution to $\mu_y + \sqrt{v_y}x$, where μ_y and v_y are the mean and the variance respectively. Given a von-Neumann Morgenstern (vNM) utility index $w: \mathbb{R} \to \mathbb{R}$, one can write the expected utility emanating from the distribution of y using the mean and the variance of y:

$$Ew(y) = \int_a^b w\left(\mu_y + \sqrt{v_y}x\right)dF(x) \equiv U\left(\mu_y, v_y\right) \tag{3.7}$$

Identity (3.7) recommends structural relationships between functions w and U. We utilise these relationships to demonstrate the comparative static results obtained in this paper have well-known correspondences in the EU framework.

The utility function $w(.)$ is three times continuously differentiable with $w'(y) > 0 > w''(y) \forall y$, implying that the firm is risk-averse (which is consistent with our sample of Indian manufacturing exporters, see Figure 4.2 in this context). As shown in Meyer (1987); Eichner and Wagener (2004; 2009)

$$w'(y) > 0 \;\forall y \Leftrightarrow U_\mu\left(\mu_y, v_y\right) > 0 \;\forall\left(\mu_y, v_y\right)$$

$$w''(y) < 0 \;\forall y \Leftrightarrow U_v\left(\mu_y, v_y\right) < 0 \;\forall(\mu_y, v_y)$$

$$\Leftrightarrow U_{\mu\mu}\left(\mu_y, v_y\right) < 0 \;\forall(\mu_y, v_y)$$

$$w'''(y) > 0 \;\forall y \Leftrightarrow U_{\mu v}\left(\mu_y, v_y\right) > 0 \;\forall(\mu_y, v_y)$$

Meyer (1987) shows that $S_\mu < 0$ (or, equivalently, $\varepsilon_\mu < 1$) indeed is the mean–variance analogue to the EU concept of DARA (i.e., to $-w''(y)/w'(y)$ decreasing in y). In other words, both propositions 1(b) and 2(a) hinge on the sufficiency condition of DARA. Lajeri-Chaherli (2004) and Eichner and Wagener (2004; 2009; 2012) showed that $\varphi = -y[w'''(y)/w''(y)] = -U_{\mu v}/U_{\mu\mu}$ is the *index of relative absolute prudence*. Given this, Wagener (2002) explicitly demonstrated that since $S_\mu = -\left[U_\mu U_{v\mu} - U_{\mu\mu}U_v\right]/U_\mu^2$; $S_\mu < 0$ (equivalently, $\varepsilon_\mu < 1$) implies $\varphi\left(\mu_y, v_y\right) > S\left(\mu_y, v_y\right)$.

The measure φ also offers a straightforward adaptation of Kimball's (1990) notion of *decreasing absolute prudence (DAP)*. As demonstrated by Lajeri and Nielsen (2000) and Wagener (2002), the equivalent to DAP in the mean-variance framework is that φ decreases in μ.

Now, following Eichner and Wagener (2004); in the absence of any background uncertainty ($\tilde{Z} = 0$), the F.O.C. in (2.5) can be expressed in terms of the following function

$$\Omega(\mu_\pi^*, v_\pi^*) = (I^*/2)(\mu_e Ap - r)U_\mu(\mu_\pi^*, v_\pi^*) + v_e(ApI^*)^2 U_v(\mu_\pi^*, v_\pi^*)$$
$$= (1/2)\mu_\pi^* U_\mu(\mu_\pi^*, v_\pi^*) + v_\pi^* U_v(\mu_\pi^*, v_\pi^*) = 0$$

It can easily be shown that $\Omega(\mu_\pi^*, v_\pi^*)$ is decreasing in v_π (see Eichner and Wagener, 2004, p. 164 (Proof for Proposition 1(b)) if and only if index of relative prudence φ is less than 2.

Gollier and Pratt (1996); Eeckhoudt et al. (1996) defined $T(z) := -u''''(z)/u'''(z)$ as the coefficient of temperance. Wagener (2002) defined a mean-variance measure for temperance:

$$\tau(\mu_y, v_y) := -U_{v\mu\mu}(\mu_y, v_y)/U_{\mu\mu\mu}(\mu_y, v_y)$$

Propositions 1(a) and 2(b) rest on the condition of "variance vulnerability" property, owing to which $S_v > 0$ and $\varepsilon_v > -1$. Kimball (1993); Eeckhoudt et al. (1996); Gollier and Pratt (1996); Eichner and Wagener (2003) suggest that this property is derived from the following properties of the EU approach:

(i) *The absolute temperance index is greater than the index of absolute risk aversion* (known as "local risk vulnerability" property).

(ii) Adding an additional (exogenous) risk makes an initial, undesirable (or desirable) background risk even more undesirable (less desirable), also known as "standard risk aversion. In the context of EU framework either of these above-mentioned properties implies when a decision maker confronts an independent zero-mean background risk, s/he reduces the optimal risk taking.

4. Empirical analysis

In this section we undertake an empirical demonstration by estimating the risk preference structure of risk-exposed exporting firms and their risk aversion elasticities. We begin with formalising how the propositions derived in the analytical model (in section 3) gives rise to a testable empirical construct. Section 4.1 illustrates how we measure the key variable of interest, namely risk-premium of the firms, using proxy of the firm-level estimates of productivity mark-ups in a large sample of Indian manufacturing firms. Then we present in sub-section 4.2 joint estimation of risk preference structure and risk aversion elasticities for a panel of 840 exporting firms over 1995-2017 period. For this purpose, we use following route (e.g., Saha et al., 1994; Saha, 1997; Serra et al., 2006; Cohen and Einev, 2007) of directly estimating a flexible utility function in a nonlinear mean – variance framework that nests all possible risk preference structures:

Let us start with by considering the flexible preference structure, as in Saha (1997); Broll and Mukherjee (2017); Broll et al. (2020).

$$U(\mu_\pi, v_\pi) = \mu_\pi^a - v_\pi^b \tag{4.1}$$

From the F.O.C. in Eq. (2.5) of the theoretical model, we obtain,

$$\frac{\text{Risk premium}}{(\partial v_\pi(I^*)/\partial I)} = S\big(\mu_\pi(I^*), v_\pi(I^*)\big) = -\frac{U_v}{U_\mu} = \frac{b}{a}\mu_\pi(I^*)^{1-a} v_\pi(I^*)^{b-1}$$

Or,

$$\ln(\text{Risk premium}) = \ln\left(\frac{b}{a}\right) + (1-a)\ln\mu_\pi + (b-1)\ln v_\pi + \ln(\partial v_\pi(I^*)/\partial I) \tag{4.2}$$

Since all the variables measuring risk distribution $(\mu_\pi, v_\pi, (\partial v_\pi(I^*)/\partial I))$, including the export sales, are expressed in INR, and given that we have deflated all these variables by the industry-specific wholesale price indices (keeping 2004 as the base year), proportional changes in these variables do subsume the proportional changes in the distribution of nominal/spot exchange rate, defined as INR per unit of foreign currency. Moreover, from Eq. 2.5, we can easily see that $(\partial v_\pi(I^*)/\partial I) = f(v_e), f'(.) > 0$. Hence, we do not need to include additional mean and variance of spot exchange rate distribution to the RHS of Eq. 4.2.

Therefore, we obtain from the model that elasticity of the MRS with respect to v is: $\varepsilon_v = (b-1)$; while the elasticity of the MRS with respect to μ_π is: $\varepsilon_\mu = (1-a)$. Proposition 1(a) states that higher exchange rate volatility leads to a decrease in optimum investment if and only if $\varepsilon_v > -1$ or $(b-1) > -1$. Proposition 1(b) implies an increase in the expected exchange rate will lead to an increase in optimum investment if and only if $\varepsilon_\mu < 1$, or $(1-a) < 1$. However, if $(1-a) < 0$, the corresponding firm(s) is(are) characterised by DARA, while if $(1-a) > 0$, the corresponding firm(s) is(are) characterised by increasing absolute risk aversion (IARA); and if $a = 1$, the corresponding firm(s) is(are) characterised by constant absolute risk aversion (CARA).

Propositions 2(a) and 2(b) stand on the sufficiency conditions of DARA and "variance vulnerability" respectively. Since,

$$S_\mu = \frac{b(1-a)}{a{\mu_\pi}^{*a}} {v_\pi}^{*(b-1)},$$

Therefore, DARA or $S_\mu < 0$ implies $(1-a) < 0$. Similarly, as

$$S_v = \frac{b(b-1)}{a} {\mu_\pi}^{*(1-a)} {v_\pi}^{*(b-2)},$$

"Variance vulnerability" implies $b > 1$. Hence, we need to examine whether the coefficient estimates of $\ln v_\pi$ is positive (and statistically significant) or not and simultaneously, the coefficient estimate of $\ln \mu_\pi$ is negative (and statistically significant) or not.

Now the imminent question becomes, how to measure μ_π, v_π and $(\partial v_\pi(I^*)/\partial I)$ empirically? Let us illustrate these aspects below.

μ_π is expected relative net profit of a firm. To measure it, we follow Schmidt and Broll (2009); and Broll et al. (2020) – both of these papers estimated expected future change in a variable as the ratio of the predicted value to the actual value, where predicted value is calculated from a time regression. Accordingly, we measure it as the ratio of the predicted net profit of each firm to the actual net profit, where the predicted net profit is arrived at by regressing *firm-specific* average net profit on a time trend. In other words, such average net profit is different for different firms and *the trend-fitted values are heterogeneous across firms*. Therefore, our measure of predicted net profit avoids the common trend bias. The same logic has been pursued in Schmidt and Broll (2009); and in Broll et al. (2020). As a result, *it varies both across firms and over time and becomes specific across industries.*

v_π is measured as the square of the mean deviation of the net export profit from the actual net profit. *Therefore, this also varies both across firms and over time and becomes specific across industries.*

$(\partial v_\pi(I^*)/\partial I)$ =change in squared mean deviation of net profits for firm i of industry j due to change in domestic investments in raw materials. *This also varies both across firms and over time and becomes specific across industries.*

Given the definition of the risk-premium, we can proxy the risk-premium, in the left-hand side of (4.2), by the firm-level mark-up *that we estimate in sub-section 4.1,* using Dai and

Cheng (2018)'s approach for 840 Indian manufacturing exporting firms. To quantitatively examine these predictions, we use (4.2) as our unique structurally estimable equation.

4.1 Measuring firm-level Markup

We estimate firm-level markup following the approach used by Dai and Cheng (2018) while estimating the latter for Chinese manufacturing firms. The estimation of firm-level markup is summarized in the following steps:

Step 1: At first, we estimate output elasticities by assuming a flexible trans-log production function with Hicks-neutral productivity,[16] highlighted in equation (4.3).

$$q_{it} = \beta_m m_{it} + \beta_k k_{it} + \beta_l l_{it} + \beta_p p_{it} + \beta_{mm} {m_{it}}^2 + \beta_{kk} {k_{it}}^2 + \beta_{ll} {l_{it}}^2 + \beta_{pp} {p_{it}}^2 + \beta_{mk} m_{it} k_{it} + \beta_{ml} m_{it} l_{it} + \beta_{mp} m_{it} p_{it} + \beta_{mkl} m_{it} k_{it} l_{it} + \beta_{mkp} m_{it} k_{it} p_{it} + \beta_{mlp} m_{it} l_{it} p_{it} + \omega_{it} + \epsilon_{it} \qquad (4.3),$$

where lower case represents logarithm of the uppercase variables ($Q_{it}, M_{it}, K_{it}, L_{it}$ and P_{it}); which denote sales revenue, raw materials expenses, capital expenses, labour expenses (i.e. compensation for labour) and power and fuel expenses, respectively. Firm productivity is denoted as ω_{it} while ϵ_{it} is the error term.[17]

Using Ackerberg, Caves, and Frazer (2015)'s two-step estimation procedure which is a modified control function approach of Levinsohn and Petrin (2003), we consistently estimate the output elasticities and finally Revenue Productivity (ω_{it}) after controlling the simultaneity

[16] This is the most robust and standard approach following the literature to estimate output elasticities by assuming a flexible trans-log production function with Hicks-neutral productivity. We would like to cite Dai and Cheng (2018) in this context. Also, please note that such trans-log production function would yield the linear relationship between Q and I for any given level of labour - capital (or investment) ratio.

[17] We use deflated sales revenue, capital spending and different input expenditures as proxies for the physical quantities of output, capital and intermediate inputs, respectively, following the literature on productivity estimation. To get the deflated values of sales, compensation to employees, power and fuel expenditure, capital employed, raw material expenditure, we use industry- specific wholesale price indices, keeping 2004 as the base year to accord with the 1995-2017 period covered by our study. All the industry specific-wholesale price indices are obtained from the Economic Adviser, Ministry of Commerce and Industry, Government of India. http://www.eaindustry.nic.in/wpi_revision_0405.asp.

problem in choosing labour, capital[18] and other factor inputs based on their current productivity levels.

Insert Table 4.1

Step 2: Once we get the estimates for firm-level output elasticities with respect to various inputs used in our translog production function, in the last step, following the approach of De Loecker and Warzynski (2012); De Loecker et al. (2016), we can recover firm-level markup (φ_{it}) using equation 4.4,

$$\varphi_{it} = \frac{\theta_{it}^M}{\alpha_{it}^M} \qquad (4.4)$$

where θ_{it}^M denotes the output elasticity with respect to intermediate materials and α_{it}^M denotes the share of expenditures on intermediate material inputs in total sales revenue. While α_{it}^M can be directly calculated using the indictors in our data, θ_{it}^M can only be obtained by estimating the production function. Equation 4.5 provides an illustration of the estimation of firm-level output elasticity with respect to raw materials expenses for all firms (m_{it}) and it uses the estimated coefficients of Column 1 in Table 4.1[19]:

$$\begin{aligned}\theta_{it}^M = {} & 0.3690546 + 2 \times 0.0591367 \times \ln M_{it} - 0.026733 \times \ln K_{it} - 0.0789584 \times \ln L_{it} \\ & - 0.0231569 \times \ln P_{it} + 0.0180044 \times \ln \mathrm{L}_{it} \times \ln K_{it} \\ & - 0.013659 \times \ln \mathrm{L}_{it} \times \ln P_{it} - 0.0111663 \times \ln P_{it} \times \ln K_{it}\end{aligned} \qquad (4.5)$$

Figure 4.2 gives the distribution of firm-level mark-ups for all manufacturing firms and profit-making exporting firms.

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[18] To estimate firm-level physical capital stocks for each year we closely follow the methodology adopted by Balakrishnan et al. (2006), which uses perpetual inventory model. At first, we obtain firm-level net investment by taking the difference between the current and lagged values of gross assets less depreciation for each year. Next, by taking the sum of investment in subsequent years for each firm, we obtain the firm-level capital stock for every time period. Moreover, using industry-specific wholesale price indices of Machinery and machine tools and keeping 2004 as the base year to accord with the 1995-2017 period, we obtain firm-level real capital stock for each year by deflating the value of capital stock obtained in the previous step. For more detail of this method see, Balakrishnan et al. (2006) (pp.71-73), and Topalova and Khandelwal (2011) (pp. 23).

[19] Note that (4.5) is the differentiated (w.r.t. m_{it}) version of the estimated trans-log production function reported in Column 1 of Table 4.1.

Insert Figure 4.2

Figure 4.2 clearly highlights a positively skewed distribution of firm-level mark-ups for profit-making exporting units (i.e., for those firms whose net export earnings to domestic raw materials expenses are positive), compared to that for all manufacturing firms. This gives an indication of firm's tendency of keeping positive and relatively higher risk premium, if firm extracts positive profits from its export markets.

4.2 Estimation Strategy and Analysis

In this section we empirically test equation 4.2, where our main objective is to examine the independent effects of firm-level mean (to infer on the changes in μ_π), squared mean deviation of net profit from export market (in order to infer on the changes in v_π) and most importantly change in the squared mean deviation of net profits (from exports) due to change in domestic investments in raw materials (in order to infer on the changes in $\ln(\partial v_\pi(I^*)/\partial I)$) on firm-level mark-up (which measures risk premium) for Indian exporting firms over the study period. We use an unbalanced panel dataset of around 840 Indian exporting firms operating over the 1995 to 2017 period. As evident from the above discussions, we require an estimation within a panel-data version of Eq. 4.2 (see Eq. 4.2.1), with risk-premium being approximated by firm-level mark-ups, a number of explanatory variables (except the firm fixed-effects and year effects) differ across firms (i) and sub-industries (j), while varying over time (t).

$$\ln\varphi_{ijt} = \alpha_1 + \beta_1\ln(\partial v_\pi(I^*)/\partial I)_{ijt} + \beta_2\ln(v_\pi)_{ijt} + \beta_3\ln(\mu_\pi)_{ijt} + \beta_4\mathrm{Size}_{ijt} + \beta_5\mathrm{age}_{ijt} + \beta_6\mathrm{age}_{ijt}^2 + C_i + \tau_t + \lambda_{ijt} + \varepsilon_{ijt} \qquad (4.2.1)$$

We use fixed effect approach to estimate Eq. 4.2.1 for determining the independent effects of all these aforementioned firm- and industry- specific explanatory variables (i.e., the firm-level performance and risk indicators in the export markets) on firm-level mark-up as the risk-premium, while taking into account other unobserved firm, year, industry level heterogeneity, as presented in Table 4.2.[20] Besides, in our fixed effect models on mark-up, we control with firm age, age square, firm size (total asset used as proxy variable) which contribute directly to the firm-level background risk, apart from the main variables of interest (i.e., risk and return of exports).[21]

Column 1 of Table 4.2 represents the estimation results of the risk aversion elasticities with respect to risk (i.e., squared mean deviations and change in squared mean deviations) and return (mean), while considering other unobserved firm and year fixed effects. In Column 2 we present the results of the updated model where along with the existing variables we also include various firm controls (age, age square and firm size) which contribute to firm's background risk. Finally, in Column 3, we present the results of the final version of our model where we also incorporate industry-year fixed effects to control for any industry level domestic as well as foreign policies during the study period, which can broadly contribute to firm's background risk. It should also be noted that in each of the regressions, the standard errors are clustered at the firm level.

As per our theoretical background, we expect positive risk aversion elasticities with respect to the squared mean deviation (i.e. variance/profit-risk) and change in mean deviation of net export earnings due to change in domestic investments on raw materials. This is because more volatile the export earning value is, higher would be firm's risk premium. While, the risk aversion elasticity with respect to the mean of net export earning is expected to be negative, as firm tends to keep less risk premium on account of higher return from its export market.

[20] We have also performed appropriate Hausman test for the model selection *ex-ante*, where the χ^2 test statistic is significant at 1% level, thereby rejecting the null hypothesis and validating the choice of fixed-effects (FE) model, as opposed to the random-effects (RE) model.

[21] Topalova and Khandelwal (2011) have shown that firm size and age (in its non-linear form) (measured as a proxy for experience) play an important role in determining the firm-level productivity over time. In similar line we also control for firm size, age and age^2 in our model while estimating firm-level Mark-up, which has been derived from firm-level Productivity.

The coefficients of all variables of interest represented in Table 4.2 remain significant and come with the expected signs. Thus, our theoretical model gets empirically validated. For instance, in our final version of the model with firm, year and industry-year fixed effects (i.e., Column 3), the coefficient of change in mean deviations of net export earnings due to change in domestic investments suggests, if the latter increases by 1 percent the firm-level mark-up increases by 0.008 percent. This highlights that the risk averse firm increases its risk premium by 0.008 percent in an event of a one percent increase in the risk (i.e., volatility) in net export earnings.

On the other hand, the coefficient of mean (i.e., average returns from export markets) suggests a 0.021 percent decline in firm-level mark-ups due to one percent increase in mean returns from export market. This gives a clear evidence of reduction in risk premium (around 0.021 percent) by a risk-averse exporting firm on account of higher average return from the export market. Comparing the estimated Eq. 4.2.1 with Eq. 4.2, it can easily be inferred that $(1-a)$ of Eq. 4.2 is negative, or equivalently, $\varepsilon_{\mu} < 0$, which leads to the inference that the firms are exhibiting "decreasing absolute risk aversion" or DARA (with $a > 1$).

Similarly, the coefficient of the variance (proxied by the square of the mean deviation) of net profit from export market (which corresponds to ε_{σ}, which is also equal to $b-1$ in Eq. 4.2) is positive and less than the unity. Therefore, b is greater than 1 or $S_{\sigma} > 0$, which implies these firms are "variance vulnerable". On the other hand, since ε_{σ} is greater than -1, we can also infer $b > 0$, implying risk aversion behaviour of the firms in our sample.

Given that the Indian manufacturing exporters' risk preferences exhibit risk aversion behaviour, DARA and variance vulnerability, we can summarise that the exporters seem to display "proper risk aversion" in our sample. Moreover, the coefficient of total asset (i.e., proxy for firm-size) suggests that a one percent increase in firm size would increase the firm-level mark up by 0.0743 percent. This indicates that a risk-averse exporting firm would able to significantly increase its risk premium if its size increases. Besides, corroborating the existing studies, we find a non-linear relationship between firm age and mark-ups.

Insert Table 4.2

Although our findings remain robust across various specifications (including unobserved firm, year and industry level heterogeneity), we extend our analysis further to control for potential endogeneity on firm-level mark-ups due to possible sample selection bias in keeping those firms' in the dataset whose export earnings are positive. Thus, we use Heckman's 2-step estimation procedure to control for possible mark-up endogeneity.[22] We adopt this approach to correct the sample selection bias and possible endogeneity bias, which stems from the economic theory underlying our analytical modelling exercise. The theory emanating from our analytical results suggests that at the beginning of period t the investment decision is made based on the firm's export performance at period $(t-1)$. If an investment decision is made at the beginning of period t, then the firm, owing to its risk-averse nature, would like to go for higher risk-premium, which implies the expected mark-up at the end of period t would be higher than that at period $(t-1)$. That's why we have explored an important source of endogeneity, i.e., lagged mark-up (equation, 4.7) which may cause the self-selection behaviour of firms in terms of increasing their mark-ups (i.e., risk-premium) in the subsequent period following a low net export earnings in the previous period.

[22] We have used a novel approach to address the possible endogeneity problem in firm's decision making on firm-level Mark-up (i.e., potential positive mark-up bias), which could arise due to possible sample selection bias in keeping only exporting firms (i.e., export earnings are positive) in our dataset (See, page 160 of James J. Heckman (1979, pp. 153-161) '*Sample Selection Bias as a Specification Error*,' for further details). However, we have also performed the conventional Dynamic Panel System GMM estimation (Blundell and Bond, 1998) to control for possible trade policy endogeneity (which arises due to reverse causality between last period's firm-level export risk and returns on current period's firm-level mark-up during our study period. The dynamic panel results remain consistent with our main results. As our main objective is to empirically estimate the risk aversion elasticities of the main variables of our theoretical model $(\mu_{\pi_{it}}, v_{\pi_{it}}\ and\ \partial v_{\pi}(I^{*})/\partial I\ )$ rather than examining any trade policy effect on mark-up, we did not provide the results of our dynamic panel (with lags 1, 2 and 3) in the main text. See Appendix A (Tables A.1 and A.2) for the detailed discussion on our Dynamic Panel analysis.

The Heckman's Two-step Model can be explained by the following system of equations which uses all these aforementioned variables:

$$\ln \varphi_{ijt} = \alpha_1 + \beta_1 \ln(\partial v_\pi(I^*)/\partial I)_{ijt} + \beta_2 \ln(v_\pi)_{ijt} + \beta_3 \ln(\mu_\pi)_{ijt} + \beta_4 \mathrm{Size}_{ijt} + \beta_5 \mathrm{age}_{ijt} + \beta_6 \mathrm{age}^2_{ijt} + C_i + \tau_t + \lambda_{ijt} + \varepsilon_{ijt} \quad if\ \rho_{ijt} > 0$$

$$\ln \varphi_{ijt} = 0\ if\ \ \rho_{ijt} \leq 0 \tag{4.6}$$

Here, $\boldsymbol{\rho_{ijt}}$ is the latent variable (unobserved) variable, which denotes the probability of having positive markup change for the *firm i from industry j* in period **t**. It can be estimated by using following selection equation:

$$\rho_{ijt} = \mu_1 + \pi_1 \ln(\partial v_\pi(I^*)/\partial I)_{ijt} + \pi_2 \ln(v_\pi)_{ijt} + \pi_3 \ln(\mu_\pi)_{ijt} + \pi_4 \mathrm{Size}_{ijt} + \pi_5 \mathrm{age}_{ijt} + \pi_6 \mathrm{age}^2_{ijt} + \kappa_1 \ln \varphi_{ijt-1} + u_{ijt} \tag{4.7}$$

Here, $\mathrm{Corr}(\varepsilon_{ijt}, u_{ijt}) = \rho_{\varepsilon u}$; $\mathrm{SE}\left(\varepsilon_{ijt}\right) = \sigma$

In the Heckman's two step estimation procedure, we first estimate ρ_{ijt} (i.e., the probability of positive mark-up change) using a Probit regression model for equations 4.7.[23] Once we estimate ρ_{ijt} we then calculate the inverse Mill's ratio (λ_{ij}). The estimated λ_{ij} gets placed in the right-hand side of equation (4.6) as an exogenous variable and subsequently we estimate equation (4.6) in Step 2. The Heckman's two step estimation procedure allows us to remove sample selection bias which occurs due to a firm's self-selection behaviour in its mark-up improvement, which depends on its 1st lag mark-up.[24] This creates an endogeneity problem. In the present analysis of firm mark-up for exporting firms, our model incorporates the sample of both positive as well as zero firm-level mark-up improvements across manufacturing firms. Hence, this avoids sample selection bias and the endogeneity problem.

23 We have explored an important source of endogeneity, i.e., lagged mark-up (equation, 4.7) which may cause the self-selection behaviour of firms in terms of increasing their mark-ups (i.e., risk premium) in the subsequent period following fewer net export earnings in the previous period.

24 It should be noted that we also extend our analysis further to examine whether the firm-level mark-up is endogenous with its second lag (lag 2). However, the result suggests the absence of endogeneity of firm-level mark-ups at lag 2.

Table 4.3 presents Heckman's estimation results for all exporting firms with 1st lag of mark-up status. The results remain symmetric with the findings of our main fixed effect models, indicating the robustness of our results. For instance, in our final version of the Heckman's two step estimated model with firm, year and industry-year fixed effects, the coefficient of change in mean deviations of net export earnings due to change in domestic investments in regression column (i.e., Column 6) suggests,[25] if the latter increases by 1 percent the firm-level mark-up increases by 0.009 percent. On the other hand, the coefficient of mean (i.e., average returns from export markets) suggests a 0.022 percent decline in firm-level mark-ups due to one percent increase in mean returns from export market. Thus, our theoretical model remains empirically robust even after correcting for sample selection bias and endogeneity problem. Moreover, interestingly the coefficient of lagged mark-up in selection column (i.e., Column 5) of our final version of the Heckman's two step estimated model remains significant and negative. This implies that there is a higher probability that the risk-averse exporting firm would increase its risk premium (i.e., firm-level mark-up) if the firm had lower risk premium in the previous period.

Insert Table 4.3

5. Concluding remarks

For a risk-averse firm gearing up to export under uncertainty, the effect of exchange rate volatility in interaction with exogenous uncontrollable firm-specific factors, is hugely detrimental to creating a positive sentiment of export-investment in a developing country. This is possibly the first paper to study a pertinent issue in the literature on international trade through the lens of behavioural responses of rational decision-maker(s) under uncertainty.

[25] In this context, the reader should note that by including all possible fixed effects (Firm, Year and Industry-Year), the R-square has increased considerably. Therefore, results in column 3 are the main results of this paper.

This is because this paper explores the behavioural responses regarding how much to invest for promoting a firm to cater the export market under external shocks.

Using a Mean-Variance Decision theoretic framework, this paper studies how the jointness of such risks (that eventually multiplies uncertainty regarding the fixed costs of exporting), determines the 'worth to invest for exporting'. This issue which is immensely important found little exposition – both theoretically and empirically – in a developing country context (at the least). The Mean–Variance Decision–theoretic analysis employed in this paper yielded various comparative static responses of the decision variable (here optimum investment to enable the firm in exporting activity) in response to the changes in the distributions of not only the spot exchange rate, but also in the background risk in terms of the marginal willingness to substitute risk for return.

We utilise a panel of 840 Indian manufacturing exporters over a time-period of 1995-2017 to perform a *joint estimation of risk preference structure and risk aversion elasticities*. For this purpose, we directly estimate a flexible utility function in a nonlinear mean-standard deviation framework that nests all possible risk preference structures. Then we employ two-step ACF corrected LP methodology to empirically estimate firm-level mark-ups. Using these mark-ups as a proxy for firms' risk-premium, we then estimate a fixed-effects regression model. To control for background risks, we consider not only the firm-level controls (firm-size and firm-age), but also the firm, year and industry-year fixed effects. We also use Heckman's 2-step estimation procedure to control for possible endogeneity and have performed other relevant robustness checks. Overall, the empirical findings suggest that the risk preferences of the Indian manufacturing exporters exhibit risk aversion behaviour, DARA and variance vulnerability. In other words, the exporting firms display "proper risk aversion" in our sample.

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Figure 2.1: Efficiency Frontier

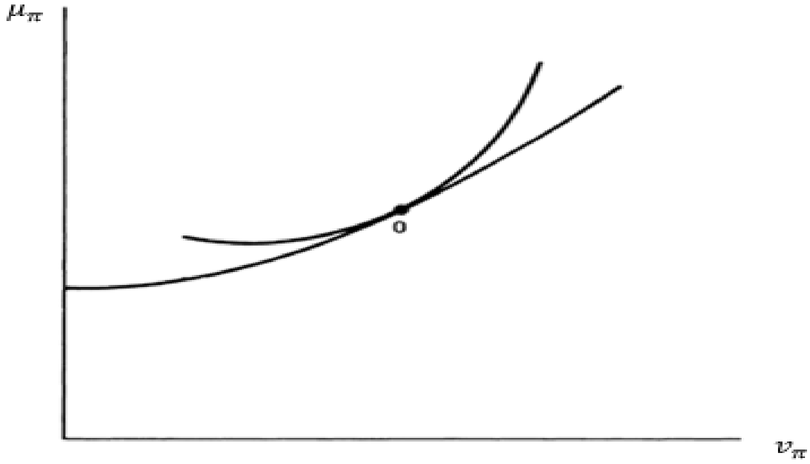
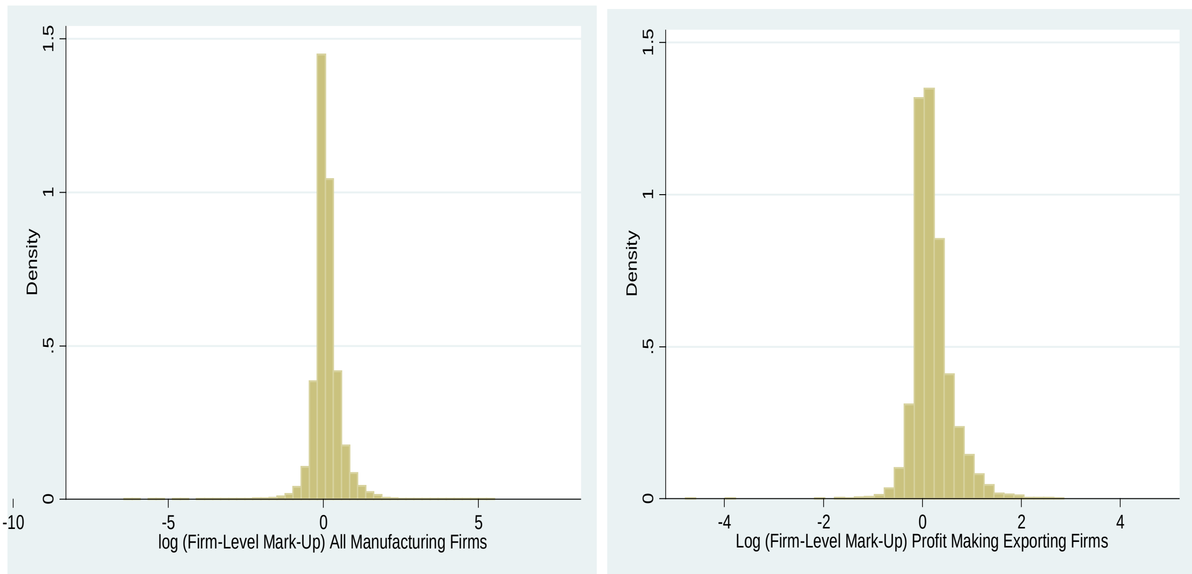


Figure 4.2: Histogram of Firm-level Log (Mark-up) for All Manufacturing Firms and Profit-Making Exporting Firms



Note:

We have performed a *t-test* to examine the statistical significance of *the difference between the mean of* $ln\,\varphi$ *for the profit-making exporting firms versus that of the non-exporting firms*. The test reveals that the mean difference of 0.09 gives the corresponding $|t| = 3.3397$, which is statistically significant at 1% level of significance. Therefore, we reject the null hypothesis of no difference between the two. In other words, we conclude that the profit-making exporting units are going to maintain higher expected mark-up (i.e. risk-premium) than their non-exporting counterparts.

Table 4.1: LP (ACF Corrected) Trans-log Production Function Estimation for Indian Manufacturing Firms

VARIABLES	(1) All Firms
$\ln L_{ijt}$	0.3501469***
	(0.0077988)
$\ln P_{ijt}$	0.1798385***
	(0.0031006)
$\ln K_{ijt}$	0.0687381***
	(0.0033789)
$\ln M_{ijt}$	0.3690546***
	(0.0051218)
$\ln L_{ijt}^2$	0.0342828***
	(0.007444)
$\ln L_{ijt} \times \ln P_{ijt}$	-0.013659***
	(0.0030434)
$\ln L_{ijt} \times \ln K_{ijt}$	0.0180044***
	(0.0051267)
$\ln L_{ijt} \times \ln M_{ijt}$	-0.0789584***
	(0.0056066)
$\ln P_{ijt}^2$	0.0188136***
	(0.0050963)
$\ln P_{ijt} \times \ln K_{ijt}$	-0.0111663***
	(0.0025436)
$\ln P_{ijt} \times \ln M_{ijt}$	-0.0231569***
	(0.0039149)
$\ln K_{ijt}^2$	0.0081677**
	(0.0041634)
$\ln K_{ijt} \times \ln M_{ijt}$	-0.026733***
	(0.0026846)
$\ln M_{ijt}^2$	0.0591367***
	(0.0037788)
Observations	46,429
Number of groups	6,635

Notes:

(i) Robust Standard errors in parentheses

(ii) *** p<0.01, ** p<0.05, * p<0.1.

Table 4.2: Firm-level Risk Aversion Elasticities with respect to Risk and Returns of Exports for Indian Exporting Firms

VARIABLES	(1) **Mark-up Pricing (Risk Premium) Decision** $(\ln \varphi_{ijt})$	(2) **Mark-up Pricing (Risk Premium) Decision** $(\ln \varphi_{ijt})$	(3) **Mark-up Pricing (Risk Premium) Decision** $(\ln \varphi_{ijt})$
$\ln(\partial v_\pi(I^*)/\partial I)_{ijt}$	0.00737**	0.00722**	0.00800**
	(0.00306)	(0.00309)	(0.00343)
$\ln(v_\pi)_{ijt}$	0.0151***	0.0112**	0.00660
	(0.00466)	(0.00570)	(0.00571)
$\ln(\mu_\pi)_{ijt}$	-0.00884	-0.00854	-0.0210*
	(0.0111)	(0.0113)	(0.0119)
Age_{ijt}		-0.00810**	-0.0124**
		(0.00408)	(0.00546)
Age^2_{ijt}		3.18e-05	0.000116**
		(6.06e-05)	(5.62e-05)
$Size_{ijt}$		0.0413	0.0743**
		(0.0354)	(0.0366)
Constant	0.185***	0.188***	0.227**
	(0.0341)	(0.0585)	(0.114)
Observations	2,611	2,581	2,581
R-squared	0.070	0.076	0.447
Number of firms	851	840	840
Firm FEs	YES	YES	YES
Year FEs	YES	YES	YES
Industry-Year FEs	NO	NO	YES

Note:

(i) Column 1 of Table 4.2 represents the estimation results of the risk aversion elasticities with respect to risk (squared mean deviations and change in squared mean deviations) and return (mean), while considering other unobserved firm and year fixed effects (FEs). In other words, it is estimating the panel version of Eq. 4.2 with firm- and year-specific FEs, i.e. $\ln \varphi_{ijt} = \alpha_1 + \beta_1 \ln(\partial v_\pi(I^*)/\partial I)_{ijt} + \beta_2 \ln(v_\pi)_{ijt} + \beta_3 \ln(\mu_\pi)_{ijt} + C_i + \tau_t + \varepsilon_{ij}$

(ii) Column 2 presents the results of the updated model where along with the existing variables we also include various firm controls (age, age square and firm size) which contribute to firm's background risk, but without any industry-year FEs. In other words, column 2 presents the estimates of the following version of Eq. 4.2: $\ln \varphi_{ijt} = \alpha_1 + \beta_1 \ln(\partial v_\pi(I^*)/\partial I)_{ijt} + \beta_2 \ln(v_\pi)_{ijt} + \beta_3 \ln(\mu_\pi)_{ijt} + \beta_4 \mathrm{Size}_{ijt} + \beta_5 \mathrm{age}_{ijt} + \beta_6 \mathrm{age}^2_{ijt} + C_i + \tau_t + \varepsilon_{ijt}$

(iii) Column 3 depicts the ***results of the final version of our model presented in Eq. 4.2.1 in the main text***, where we also incorporate industry-year fixed effects to control for any industry level domestic as well as foreign policies during the study period, which can broadly contribute to firm's background risk.

(iv) It should also be noted that in each of the regressions, the standard errors are clustered at the firm level, with robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 4.3: Firm-level Risk Aversion Elasticities with respect to Risk and Returns of Exports for Indian Exporting Firms (with Lagged Mark-up)

	(1)	(2)	(3)	(4)	(5)	(6)
	Panel 1		Panel 2		Panel 3	
Steps	**Step 1**	**Step 2**	**Step 1**	**Step 2**	**Step 1**	**Step 2**
VARIABLES	**Probability of keeping Positive Mark-ups over MCs (ρ_{ijt})**	**Mark-up Pricing (Risk Premium) Decision ($\ln\varphi_{ijt}$)**	**Probability of keeping Positive Mark-ups over MCs (ρ_{ijt})**	**Mark-up Pricing (Risk Premium) Decision ($\ln\varphi_{ijt}$)**	**Probability of keeping Positive Mark-ups over MCs (ρ_{ijt})**	**Mark-up Pricing (Risk Premium) Decision ($\ln\varphi_{ijt}$)**
	Selection Equation (4.7)	**Regression Equation (4.6)**	**Selection Equation (4.7)**	**Regression Equation (4.6)**	**Selection Equation (4.7)**	**Regression Equation (4.6)**
$\ln(\partial v_\pi(I^*)/\partial I)_{ijt}$	-0.044	0.008***	-0.044	0.008***	-0.043	0.009***
	(0.030)	(0.003)	(0.034)	(0.003)	(0.035)	(0.003)
$\ln(v_\pi)_{ijt}$	0.080***	0.012***	0.001	0.009	-0.000	0.005
	(0.020)	(0.004)	(0.038)	(0.006)	(0.039)	(0.005)
$\ln(\mu_\pi)_{ijt}$	-0.018	-0.006	-0.003	-0.007	-0.000	-0.022**
	(0.073)	(0.012)	(0.080)	(0.012)	(0.079)	(0.012)
$Size_{ijt}$			0.245***	0.038	0.245***	0.076**
			(0.050)	(0.038)	(0.051)	(0.035)
Age_{ijt}			0.014	0.021***	0.014	0.031***
			(0.010)	(0.006)	(0.010)	(0.009)
Age^2_{ijt}			-0.000*	0.000	-0.000*	0.000**
			(0.000)	(0.000)	(0.000)	(0.000)
$\ln\varphi_{ijt-1}$	-0.158		-0.285**		-0.286*	
	(0.162)		(0.147)		(0.153)	
Inverse Mills Ratio (λ_{ijt})		0.010		0.014**		0.013*
		(0.007)		(0.006)		(0.008)
Constant	1.910***	0.442	1.397***	0.241	1.394***	-0.215**
	(0.081)	(0.343)	(0.192)	(0.342)	(0.193)	(0.101)
Rho (ρ)	0.069	0.069	0.101**	0.101**	0.120*	0.120*
	(0.052)	(0.052)	(0.004)	(0.004)	(0.073)	(0.073)
Firm Fixed Effects	YES	YES	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES	YES	YES
Industry-Year Fixed Effects	NO	NO	NO	NO	YES	YES
Observations	2445	2445	2445	2419	2419	2419
Censored Observations	66	66	66	66	66	66
Uncensored Observations	2379	2379	2353	2353	2353	2353
No of Firms	805	805	794	794	794	794
Wald chi²	1.72	1.72	5.12**	5.12**	2.66*	2.66*

Note:

(i) Panel 1 (Columns 1 and 2) of Table 4.3 represents the Heckman's Two Step estimation results of the risk aversion elasticities with respect to risks (v_π and $\partial v_\pi(I^*)/\partial I$) and return ($\mu_\pi$), while taking into account other unobserved firm and year fixed effects.

(ii) Panel 2 (Columns 3 and 4) presents the results of the updated Heckman's Two Step model where along with the existing variables we also include various firm controls (age, age square and firm size) which contribute to firm's background risk.

(iii) Panel 3 (Columns 5 and 6) depicts the results of the final version of our Heckman's Two Step model where we also incorporate industry-year fixed effects to control for any industry level domestic as well as foreign policies during the study period, which can broadly contribute to firm's background risk.

(iv) In Heckman's Two Step Model (1st and 2nd Columns of each Panels) the selection (or, censoring) effect is summarized by Inverse Mills Ratio $(\lambda) = \rho\sigma$ (with ρ being the correlation between the residuals of the regression equation and the selection (i.e., censored) equation and σ the standard error of the residual in the regression equation). A significant λ justifies the use of a selection (i.e. censored) model.

(v) It should also be noted that in each of the regressions, the standard errors are clustered at the firm level, with robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table A.1: Two Step System GMM (Dynamic Panel with Lags 1-3) (with firm fixed effects)

VARIABLES	(1) Mark-up Pricing (Risk Premium) Decision $(\ln \varphi_{ijt})$	(2) Mark-up Pricing (Risk Premium) Decision $(\ln \varphi_{ijt})$	(3) Mark-up Pricing (Risk Premium) Decision $(\ln \varphi_{ijt})$
	AB 1	**AB 2**	**AB 3**
$\ln \varphi_{ijt-1}$	0.771***	0.748***	0.835***
	(0.0803)	(0.0726)	(0.0916)
$\ln \varphi_{ijt-2}$		-0.00470	0.0495
		(0.0665)	(0.0701)
$\ln \varphi_{ijt-3}$			0.0867
			(0.0598)
$\ln(\partial v_{\pi}(I^{*})/\partial I)_{ijt}$	0.00429*	0.00264	0.00201
	(0.00252)	(0.00276)	(0.00299)
$\ln(v_{\pi})_{ijt}$	0.00438*	0.00450	0.00609*
	(0.00279)	(0.00337)	(0.00311)
$\ln(\mu_{\pi})_{ijt}$	-0.00794	-0.0142*	-0.00961
	(0.00817)	(0.00842)	(0.00989)
Age_{ijt}	-0.000134	6.67e-05	-0.000315
	(0.00109)	(0.00110)	(0.00111)
Age^{2}_{ijt}	1.16e-05	9.02e-06	7.16e-06
	(1.22e-05)	(1.14e-05)	(8.21e-06)
$Size_{ijt}$	-0.00166	0.00331	-0.00856
	(0.00490)	(0.00628)	(0.00849)
Constant	0.0292	0.0191	0.0192
	(0.0180)	(0.0190)	(0.0181)
Observations	**2,573**	**2,267**	**2,014**
F Statistics	**40.00*** **	**32.51*** **	**59.65*** **
Hansen Test	**18.21**	**32.12**	**44.64**
AR 1	**-2.74*** **	**-2.24** **	**-1.94** **
AR 2	**-1.73* **	**-1.65* **	**-1.42**
Number of Firms	**803**	**705**	**609**
Number of Instruments	**29**	**47**	**62**
Firm Fixed Effects	**YES**	**YES**	**YES**

Note:

i. It should be noted that for the dynamic panel mark-up analysis, with firm effects, the AR 2 test statistics remains insignificant only with AB 3 (Column 3). This nullifies the existence of any higher order autocorrelation in final dynamic panel models, only when we include all three lags of the dependent variable (φ) in our model. Hence, we choose model AB 3 (i.e., Column 3 of Table A.1 and A.2) over AB 1 and AB 2 among the dynamic panel models.

ii. It should also be noted that in each of the regressions, the standard errors are clustered at the firm level, with robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table A.2: Two Step System GMM (Dynamic Panel with Lags 1-3) (with firm and year fixed effects)

VARIABLES	(1) Mark-up Pricing (Risk Premium) Decision ($\ln \varphi_{ijt}$)	(2) Mark-up Pricing (Risk Premium) Decision ($\ln \varphi_{ijt}$)	(3) Mark-up Pricing (Risk Premium) Decision ($\ln \varphi_{ijt}$)
	AB 1	**AB 2**	**AB 3**
$\ln \varphi_{ijt-1}$	0.398**	0.724***	0.823***
	(0.185)	(0.0815)	(0.0896)
$\ln \varphi_{ijt-2}$		-0.0121	0.0376
		(0.0787)	(0.0797)
$\ln \varphi_{ijt-3}$			0.101*
			(0.0548)
$\ln(\partial v_{\pi}(I^{*})/\partial I)_{ijt}$	0.0224**	0.00269	0.00242
	(0.00900)	(0.00291)	(0.00328)
$\ln(v_{\pi})_{ijt}$	0.00841**	0.00392	0.00596*
	(0.00361)	(0.00356)	(0.00358)
$\ln(\mu_{\pi})_{ijt}$	0.0148*	-0.0130	-0.0201*
	(0.00836)	(0.0102)	(0.0132)
Age_{ijt}	-0.0117*	0.000600	0.000417
	(0.00629)	(0.00153)	(0.00147)
Age^{2}_{ijt}	0.000138**	3.89e-06	-8.29e-07
	(6.85e-05)	(1.50e-05)	(1.33e-05)
$Size_{ijt}$	-0.000521	0.00494	-0.00892
	(0.00479)	(0.00719)	(0.00915)
Constant	-36.96*	-1.670	-5.511
	(21.73)	(6.853)	(7.992)
Observations	**2,573**	**2,267**	**2,014**
F Statistics	**11.85*** **	**7.93*** **	**6.16*** **
Hansen Test	**12.02**	**32.57**	**45.18**
AR 1	**-1.73***	**-2.15****	**-1.88***
AR 2	**-1.79***	**-1.61***	**-1.37**
Number of Firms	**803**	**705**	**609**
Number of Instruments	**50**	**67**	**81**
Firm Fixed Effects	**YES**	**YES**	**YES**
Year Fixed Effects	**YES**	**YES**	**YES**

Note:

i. It should be noted that for the dynamic panel mark-up analysis, with both firm and year effects, the AR 2 test statistics remains insignificant only with AB 3 (Column 3). This nullifies the existence of any higher order autocorrelation in final dynamic panel models, only when we include all three lags of the dependent variable (φ) in our model. Hence, we choose model AB 3 (i.e., Column 3 of Table A.1 and A.2) over AB 1 and AB 2 among the dynamic panel models.

ii. It should also be noted that in each of the regressions, the standard errors are clustered at the firm level, with robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.