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Abstract: This study evaluates the impact of privatization on the technical efficiency of six privatized enterprises, three state-owned enterprises and six private enterprises competing in three oligopolistic manufacturing industries in which privatization took place between 1984 and 1991 using panel data between 1970 and 1997. Using a two-stage estimation procedure, we first estimate technical efficiency scores based on stochastic production frontiers with and without Hicksian neutral technical change and in the second stage we investigate the relationship between technical efficiency and privatization while controlling for the other firm and industry specific characteristics. The empirical results show that in the Cobb-Douglas functions technical progress is 2.3 percent, 3.7 percent and 2.1 percent per annum in the food, chemical and transport equipment industries, respectively. We further find evidence that privatization increases the technical efficiency of all firms (industry effects) and the efficiency of privatized enterprises (firm effects). However, capital intensity, multinationality and structural adjustment programs provided further incentives for technical efficiency.

Key words: Privatization; Production Functions; Technical Efficiency; Malawi Manufacturing

JEL Classification: L13, L33, L60

1. Introduction

'Goodbye state capitalism, hello popular capitalism' has been the driving force of privatization around the world since the late 1970s. Thus, privatization of state-owned enterprises (SOEs), defined as the transfer of ownership from the public to the private sector, has been a major policy instrument in private enterprise development in developed and developing countries in the past two decades. Many developing countries, and African countries have followed the path of privatization of the state-owned enterprises (Adam et al., 1992; Cook and Kirkpatrick, 1995; White and Bhatia, 1998). The pull and push factors leading to privatization differ across countries (see White and Bhatia, 1998). Nonetheless, in most African countries, privatization of state-owned enterprises has been associated with World Bank and International Monetary Fund (IMF) sponsored structural adjustment programs (Adam, 1994; White and Bhatia, 1998). The empirical evidence on the economic impact of privatization in developed and transitional economies is emerging and is largely in support of the positive impact of privatization (Megginson and Netter, 2000). From an African perspective, Plane (1999) using the stochastic production frontier approach find evidence that privatization is associated with at least 3.5 percent points in the level of efficiency in the electricity corporation in Cote d'Ivoire. However, the empirical evidence in developing countries and African countries is limited despite a decades of economic reform programs and privatization of state-owned enterprises.

Malawi, a small developing country in Southern Africa, was not spared from the wave of popular capitalism. The government in Malawi has implemented privatization of SOEs in Malawi within the framework of expenditure-switching and expenditure-reducing structural adjustment programs of the World Bank and IMF following the poor performance of state enterprises in the early 1980s (Adam et al., 1992; Adam, 1994). First, the government introduced the parastatal reform programme in 1981 to improve monitoring and control within the SOE sector to enhance the operational efficiency of state-owned enterprises (Malawi Government, 1987). Secondly, the first phase of the privatization programme (1984 - 1992) began with asset swaps between two state holding corporations - the Agricultural Development and Marketing Corporation (ADMARC) and Malawi Development Corporation (MDC), and Press Corporations in 1984 (see Adam et al., 1992; Adam, 1994). This phase of privatization was supported under the first six structural adjustment loans that the World Bank provided to Malawi. Several estates, thirteen non-manufacturing enterprises and eleven manufacturing enterprises held by ADMARC and MDC were privatized by the end of 1992. The eleven privatized manufacturing enterprises were among the fifty-two state-owned enterprises in the manufacturing sector. The second phase is ongoing and began in 1996 under the seventh structural adjustment loan, the Fiscal Restructuring and Deregulation Programme. The scope of privatization in the second phase is much broader and the government identified more than one hundred and fifty state enterprises and assets in 1996 and more than fifteen major privatization activities have taken place between 1993 and 1998 (Privatization Commission, 1997, 1998).

This study is motivated by the existing empirical research gap on the effect of privatization on technical efficiency in developing countries. Our study also attempts to address two issues that are ignored in empirical studies of privatization. First, we use econometric analysis to determine the impact of privatization while controlling for the many other factors that influence technical efficiency. This in a way attempts to address the concerns raised by Adam (1994) and Martin and Parker (1997) with regard to the need to isolate the effect of privatization on performance from other factors such as liberalization and regulation. Second, given the structure of manufacturing sectors in small developing countries, we investigate whether privatization has industry effects following the theoretical developments in the mixed oligopoly literature. We use enterprise level data in selected manufacturing industries spanning the period 1970 to 1997, by selecting sectors in which privatization took place during the 1984-91 period in Malawi, in which privatized enterprises have been under private ownership for at least five years. The study, therefore, contributes to the limited empirical evidence on the privatization-efficiency hypotheses, particularly in developing countries by taking into account oligopolistic interdependence and the impact of other liberalization measures on economic performance. The next section reviews theoretical and empirical literature. Section 3 concentrates on a brief overview of privatization and structural reforms in the manufacturing sector in Malawi. Section 4 describes the methodology of estimating technical efficiency and describes the data and sample of enterprises. In section 5, we present empirical results and in section 6 we provide concluding remarks.

2. Privatization and Efficiency: Theoretical and Empirical Framework

The main economic justification for privatization is that it promotes the economic efficiency of privatized state-owned enterprises. Several theories explain the superiority of private ownership over public ownership, and the economic efficiency gains that are likely to emerge from the transfer of ownership and control of assets from the public to private investors. First, the property rights theory explains differences in the performance of public and private enterprises in terms of marked differences in attenuation of property rights (Demsetz, 1966, 1967; Furubton and Pejovich, 1972; De Alessi, 1980; Davies, 1981). Property rights in public enterprises are attenuated partly because property rights cannot be easily transferable, which implies that the cost and rewards of economic activities do not accrue more directly to individuals responsible for the property rights. The general conclusion from the property rights theory is that the more attenuated property rights are, the less productively efficient will be the enterprise because attenuation weakens the rewards-penalties systems that are necessary for cost minimizing behaviour.

Second, extending the property rights approach, the principal-agent theory focuses on differences in the monitoring mechanisms and incentives which public and private managers face as agents of shareholders given welfare maximization for the former and profit maximization for the latter

(Vickers and Yarrow, 1988; Bös and Peters, 1991; Bös, 1991). The change in ownership from the public to the private sector has at least two effects: a change in the objective from a weighted welfare function to profit maximisation and a change in the incentive structure by linking reward to the level of performance under the private ownership. This shift towards profit maximisation may imply higher price, thus foregoing allocative efficiency, but there may be an increase in operational or productive efficiency.

Third, the public choice theory takes the bureaucratic approach in which public enterprises are seen as an instrument of enhancing the utility functions of politicians such as maximization of votes and the budgets (Niskanen, 1972; Buchanan, 1972; Blankart, 1983; Boycko et al., 1996). Proponents of the public choice theory hold that government departments pursue objectives that do not maximize profits and usually pursue goals such as maximizing budget, risk aversion, employment and investment. Boycko et al. (1996) propose a model of privatization within the framework of public choice theory. The model shows that privatization will lead to effective restructuring of state-owned enterprises that are currently producing at inefficiently high levels to maximize employment, only if both cash flow rights and control rights pass from the government into private hands (particularly managers' hands). This will make it difficult for the government to bribe managers to produce at inefficient levels by offering them operating subsidies. Therefore, cutting the 'soft budget constraint' is vital to improving performance.

Fourth, organizational theories emphasise the role of organizational characteristics in determining the performance of firms (Hartley and Parker, 1991; Dunsire, 1991; Bishop and Thompson, 1994; Martin and Parker, 1997). Proponents of organizational theories argue that differences in the performance of public and private firms are influenced by differences in management, goals, labour, communication and reporting systems, organisational structure, and the nature and location of business. In all the four theories of privatization, there is a consensus that ownership matters and does affect the internal efficiency of firms (cost minimizing behaviour) and the allocative efficiency in the market place.

Finally, within the hard and soft budget constraint debate, Kornai (1980, 1986, 1993) suggest that state-owned enterprises face a soft budget constraint such as through provision of subsidies that imply that the firm can survive without necessarily covering its costs, and this encourages inefficiency. Thus, if the credibility of the threat of termination or liquidation is weak, incentives to increase efficiency are also weaken (Kornai, 1993; Berglof and Roland, 1998; Qian and Roland, 1996; Raiser, 1994; Bertero and Rondi, 2000).

However, the traditional theories of privatization assume away the structure of the market within which firms operate, hence only focus on the capital market. The predictive power of the traditional theories on the economic efficiency effects of privatization becomes ambiguous when we explicitly introduce issues of product market competition in form of either number and size distribution of firms or market contestability and regulation. It is generally agreed that without product market competition, privatization *per se* may not significantly alter the performance of the firm. Others argue that it is competition in the product market that provides the strongest incentives towards economic efficiency. Models of public enterprises in oligopolistic industries, in which state firms are instructed to maximize social welfare, tend to shed more light on the uncertainty in the economic efficiency effects of privatization (see among others, Cremer et al., 1989; De Fraja and Delbono, 1989; Fershtman, 1990; De Fraja, 1991; George and La Manna, 1996; White, 1996; Pal, 1998). These models of public firms in oligopolistic industries show that public ownership in imperfectly competitive markets can be an instrument of moderating private sector oligopolistic behaviour and the economic efficiency effects of privatization will depend on the trade off between productive efficiency gains and the allocative efficiency losses.

The empirical support for the impact of privatization on enterprise performance, on one hand, has mainly been motivated by a wide body of empirical evidence on the comparative performance of public and private ownership. Nonetheless, the empirical evidence to substantiate claims of the improved efficiency due to the privatization of state-owned enterprises is very scanty and is still developing. The empirical results from comparative studies of private and public enterprises are mixed although largely supporting the propositions that emerge from the property rights and public choice theories that private enterprises are more efficient than state enterprises in achieving lower costs and higher productivity and profitability where firms operate in competitive environments.[1] In monopoly environments, especially where regulation exists,

[1] See Vining and Boardman (1991), Martin and Parker (1997), Tittenbrun (1996), Domberger and Piggott (1994) and Boardman and Vining (1989) for a review of comparative public and private enterprise performance studies.

incentives for efficiency are eroded and most studies do not support the hypothesis that private enterprises are more efficient than SOEs except in health-related services and manufacturing sector where competition and absence of regulation may largely account for the superiority of private enterprises.

Existing comparative studies on the effect of privatization on economic efficiency have been undermined by the short time horizon of the period after privatization and the practical difficulties of separating other factors that affect firms' performance. In a comprehensive review of privatization studies, Megginson and Netter (2000) conclude that the overall evidence support the hypothesis that privatization increases the profitability and economic efficiency of privatized enterprises. However, the problem with the many studies of privatization is the use of the statistical analyses based on comparisons between the mean or median before and after privatization, which tend to attribute all changes in performance to privatization alone. This may be an inappropriate assumption especially in economies that are implementing broad-based economic reforms in the transitional economies and developing countries. There has been limited use of econometric analyses or methods of principal components to isolate the impact of the many other factors on enterprise performance. Secondly, most empirical studies with the exception of Eckel et al. (1997) do not consider the competitive nature of markets within which privatized firms operate and assume away the industry effects of privatization.

Motivated by theories of mixed oligopolies or mixed enterprises in oligopoly markets that suggest the important role of oligopolistic interdependence between firms within the privatization debate, in this study we exploit the long panel data from the census of manufacturing production in Malawi to investigate the effect of privatization in selected manufacturing industries and control for the many other factors that affect enterprise performance.

3. Privatization and Structural Reforms in Malawi Manufacturing

The government involvement in the manufacturing sector im Malawi was part of an industrial strategy to increase local participation in light of a weak indigenous private capital base in the post-independence era. In 1987, of the 12 commercial and 6 quasi-commercial state enterprises established by Act of Parliament only two commercial enterprises were in the manufacturing sector. However, two commercial state holding corporations fostered government ownership in the manufacturing sector, the Agricultural Development and Marketing Corporation (ADMARC) and the Malawi Development Corporation (MDC). By 1980, ADMARC and MDC had direct and indirect ownership in 32 manufacturing enterprises, operating in highly oligopolistic markets and competing with private local and foreign firms in various industrial markets. ADMARC had investments in 15 manufacturing enterprises representing 46.9 percent of the total number of its investments while MDC had investments in 17 manufacturing enterprises representing 63 percent of the total number of its investments. ADMARC investments were concentrated in supply-based industries while MDC had more investments in the demand-based industries.[2] The number of SOEs in the manufacturing sector was about a third of the total number of large-scale manufacturing enterprises in Malawi, with an average state share holding of 58.5 percent. Nonetheless, the Privatization Commission (1997) estimates that state ownership was in more than 150 commercial entities in 1996.

The poor financial performance of SOEs initiated the reform programme of the parastatal sector and the subsequent privatization of some enterprises within the framework of structural adjustment programs. The parastatal reform programme began in 1981 and mainly targeted directly owned state enterprises. The government reform strategies included review of corporate objectives, the introduction of performance related incentives, increasing the autonomy of management in recruitment and firing of employees (Malawi Government, 1987). All these strategies were in line with the overall policy objective of improving the efficiency and effectiveness of parastatal institutions including public departments responsible for reviewing, monitoring and regulating the parastatal sector. However, a review of parastatal activities in the 1990s suggested the continued existence of conflicts of objectives, the multiplicity of principals, limited managerial autonomy and low accountability levels (Lawson and Kaluwa, 1996).

The other component of the reform programme is the privatization of SOEs, mainly directed at subsidiaries and associate companies of state holding corporations. We recognize two phases of divestiture and privatization in Malawi. The first phase was part of a rationalization of

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[2] Supply-based industries are those that mostly use local raw materials while demand-based are those that mostly use imported raw materials in their production process (Malawi Government, 1971).

investment portfolios for MDC and ADMARC with Press Corporation, a holding company formed from a public trust held by the President on behalf of the people of Malawi. The second phase which began in 1996 is being implemented in the National Privatization Programme and encompasses the whole SOEs sector. In 1995 the Malawi Government produced a privatization policy that led to the legislation of the Public Enterprises (Privatization) Act in 1996.

The first phase of privatization started with the rationalization of investment portfolios for two state holding corporations, ADMARC and MDC, following financial problems during the economic crisis between 1979 and 1983. ADMARC, MDC and a quasi-private corporation, Press Corporation, had interlocking ownership in several investments, such that the poor performance in major subsidiaries affected all the three institutions (Harrigan, 1991). With the assistance of the World Bank and IMF, Press Corporation was restructured and investment portfolios of ADMARC, MDC and Press Corporation were rationalized through asset swaps in 1984 as a short-term solution to the SOEs sector crisis (Adam et al., 1992). The investment portfolio rationalization meant that ADMARC held investments in agricultural-oriented activities, MDC specializing in industrial and service sectors and Press Corporation having a heterogenous portfolio. Between 1984 and 1991, the government implemented the privatization of subsidiaries of MDC and ADMARC outside the asset swaps. The government privatized nine manufacturing enterprises between 1984 and 1991, and two were liquidated out of a total of 32 state-owned enterprises in the manufacturing sector. Two of the sales were made to existing shareholders who had pre-emptive rights and two involved new foreign investment. The privatization of the three manufacturing enterprises in the food processing industry in 1991 involved the participation of new foreign investors but the government still retained more than 20 percent ownership (Adam et al., 1992; Chirwa, 2000).[3]

The National Privatization Programme represents the second phase of privatization in Malawi designed under the Fiscal Deregulation and Restructuring Program as part of structural adjustment programs. The framework for a more comprehensive process of privatization started

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[3] There has been on policy reversal with respect to the first phase of privatization. Grain and Milling Company which was involved in the asset swaps of 1984, was sold back to Press Corporation in a joint venture partnership with Namib Mills while ADMARC retained 25 percent of ownership in the enterprise. Although Namib Mills was an experienced partner in the milling industry, it failed to improve the operational efficiency of the company and the 75 percent share hold by Press Corporation and Namib Mills was sold back to ADMARC in 1999.

in 1994, soon after the first multiparty presidential and parliamentary elections. The government drafted the Policy Framework for Privatization which became a Policy Statement after endorsement by Cabinet at the end of 1995. In March 1996, the Public Enterprises (Privatization) Act was passed by Parliament. The National Privatization Programme is an ongoing process with about 140 assets planned for divestiture. Between 1993 and 1998, eight manufacturing enterprises were privatized, with private placement and sale to existing shareholders with pre-emptive rights being the dominate the methods of privatization (Chirwa 2000). All investors with pre-emptive rights were foreign multinational firms. Public offering of equity sales through the Malawi Stock Exchange was only used for the privatization of one enterprise among the privatized enterprises in the manufacturing sector (Privatization Commission, 1997).

It is important to recognize that privatization in Malawi has taken place within the framework of structural adjustment programs and in a highly oligopolistic market structure particularly in the manufacturing sector. This justifies the need to use multiple regression analysis to determine the influence of privatization on technical efficiency. Since 1981, under structural adjustment programs, many policies affecting the manufacturing sector have been implemented with implications on the incentive structure and the environment within which firms operate. For instance, industrial price decontrols that were started in 1983 in a phased approach were completed in 1988, monopoly rights were abolished in 1988 and entry into manufacturing was deregulated in 1992 (see Kaluwa and Reid, 1991). Moreover, since 1981 there has been a phased adjustment of exchange rate leading to a flexible managed float regime in 1994 and trade policy became more open (Mulaga, 1995; Mulaga and Weiss, 1996) and liberalisation of agricultural and financial markets.

Most of these policies enhanced the competitiveness of markets in Malawi and may have altered the structure within which firms operate and the incentive structure for efficient resource use. Thus, in Malawi manufacturing it may be inappropriate to attribute changes in technical efficiency to privatization alone, therefore, we need to control for several other factors that influence performance in the analysis of the impact of privatization.

4. Methodology and Data

4.1 Estimation of Technical Efficiency

Technical efficiency is a component of productive efficiency and is derived from the production function. Productive efficiency consists of technical efficiency and allocative or factor price efficiency. Productive efficiency represents the efficient resource input mix for any given output that minimizes the cost of producing that level of output or equivalently, the combination of inputs that for a given monetary outlay maximizes the level of production (Martin and Parker, 1997; Forsund et al., 1980). Technical efficiency reflects the ability of the firm to maximize output for a given set of resource inputs. Allocative efficiency reflects the ability of firm to use the inputs in optimal proportions, given their respective prices and the production technology. Developments in cost or production frontier analysis are attempts to measure productive efficiency as proposed by Farrell (1957). The frontier defines the limit to a range of possible observed production (cost) levels and identifies the extent to which the firm lies below (above) the frontier. The deviation of the firm's observed cost and output from the frontiers measures the extent of productive and technical inefficiency, respectively.

The literature suggests several methods of estimating efficiency using cost or production frontiers.[4] We use the stochastic frontier approach (STOF) that makes allowance for stochastic errors due to statistical noise or measurement errors. The STOF model decomposes the error term in the production or cost function regression model into a two-sided random error which captures the random effects outside the control of the firm and the one-sided inefficiency component. The model was first proposed by Aigner et al. (1977) and Meeusen and van den Broeck (1977). Several approaches exist for the estimation of technical efficiency with panel data using fixed effects and random effects models.[5] We follow the Battese and Coelli (1992)

4 For a review of alternative approaches see Forsund et al. (1980), Barrow and Wagstaff (1989), Bauer (1990), Seiford and Thrall (1990), Battese (1992), Fried et al. (1993), Charnes et al. (1995), Coelli (1995), Pollitt (1995) and Coelli et al. (1998).

5 Green (1993) provides an excellent review of econometric developments in stochastic frontier functions based on cross-section and panel data. For example Pitt and Lee (1981) proposes a random effect model with half-normal distribution of the asymmetric error while Battese and Coelli (1988) assume a truncated normal distribution due to Stevenson (1980). Cornwell et al. (1990), Kumbhakar (1990), and Battese and Coelli (1992) propose time-

time-varying efficiency model for which the time effects are an exponential function of time which can accommodate half-normal and truncated normal distribution of the asymmetric error term.[6]

Consider a suitable functional form for a production function, we specify a stochastic frontier with panel data for N firms over T periods as

$$\ln(y_{jt}) = f(x_{it},\beta) + \varepsilon_{jt} \tag{1}$$

$$\varepsilon_{jt} = (v_{jt} - u_{jt}) \tag{2}$$

$$u_{jt} = \eta_{jt}u_j = [\exp(-\eta(t - T)]u_j, \qquad t = 1,...,T; \;\; j = 1,...,N \tag{3}$$

where, y_{jt} is the output of the j th firm in period t; x_{jt} is the k x 1 vector of input quantities in logarithms of the j th firm in the t th period (including the time trend accounting for technical progress); β is a vector of unknown parameters to be estimated; ε_{jt} is the composite error term; v_{jt} is the two-sided error term assumed to be identically and independently distributed as $N(0,\sigma_v^2)$ and independent of u_{jt}; u_{jt} is the time-varying one-sided (asymmetric) error term which is nonnegative random variables which are assumed to account for technical inefficiency in production and are assumed to be identically and independently distributed as truncations at zero of the $N(\mu,\sigma_u^2)$ distribution[7]; u_j is the technical inefficiency effect for the j th firm in the last period of the panel (T_j) and η is an unknown scalar parameter. Equation (3) shows that for earlier periods in the panel, the technical efficiency effects are the product of the technical inefficiency effect of the j th firm at the last period of the panel and the value of the exponential function, whose value depends on the parameter η and the number of periods before the last period of the panel. The nonnegative firm effects, u_{jt}, decrease, remain constant or increase as

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varying models under different assumptions of the error term.

6 This is the only time-varying model that has been automated in a computer program FRONTIER 4.1 for estimation of stochastic production frontier (Coelli, 1996).

7 The distribution of the inefficiency component can take many forms, but is distributed asymmetrically (see Green, 1993), but there is no theoretical basis for the choice of the distributional assumption. Meeusen and van den Broeck (1977) and Aigner et al. (1977) assume that u_j has an exponential and a half-normal distribution with a mode of zero, respectively. Others propose a truncated normal distribution (Stevenson, 1980) and the gamma density (Green, 1980).

t increases if $\eta > 0$, $\eta = 0$ or $\eta < 0$, respectively. The case in which η is positive implies that firms improve their level of technical efficiency over time. A negative value of η implies that firm's efficiency worsens over time.

Battese and Coelli (1992) using the Battese and Corra (1977) reparameterization of the variance parameters provide the log likelihood function for panel data. The model can be applied on either balanced or unbalanced panel data. Battese and Coelli (1992) work out the minimum-mean-squared-error predictor of the technical efficiency of the j th firm at the t th period, $TE_{jt} = \exp(-u_{jt})$ as:

$$E[\exp(u_{jt}|\varepsilon_j)] = \left(\frac{1 - \Phi[\eta_{jt}\sigma_j^* - (\mu_j^*/\sigma_j^*)]}{1 - \Phi(-\mu_j^*/\sigma_j^*)} \right) \exp\left(-\eta_{jt}\mu_j^* + \frac{1}{2}\eta_{jt}^2\sigma_j^{*2} \right) \qquad (4)$$

where $\boldsymbol{\varepsilon}_j$ represent the $(T_j \times 1)$ vector of ε_{jt}'s associated with the time periods observed for the j th firm, $\varepsilon_{jt} = v_{jt} - \mu_{jt}$ and

$$\mu_j^* = \frac{\mu\sigma_v^2 - \eta_j'\varepsilon_j\sigma_u^2}{\sigma_v^2 + \eta_j'\eta_j^2\sigma_u^2}, \qquad \sigma_j^{*2} = \frac{\sigma_v^2\sigma_u^2}{\sigma_v^2 + \eta_j'\eta_j\sigma_u^2}$$

where $\boldsymbol{\eta}_j$ represents the $(T_j \times 1)$ vector of η_{jt}'s associated with the time periods observed for the j th firm, and Φ is the standard normal distribution function. The maximum likelihood (ML) estimates of the production function in equation (1) are automated in a computer program, FRONTIER Version 4.1, written by Coelli (1996). FRONTIER provides estimates of β, η, μ, $\gamma = \sigma_u^2/\sigma^2$, $\sigma^2 = \sigma_u^2 + \sigma_v^2$ and average technical efficiencies for the year and firm level efficiencies. Hicks neutral technical progress is captured by including the time trend variable in the production function in equation (1).

4.2 Factors Influencing Technical Efficiency

The literature suggests several factors that influence the allocation of scarce resources in the production process. However, there exists no compact theoretical model of determinants of technical efficiency, but strategies for identifying factors that determine inefficiency have been developed in sub-optimal organization and agency relationships within the firm, sub-optimal oligopoly bargains and related competitive factors within the industry, public policy (government intervention) and structural factors such as product differentiation (Caves, 1992). Following Caves and Barton (1990) several hypotheses are formulated based on the standard structure-performance relation and other factors to explain the determinants of industrial (in)efficiency.

We explain technical efficiency by factors that include privatization, competition, organizational characteristics and the policy environment using panel data regression models. We use the two-stage estimation procedure in which first the stochastic production function is estimated, from which efficiency scores are derived, then in the second stage the derived efficiency scores are regressed on explanatory variables. This approach has been criticized on grounds that the firm's knowledge of its level of technical inefficiency affects its input choices, hence inefficiency may be dependent of the explanatory variables.[8] We specify the following econometric model to test the industry effects and direct effects of privatization:

$$TE_{jt} = f(PRIV_{jt}, X_{kt}) \qquad (5)$$

where for firm *j* in industry *i* and at time *t*, TE is the technical efficiency score, PRIV is a dummy variable for privatization, **X** is the vector of competition variables, organizational characteristics and other policy variables. We estimate four models based on equation (5) using panel data approaches of random and fixed effects by decomposing the sample. The first model uses the full sample, and tests the hypothesis that privatization increases the technical efficiency of all firms in the privatized industries (industry effect) using the full sample. Thus if the PRIV is significant in the full sample, then in general privatization affects the performance of the industry. The second model uses the subsample of privatized enterprises, and tests the hypothesis that privatization increases the technical efficiency of privatized enterprises (direct firm effects). The third model uses the subsample of privatized enterprises and non-privatized SOEs, hence enterprises that have ever been under state ownership. Finally, we use a subsample of private

[8] The second approach advocates a one stage estimation simultaneous approach as in Battese and Coelli (1995), in which the inefficiency effects (u_{jt}) are expressed as an explicit function of a vector of firm-specific or industry-specific variables. The parameters of the frontier production function are simultaneously estimated with those of an inefficiency model, in which the technical inefficiency effects are specified as a function of other variables. Given the structure of manufacturing industries in Malawi, the limited variability of the explanatory variables and the need to have a subsample of privatized enterprises justifies the use of the two-stage estimation.

enterprises to further confirm the industry effects of privatization. If PRIV is insignificant in the full sample and the subsample of private enterprises, but significant in the subsample of private enterprises, then privatization only affects privatized enterprises.

We group the other sources of technical efficiency into ownership structure, competitive conditions and industry characteristics, organizational structure and firm characteristics and policy environment. The ownership structure variable in the model is the proportion of state ownership in the enterprise at a given time (STATE). On the basis of the property rights and public choice theories and comparative empirical studies of public and private firms, we expect technical efficiency decreases with state ownership.

The role of competition and market structure in enterprise or industry performance has been an issue of considerable debate in both theoretical and empirical industrial economics, but there are no doubts that variations in market structure will lead to different performance results. Nickell (1996) notes that there are theoretical reasons to believe that competition improves corporate performance, and finds a positive relationship between competition and total factor productivity growth. We use two indicators of market power to capture the effect of competition on efficiency. The first measure is the Herfindahl-Hirschman index (HHI) as a measure to capture the extent of domestic competition. The HHI is the sum of squared market shares (sales) of all firms in the industry, measured at the four-digit industry level. The higher the monopoly power, high values of HHI, the weaker are incentives for efficient production. We expect the HHI to be negatively related to the measures of efficiency. Caves (1992) and Mayes et al. (1994) note that there is no reason to believe that the relationship between concentration and efficiency is linear as opposed to curvilinear. Torii (1992: 77) argues that there is a level of concentration that maximizes efficiency, 'when the number of firms in the market is relatively small, the efficiency level increases as the number of firms increases, which is mainly due to competition forcing firms to produce more efficiently. When the number of firms is relatively large, the efficiency level decreases as the number of firms increases, and this is due to indivisible replacement investment.' The curvilinear relationship is modelled by including squared indices of market concentration, HHISQ, in the efficiency model.

The second measure of competition is import shares (IMPS) that capture the role of international competition. We calculate IMPS as the ratio of imports of manufactured products for the industry to total domestic supply of products in that industry, measured at the four-digit industry level. The inflows of imports exert competitive pressure on domestic firms that in turn should create incentives for domestic firms to operate efficiently. However, Mayes et al. (1994) note that high import ratios could actually indicate that the industry is inefficient relative to firms abroad, not that foreign competition drives out inefficient firms. The fact that there is excess market share which foreign firms are able to fill, points to the absolute inefficiency of production by domestic firms. We therefore expect either a positive or negative relationship between efficiency and import shares.

The role of organizational status or restructuring and firm-specific characteristics on economic performance are well recognized in the literature following Williamson's (1970) hierarchical organizational structures. Our specification includes two firm-specific variables. First, we include the capital intensity (KINT) of production calculated as the ratio of real capital stock to real wage bill. KINT captures the level of sunk costs that may inhibit changes and create barriers to entry and exit (Mayes et al., 1994). We expect a negative relationship between KINT and technical efficiency. However, we may obtain a positive relationship if capital intensive firms embody the most advanced technology. Secondly, due to the multinationality of enterprises in the three privatized industries, we include a dummy variable that takes a value of one if the enterprise in a given year is a subsidiary of a multinational corporation (MNC), otherwise it is equal to zero. MNC captures the superior performance of multinational enterprises over domestic firms due the former's advantages arising from firm-specific assets, access to a wider array of locational assets and their ability to reap economies of scale and scope at firm-level (Caves, 1996; UNCTAD, 1997) and due to concentrated ownership (Boardman et al., 1997).

Privatization in Malawi is just one of the many policy changes that the government introduced in the 1980s. Prior to structural adjustment programs, industrial policy was characterized by regulation of entry into the manufacturing sector, control of prices for selected industrial products, open trade policy with fixed exchange rate regime, control of agricultural input prices and control of interest rates and credit rationing. Under structural adjustment programs many policy changes were introduced as the government was attempting to liberalise the economy.

Trade protection initially increased, but trade was subsequently liberalised in the 1990s and a more flexible exchange rate regime was introduced (Mulaga and Weiss, 1996). The programme of industrial price decontrol began in 1983 and by 1988 most of the prices in the industrial sector were liberalised (see Khan et al., 1989). In addition, monopoly rights were abolished in 1988 and entry into the manufacturing sector was liberalised in 1992 in which the government replaced the Industrial Development Act with the Industrial Licensing Act of 1992. Apparently, most of these measures were competition-enhancing in the manufacturing sector and their effects on technical efficiency cannot be ignored in the empirical analysis of privatization. We, therefore, control for changes in the general economic policy environment by including a dummy variable for the structural adjustment programs (SAPS) which takes a value of one after 1980, otherwise it is equal to zero. Since most adjustment policies were competition-enhancing, we expect SAPS to be positively related to technical efficiency. Ahsan et al. (1999) find evidence that total factor productivity growth was higher in the structural adjustment period compared with the performance before structural adjustment in the Malawi manufacturing sector.

4.3 Data and Sample

The study focuses on privatization in the Malawian manufacturing sector and excludes privatization activities in other sectors of the economy.[9] Our study uses panel data between 1970 and 1997 for fifteen large scale enterprises in three privatized manufacturing industries in Malawi. Privatized manufacturing industries are three-digit industries in which privatization occurred between 1984 and 1991. The three privatized manufacturing industries are food processing, manufacture of other chemical products and manufacture of transport equipment, and our sample include six privatized enterprises, three state-owned enterprises and six private enterprises.

The data were obtained from National Statistical Office based on unpublished data of the census of production. The census of production data is collected through a questionnaire, and with the

[9] Data on enterprise level time series financial variables in other sectors of the economy are limited. For instance, most privatization activities occurred in the agricultural sector, particularly privatization of small agricultural estates in which ownership was transferred to individuals. Financial records for firms in non-manufacturing sectors are not available.

permission of individual enterprises, we extracted the data from the questionnaire responses in each enterprise's file. We also obtained industry specific output and input deflators to adjust some variables into real values. The number of years privatized enterprises have been under the new ownership range from 5 to 10 years and range from 7 to 17 years before privatization depending on the industry. We also administered a questionnaire to all the fifteen enterprises on organizational changes and changes in the competitive environments that have occurred following privatization. We do not report the results of the enterprise survey here, but what was clear is that managers attributed changes more to the overall structural adjustment program, than to a specific policy such as privatization.

The estimation of technical efficiency requires data on output quantities and input quantities. We use the concept of one output produced by three inputs - capital (K), labour (L) and raw materials (M) in estimating equation (1). In addition, we include a time trend (T) in the production function to account for Hicksian neutral technical progress. Sector-specific deflators were obtained as unpublished data from the National Statistical Office. For each sector, we obtained output, raw material, and plant and equipment price deflators and for each class of capital (land and buildings, transport equipment and office equipment) we obtained price deflators. Output is measured by sales at constant 1980 prices using the sector specific output price deflators. Capital is measured as real capital stock based on the perpetual inventory method and deflated by capital input price deflators. Labour is measured by the number of employees in the enterprise during the year. We measure raw materials at 1980 prices using sectoral input (raw material) price deflators. The stochastic production frontiers and technical efficiencies are estimated using FRONTIER Version 4.1, a computer program written by Coelli (1996).

5. Empirical Results

5.1 Production Frontiers and Technical Efficiencies

Table 1 to Table 3 present industry-specific production frontiers based on the half-normal distribution assumption of the asymmetric (inefficiency component) error term.[10] For each of the three sectors, we estimate the Cobb-Douglas function and the more flexible translog function without and with Hicks neutral technical progress. The choice of whether the Cobb-Douglas or the translog best describes the data is based on the generalized likelihood ratio test and we use the technical efficiencies of the preferred model in the second stage regression of sources of technical efficiencies. In the food processing industry (Table 1) the Cobb-Douglas frontiers without and with technical progress reveal decreasing returns to scale, and in the latter there is technical progress of 2.33 percent per annum. The time-varying efficiency effect is positive indicating that efficiency improves over time, and that part of the improvement in technical efficiency in Model 1 may be due to technical progress as reflected in the decline in the value of η in Model 3. In the translog production frontier the trend is statistically insignificant but shows improvements in technical progress over time. Nonetheless, the Cobb-Douglas functions without and with technical progress are less preferred to the translog production function using the likelihood ratio test.

The other chemical products industry also reveal decreasing returns to scale from the Cobb-Douglas production functions in Model 1 and Model 3 in Table 2. Technical progress is 3.74 percent per annum, and the time-varying efficiency effect is positive and statistically significant implying that efficiency improves over time in the chemical products industry. Similarly the decline in the value of η when we include the time trend in the production function implies that the time-varying efficiency effect in Model 1 overstates the improvement in technical efficiency. The translog function in Model 2 is preferred to the Cobb-Douglas function in Model 1 while the Cobb-Douglas production function in Model 3 is preferred to the translog function in Model 4, based on the likelihood ratio test.

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[10] We also estimated production frontiers based on the truncated normal assumption of the distribution of the asymmetric error term, but for each model the half-normal assumption was preferred on the basis of the generalized likelihood ratio test.

The transport equipment industry also reveals decreasing returns to scale based on the Cobb-Douglas functions in Model 1 and Model 3 in Table 3, and technical progress is 2.08 percent per annum. The time-varying efficiency effect is positive and statistically significant in models without technical progress but negative and statistically insignificant in models with technical progress. The parameter γ is statistically insignificant suggesting that firms in this industry are technically efficient. The translog functions are preferred in both cases, but the average production function based on the generalized likelihood ratio test is rejected in Model 2 but is accepted in Model 4.

Table 4 presents technical efficiency scores based on preferred production frontiers without and with technical progress by status of enterprises. The overall mean technical efficiency is 0.6107 without technical progress and 0.6563 with technical progress, suggesting that ignoring technical progress understates the achieved levels of efficiency. The Pearson and Spearman's rank correlation coefficients between TE (NTP) and TE (TP) are 0.903 and 0.914, respectively and both are statistically significant at the 1 percent level. The mean changes in the technical efficiency of privatized enterprises are higher compared with those observed among non-privatized state-owned enterprises and private enterprises included in the study. Similarly, the proportion of the variance that can be attributed to privatization is higher among privatized enterprises (15.4 and 6.2 percent) than among state-owned enterprises (6.8 and 3.5 percent) and private enterprises (10.3 and 2.8 percent). Thus, the direct firm effects of privatization are stronger than the industry effects as also reflected in the efficiency scores for all enterprises in the study. In terms of levels, efficiencies are higher in state-owned enterprises than among privatized and private enterprises. One reason for this is that two of the three non-privatized state-owned enterprises are subsidiaries of multinational corporations, confirming theoretical predictions of their relative efficiency over domestic firms.

The statistical results show that privatization in Malawi has both industry and firm effects. However, the proportion of the variance that can be attributed to privatization is relatively low suggesting the importance of other factors that influence the efficiency of firms, hence we cannot assume that changes in technical efficiency are due to privatization alone. To further explore the relationship between privatization and technical efficiency, we exploit the long panel data and use multiple regression analysis to control for the many other factors that influence performance in Malawi manufacturing.

5.2 Sources of Technical Efficiency in Malawi Manufacturing

We explain the observed levels of technical efficiency among firms in privatized industries using multiple regression analysis. Panel data methods, fixed effects and random effects models, are used for the full sample, the subsample of privatized enterprises, the subsample of privatized and state enterprises and the subsample of private enterprises. In each subsample, we use the Hausman specification test to determine the suitability of the random effects model over the fixed effects model and we only report results from the preferred model. Table 5 presents multiple panel data regression results in which the dependent variable are technical efficiency scores from stochastic production functions without Hicks neutral technical progress. The full sample model shows that technical efficiency in the period after privatization is 10.6 percent points higher than in the period before privatization in the privatized manufacturing industries. The coefficient of privatization is statistically significant at the 1 percent level, suggesting that privatization has industry effects. The industry effects of privatization are also confirmed in model 4 of private enterprises, in which technical efficiencies are 8.5 percent points higher in the post-privatization period than in the pre-privatization period.

The prediction from the traditional theories of privatization is also confirmed in model 2 and model 3. Thus, from the subsample of privatized enterprises, the coefficient of privatization is statistically significant at the 1 percent level. Privatization on average is associated with 12 percent points increase in technical efficiency. However, inclusion of state-owned enterprises that had not been through privatization in the study in model 3, reduces the impact of privatization to a 9.5 percent points. Focusing on all the four models, the impact of privatization on technical efficiency is higher on enterprises that are directly involved in the privatization process compared with its effect on private firms that compete in the same markets as the privatized enterprises.

The effect of other factors cannot be ignored in explaining the observed changes in the level of technical efficiency before and after privatization. The role of domestic competition is not statistically significant in all the four models, although the sign of the coefficients suggests that technical efficiency is higher in competitive industries. In a manufacturing sector that is highly oligopolistic, it is import competition that plays a critical role in enforcing efficiency, particularly for privatized enterprises and the state-owned enterprises. The coefficient of import competition is statistically significant at the 1 percent level in model 2 and at the 5 percent level in model 3. The importance of import competition vis-a-vis domestic competition is expected due to the fact that most SOEs are relatively large and monopolistic at four-digit classification, and face fringe competition from small domestic firms.

The performance of the capital intensity variable is not consistent in the four models although the coefficients are statistically significant at the conventional levels. In model 1 and model 3, the results show that capital intensity is positively associated with technical efficiency, suggesting that capital intensive firms embody the most advanced technology. The opposite results are obtained in models of privatized enterprises and private enterprises implying support for the barriers to entry argument. The coefficient of multinationality is statistically significant at the 5 percent level in models of privatized enterprises and state-owned enterprises. Technical efficiencies are at least 4.6 percent points higher among privatized enterprises and SOEs in which majority share holding is attributed to multinational corporations. These results provide support for the firm-specific advantages or the concentrated private ownership argument with respect to multinational corporations. In many cases, there tend to be growing opposition to sell off state-owned enterprises to multinational corporations, but the results here suggest that efficiency gains may be higher with the participation of multinational corporations in the privatization process in small developing countries.

The dummy variable representing structural adjustment programs is statistically significant at the 1 percent level in all the four models. On average, technical efficiencies among firms in the privatized manufacturing sector are at least 12 percent points in the period during structural adjustment compared with the period before structural adjustment. Since, most adjustment policies were aimed at removing structural rigidities, the results strengthen the importance of competition in improving the technical efficiency of firms. It also turns out that, apart from model 2, the impact of structural adjustment policies on the technical efficiency is stronger than the impact of a single policy of privatization.

Turning to the models of technical efficiency with technical progress in Table 6, the coefficient of the privatization dummy is positive and statistically significant at the 1 percent level in three models. The hypothesis of the industry effects of privatization is supported even when we account for technical progress. In the full sample model, the results suggest that the post-privatization period is associated with technical efficiencies that are 4.4 percent points higher than in the pre-privatization period. Similarly, in the model of enterprises in the state-owned enterprises sector (model 3) and private enterprises (model 4), the post-privatization period is associated with technical efficiency that are 4.9 percent points and 5.4 percent points higher than pre-privatization period, respectively. However, there is no evidence that the performance of enterprises that were directly privatized (model 2) significantly improved following privatization. Rather, we find a negative but statistically insignificant relationship between privatization and technical efficiency when we account for technical progress in the stochastic production frontier. We also observe that the magnitude of the privatization dummy coefficient is higher when stochastic production functions do not account for technical progress than when they account for technical progress. Ignoring technical progress, therefore, overstates the impact of privatization on technical efficiency.

With regard to the control variables, the evidence suggests that we cannot ignore the role of competition, multinational corporations and structural adjustment programs. The domestic competition variable is only statistically significant at the 10 percent level in the full model, implying the weak potential of domestic competition disciplining firms in oligopolistic industries. Import competition is positively associated with technical efficiency among privatized enterprises and state-owned enterprises, but negatively associated in a subsample of private enterprises. The capital intensity variable is statistically significant at the 1 percent level in model 2 and model 4, supporting the sunk cost argument as a barrier to entry. Similar to the evidence above, multinationality is statistically significant in the three models and subsidiaries of multinational corporations show efficiency scores that are at least 11.5 percent points higher than domestically owned firms. The positive role of structural adjustment programs is supported in all the four models, and the results also show that their impact of enterprise performance is stronger than a single policy of privatization. Given that many of the structural adjustment policies implemented since 1981 aimed at promoting competition, the results suggest that competitive environments may be necessary to optimize the efficiency gains from privatization.

6. Conclusions

This study investigates the industry effects and the direct firm effects of privatization on the technical efficiency of firms using the census of production data for privatized three-digit level manufacturing industries in Malawi. Using the stochastic production frontier approach with panel data, we find evidence that privatization is associated with higher technical efficiency scores than those observed during the period before privatization. These results hold whether Hicks neutral technical progress is taken into account or not in the production functions, but efficiency scores are higher when technical progress is assumed than when it is ignored in the production functions. We also find evidence that average technical efficiency scores increase among all firms competing in the same industry, suggesting that privatization has both industry effects and direct firm effects.

The statistical results of the difference between means that assume that privatization is the only factor attributed to the increases in technical efficiency are strongly supported in the multivariate regression analysis. The multivariate regression models attempt to isolate the impact of privatization on technical efficiency from the many other factors such as domestic competition, state ownership, import competition, multinationality and structural adjustment programmes. After controlling for these factors, the period after privatization is associated with technical efficiency which are around 11 percent points higher than in the period before privatization in the pooled sample, 12 percent points in the subsample of privatized enterprises and 8 percent points in the subsample of private enterprises in the models without technical progress. The impact of privatization on technical efficiency when production functions account for Hicks neutral technical progress is much lower than in models that ignore technical progress.

We also observe that the role of other factors that influence industry or enterprise performance cannot be ignored, and empirical studies that evaluate the impact of privatization by comparing means before and after privatization may mask the economic impact of privatization. More particularly, the evidence in this study suggests that in a small domestic manufacturing sector, import competition, multinationality and market oriented policies create additional incentives for firms to pursue efficient production above incentives that would be created by privatization policy alone. In terms of public policy the findings suggest that in small economies where domestic competition is weak, a more open trade policy and market oriented policies may be necessary to ensure the positive effect of privatization on economic performance.

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Table 1 Food Products: Stochastic Production Functions

Parameters	Without Technical Progress				With Technical Progress			
	Cobb-Douglas (Model 1)		Translog Function (Model 2)		Cobb-Douglas (Model 3)		Translog Function (Model 4)	
	coeff.	*t-ratio*	*coeff.*	*t-ratio*	*coeff.*	*t-ratio*	*coeff.*	*t-ratio*
Intercept	**2.5622**	*3.964*	-7.7610	*-1.419*	**1.9467**	*3.334*	-6.7719	*-1.151*
β_L	**0.2012**	*3.534*	0.3780	*0.402*	**0.1295**	*2.258*	0.4113	*0.429*
β_K	**0.1765**	*3.531*	**1.3509**	*3.746*	**0.2631**	*5.064*	**1.3592**	*3.075*
β_M	**0.6232**	*11.381*	0.9009	*0.899*	**0.5818**	*10.575*	0.8007	*0.817*
β_T	-	-	-	-	**0.0233**	*2.597*	-0.0257	*-0.672*
β_{LL}	-	-	0.0140	*0.232*	-	-	-0.0061	*-0.092*
β_{KK}	-	-	**0.0556**	*2.001*	-	-	0.0484	*1.682*
β_{MM}	-	-	**0.0946**	*1.848*	-	-	**0.0939**	*1.865*
β_{LK}	-	-	0.0022	*0.042*	-	-	0.0155	*0.260*
β_{LM}	-	-	-0.0282	*-0.326*	-	-	-0.0236	*-0.280*
β_{KM}	-	-	**-0.1974**	*-3.193*	-	-	**-0.1914**	*-3.029*
β_{TT}	-	-	-	-	-	-	0.0006	*0.685*
$\sigma^2=\sigma_u^2+\sigma_v^2$	**0.2899**	*3.676*	**0.3712**	*2.221*	**0.2643**	*4.725*	**0.3842**	*1.908*
$\gamma=\sigma_u^2/\sigma^2$	0.2974	*1.581*	**0.5380**	*2.540*	**0.2518**	*1.726*	**0.5580**	*2.379*
η	**0.0486**	*4.348*	**0.0421**	*4.904*	**0.0420**	*3.645*	**0.0456**	*4.762*
Log (L)	-106.21		-95.32		-103.30		-95.06	
N	158		158		158		158	
LR Test								
M1 vs M2		21.78 [12.59]		Reject H_0		-		-
M3 vs M4		-		-		16.48 [14.07]		Reject H_0

Notes: The LR test is the generalized likelihood ratio test computed as λ = 2 [URLLF - RLLF] where URLLF is the unrestricted log likelihood function and RLLF is the restricted likelihood function. λ follows a chi-squared (χ^2) distribution with the degrees of freedom equal to the number of restrictions imposed by the null hypothesis. The figures in square brackets are the theoretical values of χ^2 given the degrees of freedom at the 5 percent level of significance. M1, M2, M3 and M4 stand for Model 1, 2, 3 and 4, respectively.

Table 2 Other Chemical Products: Stochastic Production Functions

Parameters	Without Technical Progress				With Technical Progress			
	Cobb-Douglas (Model 1)		Translog Function (Model 2)		Cobb-Douglas (Model 3)		Translog Function (Model 4)	
	coeff.	*t-ratio*	*coeff.*	*t-ratio*	*coeff.*	*t-ratio*	*coeff.*	*t-ratio*
Intercept	**2.3446**	*4.208*	-2.6333	*-0.867*	**0.6744**	*1.879*	-4.4357	*-1.106*
β_L	-0.0785	*-1.331*	**-2.2251**	*-3.163*	**-0.1082**	*-2.074*	-0.4837	*-0.618*
β_K	**0.4149**	*7.476*	0.3888	*0.907*	**0.4545**	*8.420*	**0.9733**	*1.894*
β_M	**0.6258**	*12.438*	**2.0827**	*3.387*	**0.6158**	*13.395*	**1.0146**	*1.850*
β_T	-	-	-	-	**0.0374**	*7.189*	**0.0414**	*3.481*
β_{LL}	-	-	**0.1105**	*2.086*	-	-	-0.0520	*-0.980*
β_{KK}	-	-	**0.0641**	*2.013*	-	-	-0.0382	*-0.933*
β_{MM}	-	-	0.0018	*0.052*	-	-	-0.0037	*-0.101*
β_{LK}	-	-	0.0181	*0.364*	-	-	**0.1072**	*1.902*
β_{LM}	-	-	0.0640	*1.271*	-	-	-0.0303	*-0.462*
β_{KM}	-	-	**-0.1359**	*-2.663*	-	-	-0.0093	*-0.178*
β_{TT}	-	-	-	-	-	-	-0.0001	*-0.132*
$\sigma^2=\sigma_u^2+\sigma_v^2$	1.0897	*1.346*	0.1573	*1.334*	**0.2472**	*1.931*	**0.2729**	*2.698*
$\gamma=\sigma_u^2/\sigma^2$	**0.9709**	*43.235*	**0.8041**	*5.343*	**0.8722**	*12.836*	**0.8887**	*20.499*
η	**0.0331**	*6.271*	**0.0641**	*5.623*	**0.0302**	*5.759*	0.0041	*0.198*
Log (L)	29.91		36.28		35.81		40.23	
N	168		168		168		168	
LR Test								
M1 vs M2		12.74 [12.59]		Reject H_0		-		-
M3 vs M4		-		-		8.84 [14.07]		Accept H_0

Notes: The LR test is the generalized likelihood ratio test computed as $\lambda = 2$ [URLLF - RLLF] where URLLF is the unrestricted log likelihood function and RLLF is the restricted likelihood function. λ follows a chi-squared (χ^2) distribution with the degrees of freedom equal to the number of restrictions imposed by the null hypothesis. The figures in square brackets are the theoretical values of χ^2 given the degrees of freedom at the 5 percent level of significance. M1, M2, M3 and M4 stand for Model 1, 2, 3 and 4, respectively.

Table 3 Transport Equipment: Stochastic Production Functions

Parameters	Without Technical Progress				With Technical Progress			
	Cobb-Douglas (Model 1)		Translog Function (Model 2)		Cobb-Douglas (Model 3)		Translog Function (Model 4)	
	coeff.	*t-ratio*	*coeff.*	*t-ratio*	*coeff.*	*t-ratio*	*coeff.*	*t-ratio*
Intercept	**8.5750**	*9.997*	**39.9568**	*3.738*	**8.7586**	*12.867*	**45.1104**	*21.035*
β_L	**0.5438**	*4.448*	2.2357	*0.794*	0.1876	*1.466*	**3.9823**	*2.223*
β_K	-0.0464	*-0.545*	-1.8892	*-0.771*	0.0034	*0.037*	**-4.0970**	*-3.117*
β_M	**0.2761**	*4.718*	**-3.4901**	*-1.880*	**0.3185**	*5.777*	**-2.9086**	*-3.093*
β_T	-	-	-	-	**0.0208**	*3.520*	-0.0209	*-1.392*
β_{LL}	-	-	0.0725	*0.278*	-	-	-0.3789	*-1.528*
β_{KK}	-	-	0.1040	*0.795*	-	-	0.1297	*1.344*
β_{MM}	-	-	0.0968	*1.631*	-	-	0.0663	*1.520*
β_{LK}	-	-	-0.2889	*-1.023*	-	-	-0.0613	*-0.268*
β_{LM}	-	-	0.0907	*0.488*	-	-	0.0585	*0.459*
β_{KM}	-	-	0.0595	*0.467*	-	-	0.0978	*0.892*
β_{TT}	-	-	-	-	-	-	**0.0016**	*2.839*
$\sigma^2=\sigma_u^2+\sigma_v^2$	**0.0543**	*3.673*	**0.0333**	*4.106*	**0.0497**	*4.367*	**0.0243**	*5.146*
$\gamma=\sigma_u^2/\sigma^2$	0.1086	*0.554*	0.0794	*0.481*	0.0000	*0.000*	0.0000	*0.000*
η	**0.0580**	*1.967*	**0.0650**	*2.036*	-0.0343	*-0.413*	-0.0273	*-0.348*
Log (L)	2.88		15.03		4.23		22.88	
N	52		52		52		52	
LR Test								
M1 vs M2		24.30 [12.59]		Reject H_0		-		-
M3 vs M4		-		-		37.30 [14.07]		Reject H_0

Notes: The LR test is the generalized likelihood ratio test computed as λ = 2 [URLLF - RLLF] where URLLF is the unrestricted log likelihood function and RLLF is the restricted likelihood function. λ follows a chi-squared (χ^2) distribution with the degrees of freedom equal to the number of restrictions imposed by the null hypothesis. The figures in square brackets are the theoretical values of χ^2 given the degrees of freedom at the 5 percent level of significance. M1, M2, M3 and M4 stand for Model 1, 2, 3 and 4, respectively.

Table 4 Technical Efficiency Scores in Privatized Manufacturing Industries

Type of Enterprise and Efficiency	Mean before Privatisation	Mean after Privatisation	Mean change [p-value]	η^2
Privatised Enterprises	*(102)*	*(48)*		
TE (NTP)	0.5174	0.7117	0.1943 [0.000]	0.154
TE (TP)	0.5993	0.7536	0.1543 [0.002]	0.062
State-Owned Enterprises	*(58)*	*(22)*		
TE (NTP)	0.6713	0.7850	0.1137 [0.020]	0.068
TE (TP)	0.6636	0.7450	0.0814 [0.098]	0.035
Private Enterprises	*(92)*	*(56)*		
TE (NTP)	0.5289	0.6970	0.1681 [0.000]	0.103
TE (TP)	0.6144	0.7029	0.0885 [0.044]	0.028
All Enterprises	*(252)*	*(126)*		
TE (NTP)	0.5570	0.7180	0.1610 [0.000]	0.102
TE (TP)	0.6196	0.7295	0.1099 [0.000]	0.040

Notes: The number in parentheses and italics is the number of observations in each period and the figure in brackets is the *F*-test probability of rejecting the null hypothesis of no difference in performance before and after privatization. η^2 is the proportion of the variance in the performance measure that we can attribute to privatization. NTP and TP stand for technical efficiency without and with technical progress, respectively.

Table 5 Regression Estimates of Sources of Technical Efficiency without Technical Progress in Privatized Manufacturing Industries

Explanatory Variables	Full Sample	Privatized Enterprises	Privatized and SOEs	Private Enterprises
	Model 1	*Model 2*	*Model 3*	*Model 4*
STATE	-0.0075	0.0378	-0.0042	-
	(-0.457)	*(1.270)*	*(-0.225)*	
PRIV	**0.1056** [a]	**0.1202** [a]	**0.0947** [a]	**0.0847** [a]
	(12.595)	*(5.274)*	*(8.194)*	*(7.823)*
HHI	-0.1830	-0.0268	-0.0220	-0.1619
	(-0.534)	*(-0.622)*	*(-0.496)*	*(-0.255)*
HHISQ	0.2303	-	-	0.5728
	(0.984)			*(1.382)*
IMPS	0.0320	**0.1299** [a]	**0.0837** [b]	-0.0256
	(0.870)	*(3.367)*	*(2.093)*	*(-0.462)*
KINT	**0.0005** [c]	**-0.0011** [c]	**0.0006** [b]	**-0.0098** [a]
	(1.715)	*(-1.856)*	*(2.045)*	*(-4.289)*
MNC	0.0441	**0.0463** [b]	**0.0487** [b]	-
	(1.637)	*(2.068)*	*(1.969)*	
SAPS	**0.1308** [a]	**0.1183** [a]	**0.1263** [a]	**0.1389** [a]
	(17.833)	*(12.401)*	*(15.163)*	*(10.508)*
Intercept	**0.4449** [a]	**0.3866** [a]	**0.4734** [a]	-
	(3.415)	*(4.696)*	*(6.684)*	
Firm Effects?	*No*	*No*	*No*	*Yes*
Adjusted R^2	0.1598	0.0563	0.0955	0.9599
Hausman test	0.2753	0.0013	0.2296	402.97
[*p*-value]	[0.871]	[0.999]	[0.892]	[0.000]
N	378	150	230	148
No. of Firms	15	6	9	6

Notes: The figure in parentheses and italics are t-statistics based on heteroscedastic-consistent standard errors. Superscripts *a, b* and *c* indicate that the parameter is statistically significant at the 1%, 5% and 10% level, respectively. *Yes* on 'firm effects' implies a fixed effects model with firm specific effects and *No* implies a random effects model.

Table 6 Regression Estimates of Sources of Technical Efficiency with Technical Progress in Privatized Manufacturing Industries

Explanatory Variables	Full Sample *Model 1*	Privatized Enterprises *Model 2*	Privatized and SOEs *Model 3*	Private Enterprises *Model 4*
STATE	-0.0156	**-0.0760** [b]	0.0139	-
	(-1.097)	*(-2.526)*	*(0.730)*	
PRIV	**0.0444** [a]	-0.0311	**0.0490** [a]	**0.0540** [a]
	(6.142)	*(-1.351)*	*(4.199)*	*(6.253)*
HHI	**-0.5229** [c]	0.0435	0.0175	0.2828
	(-1.762)	*(0.997)*	*(0.389)*	*(0.613)*
HHISQ	**0.4529** [b]	-	-	0.0718
	(2.234)			*(0.241)*
IMPS	-0.0100	**0.1141** [a]	**0.1014** [b]	**-0.3022** [a]
	(-0.312)	*(2.917)*	*(2.495)*	*(-5.986)*
KINT	-0.0003	**-0.0020** [a]	-0.0002	**-0.0062** [a]
	(-1.175)	*(-3.379)*	*(-0.810)*	*(-3.447)*
MNC	**0.1149** [a]	**0.1502** [a]	**0.1428** [a]	-
	(4.880)	*(6.642)*	*(5.710)*	
SAPS	**0.0806** [a]	**0.0665** [a]	**0.0835** [a]	**0.0702** [a]
	(12.750)	*(6.905)*	*(9.931)*	*(7.389)*
Intercept	**0.6538** [a]	**0.5473** [a]	**0.4783** [a]	-
	(5.490)	*(5.484)*	*(5.849)*	
Firm Effects?	*No*	*No*	*No*	*Yes*
Adjusted R^2	0.0499	0.1040	0.1094	0.9821
Hausman test	0.2659	0.0762	0.0729	70.532
[*p*-value]	[0.966]	[0.995]	[0.964]	[0.000]
N	378	150	230	148
No. of Firms	15	6	9	6

Notes: The figure in parentheses and italics are t-statistics based on heteroscedastic-consistent standard errors. Superscripts *a, b* and *c* indicate that the parameter is statistically significant at the 1%, 5% and 10% level, respectively. *Yes* on 'firm effects' implies a fixed effects model with firm specific effects and *No* implies a random effects model.