Outbound FDI by software companies

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Abstract

The HMY model makes the prediction that in a static setting, high-productivity firms self-select themselves to do FDI. This reflects a tradeoff between the fixed costs of FDI versus the costs of transportation which are encountered in exporting. In this paper, we examine a natural experiment where capital controls, which prevented outbound FDI by Indian software companies, were eased. Software services have two unique features: near-zero transportation costs, and non-commoditised products. We propose a model of the optimisation of the firm which yields a reversal of the HMY prediction: it predicts that the least productive firms will self-select themselves to do FDI. The empirical evidence supports this prediction.

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Contents

1 Introduction

The New Trade Theory has emphasised a firm-optimisation perspective on the linked decisions by firms to export or to do outbound FDI. It sees FDI as serving foreign customers through other means. Firms choose between serving domestic customers vs. producing at home to serve foreign customers vs. producing abroad to serve foreign customers, as three alternative paths towards maximising profit. This approach has given new insights into international trade and FDI.

The model developed by Helpman *et al.* (2004b) places heterogeneity in firm productivity at the heart of these questions. As an example, if embarking on exporting involves a certain fixed cost, then only more productive firms will cross this threshold since their payoffs from exporting will pay for this fixed cost. In equilibrium, firms will self-select themselves so that more efficient firms will export while less efficient firms will serve the domestic market. The models of the HMY approach generate predictions about which firms export and which firms do FDI based on the interplay between transportation costs and fixed costs.

In this paper, we examine the phenomena of exports and outbound FDI by Indian software companies. We identify two key characteristics which are unique to this problem. First, transportation costs for software are near-zero. This should encourage production at home. Second, software is non-commoditised, has myriad intangible characteristics, and customers may feel it is risky to buy software from a firm in a distant third world country. This should encourage FDI.

We integrate these features into a model of the optimisation of an Indian software company. The predictions of this model are a reversal of the standard HMY setting: it predicts that *less* efficient software companies should be more keen to engage in outbound FDI.

We test these predictions using a rich firm-level dataset for export and FDI by Indian software companies, and a natural experiment where capital controls against outbound FDI were eased. We observe some software companies which were the pioneers in doing outbound FDI, in the immediate period after outbound FDI was permitted. Several alternative strategies for productivity measurement are applied to this problem. There is significant support for the prediction of this model, that less productive companies are more inclined to do outbound FDI.

2 The problem of outbound FDI by software companies

Why do some firms decide to export or invest abroad while others produce for domestic markets? The recent literature has emphasised the role of differences in productivity, size, capital and skill intensity between firms in shaping these choices. When the cost of producing abroad is high, then exports might be preferred (Melitz, 2003; Helpman *et al.*, 2004a). Heterogeneity in productivity levels generates self-selection, as firms are faced with different costs in serving domestic and foreign markets. Only the most productive firms invest abroad. Less productive firms export, while the least productive ones serve their domestic markets. These arguments have found support in Head and Ries (2003, 2004); Kimura and Kiyota (2006); Tomiura (2007); Girma *et al.* (2004b,a).

In the context of FDI from industrialised countries Helpman *et al.* (2004a) (HMY) show that there is a hierarchy of firms sorted by productivity where more productive firms export and the most productive firms invest abroad. Head and Ries (2003) find empirical support for the HMY model from Japanese firms. Similar results are found in a small empirical literature on outbound FDI by Indian firms also (Demirbas *et al.*, 2009; Pradhan, 2004; Pradhan and of Development Research, 2006; Kumar, 2007).

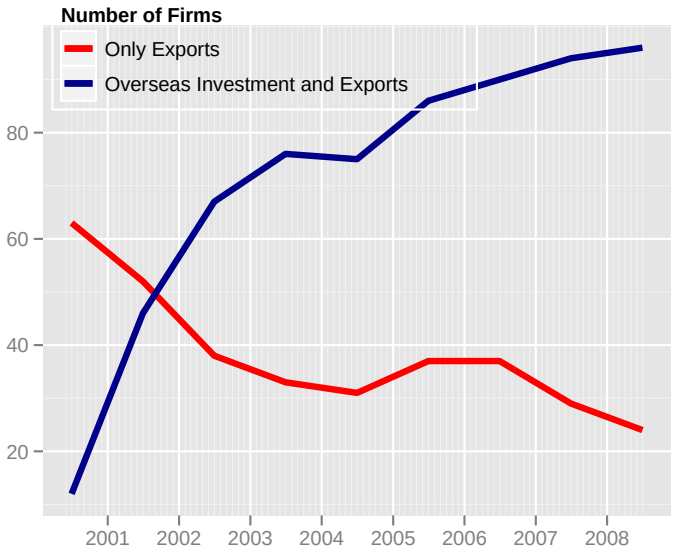
The Indian software industry has long had a strong export orientation. In this paper, we only focus on exporters. By the late 1990s, a strong set of domestic exporting firms had come together. However, at this time, they could not engage in outbound FDI owing to capital controls.

In 1999, capital controls which impeded outward FDI were eased. This gives us a natural experiment. When capital controls were eased, there was a sharp increase in the number of firms who undertook outbound FDI. At the same time, not all firms did outbound FDI. In this paper, we seek to obtain insights into outbound FDI by software companies using this natural experiment.

Figure 1 shows the time-series of the number of exporting software companies, and the number of exporting software companies who also had FDI, in the CMIE database. We see a sharp rise in the number of companies which did FDI in 2000, 2001 and 2002. In this paper, we focus on conditions in 2000, 2001 and 2002, which reflects the first flush of decisions after the removal of capital controls. The firms who setup operations outside India in this period after the capital controls were removed are likely to be the ones where the economic argument in favour of outward FDI is the strongest.

Figure 1 Exporting software companies who did outbound FDI vs. those that did not

This graph shows the time-series of the number of software exporting firms in the CMIE database in each year. This is broken down into two groups: those that have outbound FDI and those that do not. A sharp rise in the number of firms that had outbound FDI is visible in 2000-2002. In this paper, we focus on explaining the choices of firms to do outbound FDI vs. not do outbound FDI in 2000-2002.



The HMY framework, and other models of this tradition, are a *static* framework and do not address dynamic issues such as birth and death of firms, changes in firm productivity, etc. When explaining the evolution of the Indian software industry from 1999 to 2009, a dynamic framework would perhaps be more useful. In this paper, we focus on the immediate aftermath of the removal of capital controls. We focus only on the firms which did FDI in 2000, 2001 and 2002, and analyse this choice in a static setting.

The standard HMY framework would predict that this first wave of firms to engage in outward FDI would be the most productive firms. However, when we turn to the problem of exporting and FDI by Indian software companies, two key features loom large. The first is the issue of transportation cost. Transportation cost is roughly zero for software. If the only reason to do FDI was to avoid the cost of transportation, then there should be no FDI for software companies.

The second issue is the acutely non-commoditised nature of software. In a commodity such as steel, there are objective technical standards that define a certain grade of steel. The buyer of steel is fully confident in the steel that he has purchased, once it has passed certain technical tests, regardless of the nationality of the producing firm or the location of production. In contrast, software has myriad intangible characteristics. Customers sometimes take on strategic risk influencing the future of the entire firm, when they buy computer software services, which is the dominant activity of Indian software companies. There is significant uncertainty about the true characteristics of the software that is being purchased. The risk perceived by customers is likely to be greater when software is purchased from a foreign company as opposed to purchase from a local company.

These two features distinguish the software industry from the standard HMY setting. The uncertainty problem encourages Indian companies to do FDI while the transportation cost dimension discourages FDI. The interplay between productivity, uncertainty and transportation cost is not obvious. In order to understand the problem, we setup a model of the optimisation of the firm.

3 A model

3.1 Preferences

Consider an open economy where a continuum of differentiated goods is consumed. The representative consumer's utility is defined over a composite good Q given by $U = Q$. The composite good Q is given by a C.E.S function :

$$Q = \left[\int_{i \in \Omega} q(i)^{\epsilon} di \right]^{(1/\epsilon)} \quad 0 < \epsilon < 1 \tag{1}$$

where the measure of the set Ω denotes the mass of available goods and the elasticity of substitution between any two goods is $\sigma = 1/(1-\epsilon) > 1$.

3.2 Firms

There is a continuum of firms, each producing a different variety. The production technology uses only one factor, labor l and exhibits constant marginal cost and fixed over head cost. Firms are heterogeneous in terms of productivity level. We assume that firms are productive enough to operate in the domestic market. We focus on firms choice problem about the mode of serving the foreign market. The foreign demand faced by a firm is:

$$q(i) = \begin{cases} 0 & \text{with prob} \quad \gamma_j \\ Dp(i)^{-\sigma}, \quad \sigma = 1/(1-\epsilon) > 1 & \text{with prob} \quad 1-\gamma_j \end{cases} \tag{2}$$

where D is given from an individual firm's perspective and $j = X, I$. The consumer's perceived risk about the quality of imported software is greater when compared with that purchased from a local firm (Lee and Tan, 2003), so $\gamma_X > \gamma_I$.

The cost of transportation of software is zero. There is a fixed cost of exporting F_X, and F_I is the fixed cost associated with setting up a production unit abroad. The production function is given by

$$q(i) = A(l_i - F_{pl}) \quad pl = D, I \tag{3}$$

depending on whether the firm is exporting or investing abroad (pl stands for production location). The parameter A denotes productivity of the firm.

The firm, taking the demand for a variety as given, sets the price for that variety which maximises expected profit :

$$E(\Pi) = (1-\gamma_j)[q(i)p_i - w(l_i - F_{pl}) - F_j] + \gamma_j[-w(l_i - F_{pl}) - F_j] \qquad (4)$$

where $j = X \quad \text{if} \quad pl = D; \quad j = I \quad \text{if} \quad pl = I$, and it is assumed that there is no wage difference.

Using expressions in 2 and 3 and normalising the wage rate to 1, the expected profit is:

$$E(\Pi) = DA_i^{\sigma-1}\frac{1}{\sigma-1}\left(\frac{\sigma}{(1-\gamma_j)(\sigma-1)}\right)^{-\sigma} - F_j$$

Firms maximise $E(\Pi)$ and if the optimised profit in a certain activity is negative, they do not undertake that activity. The threshold productivity level associated with zero expected profit out of export and FDI are:

$$\begin{aligned} A_X^{*\,\sigma-1} &= \frac{F_X(\sigma-1)(\frac{\sigma}{\sigma-1})^\sigma}{D(1-\gamma_X)^\sigma} \\ A_I^{*\sigma-1} &= \frac{F_I(\sigma-1)(\frac{\sigma}{\sigma-1})^\sigma}{D(1-\gamma_I)^\sigma} \end{aligned}$$

These expressions indicate that for any finite value of F_X, F_I and γ_I, we can find a value of $\gamma_X \approx 1$, so that $A_X^* > A_I^*$. Thus, when the risk perception associated with export is large, the exporting firm that endogenises the risk of facing zero demand has to be more productive than a firm that does outbound FDI. Figure 2 illustrates these relationships.

4 Empirical testing

When capital controls against outbound FDI are eased in a country, the standard HMY framework predicts that the most productive firms would

Figure 2 Productivity Ranking of export and FDI firms

This graph shows the optimised profit (on the y axis) associated with alternative values of firm productivity (on the x axis). At the productivity threshold A_I^*, it is efficient for a domestic firm to do outbound FDI. At the productivity threshold A_X^*, it is efficient to export.

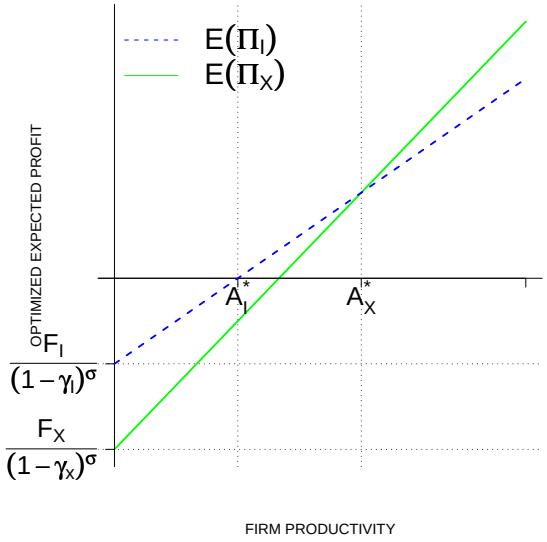


Table 1 Summary statistics about the dataset

			(Billion rupees)	
	Mean	25%	Median	75%
Sales	3.40	0.096	0.36	1.32
Total assets	4.24	0.25	0.634	1.32
Exports	2.75	0.028	0.194	0.88
Foreign investment	0.59	0.00	0.02	0.25

engage in outward FDI. However, in the case of the software industry, the model above – which focuses on the two unusual features of the software industry: zero transportation cost and the risk borne by customers owing to the non-standardised nature of software – yields the reverse prediction. We now turn to the empirical evidence to discriminate between these alternative explanations.

The dataset that we utilise is based on the firm-level database maintained by Centre for Monitoring Indian Economy (CMIE).[1] We use the term 'DX' for exporting companies which have no FDI and 'DXI' for firms which have both exports and FDI. Table 1 shows summary statistics about these firms.

CMIE observes most large firms present in the country in a given year. The exact set of firms who make up the dataset fluctuates from year to year, given birth and death processes, and non-observation of the firm by CMIE.

4.1 Testing

The CMIE dataset identifies firms which did FDI in 2000, 2001 and 2002. We seek to measure whether these firms were productive when compared with the firms who did not do FDI in these years. This requires measurement of productivity at the firm level. In the field of productivity measurement, many alternative techniques have been offered. Given the lack of consensus about a single ideal method, we apply many methods.

We use stochastic frontier analysis (henceforth SFA) developed by Aigner

[1]India has a long tradition of sound accounting standards. Publicly traded corporations face pressures from public shareholders and the securities regulator. Owing to these factors, Indian firm level data is of a high quality by the standards of emerging markets. CMIE has a well developed 'normalisation' methodology which ensures inter-year and inter-firm comparability of accounting data. This database has encouraged an emerging empirical literature, including papers such as Khanna and Palepu (2000); Bertrand *et al.* (2002); Ghemawat and Khanna (1998).

et al. (1977) and extended for panel data by Battese and Coelli (1992, 1995). Under SFA, we apply two methods: the Efficiency effect SFA model developed by Battese and Coelli (1995) and a time-varying SFA analysis.

1. The first strategy involves estimating a model of the form:

$$y_{it} = x'_{it}\beta - u_{it} + v_{it}, \quad u_{it} \geq 0 \tag{5}$$

The noise component v_{it} is i.i.d. $N(0, \sigma_v^2)$ and represents a systematic error which is not under control of the firm. The other component u_{it} accounts for the firms failure to produce maximum output given the set of inputs used, due to some factors which are unobserved but are under firm's control such as managerial ability. It provides a measure of technical efficiency or productivity of the firm. It is assumed that u_{it} follows a truncated normal distribution $N^+(Z_{it}\delta, \sigma_u^2)$ where U_{it} can be explained by firm-specific characteristics. The coefficients of inputs and factors determining productivity are simultaneously determined by maximum likelihood method.

We estimate the SFA model using sales as a proxy for output. Total wages paid, total asset, expenses on material and energy are used as inputs while a dummy indicating whether the firm invests abroad or not is used as an explanatory variable for technical efficiency of the firms.

Table 2 SFA analysis without raw material and energy as inputs

Coefficient	Estimate	Std. Error
(Intercept)	0.668299***	0.0797
Log Wages	0.249465***	0.0156
Log total assets	0.738533***	0.020
FDI dummy	-0.341159	0.182
$\sigma_u^2 + \sigma_v^2$	1.430967***	0.127
$\frac{\sigma_u^2}{\sigma_u^2+\sigma_v^2}$	0.850180***	0.0267

The first specification, shown in Table 2, treats total wages paid and total assets are considered as inputs. The coefficient $\sigma_u^2/(\sigma_u^2 + \sigma_v^2)$ is highly significant, which suggests that frontier analysis is required. We find that the dummy indicating OFDI status of the firm is negative though not significant at a 95% level using a two-tailed test. It is significant using a one-tailed test.

Table 3 SFA analysis with raw material and energy as inputs

Coefficient	Estimate	Standard error
(Intercept)	0.73033646***	0.084
Log Wages	0.24184873***	14.89
Raw material expenses	0.00031834	0.0004
Log total assets	0.72458337***	0.021
Energy expenses	0.00432048	0.003
FDI dummy	-0.41695749*	0.193
$\sigma_u^2 + \sigma_v^2$	1.46623764***	0.131
$\frac{\sigma_u^2}{\sigma_u^2+\sigma_v^2}$	0.85717722***	0.026

2. Table 3 shows an alternative specification where raw material and energy expenses are also used in the model. Here, the OFDI dummy is negative and significant.

3. We then estimate productivity by using a fixed-effect regression model:

$$y_{it} = \alpha_i + x'_{it}\beta + v_{it}$$

where the estimated α_i provides the measure of productivity. The ratio of α_i to its maximum value gives us a measure of relative productivity. We regress this measure of relative productivity on a dummy indication whether firm does OFDI. We find that the coefficient of the dummy is negative and significant: with a value of -0.3724 and a standard error of 0.1716.

4. Finally, we conduct a time-varying SFA estimation following Battese and Coelli (1992):

$$\begin{aligned} y_{it} &= x'_{it}\beta - u_{it} + v_{it}, \quad u_{it} \geq 0 \\ u_{it} &= u_i e^{\eta(t-T)} \quad u_i \quad \text{is} \quad iidN^+(\mu, \sigma_u^2) \end{aligned}$$

We test for first order stochastic dominance of the distribution of estimated productivities of one category over the other using the Kolmogorov-Smirnov test. We test whether productivity distribution of export firms and FDI firms are same:

$$H_0 : F_{\text{Ex}}(z) - F_{\text{FDI}}(z) = 0, \quad \text{vs} \quad H_1 : F_{\text{Ex}}(z) - F_{\text{FDI}}(z) \neq 0, \text{for all} z \in R$$

and whether the productivity of export firms stochastically dominates that of FDI firms

$$H_0 : F_{\text{Ex}}(z) - F_{\text{FDI}}(z) \leq 0, \quad \text{vs} \quad H_1 : F_{\text{Ex}}(z) - F_{\text{FDI}}(z) > 0, \text{for all} z \in R \neq 0$$

Table 4 Testing for stochastic dominance

	DX over DXI (p-value)		DXI over DX (p-value)	
Year	Two-sided	One-sided	Two-sided	One-sided
2000	5.269e-13	0.6902	5.269e-13	2.635e-13
2001	0.0001678	0.9784	0.0001678	8.388e-05
2002	1.131e-06	0.9655	1.131e-06	5.653e-07

The rejection of the null in two-sided test and non-rejection of null in one-sided test implies that the distribution of productivity of exporting firms stochastically dominates that of FDI firms, as predicted by our model. The results, shown in Table 4 show that this is indeed the case. If productivity distribution of DX firms stochastically dominates that of DXI firms then empirical cumulative distribution of the former will lie right to that of the latter. Figures 3, 4 and 5 show that in these three years this holds true for exporting and FDI firms in the Indian software industry.

5. We conduct our efficiency effect SFA analysis and fixed effect dummy variable regression analysis over the sample period of three years namely 2000, 2001 and 2002. Our SFA analysis indicate that OFDI firms tend to have lower efficiencies however the OFDI dummy coefficient is not significant.

Table 5 SFA analysis for sample of three years

Coefficient	Estimate	Std. Error
(Intercept)	0.77809843***	0.15392474
Log Wages	0.23813068***	0.03180916
Log total assets	0.74216488***	0.04464296
Raw material expenses	0.00089134	0.00166200
Energy expenses	0.01294631	0.02614751
FDI dummy	-0.31635160	0.32560326
$\sigma_u^2 + \sigma_v^2$	1.55219563***	0.20336600
$\frac{\sigma_u^2}{\sigma_u^2+\sigma_v^2}$	0.90167607***	0.02981549

Our fixed effect dummy regression also this three years sample period also indicates similar implications: We find that the coefficient of the

Figure 3 Technical efficiency difference between DX and DXI firms in 2000

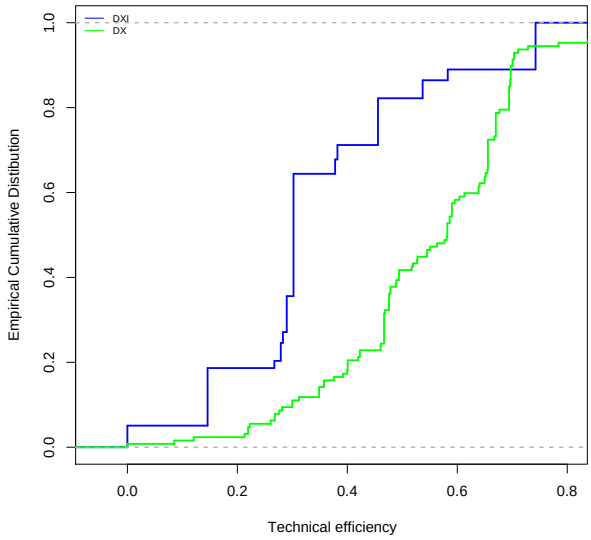


Figure 4 Technical efficiency difference between DX and DXI firms in 2001

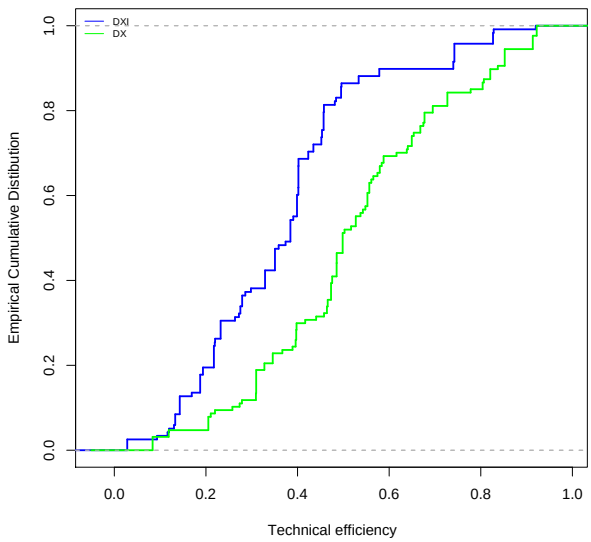
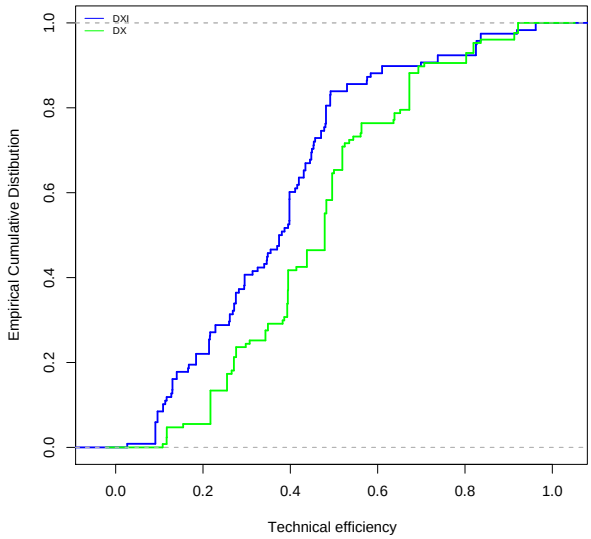


Figure 5 Technical efficiency difference between DX and DXI firms in 2002



dummy is negative and significant: with a value of -0.5448 and a standard error of 0.2117.

5 Conclusions

In this paper we attempt to explain the international business organization by firms in a sector with near-zero transport cost of exporting, where non-standardisation of the product implies that risk as seen by customers is greater when buying from an overseas supplier.

In our model, contrary to HMY hypothesis, the exporting firms' threshold productivity level to break even is higher compared to OFDI firms. We find support of our hypothesis in a natural experiment with the software industry of India, where we examine the characteristics of the early firms who setup FDI outside the country when capital controls were eased. We find that the exporting firms are more productive compared to OFDI firms.

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