

**Determinants of Efficiency in Least Developed Countries:
Further Evidence from Nepalese Manufacturing Firms**

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Table of Contents

Abstract	4
1. Introduction	5
2. Characteristics of Nepalese Manufacturing	7
3. Determinants of Firm Inefficiency	9
4. Empirical Model and Results	11
5. Conclusion	15
Appendix 1: The Data and Variable Measurements	17
References	18

Abstract

Using a translog stochastic production frontier and maximum likelihood econometric methods, we estimate and model the determinants of firm level efficiency in the Nepalese context. Our results are broadly in line with theoretical expectations. We find that large firms are more efficient and that a higher capital intensity leads to inefficiency. There is no statistical evidence to suggest that foreign investment leads to efficiency improvements. Also, we do not observe any link between export intensity and efficiency improvement. We find that higher protection leads to inefficiency. Overall, our results suggest that an outward-looking industrial strategy, which relies on less intervention and permits the development of large-scale industries, is conducive to efficiency improvement in LDCs like Nepal.

1. Introduction*

There is a widespread perception that manufacturing firms in least developed countries (LDCs) are inefficient and that most firms perform well below best international practices. This appears to be linked to the small size of the domestic market, low export-orientation, excessive government intervention and low levels of physical and human capital. It is also widely believed that the protection of the domestic market may have retarded efficiency in these countries. While there is some truth in these claims, empirical findings are ambiguous. For example, Rodrik (1988) noted that ‘there is practically no evidence on the importance of scale economies in specific industrial sectors of the developing countries’. While Pack (1988) observed that ‘to date there is no clear confirmation of the hypothesis that countries with an external orientation benefit from greater growth in technical efficiency in the component of manufacturing’. Finally, Bhagwati (1988) concluded that ‘although the arguments for the success of the export promotion strategy based on economies of scale and X-efficiency are possible, empirical support for them is not available’.

This is not accidental. To perform an analysis of manufacturing efficiency one needs highly disaggregated firm level input and output data, which are rarely available in LDCs. Thus, most studies have relied on highly aggregated industry level data which fails to capture firm level differences and hence produces ambiguous results. In this paper we overcome this problem by estimating and analysing manufacturing sector efficiency using firm level data from Nepal.

The examination of the Nepalese experience is important not only in its own right being a LDC, but also because it has experienced significant reforms since the mid 1980s. Liberalisation began with the relaxation of quantitative restrictions (QRs) in 1985/86 under the structural adjustment program of the IMF. Tariffs, including sales taxes, excise duties and additional duties, were gradually reduced and dispersions in tariff rates were narrowed from the late 1980s. By the late 1990s, the trade weighted nominal rate of protection (NRP) fell to 30 percent from about 80% in the mid 1980s. The tariff regime has been substantially

* We are grateful to Philippe Scholtes of the UNIDO for permitting us to use the Survey data collected for the preparation of Nepal's Industrial Development Perspective Plan, Kathmandu, Oct 2001 (Project NC/NEP/00/009).

simplified and currently there are only five tariff bands (ie, 5%, 10%, 15%, 25% and 40%), making the import regime highly transparent.

The bias against exports was reduced through a real devaluation of the rupee and the simplification of export procedures. There are no export duties and exporters are entitled for a duty draw back under the duty draw back scheme. Also, to facilitate exports, by reducing costs and the administrative burden, the government introduced a bonded warehouse scheme for enterprises that export over 90% of their total output.¹ A ‘one window’ sanctioning procedure was introduced in the early 1990s to facilitate foreign investment. By the mid 1990s, most sectors were open for foreign investment, with the exception of a few related to environment, public health and national security. The government has gradually reduced its role in trade and investment by privatising the public enterprises as well as permitting the private sector to operate in areas where the public sector remains active. This has forced the remaining public enterprises to be efficient. However, there remains a significant public sector domination in the energy sector.

The reforms introduced since the mid 1980s have changed the structure of the manufacturing sector. For example, Nepalese manufacturing has become more export-oriented and there has been an improvement in capacity utilisation as the access to imported inputs increased. Also, there has been an increase in manufacturing employment. These structural changes may have some impact on efficiency, although a detailed firm level analysis based on a well-grounded theory has not yet been undertaken.² This paper aims to bridge this gap by investigating the level and determinants of efficiency in Nepalese manufacturing firms; this could provide useful policy insights for policy makers in LDCs.

¹ Under the Scheme, all imported raw materials are stored in a warehouse under the bond. Exporters are required to deposit duties, which are refunded after producing the evidence of exports. The bonded warehouse Scheme was initially introduced in 1988 to encourage garment exports, later it was also extended to other export-oriented industries.

² There are few industry-level analysis of productivity growth in the Nepalese manufacturing which suggest that even after liberalisation total factor productivity (TFP) continued to declined. A recent study by the United Nations Industrial Development Organisation (UNIDO, 2002) indicates that out of 44 industries at the four-digit level, 23 recorded an absolute fall in TFP growth. Most of these are labour-intensive industries, producing mainly for export markets. However, these results should be taken with a great degree of caution due to the highly aggregated nature of data.

In particular, through the use of a unique primary data set of manufacturing firms, a translog stochastic production frontier is estimated via maximum likelihood econometric methods. The estimated production frontier permits us to establish the efficiency levels of individual firms and then to model the determinants of their inefficiency.

The rest of the paper is organised as follows. The characteristics of Nepalese manufacturing are discussed in Section 2. Section 3 outlines the likely determinants of Nepalese firm inefficiency, while the empirical model and results are reported in Section 4. The paper concludes in Section 5 with concluding remarks.

2. Characteristics of Nepalese Manufacturing

The Nepalese manufacturing sector is dominated by small-scale industries. Manufacturing contributes about ten percent to GDP, rising from five percent in the mid 1980s. This rapid rise in the GDP share of manufacturing was mainly brought about by growth in labour-intensive exports, in particular carpets and readymade garments. As access to imported inputs increased and the investment climate liberalised, investment in carpets and readymade garments rose sharply to take advantage of Nepal's generalised system of preferences (GSP) quotas, leading to a rise in their exports. By the late 1990s, these two items together accounted for about a 75 percent share in total manufacturing exports.³ The Nepalese manufacturing sector has attracted a number of foreign firms since the introduction of a liberalisation program in mid 1980s, helping the country to meet a short-fall in technology and capital.⁴ Most of these foreign firms have come from India. Manufacturing employs about three percent of the work force.

The examination of firm efficiency is based on a survey of 121 manufacturing firms conducted for a United Nations Industrial Development Organisation (UNIDO) study. Some

³ For further discussion on the impact of liberalisation on trade intensity, see Sharma et.al (2001).

⁴These investments have come in electronic goods assembly activities, food and beverages, garments and carpets, and the chemical sub-sector.

descriptive statistics about the firms covered by this study are presented in Table 1.⁵ Appendix 1 discusses the data and variables employed for estimation in more detail.

Table 1: Characteristics of Surveyed Nepalese Manufacturing Firms

Firm type	Exports % of gross output *	Value added share (%)	Employment share (%)	Value added per worker (US\$)	Net capital per worker (US\$)	ERP (%)
Resource intensive	3.17	61.18	45.22	241.49	191.71	146.5
Labour intensive	13.87	17.55	32.02	30.45	26.71	21.1
Specialised supplier	0.91	9.47	8.13	29.80	78.96	-30.5
Scale intensive	0.34	12.14	12.12	55.78	45.93	20.5
Science based	0.14	0.42	2.5	1.63	0.77	25.8

*Weighted average using the value added share.

Source: Computed by the authors based on the UNIDO Survey data.

It is immediately apparent from Table 1, that there are significant differences between the sectors in terms of export-orientation, value added contribution and employment generation. As expected, labour-intensive industries are more export-oriented than any other branch of manufacturing, while science and scale based industries contribute least to manufacturing exports. Despite an abundant supply of labour, the value-added share of labour-intensive industries is just over 17 percent and these industries employ 32 percent of the manufacturing work force. The resource based industries, which are mainly mineral based, are the most important source of manufacturing employment and value added, employing 45 percent of the work force and contributing over 61 percent to the manufacturing value added. The

⁵ Based on the OECD classification, firms are grouped into resource intensive, labour intensive, specialised supplier, scale intensive and science-based industries in Table 1. Resource based industries include: food, beverages and tobacco, wood products, petroleum refining, non-metallic mineral products and non-ferrous metal. Labour intensive industries are: textile, jute manufacturing, carpets, apparel and leather, metal products and other manufacturing. Specialised industries are: non-electric machinery, electric machinery, communications equipment and semiconductors, while scale intensive industries are paper and printing, chemical excluding drugs, rubber and plastics, iron and steel, ship building, motor vehicles and other transport equipment. Science based industries include aerospace, computers and office equipment, pharmaceutical and scientific instruments. See Sharma (2001).

resource based industries also have the highest value-added per worker and a high capital intensity (see Table 1, column 6).

It is surprising to note that the net capital per worker is extremely low in science based industries, in fact even lower than the labour-intensive industries. There is a wide variation in the effective rate of protection (ERP) between the sectors. For example, resource-based industries (which are capital intensive) receive the highest level of protection (146 percent) followed by the labour-intensive industries which receive 21 percent. Specialised supplier industries receive negative protection. This large dispersion in the effective rate of protection between the sectors indicates that there remains a significant distortion in the incentive environment.

3. Determinants of Firm Inefficiency

The main focus of this paper is to explain why firms are inefficient. Based on previous theoretical and empirical literature, this section develops a series of likely sources of firm inefficiency for Nepalese manufacturing.

It is argued in the literature that the efficiency of a firm depends on its size. Large firms tend to be more efficient than small firms because they have market power and they enjoy the benefits of scale economies. Jovanovic (1982) argued that efficient firms grow and survive, while inefficient firms stagnate or exit the industry. As efficient firms grow, they gain experience and improve work practices, leading to efficiency improvement. On these grounds a positive link between the firm size and efficiency is expected.

LDCs not only have shortages of capital, but they also lack effective physical infrastructure, which is essential for the efficient utilisation of capital intensive technology. Shortages of electricity and technical personnel often deter capacity utilisation in capital intensive industries (Pack, 1984). Hence, it is reasonable to expect a lower level of efficiency in firms that have higher capital intensity. This expectation is also consistent with conventional trade theory, which argues that LDCs have a comparative advantage in labour intensive commodities because of the abundant supplies of labour. Hence, firms that use labour intensively are firms with higher efficiency.

Since foreign firms have access to superior technologies, management talent, and a well-established marketing network, their participation may lead to efficiency improvement in LDCs. However, it is argued that the nature of the link between foreign participation and efficiency improvement depends on the motive behind such participation. If the motive is to capture the protected market or to take advantage of generous tax incentives offered by the host country, then foreign participation may not improve efficiency because there is no real pressure to improve efficiency (World Bank, 1993). Thus, the link between foreign participation and efficiency improvement is an empirical matter.

Conventional theory suggests that protection, by discouraging foreign competition, retards efficiency, while liberalisation enhances efficiency by attracting competition. Also, in a protected regime there is no motivation for a firm to be innovative and to adopt best practice, leading to *X*-inefficiency. However, Rodrik (1992a,1992b) argued that there are no theoretical reasons to believe that protection reduces efficiency. If the incentive for greater technological progress is linked to the scale of operation, protection may in fact improve efficiency by increasing the domestic firm's output and its market share, while import liberalisation induces inefficiency by reducing domestic sales (Rodrik 1992b). In fact, rapid removal of protection can adversely affect efficiency in firms with long gestation periods and technologies that are difficult to master. Hence, the effect of protection on efficiency is ambiguous.

Export-oriented firms may be more efficient as a result of scale economies, greater horizontal specialisation as each firm concentrates on a narrow range of products, and increasing familiarity with and absorption of new technologies (Pack, 1988, Nishimizu and Robinson, 1984). Furthermore, with foreign exchange earned from exports, firms would have greater access to inputs and technologies. Export expansion brings local firms closer to foreign firms, and gives them opportunities to become familiar with better management practices. International exposure also encourages local firms to train their workers better and increase the number of skill-intensive jobs, leading to efficiency improvement. This leads us to believe that the firms that export a greater proportion of their output are more efficient. Hence, we expect a positive link between export intensity and efficiency.

4. Empirical Model and Results

To determine the level of efficiency of firms and examine inefficiency determinants we employ the stochastic production frontier developed by Battese and Coelli (1995). The model specifies a production frontier with two error terms, one to capture standard random variation (V) and the other to measure the extent to which a firm operates inside the production frontier (U). This specification permits the simultaneous estimation of both the production frontier and the explicit modelling of inefficiency effects.⁶ Firm inefficiency effects are assumed to follow a general truncated normal distribution. The following translog form is used for the stochastic production frontier⁷:

$$\ln(Y_i) = \beta_0 + \sum_{j=1}^3 \beta_{0j} D_{ji} + \sum_{j=1}^4 \beta_j \ln x_{ji} + \sum_{j \leq k}^4 \sum_{k=1}^4 \beta_{jk} \ln x_{ji} \ln x_{ki} + V_i - U_i \quad (1)$$

where, $i = 1, \dots, 121$ firms;

Y_i is gross output (in Rupees, Rs);

D_j are dummy variables: unity for a positive input, zero otherwise

$j = 1$, local intermediate input

$j = 2$, imported intermediate input

$j = 3$, capital input;

x_1 labour input cost (in Rs);

x_2 max (local intermediate input in Rs, $1 - D_1$);

x_3 max (imported intermediate input in Rs, $1 - D_2$);

x_4 max (capital input in Rs, $1 - D_3$);

⁶ The approach has been recently employed for manufacturing firms in other developing countries, including Kenya (Lundvall and Battese, 2000) and Korea (Kim, 2003).

⁷ For a very small number of firms, some specific inputs are not used. This poses estimation problems for production frontier estimation as the logs of inputs are employed. The frontier specification includes dummy variables to account for zero input usage for some variables, this overcomes estimation bias problems associated with the use of zero inputs, see Battese (1997).

V_i is normally, independently and identically distributed with zero mean and variance σ_v^2 ;

U_i is a non-negative random variable reflecting inefficiency such that:

$$U_i = \delta_0 + \delta_1 \ln(x_{2i} + x_{3i}) + \delta_2 \ln(x_{4i} / x_{1i}) + \delta_3 x_{5i} + \delta_4 x_{6i} + \delta_5 x_{7i} + W_i = \mu_i + W_i \quad (2)$$

where, x_5 is unity for foreign participation and zero otherwise;

x_6 nominal rate of protection (NRP);

x_7 exports as a proportion of total output;

W_i is defined so that each U_i is truncated to be non-negative in normal and

independent distribution with mean μ_i and variance σ^2 , with $\gamma = \sigma^2 / (\sigma_v^2 + \sigma^2)$ and

$$\sigma_s^2 = \sigma_v^2 + \sigma^2.$$

The data definitions and summary statistics for the data are provided in Appendix 1. Given the non-homogenous outputs of the sampled firms, all inputs and output are measured in monetary terms so the inefficiency estimates capture elements of both technical and allocative inefficiency. The determinants of inefficiency in equation (2) are motivated in Section 3 and therefore the expected estimated parameter signs are: $\delta_1 < 0, \delta_2 > 0, \delta_3 < or > 0, \delta_4 < or > 0, \delta_5 < 0$.

Equations (1) and (2) are simultaneously estimated via maximum likelihood using FRONTIER 4.1, Coelli (1994), estimates are provided in Table 2. Various specification likelihood ratio tests can be performed, see for example Battese and Broca (1997). First, the null hypothesis of a Cobb-Douglas functional form is rejected, $LR = 56.34 \sim \chi^2(10) = 23.21$ at the 1% level. Second, the test of the null that there is no inefficiency among firms ($H_0 : \gamma = 0$), is rejected: $LR = 47.17 \sim \chi^2(7) = 17.75$ at the 1% level, for a one-sided test. Third, the test of the null that all the inefficiency determinants are jointly zero, is rejected: $LR = 15.14 \sim \chi^2(5) = 15.09$ at a 1% level. These results support the presented specification.

Table 2: Maximum Likelihood Frontier and Inefficiency Estimates

Variable	Coeff	t-ratio	Variable	Coeff	t-ratio
Frontier					
Constant	-7.822*	5.27	(ln x_1) (ln x_2)	-0.034*	-2.59
Dummy-local intermediate	-3.902*	-3.32	(ln x_1) (ln x_3)	-0.038*	-3.56
Dummy- imported Intermediate	1.100	1.14	(ln x_1) (ln x_4)	0.019	1.15
Dummy capital	1.369*	1.98	(ln x_2) (ln x_2)	0.072*	5.21
Ln x_1 (labour)	-0.445	-1.46	(ln x_2) (ln x_3)	-0.015*	-2.45
Ln x_2 (local intermediate)	-0.505*	-1.98	(ln x_2) (ln x_4)	-0.012*	-1.96
Ln x_3 (imported intermediate)	0.381	1.78	(ln x_3) (ln x_3)	0.033*	3.36
Ln x_4 (capital)	0.258	1.94	(ln x_3) (ln x_4)	-0.010*	-2.04
(ln x_1) (ln x_1)	0.068*	3.51	(ln x_4) (ln x_4)	-0.012	-1.43
Inefficiency					
Constant	4.554*	3.99	Foreign participation	-0.559	-0.56
Ln (Firm size)	-0.841*	-4.14	NRP	3.634*	2.39
Ln (Capital intensity)	0.339*	2.69	Export intensity	0.639	0.84
Variances					
σ_s^2	1.198	3.99	γ	0.907	35.91

* Denotes that coefficients are significant at a 5% level.

At the means of the data, the elasticity of output (at the frontier) with respect to each input are: labour 0.282, local intermediate input 0.344, imported intermediate input 0.498 and capital -0.034. These elasticities imply a returns to scale estimate of 1.090.

The average efficiency level is 74.6% with a standard deviation of 18.4% and a range from 2.3% for a furniture manufacturing firm to 93.1% for a printing press firm. The efficiency levels are highly negatively skewed with the majority of firms having efficiency levels of between 70% and 90%. In terms of the industrial classification of Table 1, average efficiencies are: resource intensive (72.2%), labour intensive (77.9%), specialised supplier (75.5%), scale intensive (75.4%) and science based (86.4%). These levels of efficiency are broadly consistent with Kenyan manufacturing firms where average efficiency scores range

from 68% to 80% (Lundvall and Battese, 2000) and Malaysian food manufacturing firms with average scores ranging from 60% to 81% (Kalirajan and Shand, 1994).

The majority of the production frontier parameter estimates are precisely estimated, as testified by their statistical significance at the 5% level. Three of the inefficiency parameter estimates are statistically significant, i.e., firm size, capital intensity and the nominal rate of protection.

These results are broadly consistent with theoretical expectations. For example, small firms appear to be inefficient. As argued earlier, this may be because small firms have no market power and they are unable to exploit the benefits of large-scale production. Our finding about the link between firm size and inefficiency is consistent with previous studies by Lundvall and Battese (2000) and Kim (2003).

As expected, we find that firms with higher capital intensity are inefficient. This is because, being a labour abundant country, Nepal has a comparative advantage in labour rather than capital-intensive technology that requires efficient physical infrastructure and human capital, which she lacks. Despite this, during the import-substitution regime firms accumulated capital-intensive technology, because incentives, including import licenses, were granted based on the amount of capital accumulated, although the country did not have comparative advantage in capital intensive activities. Following market-oriented reforms, however, these firms experienced a significant fall in efficiency. For example, the efficiency level was well below the average in most capital intensive firms, which include metal crafts and appliances. Our finding about the link between capital intensity and efficiency is consistent with an earlier study on the Nepalese manufacturing, based on industry level data, which found a fall in productivity growth in industries with a higher level of capital intensity (Sharma et. al 2000).

Foreign investment appears to have statistically no significant impact on inefficiency. In earlier work on the Nepalese manufacturing, based on industry level data, a statistically significant and a positive link between the foreign investment and manufacturing productivity growth was found (Sharma et al. 2000). Variations in results appear to be mainly

due to differences in data, the present study is based on the firm level while the previous study was based on industry level data.

We find a statistically significant and a positive link between the level of protection and inefficiency, suggesting that the higher the level of protection, the higher the inefficiency. This is probably because protection discourages innovation and cost reduction. A previous study on the Nepalese manufacturing by Sharma et. al (2000) did not find a statistically significantly link between protection and efficiency. Again, the difference in results is probably due to differences in the time period covered and differences in data levels.

On theoretical grounds, we expected a strong positive link between export-orientation and efficiency improvements, however, we found no statistical evidence to suggest that export-oriented firms are more efficient in Nepalese manufacturing. Interestingly, Kim (2003) found a mixture of positive and negative effects of export intensity on inefficiency. The positive impact of export intensity on inefficiency is rationalised by arguments such as: exports may be targeted at low price products which takes the focus away from improving production processes; and exports might be more associated with productive excess capacity rather than the desire to compete internationally. These motivations may offset the traditional arguments about scale economies and absorption of new techniques, which support a negative link between export intensity and inefficiency, to result in an insignificant link between export intensity and inefficiency.

5. Conclusion

Efficiency is a key to sustaining growth and alleviating poverty in LDCs. However, there is a widespread perception that manufacturing firms in these countries are not efficient because of excessive protection, poor export performance, and a low level of physical and human capital. While there is some truth in these claims, empirical findings are ambiguous as most existing studies rely on aggregate industry-level rather than firm-level data. Fortunately, we have access to firm level data from Nepal which covers 121 firms, ranging from food, beverages and tobacco to textiles and wearing apparels, paper and chemical products, fabricated metal products, non-metallic mineral products and radio and TV. The examination of the Nepalese experience is important not only in its own right being a LDC, but also

because it has experienced significant reforms since the mid 1980s and there have been no previous firm level studies of efficiency in Nepalese manufacturing.

In this study we have estimated a translog stochastic production frontier via maximum likelihood econometric methods which allowed us to establish the efficiency levels of individual firms and then to model the determinants of their inefficiency. The average efficiency level in Nepalese manufacturing is 74.6%, with the majority of firms having efficiency levels of between 70% and 90%. These levels of efficiency are broadly consistent with similar studies conducted in other developing countries.

Our results are broadly in line with theoretical expectations. We find that large firms are more efficient and that a higher capital intensity leads to inefficiency. There is no statistical evidence to suggest that foreign investment leads to efficiency improvements. Also, we did not observe any link between export intensity and efficiency improvement. Overall, our results suggest that higher protection leads to inefficiency. Taking all these points together, our results suggest that an outward-looking industrial strategy, which relies on less intervention and permits the development of large-scale industries, is conducive to efficiency improvement in LDCs like Nepal.

Appendix 1: The Data and Variable Measurements

Data used in this study were collected for the Industrial Development Perspective Plan: Vision 2020 funded by the United Nations Industrial Development Organisation (UNIDO). The data set covers 121 firms, including food, beverages and tobacco, textiles and wearing apparels, paper and chemical products, fabricated metal products, non-metallic mineral products, radio, TV and communication equipment. Data were collected from major industrial towns. About 80 percent of manufacturing establishments are located in the area covered by the survey, indicating that the sample is a good reflection of the Nepalese manufacturing sector. Our dataset covers the post-reform period (year 2000/01) and includes firms ranging from the processed food to mineral and readymade garments.

For the production frontier all inputs and output are measured in monetary terms (Rs). Our measure of capital is adjusted for capacity utilisation, because during the import-substitution regime there was an incentive for capital accumulation as import licences were based on firm capacity rather than the actual utilisation. *Firm Size* is proxied by intermediate input usage. This is used in Lundvall and Battese (2000) and reflects the notion that intermediate inputs change less than other inputs and hence provide a more stable and consistent measure of firm size. Other measures for firm size including labour input proved to be unsuccessful. *Capital Intensity* is defined as capital per labour. *Foreign Investment* is proxied by a dummy variable, whose value is 1 for the firm that has foreign participation and 0 otherwise. *Nominal Rate of Protection* defined as tariffs on final goods. At the experimental stage, our model was also estimated using the industry-specific effective rate of protection (ERP). However, in the absence of firm specific ERP data, our model had poor explanatory power. Hence, we employed firm specific NRP data. *Export Intensity* is defined as the export percentage of total output.

*Data Summary Statistics**

Variable	Mean	Std. Dev.	Variable	Mean	Std. Dev.
Gross Output	180.1	297.6	Firm Size	106.0	195.6
Labour	15.46	25.73	Capital Intensity	0.781	27.515
Local Intermediate	26.46	44.65	Foreign Participation	0.083	0.276
Imported Intermediate	79.57	189.3	NRP	0.199	0.137
Capital	32.60	100.4	Export Intensity	0.166	0.322

* Output and inputs measured in 1,000 Rs.

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