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Technological Efforts, Firm Size and Exports In Basic Chemical Industry in India

Savita Bhat^[1] & K. Narayanan^[2]

^[1] *Ph. D. Scholar, Department of Humanities and Social Sciences, Indian Institute of Technology, Bombay*

^[2] *Associate Professor of Economics, Department of Humanities and Social Sciences, Indian Institute of Technology, Bombay, Powai, Mumbai 400076.
E mail: knn@hss.iitb.ac.in Fax: 91-22-25723480.*

Objective

To **examine** the role of **technological efforts** and **firm size** in determining the **export behavior** of firms belonging to the Basic Chemical industry in India.

Sample

Capitaline2000 database provided by Capital Market:

- Balanced panel of 91 firms from Chemical industry for time period 1997 to 2003
- Sample contains data on exporter as well as non-exporter firms

Methodology

- When sample contain zero values on dependent variable maximum likelihood estimation based limited dependent variable technique is more appropriate than ordinary least square regression technique (Green, 2002; Gujarati, 2003)
- Kumar and Siddharthan, 1994; Bhaduri and Ray, 2004; Siddharthan and Nollen, 2004; Narayanan, 2006 have followed Tobit model
- However Wakelin (1998), Sterlacchini (1999), and Basile (2001) test the suitability of the Tobit model with respect to double specification model (Probit + Truncation)

Methodology (contd.)

- **Tobit** technique intrinsically **assumes** the explanatory variables to have **same effect** on the **decision to export** and on the **export intensity**

However this **may not always be a correct assumption**.

- In **double specification** model (Probit + Truncation) effect of the explanatory variables on decision to export **first** analyzed for **complete sample** using **Probit** technique, **followed by** a **truncation** model fitted to analyze effect of explanatory variables on **export intensity of exporters**.

Tobit model is then a specific case of the more general double specification model

Methodology (contd.)

- Using **likelihood ratio test** one can determine whether the restriction of Tobit specification model is appropriate as compared to the unrestricted double specification model (**Sterlacchini**, 1999, and **Basile**, 2001). The likelihood ratio statistic is:

$$\lambda = -2 [\log L_T - (\log L_P + \log L_{TR})] \text{ (Green, 2002, p. 915)}$$

- Thus, following **Wakelin** (1998), **Sterlacchini** (1999), and **Basile** (2001), suitability of the **double specification model** (Probit + Truncation) tested as against **Tobit model** in the present study

Tobit model gets rejected in present study.

Indian Basic Chemical Industry

- Characteristics of Basic Chemical firms
 - Producers of **intermediate products**
 - Industry characterized to be **high volume, low value added, limited product differentiated** industry with **high entry barriers** due to **high capital requirement** and **stringent regulations** (KPMG-CHEMTECH, 2003).
 - Competitiveness through **efficiencies** in the underlying **process** of **production** and **quality of product**.
- Policy Environment in India during last One and a Half decades
 - Most **restrictions removed** except for hazardous chemicals and few specified drugs.
 - Most **chemicals** and petrochemical products **freely importable** and **tradable**.
 - **Automatic approval** of **foreign equity** up to 51 percent in most drugs and formulations.
 - After India becoming signatory to the general agreement on tariffs and trade (**GATT**) in 1993, firms have to adhere to **product** and **process patents**
- Activities taking place in the industry
 - Competing through **mergers** and **acquisitions, collaborations**, and rigorous **in-house R&D**

Indian Basic Chemical Industry (Contd.)

Export performance of Basic Chemicals during 1997-98 to 2003-04 period¹

(Indian Trade Classification based on Harmonised System or the ITC (HS))

| ITC HS Code → | HS 28 | HS 29 | HS 36 | HS 38 |
|--|--------|---------|-------|--------|
| Value of Exports (In US \$Million) in 1997-98 ¹ | 207.75 | 1214.98 | 15.17 | 350.65 |
| Value of Exports (In US \$Million) in 2003-04 ¹ | 424.09 | 2823.55 | 15.59 | 575.27 |
| Compound Export Growth Rate for the period 1997-98 to 2003-04 (in Percentage) ² | 12.63 | 15.09 | 0.456 | 8.60 |

¹ Data source is the data available on the website of Ministry of Commerce and Trade, Government of India.

² Here export growth rate is calculated as: $100 * (\text{Antilog} [1/6 * \text{Log} (\text{Value in period 03-04} / \text{Value in period 97-98})] - 1)$.

Top Three Export Destinations of Basic Chemicals during 1997-98 to 2003-04 period

HS28: Mainly to NE Asia, EU, and WANA

HS29: In all the periods EU, NE Asia, N. America (in the order of descending value of exports)

HS36: Mainly to WANA, E. Africa, and W. Africa

HS 38: Mainly to EU, WANA, and ASEAN

Variables and Cross Tabulations

The variables and their Definitions

| Sl. | Variable | Symbol | Definition Used in the Study |
|-----|---|-------------|---|
| 1 | Export Intensity | EXPI | (FOB Value of Exports / Sales Turnover of the firm) * 100 |
| 2 | R&D Intensity | RDI | (Expenditure on R&D / Sales Turnover of the firm) * 100 |
| 3 | Import of embodied technology (capital goods) Intensity | MKI | (Expenditure on import of capital goods / Sales Turnover of the firm) * 100 |
| 4 | Import of disembodied technology Intensity | LRI | (Lump sum, royalty, and technical fees payments in foreign currency / Sales Turnover of the firm) * 100 |
| 5 | Size in terms of Market Share | SIZE | (Sales Turnover of the firm / Sum of the Sales Turnover of all the firms) * 100 |
| 6 | Age of the firm | AGE | One added to the difference between the year of incorporation and the year in the study |
| 7 | Advertisement Intensity | ADVT | (Expenditure on advertisements/ Value Added by the firm) * 100 |
| 8 | Vertical Integration | VI | (Value Addition by the firm / Sales Turnover of the firm) * 100 |
| 9 | Choice of Technology | LABCAP | (Expenditure on Wages, Salaries and Bonuses / Gross Block of the firm) * 100 |
| 10 | Foreign Equity Participation | D_{fe} | $D_{fe} = 1$ when foreign equity participation exists $D_{fe} = 0$ otherwise |
| 11 | Ownership | D_{house} | $D_{house} = 1$ when observation is owned by a business house $D_{house} = 0$ otherwise |
| 12 | Organic Chemical Firm | D_{org} | $D_{org} = 1$ when observation is organic chemical producer $D_{org} = 0$ otherwise |

Minimum & Maximum Value, Mean and Standard Deviation for the sample

| Variables | Minimum | Maximum | Mean | Std. Deviation |
|------------------|----------------|----------------|-------------|-----------------------|
| EXPI | 0 | 99.321 | 15.827 | 24.087 |
| RDI | 0 | 6.710 | 0.386 | 0.970 |
| MKI | 0 | 0.397 | 0.004 | 0.02 |
| LRI | 0 | 4.610 | 0.114 | 0.466 |
| SIZE | 0.0009 | 7.963 | 0.892 | 1.107 |
| AGE | 1 | 82 | 25.74 | 14.31 |
| ADVT | 0 | 40.21 | 1.36 | 4.49 |
| LABCAP | 0 | 46.43 | 7.47 | 7.16 |
| VI | 2.992 | 433.333 | 35.178 | 23.618 |

Total Number of Observations = 637

Mean with Standard deviation (in parenthesis) for Non-Exporters & Exporters and Inorganic & Organic groups

| Variables | Non-Exporters | Exporters | Inorganic | Organic |
|---------------|-----------------|----------------|----------------------------|----------------------------|
| EXPI | - | 22.45 (25.97) | 10.34 [†] (20.40) | 18.27 [†] (25.19) |
| RDI | 0.06* (0.17) | 0.52* (1.12) | 0.14 [†] (0.40) | 0.49 [†] (1.11) |
| MKI | 0.0009* (0.004) | 0.006* (0.03) | 0.004 (0.02) | 0.005 (0.02) |
| LRI | 0.11 (0.51) | 0.11 (0.45) | 0.10 (0.39) | 0.12 (0.50) |
| SIZE | 0.39* (0.46) | 1.10* (1.22) | 0.50 [†] (0.43) | 1.06 [†] (1.26) |
| AGE | 22.46* (16.20) | 27.11* (13.21) | 27.28 [†] (12.18) | 25.05 [†] (15.12) |
| ADVT | 2.19* (6.09) | 1.02* (3.56) | 1.3 (5.72) | 1.39 (3.82) |
| LABCAP | 4.92* (4.87) | 8.53* (7.68) | 8.66 [†] (8.49) | 6.94 [†] (6.42) |
| VI | 35.32 (36.74) | 35.12 (15.11) | 41.86 [†] (14.85) | 32.21 [†] (26.07) |
| NOB | 188 | 449 | 196 | 441 |

* indicates the differences in the means of the firm characteristic for Non-Exporters and Exporters at t-statistic significance level better than or equal to 5 percent

[†] indicates the differences in the means of the firm characteristic for Inorganic and Organic firms at t-statistic significance level better than or equal to 5 percent

Correlation Matrix (NOB = 637)

| | EXPI | RDI | MKI | LRI | AGE | SIZE | ADVT | LABCAP | VI |
|--------|--------|-------|-------|---------|-------|--------|-------|--------|------|
| EXPI | 1.00 | | | | | | | | |
| RDI | 0.04 | 1.00 | | | | | | | |
| MKI | 0.06 | -0.02 | 1.00 | | | | | | |
| LRI | -0.08* | -0.04 | 0.04 | 1.00 | | | | | |
| AGE | -0.19* | 0.27* | -0.03 | 0.19* | 1.00 | | | | |
| SIZE | -0.03 | 0.53* | 0.02 | 0.16* | 0.29* | 1.00 | | | |
| ADVT | -0.12* | 0.06 | -0.04 | -0.03 | -0.04 | 0.28* | 1.00 | | |
| LABCAP | -0.06 | 0.32* | -0.05 | -0.0001 | 0.45* | 0.21* | 0.002 | 1.00 | |
| VI | -0.08* | -0.02 | 0.004 | -0.05 | 0.02 | -0.11* | -0.06 | -0.04 | 1.00 |

* indicates statistical significance at 10%

Variance Inflation Factor (VIF) and Breusch-Pagan / Cook-Weisberg test results

| Variables | Full Sample (NOB: 637) | | Inorganic Firms (NOB: 196) | | Organic Firms (NOB: 441) | |
|---|--|-------|--|-------|--|-------|
| | VIF | 1/VIF | VIF | 1/VIF | VIF | 1/VIF |
| RDI | 1.56 | 0.64 | 1.97 | 0.51 | 1.54 | 0.65 |
| MKI | 1.02 | 0.98 | 1.07 | 0.94 | 1.02 | 0.98 |
| LRI | 1.14 | 0.88 | 1.27 | 0.79 | 1.16 | 0.86 |
| AGE | 1.45 | 0.69 | 1.50 | 0.67 | 1.52 | 0.66 |
| SIZE | 1.85 | 0.54 | 1.83 | 0.55 | 1.88 | 0.53 |
| ADVT | 1.14 | 0.87 | 1.43 | 0.70 | 1.23 | 0.81 |
| LABCAP | 1.37 | 0.73 | 2.56 | 0.39 | 1.41 | 0.71 |
| VI | 1.06 | 0.95 | 1.24 | 0.81 | 1.02 | 0.98 |
| D _{fe} | 1.16 | 0.86 | 1.30 | 0.77 | 1.19 | 0.84 |
| D _{house} | 1.21 | 0.83 | 1.33 | 0.75 | 1.27 | 0.78 |
| D _{org} | 1.18 | 0.85 | - | - | - | - |
| Mean VIF | 1.28 | - | 1.55 | - | 1.32 | - |
| Breusch-Pagan / Cook- Weisberg test | Chi ² = 87.06 Prob > Chi ² = 0.0000 | | Chi ² = 94.72 Prob > Chi ² = 0.0000 | | Chi ² = 55.25 Prob > Chi ² = 0.0000 ¹³ | |

Model

- Tobit:

$$\text{EXPI}^* = \alpha_0 + \alpha_1 \text{RDI} + \alpha_2 \text{MKI} + \alpha_3 \text{LRI} + \alpha_4 \text{SIZE} + \alpha_5 \text{AGE} + \alpha_6 \text{ADVT} + \alpha_7 \text{LABCAP} + \alpha_8 \text{VI} + \alpha_9 \text{D}_{fe} + \alpha_{10} \text{D}_{house} + \alpha_{11} \text{D}_{org} + u_1$$

$$\text{EXPI} = 0 \quad \text{if } \text{EXPI}^* \leq 0$$

$$= \text{EXPI}^* \quad \text{if } \text{EXPI}^* > 0$$

- Probit:

$$\text{DX} = \alpha_0 + \alpha_1 \text{RDI} + \alpha_2 \text{MKI} + \alpha_3 \text{LRI} + \alpha_4 \text{SIZE} + \alpha_5 \text{AGE} + \alpha_6 \text{ADVT} + \alpha_7 \text{LABCAP} + \alpha_8 \text{VI} + \alpha_9 \text{D}_{fe} + \alpha_{10} \text{D}_{house} + \alpha_{11} \text{D}_{org} + u_1$$

$$\text{X} = 0 \quad \text{if } \text{DX} \leq 0$$

$$= 1 \quad \text{if } \text{DX} > 0$$

- Truncated:

$$\text{EXPI} = \alpha_0 + \alpha_1 \text{RDI} + \alpha_2 \text{MKI} + \alpha_3 \text{LRI} + \alpha_4 \text{SIZE} + \alpha_5 \text{AGE} + \alpha_6 \text{ADVT} + \alpha_7 \text{LABCAP} + \alpha_8 \text{VI} + \alpha_9 \text{D}_{fe} + \alpha_{10} \text{D}_{house} + \alpha_{11} \text{D}_{org} + u_1 \quad \text{if firm exports}$$

Tobit, Probit and Truncation model results (Full Sample)

| | Tobit | Double Specification | |
|--------------------|----------------------------------|----------------------------------|------------------------------------|
| | | Probit (Robust) | Truncation (Robust) |
| Const. | 6.78 (1.48) | -0.50 (-2.52) ^b | 77.86 (1.50) |
| RDI | 1.23 (0.82) | 0.21 (2.21)^b | 15.52 (1.71)^c |
| MKI | 73.68 (1.51) | 12.53 (1.31) | 30.45 (0.09) |
| LRI | -2.67 (-0.95) | -0.14 (-1.02) | -144.41 (-2.31)^b |
| AGE | -0.54 (-5.09)^a | -0.02 (-2.77)^a | -6.27 (-3.33)^a |
| SIZE | 2.07 (1.42) | 0.67 (4.49)^a | -28.89 (-2.61)^c |
| ADVT | -1.74 (-4.70)^a | -0.07 (-3.71)^a | -21.72 (-2.33)^b |
| LABCAP | 0.32 (1.66)^c | 0.06 (4.77)^a | -3.04 (-1.40) |
| VI | -0.08 (-1.24) | 0.002 (0.96) | -2.55 (-2.64)^b |
| D _{fe} | 14.06 (5.07)^a | 0.55 (3.88)^a | 54.37 (2.44)^b |
| D _{house} | 12.75 (4.71)^a | 0.96 (6.64)^a | -26.28 (-1.17) |
| D _{org} | 9.20 (3.17)^a | 0.15 (1.16) | 72.26 (1.95)^c |
| NOB | 637 | 637 | 449 |
| Chi ² | 99.64^a | 142.34^a | 18.71^c |
| LL | -2283.16 | -280.51 | -1766.54 |

Value in bracket is t-statistics for tobit and z-statistics for probit and truncation
Statistically significant values are represented in bold where ^a, ^b, and ^c denote 1%, 5% and 10% significance level respectively

Tobit, Probit and Truncation model results (Organic & Inorganic)

| | Inorganic Group | | | Organic Group | | |
|--------------------|----------------------------------|----------------------------------|-----------------------------------|----------------------------------|----------------------------------|-----------------------------------|
| | Tobit | Double Specification | | Tobit | Double Specification | |
| | | Probit (Robust) | Trunc. (Robust) | | Probit (Robust) | Trunc. (Robust) |
| Const. | 28.99 (4.14) ^a | -0.61 (-1.28) | 141.55 (4.92) ^a | 5.75 (1.36) | -0.59 (-3.41) ^a | 82.82 (2.81) ^a |
| RDI | 4.48 (0.78) | 0.57 (0.60) | 27.32 (1.89)^c | 0.93 (0.59) | 0.21 (2.30)^b | 10.78 (1.52) |
| MKI | 11.42 (0.14) | 39.10 (1.60) | -557.05 (1.26) | 71.86 (1.27) | 6.75 (0.77) | 71.19 (0.32) |
| LRI | -8.01 (-1.63) | -1.07 (-2.72)^a | -22.80 (-0.92) | -1.73 (-0.53) | -0.07 (-0.40) | -85.98 (-2.07)^b |
| AGE | -1.09 (-5.99)^a | -0.04 (-3.70)^a | -10.48 (-5.00)^a | -0.35 (-2.82)^a | -0.006 (-0.84) | -2.89 (-3.21)^a |
| SIZE | 22.38 (4.17)^a | 3.00 (4.34)^a | 89.71 (3.56)^a | -0.10 (-0.07) | 0.43 (3.97)^a | -32.30 (-3.41)^a |
| ADVT | -2.94 (-1.65) | -0.17 (-3.64)^a | -6.11 (-1.02) | -1.32 (-3.10)^a | -0.06 (-2.60)^a | -13.80 (-2.46)^b |
| LABCAP | 0.23 (0.71) | 0.09 (3.08)^a | 2.35 (2.23)^b | 0.17 (0.63) | 0.04 (3.15)^a | -2.34 (-1.38) |
| VI | -0.12 (-0.90) | 0.009 (1.11) | 0.26 (0.26) | -0.03 (-0.42) | 0.003 (1.04) | -2.01 (-2.40)^b |
| D _{fe} | -5.66 (-1.36) | 0.20 (0.77) | -61.18 (-3.05)^a | 24.27 (7.06)^a | 0.85 (4.78)^a | 69.76 (3.54)^a |
| D _{house} | 1.40 (0.35) | 0.07 (0.26) | -46.56 (-3.09)^a | 20.05 (5.84)^a | 1.47 (7.55)^a | 0.47 (0.03) |
| NOB | 196 | 196 | 130 | 441 | 441 | 319 |
| Chi ² | 65.03^a | 59.80^a | 40.38^a | 83.92^a | 143.26^a | 25.47^a |
| LL | -629.75 | -81.23 | -406.54 | -1619.73 | -177.19 | -1296.74 |

Value in bracket is t-statistics for tobit and z-statistics for probit and truncation

Statistically significant values are represented in bold where ^a, ^b, and ^c denote 1%, 5% and 10% significance level respec.

Marginal Effects

| | Double Specification | | | | | |
|---------------|----------------------|------------------------|--------------------|------------------------|--------------------|------------------------|
| | Full Sample | | Inorganic Group | | Organic Group | |
| | Probit (Robust) | Truncation (Robust) | Probit (Robust) | Truncation (Robust) | Probit (Robust) | Truncation (Robust) |
| RDI | 0.06 | 0.96 | - | 1.28 | 0.05 | - |
| LRI | - | -8.91 | -0.27 | - | - | -9.32 |
| AGE | -0.004 | -0.39 | -0.01 | -0.49 | - | -0.31 |
| SIZE | 0.18 | -1.78 | 0.75 | 4.21 | 0.10 | -3.50 |
| ADVT | -0.02 | -1.34 | -0.04 | - | -0.01 | -1.50 |
| LABCAP | 0.01 | - | 0.02 | 0.11 | 0.01 | - |
| VI | - | -0.16 | - | - | - | -0.22 |
| D_{fe}^* | 0.13 | 3.53 | - | -2.66 | 0.18 | 8.35 |
| D_{house}^* | 0.23 | - | - | -2.31 | 0.31 | - |
| D_{org}^* | - | 4.09 | - | - | - | - |
| NOB | 637 | 449 | 196 | 130 | 441 | 319 |

* dy/dx is for discrete change of dummy variable from 0 to 1

Summary and Conclusion

1. Study also finds that investment on **technological strategies** is **important determinant** of **export** behavior of a firm.
Effect of the technology variables is **different for** the **probability** of exporting, and **export intensity** of the exporters.
Except for MKI all others, namely, **RDI, LRI, FE** have turned out to be **statistically significant** in determining export behavior of the firms.
2. There are differences in the intrinsic characteristics of the **organic and inorganic** firms which results in **dissimilarity** in the effects of the explanatory variables on the export behavior for the two groups.

Summary and Conclusion (Contd.)

3. **Organic firms:** Those having **FE** or investing more on **RDI** more likely to export than others. **Once exporting, only** brand names & tacit knowledge from **FE** holders important for export intensity.

Higher **LR** detrimental on EXPI. Possible reason: products generated using the imported technology new for local market → demand for products in local market increases → shrinking export market.

RDI important **for X** but **not for EXPI** implies some product quality improvements required for reaching level of export market but once into exports incremental improvements unimportant.

Inorganic firms: ↓ **LR** implies ↑ **X**. Possible reason: Few inorganic firms in domestic market → **better-quality** chemicals produced by **using** the imported **LR** get **sold in the domestic market** → **little left for export**. But **for exporters** only incremental innovation through **RDI** important to ↑ EXPI.

FE reducing exports. To draw firmer conclusions, further investigation needs to be carried out.

Summary and Conclusion (Contd.)

4. **Larger firms** have more resources and power therefore more likely to export. However **once exporting** firm **size negatively** affects EXPI.

However, for inorganic group, **size** is important **+ive** factor for both, **probability of X** and **EXPI**

5. **Younger firms** more likely to export than the older and more experienced firms. Following Bhaduri and Ray (2004), one can argue- **newer firms** finding the **domestic market too crowded** are using **export-oriented policy** from the beginning.
6. Firm adopting **labor-intensive technology** more likely to export than a firm using capital-intensive technology. In India **human resource is abundant** and **inexpensive**. Employing more highly **trained technicians** can help the firm in bringing down the cost of production and increasing the quality of the chemicals

Summary and Conclusion (Contd.)

7. Rigorous **marketing strategy** unfavorable for X. Likely Reason: **Not much scope for product differentiation** → excessive advertising **pulling up price** of product.

So, firm desirous of improving EXPI should try to make investments on other activities like in-house R&D efforts rather than on promotional activities alone.

8. For **organic**: high **VI** detrimental for export intensity. After liberalization process began most of the **chemicals freely importable** → internalizing more stages of the production process deterrent for product diversification, i.e., **subcontracting firm more flexible** in terms of the kind of raw materials used for diversified products for export market.

9. Belonging to a **business house** positively determines the **probability** of an organic firm becoming an exporter. Firm is able to use all the resources including brand name of the business house to venture into export market

Thank You

For your attention