CHAPTER V

FIRM SIZE and EXPORTS:

Technical and Allocative Efficiency:
The Empirical Analysis.

In the previous Chapter the direct relationship between firm size and exports and the effect of certain specific variables on firm level exports through the firm size factor is established. The effect of the variables like capital and labour intensity and financial efficiency measures on exports through firm size factor has implicit implications on technical and allocative efficiency differentials across firms in relation to exports. As argued in Chapter III, the firm level efficiency differentials are not only in terms of firm level utilization of inputs but also in terms of adopting the optimum choice of techniques in accordance with the domestic factor endowments and technological conditions. The present Chapter explicitly brings out the firm level technical and allocative efficiency variables to empirically examine their effect on exports through firm size variable.

In equations II and III of the previous chapter a simple measure of firm level financial efficiency was used mainly to empirically examine the efficiency aspect at the aggregate industry sample. This is because technical efficiency measures are not applicable to the samples which consists of firms belonging to different
industries. In the present chapter firm level relative technical and allocative efficiency measures are estimated for a sample of firms belonging to an industry at the disaggregate level. A comparison of the results with financial efficiency measure and the results at the disaggregate industry should facilitate certain generalizations and also to test for their consistency.


The firm level relative efficiency measures are derived following Farrell's (1957) production frontier approach. Farrell's original approach in measuring technical efficiency (TE) is a non-parametric one, where a technology envelope or frontier is derived from observed (scattered) technical coefficients (the capital and labour ratios).

As shown in Diagram IV the scattered observations give the K and L combinations employed by different firms to produce an unit of output under the existing technology of an industry. Observations below the isoquant are not technologically feasible. The observations above the frontier indicate the presence of technical inefficiency. By taking the derived isoquant one can derive firm level allocative efficiency (AE) under the constraint imposed by the factor price line 'wr', on cost minimization. On the basis of the above Diagram:

\[ ab = \text{TE} \]
\[ bc = \text{AE} \]
K = Capital Employed
L = Labour Employed
W = Wage Rate
P = Price of capital
Y = Output
Nishimizu and Page (1982) and also Little et al (1987) argue that the concept of TE is similar to the concept of total factor productivity (TFP). The extent of actual output is less than potential output is equivalent to the difference between total factor productivity that is based on the best practice and that of the actual practice of a firm. The potential output for a given level of inputs is determined by the most efficient firms in the industry, which lie on the frontier. Diagram V illustrates the argument. The points 'a, b, and c' are three levels of outputs realized by a given level of inputs; with 'a' being the potential or the maximum output that can be realized. Y1 and Y2 can also be taken as two different levels (or vintage) of technology of say firm 'A' and 'B'. If both firms are on their respective frontiers, the technical efficiency differences between the two firms can be taken to be only due to technology differences or distance between the firms. The TFP or TE differences between firms in an industry can be taken as consisting of both differences in technical efficiency (ac) and also differences in technological levels (ab).

Therefore the TE measure is a relative measure across firms in an industry. Therefore if the usual assumption of homogenous technology across firms in a sample fails and firms in an industry operate with different levels (differences in the vintage) or types of technology.

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the estimated TE measure captures the technical efficiency differences across firms not only due to excess use of inputs under a given technology but also the efficiency differences due to technological gap between firms.

The later aspect of technical efficiency differences across firms due to differences in technology levels adopted by different firms within an industry is highly relevant in the present context, especially in explaining exports. The technology difference across different size group of firms and its implications on technical efficiency is relevant because it is argued that large firms generally operate with imported technology and small firms operate with indigenous technology. As argued in Chapter III.11, whichever firms within the industry that adopt the technologies that are closer to the domestic comparative advantage in certain technological characteristics of the country should be more relevant to exports.

The firm level AE measure is based on the neo-classical approach which ignores one other dimension of allocative efficiency that is of Lebenstein's (1980) x-efficiency. There could be efficiency differences across firms in terms of costs incurred for realization of a given level of output due to organizational x-efficiency in the allocation of factors of production within a firm in accordance with their
opportunity costs. For example, employees may have differences in their opportunity costs within a firm determined by their respective aptitudes and motivations. The management which realizes these aspects and allocates functions according to the aptitudes of the employees might be able to realize higher output for a given level of inputs than a firm which does not realize these x-efficiency factors. Empirically, it is extremely difficult to segregate the extent of firm level x-efficiency, as it requires information regarding the issues like motivation of the managers and labour etc. Relative x-efficiency across firms can partly reflect in the TE measure as the TE measure is a relative measure. Higher relative X-efficiency could result in higher relative total factor productivity.


The production relation between inputs and outputs is taken to be purely a technological relationship. A given technology of an industry determines the possible combinations of inputs on a frontier to produce a unit of output. Farrell's estimation of the efficient isoquant is non-parametric in approach in the sense that he simply constructs the free disposable convex hull of the observed input-output ratios by linear programming techniques. No functional form is imposed on the data but constant returns to scale are assumed. Aigner and Chu (1968) are the first
ones to apply Farrell's approach to parametric estimation. The principle advantages of the parametric approach are its ability to characterize frontier technology in a simple mathematical form and its ability to accommodate non-constant returns to scale. The disadvantage could be that it imposes structure on the frontier that may be unwarranted.

Even though a functional production form may be imposed on the frontier, in the present analysis TE is taken to be determined purely by the technological relationship between inputs and outputs. The production relation, in simple terms, can be expressed as:

\[ Y = (X;B) + u ; \]

where 'Y' is a vector of output observations, 'X' is a matrix of input observations, 'B' represents the parameters and 'u' represents the one sided error. The one sided error term forces \( Y \leq f(X) \).

In general estimations of production functions, 'u' is specified to be normally, independently and identically distributed with zero mean and finite variance. Frontier estimations, from the above specification, takes 'u' to have a negative expectation indicating presence of technical inefficiency in production. The crucial aspect of the estimation of TE is the specification of the distribution of 'u', which in

\[ \text{Forsund et al (1980) pp 10.} \]
turn determines the possible efficient econometric estimators.

The frontier is called deterministic if all the observations must lie on or below the frontier and stochastic if observations can be above the frontier due to random events. In case of the deterministic frontier the technical inefficiency (the negative expectation of the error) is purely due to managerial failure to arrive at the efficient frontier. In case of the stochastic function, a firm could be technically inefficient due to the reasons beyond it’s control.

The one sided error component in the above specification would imply the frontier is deterministic. If we impose Cobb-Douglas production form on the above specification, it can be specified as:

\[ Y = f(X) e^{u} \]

\[ \log Y = \log [f(X)] - u \]

where \( u \geq 0 \) and thus \( 0 \leq e^{-u} \leq 1 \) and where \( \log [f(X)] \) is linear in the Cobb-Douglas case. It is assumed that the observations \( u \) are independently and identically distributed and \( X \) is 'exogenous', independent of \( u \). Any number of distributions for \( u \) can be specified. Afriat (1972) specified a two parameter beta distribution for \( e^{-u} \) and proposed that the equation could be estimated by maximum likelihood method, which would mean a gamma distribution for \( u \). \(^3\)

\(^3\) Richmond (1974).
As suggested by Richmond (1974) the above Cobb-Douglas specification can be estimated by ordinary least squares (OLS) by a simple modification. If we let \( w \) be the mean of \( u \), we can write:

\[
\log Y = (\beta_0 - w) + \sum_i \beta_i \log X_i - (u-w)
\]

where \( w \) has zero mean. The error term satisfies all the usual properties except normality. The above equation can be estimated by OLS to obtain the best linear unbiased estimates of \((\beta_0 - w)\) and \(\beta_i\). The estimated residuals can be used to correct the OLS constant term. One of the possible drawbacks of the above method in measuring technical inefficiency for individual observations is that some of the residuals may still end up above the estimated frontier. One way this problem can be resolved is that the constant term can be corrected by shifting it up until no residual is positive and one is zero and take deviations of rest of the observations to estimate TE. 4 This can be illustrated in Diagram VI. \('a'\) is the estimated constant and \('a*'\) is the corrected constant. All the observations except one (c) lie below \('Y*'\). The deviations of the observations from \('Y*'\) can be measured to estimate firm level TE.

The above specification as mentioned earlier is a deterministic frontier. A composite error or a two sided

error specification leads to stochastic element in efficiency in the sense of systematic efficiency differences between production units and random differences. The specification of stochastic frontier can be:

\[ Y = f(X) \exp(v-u). \]

The error consists of the symmetric components, which are assumed to be independently and identically distributed. The error component `u` is assumed to be distributed independently of `v`. The symmetric component permits the random variations of the frontier across firms and capture the effects of measurement error, other statistical `noise` and random shocks beyond the control of the firms.

The major defect of the stochastic frontiers is that it is not possible to decompose individual residuals into their two components and so it is not possible to estimate technical inefficiency for each observation. Broeck et al. (1980) observe `the choice between deterministic and stochastic frontiers must be made on the basis of `the information about the quality of the data`.

\[ ^5 \text{Aigner et al.(1977), Meesen et al.(1977), Broeck et al.(1980).} \]

\[ ^6 \text{Aigner et al.(1977) pp 24.} \]

\[ ^7 \text{Forsund et al.(1980).} \]
or how the data are generated and above all the purpose of the study.\textsuperscript{8}

Obviously, as we are interested in measuring relative extent of inefficiency across firms in a sample, the deterministic frontier specification is taken for the estimation of firm level relative TE. One of the limitations of the deterministic frontiers is the problem of extreme 'outliers' which can overestimate firm level inefficiency or efficiency. The possible solution to the problem is to remove the observations which are suspected to cause the extreme outliers from the sample.

The Production Function.

The production function is taken to be a two inputs function; labour (L) and capital (K). The extent of firm level efficiency can be influenced by the omission (or non-measurement) of relevant inputs and also by measurement errors. In such a case the accuracy of the estimated TE can be questionable. A fair amount of the residual factor in the estimation of production function could be due to omission of information regarding the managerial inputs and also technology vintage differences between firms.\textsuperscript{9} The managerial input reflects especially on the degree of X-efficiency in a firm. Since the managerial and

\textsuperscript{8} pp 138.

\textsuperscript{9} Page (1984) pp 133.
vintage factor are built into the theory (see Chapter III.III) and the objective here is towards measuring relative efficiency indices across firms, the two input production functions should serve the purpose to a large degree.

As far as the choice of the functional forms is concerned, the most appropriate form for the exercise is the translog production function due to it's relative merits in capturing the underlying functional relationships especially in the present case where the sample consists of firms with a large degree of size distribution. 10 Cobb-Douglas functional specification is also used in such cases where the size distribution of firms in a sample is not large. Expressing in logarithms, the translog case takes the form:

\[ \log Y = \log a + b_1 \log L + b_2 \log K + b_3 \log \frac{1}{2} (\log L)^2 + b_4 \frac{1}{2} (\log K)^2 + b_5 (\log L \times \log K) + u. \]

The form reduces to Cobb-Douglas if the parameters \( b_3, b_4 \) and \( b_5 \) are zero and insignificant. In the present case, the translog function is more appropriate than Cobb-Douglas as it imposes fewer a priori restrictions on the properties of the underlying technology. The basic limiting properties of Cobb-Douglas form are;

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10 For the derivation of the translog production function, see Christensen et al (1973) and (1971) for review of literature on the translog functions see Barua (1985) and Chakraborty (1983). And also see Little et al (1985) for a discussion of the relative merits of the translog case for an exercise of the present kind.
i) The elasticity of substitution between $L$ and $K$ is constant and equal to 'one'.

ii) The output elasticities $(\frac{d\log Y}{d\log L})$ are constant (so are the factor shares).

iii) It imposes the homothecity conditions. The optimal factor proportions are independent of scale.

In a case where the sample consists of firms with large of size or scale differences, which is the case in the present context, it is highly likely that the above conditions fail to hold. The translog function relaxes the above conditions. The output elasticities with respect to inputs are:

$$(\frac{d\log Y}{d\log L}) = b_1 + b_3 \log L + b_5 \log K$$

Under the producers equilibrium;

$$(\frac{d\log Y}{d\log L}) = (wL/pY) ; (\frac{d\log Y}{d\log K}) = (rK/pY) ;$$

'w' is the wage rate and 'r' is the price of capital and 'p' is the price of output.

When $(\frac{d\log Y}{d\log L})$ and $(\frac{d\log Y}{d\log K}) > 0$, the value shares of the respective factors increases as the quantity of the inputs increases at constant factor and product prices, holding all other inputs constant. In contrast when the output elasticities are less than '0', the opposite case holds. As a result the factor shares are also variables depending on the scale. Consequently the elasticity of substitution between the inputs is variable with the changes in the scale (the parameters $b_3$, $b_4$ and $b_5$ provide the
information on the curvature of the function and the elasticity of substitution).

In case of Cobb-Douglas form, the function is self-dual i.e. both the production and cost functions belong to the same group of functional form. But the translog functions are not self-dual.

Since both the translog and Cobb-Douglas functions are linear in parameters and non-linear in the variables, OLS can be applied in estimating the functions. 11

V.I.II. Estimation of Allocative Efficiency.

As mentioned earlier, firm level allocative efficiency is observed in terms of choosing the optimum point on the frontier determined by the relative input prices (the factor price line). By taking the production frontiers approach, Schmidt and Lovell (1979), decomposed technical and allocative efficiencies. They take that departures from minimum cost are a result of both technical and allocative inefficiencies. Since a frontier cost function standard alone can not define the two components, they employ a stochastic frontier production function and the necessary conditions for a cost minimum to identify both technical and allocative inefficiency. They take the variations in output attributed to technical inefficiency and introduce a composite stochastic

disturbance structure. Violations of the necessary conditions are modelled by a symmetric disturbance and lead to allocative inefficiency. The production parameters are estimated by maximum likelihood techniques. The estimated parameters are then substituted into the necessary conditions equations and the residuals from these equations are used to estimate allocative inefficiency. The merit of this methodology is that it can estimate both technical and allocative efficiency simultaneously and also allocative efficiency for each observation.

Schmidt and Lovell specify, on the basis of Cobb-Douglas functional form, a stochastic production frontier:

$$\log Y = \log a + \sum_{i=1}^{n} \alpha_{i} \log X_{i} + (v - u).$$

Log $Y$ is bounded from above by the stochastic frontier. TE relative to the frontier is given by $'u'$. The firm is assumed to be allocatively efficient in the sense that it makes no mistakes in selecting the cost minimizing factor proportions which are given by the solution to:

$$\log X_{1} - \log X_{i} = B_{i}, \; i = 2, \ldots, n.$$  

where $B_{i} = \log \left( \frac{p_{i} \alpha_{i}}{p_{1} \alpha_{1}} \right)$ and $p_{1}, p_{2}, \ldots, p_{n}$ are the input prices. From this, stochastic factor demand frontiers are derived.

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bounded from below by the factor demand frontiers. On the basis of these, the cost function \((\log C)\) is derived. The cost function is bounded from below by the stochastic cost frontier. With allocative efficiency assumed, a firm can be above its cost frontier only by being below its production frontier. TE is measured by taking the residuals from the estimated production or cost frontier.

Allocative inefficiency is measured on the basis that the firm seeks to minimize costs of producing its desired rate of output subject to a stochastic production frontier constraint. In measuring AE, presence of technical inefficiency is allowed. Allocative inefficiency is modelled by permitting the cost minimizing conditions, which define the least cost expansion path, in implicit form, to fail to hold exactly. The errors in choosing the cost minimizing factor proportions then correspond to the disturbances from the exact satisfaction of first order conditions for cost minimization. The specification of the production frontier is:

\[
\log Y = \log a + \sum_{i=1}^{n} \beta_i \log X_i + (\nu - \mu)
\]

\[
\log X_i - \log X_i = B_i + e_i, \quad i = 2, \ldots, n.
\]

where as before \(B_i = \log (p_i/@_i/p_l/@_i), \quad \nu \sim N(0, \sigma^2)\), \(u\) is the absolute value of a \(N(0, \sigma^2)\) variable and \(e_i\) represents the amount by which the first order conditions fail to hold and represents the extent of allocative inefficiency.
As before in case of TE, from the above equation the factor demand equations and the cost functions are derived with added term 'ei'. The residuals of the cost minimizing conditions can be taken as 'e's which enables to estimate the extra cost due to allocative inefficiency for each observation.

Unlike in Schmidt and Lovell, the methodology adopted for the present purpose, estimates TE and AE separately. As discussed earlier, technical efficiency is estimated on the basis of a deterministic production frontier. The extent of firm level relative technical inefficiency is determined by the extent of the deviation of the input use from the most efficient technological frontier. Although production functional forms are used, TE is taken to be determined purely by technological relationship between inputs and outputs and factor prices taken to have no role to play.

Subsequently in order to estimate allocative inefficiency all the firms in the sample are assumed to be technically efficient, which can be achieved by pushing all the firms to be on the frontier. The extent of the technical inefficiency for each firm is the difference between the output that can be realized by being on the production frontier and the actual output. The extent of the difference \((Q_i)\) is added to the output of all firms in the sample to remove technical inefficiency in the sample.
\( Y^i = Y_i + Q_i. \)

To estimate allocative inefficiency (at each data point) \( Y^i \) is introduced into the translog cost function, which takes the form:

\[
\log C = \log a + b_1 \log Y^i + b_2 \frac{1}{2} (\log Y^i)^2 + b_3 \log w \\
+ b_4 \log r + b_5 (\log w * \log r) + b_6 (\log Y^i * \log w) \\
+ b_7 (\log Y^i * \log r)
\]

Firm level allocative efficiency indices can be derived by minimizing costs \( C \) subject to \( Y^i \). The factor prices enter the optimization through the cost function. The objective function to be minimized is:

\[
\text{Min } \sum_{i=1}^{N} \log C - \text{ (right hand side) of cost function specified above}
\]

subject to

\[
C_i \geq C_i (Y^i)
\]

The residuals in the minimization programme are taken to be the firm level indices of AE. In the other words the difference between the estimated and the actual costs is taken to be the extent of firm level AE.

\[ AE = \frac{C_{ei}}{C_{ai}} \]

where \( C_{ai} \) is firm level actual cost and \( C_{ei} \) is the firm level estimated cost.

If \( \frac{C_{ei}}{C_{ai}} > 1 \), it would imply presence of firm level allocative inefficiency.
The Factor Prices and

The Systematic Allocative Efficiency (AEii).

The systematic allocative efficiency that is considered
in the present context is different from the pure firm level
allocative efficiency discussed above.

It is obvious that it is the relative factor
prices which determine the allocative efficiency. In
competitive market conditions factor prices, given
exogenously, are same for all the firms. But if the
factor markets are highly distorted and segmented, different
firms in the industry may have not only unequal access to
the inputs but also may pay differential prices to the
factors of production.

As argued in Chapter III.III, due to the factor market
segmentation in the Indian economy, large and small in an
industry have differential access to the inputs and pay
different factor prices to the factors of production. Our
objective is to examine firm level systematic allocative
efficiency in relation to exports, rather than the
absolute allocative efficiency of firms with respect to
their respective factor price lines. The firms which choose
the optimal techniques of production on the basis of the
shadow prices of factors of production would be closer
to the domestic comparative advantage in relative
factor endowments. In a highly distorted factor market
conditions, the relative shadow factor prices (at the
country level) would represent the country's comparative
advantage in relative factor endowments. So the allocative
efficient point on the frontier determined by the
factor price line closely representing the relative shadow factor prices would be the appropriate one to estimate firm level systematic allocative efficiency (AEii) in relation to exports.

The above argument is illustrated in Diagram VII. The factor price lines 'rlw1' and 'r2w2' represent two factor markets (segmented). If the large firms have higher access to capital at a lower price, one can take 'r2w2' is the factor price line faced by the large firms. Let us take the factor price line 'rlw1' to represent relative shadow factor prices and is the one faced by small firms. So the point 'b' represents the systematic allocative efficiency. A (large) firm which faces the factor price line 'rlw1', could be (firm level) allocatively efficient at the point 'a' on the basis of its factor price line. But the firm will be systematically allocatively inefficient to the extent of 'ac' on the basis of the relative shadow factor price line.

The allocative efficiency is estimated on the basis of two approaches:

1) (AEi). In this approach the price of capital is taken to be the bank lending interest rate of 12 percent. Large firms (of the organized sector) generally get access to capital at this rate. If one takes the share capital of the large public limited companies into account, the price of capital to the large firms might be even lower. The wage rate is taken to be the average wage rate of firms in the sample. In this approach the factor prices are
the same for all firms in the sample. In this case allocative efficiency is estimated by linear programming.

2) (AEii). In a capital scarce and labour abundant Indian economy the shadow price of capital is generally observed to be a lot higher than the bank lending rate. In this approach the price of capital is taken to be 21 percent, which is closer to its shadow price and is the rate at which small firms obtain capital. Majority of small firms covered in the field study reported that they pay interest rate ranging between 18 to 24 percent. The wage rate is taken variable across firms in the sample, in terms of total wage bill divided by the total number of workers employed by each individual firm. Firm level allocative indices are measured by estimating the translog cost function by OLS.

V.I.III. The Notations of The Variables.

TE = Firm level relative technical efficiency.
TIE = (1/TE), firm level relative technical inefficiency

AEi = Firm level allocative efficiency measured with interest rate of 12 percent and an average wage rate of the sample.

AEii = Systematic allocative efficiency measured with interest rate of 21 percent (shadow price) and the variable wage rate.

ZS = Firm size, with total sales turnover as size measure.

14 Lall (1980)
(IM/S) = Firm level import intensity.
VK = Vintage or age of machinery in years.
EXM = Experience of managers in years.
EXL = Experience of permanent labour in years.
SL = Skill intensity of labour.
(number of skilled labour * wage rate of skilled labour)/value-added.
YEX = Number of years a firm is in export activity.

The Data.
The industry at the disaggregate sub-group level, that is taken for the exercises is Hand, small and cutting tools industry. The sample, used, is based on the sample II, discussed in Chapter IV. The sample consists of 76 large and small firms (see Table 6) out of which 41 firms are small and medium firms. For the sub-sample of 41 S&M firms, apart from the quantitative data, qualitative information was also collected from the primary sources. The additional information for the 41 firms covers managerial and employees experience, vintage of machinery, number of years in export activity, skilled and unskilled labour, wage and interest rate paid etc.

V.I.IV. The Specification of the Equation V and the Results.
V.I.IV.I. The Specification.
V.I. E, (E/S) = a + b1 (ZS) + b2 (TE) + b3 (AE)
+ b4 (ZS)(TE) + b5 (ZS)(AE) + i.

b2; b3 > 0
b1; b4 \leq 0
If one ignores the interactive terms, \( b_2 \) can be expected to be positive under the implication higher the relative technical efficiency higher the exports and export propensity. But the effect of \( \text{TE} \) on exports need not be straightforward. This is because, as mentioned earlier, the measure reflects relative efficiency differences due to technological differences between firms. As discussed in Chapter III. III, firms which adopt the technology which facilitates realization of higher total factor productivity on the basis of the (specific) domestic (indigenous) technological conditions or features, should be in a better position to export. If this technology is the one that determines the efficient production frontier the positive relationship between exports and \( \text{TE} \) (measured) is straightforward. It is argued in Chapter III. III, the technological differences between firms is on the basis of firm size groups. As a result firm size variable becomes a crucial determinant of the nature of causality between \( (E/S) \) and \( \text{TE} \). Apart from it, the relationship between firm size, efficiency and exports could be governed by the domestic market structure conditions, as discussed in

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15 As mentioned in Chapter IV, in the case of \( (X) \), the causality between exports and \( \text{TE} \) could be other way round if one takes the dynamic effects of the export activity itself.
Chapter III.I.1. These aspects are captured by the interactive terms. The interactive terms show at which size group the comparative efficiency reflected by TE is realized in the revealed exports.

It is established in the previous chapter that revealed exports of different size groups are governed mostly by the market structure conditions. So the causality between TE and exports could change depending on the firm size factor, which reflects firm level domestic market power. For example, among large firms, which have oligopoly rivalry for domestic monopoly profits, the relatively efficient ones would be domestic market leaders, which, in turn, could push the relatively inefficient ones to export markets.

In case of allocative efficiency variable (AE), the expected causality depends on whether AEi or AEii is used in the equation. In case of AEi, 'b3' is expected to be negative. This is because AEi is measured on the basis of the price of capital to be 12 percent interest rate, which is assumed to be far lower than the shadow price of capital, in the capital scarce and labour abundant Indian economy. The firms which are allocatively efficient on the basis of 'AEi' adopt relatively capital intensive techniques and deviate from the country's comparative advantage. In case of AEii which is measured on the basis of the interest rate of 21 percent, which is assumed to be closer to the shadow price of capital, 'b3' is expected to be
positive. The expected signs of the parameters associated with the interactive terms are, again, based on the firm size dimension operating through the market structure argument.

\[ \text{V.2. TIE} = a + b_1 \langle ZS \rangle + b_2 \langle ZS \rangle^{*2} + b_3 \langle IM/S \rangle + b_4 \langle VK \rangle + i. \]

\[ b_1 < 0; \; b_2 \geq 0; \; b_3 \geq 0; \; b_4 > 0; \]

The previous equation specifies the relationship between exports and technical efficiency. Equation V.2 brings out the explicit relationship between technical 'inefficiency' and firm size and the other variables which can be explained through the firm size variable. The quadratic relation specified with respect to technical inefficiency (TIE) and firm size is based on the argument of technological threshold size. The argument is that small firms have to reach a minimum technological threshold size in order to be technically efficient. In other words very small firms which operate with outdated technologies would not be able to realize relative technical efficiency in an industry. In such case \( b_1 \) is expected to be negative and \( b_2 \) negative or positive. Technical inefficiency should decrease until a critical firm size. After the critical firm size it might go up if large firms turn out to technically inefficient. On the other hand, \( b_1 < 0 \), \( b_2 \) could turnout

\[ 16 \] It is necessary to take into notice that 'TIE' is technical inefficiency, \( (1/\text{TE}) \).

\[ \text{TE} = \langle Y/Y* \rangle \]
\[ \text{TIE} = \langle Y*/Y \rangle \]
\[ Y = \text{actual output.} \]
\[ Y* = \text{the predicted (or optimal) output.} \]
to be negative if large firms which have higher access to imported and latest vintage technology are the ones which are determining the efficient technology frontier in the industry.

The (IM/S) variable is taken to capture the extent of imported technology of firms. The (IM/S) and (VK) (vintage of technology) variables are taken to capture the arguments regarding technological gap or distance and it's implications on the measured technical inefficiency. If it is the imported technology which is determining the efficient technology frontier in the industry, then 'b3' should be negative. Higher the extent of imported technology lower should be technical inefficiency (TIE). On the other hand if imported technology and it's process results in higher costs and technological rigidities 'b3' could be expected to be positive. The relationship between the vintage variable (VK), and TIE, irrespective of the analytical arguments, could be a result of incomplete specification of the measured capital. As TE is measured relative to a single industry frontier, enterprises employing older vintage technologies will appear inefficient, even if they are achieving maximum output for a given vintage of capital. 17 Apart from this the (VK) should also capture the argument regarding technological threshold size. Firms operating with very old and outdated technologies would be technically inefficient.

17 Page (1984), pp 133.
V.3. \[ AE = a + b_1 (ZS) + b_2 (IM/S) + \epsilon \]
\[ b_1 \geq 0; b_2 \leq 0. \]

In case of \( AE_i \), \( b_1 \) is expected to be positive. This is because the larger firms have access to capital at lower private price than S&M firms. In case of \( AE_{ii} \), the parameter is expected to be negative for the obvious reason. Similarly the sign of \( b_2 \) with respect to imported technology variable \( (IM/S) \) is expected to different for \( AE_i \) and \( AE_{ii} \). Under the assumption that imported technologies are capital intensive, the sign should be positive in case of \( AE_i \) where capital price is lower.

V.I.IV.II. The Results.

The Production and Cost Functions Estimated For the Sample of 76 firms.

\[ \log Y = 1.87 + 0.62 \log (LS) + 0.26 \log K \]
\[ (7.0)* \quad (2.75)* \]
\[ R^2 = 0.92, \quad F = 465 \quad N = 76 \]
Multiple correlation coefficient = 0.96

2. The Translog Production Function.
\[ \log Y = 5.4 + 1.12 \log (LS) - 1.02 \log K \]
\[ (2.68)* \quad (2.22)* \]
\[ + 0.33 (1/2)(\log LS)^{**2} + \]
\[ (2.68)* \]
\[ + 0.42 (1/2)(\log K)^{**2} \]
\[ (2.22)* \]
\[ - 0.30 \log (LS)*\log (K) \]
\[ (2.12)* \]
\[ R^2 = 0.94 \quad F = 220 \quad N = 76 \]

Multiple correlation coefficient = 0.96

Figures in the brackets are \('t'\) values.

* Significant at 0.01 level.

The estimated translog function shows higher explanatory power than the Cobb-Douglas. Apart from this, the estimated coefficients of the interactive terms are significantly different from zero.

The partial derivatives of the estimated function are:

\[
\left(\frac{1}{Y}\right) \frac{dY}{dK} = -0.98/K + \left(\frac{0.42 \log K}{K}\right) - \left(\frac{0.3 \log LS}{K}\right)
\]

\[
\frac{dY}{dK} = \frac{Y}{K} \left(- 1.02 + 0.42 \log K - 0.30 \log LS\right) \tag{i}
\]

\[
\left(\frac{1}{Y}\right) \frac{dY}{d(LS)} = 1.12/LS + \left(\frac{0.33 \log LS}{LS}\right) - \left(\frac{0.3 \log K}{LS}\right)
\]

\[
\frac{dY}{d(LS)} = \frac{Y}{LS} \left(1.12 + 0.33 \log LS - 0.3 \log K\right) \tag{ii}
\]

The estimated function is checked (at all the data points) for monotonicity and the function is observed to be well behaved. These results support the choice of translog production function to estimate the production frontier for the sample of 76 firms consisting of very large and small firms.

3. The Cobb-Douglas Production Function

For the Sub-sample of 41 S&M firms

Since the translog function is not appropriate to estimate TE for the sub-sample which consists of only small and medium firms, the Cobb-Douglas is used.

18 The translog function does not fulfill the requirements of quasi-concavity (convex isoquants) and monotonicity globally. But if the conditions are met over a sufficient number of the observed levels of inputs and outputs, the function is considered well behaved. See Little et al (1987) pp 325.
\[
\log Y = 2.38 + 0.57 \log (LS) + 0.21 \log (K) \\
(2.16) \quad + (1.58) \\
R^2 = 0.4 \quad F = 9.9 \quad N = 41 \\
* \ 't' \ values. \ Statistically \ significant \ at \ 0.05 \ level.
\]

4. The Translog Cost Function.

To estimate \"AE\"\textsubscript{i}, the translog cost function is estimated with; \( Y^* = Y + Q \) and \( r = 21 \) percent of interest rate, by OLS.

\[
\log C = 1.26 - 0.32 \log Y^* + 0.07 (1/2)(\log Y^*)^2 \\
(4.78) \quad (6.39) \\
- 0.13 \log w + 1.48 \log r \\
(2.4) \quad (2.5) \\
+ 0.07 (\log Y^*)(\log w) - 0.05(\log Y^*)(\log r) \\
(4.2) \quad (7.6) \\
- 0.071(\log w)(\log r) \\
(4.73) \\
R^2 = 0.98 \quad F = 34477 \quad N = 76 \\
* \ 't' \ values. \ Statistically \ significant \ at \ 0.01 \ level.
\]

Due to multi-colinearity between TE and AE indices their respective explanation of exports is tested separately.

The Results for Technical Efficiency.

V.1.1.a. \( E = 953 + 13 \ (ZS) + 681 \ (TE) + 11 \ (ZS)(TE). \)
\[
(1.99) \quad (0.10) \quad (0.4) \\
R^2 = 0.29 \quad F = 10
\]
V.1.1. b. \( (E/S) = 0.1 + 0.0001 (ZS) + 0.259 \) \((TE)\)

\( (0.77) \quad (1.62)*** \)

\[-0.00093 (ZS)(TE)\]

\( (1.92)** \)

\( R^{**2} = 0.12 \quad F= 3.5 \quad N = 76 \)

Figures in the brackets are 't' values.

* Statistically significant at 0.025 level
** Significant at 0.05 level.
*** Significant at 0.10 level.

\( d(E/S)/d(TE) = 0.259 - 0.00093 (ZS)\)

The critical turning point, \((ZS)_{te}^{*}\) = Rs. 1782 lakhs.

Firm level relative technical efficiency is explaining export propensity significantly rather than absolute exports. TE is explaining export propensity positively. But, as in the case of 'X' in the previous chapter, there is a critical firm size after which it is associated with export propensity negatively. The critical turning firm size in the present case is about Rs.18 crores sales turnover. The low turning point is rather expected given the size distribution in the sample.

The results imply that before the critical firm size of Rs. 18 crores the relatively technically efficient firms are the ones which are more export intensive and after the critical size, within the size group, it is the relatively technically inefficient which are more export intensive. If we interpret the present results along with the results of equation 234.
III with respect to capital and labour intensity variables in the previous chapter, it is mostly in the size range of about Rs.1 crores to Rs. 20 crores sales turnover, the firms in the industry are able to realize domestic supply side advantages in exports. This is in terms of employing the appropriate choice of production techniques and realizing high TE, in accordance with the country's comparative advantage. But, at this stage, this does not mean that all the firms above the critical size do not realize this efficiency. The most likely reason for the negative association between TE and (E/S) after the critical size could be that, on the basis of the market structure argument, the relatively efficient firms in the size group attain certain degree of domestic market power and performance. As a result they do not have the pressure to export at higher intensity and do not transmit the efficiency into exports. As argued in case of the result obtained for (X) in the previous chapter, within the size group of large firms, the relatively inefficient would be pushed to the export markets due to the oligopoly rivalry in the domestic market. Among the small firms (below the critical size), it is relatively efficient ones which are more export oriented. This supports the argument in Chapter III.I, that small firms face severe competitive pressures and expansion barriers in the domestic market and those small firms which adopted themselves as efficient producers could branch out into export markets.
V.2. TIE = 4.0 - 0.003 (ZS) + 0.00000183(ZS)**2  
\[(1.8)** \ (2.10)** \]
+ 2.15(IM/S)  
\[(0.78)\]

R**2 = 0.10  \( F = 1.9 \)  \( N = 76 \)  
The figures in the brackets are 't' values.  
* Statistically significant at 0.01 level.  
** Statistically significant at 0.05 level.

The critical turning point of \( (ZS) = Rs \, 50 \) crores.

The above results show the explicit relation between TIE and firm size (see Graphs 7A and 7B). The above results have very interesting implications. The results indicate that until the firm size of Rs 50 crores sales turnover, (the estimated) technical inefficiency is declining. But after the critical firm size of Rs 50 crores sales turnover, technical inefficiency is increasing as firm size increases.  

When one observes Graph 7B, where the firm level technical inefficiency indices and the estimated curve of equation V.2 are fitted (against firm size), it can be seen, if one ignores few observations in the middle, the relationship between firm size and technical inefficiency is an "U" shaped one. The results give support to the argument regarding the technological threshold size to realize relative technical

19 The linear relationship estimated between technical inefficiency (TIE) and firm size (ZS) is as follows:

\[
\text{TIE} = 3.87 + 0.000317 \ (ZS) + 0.96 \ (IM/S)  
\]
\[(0.5) \quad (0.35)\]

R**2 = 0.005  \( F = 0.18 \)  
The linear relationship estimated is statistically insignificant.
(ZS) is reduced to natural logs for graphical Presentation.
TIE and Predicted TIE

Firm Size (ZS)

Reduced to logs for Graphical Presentation

$Q = \frac{1}{Y}$

$Y =$ Optimal output

$Y =$ Actual output

$V.2$ The estimated curve of equation.
efficiency in the industry. Very small firms which operate with older and outdated technologies would not be in a position to be relatively technically efficient. Although it is the large firms which have higher access to the latest vintage and imported technology and information, are the ones which should be determining the efficient frontier, this is not the case here. Very large firms due to X-inefficiency and technological rigidities would be relatively technically inefficient. Given high domestic market power large firms hold, they might not have enough pressure to operate on the most efficient path possible.

As discussed earlier, the import intensity variable is taken to capture the extent of imported technologies of firms. It is established in Chapter III.I that it is the larger firms which have higher access to imported technologies and inputs. Although it is not statistically significant, the estimated parameter of (IM/S), indicate imported technology is not explaining technical inefficiency. This result suggest that higher access to (latest) imported technology is not giving any additional advantage in realizing relative technical efficiency. In other words the result can be interpreted that higher technical efficiency is realized by those firms which could realize high total factor productivity on the basis of indigenous technological conditions.
Technical Efficiency:

The Results for the Sub-sample of 41 S&M Firms.

As mentioned in the Data section, for this sample, the information collected covers additional factors. This facilitated the use of some additional variables in explaining exports and TE.

V.1.1.i.a. \[ E = 905 + 480 (ZS) - 1568 (TE) - 61 (ZS)(TE) \]
\[ (7.0)^* \quad (1.0) \quad (0.43) \]
\[ + 62 (YEX) \]
\[ (1.75)^** \]
\[ R^2 = 0.79 \quad F = 34 \quad N = 41 \]

V.1.1.i.b. \[ (E/S) = 0.05 + 0.056 (ZS) - 0.12 (TE) \]
\[ (3.43)^* \quad (0.38) \]
\[ - 0.026 (ZS)(TE) + 0.002 (YEX) \]
\[ (0.77) \quad (2.38)^* \]
\[ R^2 = 0.47 \quad F = 8.1 \quad N = 41 \]

The figures in brackets are 't' values.
* Statistically significant at 0.025 level.
** Significant at 0.05 level.

In the above results for the sample, TE is not explaining exports. But the important aspect of the results is the significant positive association between export propensity and firm size. As the sample consists of only small firms, this result supports the argument regarding the threshold or minimum efficient size in exports. In the estimations, other variables like skilled labour intensity, number of years of experience of
managers and permanent labour, were tested for their explanation of exports. But, none of them were statistically significant. As presented in the results, only the variable of number of years of export activity turned out to be significant. This variable is taken to capture the dynamic learning by doing cumulative economies in export activity. The statistically significant positive sign of the estimated coefficient of the variable indicates the presence of these economies.

V. 1.2.i. TE = 0.16 + 0.028 (ZS)

(3.7)*

R**2 = 0.26  F = 13.9

ii. TE = 0.50 - 0.024 (VK)

(1.88)**

R**2 = 0.08  F = 3.5  N = 41

The figures in the brackets are 't' values
* Statistically significant at 0.025 level.
** Significant at 0.05 level.

In the estimations for this sample, only ZS and VK variables are explaining TE. Because of strong multi-collinearity between (ZS) and (VK), they are tested separately for their explanation of TE. The above results show positive association between relative technical efficiency and firm size. The result is expected because the sample consists of only small firms. This result supports the argument that there is a technological threshold firm size, firms have to reach to be technically efficient. The result obtained with respect to the capital vintage variable (VK) reconfirms
the argument regarding the minimum efficient size. The statistically significant positive sign of the estimated coefficient of the variable, \( VK \) indicate that among the small firms, the firms with older vintage and outdated technologies are not technically efficient.

In the above equation, the variables like, skill intensity and managerial and labour experience were used as the explanatory variables. But none of them gave statistically significant results.

From the above results, it is obvious that firm size and TE are highly correlated. Due to this reason the TE variable in V. 1.1.i. does not explain exports significantly, statistically. The equation is re-estimated by removing \( ZS \) as a separate variable (for the sample of 41 firms).

V.1.1.ii.a. \( E = 1120 - 5472 \text{ (TE)} + 717 \text{ (ZS)(TE)} \)
\( \quad (3.0)* \quad (5.1)* \)
\( + 92 \text{ (YEX)} \)
\( \quad (1.76)** \)
\( R**2 = 0.51 \quad F = 12.8 \)

V.1.1.ii.b. \( (E/S) = 0.29 - 0.579 \text{ (TE)} + 0.064 \text{ (ZS)(TE)} \)
\( \quad (1.8)** \quad (2.59)* \)
\( + 0.023 \text{ (YEX)} \)
\( \quad (2.46)* \)
\( R**2 = 0.3 \quad F = 5.3 \quad N = 41 \)

The figures in the brackets are \('t'\) values.

* Statistically significant at 0.025 level.

** Significant at 0.05 level.

a. The critical turning firm size \( \text{ (ZS) te* } = \text{ Rs. 49 lakhs.} \)
b. The critical turning firm size (ZS)te* = Rs.58 lakhs.

The above results have significant implications. Unlike in the previous estimations, the coefficient associated with TE variable is statistically significant. But the interesting aspect of the results is the non-linearity and the turning points. Only after the critical firm size of Rs.58 lakhs sales turnover, relative technical efficiency is contributing positively to export propensity. This result has to be interpreted on the basis of the previous result in V.1.1.i, of the positive association between technical efficiency and firm size for this sample of small firms. This result give support to the argument that firms have to reach a technological minimum threshold size in order to "produce" the exportable products on a vertical product differentiation (product quality difference) plane. Firms below the threshold size appears to be not relevant to exports.

In this context, it is important to take into notice that in both the samples of 76 firms (including large and small firms) and 41 small firms, we have included 10 small firms which are indirect exporters. The value of their indirect exports are taken into notice. Some of the small firms tend to be indirect exporters because they could not break the marketing barriers involved in export activity. Generally there is a certain minimum firm size involved to break the marketing barriers. The above results obtained despite
the inclusion of the small firms which undertake indirect exports (in the sense that the extent of the indirect exports coming in the left hand side of the equations) give support to the argument of technological minimum efficient size in order to "produce" the exportable products.

The Results for Allocative Efficiency.

AEi: $r = 12$ percent interest rate.
$w = $ an average fixed wage rate.

The following show the results without the interactive term of AEi and ZS, on the right hand side.

V.1.2.i.a. $E = 1942 + 16.4 (ZS) - 1429 (AEi)$

\[ R^{**2} = 0.29 \quad F = 15 \]

V.1.2.i.b. $(E/S) = 0.32 - 0.00017 (ZS) - 0.21 (AEi)$

\[ R^{**2} = 0.11 \quad F = 4.7 \]

The following show the results with the interactive term.

V.1.2.i.c. $E = 799 + 24.4 (ZS) + 1901 (AEi) - 23.9(ZS)(AEi)$

\[ R^{**2} = 0.31 \quad F = 11.2 \]

V.1.2.i.d. $(E/S) = 0.32 - 0.00016 (ZS) - 0.20 (AEi)$

\[ R^{**2} = 0.092 \]
In the above results, the estimated coefficient of the allocative efficiency variable, \( \text{AE}_i \), is consistently of negative sign. The coefficient is statistically significant in (b) and (d), where export propensity is used as the dependent variable. The result implies that higher the firm level allocative efficiency, \( \text{AE}_i \), lower the export propensity. The explanation for the negative association lies in the factor price line used in estimating \( \text{AE}_i \). The price of capital i.e. the rate of interest of 12 percent used in estimating \( \text{AE}_i \) has been argued to be far below the shadow price of capital in the capital scarce Indian economy. The firms which get access to capital at this rate of interest would tend to adopt the production techniques in favour of capital intensity and might use excess capital than (optimally) necessary as the private cost capital is lower than its opportunity cost. Consequently the production techniques of these firms could deviate from the country's comparative advantage, reflected by the relative shadow prices of the factors of production.

So the allocative efficiency measure, \( \text{AE}_i \), represents a point like 'a' in Diagram VII. If the relative shadow price line is 'riwi', the point 'a' is
(systematically) allocatively inefficient to the extent of 'ca', on the basis of the country's comparative advantage in the relative factor endowments. This, in turn, explains the negative association between AEi and export propensity.

As argued in Chapter III.III, the large firms in the industry get access to capital at relatively cheaper price than small and medium sized firms and pay higher wage rate to labour. The AEi measure represents the allocative efficiency point biased in favour of the large firms. Although the relationship between AEi and firm size is not established here, the established relationship between firm size and exports show that the export propensity of larger firms is lower than that of S&M firms, as shown by the negative sign of the estimated coefficient associated by the firm size variable (ZS). The negative association between AEi and export propensity explains the export behaviour of large and small firms from the supply side factors in terms of the factor market segmentation and factor price differentials. In the capital scarce and labour abundant Indian economy, the large firms which get access to capital at lower price than small firms might adopt the production techniques deviated from the country's comparative advantage.

Although the estimated coefficients with respect to the interactive terms of AEi and firm size (ZS) are of negative sign, in (c) and (d), they are not statistically significant to make any reliable
interpretations. The explicit relationship between AEi and firm size will be observed at a later stage.

The Results of Systematic Allocative Efficiency (AEii).

\[ r = 21 \text{ percent interest rate.} \]
\[ w = \text{variable wage rate, } i, \ldots, n. \]

The following shows the results without the interactive term of AEii and ZS on the right hand side.

\[
V.1.2.ii.a. \quad E = -10970 + 16.3 (ZS) + 122286 (AEii) \\
(5.4)* \\
R**2 = 0.29 \quad F = 15
\]

\[
V.1.2.ii.b. \quad (E/S) = 0.59 - 0.00017 (ZS) + 0.83 (AEii) \\
(2.4)* \quad (1.65)*** \\
R**2 = 0.10 \quad F = 4.06
\]

The following show the results with the interactive term.

\[
V.1.2.ii.c. \quad E = -5423 - 146 (ZS) \\
(0.75) \\
+ 6696 (AEii) + 162(ZS)(AEii) \\
(0.3) \quad (0.08) \\
R** = 0.3 \quad F = 10.4
\]

\[
V.1.2.ii.d. \quad (E/S) = -0.68 + 0.0024 (ZS) + 0.92 (AEii) \\
(0.5) \quad (1.72)** \\
- 0.002 (ZS)(AEii) \\
(0.55) \\
R**2 = 0.10 \quad F = 3.0 \quad N=76
\]

The figures in brackets are \textquoteleft t\textquoteleft values.

* Statistically significant at 0.025 level.
** Significant at 0.05 level.

*** Significant at 0.10 level.

Contrary to the results with AEi, in the present case the estimated coefficients associated with the systematic allocative efficiency variable, (AEii) are consistently of positive sign. The estimated coefficients of AEii are statistically significant only in (b) and (c) where export propensity is the dependent variable. The positive association between AEii and export propensity obviously imply that higher the systematic allocative efficiency based on the shadow factor prices, higher the export propensity. This result gives support to the argument regarding the domestic comparative advantage in relative factor endowments reflected by the relative shadow factor prices of factors of production. The 21 percent of interest rate which is used to estimate AEii is argued to be closer to the shadow price of capital.

The firms which are relatively allocatively efficient on the basis of AEii will be able to minimize costs by adopting the optimum combination of the factors of production on the basis of their true opportunity costs at the country level, on the given production frontier. As a result they would be in a better position to reap the country's comparative advantage in the relative factor endowments and incomes.

As argued in Chapter III.III, the 21 percent of interest is the one which the S&M firms, which have lower access to capital compared to large firms, would pay
for capital. Although the relationship between AEi\textsubscript{ii} and firm size is not established here, on the basis on the given relationship between (E/S) and (ZS), one can say that it is the S&M firms production techniques which are closer to the country's comparative advantage under the segmented factor market conditions.

The above observation does not necessarily mean that only the small firms which would be able to attain the comparative advantage reflected by AEi\textsubscript{ii}. The comparison of the results obtained with AEi and AEi\textsubscript{ii}, tells that the firms, irrespective of size, which are maximizing the systematic allocative efficiency of AEi\textsubscript{ii} are able to export at higher propensity. 20

Firm Size and AEi and AEi\textsubscript{ii}.

The following results show the explicit relationship between firm size and AEi and AEi\textsubscript{ii}, estimated.

\[
\begin{align*}
V.3.i \quad AE_i & = 0.36 - 0.00007 (ZS) + 1.04 (IM/S) \\
& \quad (0.56) \quad (3.4) *
\end{align*}
\]

\[
R^{**2} = 0.16 \quad F = 4.6
\]

\[
V.3.ii \quad AE_{i\text{ii}} & = 1.0 - 0.000007 (ZS) - 0.13 (IM/S) \\
& \quad (0.26) \quad (1.92)**
\]

\[
R^{**2} = 0.09 \quad F = 1.7 \quad N = 76
\]

The figures in the brackets are 't'values.

* Statistically significant at 0.025 level.

\[
\begin{align*}
20 \quad AE_{i\text{ii}} \text{ is estimated by taking a variable interest of 12 percent for the large firms and 21 percent for the small firms in the sample. The results are similar to the above.}
\end{align*}
\]
** Significant at 0.05 level.

In the above results, in the both cases of AEi and AEii, the estimated coefficients associated with firm size are of negative sign but are not statistically significant. This indicates that there may not be systematic relationship between firm size and the allocative efficiency measures. But if one observes the graphs 8 and 9 where the AEi and AEii measures are fitted against firm size (reduced to logs), there is a systematic pattern in the cluster of observations of AEi and AEii (on the Y axis) with respect to the size groups (on X axis). The maximum values AEi are mostly at the larger size group, which is argued out to be the expected outcome as the factor price of capital used, in this case is in favour of large firms. There is more clear cut pattern in the case of AEii, where the separate size groups is very striking. The S&M firms have the distinct cluster of the higher AEii points. And after the maximum point, there is a sudden dip after which the large firms have the distinct pattern in the cluster of the AEii points at the lower level. (This could be the major reason behind the very low $R^{**2}$ in the above estimated equation with respect to AEii variable.) These patterns in the graphs gives support to the argument regarding the factor segmentation and it's possible effect on the realization of the country's comparative advantage in the relative factor endowments (relative shadow factor prices) by small and large firms.

The above observation basically demonstrates the existing phenomena. But the crucial aspect of the
Graph 8

Allocative Efficiency (AEi) and Firm Size (Zi)

(Firm size measure is reduced to logs for graphical presentation)
(Firm size measure is reduced to logs for graphical presentation)
difference between AEi and AEii in explaining exports could be that, irrespective of firm size, it is the firms which are maximizing the systematic allocative efficiency reflecting the country's comparative advantage, which are in a better position to export.

The interesting aspect of the above results is the nature of the coefficients estimated with respect to the import intensity variable, (IM/S). In both the cases the coefficients are statistically significant. But the signs are different. In V.3.i. of AEi the sign of the parameter is positive and in V.3. ii. of AEii it is negative. These results support the argument put forward in Chapter III.III., the firms which get capital at far lower price than it's shadow price, as in case of AEi, would tend to adopt capital intensive imported technologies. If these technologies are not adapted on the basis of the domestic factor endowments and incomes, these capital intensive technologies could result in the deviation of the production processes from the optimal combinations based on the domestic factor endowments and incomes. This observation explains the negative association between AEii and (IM/S) and the positive association between AEi and (IM/S). As far as the firm size aspect, here, is concerned, as established in Chapter III.I., it is large firms which have higher access to imported technology. Small firms depend mostly on the indigenous technologies. As a matter of fact, majority of small firms in the present sample do not use imported inputs at all (see Table 2B).