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THE EFFECTS OF ECONOMIC REFORMS ON MANUFACTURING DUALISM : EVIDENCE FROM INDIA

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Abstract

Dualism is a pervasive feature of the manufacturing sectors of less-developed countries, with large differences in productivity between the informal and the formal sectors. Policy distortions are viewed as an important factor behind the prevalence of manufacturing dualism. We examine whether tariff reforms, industrial de-licensing and the withdrawal of reservation of products for small firms implemented since the mid-1980s have had any effects on efficiency differentials between informal and formal firms in Indian manufacturing. We find strong evidence that economic reforms have exacerbated dualism by increasing the productivity differentials between the more efficient formal firms and the less efficient informal firms. Furthermore, the reforms have widened within industry efficiency differences for both formal and informal firms, though the unequalising effect of the reforms on within industry productivity differences has been larger for formal firms.

JEL Classification: **O1, O4, L6.**

***Key-Words*: reforms, dualism, efficiency, informal, manufacturing, India.**

THE EFFECTS OF ECONOMIC REFORMS ON MANUFACTURING DUALISM: EVIDENCE FROM INDIA

I. Introduction

Dualism is a pervasive feature of the manufacturing sectors of most developing economies. Typically the manufacturing sector in these economies has a large low-productive informal sector, where most firms reside, along a relatively small high productive formal sector, comprising fewer firms (Little *et al*. 1987, Bourguignon and Morrisson 1998, Temple 2005, World Bank 2005)[i] The informal sector comprises around two-thirds of non-agricultural employment and about a quarter of non-agricultural output in Africa and Asia[ii] (Charmes 2000, 2006), and in spite of strong economic growth in several African and Asian countries in recent years, the persistence in the size of the informal sector along with large differences in productivity and earnings between the informal and formal sectors has remained a matter of policy concern (ILO 2002, WTO 2009).

Persistence of manufacturing dualism has strong negative implications both for efficiency and equity in the economy. The lack of significant structural change that reallocates workers and firms from the low productive informal sector to the high productive formal sector constrains the growth of aggregate productivity in the economy.[iii] At the same time, sharp differences in earnings between workers in the informal and formal sectors and the existence of a large pool of workers in the informal sector leads to a high level of income and asset inequality, which may worsen further if the process of economic growth is biased towards the growth of the formal sector (in terms of productivity and capital accumulation) rather than the informal sector (WTO 2009).

While the determinants of the persistence of manufacturing dualism is not well understood, it is commonly believed that an important factor behind the prevalence of dualism is the policy regime, and that trade and industrial policies that inhibit competition and technological change may exacerbate dualism, especially if they are protective of the formal sector or constrain the growth of the informal sector (Little 1987, Gang 1992, Tybout 2000). Economic reforms that allow for a level playing field between the informal and formal sectors may therefore act as a significant positive force in reducing dualism (World Bank

2005). However, it is not clear if this will indeed be the case if economic reforms provide a more favourable environment for the more well-resourced larger firms in the formal sector to expand and reap economies of scale, to obtain best-practice technology, and to seek market opportunities overseas as compared to less well resourced smaller firms in the informal sector. Therefore, whether economic reforms help reduce manufacturing dualism or exacerbate it is an empirical question.

In this paper, we examine the effects of economic reforms on manufacturing dualism, as evident by the total factor productivity levels of informal and formal manufacturing firms.[iv] We are specifically interested in the technical efficiency levels of formal and informal manufacturing firms and the effects of economic reforms on these.[v] We measure efficiency using a semi-parametric method to productivity computations – the stochastic frontier analysis (SFA) method pioneered by Aigner *et al*. (1977). We look at both absolute and relative technical efficiency. Absolute technical efficiency captures the extent to which firms in the manufacturing sector are producing the maximum possible output, for a given bundle of inputs, in a given industry, and improvements in the absolute technical efficiency of the average firm imply a higher level of output being produced on average, for a given level of inputs in that industry (Kumbhakar and Lovell 2000). Relative technical efficiency, on the other hand, captures the extent to which the efficiency levels of other firms are close to the most efficient firm (termed as the frontier firm in the SFA literature) in a given industry, and improvements in relative technical efficiency imply a more *equal* distribution of efficiency in the industry.[vi]

We examine whether economic reforms have led to an increase in absolute and relative technical efficiency of informal firms relative to formal firms. If both the absolute and relative technical efficiency of informal firms have improved relative to formal firms as caused by economic reforms, this may reduce manufacturing dualism, both by decreasing the efficiency differentials between formal and informal firms, and also making it more likely for the more efficient informal firms to graduate to the formal sector, and by doing so, reducing the size of the informal sector. A reduction in manufacturing dualism, in this case, can have strong pro-poor growth effects.

The country we study is India, where there is a long history of manufacturing dualism (Little *et al*. 1987) and where about 80 per cent of manufacturing employment and 17 per

cent of manufacturing output is in the informal sector (NCEUS 2007). It is commonly believed that the dualism evident in the manufacturing sector was a legacy of a set of economic policies that provided protection to the larger manufacturing firms from external competition via an import substituting industrialization policy regime and also made it difficult for new firms, whether domestic or foreign, to enter existing industries through a strict licensing policy (Panagariya 2008). At the same time, small firms were protected via a small scale sector reservation policy which did not allow larger firms to produce specific products that were seen as the domain of small firms (Mohan 2002). This led to an industrial structure where both very small and very large firms were present in the same industry, with significant productivity differences between the informal and formal sectors (Kochhar *et al*. 2006, Mazumdar and Sarkar 2008). In 1991, with the advent of major economic reforms, industrial licensing was abolished in majority of industries, followed by a second wave of de-licensing in the mid 1990s. India has also witnessed rapid trade liberalisation since 1991, where there was a significant reduction in tariffs on most commodities (Sen 2008). The trade reforms were particularly targeted to the manufacturing sector which was among the most protected in the developing world prior to the 1990s (Bhagwati and Srinivasan 1975). The reservation of industries for the small sector was also gradually phased out since the mid 1990s. These reforms were mainly in product markets and varied substantially over time and across industries. Thus, they provide us a unique empirical context to evaluate the effects of economic reforms on efficiency differentials between informal and formal firms. Existing studies do not provide an unambiguous answer on the impact of these reforms on efficiency of formal and informal manufacturing firms, and whether there has been a widening or narrowing increasing efficiency gap between the more efficient formal firms and the less efficient informal firms following these reforms (Kathuria *et al.* 2010). [vii] This is an issue that needs further empirical analysis.

To investigate the effect of economic reforms, we use a very rich data-set which combines large representative surveys of informal firms with the census-cum-sample data on formal manufacturing firms. The data are pooled cross-sections of firm-level data, available quinquennially, beginning in 1989-90 and ending in 2005-06. We employ stochastic frontier analysis to obtain firm level measures of absolute and relative efficiency. Since the location of the firm, especially around the threshold size, either in the formal or in the informal sector is

not random but depends on firm choice, a comparison of efficiency levels between firms in the informal and formal manufacturing sectors without addressing the endogeneity of firm location is not correct. Such a comparison would bias upwards the efficiency levels of formal manufacturing firms if these levels depended on the firm being located in the formal sector. Our stochastic frontier analysis corrects for this selection bias, using a methodology proposed by Greene (2010). We find strong evidence that economic reforms have helped the productivity of Indian manufacturing to grow, the growth being more for the formal sector firms. Thus, economic reforms have caused an increase in manufacturing dualism in India by increasing efficiency differentials between formal and informal firms. At the same time, the reforms have widened within industry efficiency differences for both formal and informal firms, though the unequalising effect of the reforms on within industry productivity differences has been larger for formal firms.

The rest of the paper is in six sections. In the next section, we provide a brief discussion of the Indian policy regime pertaining to the manufacturing sector and how these reforms may have affected the efficiency levels of formal and informal firms. In Section III, we describe our econometric methodology. In Section IV, we discuss the empirical specification. Section V describes the data and the variables used in the empirical analysis. Section VI presents the results of the empirical analysis. Section VII concludes.

II. Policy Reforms in Indian Manufacturing

The formal sector in India is taken to be definitionally equivalent to the organized sector, which comprises firms which are registered under the Indian Factories Act of 1948. Firms have to register under the Factories Act if they employ ten or more workers and use power, or if they employ twenty or more workers. Registration under the Factories Act implies that the firm will have to comply with a wide range of government regulations that are exclusively applicable to the formal sector. However, it also implies that the firm will be able to access credit from the formal financial sector, including loans from specialized development financial institutions and commercial banks. Among the most onerous government regulations that firms in the formal manufacturing sector in India face are employment protection legislation which is among the most restrictive in the world (Ahsan and Pages 2009, Dougherty 2008). In addition, all firms in the formal sector, irrespective of size, are subject to environmental regulations and minimum wage legislation, which informal sector firms are not.

The most important set of policies that the Indian government has followed with respect to the manufacturing sector was a comprehensive industrial licensing system (more commonly known as the License Raj in the literature). For first four decades since independence, the government intervened in almost all aspects of the activities of formal manufacturing firms. Industry in India was subject to rather formidable legal barriers to entry. Investments, both in terms of expansion of capacity of existing firms and creation of new firms, was controlled by the government through its licensing policies that were in turn determined according to plan priorities. Though the purported objective of the licensing regime was balanced growth, it effectively led to a more monopolistic structure and significantly encouraged rent-seeking by corporations entrenched with public powers (Aghion *et al*. 2008). Following an initial attempt in 1975-76, the liberalisation of industrial controls gathered momentum in 1985-86 when some industries and medium sized firms were taken out of the purview of industrial licensing and modernisation of equipment along with expansion of capacity were also allowed in a limited manner. In 1991, the License Raj effectively came to an end, when industrial licensing was abolished irrespective of the level of investment except for sixteen core industries. The number of industries reserved for the public sector was significantly reduced. Also, under the new policy guidelines on foreign investment, automatic permission is granted for foreign equity participation up to 51 per cent in a specified list of high technology and high investment priority industries.

In addition to the industrial licensing system, the Indian government followed a trade regime since independence which was aimed at the comprehensive, direct control over foreign exchange utilisation, with an overwhelming reliance on quotas rather than tariffs (Bhagwati and Srinivasan 1975). The trade regime provided a significant degree of protection to firms in Indian manufacturing. Nearly all imports were subject to discretionary import licensing or were "canalised" by government monopoly trading organisations. Beginning with the export-import policy of 1977-78, there was a slow but sustained relaxation of import controls. The pace of the trade reforms - in particular, the shift from quantitative import controls to a protective system based on tariffs - initiated in the mid-seventies were considerably quickened in the second half of the 1980s. Restrictions on the import of capital goods were further eased to encourage technological modernisation. In 1991, as a part of the comprehensive economic reform programme initiated that year, there was a significant

liberalization of the trade regime with respect to capital goods. Import licensing was virtually abolished with respect to the imports of most machinery and equipment and manufactured intermediate goods (Sen 2008). There was also a significant cut in tariff rates, with the peak tariff rate reduced from 300 per cent to 150 per cent and the peak duty on capital goods cut to 80 per cent. Import-weighted average tariff rates fell from an average of 83 per cent in 1990 to 29 per cent in 1995-96 (Alessandrini *et al*. 2011).

While the industrial licensing and trade policies were mostly targeted to the formal manufacturing, the reservation policy for the small-scale sector which initiated in 1967 mostly applied to the informal sector. Under this policy, selected products were identified for exclusive production by the small-scale sector.[viii] The products chosen for reservation by the government were very diverse, and covered industries such as food, chemicals, electronics and textiles. The initial list of products reserved for the small-scale sector was 47 but this increased to 836 by 1989 (Mohan 2002). Entry into the products reserved for the small scale sector was not allowed for large firms and by foreign investors. While the small-sector reservation policy was designed to protect small firms, it also did not allow these firms to grow, to invest in quality upgrading and to benefit from foreign direct investment (Mohan 2002, Mazumdar and Sarkar 2008). Starting in 1997, products were gradually removed from the reservation list and by 2010 only 21 products remained in this list.

Expected Effect of Product Market Reforms on Efficiency Differentials between Formal and Informal Firms

Industrial de-licensing, trade reforms and de-reservation were the key product market reforms enacted by the Indian government with respect to the manufacturing sector.[ix] The impact of these product market reforms may be different on formal versus informal firms. Consider first the de-licensing reforms of the mid-1980s and early 1990s that largely pertained to the formal manufacturing sector. With the withdrawal of restrictions on firm expansion and new firm entry, formal firms would be expected to increase in size and reap economies of scale. In addition, new firm entry is likely to bring about an increase in average efficiency of formal firms in a given industry, both by exerting competitive pressures on incumbent firms and via the introduction of more productive new firms into the industry (Taymaz 2005).[x] The licensing reforms are also expected to stimulate many dynamic small and medium entrepreneurs who have been unnecessarily hampered by the licensing system

(Government of India, 1991). At the same time, informal firms may have benefited indirectly from the license reforms as expanding formal firms entered into sub-contracting arrangements with informal firms for supply of inputs, and invested in the technological capabilities of informal firms so as to obtain reliable and high quality specialized intermediate and capital goods (Schmitz 1982, Yang and Chen 2009; Kotwal *et al*. 2011).

Similarly, trade reforms in the form of reduced tariffs would have had a pro-competitive effect on those firms that are in direct competition with imports, these firms being mostly in the formal sector (Tybout 2000). Since informal firms primarily cater to the local market, and do not compete directly with imports, the efficiency enhancing effects of trade reforms would be less for these firms. On the other hand, informal firms would be better able to adjust their use of labour and capital in response to trade reforms as compared to formal firms who face various policy induced impediments to the adjustment of factors of production. Besides, there can also be an indirect impact on informal firms if they are working as subcontractors for formal firms. Thus, it is not clear that trade and license reforms would necessarily increase efficiency levels in formal firms more than in informal firms.

With respect to the de-reservation of products for the small scale sector, it would be expected that these reforms would benefit informal firms in particular as these firms would not face disincentives to expand the scale of production that existed under the reservation policy (since the size limits that applied under this policy penalized the expansion of firms). Efficiency levels of informal firms may also increase via the greater competition that these firms will face from formal firms entering into product markets that were reserved for small firms. At the same time, the ability of formal firms to move into new product markets may provide efficiency gains to these firms as they obtain both economies of scale and scope in production.

We empirically investigate in this paper whether the product market reforms enacted since the mid-1980s have led to an increase in efficiency of formal firms relative to informal firms. But first we set out our econometric methodology below.

III. Econometric Methodology

We use stochastic frontier analysis (SFA) to estimate firm efficiency.[xi] We are interested in determining the technical efficiency of the firm – the maximum possible output

that a firm can produce, given its inputs. The standard approach to SFA is the one proposed by Aigner *et al*. (1977). Under this approach, a single-equation cross-sectional stochastic production frontier model is estimated, with the assumption that firm i uses the input vector x_i to produce a single output y_i based on the following equation:

$$y_i = x_i\beta + (v_i - u_i)$$

$$where\ u_i = |\sigma_u U_i| = \sigma_u |U_i|.\ U_i \sim N[0,1] \quad \text{---------- (1)}$$

$$y_i = \sigma_v, v_i \sim N(0,1)$$

The model is estimated using the maximum likelihood method. However, the model does not account for selection bias. If being located in the formal sector is not by chance but by choice, the comparison of efficiency levels of formal and informal firms without addressing the endogeneity of firm location may yield biased results. It is, therefore, important to correct for the selection bias in firm location in the informal or formal manufacturing sector in the estimation of technical efficiency.

Correcting for Selection Bias

The method proposed by Heckman (1976) is the conventional one used in the literature to address the selection bias. It involves two steps. In the first stage, the probit model is fit to the data and estimate the sample selection equation. In the second stage, the model is fitted to the selected sample data by adding the inverse Mills ratio obtained from the first step as an independent variable to correct for selectivity bias and test its significance.

As is argued by Greene (2006), this approach is not appropriate for models that are non-linear in nature such as probit and tobit models.[xii] As an alternative, Greene (2006) proposed an internally consistent method of incorporating 'sample selection' into a stochastic frontier framework. He proposes the following analytical approach:

$$d^* = \alpha' z + w, d = 1, d^* > 0 \quad \text{---------- (2)}$$

$$y = \beta' x + v - u \quad \text{---------- (3)}$$

$$u = |U|, with\ U \sim N[0, \sigma_u^2]$$

$$(v.w) \sim bivariate\ normal\ with\ [(0,0), (\sigma_u^2, \rho\sigma_v, 1)]$$

$(y, x) only\ observed\ when\ d = 1$

where d is a probit selection equation (with its adoption depending on a host of price and non-price factors) and y is the stochastic frontier function, specified only for the adopting firms.

The estimation is divided into two parts. For the selected observations, d=1, conditioned on v, the joint density for y and d is the products of the marginals as conditioned on v, where y and d are independent.

$$f(y, d = 1|x, z, v) = f(y|x, v) prob\ (d = 1|z, v)$$

This is the second part. For the first part,

$$y|x, v = (\beta' x + \sigma_v v) - \sigma_u u$$

where u is the truncation at zero of a standard normal variable.

Therefore, the joint conditional density is given by:

$$f(y, d = 1|x, z, v) = \frac{2}{\sigma_u} \emptyset \left(\frac{(\beta' x + \sigma_v v) - y}{\sigma_u} \right) \varphi \left(\frac{\alpha' z + \rho v}{\sqrt{1-\rho^2}} \right) \text{---------- (4)}$$

We obtain the unconditional density by integrating v out of equation (4). The integral does not exist in a closed form and hence, Greene (2006) proposes computation by simulation. The final simulated log likelihood is given by:

$$\log L_s = \sum_i \log \frac{1}{R} \sum_{r=1}^{R} \left\{ d_i \left[\frac{2}{\sigma_u} \emptyset \left(\frac{\beta' x + \sigma_v v_{ir} - y}{\sigma_u} \right) \varphi \left(\frac{\alpha' z + \rho v_{ir}}{\sqrt{1-\rho^2}} \right) \right] + (1 - d_i) \left[\varphi \left(\frac{-\alpha' z + \rho v_{ir}}{\sqrt{1-\rho^2}} \right) \right] \right\} \quad (5)$$

The model is estimated using NLOGIT version 4.

IV. Empirical Specification

Our empirical strategy involves three stages: in the first stage, we estimate a probit equation which models the selection of firms into the informal and formal sectors, and in the second stage, estimates for the production function and for technical efficiency are obtained, conditioned on the sample selection. Once we obtain the efficiency estimates, in the third stage of the analysis, we carry out regressions to see the impact of reforms on efficiency differentials between the formal and informal sector.

First Stage Analysis

We assume that firms can choose between being in the formal or informal sector subject to a set of variables that capture the benefits and costs of formalization. The decision of the i^{th} firm to be in the formal sector is described by an unobservable selection criterion function, F*, that is postulated to be a function of variables that determine the benefits and costs of formalization. The model is specified as:

$$F^* = \alpha Z_i + w_i \qquad (6)$$

Where Z is a vector of variables explaining the decision to formalize, α is a vector of parameters, and w_i is the white noise error term.

The selection criterion F* is not observed. Instead, a dummy variable F is observed which takes the value of one for formal sector firms, and zero for informal sector firms.

Therefore, F = 1, if $F^* = \alpha Z_i + w_i \geq 0$; and F = 0, otherwise

To obtain the set of explanatory variables which determine the benefits and costs of formalization, we draw from recent theoretical literature on why firms formalize. We also exploit the fact that there are important differences in institutions relating to labour regulation, access to credit and the provision of infrastructure across Indian states and over time. A key factor that has been highlighted by both the theoretical and empirical literature is the degree of regulation faced by the firm if it chooses to be in the formal sector (Fajnzylber *et al*. 2011, Ulyssea 2010, Taymaz 2009, Dabla-Norris *et al.* 2005). While the regulatory framework relating to product market entry and exit are the same across states in India, labour regulations have differed greatly across Indian states. Industrial relations in India fall under the joint jurisdiction of the central and state governments. A particular piece of labour legislation that has particularly detrimental to the growth of the formal manufacturing sector in India, and has encouraged informality, is the Industrial Disputes Act (IDA) of 1947, which sets out the conciliation, arbitration and adjudication procedures to be followed in the case of an industrial dispute. The IDA applies only to formal sector firms and imposes significant restrictions on employers regarding layoff, retrenchment and closure.[xiii]

Since labour laws are both within the jurisdiction of state and central governments, the IDA has been extensively amended by state governments during the post-independence period. Besley and Burgess (2004) have coded each state amendment to labour laws as neutral, pro-worker or pro-employer for the period 1947-1997. We extended the Besley-Burgess variable till 2005 and then normalized it between 0 and 1 such that the more pro-employer labour law amendments in a state would result in higher value for that state. We would expect that more pro-employer labour law amendments *(LABOUR LAWS*) as seen by a higher value of our variable would have a positive effect on the firm's decision to formalize.

A second factor highlighted by the theoretical literature is access to formal sector credit (Straub 2005). The higher the likelihood for a firm to obtain formal sector credit, which are usually on more favourable terms than informal sector credit and at lower interest rates, the more likely that the firm will choose to be in the formal sector. This is because registration as a formal sector unit is often a precondition for firms to access credit from specialized formal sources such as commercial banks and development finance institutions. In India, government regulations made it mandatory for commercial banks to lend a large proportion of their funds to small and medium enterprises in the formal manufacturing sector (which are mostly the units that are making the transition from the informal sector) along with farmer-households in the agricultural sector – these regulations were called priority sector lending requirements (Sen and Vaidya 1997). Access to priority sector lending depended a great deal on the level of financial development in a given state, and this differed from state to state and across time (Burgess and Pande 2005). We capture differential access to formal sector credit for small and medium enterprises across Indian states and over time by the share of bank lending going to priority sectors (*PRIORITY SECTOR LENDING*) for 1989-90, 1994-95, 2000-01 and 2005-06.

Our third variable to explain the decision of a firm to formalize is the provision of a productive public good to formal sector firms which creates a strong incentive to formalize (Dessy and Pallage 2003). We take the public good to be electricity, which has been found to be a binding constraint for formal manufacturing growth in India (World Bank 2004). Indian states have differed widely in their ability to provide electricity to manufacturing firms, in part due to the very different performance of State Electricity Boards, the main agency responsible for transmission and distribution, across Indian states (Krueger and Chinoy 2002,

Panagariya 2008). We measure the electricity constraint on a firm's decision to formalise by the real price of power supply (*COST OF POWER SUPPLY*), which is less subject to endogeneity concerns in comparison to measures of electricity infrastructure such as the degree of electrification (Cali and Sen 2011). A higher price of electricity would reflect better quality of electricity provision (for example, less frequent power outages) and provide an incentive for firms to move from the informal to the formal sector to take advantage of electricity provision in the state, but it could also deter informal firms to move into the formal sector as the cost of production in the formal sector increases. Which of the two impacts dominates is an empirical issue.

Finally, we assume that the larger the firm (in terms of employment) (*FIRM SIZE*), the more likely that the firm will be in the formal sector as it will be difficult for the firm not to be noticed by regulators (and state agents such as tax and labour officials) if it remains in the informal sector (Taymaz 2009).

We estimate probit model of the following type:

$$F = f(\text{LABOUR LAWS, PRIORITY SECTOR LENDING, COST OF POWER SUPPY, FIRM SIZE}) \quad \text{----------(7)}$$

where F is 1 if the firm is in the formal sector, 0 otherwise. We expect that the signs of *LABOUR LAWS, PRIORITY SECTOR LENDING* and *FIRM SIZE* will be positive while the sign of *COST OF POWER SUPPY* will be indeterminate.

We estimate the probit equation for each industry separately, but for all four years combined. We explain below why we estimate the probit model separately for each industry.

Second Stage Analysis

The production behaviour of formal and informal sector firms is modeled using a simple Cobb Douglas function. Thus, we have:

$$\ln(Y_{iT}) = \beta_0 + \beta_1 \ln(K_{iT}) + \beta_2 \ln(L_{iT}) + (v_{iT} - u_{iT}) \quad \text{----------(8)}$$

Where T=1989-90, 1994-95, 2000-01 and 2005-06 and i is the firm. Y is gross value added, K is capital stock, L is labour, and βs are the parameters to be estimated. The v_{iT}s are random variables independent of the u_{iT}s and purport to capture the random shocks that are beyond the control of firms. The u_{iT}s capture technical inefficiency and are the combined

outcome of non-price and organizational factors that constrains a firm from achieving their maximum possible output from the given set of inputs and technology. The u_is are non-negative and assumed to be identically distributed at truncations at zero, $u = |U|$ with $U \sim N [0, \sigma^2_u]$. Thus technical efficiency (TE_i) is measured as the ratio of the observed output of the firm to the potential output derived by the frontier function. We examine both the absolute and the relative technical efficiency of firms of both the groups in our sample, where the latter is defined as the difference between the actual absolute technical efficiency for the firm in question and the maximum absolute efficiency obtained for a given type of firm for a given industry in a given year.

Instead of estimating the same production function for the entire set of firms, irrespective of industry, we estimate equation (8) industry by industry and for each of the two groups – formal and informal separately, at the National Industrial Classification (NIC) 2 digit industry level (broadly corresponding to the ISIC 3 digit level of industrial classification used by the United Nations Industrial Development Organization). There are twenty-two industries in our data-set (we provide the list of industries along with the industry codes in Appendix A). By estimating the production function separately for formal and informal firms at the industry level, we not only allow the parameters for capital and labour in the firm-level production function to differ across industries but also across the two groups. This is a reasonable assumption to make when a) the industries differ so widely in their production technology and in characteristics relating to export orientation and market structure (e.g., leather versus electrical machinery); and b) even within the same industry, production coefficients may be different for labour-intensive informal firms and capital-intensive formal firms.

Third Stage Analysis: Impact of Reforms on Technical Efficiency

Once we have estimated efficiency at the firm level, we regress firm-specific technical efficiency on a composite measure of reforms (REFORM) and a variable representing firm location (FORMAL). As discussed in Section II, the major product market reforms that have occurred in the Indian economy since the mid-1980s were the withdrawal of the requirement of a license that firms require if they wish to produce in a given industry (DELICENSE), the de-reservation of products earlier earmarked only for small scale and informal producers (DERESERVE) and trade reforms in the form of cuts in import tariffs (TARIFF). The Composite measure is a weighted index of these three reforms and is given by:

$REFORM_{jt} = {}_{i=1}\Sigma^{3} w_i Reform_{ijt}$

where w_i is the weight for each of the product market reform variables. We assume equal weights for each of the three product market reform variables (that is $w_i = 0.33$).

To estimate the effect of economic reforms and firm location in the formal sector on technical efficiency, we use the following specification:

$$TE_{ijt} = \alpha + \beta_1 * FORMAL_{ijt} + \beta_2 * REFORM_{jt} + \delta_j + \gamma_t + \varepsilon_{ijt} \quad \text{----------(9)}$$

Where TE_{ijt} is technical efficiency of firm i in industry j and year t and FORMAL is a dummy for firm location which takes the value one if the firm is in the formal sector, and zero if the firm is in the informal sector. δ_j are industry fixed effects, γ_t are year effects and ε_{ijt} is the error term. If β_2 is greater than zero (and statistically significant), this would imply that product market reforms have facilitated firms to increase their efficiency. Similarly, if β_1 is greater than zero and statistically significant, we would conclude that formal firms are more efficient than informal firms and vice versa if β_1 is less than zero. We use both absolute and relative technical efficiency as our dependent variables.

To examine the differential impact of reforms on informal and formal firms, we introduce an interaction term (FORMALxREFORM), where we interact our reform variable (REFORM) with FORMAL variable. Thus, the revised model estimated is as follows:

$$TE_{ijt} = \alpha + \beta_1 * FORMAL_{ijt} + \beta_2 * REFORM_{jt} + \beta_3 * FORMALxREFORM_{ijt} + \delta_j + \gamma_t + \varepsilon_{ijt}$$

----------(10)

The coefficient β_3 measures the differential impact of reforms on formal and informal firms. A positive and statistically significant β_3 (along with a positive and statistically significant β_2) implies that reforms have led to a greater increase in the efficiency of formal firms as compared to informal firms indicating exacerbation of dualism in Indian manufacturing sector. A negative and statistically significant β_3 would imply just the reverse.

We estimate the above equations using Ordinary Least Squares. There is a possibility that the FORMAL variable is endogenous if firms with higher technical efficiency may tend to move to the formal sector. We do not need to use instrumental variable methods as our first stage analysis controls for this possibility and therefore, of simultaneity bias.[xiv]

V. Data and Variables

We use unit level data for the formal and informal manufacturing sectors for four years, 1989-90, 1994-95, 2000-01 and 2005-06.[xv] The choice of years is governed by the fact that the data on informal sector firms are only available for these years. Data on the formal manufacturing sector is drawn from the Annual Survey of Industries (ASI), undertaken by the Central Statistical Organization (CSO), which is the annual census-cum-sample survey of all the formal manufacturing units for all the industries across all the states. For the informal sector, we use the National Sample Survey Organization (NSSO) firm-level surveys on the informal manufacturing sector (that is, those firms which are not registered under the Indian Factories Act of 1948) which are undertaken quinquennially using a stratified sampling procedure.[xvi] It is to be noted that during the sixteen years of our analysis period, industrial classification has undergone some changes. For instance, ASI data for 1994-95 and 2000-01 uses NIC 1987 codes, whereas 2005-06 uses NIC 1998 codes NSSO data for 1989-90 and 1994-95 are based on NIC 1987, whereas 2000-01 data is based on NIC 1998 and 2005-06 data is based on NIC 2004. We harmonized the whole data at NIC 1998 codes. The average number of firms in the formal sector that we use in our empirical analysis is 25,000 and for the informal sector, 28,000.[xvii]

The variables for the stochastic frontier model are real value added and real capital stock at 1993-94 prices and number of persons employed. We omitted observations for which real value added, real capital and the labour variables are less than or equal to zero. Real value added is obtained by deflating nominal value added using the wholesale price index (WPI) for manufactured products at the four digit industry level. Labour is measured as total number of persons engaged in the production activity, which include production workers as well as employees. Real capital stock is constructed by deflating gross fixed assets by WPI for machinery and machine tools. To ensure that the empirical analysis is not sensitive to the inclusion of outliers, we have dropped all firms where real capital stock, employment or real output are more than two standard deviations from the industry means of these variables.

Labour regulation data till 1997 comes from Besley and Burgess (2004), and we have updated it using similar coding procedures till 2005. Data on the share of credit going to the

priority sector are drawn from Burgess and Pande (2005) till 1995, and we have updated it for the years 2000-01 and 2005-06 from an annual publication titled *Statistical Tables Relating to Banks in India* published by the Reserve Bank of India (RBI). The data on the cost of power supply comes from the Indian Planning Commission (2002).

We obtain simple and weighted tariffs ratios from the trade and industrial output data of the *World Bank Trade Data-base* (World Bank 2006). The *World Bank Trade Data-base* provides simple and import weighted average tariffs data for 28 manufacturing sectors at the ISIC 3 digit level of classification till 2006. We match the data to the NIC 3 digit classification of the Annual Survey of Industries. Thus, our tariff variables vary across industries and over time (but not across states).[xviii]

As discussed, the de-licensing of industries started in 1980s with nearly half of the 4-digit industries de-licensed by 1985. The industrial licensing was effectively abolished in 1991 except for a small number of industries where it was retained for reasons related to security, strategic or environmental concerns. As of 2006-07, only 4 per cent of the industries were under licensing requirements. We construct the de-licensing variable as the total number of four-digit industries de-licensed in a year to that of total number of four-digit industries in the sector. Similar to Aghion *et al*. (2008), we consider an industry to be de-licensed if all or part of a four-digit industry (3-digit in their case) is de-licensed in a year.

The reservation of items for exclusive manufacture in the small scale sector, as statutorily provided in the Industries (Development and Regulation) Act, 1951, was one of the key policy measures to promote the sector. Exception to this reservation was allowed only if a non-small scale sector unit undertakes 50 per cent export obligations of the reserved product. We construct the de-reservation variable as the ratio of cumulative number of products de-reserved in respective two-digit industries to that of total reserved products in these industries. The list of number of products de-reserved is obtained from different notifications of the Government of India. Like tariffs, our de-licensing and de-reservation variables also vary across industries and over time, but not across states.

Figure 1 and Table 1 present the trend in de-licensing, de-reservation and tariff reforms since 1985. It is interesting to note that de-licensing and de-reservation reforms together staggered two decades – most of the de-licensing reforms were over by 1995,

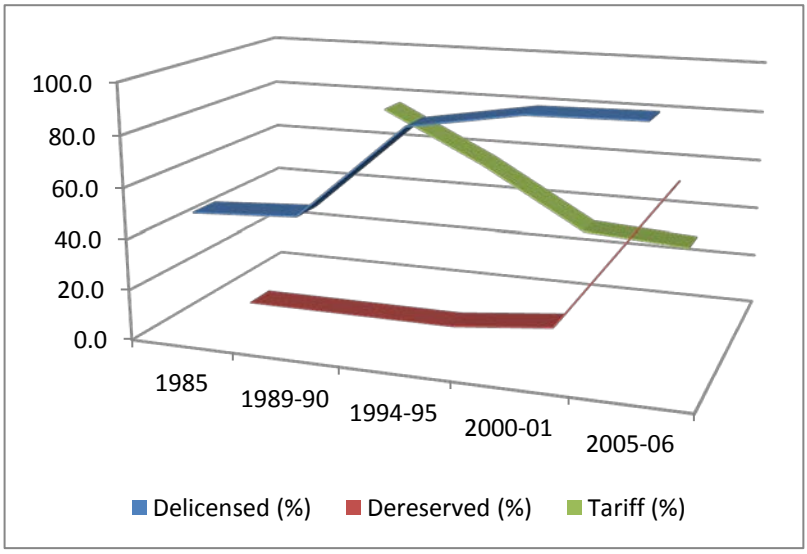
whereas de-reservation reforms started after 1995. Two important points are to be noted – a) all these reforms were nationwide in nature, when an industry de-licensed or a product de-reserved or tariffs reduced, it affected all the firms irrespective of their geographical location; and b) by 2005-06, the terminal year of our study period, only six per cent of industries required de-licensing, nearly one-third of products needed to be de-reserved and average tariff was 29 per cent (ranging between 24 per cent to 38 per cent), much below the 100 per cent average tariff rate that prevailed in 1991. Table 2 gives industry-wise reforms accomplished till 2005-06. It is clear from Table 2 that the pace of the three product market reforms differed greatly across industries.

Table 1: Trend in Reform variables

	1989-90	1994-95	2000-01	2005-06
De-licensing (per cent of 4-digit industries de-licensed)	53.02 (36.85)	84.41 (26.28)	93.47 (21.64)	93.82 (21.42)
De-reservation (per cent of products de-reserved)	9.09 (29.42)	9.09 (29.42)	15.30 (30.4)	70.83 (32.13)
Trade reforms (Tariffs in per cent)	76.67 (15.0)	56.09 (10.1)	31.80 (4.55)	29.02 (3.93)

Note: Figures in parenthesis are the standard deviations.

Figure 1: Trend of different Reform variables



Notes: De-licensing indicates percentage of 4 digit industries de-licensed, de-reserved indicates percentage of industries became open to large and medium firms and tariffs represents percentage of import duties levied on an industry.

Table 2: Industry-wise status of Reforms, 2005-06

Industry	De-licensed (in per cent)	De-reserved (in per cent)	Tariff (in per cent)

Food Products	93.8	62.5	37.79
Tobacco	0.0	100	30.00
Textiles	100.0	100	27.06
Wearing Apparel	100.0	100	29.93
Leather Products	100.0	100	28.23
Wood and Wood Products	100.0	43.75	29.22
Paper and Paper Products	100.0	38.71	27.05
Publishing	100.0	100	23.57
Coke and Petroleum	100.0	100	29.71
Chemicals	84.6	78.19	28.57
Rubber & plastic products	100.0	36.90	29.56
Non-Metallic Mineral Products	100.0	10	29.25
Basic metal	100.0	100	33.50
Metal products	100.0	64.66	28.66
Machinery	100.0	78.79	25.10
Office machinery	100.0	100	25.10
Electrical machinery	100.0	54.05	24.57
Radio & Television	100.0	83.33	24.74
Medical, precision inst.	100.0	80	24.74
Motor vehicles	100.0	100	36.02
Transport equipment	85.7	5.88	36.02
Furniture	100.0	21.43	30.00
Average	**93.8**	**70.83**	**29.02**

Using the data for these three product market reforms, we construct a composite index of reform (REFORM) by assigning equal weights for all the three reforms. As the reform variables move in different directions - trade reform moves from high to low, whereas other two reforms move from low value to high with progressive reforms - we reconstruct our tariff reform variable as 100 - Current Tariff. This modification reconciles the direction of tariff reform with other two reforms. A high value of REFORM thus indicates a greater extent of reforms and a lower value indicates more restrictions and thus less reform. As indicated in Figure 2, the progress of reform is not uniform but varies significantly across industries. Industries like tobacco, minerals and transport equipment are far behind textiles, apparels, leather, office machinery, publishing and basic metals in these reforms.

Figure 2: Industry-wise trend of composite Reform variable (REFORM)

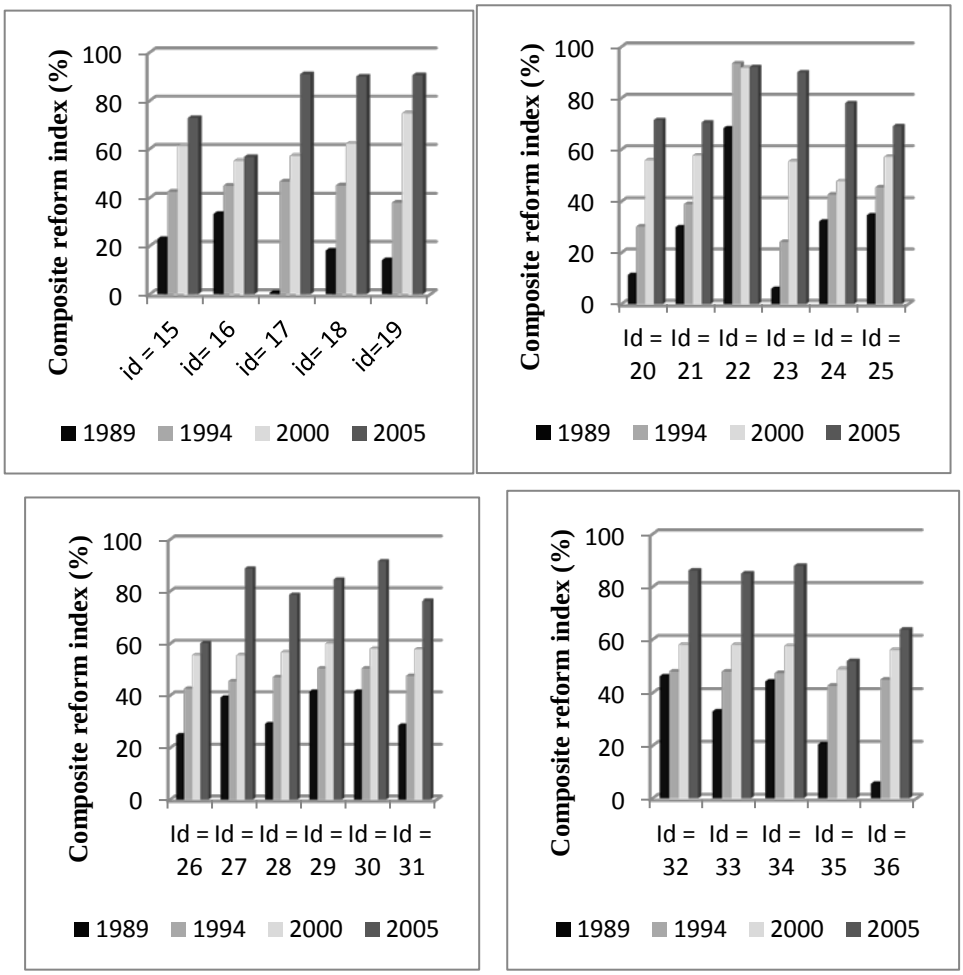


Table 3 presents the descriptive statistics for the main variables that we use in our first stage probit model, second stage stochastic frontier estimation and third stage where we test for duality in manufacturing. On average, priority sectors such as small-scale industries, services and agriculture together received about 31 per cent of the total bank lending for the period 1989-90 to 2005-06. The labour regulation variable suggests that, on average, labour laws in India have been pro-worker. It is clearly evident from the Table that average value added per employee is considerably higher for firms in the formal sector as compared to their counterparts in the informal sector. Evidence also points to significant differences in the level of input use between firms in the formal and informal sector. The capital-labour ratio computed for both the sectors suggest the highly capital intensive nature of production process employed in the formal sector vis-à-vis the informal sector.

Table 3: Descriptive statistics at the aggregate level: 1989-2006

	Mean	Standard deviation
Selection Variables		
Labour regulation index (pro-worker: +1; pro-employer: -1)	0.576	0.235
Cost of power supply, state level, (Rs./Kwhr)	5.323	0.5422

Share of priority sector lending, state-level (per cent)	31.457	9.883
Firm size (log (ln) employment)	2.652	1.557
Stochastic Frontier Variables		
Ln formal manufacturing value added per employee	10.719	1.126
Ln informal manufacturing value added per employee	8.920	1.199
Ln formal manufacturing capital labour ratio	10.454	1.727
Ln informal manufacturing capital labour ratio	9.821	1.341
Ln formal manufacturing employment (No.)	3.893	1.211
Ln informal manufacturing employment (No.)	1.404	0.529
Reform Variables		
REFORM (weighted Reform measure)	52.58	19.50
De-licensing (per cent of four-digit industries de-licensed)	81.6	31.2
De-reservation (per cent of products de-reserved)	26.07	48.39
Trade liberalization (Tariff in per cent)	48.39	21.66

Notes: The data are for the 15 major sates for the period 1989-2006. Since Bihar, MP and UP were bifurcated in 2000 to form the new states, Uttarakhand, Chhattisgarh and Jharkhand, we have merged these three states with their parent states so as to have consistent data for the study period.

VI. Results

We first present the results for the first stage estimation followed by the results for the second stage and third stage estimation respectively.

First stage estimation

Results of the first stage probit equation estimation are presented in Table 4. The chi-square test statistic in the probit selection equation is significant at the 1 per cent level in all the industries except three industries, namely medical, precision and optical instruments, office machinery and basic metal industries. As expected, the likelihood of the firm being in the formal sector is positively correlated with firm size (*FIRM SIZE*). We also find that weaker labour regulation (*LABOUR LAWS*) significantly and positively (except for Tobacco and Chemical Sectors)[xix] influences the firm's decision to be in the formal sector. By and large, wherever the variable is significant in the industry by industry results, there seems to be a positive relationship between the availability of power (*COST OF POWER SUPPLY*) supply and the firm's decision to be in the formal sector. This suggest that the greater the quality of the electricity supplied in a given state, the more likely is it that firms in that state will be formalized. In most industries, greater availability of priority sector lending (*PRIORITY SECTOR LENDING*) from commercial banks seems to have been influencing the firms' decision to be in the formal sector.

Table 4: Parameter estimates of the Probit Selection Equation, Industry Level, All Years

Industries	Constant	FIRM SIZE	LABOUR LAWS	COST OF POWER SUPPLY	PRIORITY SECTOR LENDING	Log likelihood	MaFadden R-square	N	Chi-squared
Food	-7.54* (0.21)	2.45* (0.03)	0.89* (0.07)	0.33* (0.03)	-0.01* (0.002)	-5072.35	0.81	38978	154.53
Tobacco	-9.32* (0.48)	1.31* (0.04)	-1.43* (0.14)	0.92* (0.07)	0.07* (0.01)	-1064.94	0.65	4449	28.70
Textiles	-10.22* (0.26)	2.84* (0.04)	0.38* (0.07)	0.43* (0.04)	0.01* (0.001)	-3955.03	0.83	35138	203.86
Apparel	-23.90* (2.96)	11.60* (1.21)	0.14 (0.48)	-0.41 (0.26)	0.001 (0.01)	-98.57	0.98	12320	
Leather	-7.79*	2.90*	1.26*	0.07	0.01*	-490.19	0.82	4035	16.90

	(0.68)	(0.12)	(0.18)	(0.11)	(0.005)				
Wood	-6.10* (0.32)	2.48* (0.06)	0.18* (0.11)	0.10* (0.05)	0.01* (0.003)	-1930.47	0.66	9400	149.49
Paper	-5.92* (0.60)	2.42* (0.09)	0.65* (0.19)	0.09 (0.09)	0.0003 (0.004)	-661.49	0.67	3692	10.53
Publishing	-7.76* (0.47)	2.88* (0.08)	0.27* (0.14)	0.17* (0.07)	0.01* (0.004)	-973.04	0.80	7122	30.49
Petroleum	-4.94* (0.89)	1.52* (0.11)	1.79* (0.36)	0.23 (0.14)	0.01 (0.01)	-208.23	0.57	1259	17.50
Chemicals	-5.44* (0.33)	1.93* (0.05)	-0.74* (0.11)	0.24* (0.05)	0.01* (0.002)	-2044.35	0.62	11649	12.55
Rubber	-7.83* (0.41)	2.31* (0.06)	0.59* (0.13)	0.40* (0.06)	0.01* (0.003)	-1459.21	0.67	6848	24.91
Minerals	-4.12* (0.21)	1.51* (0.02)	0.77* (0.07)	-0.02 (0.03)	0.01* (0.002)	-5131.86	0.54	16634	44.73
Basic metal	-5.73* (0.47)	2.30* (0.07)	0.83* (0.15)	0.21* (0.07)	-0.01* (0.003)	-970.82	0.69	7594	3.46
Metal products	-8.32* (0.30)	2.83* (0.05)	0.32* (0.09)	0.33* (0.04)	0.01* (0.002)	-2585.47	0.78	17146	153.99
Machinery	-7.40* (0.30)	2.42* (0.05)	1.05* (0.10)	0.36* (0.05)	-0.004* (0.002)	-2386.36	0.73	13571	88.99
Office machinery	-2.55* (2.18)	2.08* (0.38)	-0.46 (0.76)	-0.57 (0.38)	0.04* (0.02)	-34.98	0.69	294	1.38
Electrical machinery	-5.91* (0.50)	2.39* (0.08)	0.52* (0.17)	0.005 (0.08)	0.02* (0.004)	-874.18	0.73	5281	24.94
Radio & Television	-7.00* (1.23)	2.40* (0.19)	1.50* (0.43)	0.05 (0.19)	0.03* (0.009)	-134.77	0.74	1353	3.75
Medical, precision & optical instrmnts	-5.71* (0.99)	2.40* (0.16)	1.60* (0.35)	0.05 (0.150	-0.009 (0.007)	-196.34	0.74	1427	0.62
Motor vehicles	-4.14* (0.72)	2.14* (0.10)	0.03 (0.230	-0.09 (0.11)	0.001 (0.005)	-527.59	0.67	3162	8.71
Transport equipment	-4.58* (0.56)	2.02* (0.08)	1.24* (0.23)	0.11 (0.09)	-0.02* (0.004)	-647.97	0.65	3241	34.60
Furniture	-5.90* (0.33)	2.28* (0.05)	0.77* (0.12)	-0.04 (0.05)	0.01* (0.003)	-1850.72	0.71	14843	96.01

Notes: a) N is the total number of firms; b) * indicates level of significance at 5 per cent; c) Figures in parenthesis are standard errors.

Second stage estimation

Table 5 and Figure 3 give the summary statistics for variables used in estimating stochastic production frontier for formal and informal firms separately. As expected, in each industry the informal firms on an average use less labour and capital and produce less, though the variation is smaller for the group. These differences in input usage is also clearly evident from figure 3 which displays kernel density plots showing cumulative differences in the logged values of value added, capital stock and labour between formal and informal sector. Is the use of labour and capital relatively more inefficient for informal firms? This is investigated next.

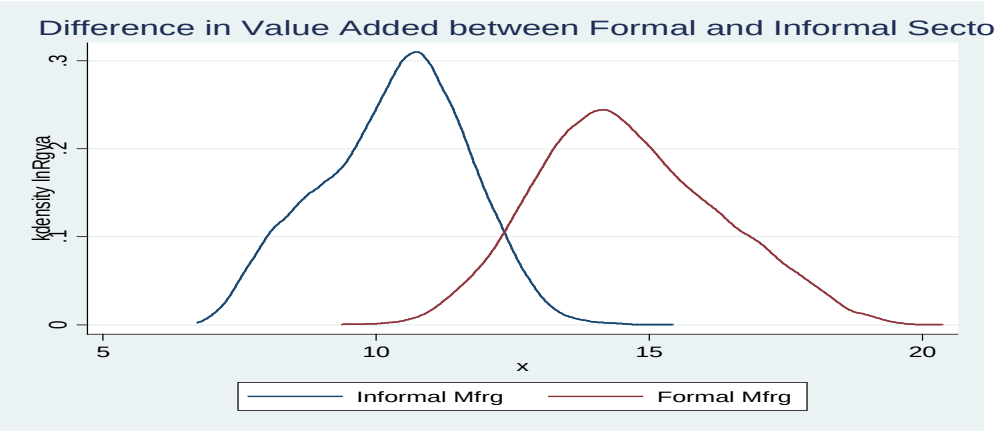
Table 5: Summary statistics for second stage estimation – average over 1989-90 to 2005-06

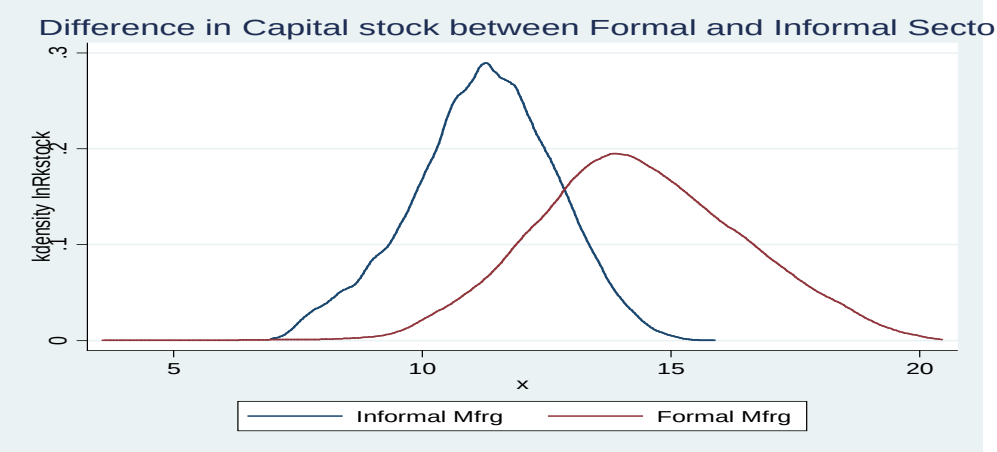
Industry	Informal Sector			Formal Sector		
	Y	K	L	Y	K	L
Food	9.96 (6.93-13.04)	10.99 (7.36-14.50)	1.24 (0.69-2.48)	14.52 (10.68-18.54)	14.32 (9.39-19.30)	4.01 (1.39-6.73)

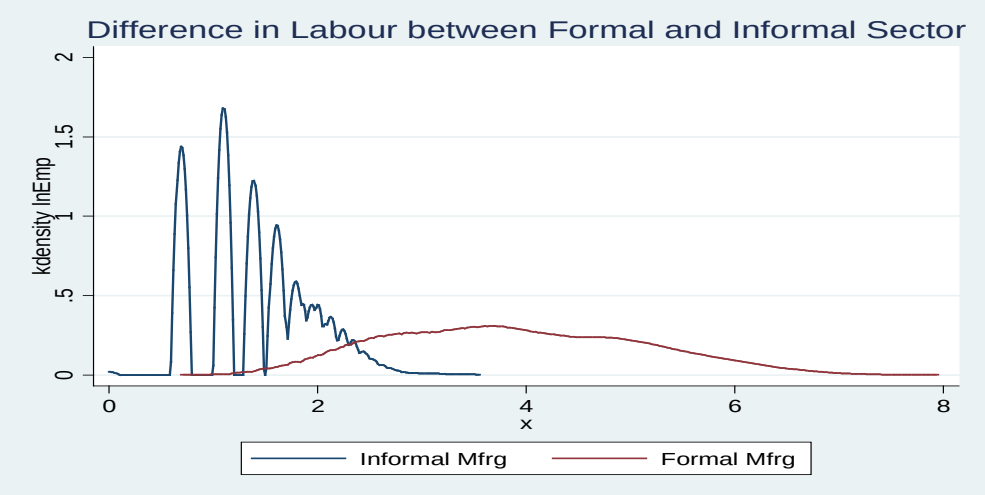
Tobacco	9.63 (6.99-12.26)	10.18 (7.07-13.12)	1.39 (0-3.18)	13.85 (9.37-18.44)	11.77 (3.58-18.92)	4.21 (0.69-7.95)
Textiles	10.37 (7.44-13.20)	10.93 (7.40-14.32)	1.57 (0.69-2.71)	15.10 (11.12-19.15)	15.12 (9.96-20.21)	4.34 (1.61-7.36)
Apparel	9.84 (6.72-13.11)	11.14 (8.80-13.53)	1.14 (0.69-2.20)	15.38 (12.19-18.40)	14.90 (10.67-18.89)	4.69 (2.08-7.21)
Leather	10.51 (7.43-13.57)	11.02 (7.81-14.15)	1.40 (0.69-2.56)	14.74 (11.32-18.08)	14.64 (10.49-18.69)	4.01 (1.39-6.73)
Wood	10.19 (7.26-12.96)	10.90 (6.96-14.59)	1.27 (0.69-2.30)	12.98 (10.13-16.04)	12.63 (8.27-16.87)	2.88 (1.10-5.07)
Paper	11.07 (7.89-14.17)	12.12 (8.82-15.14)	1.63 (0.69-2.83)	14.55 (11.00-18.35)	14.60 (10.19-19.36)	3.63 (1.39-6.34)
Publishing	10.28 (7.10-13.29)	11.92 (8.43-15.05)	1.34 (0.69-2.40)	14.23 (10.63-17.93)	14.01 (9.01-18.93)	3.62 (1.39-6.14)
Petroleum	10.43 (7.21-13.51)	11.71 (8.12-15.04)	1.63 (0.69-2.71)	14.72 (10.41-19.71)	14.99 (9.97-20.38)	3.73 (1.10-6.66)
Chemicals	11.04 (7.51-14.54)	12.06 (8.43-15.50)	1.82 (0.69-3.14)	15.15 (11.00-19.57)	14.91 (9.58-20.44)	4.14 (1.61-6.98)
Rubber	11.25 (7.82-14.54)	12.47 (8.76-15.82)	1.64 (0.69-2.77)	14.64 (11.26-18.27)	14.64 (10.64-18.92)	3.55 (1.39-6.13)
Minerals	10.59 (7.45-13.73)	11.42 (7.60-15.08)	1.83 (0.69-3.56)	13.75 (10.20-17.87)	13.36 (8.84-18.57)	3.65 (1.39-6.25)
Basic metal	10.76 (7.31-14.27)	11.86 (8.23-15.43)	1.55 (0.69-2.77)	14.97 (11.10-19.18)	14.98 (10.15-20.13)	3.97 (1.39-6.86)
Metal products	10.54 (7.44-13.55)	11.52 (8.13-14.66)	1.35 (0.69-2.40)	14.23 (10.87-17.89)	13.83 (9.67-18.19)	3.50 (1.39-6.11)
Machinery	10.79 (7.56-13.93)	11.91 (8.23-15.29)	1.41 (0.69-2.56)	14.54 (10.98-18.44)	14.20 (9.94-18.74)	3.60 (1.10-6.38)
Office machinery	12.43 (9.73-14.57)	12.96 (10.97-15.88)	1.85 (0.69-3.00)	16.11 (11.84-20.35)	15.66 (11.20-19.47)	4.27 (1.79-6.69)
Electrical machinery	10.77 (7.17-14.52)	11.98 (8.32-15.20)	1.46 (0.69-2.77)	15.02 (11.24-19.20)	14.51 (9.99-19.34)	3.75 (1.39-6.59)
Radio & Television	11.70 (7.74-15.42)	12.33 (8.79-15.32)	1.70 (0.69-3.00)	15.70 (11.60-20.08)	15.37 (10.49-20.32)	4.19 (1.61-7.02)
Medical, precision inst.	11.17 (7.85-14.48)	11.87 (8.61-14.90)	1.49 (0.69-2.77)	15.08 (11.40-18.76)	14.63 (10.11-19.11)	3.79 (1.39-6.44)
Motor vehicles	11.38 (8.33-14.29)	12.53 (9.81-15.10)	1.72 (0.69-2.89)	15.33 (11.27-19.59)	15.30 (10.49-20.34)	4.18 (1.39-7.26)
Transport equipment	11.05 (7.94-14.10)	12.18 (1.38-8.28)	1.58 (0.69-2.71)	14.82 (10.95-19.08)	14.37 (9.72-19.40)	3.84 (1.10-7.13)
Furniture	10.24 (7.18-13.30)	10.96 (7.68-14.03)	1.28 (0.69-2.56)	14.07 (10.32-18.14)	13.38 (8.17-18.59)	3.39 (1.10-6.10)

Note: Figures in the parentheses show the ranges for the respective variables; Y, K and L represent log of real gross value added, real fixed capital stock and number of workers respectively.

Figure 3: Differences in value added, capital and labour employed between firms in the informal and formal sectors (averages over the period, 1989-90 to 2005-06)







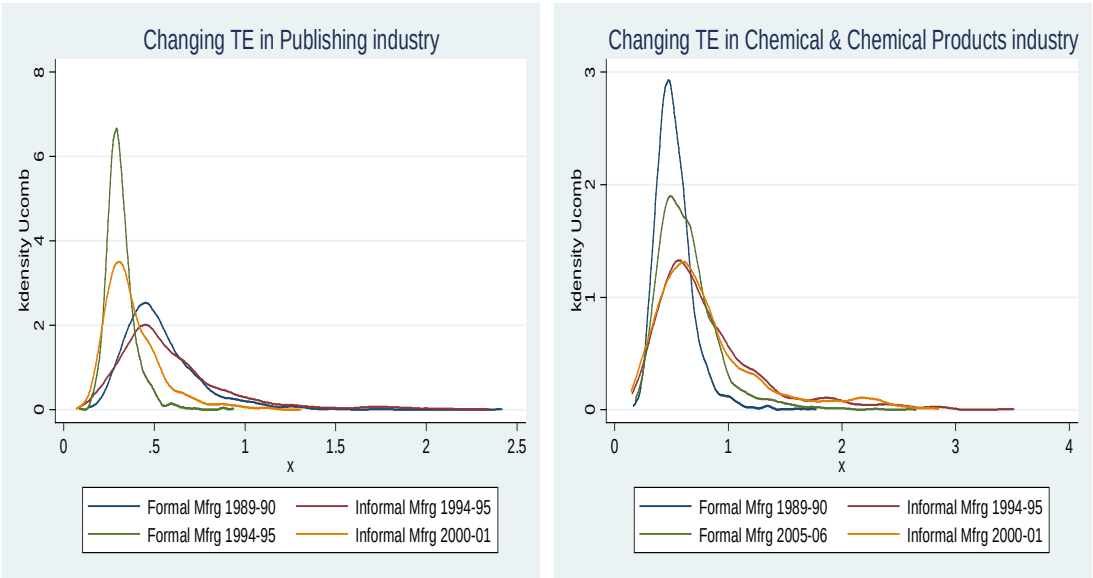
Note: Mfrg=Manufacturing

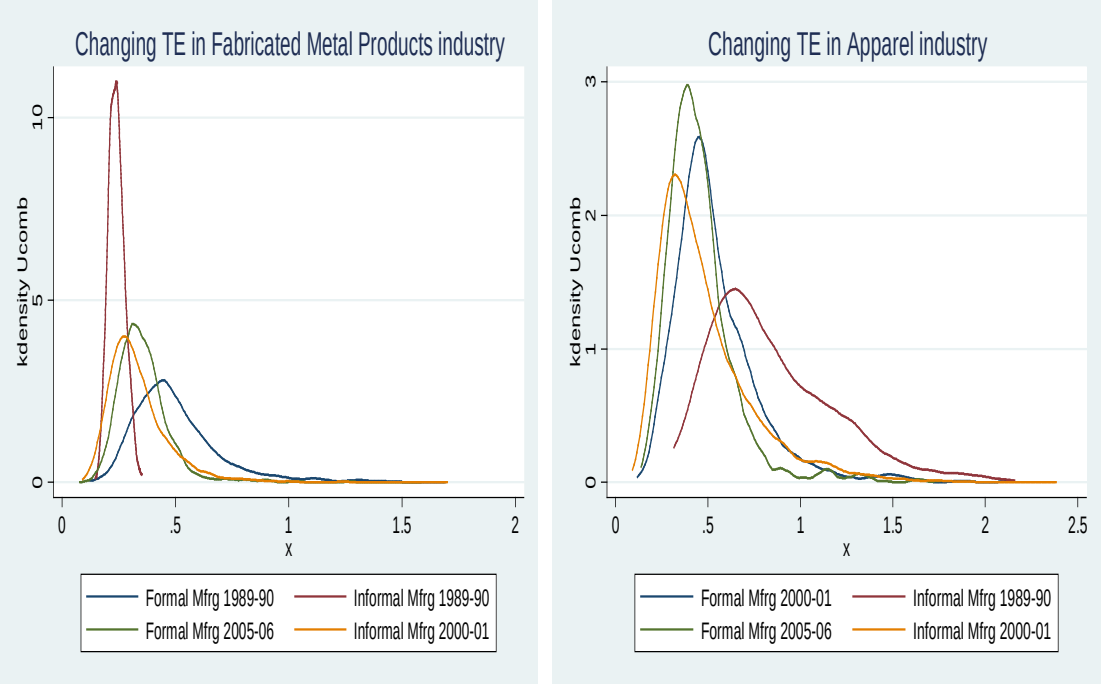
The maximum likelihood estimates of the parameters of the model obtained from estimating the stochastic production frontier model separately for 22 industries for each of the groups are presented for 1989-90, 1994-95, 2000-01 and 2005-06 in Tables A2 to A5 (in the Appendix) respectively. The models estimated by the maximum likelihood method are highly significant as shown by the large likelihood values. The coefficient of the selectivity variable ($\rho_{w,v}$) is significantly different from zero at the 5 per cent level in most of the industries especially for 2000-01 and 2005-06, which confirms that serious selection bias exists, thereby supporting the use of a sample-selection framework in the stochastic frontier model. The results of the stochastic production frontier models show that the coefficient of labour is higher than that of capital for most industries and for most years irrespective of the group suggesting that labour is a more important input than capital in the production function, which is a quite plausible finding for a labour surplus economy like India. For

informal sector, we find elasticity of labour or capital is negative in some industries. This could be because of two reasons – first, some of these industries are highly capital intensive, thereby having less scope for informal firms (for example, Petroleum); and second, the estimates for these industries are not consistent due to less degrees of freedom as these industries consist of only few informal firms (for example, Office Machinery). We also examine whether there has been any changes in the estimated parameters of the industry production functions over time. Our results preclude any such possibility in the formal sector as the t-ratio for differences in coefficients is found to be insignificant for most industries and most years. However, the t-test for differences in coefficients do suggest changes in estimated parameters over time for the informal sector with the sector reporting increasing returns to scale for the later period.

In Figure 4, we present kernel density plots of changes in absolute technical efficiency for formal and informal firms for selected industries. We observe that absolute efficiency levels of firms in the formal and informal sector show a clear improvement over time.

Figure 4: Kernel density plots showing change in absolute Technical Efficiency (TE) for selected industries for formal and informal firms

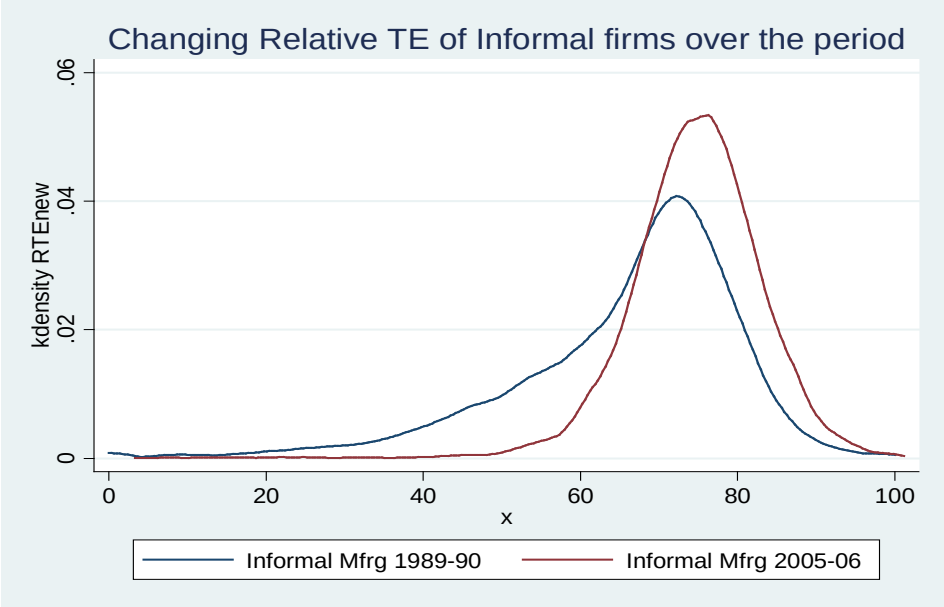


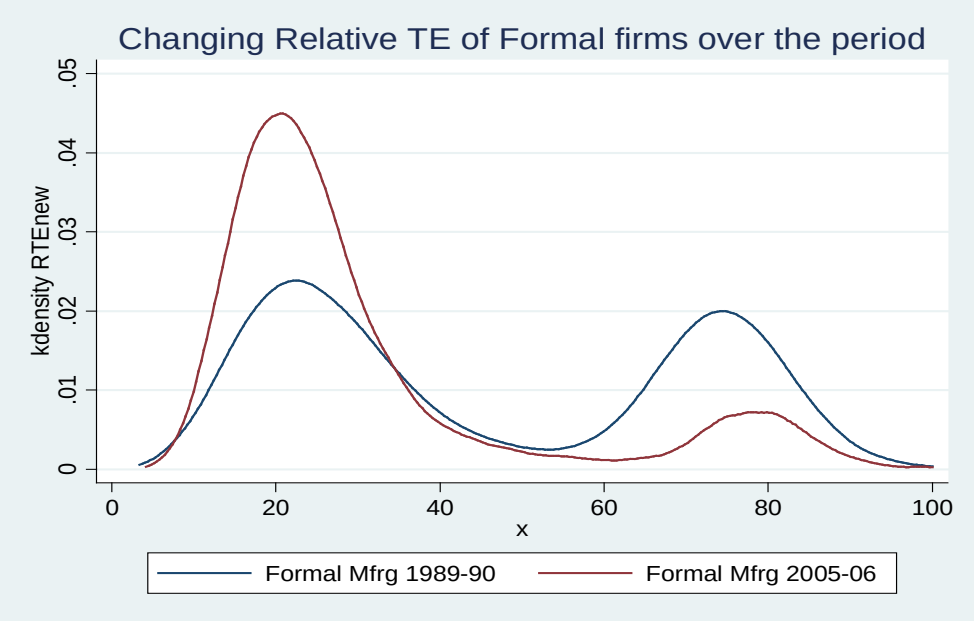


Note: Mfrg=Manufacturing.

In Figure 5 we present kernel density plot of changes in relative technical efficiency over the period for the two groups separately. The plot indicates that more informal firms are now closer to the frontier in 2005-06, than they were in 1989-90. The picture is different for formal firms where the density plot is bimodal for both the years with more firms moving away from frontier in 2005-06 vis-à-vis 1989-90.

Figure 5: Changing Relative TE of Informal and Formal Firms over the period





Third Stage Estimation: Impact of Reforms on Dualism

We now examine how the reforms have impacted on dualism in Indian manufacturing. First, we examine the impact of reforms on absolute and relative efficiency of Indian manufacturing firms as in equation (9).[xx] Next, we see whether reforms have reduced or exacerbated manufacturing dualism. This is done by including the interaction term FORMALxREFORM as in equation (10). To take into account that efficiency may be impacted by macroeconomic shocks and cyclical factors and that firm efficiency may be correlated with unobserved industry characteristics, we include year and industry fixed effects in all our regressions. In Cols. (1) and (5) of Table 6, we present our results on the effects of reforms

and firm location in the formal sector on absolute and relative technical efficiency, and in Cols. (1) and (5) of Table 7, we present the results for both absolute and relative technical efficiency, with the interaction term included.

Table 6: Impact of Reforms on Technical Efficiency in Indian Manufacturing

Variables	Absolute Technical Efficiency				Relative Technical Efficiency			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Formal	0.0186***	0.044*	0.026*	0.042*	-4.88***	-7.00***	-5.72***	-6.54***
	(0.00173)	(0.002)	(0.002)	(0.002)	(0.0998)	(0.102)	(0.103)	(0.106)
REFORM	0.012*				-1.01***			
	(0.0001)				(0.0061)			
DELICENSE		0.005*				-0.45***		
		(0.00005)				(0.0028)		
DERESERVE			0.004*				-0.27***	
			(0.00006)				(0.0039)	
TARIFF				-0.0005*				0.212***
				(0.0001)				(0.007)
Constant	0.092*	0.135*	0.324*	0.378*	81.10***	77.77***	61.38***	43.50***
	(0.003)	(0.003)	(0.003)	(0.009)	(0.185)	(0.170)	(0.177)	(0.586)
Ind. Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Observations	173070	173070	173070	173070	173070	173070	173070	173070
R-Squared	0.175	0.164	0.133	0.110	0.41	0.4	0.34	0.320

Note: * indicates significance at minimum 5per cent level; Figures in parenthesis are standard errors.

Our estimates of equation (9) as reported in Table 6 show that formal firms are, on average, more efficient than informal firms, as the coefficient on the FORMAL dummy in Col. (1) is positive and statistically significant. However, the coefficient is negative and significant in Col. (5) suggesting that the distance from the frontier is on an average greater for the formal sector firms as compared to the informal sector firms. Given the greater heterogeneity in size of firms in the formal sector, this result is not surprising. Our computations based on the coefficient value of FORMAL indicate that the absolute efficiency level of formal firms is 1.26 per cent higher than that of informal firms. It is also found that the efficiency gap between the representative firm and the most efficient firm in a particular industry is lesser by 8.6 per cent in formal firms vis-à-vis informal firms.

Firms in both formal and informal sectors have gained in efficiency in the reform period as given by the positive and statistically significant coefficient of the REFORM variable in Col. (1). Interestingly reforms have led to a decline in relative technical efficiency, as indicated by the negative and statistically significant coefficient of REFORM variable in Col. (5) suggesting that the efficiency gap between the representative firm and the most efficient firm, in a given industry, has widened faster in the formal sector in the reform period.

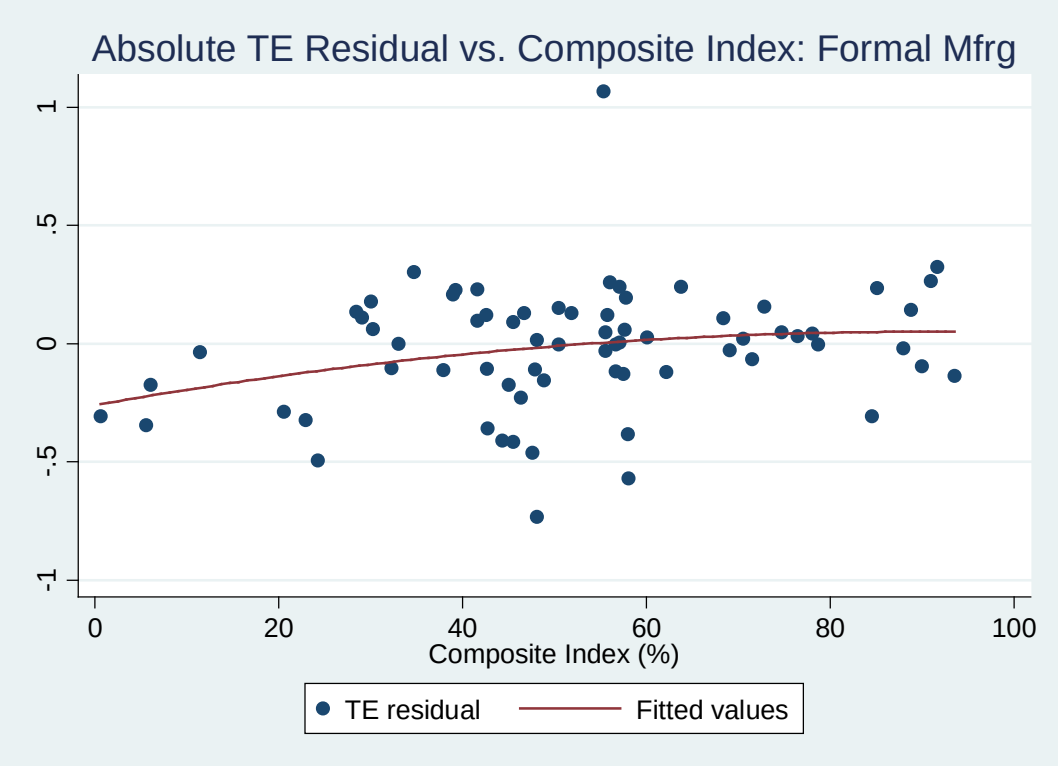
To gauge the possible role of reforms on manufacturing dualism, we estimate equation (10) where an interaction term FORMALxREFORM is introduced, along with REFORM and FORMAL variables. The results are reported for absolute and relative technical efficiency separately in Col (1) and Col (5) of Table 7. Our earlier findings related to efficiency gains for both formal and informal firms in the reform period and fast increase in efficiency gap for the formal firms following reforms are confirmed by the positive coefficients of β_2 and β_3 for absolute technical efficiency and negative coefficients of β_2 and β_3 for relative technical efficiency respectively. Unlike in table 6, now the effect of FORMAL on absolute or relative technical efficiency is given by the expression: $\beta_1 + \beta_3 * REFORM$. Therefore, even if β1 is negative, $\beta_1 + \beta_3 * REFORM$ can be positive if the $\beta_3 * REFORM$ is positive, when we evaluate the expression at the mean value of REFORM. [xxi] Our results based on β_1 and β_3 shows that, at the mean value of REFORM, β1 + β3*REFORM is positive for both absolute and relative technical efficiency. This suggests that the economic reforms have brought about a widening of efficiency differentials between formal and informal firms where formal firms were more efficient than informal firms to begin with, exacerbating dualism in the Indian manufacturing sector. We also find that the efficiency gap between the representative firm and the most efficient firm has widened in both formal and informal manufacturing sectors following reforms, but the gap widened faster for the formal firms. Against average relative technical efficiency of 25.6 per cent, it has declined to 24.4 per cent for the formal firms, whereas it has declined only marginally for informal firms from 27.99 to 27.55. A movement away from the frontier in 2005-06 for formal firms may be a pointer to significant barriers to exit for less productive formal firms as compared to informal firms in India.[xxii]

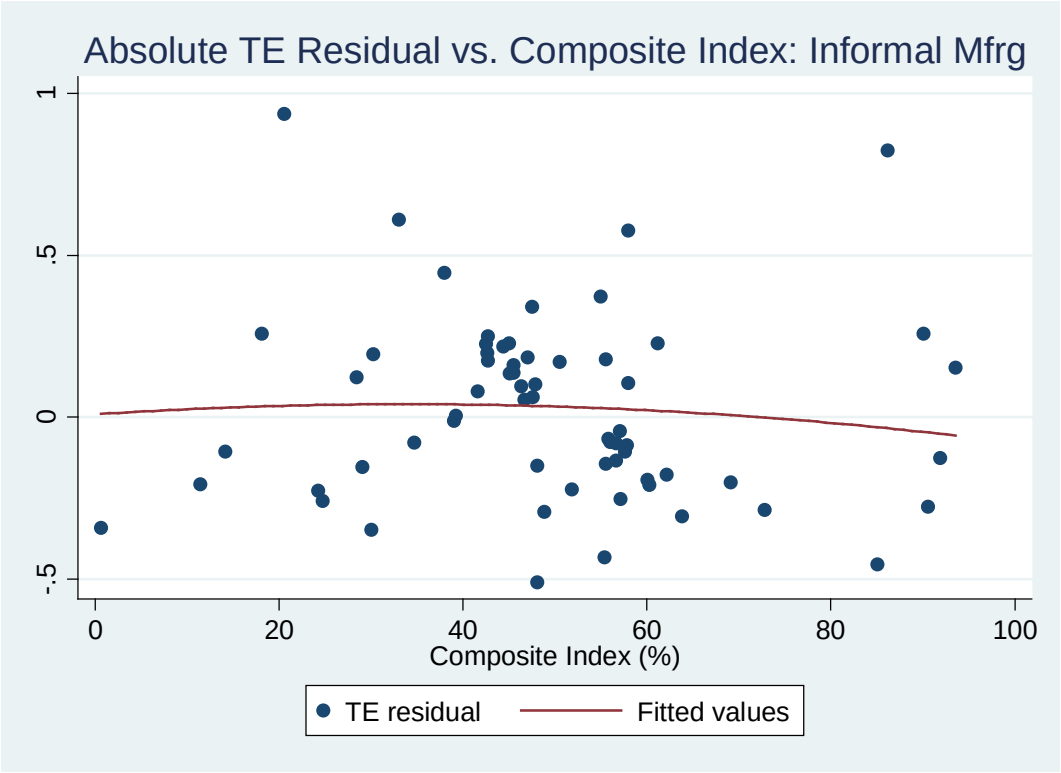
We also estimate the extent of differential impact of the REFORM variable on the efficiency of formal and informal sector firms. Our calculations indicate that for the average values of REFORM variable, the efficiency difference between formal and informal firms is 0.03 for absolute efficiency and 5.78 for relative technical efficiency. At the mean value of absolute technical efficiency (0.44), this suggests that reforms have increased the efficiency of formal firms by 7.45 per cent vis-à-vis informal firms. Similarly, relative to a mean relative technical efficiency of 34.5 per cent, the efficiency gap between the representative informal firm and the most efficient firm in a particular industry has reduced by 17.0 per cent as compared to the efficiency gap between the representative formal firm and the most

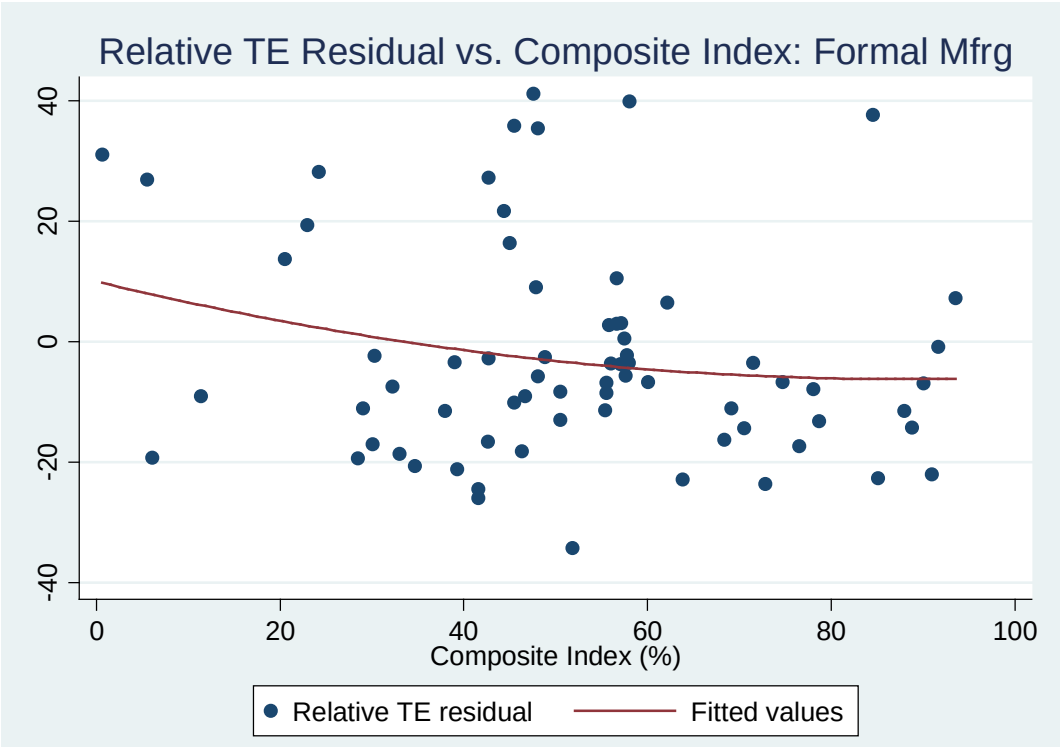
efficient firm in the same industry. Together, these results suggest that though technical efficiency on an average grew faster in the formal sector, but there has been a wider dispersion in efficiency for formal firms as a result of reforms with more firms moving away from the frontier.

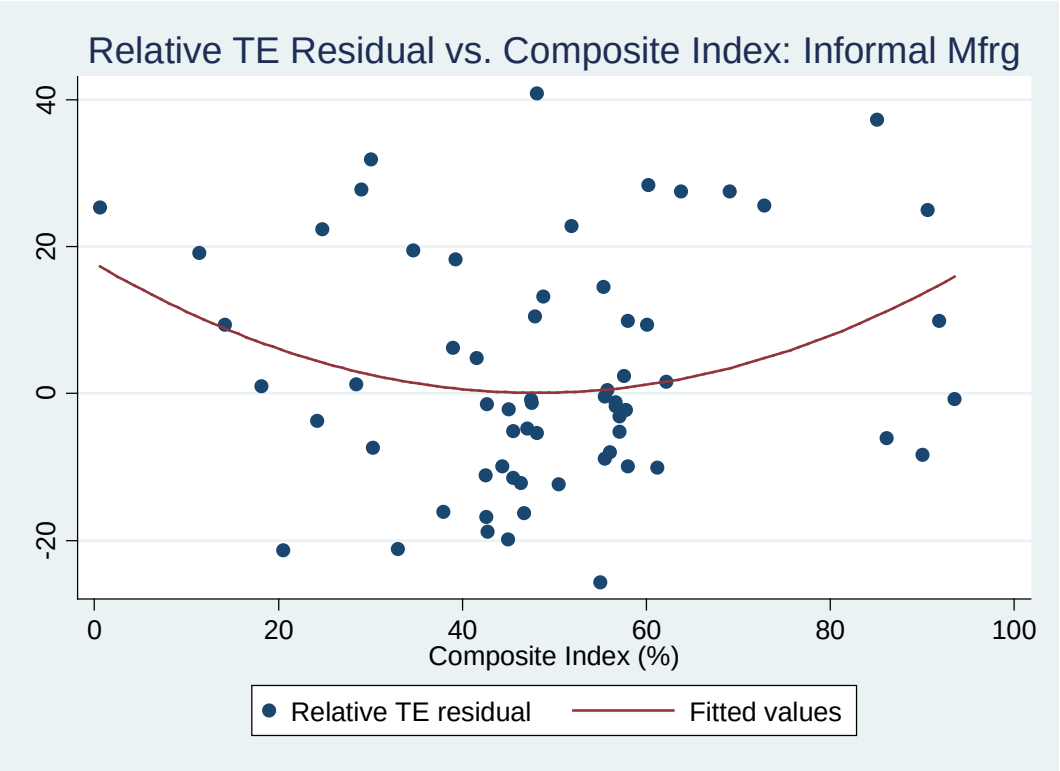
The REFORM vs efficiency relationship in the formal and informal sectors is also captured in Figure 6 where we plot our REFORM variable against absolute and relative technical efficiency.[xxiii] The figure shows that the relationship is stronger in the formal sector as compared to the informal sector, and that the relationship between absolute technical efficiency and the reform variable is positive, while the relationship between relative technical efficiency and the reform variable is negative.

Figure 6: Composite Reform Index (per cent) versus Technical Efficiency – Absolute and Relative.




Absolute TE Residual vs. Composite Index: Informal Mfrg
1
.5
0
-.5
0
20
40
60
80
100
Composite Index (%)
TE residual
Fitted values


Relative TE Residual vs. Composite Index: Formal Mfrg
40
20
0
-20
-40
0
20
40
60
80
100
Composite Index (%)
Relative TE residual
Fitted values



As we have noted in Section III, not all industries have been equally affected by reforms, and the extent of impact of de-licensing, de-reservation and trade reforms differed widely across industries and over time. Figure 2 indicated that trade reform has had a significant overlapping timeline with de-licensing and de-reservation reforms. Hence we also examine the impact of each of these product market reforms on efficiency. We do this by entering each reform variable sequentially rather than including all of them at the same time in equation (9). Cols (2) to (4) and Cols (6) to (8) in Table 6 presents the results for each of the reform variables on absolute and relative technical efficiency respectively. All the three types of reforms - increased de-licensing, de-reservation and tariff reduction – have had a discernible positive impact on absolute technical efficiency, as indicated by the positive and statistically significant coefficients on the DELICENSE and DERESERVE variables and negative and statistically significant coefficient of TARIFF variables.[xxiv] The impact of reforms is identical too in the case of relative technical efficiency. De-licensing, de-reservation and tariff reforms seem to widen the gap between the most efficient firm and average firm in the industry. The results indicate that additional de-licensing and de-reservation reforms and further reduction in tariff to the tune of 10 per cent from their mean values would have

resulted in a 7.4 per cent, 1.8 per cent and 0.62 per cent increase in absolute efficiency of Indian manufacturing firms respectively. On the other hand, additional reforms would have increased the gap between the most efficient firm and the average firm by 11, one and two per cent in case of de-licensing, de-reservation and trade reforms respectively.[xxv]

To see how individual reforms have influenced manufacturing dualism, the interaction of the three reform variables with that of whether the firm is a formal firm or not (FORMAL) has been introduced sequentially. Cols (2) to (4) and Cols (6) to (8) of Table 7 report the results. When absolute technical efficiency is the dependent variable, we find that the interaction terms between de-licensing and FORMAL and between de-reservation and FORMAL are positive and significant, while the interaction term between tariff cuts and FORMAL is negative and significant. This suggests that all three product market reforms have led to an increase in absolute efficiency of formal firms relative to informal firms (though the coefficient on TARIFF by itself is positive and significant, suggesting that the overall effect of tariff cuts on firm efficiency in the entire manufacturing sector has been negative). On the other hand, when relative technical efficiency is the dependent variable, we find that the interaction term between de-licensing and de-reservation with FORMAL is negative and significant. Finally, the interaction term between tariff cuts and FORMAL is positive and significant. This suggests that all the three reforms - de-licensing, de-reservation and tariff reforms have led to a decrease in relative efficiency of formal firms relative to informal firms, increasing the efficiency gap between the average formal firm and the most efficient firm in the formal sector, relative to a similar efficiency gap for the informal sector, within industries.

Table 7: Impact of Reforms on Dualism in Indian Manufacturing

/ARIABLES	Absolute Technical Efficiency				Relative Technical Efficiency			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ormal	-0.223*	-0.220*	-0.00277	0.205*	17.977*	39.41*	3.972*	-2.318*
	(0.004)	(0.00469)	(0.00199)	(0.00455)	(0.310)	(0.297)	(0.111)	(0.285)
REFORM	0.009*				-0.166*			
	(0.000)				(0.007)			
ormal*REFORM	0.005*				-0.240*			
	(0.000)				(0.006)			
DELICENSE		0.00415*				-0.0724*		
		(4.84e-05)				(0.00247)		
ormal*DELICENSE		0.00317*				-0.409*		
		(5.37e-05)				(0.00328)		
DERESERVE			0.00208*				-0.102*	
			(9.49e-05)				(0.00618)	

Formal*DERESERVE			0.00205* (6.73e-05)				0.109* (0.00439)	
TARIFF				0.000885* (0.000110)				-0.105* (0.00683)
Formal*TARIFF				-0.00338* (8.64e-05)				0.158* (0.00569)
Constant	0.247* (0.004)	0.269* (0.00362)	0.357* (0.00304)	0.333* (0.00901)	36.937* (0.240)	29.55* (0.194)	40.18* (0.194)	43.79* (0.620)
Ind. Dmy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yr Dmy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	173108	173108	173108	173108	173108	173108	173108	173108
R-squared	0.19	0.179	0.139	0.119	0.23	0.314	0.215	0.215

Note: * indicates significance at minimum 5 per cent level; Figures in parenthesis are standard errors.

VII. Conclusions

Do economic reforms reduce or exacerbate manufacturing productivity dualism? We investigate this question using firm level data for the informal and formal manufacturing for the Indian economy combined from four repeated cross-sections over the period 1989-2005. We use stochastic frontier analysis applied to twenty-two industries to calculate absolute and relative efficiency at the firm-level for the Indian economy for both formal and informal firms separately. We use a recent econometric methodology proposed by Greene (2010) to correct for selection bias in the firm's decision to be in the informal or formal sectors in the estimates of efficiency. We then estimate the effects of key reforms enacted in India since the mid 1980s – tariff reforms, industrial de-licensing and the scaling back of small sector reservation policy – on relative and absolute efficiency differentials between informal and formal firms.

Our regression results suggest that economic reforms have had an unambiguous positive effect on absolute levels of technical efficiency in the entire manufacturing sector (both informal and formal sectors combined). While average efficiency levels in both the informal and the formal manufacturing sectors have increased, the increase has been more for the formal firms. We also find that economic reforms have increased the efficiency differentials between the more efficient formal firms and the less efficient informal firms in

Indian manufacturing. At the same time, economic reforms have led to a decline in relative efficiency levels for both formal and informal sector firms, but the negative effect of economic reforms on relative efficiency levels has been larger for formal firms. This suggests that the within industry effects of economic reforms on efficiency have been more unequalising for the formal manufacturing sector as compared to the informal manufacturing sector. Overall, our results suggest that productivity dualism has increased in Indian manufacturing since the reforms, both by increasing the efficiency differential between formal and informal firms.

Our results have important implications for the effects of economic reforms on pro-poor growth in emerging economies. While economic reforms can have strong positive effects on overall efficiency in the manufacturing sector, the widening gap between the productivity of formal and informal firms in manufacturing will make it difficult for informal firms to compete in external and domestic markets that are increasingly integrated. Given the large presence of unskilled and semi-skilled workers who comprise the majority of the workforce in the informal manufacturing, such a process of dualistic development may act as a significant obstacle for poverty reducing and employment creating impact of economic growth.

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APPENDIX A1: LIST OF INDUSTRIES

National Industrial Classification (NIC) – 1998 (At Two Digit Level)

NIC 2-digit	SIC Code	Description

classification		
15	311, 313	Manufacture of food products and beverages
16	314	Manufacture of tobacco products
17	321	Manufacture of textiles
18	322	Manufacture of wearing apparel; dressing and dyeing of fur
19	323, 324	Tanning and dressing of leather; manufacture of luggage, handbags, saddler, harness and footwear
20	331	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
21	341	Manufacture of paper and paper products
22	342	Publishing, printing and reproduction of recorded media
23	353, 354	Manufacture of coke, refined petroleum products and nuclear fuel
24	351, 352	Manufacture of chemicals and chemical products
25	355, 356	Manufacture of rubber and plastics products
26	361, 362, 369	Manufacture of other non-metallic mineral products
27	371, 372	Manufacture of basic metals
28	381	Manufacture of fabricated metal products, except machinery and equipment
29	382	Manufacture of machinery and equipment not elsewhere classified
30	382	Manufacture of office, accounting and computing machinery
31	383	Manufacture of electrical machinery and apparatus not elsewhere classified
32	385	Manufacture of radio, television and communication equipment and apparatus
33	385	Manufacture of medical, precision and optical instruments, watches and clocks
34	384	Manufacture of motor vehicles, trailers and semi-trailers
35	384	Manufacture of other transport equipment
36	332	Manufacture of furniture; manufacturing not elsewhere classified

Table A2: Estimated production parameters, industry level, 1989-90 and 1994-95 (Formal Firms)

Industry	1989-90						1994-95					
	Constant	Ln K	Ln L	Log L	Rho	N	Constant	Ln K	Ln L	Log L	Rho	N
Food	7.57* (0.15)	0.35* (0.01)	0.61* (0.02)	-4356.28	-0.08 (0.09)	3597	6.73* (0.12)	0.38* (0.01)	0.67* (0.01)	-9955.52	0.04 (0.04)	6766
Tobacco	8.59* (0.65)	0.19* (0.02)	0.72* (0.06)	-771.78	-0.10 (0.19)	477	8.26* (0.33)	0.24* (0.01)	0.76* (0.04)	-1340.60	0.02 (0.11)	840
Textiles	6.96* (0.17)	0.32* (0.01)	0.82* (0.02)	-2932.03	0.20* (0.08)	2103	7.26* (0.10)	0.34* (0.01)	0.66* (0.02)	-6103.41	0.13* (0.05)	4432
Apparel	8.03* (0.79)	0.35* (0.03)	0.50* (0.06)	-375.97	0.10 (0.65)	306	8.06* (0.33)	0.37* (0.02)	0.44* (0.03)	-1366.52	-0.35 (0.60)	1012
Leather	7.91* (0.59)	0.30* (0.05)	0.67* (0.07)	-492.13	-0.45 (0.29)	350	7.56* (0.49)	0.27* (0.02)	0.77* (0.04)	-977.52	0.01 (0.21)	759
Wood	7.96* (0.60)	0.23* (0.03)	0.73* (0.08)	-740.03	0.26* (0.15)	535	8.07* (0.22)	0.24* (0.02)	0.75* (0.05)	-1394.81	0.12 (0.12)	1025
Paper	8.08* (0.31)	0.33* (0.02)	0.63* (0.06)	-612.75	-0.12 (0.48)	492	7.11* (0.21)	0.35* (0.02)	0.77* (0.04)	-1147.83	0.20 (0.25)	926
Publishing	7.20* (0.21)	0.30* (0.02)	0.85* (0.04)	-961.20	0.09 (0.16)	779	7.42* (0.20)	0.28* (0.01)	0.92* (0.03)	-1278.57	0.03 (0.14)	1061
Petroleum	4.47* (0.82)	0.46* (0.04)	0.85* (0.07)	-286.72	0.28 (0.53)	194	4.55* (0.75)	0.55* (0.03)	0.60* (0.05)	-524.74	-0.82* (0.13)	357
Chemicals	5.75* (0.21)	0.51* (0.01)	0.61* (0.03)	-2716.27	-0.22 (0.20)	1861	6.08* (0.14)	0.45* (0.01)	0.67* (0.02)	-4612.17	0.12 (0.13)	3289
Rubber	7.86* (0.31)	0.33* (0.02)	0.71* (0.05)	-1116.25	0.37* (0.20)	802	6.90* (0.19)	0.35* (0.01)	0.84* (0.05)	-1947.59	0.48* (0.15)	1586
Minerals	6.43* (0.17)	0.30* (0.01)	0.85* (0.03)	-2471.65	0.61* (0.09)	1977	6.46* (0.13)	0.34* (0.01)	0.82* (0.02)	-4351.07	0.31* (0.10)	3395
Basic metal	6.51* (0.39)	0.46* (0.03)	0.47* (0.06)	-1831.99	0.44 (0.42)	1268	6.65* (0.27)	0.34* (0.01)	0.77* (0.02)	-2753.51	0.14 (0.14)	2231
Metal products	7.59* (0.19)	0.24* (0.01)	0.95* (0.03)	-1805.86	0.43* (0.13)	1422	6.97* (0.24)	0.30* (0.01)	0.85* (0.02)	-2952.08	0.13 (0.09)	2443
Machinery	7.18* (0.16)	0.30* (0.01)	0.94* (0.03)	-2183.91	0.48* (0.13)	1771	7.51* (0.13)	0.30* (0.01)	0.85* (0.02)	-3507.10	0.15* (0.08)	2878
Office machinery	6.97* (1.07)	0.31* (0.08)	1.10* (0.12)	-77.46	1.00 (10.25)	65	5.87* (1.35)	0.51* (0.09)	0.64* (0.13)	-151.07	-0.68 (1.11)	99
Electrical machinery	6.55* (0.52)	0.35* (0.02)	0.85* (0.04)	-933.50	-0.17 (0.26)	712	7.16* (0.34)	0.31* (0.02)	0.88* (0.03)	-1565.09	0.02 (0.20)	1247
Radio & Television	7.03* (0.76)	0.33* (0.06)	0.77* (0.10)	-276.47	0.60 (0.62)	195	7.43* (0.38)	0.34* (0.03)	0.81* (0.07)	-691.09	-0.32 (0.40)	502
Medical, precision inst.	8.67* (0.58)	0.26* (0.05)	0.81* (0.10)	-259.45	0.00 (0.42)	193	7.80* (0.43)	0.30* (0.03)	0.84* (0.06)	-420.35	0.96* (0.24)	328
Motor vehicles	6.18* (0.69)	0.35* (0.03)	0.85* (0.05)	-358.00	-0.18 (0.54)	329	6.76* (0.39)	0.32* (0.02)	0.87* (0.03)	-764.52	0.27 (0.18)	702
Transport equipment	8.01* (0.76)	0.22* (0.03)	0.89* (0.05)	-547.11	0.22 (0.30)	401	7.53* (0.23)	0.29* (0.02)	0.85* (0.03)	-1135.97	0.32* (0.14)	894
Furniture	7.29* (0.35)	0.28* (0.03)	0.87* (0.07)	-681.00	0.07 (0.19)	450	6.98* (0.47)	0.29* (0.02)	0.91* (0.05)	-1283.84	0.12 (0.10)	771

Notes: a) Ln K and ln L are natural logarithms of capital stock and labour respectively; b) Log L is the value of the log likelihood function, Rho is selection parameter; and N is the total number of firms; d) * indicates level of significance at 5 per cent; e) Figures in parenthesis are standard errors.

Table A3: Estimated production parameters, industry level, 2000-01 and 2005-06 (Formal Firms)

Industry	2000-01						2005-06					
	Constant	Ln K	Ln L	Log L	Rho	N	Constant	Ln K	Ln L	Log L	Rho	N
Food	6.11* (0.11)	0.44* (0.01)	0.66* (0.02)	-9055.74	0.11* (0.06)	4137	6.66* (0.11)	0.43* (0.01)	0.56* (0.010	-6533.19	-0.08 (0.06)	5676
Tobacco	7.58* (0.68)	0.24* (0.02)	0.81* (0.05)	-659.94	-0.11 (0.16)	402	7.23* (0.50)	0.27* (0.01)	0.87* (0.04)	-1067.91	-0.09 (0.12)	656
Textiles	7.55* (0.13)	0.38* (0.01)	0.56* (0.02)	-3889.29	-0.15* (0.06)	2648	7.76* (0.10)	0.38* (0.01)	0.62* (0.01)	-4861.61	-0.25* (0.05)	3680
Apparel	8.30* (0.29)	0.33* (0.02)	0.61* (0.03)	-893.34	0.48* (0.20)	770	8.85* (0.22)	0.28* (0.01)	0.61* (0.02)	-1098.24	-0.39* (0.22)	1042
Leather	8.39* (0.40)	0.26* (0.03)	0.78* (0.05)	-529.66	-0.16 (0.20)	405	7.27* (0.59)	0.38* (0.02)	0.52* (0.03)	-710.77	-0.01 (0.12)	559
Wood	7.23* (0.35)	0.28* (0.02)	0.90* (0.09)	-847.22	0.21 (0.15)	469	7.75* (0.30)	0.29* (0.01)	0.79* (0.09)	-1083.45	-0.08 (0.14)	627
Paper	7.67* (0.29)	0.34* (0.02)	0.64* (0.04)	-681.14	-0.41* (0.12)	575	7.89* (0.21)	0.36* (0.02)	0.62* (0.04)	-1013.39	-0.21* (0.10)	831
Publishing	6.40* (0.54)	0.35* (0.02)	0.80* (0.05)	-757.13	-0.10 (0.13)	528	6.98* (0.40)	0.34* (0.01)	0.74* (0.04)	-963.62	-0.11 (0.10)	714
Petroleum	4.76* (0.96)	0.49* (0.03)	0.69* (0.06)	-318.56	-0.46* (0.22)	203	3.96* (0.76)	0.47* (0.03)	1.00* (0.05)	-425.10	0.52* (0.18)	277
Chemicals	6.51* (0.19)	0.42* (0.01)	0.67* (0.03)	-2957.92	0.24* (0.12)	1974	7.61* (0.16)	0.39* (0.01)	0.58* (0.02)	-3769.07	-0.13 (0.09)	2492
Rubber	7.14* (0.29)	0.40* (0.02)	0.60* (0.04)	-1127.65	-0.40* (0.11)	829	8.08* (0.19)	0.35* (0.010	0.65* (0.03)	-1776.14	-0.11 (0.10)	1334
Minerals	6.24* (0.19)	0.40* (0.01)	0.70* (0.03)	-2822.38	-0.10 (0.10)	1779	7.07* (0.16)	0.37* (0.01)	0.70* (0.03)	-4946.57	-0.30* (0.06)	3122
Basic metal	7.54* (0.20)	0.35* (0.02)	0.68* (0.03)	-1503.30	-0.47* (0.13)	1164	8.19* (0.17)	0.35* (0.01)	0.64* (0.03)	-2387.69	-0.62* (0.07)	1823
Metal products	7.99* (0.18)	0.31* (0.01)	0.73* (0.03)	-1691.65	-0.26* (0.08)	1142	8.30* (0.15)	0.34* (0.01)	0.56* (0.02)	-2533.25	-0.40* (0.05)	1825
Machinery	7.66* (0.17)	0.31* (0.01)	0.82* (0.02)	-2273.62	0.03* (0.09)	1687	7.74* (0.14)	0.34* (0.01)	0.74* (0.02)	-2853.54	-0.20* (0.06)	2299
Office machinery	5.71* (1.68)	0.57* (0.14)	0.55* (0.17)	-60.18	0.99* (0.53)	49	11.08* (1.43)	0.16* (0.14)	0.93* (0.23)	-61.70	-0.99 (0.002)	43
Electrical machinery	7.92* (0.26)	0.34* (0.02)	0.76* (0.04)	-1073.98	-0.22 (0.14)	750	8.32* (0.25)	0.33* (0.02)	0.74* (0.04)	-1318.18	-0.12 (0.13)	944
Radio & Television	7.49* (0.53)	0.38* (0.04)	0.74* (0.06)	-292.97	-0.72* (0.32)	248	10.71* (0.64)	0.21* (0.05)	0.71* (0.09)	-333.99	-0.45* (0.18)	238
Medical, precision inst.	8.53* (0.46)	0.32* (0.04)	0.69* (0.06)	-386.39	-0.53* (0.20)	290	9.74* (0.52)	0.28* (0.04)	0.63* (0.08)	-428.31	-0.61* (0.19)	306
Motor vehicles	7.00* (0.24)	0.37* (0.02)	0.76* (0.04)	-744.36	-0.18 (0.18)	621	7.96* (0.27)	0.34* (0.02)	0.70* (0.04)	-1096.71	-0.28* (0.16)	882
Transport equipment	7.44* (0.38)	0.34* (0.03)	0.71* (0.05)	-596.37	-0.09 (0.17)	475	7.98* (0.22)	0.36* (0.02)	0.62* (0.03)	-724.00	-0.32* (0.12)	610
Furniture	8.33* (0.35)	0.28* (0.02)	0.88* (0.06)	-830.08	-0.29* (0.14)	420	9.61* (0.25)	0.22* (0.02)	0.77* (0.04)	-1131.41	-0.40* (0.09)	647

Notes: a) Ln K and ln L are natural logarithms of capital stock and labour respectively; b) Log L is the value of the log likelihood function, Rho is selection parameter; and N is the total number of firms; d) * indicates level of significance at 5 per cent; e) Figures in parenthesis are standard errors.

Table A4: Estimated production parameters, industry level, 1989-90 and 1994-95 (Informal Firms)

Industry	1989-90						1994-95					
	Constant	Ln K	Ln L	Log L	Rho	N	Constant	Ln K	Ln L	Log L	Rho	N
Food	7.66* (0.267)	0.16* (0.01)	0.21* (0.06)	-6301.2	-0.27 (0.53)	4146	6.67* (0.12)	0.33* (0.01)	0.54* (0.04)	-6791.8	-0.27 (0.10)	4993
Tobacco	8.65* (0.81)	0.04 (0.035)	-0.13 (0.16)	-558.7	0.78* (0.12)	386	9.1* (0.46)	0.036 (0.026)	0.007 (0.045)	-1570.9	0.55* (0.1)	1063
Textiles	7.63* (0.25)	0.17* (0.01)	0.13* (0.05)	-5712.5	0.99* (0.05)	4046	5.91* (0.06)	0.34* (0.005)	0.74* (0.02)	-8915.0	0.09 (0.08)	8969
Apparel	7.13* (0.84)	0.31* (0.07)	0.28* (0.23)	-462.51	-0.98 (10.65)	283	8.47* (0.38)	0.16* (0.04)	0.84* (0.1)	-411.32	0.64 (0.88)	371
Leather	7.78* (0.92)	0.17* (0.04)	0.25 (0.23)	-435.70	-0.44 (1.30)	292	6.98* (0.38)	0.35* (0.03)	0.77* (0.11)	-719.86	-0.60* (0.25)	551
Wood	7.94* (0.43)	0.15* (0.02)	0.35* (0.17)	-2009.27	-0.05 (0.65)	1323	7.98* (0.13)	0.21* (0.01)	0.73* (0.06)	-1853.07	0.36 (0.23)	1639
Paper	9.51* (1.79)	-0.004 (0.8)	0.90* (0.44)	-175.62	-0.52 (0.83)	113	6.09* (0.51)	0.32* (0.05)	0.95* (0.18)	-219.89	0.11 (0.38)	171
Publishing	7.26* (0.69)	0.18* (0.03)	0.31* (0.19)	-1075.93	0.14 (1.12)	708	7.29* (0.25)	0.27* (0.02)	0.74* (0.09)	-1074.20	0.12 (0.28)	979
Petroleum	-	-	-	-	-	0	6.54* (1.25)	0.32* (0.07)	0.72 (0.48)	-70.01	-0.12 (0.70)	48
Chemicals	6.84* (1.30)	0.22* (0.06)	0.49 (0.40)	-411.48	-0.28 (0.94)	268	5.33* (0.44)	0.44* (0.03)	0.99* (0.16)	-937.06	-0.57 (0.22)	541
Rubber	8.14* (1.11)	0.16* (0.05)	0.61* (0.30)	-500.14	-0.27 (1.13)	308	6.50* (0.36)	0.33* (0.03)	0.83* (0.15)	-819.11	0.15 (0.35)	566
Minerals	8.20* (0.64)	0.11* (0.03)	0.10 (0.22)	-850.93	-0.003 (0.75)	586	6.72* (0.18)	0.35* (0.01)	0.41* (0.06)	-2252.83	0.52* (0.11)	1435
Basic metal	8.48* (1.90)	-0.01 (0.09)	1.49* (0.68)	-288.10	-0.39 (1.01)	162	7.93* (0.49)	0.20* (0.04)	0.94* (0.29)	-377.65	0.13 (0.46)	223
Metal products	7.19* (0.45)	0.21* (0.02)	0.43* (0.11)	-2383.10	-0.04 (0.75)	1565	7.18* (0.12)	0.28* (0.01)	0.82* (0.04)	-2819.40	0.18 (0.16)	2546
Machinery	8.27* (0.43)	0.15* (0.03)	0.48* (0.18)	-1522.37	-0.09 (0.82)	1002	6.99* (0.18)	0.28* (0.02)	0.93* (0.07)	-1788.85	0.28 (0.18)	1527
Office machinery	28.27 (18.93)	-1.42 (8.85)	-0.34 (8.44)	-15.36	0.86 (6.52)	7	25.32 (32.73)	-0.96 (2.94)	1.03 (7.96)	-15.22	0.68 (12.00)	6
Electrical machinery	8.60* (0.91)	0.16* (0.06)	0.27 (0.36)	-309.33	0.001 (0.96)	192	7.38* (0.36)	0.24* (0.03)	1.03* (0.15)	-426.28	0.09 (0.30)	310
Radio & Television	11.30* (1.80)	0.09* (0.13)	-1.18 (0.83)	-57.40	0.96 (0.85)	35	5.35* (0.59)	0.45* (0.05)	0.94* (0.15)	-52.99	-0.99* (0.15)	39
Medical, precision inst.	10.49* (1.78)	0.01 (0.14)	0.99* (0.56)	-75.21	-0.50 (3.96)	56	6.28* (1.85)	0.31* (0.12)	1.01* (0.61)	-104.92	0.12 (0.73)	69
Motor vehicles	9.37* (3.33)	0.05 (0.31)	0.96 (0.60)	-23.94	-0.59 (4.14)	22	6.06* (0.77)	0.41* (0.06)	0.79* (0.21)	-138.08	-0.77 (0.73)	98
Transport equipment	10.09* (0.53)	0.12* (0.04)	0.28* (0.20)	-213.43	-1.00* (0.001)	144	7.83* (0.63)	0.23* (0.05)	0.92* (0.21)	-447.88	-0.01 (0.48)	300
Furniture	6.90* (0.37)	0.18* (0.02)	0.59* (0.10)	-3554.82	-0.22 (0.73)	2358	7.85* (0.10)	0.22* (0.10)	0.79* (0.04)	-3194.97	0.17 (0.17)	2992

Note: Shaded Industry is having very small number of informal firms; the estimates thus are not efficient. Hence the industry has not been considered for further analysis.

Table A5: Estimated production parameters, industry level, 2000-01 and 2005-06 (Informal Firms)

Industry	2000-01						2005-06					
	Constant	Ln K	Ln L	Log L	Rho	N	Constant	Ln K	Ln L	Log L	Rho	N
Food	6.61* (0.01)	0.34* (0.01)	0.74* (0.03)	-7842.5	-0.46* (0.07)	6188	4.19* (0.24)	0.26* (0.01)	1.27* (0.06	-5097.98	0.08 (0.09)	3475
Tobacco	7.22* (0.36)	0.31* (0.03)	0.18* (0.10)	-889.47	0.7* (0.18)	538	3.99* (0.87)	0.33* (0.07)	0.78* (0.33)	-116.47	-0.36 (0.64)	87
Textiles	5.79* (0.13)	0.37* (0.005)	0.93* (0.02)	-6995.6	-0.75* (0.03)	7482	3.82* (0.26)	0.33* (0.01)	0.74* (0.05)	-1991.68	0.08 (0.15)	1778
Apparel	7.07* (0.08)	0.27* (0.01)	0.96* (0.18)	-4435.96	-0.86* (0.17)	5582	3.97* (0.16)	0.27* (0.01)	0.94* (0.03)	-2437.32	0.45 (0.42)	2954
Leather	8.07* (0.35)	0.17* (0.02)	0.85* (0.06)	-794.31	-0.26 (0.17)	807	4.18* (0.65)	0.32* (0.04)	0.85* (0.14)	-370.79	-0.16 (0.24)	312
Wood	8.05* (0.08)	0.20* (0.01)	0.82* (0.05)	-2390.10	0.25 (0.19)	2638	5.69* (0.32)	0.14* (0.02)	1.09* (0.10)	-1311.09	0.13 (0.24)	1144
Paper	6.55* (0.27)	0.38* (0.02)	0.43* (0.10)	-448.97	-0.63* (0.20)	389	-0.51 (1.93)	0.64* (0.12)	1.65* (0.63)	-435.45	-0.04 (0.39)	195
Publishing	5.87* (0.17)	0.35* (0.01)	0.80* (0.05)	-1507.07	-0.01 (0.19)	1672	4.00* (0.58)	0.24* (0.04)	1.24* (0.14)	-979.56	0.14 (0.23)	681
Petroleum	14.49* (2.96)	-0.38* (0.18)	0.64 (0.89)	-90.43	0.50 (0.62)	46	2.56 (2.91)	0.42 (0.15)	1.01 (0.92)	-104.88	0.54 (0.59)	39
Chemicals	5.23* (0.37)	0.49* (0.02)	0.68* (0.16)	-1244.32	-0.36 (0.27)	691	-0.10 (1.05)	0.69* (0.05)	0.85* (0.30)	-1328.28	0.18 (0.20)	533
Rubber	6.59* (0.22)	0.35* (0.02)	0.78* (0.09)	-1035.66	0.09 (0.21)	912	1.66* (1.07)	0.46* (0.05)	1.71* (0.33)	-1089.19	-0.07 (0.23)	511
Minerals	7.33* (0.13)	0.32* (0.01)	0.42* (0.05)	-3629.75	0.41* (0.11)	2486	5.09* (0.47)	0.25* (0.02)	0.92* (0.13)	-4946.57	-0.07 (0.15)	1854
Basic metal	6.31* (0.27)	0.35* (0.02)	0.93* (0.12)	-568.39	-0.35* (0.25)	456	2.52* (1.30)	0.37* (0.07)	1.44* (0.47)	-630.86	0.16 (0.27)	267
Metal products	7.76* (0.08)	0.24* (0.01)	0.79* (0.02)	-3437.30	0.38* (0.04)	4184	4.25* (0.30)	0.28* (0.02)	1.07* (0.07)	-2629.71	0.14 (0.13)	2019
Machinery	6.49* (0.18)	0.31* (0.01)	0.99* (0.06)	-1812.91	-0.001 (0.15)	1662	2.61* (0.74)	0.35* (0.04)	1.71* (0.18)	-1355.56	0.17 (0.16)	745
Office machinery	5.37 (18.89)	0.42 (1.86)	1.51 (4.52)	-10.33	-0.71 (13.19)	11	16.96 (11.12)	-0.52 (0.95)	2.05 (1.64)	-30.72	0.57 (4.87)	14
Electrical machinery	6.44* (0.29)	0.35* (0.03)	0.98* (0.10)	-622.26	-0.20 (0.28)	524	3.02* (0.85)	0.33* (0.04)	1.97* (0.21)	-1140.86	-0.11 (0.18)	602
Radio & Television	3.15* (1.56)	0.92* (0.14)	-0.57 (0.35)	-105.72	0.99* (0.001)	56	3.31 (2.87)	0.39 (0.25)	2.82* (0.74)	-90.48	-0.10 (1.13)	40
Medical, precision inst.	8.57* (1.13)	0.27* (0.10)	0.38* (0.22)	-155.70	-0.99* (0.08)	120	1.33 (3.14)	0.52* (0.14)	1.61 (1.02)	-130.96	-0.03 (0.74)	65
Motor vehicles	6.62* (0.49)	0.28* (0.03)	1.08* (0.11)	-409.80	-0.38 (0.24)	358	3.91* (1.71)	0.28* (0.08)	1.53* (0.72)	-300.95	-0.25 (0.55)	150
Transport equipment	5.25* (0.66)	0.46* (0.04)	0.58* (0.17)	-330.74	-0.63* (0.13)	254	4.98* (1.64)	0.23* (0.11)	1.27* (0.47)	-338.44	0.12 (0.35)	163
Furniture	7.72* (0.08)	0.24* (0.01)	0.80* (0.02)	-3732.66	0.45* (0.10)	4624	5.27* (0.23)	0.22* (0.01)	0.91* (0.04)	-2763.44	0.09 (0.19)	2581

Note: Shaded Industry is having very small number of informal firms; the estimates thus are not efficient. Hence the industry has not been considered for further analysis

NOTES

[i] Duality in manufacturing can be defined in two ways –first, in terms of size of the two segments – formal and informal sector and second, in terms of heterogeneity in efficiency of the firms in the two segments (World Bank 2005).

[ii] The contribution of informal economy to GDP in Africa is as high as 59 per cent in Zimbabwe to 28.4 per cent in South Africa. The figures for Asia are 53 per cent for Thailand and 11.3 per cent for Japan. The contribution is highest in case of Georgia – 67.3 per cent (Schneider 2002).

[iii] Temple (2005) finds that lack of structural change that leads to the reallocation of labour from the low productivity 'backward' sector to the high productivity 'modern' sector is an important reason why there are international differences in aggregate productivity growth.

[iv] An early literature on dualism (e.g. Schmitz 1982) has taken the latter to mean significant differences in labour productivity between informal and formal firms. However, given that formal firms tend to be more capital intensive, it would be natural to expect that labour productivity in formal firms are higher than that in informal firms. Therefore, partial productivity measures are inherently problematic and it is preferable to use total factor productivity measures in the analysis of dualism.

[v] Though productivity growth is much broader than efficiency, as the former consist of change in technical efficiency as well as technological progress, in the present paper – we use the terms interchangeably.

[vi] As discussed later, we will estimate separate production frontiers for the two groups of firms - formal and informal sector firms. Moreover, for relative technical efficiency, a formal or informal firm in the industry is compared relative to the most efficient formal or informal firm in that industry. Given that formal firms are more likely to be capital intensive and informal firms more likely to be labour intensive, we allow for the possibility that production functions differ across formal and informal firms in the same industry (as well as being different across industries).

[vii] De Vries *et al*. (2012) find evidence of increasing dualism in the Indian manufacturing sector, using employment survey data rather than the firm-level data we use in this paper in the post-1993 period, though they do not explicitly test for the effect of reforms on manufacturing dualism.

[viii] A firm was classified as being in the small-scale sector if its investment in fixed assets in plant and machinery did not exceed a certain limit, and the limit was frequently changed over time.

[ix] In contrast, there were less significant reforms in factor markets that manufacturing firms operate in, such as reforms in land, labour and credit markets (Joshi 2010).

[x] Chari (2011) estimates that the license reform led to an aggregate productivity improvement of 22 per cent in the formal manufacturing sector, three-fourths of which can be attributed to the relaxation of entry constraints.

[xi] For an early application of SFA to the estimation of firm efficiency in developing countries, see Taymaz and Saatci (1997).

[xii] See Greene (2006, 2010) for details.

[xiii] Under Chapter VB of the IDA, labour courts and Tribunals can set aside any discharge or dismissal referred to them as not justified. In units employing more than 100 workers, retrenchment requires seeking authorization from the state government and this authorization is rarely granted.

[xiv] With respect to the possible endogeneity of the REFORM variable – that is, if the government is reforming more efficient industries first – there is a large literature that suggests that the choice of industries for de-licensing, de-reservation and trade reforms were largely exogenously determined by Indian policy-makers (see Chari 2011).

[xv] Data are in the form of repeated cross-sections, and not in panel form. This is because the Indian statistical agencies do not reveal the identity of the firm/plant in the unit level data, and for the informal sector, the same firms may not be surveyed in each round.

[xvi] We limit our analysis of informal firms to only those which hire outside labour, as there are serious limitations on the quality of data for family firms. One such limitation emanates from the very reason of these firms in business. Family firms (i.e. those which do not hire outside labour) are often in business simply because running a small enterprise allows them to bring in additional income with little additional effort and they are unlikely to expand or invest in their businesses (Banerjee and Duflo, 2008). As our interest is in those firms that

are likely to modify their behavior in response to policy changes, we confine our analysis to those informal firms that employ at least one hired worker.

[xvii] It should be noted that while the ASI data are available at the plant level, the NSS provides firm level data and not plant level data. However, in the case of the informal/unorganized sector, firms are by their very nature, single plant, so in essence, we are comparing plant-level estimates for the formal and the informal sectors. However, differences in sampling approach and conceptual modifications introduced to accommodate the need for improved data collection may affect comparability of NSS data over time as it may underestimate the number of own account enterprises in the sector (Saluja, 1988). As our study excludes own account enterprises from the purview of our analysis, it may not introduce significant bias in our results. See Kathuria *et al*. (2010) for detailed discussion on this issue.

[xviii] We have noted from the discussion in Section II that trade reforms also included major roll-backs and eventual withdrawal of import quotas. However, we do not include import quotas in our measure of trade reforms as we do not have industry data on quotas. Moreover, most of the quotas were dismantled in 1991, while tariff reforms occurred all through the 1990s and early 2000s.

[xix] The only plausible explanation for this result can be given by looking at the nature of input requirement for the sectors. Since both the sectors were reserved for the small-sized firms and tobacco firms are required to be closer to the input also. In that case, firms' decision may be more governed by the high tobacco cultivation or availability of raw material for chemicals than by labour regulation as such.

[xx] Absolute efficiency is defined as the ratio of the observed output (y_i) of the firm to the potential output ($\hat{y}$) derived by the frontier function,$TE_{i,t}=y_{t,i}/\hat{y}_t$, where $TE_{i,t}$ is technical efficiency for industry i and year t. Relative technical efficiency (RTEi,t) is defined as the difference between the maximum absolute efficiency obtained in a given industry for a given year and the actual absolute technical efficiency relative to the maximum absolute efficiency in that industry and year i.e., RTEi,t = (TEmax,t – TEi,t)*100/TEmax,t.

[xxi] It should be noted that the coefficient on the formal sector dummy variable is negative and significant in Col. (1) in Table 7 (and in Cols. (2) and (3)) which is different from the results obtained on this variable in Table 6.

[xxii] Goldberg *et al*. (2010) find little evidence of product rationalization and creative destruction that accompanies economic reforms in the case of the Indian manufacturing sector. This is in contrast to the other developing countries where much of the increases in productivity accompanying economic reforms is due to a re-allocation of productivity within industries from the exit of less productive firms and the entry of more productive firms (Alvarez and Vergara 2010).

[xxiii] We use the residuals obtained by regressing actual firm level absolute and relative technical efficiency against industry and year dummies as the estimates of absolute and relative technical efficiency in Figure 6. This was done to control for differences in efficiency across firms that originate from industry specific characteristics and cyclical factors.

[xxiv] We also used weighted tariff instead of simple tariff as a measure of trade reforms. Our results did not change, indicating the robustness of the results to different measures of tariffs.

[xxv] Our finding of an increase in within industry inequality in efficiency across firms following de-licensing is similar to the finding of Aghion *et al*. (2005) that within industry standard deviation of labour productivity and total factor productivity increased in industries that were de-licensed in India in the mid 1980s and early 1990s. Their finding is based on data on formal manufacturing alone, while our results show that within industry inequality in efficiency levels increased for both the formal and the informal manufacturing sector.