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Export under Background Risk: A Mean-Variance Decision Analysis for Indian Manufacturing Firms

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GEP

Export under Background Risk: A Mean-Variance Decision Analysis for Indian Manufacturing Firms

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Abstract

How would accessing foreign markets affect risk exposure of manufacturing firms? Producing for and selling specific goods to foreign markets (exports) require specialized attention. For example, manufacturing firms are exposed to idiosyncratic shocks in their global supply chains, such as exchange rate volatility, asset market frictions, transaction risks, credit tightening, and so on. Given this background, we probed production and exporting decision for a manufacturing firm (that serves both domestic and foreign markets) in the context of firm-specific and industry-specific shocks on trade, with a view of searching for optimality. These shocks are aggregated to form a type of risk that literature labels as 'non-hedgeable' background risk. We also propose that background risk is dependent on direct (endogenous) risk pertaining to fluctuations in the spot/nominal exchange rates. To test for potential optimal conditions, we employ a mean-variance decision-theoretic modelling approach. This approach was selected in order to trace out the comparative static responses of optimal export sales following the changes in the distribution of background risk or due to the dependence structure between the two sources of risks (i.e., background risk and exchange rate risk). Our contribution includes isolating all comparative static effects of these changes in the context of optimal production and exporting decisions. In particular, we consider the relative trade-offs between risks and returns, and offer intuitive economic theory-based interpretations of our results. In order to demonstrate robustness of the key results in our model empirically, we

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utilised an unbalanced panel data of 1,273 exporting Indian manufacturing firms over the time period of 1996-2017 to perform a structural estimation of our theoretical model. This model is derived using a flexible utility function that incorporates all possible options of risk preferences. Through this approach, we are able to estimate risk aversion elasticities specific to our context.

Keywords: Exports; Background risk; Background risk –augmented profit; Decision under risk; Mean-variance model; Risk aversion.

JEL Classifications: D21; D81; F41.

1. Introduction.

Export sales associated with global production networks in a supply chain, also known as supply-chain exports, are influenced significantly by changes in business cycles, as well as by firm- or industry- specific policy changes. A prominent example of global business cycle change is the global financial crisis/recession of 2008. An example of an industry-specific policy shock is the withdrawal of multi-fibre agreements by multilateral agencies over a span of a decade in the textile industry. Also, the recent political crisis in Venezuela, and in India, withdrawal of higher denomination currencies with very short notice (also known as 'demonetisation') are other examples of unprecedented policy changes in the global economic context. A prospective manufacturing exporter requires efficient use of hard and soft technologies (Nair et al., 2013), for which the financial profile of the exporting manufacturing firm is of utmost importance (Beck et al., 2008; Manova, 2008; 2013; Manova et al., 2014). Financial resources are crucial for the smooth functioning of any operational activity. One of the most critical decisions that a capital-constrained manufacturer faces, in a price sensitive market, is *how to finance operational activities*. Due to competitive market conditions, the majority of manufacturers tend to deliver products and services to retailers on a credit basis in order to expand their market share. Selling on a credit basis gives rise to associated risks. As a result, financially constrained manufacturers face obstacles of survival in the marketplace, especially if they are exposed to higher levels of default risk.

There are several operational risks associated with exporting, such as risks of default by a foreign buyer, demand shocks in the export markets, and expropriation of (intellectual) property. Under such circumstances, a firm enjoying good financial health, is somewhat protected because it can pledge its tangible assets as collateral to raise finances (Cheung & Sengupta, 2013; Manova et al., 2014). Also, given the fact that smaller firms (i.e. firms with lower asset-base) tend to be more credit-constrained than larger ones, the impact of any unanticipated credit friction on the firm's level of exports could depend on the total asset-base that the firm had at the end of the last period (Beck et al., 2008; Manova, 2008; 2013; Manova et al., 2014). Therefore, any shortage in the firm's total asset-base, for example, share of plant, property and equipment compared to its total book value assets in the last year prior to exports could significantly make the firm more vulnerable towards the above-mentioned unanticipated risks associated with its decision to cater to export markets. In addition, there might be business cycle fluctuations or other industry-specific policy-shocks that the firm is not hedged against, which can further exacerbate the firm's position.

All such shocks related to asset market frictions, greater transaction risks, variations in labour income, entrepreneurial income, credit tightening and unexpected working capital needs due to unanticipated shipping times are belonging to the idiosyncratic risks (Heaton & Lucas, 2000; Fitzgerald, 2012; and so on), which can be summarised, likewise the literature on financial market and portfolio analysis does, by defining the concept of 'background risk' (see, for example, Jiang et al., 2010; Gollier & Pratt, 1996; Wagener, 2003; Ortega & Escudero, 2010; Eichner & Wagener, 2009; 2012; and many more). In other words, all the above-mentioned shocks related to the operational expenses for exporting, gives birth to the idiosyncratic background risk, influencing the firm's decision of how much to sell abroad via-a-vis the local market when the firm is already facing price-risk (owing to exchange rate volatility) in the output market. Such risk can be mitigated when background risk is explicitly considered by including it in the exporting firm's profit function.

Quite often, the government of the exporting country offers firms export incentives to cover the firm's fixed costs of exporting. However, once the firm receives more export incentives in the last year prior to exporting, managers of such firms may be inclined to show part of these incentives to show as gains to their operating profits, instead of utilising them to proper purpose, in order to give an impression that the executives have made enormous contributions in boosting profits (which happened for S&P during 1988 – 2001, see Evans, 2003 (pp. 43-44);

Beladi et al., 2019). If this happens, then export incentives cannot provide the necessary support needed to combat unanticipated frictions in export markets.

The extant literature has explored production and export decisions of exporting firms by framing decision-theoretic models under exchange rate uncertainty using the standard von Neumann-Morgenstern expected utility representation (Kawai and Zilcha, 1986; Viaene and Zilcha, 1998; Broll and Eckwert, 1999; to name just a few). More recently, Broll and Mukherjee (2017) offered decision-theoretic analysis for an exporting firm's production allocation problem between domestic and foreign markets under exchange rate risk, using a mean-variance decision-theoretic framework. This framework was also empirically demonstrated to be valid using Indian firm-level data by Broll et al. (2019).

The mean-variance decision-theoretic model has been acknowledged as an appropriate alternative model of risk preferences compared to the expected utility approach provided feasible distributions of any random variable emanate from a location–scale family (Meyer, 1987), which is also valid in our context. In our context, final profit from exporting is a linear combination of two random variables (price and background risk), as has been also operationalized in Eichner and Wagener (2003; 2009; 2012).

The major advantage of the mean-variance decision-theoretic model is its intuitive simplicity - everything can be understood in terms of the trade-offs between return and risk. This flexibility allows us to yield simpler and interpretable comparative static results, which *would not be feasible* in the expected utility framework, where a researcher encounters far more complexity. In addition, the interpretability of the solution in analysing the impact of dependent idiosyncratic risks using the expected utility framework is almost nil.

This paper contributes to this line of research by answering another important and yet unexplored research question which is: How will the optimum production and exporting decision for a firm that serves both domestic and foreign markets, change in the presence of background risk? Specifically, by considering perturbations in the form of a non-hedgeable background risk, which incidentally is dependent upon the prevailing price risk, how will the optimal production and exporting decision be affected? This is an important issue to consider given that few studies have examined the specific context of background risk. Simply defined, background risk is risk that cannot be avoided or diversified. Background risks cause managers to be less willing to take other independent risks when making decisions. Wagener (2003) demonstrates the impact of changes in the distributions of background risk under mean-variance decision theoretic framework on the risk-taking attitude concerning the equivalent comparative static effects to that under the expected utility setting. This paper therefore, serves as an application of Wagener (2003); Eichner & Wagener (2003; 2009; 2012) in the context of a problem in the domain of international trade and decision to export.

Sun et al. (2017) explored a hybrid manufacturing/remanufacturing model for risk-averse remanufacturers and reported insights into the trade-off relationship between profit and product reliability using the mean-variance framework. However, their paper did not consider background risk, thereby amplifying the endogenous risk resulting in financial constraints. In the present paper, we address this research gap. As the domestic and foreign markets are segmented with zero pass-through of changes in the exchange rate, changes in financial frictions could affect the fixed costs of selling in a global market. This is because of uncertain returns (i.e. uncertain C.I.F. export prices), which is affected by background risk. Therefore, this paper is only concerned with the issue of how changes in distribution of background risk and changes in dependence structure along with volatility in C.I.F. export prices, could influence production allocation decisions of risk-averse firms?

At the same time, this paper emphasizes the importance of background risk uncertainty that is dependent on foreign exchange currency fluctuations (owing to randomness in the spot exchange rate) in global trade. We do this using a two-moment (i.e. mean – variance) decision-theoretic model, similar to the one considered in the work of Broll and Mukherjee (2017). However, that paper did not consider background risk in their model, and consequently, the impacts of changes in distribution of background risk and/or changes in the dependence structure between two sources of risks on the firm's optimal decision of how much to sell domestically versus the foreign market remains an untapped research issue in the literature, as also acknowledged in Guo et al. (2018).

After that this paper has also offered an empirical demonstration of how to estimate the risk preference structure of such exporting firms and the risk aversion elasticities. For this purpose, we follow the 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. Talking about the sample, we utilise an unbalanced panel data of 1,273 exporting Indian manufacturing firms over the time-period of 1996-2017. Following Dai & Chang (2018), we employ two-step ACF (Ackerberg et al., 2015) corrected LP (Levinsohn & Petrin, 2003) procedure to estimate firm-level mark-ups. After that we have conducted a two-step estimation approach. In the first step, we regressed firm's current period's net profit on lagged values of firm-specific factors (which affect background risk) and fixed effects (firm-specific, year-specific and industry-year specific) to estimate the background risk -augmented firm-specific net profit function. Then, we introduced the firm-level means, squared mean-deviations of predicted profits and changes in the squared mean-deviation of predicted profits due to change in exports. After that, we regressed all these aforementioned variables on estimated firm-level mark-up (proxy for expected risk premium) to estimate the risk aversion elasticities with respect to variances (i.e. squared mean-deviations) and mean. Thereafter, we also extend our fixed effect 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.[1] The findings suggest that the 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).

2. The Model.

We study a firm that serves both the domestic market and a foreign country market, facing a downward sloping residual demand curve at home and abroad. The firm operates in a single period with two dates, $t = 0$, and $t = 1$, with a known cost function $C(x + y)$, following increasing marginal costs. Denoting the random spot exchange rate (expressed in units of the home currency per unit of foreign currency) as $\tilde{e}$ (distributed according to an objective cumulative distribution function over $[\underline{e}, \overline{e}]$), price schedule of the exportable x as (in units of foreign currency) $p(x)$; price schedule of the product y sold in the domestic market as (in units of domestic currency) $p(y)$; concave revenue functions in both home and foreign markets (in units of their respective currencies) as $R(x)$ and $R(y)$. $\tilde{Z}$ denotes the already mentioned operational risk of exporting, which is also a random variable over $[\underline{Z}, \overline{Z}]$.

$\delta \in (0,1)$ is the share of the export incentives, when the other part of the incentives are used by the managers for personal purpose. $(1 - \delta)\tilde{Z} = \beta\tilde{Z}$ is the background risk that influences the exporter's production allocation decision excluding the 'endogenous' exchange rate risk.[2]

[1] The result remains robust for Heckman's estimation procedure as well.
[2] Since, risk-averse firm always opts for partial coverage, $\beta \neq 0$.

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

Or,

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

$\tilde{\pi}$ is the final net profit after realisation of the background risk at the end of the period (or, equivalently, the risk-augmented final profit). For any random variable $\widetilde{W}$, the mean and variance are denoted by respectively, μ_W and v_W. For the pair of random variables $\tilde{e}$ and $\tilde{Z}$, $\mathrm{Cov}(\tilde{e}, \tilde{Z})$ denotes their covariance. The variance and mean of final risk-augmented profit can then be written respectively as

$$v_\pi = v_e R(x)^2 + \beta^2 v_Z - 2\beta R(x)\mathrm{Cov}(\tilde{e}, \tilde{Z}) \quad (2)$$

$$\mu_\pi = \mu_e R(x) + R(y) - C(x+y) - \beta\mu_Z \quad (3)$$

Since $\tilde{\pi}$ is a linear function of the random variables, correlation (or covariance) serves as the most appropriate parameters to characterize how the dependence structures between the exchange rate risk and background risk would affect the profit-risk (see, for example, Embrechts et al., 2002).

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 the preference of the exporter satisfies non-satiation and the exporter is risk-averse[3], wherein the indifference curves in (μ_π, v_π)-space are upward-sloped.

The marginal rate of substitution (MRS) between risk and return is defined by

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

$S > 0$ is the two-parameter equivalent to Arrow–Pratt measure of absolute risk aversion, reflecting the marginal willingness to pay in terms of expected returns foregone renouncing to export for a reduction in profit-risk.

The firm solves the following problem:

$$\max_{(x,y\geq 0)} U(\mu_\pi, v_\pi) \text{ s.t. (2) \& (3)} \quad (4)$$

[3] Recent empirical evidence (see, for example, Nakhoda, 2018) states on the fact that the prospective exporting firms of developing countries tend to accumulate long-term secured loans in the period prior to their entry into the export market. This also implies that the exporters are generally risk-averse.

The interior solution[4] for (x^*, y^*) holds if and only if

$$U_\mu(\mu_\pi^*, v_\pi^*)\big(\mu_e R'(x^*) - C'(x^* + y^*)\big) + U_v(\mu_\pi^*, v_\pi^*)(\partial v_\pi(x^*)/\partial x) = 0 \tag{5}$$

with

$$(\partial v_\pi(x^*)/\partial x) = 2R'(x^*)\big[v_e R(x^*) - \beta \mathrm{Cov}\big(\tilde{e}, \tilde{Z}\big)\big]$$

and

$$U_\mu(\mu_\pi^*, v_\pi^*)\big(R'(y^*) - C'(x^* + y^*)\big) = 0 \tag{6}$$

From (6) we obtain

$$R'(y^*) = C'(x^* + y^*) \tag{7}$$

since $U_\mu(\mu_\pi^*, v_\pi^*) > 0$. This demonstrates the fact that the total amount of production of the firm, $x^* + y^*$, is independent of the firm's attitude towards risk and of the probability distribution of the random marginal export revenue. However, the allocation of production between domestic supply and exports depends on the firm's risk preferences. Note that the two markets (domestic and foreign) are segmented with zero pass-through of changes in the exchange rate.

From (5) and (6), the first-order condition (F.O.C.) becomes

$$\{\mu_e R'(x^*) - R'(y^*)\}/(\partial v_\pi(x^*)/\partial x) = S(\mu_\pi^*, v_\pi^*) \tag{8}$$

The term $\{\mu_e R'(x^*) - R'(y^*)\}$ in Eq. 8 is merely the risk premium of the firm for the risky activity of exporting. This is always positive owing to the assumption of risk aversion. Hence, Eq. 8 suggests $(\partial v_\pi/\partial x) > 0$, implying exporting is risky: higher export increases standard deviation of the final profit at the margin. $(\partial v_\pi/\partial x) > 0$ is satisfied if $v_e > \beta \mathrm{Cov}\big(\tilde{e}, \tilde{Z}\big)/R(x^*)$.

Also, we are going to ascertain that an upscaling of background risk increases the overall riskiness of exporting, i.e.

$$(\partial v_\pi(x^*)/\partial \beta) = 2\big[\beta v_Z - \mathrm{Cov}\big(\tilde{e}, \tilde{Z}\big)R(x^*)\big] > 0, \tag{9}$$

which yields us the sufficiency condition $\mathrm{Cov}\big(\tilde{e}, \tilde{Z}\big) < \{\beta v_Z/R(x^*)\}$.

[4] Corner solution in this scenario, as demonstrated in Broll and Mukherjee (2017), would entail the possibility of zero exports ($x^* = 0$), which is not the focus of this paper.

A depreciation of the exporting country's currency (reflected by an increase in $\tilde{e}$ in our framework) encourages to export more and therefore increases expected profit. But that also increases the background risk.

It is easily seen that both the sufficiency conditions (i) $\mathrm{Cov}\left(\tilde{e}, \tilde{Z}\right) < v_e R(x^*)/\beta$, and (ii) $\mathrm{Cov}\left(\tilde{e}, \tilde{Z}\right) < \{\beta v_Z / R(x^*)\}$ are ensured whenever $0 < \mathrm{Cov}\left(\tilde{e}, \tilde{Z}\right) < \min\{v_e, v_Z\}$ holds, which henceforth we assume.

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

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

Implicit differentiation of Eq. 8 with respect to (w.r.t. hereafter) μ_Z, we obtain

$$\begin{aligned} \mathrm{sgn}\left(\frac{\partial x^*}{\partial \mu_Z}\right) &= \mathrm{sgn}\left[-S_\mu \frac{\partial \mu_\pi^*}{\partial \mu_Z}\right] \\ &= \beta \ \mathrm{sgn}\ S_\mu(\mu_\pi^*, v_\pi^*) \end{aligned} \tag{10}$$

Similarly, totally differentiating Eq. 8 w.r.t. v_Z, we obtain

$$\begin{aligned} \mathrm{sgn}\left(\frac{\partial x^*}{\partial v_Z}\right) &= \mathrm{sgn}\left[-S_v \frac{\partial v_\pi^*}{\partial v_Z}\right] \\ &= -\beta^2 \ \mathrm{sgn}\ S_v(\mu_\pi^*, v_\pi^*) \end{aligned} \tag{11}$$

From Eq. 10 we find as μ_Z increases, the risk-averse firm opts for optimally exporting less (i.e. $\frac{\partial x^*}{\partial \mu_Z} < 0$) 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 in terms of expected returns foregone by reducing exports for a reduction in v_π decreases in expected profit.

On the other hand, an increase in background risk leads to an unambiguous substitution effect (the exporting firm reacts by selling more domestically), and an ambiguous income effect (Davis, 1989). To this extent, Eq. 11 predicts $\frac{\partial x^*}{\partial v_Z} < 0$, if and only if $S_v > 0$, which establishes the "variance vulnerability" property of the preferences. This implies the exporting firm exports even lesser when the higher background risk aids to the overall riskiness of the export market, compared to the scenario under only exchange rate risk). Hence, higher volatility of $\tilde{Z}$ makes the firm to sell relatively less to the foreign market if its willingness to accept risks intensifies when the profit-risk is escalated. The readers are advised to see Eichner and Wagener (2003; 2009; 2012) in this context.

Therefore, we arrive at the following proposition.

Proposition 1.

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'.*

Then, we move on to trace out the implications of change in the dependence structure between the two risks.

4. Change in the dependence between background risk and the exchange rates.

Here the key comparative static exercise is under what condition, the risk-averse firm might be induced to export more when the two risks become more concordant, (i.e. owing to a small increase in $\text{Cov}(\tilde{e}, \tilde{Z})$, given the individual variances of the two risks). This is because an increase in $\text{Cov}(\tilde{e}, \tilde{Z})$ leads to a reduction in the variability of firm's profit, which may prompt the firm to optimally export more. Therefore, our comparative static exercise in this section contributes to explore this possibility.

(DETAIL PROOF AVAILABLE FROM AUTHORS)

Proposition 2. *The firm will optimally export more in response to* $\Delta\text{Cov}(\tilde{e}, \tilde{Z}) > 0$, *whenever* $\varepsilon_v > -0.5$ *holds.*

(DETAIL PROOF AVAILABLE FROM AUTHORS)

5. A parametric example.

Let us exemplify the generic framework in terms of a specific preference function, say

$$U(\mu_\pi, v_\pi) = \mu_\pi^a - v_\pi^b \tag{13}$$

As demonstrated in Saha (1997), Eq. 13 allows us to have the most flexibility, since it does not require to presume any specific assumption on the pattern of risk-preference structure.

Hence, the expression for the MRS between risk and return for the exporting firm would become

$$S(\mu_\pi, v_\pi) = (b/a)\mu_\pi^{1-a} v_\pi^{b-1} \tag{14}$$

and the F.O.C. for exporting sales turns out to be

$$a\{\mu_e R'(x^*) - R'(y^*)\}\mu_\pi^{*\,(a-1)} - b\left(\frac{\partial v_\pi(x^*)}{\partial x}\right) v_\pi^{*\,(b-1)} = 0 \tag{15}$$

Given Eq. 15, we can come up with the following results equivalent to Propositions 1 – 2.[5]

(a) **Comparative static effect w.r.t. $\boldsymbol{\mu_Z}$:**

Implicit differentiation of (15) w.r.t. μ_Z yields

$$\text{sgn}\left(\frac{\partial x^*}{\partial \mu_Z}\right) = \text{sgn}\left[\beta a(a-1)\{\mu_e R'(x^*) - R'(y^*)\}\mu_\pi^{*\,(a-2)}\right] \tag{16}$$

It is straightforward to show $S_\mu < 0$, whenever $(1-a) < 0$.

Therefore, $\left(\frac{\partial x^*}{\partial \mu_Z}\right) < 0$, if and only if $a > 1$, i.e. the preference follows DARA. This is precisely the statement in Proposition 1(a).

(b) **Comparative static effect w.r.t. $\boldsymbol{v_Z}$:**

Implicitly differentiating (15) w.r.t. v_Z gives

$$\text{sgn}\left(\frac{\partial x^*}{\partial v_Z}\right) = -\text{sgn}\left[\beta^2 b(b-1)\frac{\partial v_\pi(x^*)}{\partial x} v_\pi^{*\,(b-2)}\right] \tag{17}$$

[5] See Appendix for the algebraic proofs for (a) – (c).

It is easy to show that $\left(\frac{\partial x^*}{\partial v_Z}\right) < 0$ if and only if $S_v > 0$, or $b > 1$: this is what has been argued in Proposition 1(b).

(DETAIL PROOF AVAILABLE FROM AUTHORS)

(c) **Comparative static effect of $\Delta\mathrm{Cov}(\tilde{e}, \tilde{Z}) > 0$**

Implicit differentiation of (15) w.r.t. $\mathrm{Cov}(\tilde{e}, \tilde{Z})$ yields,

$$\mathrm{sgn}\left(\frac{\partial x^*}{\partial \mathrm{Cov}(\tilde{e}, \tilde{Z})}\right) = \mathrm{sgn}\left[\frac{1}{2}\left(\frac{1}{v_e R(x^*) - \beta Cov(\tilde{e}, \tilde{Z})}\right)\left(\frac{v_\pi(x^*)}{R(x^*)}\right) + b - 1\right] \qquad (18)$$

Now It is straightforward to show that $\frac{\partial x^*}{\partial \mathrm{Cov}(\tilde{e}, \tilde{Z})} > 0$, if and only if $(b-1) = \varepsilon_v > -0.5$. This confirms Proposition 2.

(DETAIL PROOF AVAILABLE FROM AUTHORS)

6. Empirical Framework

In this section we estimate the background risk sourced from firm, industry and other year specific sources faced by the exporting firms (i.e., domestic firms which also cater in external markets) and eventually provide an empirical demonstration of the risk preference structure of such exporting firms and the risk aversion elasticities. Using a large sample of Indian manufacturing firms, we demonstrate how to jointly estimate risk preference structure and risk aversion elasticities for a panel of 1,273 exporting firms over 1996-2017 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 & Mukherjee (2017).

$$U(\mu_\pi, v_\pi) = \mu_\pi^a - v_\pi^b \qquad (6.1)$$

Where,

$\mu_{\pi_{it}}$ is expected relative net profit of a firm. To measure it, we follow Schmidt and Broll (2009) who 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 $\mu_{\pi_{it}}$ 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 average net profit on a time trend.

$v_{\pi_{it}}$ is measured as the square of the mean deviation of the net profit from the actual net profit.

$(\partial v_\pi(X^*)/\partial X)$ =change in mean deviation of net profits due to change in exports.

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

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

Or,

$$\ln(\text{Risk premium}) = \ln\left(\frac{b}{a}\right) + (1-a)\ln\mu_\pi + (b-1)\ln v_\pi + \ln(\partial v_\pi(X^*)/\partial X) \quad (6.2)$$

Since all the variables measuring risk distribution $\big(\mu_\pi, v_\pi, (\partial v_\pi(X^*)/\partial X)\big)$, 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. Hence, we do not need to include additional mean and variance of spot exchange rate distribution to the RHS of Eq. 6.2.

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 exports 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 exports 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).

Proposition 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 estimates of $\ln \mu_\pi$ is negative (and statistically significant) or not.

Given the definition of the risk-premium, we can proxy this risk-premium by the firm-level mark-up that we estimate using the Dai and Cheng (2018)'s approach for 1,273 Indian manufacturing exporting firms (See, Sub-Section 6.2). To quantitatively examine these predictions, we use (6.2) as our unique structurally estimable equation.

6.2 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 translog production function with Hicks-neutral productivity, highlighted in equation (6.3):

$$q_{it} = \beta_m m_{it} + \beta_k k_{it} + \beta_l l_{it} + \beta_p p_{it} + \beta_{mm} {m_{it}}^2 + \beta_{kk} {k_{it}}^2 + \beta_{ll} {l_{it}}^2 + \beta_{pp} {p_{it}}^2 + \beta_{mk} m_{it} k_{it} + \beta_{ml} m_{it} l_{it} + \beta_{mp} m_{it} p_{it} + \beta_{mkl} m_{it} k_{it} l_{it} + \beta_{mkp} m_{it} k_{it} p_{it} + \beta_{mlp} m_{it} l_{it} p_{it} + \omega_{it} + \epsilon_{it} \tag{6.3}$$

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 and power and fuel expenses, respectively. Firm productivity is denoted as ω_{it} while ϵ_{it} is the error term.[6]

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 problem in choosing labour, capital[7] and other factor inputs based on their current productivity levels.

Table 6.1: LP (ACF Corrected) Translog Production Function Estimation for Indian Manufacturing Firms

INSERT THE TABLE 6.1

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 De Loecker and Warzynski (2012)'s approach, we can recover firm-level markup (φ_{it}) using equation 6.4,

[6] 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 1996-2017 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

[7] To estimate the firm-level physical capital stocks for each year we closely follow the methodology adopted by P. 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 1996-2017 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, P. Balakrishnan et al. (2006) (pp.71-73), and Topalova and Khandelwal (2011) (pp. 23).

$$\varphi_{it} = \frac{\theta_{it}^M}{\alpha_{it}^M} \tag{6.4}$$

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 material input expenses for all firms, which uses the estimated coefficients of Column 1 in Table 6.2:

$$Output\_Elasticity\_RM_{it} = 0.3690546 + 2 * 0.0591367 * ln\_RM\_Expences_{it} - 0.026733 * ln\_Capital_{it} - 0.0789584 * ln\_Compensation_{it} - 0.0231569 * ln\_Power\_Fuel_{it} + 0.0180044 * ln\_Compensation_{it} * ln\_Capital_{it} - 0.013659 * ln\_Compensation_{it} * ln\_Power\_Fuel_{it} - 0.0111663 * ln\_Power\_Fuel_{it} * ln\_Capital_{it} \tag{6.5}$$

Figure 6.2 gives the distribution of firm-level mark-ups for all manufacturing firms and profit-making exporting firms.

Figure 6.1: Histogram of Firm-level Log (Mark-up) for All Manufacturing Firms and Profit-Making Exporting Firms

INSERT THE FIGURE 6.1

Figure 6.2 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.

6.3 The Estimation Strategy and Analysis

In this section we empirically test equation 6.2, where our main objective is to examine the independent effects of firm-level mean (to infer on the changes in $\mu_{\pi_{it}}$), mean deviation of net profit (in order to infer on the changes in $v_{\pi_{it}}$) and change in mean deviation of net profits due to change in exports (in order to infer on the changes in $\ln(\partial v_{\pi}(X^{*})/\partial X)$) 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 1273 Indian exporting firms operating over the 1996 to 2017 period.

In our empirical estimation we follow a two-step estimation procedure.

Step 1: Given that at first we need to measure exporting firm's background risk sourced from firm, industry and year specific factors, we at first regressed firm's current period's profit-after tax on lag period's firm-specific factors (such as, export incentives, collateral base (proxied by the ratio of net-fixed asset to total asset) and firm-size (measured by total asset), which are negatively functioned with firm's background risk $(\tilde{Z})$, and other firm, year and industry-year dummies, which account for all unobserved firm, year and industry-year (i.e., any internal and external industry level policy changes) factors which affects firm's background risk $(\tilde{Z})$ over time.

Step 1 can be represented by the equation 6.6.

$$\pi_{ijt} = \alpha + \beta_1 ln\_export\ insentives_{ijt-1} + \beta_2 ln\_collateral\ base_{ijt-1} + \beta_2 ln\_size_{ijt-1} + c_i + \tau_t + \lambda_{ij} + \epsilon_{ijt} \tag{6.6}$$

Where, all variables are in natural log. Firm, year and industry-year fixed effects are denoted as $c_i, \tau_t, \lambda_{ij}$, respectively, while ϵ_{ijt} is the error term.[8]

Table 6.2 provides the estimation result of the **'background' risk-augmented profit after tax** obtained from step 1.

Step 2: Next, we use predicted[9] exporting firm's profit-after tax (as a proxy for firm's 'background' **risk-augmented** profits, $\hat{\pi}$) and measure the firm-level mean (to infer on the changes in $\mu_{\hat{\pi}_{it}}$), mean deviation of net profit (in order to infer on the changes in $v_{\hat{\pi}\ it}$) and change in mean deviation of predicted profits due to change in exports (in order to infer on the changes in $\ln(\partial v_{\hat{\pi}}\ (X^*)/\partial X)$). Eventually, we regress all these aforementioned variables on firm-level mark-up (which measures risk premium) to estimate the risk premium elasticities with respect to variance (mean deviations) and mean. We use fixed effect approach to determine the independent effects of all these aforementioned firm-level variables (i.e., the firm-level performance and risk indicators in the export markets) on firm-level mark-up, while taking into account other unobserved firm level heterogeneity, as presented in equation 6.7.

$$log\ markup_{ijt} = \alpha_1 + \beta_1 log\left(\frac{d\ (mean\ deviation\ of\ \hat{\pi})}{d(export\ earnings)}\right)_{ijt} + \beta_2 \log(mean\ deviation\ of\ \hat{\pi})_{ijt} + \beta_3 \log(mean\ of\ \hat{\pi})_{ijt} + c_i + \varepsilon_{ijt} \tag{6.7}$$

Where, all variables are in natural log. Firm fixed effect is denoted as c_i, while ϵ_{ijt} is the error term.

[8] We deflate all variables used in the model using industry- specific wholesale price indices, keeping 2004 as the base year to accord with the 1996-2017 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

[9] Profit-after tax predicted by all background risk factors in step 1.

Column 1 of Table 6.3 represents the fixed effect estimation result of the risk premium (firm-level mark-ups) elasticities with respect to risk (mean deviations and change in mean deviations) and return (mean), while taking into account other unobserved firm fixed effects.

As per our theoretical background, we expect positive risk premium elasticities with respect to mean deviation and change in mean deviation of risk-augmented profits due to change in export earnings. This is because more volatile the change in risk-augmented profits due to change export earning value is, higher would be firm's risk premium. While, the risk premium elasticity with respect to the mean of **risk-augmented profits** is expected to be negative, as firm tends to keep less risk premium on account of higher return from its export market. The coefficients of **most of the** variables of interest represented in **Column 1 of Table 6.3** remain significant and come with the expected signs. Thus, empirically validates our theoretical model. For instance, the coefficient of mean of **risk-augmented profits** ($\mu_{\hat{\pi}_{it}}$) suggests a **0.31 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 0.31 percent) by a risk-averse exporting firm on account of higher **average return from the export market**. In other words, $(1 - a)$ of **Eq. 6.2** 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 square of the mean deviation of **risk-augmented profits** ($v_{\hat{\pi}_{it}}$) (which corresponds to ε_σ, which is also equal to $b - 1$ in Eq. 4.2) is positive, **significant** and **less than the unity (0.003).** 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.[10]

Although the result remains robust with respect to the unobserved firm, year and industry level heterogeneity, which we have already taken in to account in **step 1** (i.e., while estimating the risk-augmented profit), 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.[11] The Heckman's Two step Model can be explained by the following system of equations which uses all the aforementioned variables:

$$log\ markup_{ijt} = \alpha_1 + \beta_1 log\left(\frac{d\ (mean\ deviation\ of\ \hat{\pi})}{d(export\ earnings)}\right)_{ijt} + \beta_2 \log(mean\ deviation\ of\ \hat{\pi})_{ijt} + \beta_3 \log(mean\ of\ \hat{\pi})_{ijt} + C_i + \varepsilon_{ijt}, if\ \rho_{ijt} > 0$$

$$log\ markup_{ijt} = 0\ if\ \rho_{ijt} \leq 0 \tag{6.8}$$

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

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[10] Moreover, it should also be noted that the coefficient of change in mean deviation of risk-augmented profits due to change in export earnings in Column 1 Table 6.3 came positive (0.001) (expected sign), however marginally insignificant with very low standard error value.

[11] It should be noted that 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. **(please 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 usual **Dynamic Panel System GMM** (**Blundell and Bond, 1998)** approach 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 symmetric 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 and 2), which could be obtained from authors upon request.

$$\rho_{ijt} = \mathrm{C}_1 + \gamma_1 log\left(\frac{d\,(mean\ deviation\ of\ \hat{\pi})}{d(export\ earnings)}\right)_{ijt} + \beta\gamma_2 \log(mean\ deviation\ of\ \hat{\pi})_{ijt} + \gamma_3 \log(mean\ of\ \hat{\pi})_{ijt} + \varphi_1 log\ markup_{ijt-1} + u_{ijt} \tag{6.9}$$

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

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 6.9.[12] 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 (6.8) as an exogenous variable and subsequently we estimate equation (6.8) 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.[13] 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.

Columns 2 and 3 of Table 6.3 provide the Heckman's estimation result for all exporting firms with 1st lag of mark-up status. The result remains symmetric with the findings of our main fixed effect model **(Column 1),** indicating the robustness of our results. For instance, the coefficient of **mean deviations of risk-augmented profit** in regression column **(i.e., Column 2)** suggests, if the latter increases by 1 percent the firm-level mark-up increases by **0.003 percent**. On the

[12] We have explored an important source of endogeneity, i.e., lagged mark-up (equation, 6.9) 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.

[13] 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.

other hand, the coefficient of **mean risk-augmented profit** (i.e., average returns from export markets) suggests a **0.031 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 3)** 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. It should also be noted that in each of the regressions, the standard errors are clustered at the firm level.

Table 6.2: Estimation of Firm-level Background Risk Augmented Profits for Indian Exporting Firms

INSERT THE TABLE 6.2

Table 6.3: Firm-level Risk Premium Elasticities with respect to Risk and Returns of Background Risk Augmented Profits for Indian Exporting Firms (with Mark-up-Lag-1)

INSERT THE TABLE 6.3

7. Concluding remarks.

For an exporting firm under uncertainty, effect of background risk on the decision problem of a risk-averse exporting firm (facing both exchange rate risk and a background risk) regarding the relative quantity to be sold optimally abroad, vis-à-vis to the domestic market, is an immensely important issue but has been left unexplored. The mean–variance decision–theoretic analysis considered in this paper provides plethora of astounding insights with clear intuitive appeal. The major advantage of this approach has been to yield all the comparative static responses of the optimal export sales in response to the changes in distribution or in the dependence structure of the background risk in terms of the marginal willingness to pay in terms of expected returns foregone renouncing to export for a reduction in the risk from exporting. Such analytical insights are quite novel in the literature of international economics.

After that, we utilise a panel of 1273 Indian manufacturing exporters over a time-period of 1996-2017 to perform 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 perform a two-step estimation approach. In the first step, we regress firm's current period's net profit on lagged values of firm-specific factors (which affect background risk) and fixed effects (firm-specific, year-specific and industry-year specific) to estimate the risk-augmented firm-specific net profit function. Then we the firm-level means, mean-deviations of net profit and changes in mean-deviation of predicted profits due to change in exports. After that, we regress all these aforementioned variables on estimated firm-level mark-up (proxy for expected risk premium) to estimate the risk aversion elasticities with respect to variances (mean-deviations) and mean. We use fixed effect approach to determine the independent effects of all these aforementioned firm-level variables (i.e., the firm-level performance and risk indicators in the export markets) on firm-level mark-up, while taking into account other unobserved firm level heterogeneity. We also use Heckman's 2-step estimation procedure to control for possible endogeneity. Overall, the empirical findings suggest that the risk preferences of the Indian manufacturing exporters are characterised by 'proper' risk aversion (satisfying both the DARA and 'variance vulnerability' properties of risk preferences). As a future direction, one can extend this analysis to explore the decision problem for a firm regarding how much to invest abroad optimally for acquiring foreign assets.

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Appendix:

Table A.1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
ln_sa_export_incentives_def	7071	-2.38731	1.997535	-7.68603	3.427677
ln_sa_pat_def	6345	-0.61506	2.12173	-7.35425	6.563422
ln_net_fixed_total_asset_def	7767	-0.71063	0.623515	-5.07683	1.2844
d_sa_export_earnings_def	7774	0.932606	17.20789	-852.892	497.1092
hat_ln_sa_pat_def	7774	-0.87628	2.349147	-8.24659	6.01765
hat_sa_pat_def	7774	2.454601	9.586168	0.000262	410.6124
avg_hat_sa_pat_def	7774	2.450938	9.110461	0.000508	280.4951
fitted_hat_sa_pat_def	7774	2.499028	9.655037	-0.55724	347.1079
resid_hat_sa_pat_def	7774	-0.04443	3.11009	-101.472	96.81088
mu_hat_sa_pat_def	7774	1.032191	0.297312	-0.51349	2.634455
ln_mu_hat_sa_pat_def	7763	-0.01912	0.37719	-7.87253	0.968676
mean_dev_hat_sa_pat_def_sq	7774	19.09419	535.1539	3.05E-11	32620.8
d_mean_dev_hat_sa_pat_def_sq	7774	-28.1475	2261.685	-196867	16077.73

'*Under review*' in *International Economic Review*.

abs_d_sa_export_earnings_def	7774	3.450971	16.88404	0.000066	852.8921
abs_d_mean_dev_ha t_sa_pat_def_sq	7774	41.36724	2261.482	6.83E-16	196867.1
ratio_abs_d_mean_dev_pat_d_export_earnings_def	7774	3026.805	262538.1	9.29E-16	2.31E+07
ln_ratio_abs_d_mean_dev_pat_d_export_earnings_def	7774	-4.04314	5.171312	-34.612	16.95738

Table A.2: Summary of Industries

co_industry_name	Freq.	Percent	Cum.
Agricultural machinery	18	0.23	0.23
Aluminium & aluminium products	72	0.93	1.16
Boilers & turbines	30	0.39	1.54
Castings & forgings	386	4.97	6.51
Caustic soda	2	0.03	6.53
Cloth	492	6.33	12.86
Coal & lignite	1	0.01	12.88
Communication equipment	19	0.24	13.12
Copper & copper products	30	0.39	13.51
Cotton & blended yarn	596	7.67	21.17
Diversified	6	0.08	21.25
Diversified cotton textile	107	1.38	22.63
Diversified machinery	56	0.72	23.35
Diversified metal & metal products	99	1.27	24.62
Drugs & pharmaceuticals	979	12.59	37.21
Dyes & pigments	259	3.33	40.55
Engines	33	0.42	40.97
Ferro alloys	103	1.32	42.29
Fertilisers	9	0.12	42.41
Gems & jewellery	9	0.12	42.53
General purpose machinery	177	2.28	44.8
Generators, transformers & switchgears	117	1.51	46.31
Industrial cooling equipment	6	0.08	46.39
Industrial machinery	133	1.71	48.1
Inorganic chemicals	161	2.07	50.17
Lubricants, etc.	39	0.5	50.67
Machine tools	55	0.71	51.38
Man-made filaments & fibres	213	2.74	54.12
Minerals	72	0.93	55.04
Mining & construction equipment	49	0.63	55.67
Miscellaneous electrical machinery	50	0.64	56.32
Organic chemicals	247	3.18	59.49
Other chemical products	303	3.9	63.39
Other electronics	173	2.23	65.62
Other ferrous metal products	225	2.89	68.51
Other industrial machinery	19	0.24	68.75
Other textiles	466	5.99	74.75
Pesticides	187	2.41	77.15
Pig iron	15	0.19	77.35

Plastic films & flexible packaging	141	1.81	79.16
Plastic packaging goods	100	1.29	80.45
Plastic tubes, pipes, fittings & sheets	115	1.48	81.93
Polymers	71	0.91	82.84
Readymade garments	433	5.57	88.41
Refinery	13	0.17	88.58
Rubber products	87	1.12	89.7
Sponge iron	9	0.12	89.81
Steel	389	5	94.82
Steel pipes & tubes	172	2.21	97.03
Synthetic rubber	5	0.06	97.09
Textile processing	112	1.44	98.53
Wires & cables	114	1.47	100
Total	7,774	100	