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Zahid Gulzar Rather**

ISID **Institute for Studies in Industrial Development**
An institution of Indian Council of Social Science Research (Ministry of Education)

4 Vasant Kunj Institutional Area, New Delhi – 110 070

Phone: +91 11 2689 1111 | E-mail: info@isid.org.in | Website: <https://isid.org.in>

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Abstract: Indian economy is categorized as one of the fastest growing advancing economy. Much of the growth has been attributed to the industrialization process post-independence especially after economic reforms of 1990s. . However the formal industrial sector has been unable to absorb the growing labor force and thus majority of labor force have been forced to derive and find self-employment options in the informal sector. The current study is an attempt to analyze the Indian industry in light of this formal and informal bifurcation. Using the Stochastic Frontier Analysis, the production functions are validated and technical efficiency (TE) predicted. The study reveals that the formal industrial sector in India is relatively efficient. However, the informal sector, apart from absorbing higher number of labor force, is performing better than dictated by hitherto classic theoretic predictions. The study also analyzes the factors influencing the TE of the formal and informal sectors. The study concludes that the formal and informal sectors mutually reinforce the industrial growth in India, have positive linkages and contribute efficaciously to economic outcomes like output and employment.

Keywords: Formal Sector, India, Industry, Informal Sector, Technical Efficiency

JEL Classification: D21; O14; O17

1. Introduction

Following the experiences and outcomes of the developed world, the developing nations associate the growth of industrialization process with long run sustainable economic development. The economic growth driven by industrialization is further characterized by a structural change. By moving the economy from low-productive sectors to high-productive and efficient sectors, the industrialization process alters the social, political and economic dynamics of a society/population towards a positive and sustainable growth progression (Guadagno, 2003). However, a direct application of the experiences of the developed world cannot be copied and pasted into the current policies and practices of the

* Mehak Majeed (Corresponding Author), Faculty, Department of Economics, Islamic University of Science & Technology, J&K, India, dhaarmehak.scholar@kashmiruniversity.net & dhaarmehak_vs@isibang.ac.in; Saeed Owais Mushtaq, Faculty, Department of Economics, University of Kashmir, saedowais.scholar@kashmiruniversity.ac.in; Zahid Gulzar Rather, Assistant Professor, Department of Higher Education, J&K, zahideco46@gmail.com

developing nations. The developing nations have started their journey of independence and welfare governance roughly after the end of the Second World War (1945 onwards). Most of these nations sought to go for the planned national development (Slater, 1975). The delivery of the expected outcomes failed at certain levels. The evidence for the same can be quoted from across the globe, for example, studies like (Clark, 2008; Han, 2020; Haqqani, 2006; McLaren & Cop, 2011; Rao et al., 2017) among many others. People continuously moved out from agriculture but the industry failed and proved to be inadequate in absorbing all of this surplus labor. As a result of which people in the developing world were left with the option of finding self-employment ventures. Necessity and compulsion forced people into petty economic activities the sum total of which is referred to as the informal sector (Gurtoo & Williams, 2009). As such the current economies of the developing world has starkly bifurcated in-to (a) the formal sector and (b) the informal sector.

Though there exists vast ambiguity over a well-defined, formal and globally accepted definition of the formal and the informal sectors in the economic literature, there is a general unanimity of thought that the registered economic units are a part of the formal sector economy while the un-registered economic entities belong to the informal sector (Desai, 2011). Though the neo-classical school of economic thought has associated economic growth and sustainable development with the formal sector of the economy (De Paula & Scheinkman, 2007; Ghose, 2017; Pratap & Quintin, 2006), the developing world has been growing on its own indigenous patterns. Self-employment has been pulling more and more people into the informal sector as the formal sector has been failing to absorb the ever increasing labor force in the developing world.

One of the major questions arising from this observed digression to development manifested by the developing nations including India is whether the informal sector in the developing world is contributing positively to the economic outcomes or is it a negative sub-sector of the economy that needs to be disfranchised and halted to grow any further. The present study is an attempt to simultaneously understand the economic status of formal and the informal sector(s) in terms of efficiency of the Indian economy at a point in time. The Stochastic Frontier Analysis is used as the econometric approach towards the understanding of the same. India being a large nation, the largest democracy of the world and having the second largest population as a country is a strong case to understand the nature of the formal and informal sectors of the (Indian) economy. At the same time, it is a perfect fit to open up the debate about the simultaneous existence of the formal and the informal sectors. Therefore, the present study first analyzes some descriptive statistics pertaining to the formal and the informal sectors of the Indian economy. After the preliminary analysis is made, the study estimates the stochastic frontier production functions for the two sectors and predicts the technical efficiency of the firms. The findings of the study bring forth some features of the two sectors and validate a positive and constructive presence and contribution of the informal sector in the Indian economy alongside the formal sector. The regression analysis in the study highlights the factors

contributing positively and negatively towards the TE of both the formal and informal sector in order to arrive at better policy recommendations.

The manuscript is divided into five sections. Section 2 briefly discusses the Indian industry in light of the formal and informal sub-sectors. This is followed by data and methodology summed up in section 3. The results and discussions of the current study are presented and analyzed in detail in section 5. The study is concluded in section 5 and the policy recommendations following the analysis are presented therein.

2. The Formal and Informal Sub-Sectors of the Indian Economy

Based on the government monitoring and regulations an economy can broadly be classified into the formal and the informal sectors. The economic activities directly monitored, regulated and taxed by the government fall under the formal sector. The formal sector economic entities are registered with the relevant public sector authorities. On the other hand all the economic activities falling outside the monitoring of the government are categorized under the informal sector of the economy. The formal sector of the economy directly contributes to the Gross Domestic Product (GDP, henceforth) of the economy while the contribution of the informal sector remains hidden and unknown (Guha-Khasnobis & Kanbur, 2006; Majeed & Mushtaq, 2022a). The traditional neo-classical theory pins the tasks of economic growth and development to the formal sector. It associates the informal sector with poverty, exploitation and under-development thus putting a case for curbing the informal sector in order to endorse growth and development (Gibson & Kelley, 1994). However, at a practical level the formal and the informal sector of an economy are closely linked and cannot operate in isolation from one another. There are direct and indirect linkages running through the formal and the informal sectors of an economy. On the same lines at a disaggregated sectorial level, the secondary sector of an economy can be classified into (a) formal sector industrialization and (b) informal sector industrialization.

The Indian economy is considered to be one of the leading nations among the emerging economies of the modern day world, especially in the South-East Asia. The 21st century has been seeing a growing potential and increase in the output and global market presence of the Indian economy (Bosworth et al., 2007). The major reforms of 1991 in the Indian economy, termed as the ‘New Economic Policy’ (LPG¹ henceforth) opened up the economy (Anand, 2014). Initially the LPG helped in raising the vital economic parameters of the Indian economy but soon the global recession depressed these parameters. The economic outcomes during the first decade of the 21st century again took-up with a decadal growth rate of approximately 10% (Rye & Jackson, 2020). The global financial crisis that hit the world in 2008 clearly impacted the Indian economy given the openness. At the sectoral level, the Indian economy has been witnessing a huge structural shift over time. The

¹ Liberalization, Privatization and Globalization

sectoral structure, GDP contribution and employment generation capabilities have been changing between the primary, secondary and tertiary sectors (Sastry et al., 2003). However the structural change has been unbalanced as validated by data and studies like (Aneja et al., 2021; Majeed et al., 2022; Saikia, 2011; Solanki et al., 2020) among many others. With the shrinking of the primary sector, the services sector has been taking over and the secondary sector has been lagging behind. A balanced growth between the three sectors with a declining share of agriculture and growing share of industry and later on in the advanced stage of development, a takeover by the services sector is the established path to sustainable growth and development (Acemoglu, 2012; Aghion et al., 2014). As such, the Indian economy is seen to be marching towards an unsustainable growth path where the industrial sector is highly lagging behind to support the sustainability and inclusive growth.

There has been a long void and confusion in defining the formal and the informal sector of the Indian economy. No particular and unique definition has been in vogue stating clearly as to what is meant by the formal and the informal sectors (particularly in the context of the Indian economy)². Therefore, the current study uses the definitions of the formal and the informal sector as put forward by the Annual Survey of Industries (ASI, henceforth) and the National Sample Survey Organization (NSSO, henceforth). The ASI classifies all the factories registered under (*The Factories Act*, 1948) as the firms falling under its coverage. Therefore based on the status of registration such units are categorized as the formal sector firms. On the other hand NSSO defines all the firms not registered under (*The Factories Act*, 1948) as the informal enterprises, therefore, describing the informal sector under study ((NSS) & (GoI), 2016). The understanding of the Indian economy in the current research is limited to the pre-pandemic period. One of the main reasons for it is the data deficiency. Both the ASI and the NSSO data-sets haven't been updated latest after 2018 and 2016, respectively. Therefore, the current study intends to provide a broader framework of affairs pertaining to the Indian Economy's formal and the informal sectors based on 2015-2016 surveys. This way a comparative analysis can be carried out between two sectors.

3. Data and Methodology

The present study is based on two secondary level cross-sectional data-sets. The formal sector of the Indian economy is analyzed using the latest round of Annual Surveys of Industries (ASI) data (2015-16). The year of the study is chosen in light of the latest data availability and a direct comparability with the informal sector firms. The informal sector accordingly is analyzed using the latest available NSSO data wave of the 73rd round (2015-

² The government of India has loosely been following the IMF's definition of the formal and informal sectors which is motivated by the fiscal aspects. The aim of this definition is to bring more and more units under the tax-paying regimes. On the other hand, the developmental economists consider equitable development to be the defining feature of the same.

16). Taking two cross-sections at a point in time across the formal and the informal sectors of the Indian economy makes the comparison plausible.

Some basic descriptive statistics are presented and analyzed to understand the broader characteristics of the formal and the informal sectors of the Indian Economy. This is followed by a detailed econometric analysis. The econometric strategy applied for the analysis of the study is the Stochastic Frontier Analysis (SFA, henceforth). The concept of SFA was first of all given and empirically validated in 1977 by two independent studies of (Aigner et al., 1977; Meeusen & Broeck, 1977). Since then the methodology of SFA has been improvised over time and enhanced in appeal and applications. The Stochastic Frontier Production Frontier (SFPF, henceforth) postulates the presence and existence of some technical inefficiency (TE) in the production processes undertaken by the firms. The estimation is carried out in a two steps. First the SFPF is estimated and TE is predicted. In the second step a regression analysis is carried out to determine various factors affecting the (in)efficiency in the production process. The present study is based on the (Battese, G.; Coelli, 1995) The general form of the model is given in equation 1 and the technical inefficiency effects in equation 2;

$$Y_i = \exp(x_i\beta + V_i + U_i), U_i \geq 0 \quad \dots 1$$

and

$$U_i = z_i\delta + W_i \quad \dots 2$$

The output at a point in time produced by a firm is given by Y_i . The $(1 \times k)$ vector of explanatory variables is denoted by x_i and the $(1 \times k)$ parameters to be estimated are denoted by β . The random error term V_i is assumed to be independently distributed by the inefficiency term which is given by U_i . U_i is a non-negative random variable obtained by truncation of the normal distribution (at zero) with 0 mean and σ^2 variance.

The prediction of the TE is based on its conditional expectation as given in the assumption of the model. TE of the i^{th} firm is defined in equation 3 as;

$$TE_i = \exp(-U_i) = \exp(-Z_i\delta - W_i) \quad \dots 3$$

The SFPFs to be estimated for the formal and the informal sub-sectors are given in equations 4 and 5 respectively as;

$$ly_{Fi} = \alpha_i + \beta_1 lcapi_i + \beta_2 llabo_i + \beta_3 lramat_i + u_i + v_i \quad \dots 4$$

and

$$ly_{INFi} = \alpha_i + \beta_1 lcapi_i + \beta_2 llabo_i + \beta_3 lramat_i + u_i + v_i \quad \dots 5$$

The estimation of the model is based on the Cobb-Douglas SFPF as validated in the next section by proper model testing. Equation 4 depicts the SFPF for the formal sector and

equation 5 represents the SFPF of the informal sector firms. The log value of the output produced by the firms in the formal sector is depicted by ly_{Fi} for the formal sector and as ly_{INFi} for the informal sector. The input values in the production function include capital ($lcapi_i$), labor ($llabo_i$) and raw-materials ($lramat_i$). Based on the results of the SFPF, the Technical Efficiency of the firms is predicted across both the sub-sectors. TE of a(ny) firm ranges between 0 (complete technical inefficiency) and 1 (complete technical efficiency). In the next step of the ‘two step SFA model’, a regression analysis is carried out to empirically validate and determine the factors influencing technical (in)efficiency among the firms. Given the truncated nature of the TE and its specification of being a latent variable, Tobit regression analysis is used in line with the empirical specifications given by (Aigner et al., 1977; Battese, G.; Coelli, 1995; Bezat & Relations, 2010) among many others. The Tobit regression equations to be estimated for the formal and the informal sub-sectors in India are presented in equations 6 and 7;

$$u_{Fi} = \delta_i + \delta_1 l_{k_i} + \delta_2 l_{pc_i} + \delta_3 l_{sup_i} + \delta_4 l_{wd_i} + \delta_5 D1_i + \delta_6 D2_i + w_i \quad \dots 6$$

and,

$$u_{INFi} = \delta_i + \delta_1 l_{ko_i} + \delta_2 l_{py_i} + \delta_3 l_{ec_i} + \delta_4 D1_i + \delta_5 D2 + \delta_6 D3_i + w_i \quad \dots 7$$

In equation 6, l_{k_i} is the logged value of the capital used in the production process. The use of capital is associated with efficient production processes and better firm outcomes. As such, capital is an important variable to be accounted for, while analyzing the determinants of TE especially in the formal industrial sector. The direct and indirect costs borne by a firm during the production process are known as the production costs. By establishing regular supply chains and bulk buying firm gain an advantage in decreasing the production costs. To validate the impact of such costs on the TE of the firms the variable l_{pc_i} is analyzed. The proxy for entrepreneurship in the analysis is taken as the amount of money spent on the supervisory staff, l_{sup_i} . The number of working days registered during an accounting year by the firm are estimated using the variable l_{wd_i} . D1 is the binary dummy (taking value =1) for the firm specific Research & Development (R&D, henceforth) unit existing within the jurisdiction of the firm. D2 is a binary dummy of ownership. It equals 1 if the firm is an ‘individual proprietorship’ and 0 otherwise. This variable is taken as a proxy for timely decision making in the firm as the power to decide lies in one hand (i.e. the owners).

For the informal sector, as presented in equation 7, the explanatory variables include l_{ko_i} , which is the logged value of the capital owned by the firms. As explained in the latter part of analysis, informal firms are marginal firms and any amount of capital owned by them is used to the best to their capacity, as explained in detail in the next section. The informal sector has been notoriously infamous for working with unpaid labor. The change in trend has been modeled in the current analysis using the variable l_{py_i} , which represents the sum total of payments made to labor by the firm(s) operating in the Indian informal sector. The energy accessibility of the sector is determined by l_{ec_i} , which is the value of electricity

used in the production process. Three binary dummies used in the analysis of the TE in the informal sector include, D1, representing male ownership, D2, is the 'own account enterprises' and D3, presents the main problem faced by the enterprise. D3 takes value =1 if the main problem faced by the firms is 'decrease in demand for the output produced by the firm' a proxy for market failure. The variables have been explained in detail in the next section.

4. Results and Discussions

4.1. Descriptive analysis

The total number of firms under studies both in the formal and the informal sector(s) are presented in table 1. The number of firms under study in the informal sector is much larger than the number of firms in the formal sector. It is an observed fact that the informal sector is the major employment provider in the Indian economy (ILO, 2018). However, even after repetitive attempts of the NSSO, the true nature and magnitude of the informal sector in the Indian economy remains hidden till date (Naik, 2009). The sample size of the current study again bears testimony to the existence of a larger informal economy in India.

Table 1: Firms under Study

<i>Sector</i>	<i>Observations</i>
Informal Sector	141,744
Formal Sector	65,110
Total	206854

Source: Author's compilation from ASI and NSSO data

The states with a larger sample size are the states with maximum number of firms. Table 2 ranks the states of India in terms of maximum number of units. In order to maintain the precession, the ranking has been limited to top ten across both the formal and the informal sectors. 14% of the total firms located in the Indian formal sector are situated in Tamil Nadu itself. This is followed by Gujarat and Maharashtra. All three of these states are designated Special Economic Zones (SEZs henceforth) (Sampat, 2008). The SEZs act was enacted by the UPA government in 2005 in order to boost the economic development of the country. SEZ promotion and development is the government's way of endorsing corporate-led economic growth. Though it comes with its costs and benefits, SEZ declaration of a certain place/region does yield positive outcomes in terms of growing industrialization (Ramachandraiah & Srinivasan, 2011). Other states in the table are large in terms of geographic area and population and thus reflect a considerable share of industrialization pan-India.

In the informal sector, Uttar Pradesh tops the list of hosting informal sector enterprises. The rank of informal sector units correspond the size of the state in terms of population.

Larger the state, greater is the magnitude of the presence of the informal sector. Empirical literature from the developing nations including India validates the policy failure to generate adequate employment in the public and formal sectors (Aruoba, 2010; Dhakal, 2020; Meagher, 2010; Rothenberg et al., 2016). This pushes people into petty and small economic activities in order to maintain sustenance and subsistence (Grimm et al., 2011). It can be seen from table 2 that informal sector is considerably present across India and each state has a considerably large informal sector.

Table 2: Top 10 States in Terms of Number of Units

<i>Rank</i>	<i>State</i>	<i>Percent (Formal Sector)</i>	<i>State</i>	<i>Percent (Informal Sector)</i>
1	Tamil Nadu	14.14	Uttar Pradesh	9.66
2	Maharashtra	11.44	Tamil Nadu	7.74
3	Gujarat	9.27	West Bengal	6.99
4	Uttar Pradesh	7.56	Maharashtra	6.82
5	Karnataka	5.7	Madhya Pradesh	5.91
6	Andhra Pradesh	4.92	Kerala	4.87
7	Rajasthan	4.44	Rajasthan	4.57
8	Punjab	4.19	Karnataka	4.55
9	Telangana	4.16	Andhra Pradesh	4.4
10	Haryana	4.08	Bihar	4.36

Source: Author's compilation from ASI and NSSO data

Table 3 is based on the four-digit NIC³ classification of the firms. It sums up the dominant type of firms in-terms of the nature of the activities undertaken by the firms. The formal sector across the country is dominated by the brick industry. Given the status of development across the nation in light of the fact that construction sector is contemporarily a very large sector in itself. Studies like (Keniston, 2021), quote the statistics highlighting the dominant nature and dense presence of the bricks manufacturing sector across India. Analysis like (Rivera et al., 2016) and the forecast reports like '(Economics, 2015) clearly predict a longer run dominance of construction related industries across the sub-continent including India.

Maintenance and repair of motor vehicles industry is placed at second number among formal industries. In terms of market size, India has the fourth largest automobile sector at the global level in terms of market size (IBEF; & Foundation, 2021). By its very nature, the motorized vehicles need maintenance in terms of vehicular health, longevity and human safety. As such a forward linkage is created with the need and scope for the motorized vehicles need and repair. Another industry growing due to a forward linkage of the Indian auto-industry is the manufacturing of motor vehicles part and accessories, which ranks 6 as per the current analysis. The related industry motorized road freight transport is ranked

³ National Industrial Classification is a classification code maintained in India in order to statistically classify the business units across the country and maintain a common standard.

ranked 6th in informal enterprises. As such, this industry has grown in India in both formal and the informal sub-sectors (Jain et al., 2020).

Table 3: Dominant Firms as Per NIC Classification

<i>Rank</i>	<i>% Formal Sector Units</i>	<i>% Informal Sector Units</i>	<i>%</i>
1	Manufacture of bricks	3.5 Custom tailoring	8.84
2	Maintenance and repair of motor vehicles	2.83 Retail sale of cereals and pulses, tea, coffee, spices and flour	5.35
3	Rice milling	2.67 Restaurants without bars	4.3
4	Manufacture of all types of textile garments and clothing accessories	2.12 Hairdressing and other beauty treatment	3.51
5	Cutting, shaping and finishing of stone	2.04 Retail sale in non-specialized stores with food, beverages or tobacco predominating	3.08
6	Manufacture of diverse parts and accessories for motor vehicles	1.89 Motorized road freight transport	2.64
7	Preparation and spinning of cotton fiber including blended cotton	1.86 Taxi operation	2
8	Manufacture of Bidi	1.63 Retail sale of fresh or preserved fruit and vegetables	1.82
9	Manufacture of plastics products	1.57 Manufacture of furniture made of wood	1.8
10	Manufacture of other fabricated metal products	1.28 Tea/coffee shops	1.68

Source: Author's compilation from ASI and NSSO data

The dominance of rice mills is explained by the fact that the staple food of 65% of Indian population is rice. From North to South, people consume rice in different ways and therefore rice mills are found pan-India. The findings of Table 3 validate the prevalence of such firms in the formal sector across India. NSSO data shows that the rice mills simultaneously do exist in the informal sector as well but the dominance is in the formal sector where the mills are duly registered and are answerable for quality checks and control.

Predominantly in the informal sector goods and services needed and provided at a more localized level dominate the sector. Around 09% of the informal sector units deal in custom tailoring of all sorts. The tailoring industry in the Indian informal sector hasn't received much attention till date. Previous empirical research like (Regel & Pilz, 2019) give some basic rudimentary insights into the Indian informal tailoring sector. In a unique attempt, (Rekha & Sadhana, 2014) while undertaking a primary study of young adults in India reveal that most of them prefer tailor made custom clothes instead of ready-made garments. Given the diversity of body type and traditional clothing across India, people (both male and female) prefer to get their clothes made locally. The study reveals that they find it comfortable, cheap, creative and culturally viable. As such the (custom) tailoring industry overall dominates the informal sector in India. The table also reveals the

dominance of 'kiryna'⁴ and daily utility shops across India. Such shops are found across the whole country in every locality. Recent studies like (A. Kumar & Khan, 2020; Lupane, 2019a) highlight the presence and importance of these shops across the country in meeting the daily household needs of the common masses. The rest of the table also reveals the localized nature of the dominant activates across the country.

Table 4 : Hypothesis Testing

<i>Sector</i>	<i>Serial No.</i>	<i>Null Hypothesis</i>	<i>Log Likelihood Statistic</i>	<i>Decision</i>
Formal Sector	1.	$\sqrt{b1} \neq 0$	101.01	Reject
	2.	$\mu \neq 0$	20.86	Reject
	3.	$\gamma = 0$	0.41	Reject
	4.	$ll * li = 0$ $ll^2 = 0$ $li^2 = 0$	0.35	Reject
Informal Sector	1.	$\sqrt{b1} \neq 0$	132.11	Reject
	2.	$\mu \neq 0$	18.13	Reject
	3.	$\gamma = 0$	0.38	Reject
	4.	$ll * li = 0$ $ll^2 = 0$ $li^2 = 0$	0.40	Reject

Source: Author's estimation from ASI and NSSO data using (Kodde & Palm, 1986)

4.2. Stochastic Frontier Production Function Analysis

In order to validate and justify the use of econometric strategy employed to empirically validate the formal and the informal sectors of the secondary sector of the Indian economy, table 4 reports the results of the hypothesis testing. The absence of skewness in the OLS estimation is tested by the first null hypothesis. The residuals are predicted by running the OLS regression on the variables of interest. The presence of skewness is validated by plotting a subsequent histogram and the presence of negative skewness is established. These findings are consistent with the specification of the production function to be employed in the current analysis. As such the null hypothesis is rejected. To further strengthen this justification, the Schmidt and Lin's $\sqrt{b1} / sktest$ is conducted in Stata. The presence of skewness is further validated by the results equaling 0.00. Rejection of the null hypothesis points to the biasness of OLS estimates paving grounds for the use of a stochastic model specification.

A truncated half-normal distribution is specified for the error term in the (Battese, G.; Coelli, 1995). Hypothesis two is tested against the presence of this one sided inefficiency term. Given the log-likelihood value presented in table 4, this hypothesis is rejected. The validation of technical efficiency in the model establishes the distribution of the technical

⁴ Small retail household utility shops

efficiency as that of truncated half-normal. (Battese, G.; Coelli, 1995) in their model specify that this distribution is most close to reality. To check for the stochastic nature of the inefficiency term, the third null hypothesis is set to find the value of gamma. Since the value of gamma in both the cases ranges between 0 and 1, the null hypothesis is strongly rejected, validating the stochastic effects in the model. The model specification of the stochastic frontier production function is determined by the fourth null hypothesis. The hypothesis validates the use of Cobb-Douglas specification over the trans-log production frontier. The values of the log-likelihood derived from the hypothesis testing are validated using the (Kodde & Palm, 1986) table.

Table 5: Mean of variables used in SFPP

	<i>Variable</i>	<i>Mean</i>
Formal sector	Output	1080000000
	Capital	446000000
	Wages	47400000
	Raw Material	476000000
Informal sector	Output	144769.2
	Capital	280427.2
	Wages	17800.98
	Raw material	86441.53

Source: Author's compilation from ASI and NSSO data

Table 5 sums up the descriptive statistics used for the estimation of the stochastic frontier production function for both formal and the informal sectors. The table clearly reflects the lower mean value of the variables in the informal sector as compared to the formal sector. All the variables in the table are expressed in monetary terms (Indian rupees). The minimum value of the input variables is zero across both the sectors. At any point in time there are some firms that due to technical issues or some short-run reasons do not operate at a point in time therefore the value registered across such variables is zero.

The results of the stochastic frontier analysis are presented in table 6. The elasticity of output with respect to labor keeping all other inputs constant is high in the formal sector as compared to the informal sector (0.55 and 0.13). The variables are both positive and significant. It is an established fact that the industrialization process in India is mostly labor intensive. Wide array of empirical evidence ranging from (S.P.Kashyap, 1988) through (Das & Kalita, 2009) to (Gupta & Helble, 2021) among others have been validating the labor-intensive nature of the Indian industry. The genesis for the same can be found in the (Lewis, 1954) model of surplus labor in the third world. The way to industrialization in the developing world is found through successfully pulling out the surplus labor from the traditional (mostly informal) sector and gainfully employing the same in the formal sector. Although potential of moving the surplus labor from traditional informal sector to formal sector has remained high, India's policy makers, however, has not been able to make a large and gainful transformation ((Majeed & Mushtaq, 2022b; Nagaraj & Kapoor, 2022).As a result a differentiated and layered labor market developed over the years in the country.

In order to maintain subsistence, people were forced into petty activities all categorized as informal breeding squalor and poverty (Grimm et al., 2011).

Table 6: Stochastic Frontier Analysis

	(Formal Sector)	(Informal Sector)
	<i>ly</i>	<i>ly</i>
Frontier		
ll	0.551*** (0.00501)	0.134*** (0.000678)
lk	0.0632*** (0.00262)	0.0165*** (0.00110)
lrm	0.0303*** (0.00378)	0.322*** (0.000969)
_cons	8.797*** (0.0600)	7.629*** (0.0125)
Usigma		
_cons	0.775*** (0.0091)	0.648*** (0.00713)
Vsigma		
_cons	0.744*** (0.00567)	0.681*** (0.00667)
N	65,110	141744

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Author's compilation from ASI and NSSO data

The lower elasticity of labor with respect to output (0.13) in the informal sector points to the fact that the informal sector in India is not labor intensive. The findings need to be interpreted with caution. Most of the firms located across the informal sector are the 'own account enterprises' (self-employed but not employing hired labor) (Bhattacharya & Kesar, 2018a). And at the same time, most of these enterprises are always working on the margin, struggling to survive (Nagaraj & Kapoor, 2022). As such, in the own account informal enterprises the owner works him/herself in the business units (like in the case of *Kirana* shops as mentioned by (Lupane, 2019b) and hires some family, apprentice or unpaid labor at times of need. The marginalized nature of the informal enterprises doesn't allow it to expand much and thus the need to hire (extra) labor remains stunted.

The coefficient of capital is low in the formal sector (6.3%) while as very low in the informal sector (1.6%). As also depicted by the descriptive statistics, the mean value of capital for the formal sector firms pan India is Rs.44.6 crores, it is only Rs.28 lakhs in the informal sector. These coefficients starkly vouch for low capital intensity across the formal sector and the existence of an almost capital-less informal sector. Empirical literature highlights a unique trend prevalent in the Indian industry. Some manufacturing industries like the

auto industry, FMGCs⁵, the IT sector among others are found to be highly capital intensive (Hasan et al., 2021; Madhani, 2014; Saji & Eldhose, 2017). While other sectors like the construction industry, vehicle repair and maintenance industry and other units producing simple consumer durables are found out to be less capital intensive by their very nature (Robertson et al., 2009). In case of India as highlighted in table 3, the latter industries dominate the Indian secondary sector, most of them falling under the MSMEs category. At an aggregate level the dominance of the latter group of industries pan India characterizes the Indian industry as one using the least capital. These findings validate a self-sufficient mature of the industrialization process in India in terms of technology use and innovation. Low capital intensity vouches for a sustainable competitive advantage accruing to the firms, as also highlighted by two recent studies by (Hasan et al., 2021; Majeed et al., 2021a).

The informal sector by its very nature and characteristics is associated with petty and simple production, using the least of human or physical capital (Papola, 1980). The coefficient presented in table 6 confirms the low elasticity of output with respect to (physical) capital in the informal sector. Empirical evidences like (De Paula & Scheinkman, 2007), confirm the high-cost of capital accruing to the informal firms. Even if these units want to get capital-intensive in their production processes (simultaneously increasing their productivity), they are limited by a number of considerations like; small size, lack of fixed premise, lack of existing assets to serve as collateral and a generally inaccessible financial market (Amaral & Quintin, 2006a; Pratap & Quintin, 2006). As such the informal firms are crippled in their small size and the vicious cycle of low productivity keeps them from attaining better outcomes. Some recent studies like (Daniel, 2021; Manyati & Mutsau, 2019; Mhando, 2018) among many others establish the fact that a substitution of physical capital with that of the unskilled labor prevalent in the informal sector has the potential to increase the output and productivity of the sector. As such, the existing capital usage of the informal Indian industry in itself vouches for low levels of productivity and efficiency.

It is an established axiom that materials fuel the economic growth (Wrigley, 1962). Nature, quality and availability of the raw-materials are one of the most important input variables in a production function. A sustained industrial growth depends on a steady supply of raw materials (Salgueiro et al., 2010). The coefficients in the table show a positive and significant relationship between the output and the raw-materials used in the production process. The coefficient is 0.03 for the formal sector. The small value needs a careful interpretation in light of the fact that the value of other inputs like labor and capital is very high in the formal sector. As such the output elasticity in the sector is considerably low with respect to the input of raw-materials. The same coefficient is substantially high for the informal sector, equaling 0.32. One of the fundamental reason is the simple production process and little value addition made during the process (Pratap & Quintin, 2006). The production of output in the informal sector in India depends mostly on the raw-material.

⁵ Fast Moving Consumer Goods like soft drinks and fast-foods have a limited shelf life

The sector already uses least capital and labor and thus the main input in the production process is the raw-material itself.

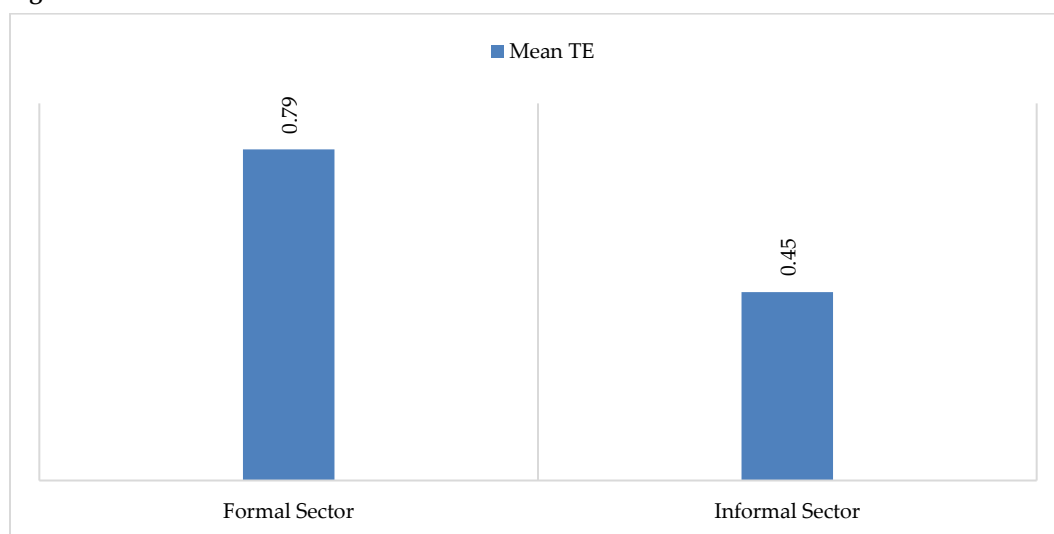
4.3. Technical Efficiency (TE) Analysis

Table 7 : Mean Technical Efficiency

<i>Sector</i>	<i>TE</i>	<i>Std. Dev.</i>	<i>Min</i>	<i>Max</i>
Formal Sector	0.79	0.09	0.03	0.97
Informal Sector	0.45	0.19	0.02	0.92

Source: Author's compilation from ASI and NSSO data

Figure 1: Mean TE of Formal and Informal Sectors



Source: Table 7

Based on the estimation of the stochastic frontier production function for both the formal and the informal sectors, the mean technical efficiency of the firms is predicted. Table 7 and Figure 1 present the values of the same. It can be observed that the mean technical efficiency of the formal sector at an aggregate level in India is 79%. The informal sector in India has a mean technical efficiency level of 45%. Though still far from high performing nations where the mean TE of the firms ranges between 90% and 98%, Indian formal sector is doing considerably well. An important consideration to be taken care of is the fact that the current study takes an aggregate of the firms from the sample. It is an established fact in the understanding of the industrialization process that some firms by their very nature are more efficient as compared to other firms (Amsden, 1994). As such the TE outcomes are deemed to vary at industry level. The same can be validated from the ranking of the top and bottom five firms across both the sub-sectors as presented in Table 8. At an aggregate level, however, it all clusters around the mean value. The TE of the informal

sector is considerably good given the fact that the sector has been operating on its own for decades at a stretch without any intervention and execution from the government. Despite its low use of capital and skilled labor the informal sector with its bulk of unskilled and semi-skilled labor force has been performing well. (Nagaraj & Kapoor, 2022) in their latest article contemplate the linkages and mutually reinforcing growth of the formal and informal sector. Using the PLFS⁶ data, the duo establish the fact that 63% people in the informal sector are self-employed in India. In yet another detailed study, (Nagaraj, 2015) points out to the development of these linkages through, (a) labor markets and (b) product markets. The formal sector in India steadily started to buy semi-finished inputs and labor-intensive output from the informal sector boosting its potential and growth. This sub-contracting has been getting denser by the passing day increasing the inter-dependence and inter-connectivity of the formal and the informal sub-sectors in the Indian industrialization process. The overall TE of the industrial sector in India is 62%. The TE scores validate a mutual and inter-linked existence of the formal and the informal secondary sector in India. The neo-classical hypothesis of shrinking informal sector as a pre-requisite for the growth of the formal sector stands invalidated as far as the nature of Indian labor market is concerned. Both the sub-sectors in India need to grow simultaneously to tackle the problems of poverty and unemployment in order to attain sustainable growth and development over time.

Table 8: Mean TE by Industry

<i>Rank</i>	<i>Type of Industry</i>	<i>Mean TE</i>
Formal Sector		
Top		
1	Electric power generation and transmission by nuclear power plants	0.95
2	Collection and management of hazardous waste	0.92
3	Manufacture of helicopters	0.92
4	Production and refining of precious metals	0.91
5	Manufacture of spacecraft and launch vehicles, satellites and similar missiles	0.9
Bottom		
1	Treatment of waste water or sewer by means of physical, chemical or biological processes	0.37
2	Warehousing non-refrigerated	0.33
3	Repair of communication equipment	0.31
4	Repair of consumer electronics	0.29
5	Washing and (dry-) cleaning of textile and fur products	0.25

⁶ Periodic Labor Force Survey Data Set

<i>Rank</i>	<i>Type of Industry</i>	<i>Mean TE</i>
Informal Sector		
Top		
1	Manufacture of unassembled wooden flooring including parquet flooring	0.84
2	Manufacture of essential oils; modification by chemical processes of oils and fats	0.75
3	Manufacture of integrated circuits (analog, digital or hybrid)	0.75
4	Manufacture of oil cakes & meals incl. residual products, (e.g. Oleostearin, Palmstearin)	0.75
5	Finishing of wool and blended wool textiles	0.71
Bottom		
1	Repair of bicycles	0.15
2	Collection of non-hazardous waste	0.12
3	Recovery of materials from garbage (such as paper, plastics, used beverage cans and metals, into distinct categories,)	0.11
4	Activities of sculptors, painters, cartoonists, engravers, etchers etc	0.05
5	Repair of footwear and leather goods	0.02

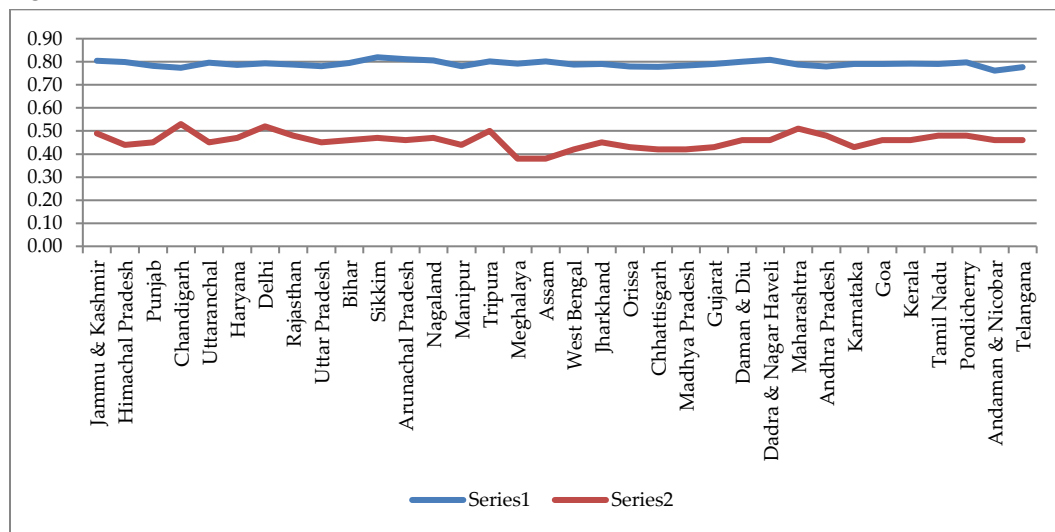
Source: Author's compilation from ASI and NSSO data

Table 9 and Figure 2 present the values of the mean technical efficiency of the firms by state both the formal and the informal sectors. Most of the states have a TE level clustering around the mean value for the whole country. Same pattern is reflected by both the formal and the informal sectors.

Table 9: State Wise Tech Eff.

<i>State</i>	<i>Formal Sector</i>	<i>Informal Sector</i>	<i>State</i>	<i>Formal Sector</i>	<i>Informal Sector</i>
Jammu & Kashmir	0.80	0.49	Jharkhand	0.79	0.45
Himachal Pradesh	0.80	0.44	Orissa	0.78	0.43
Punjab	0.78	0.45	Chhattisgarh	0.78	0.42
Chandigarh	0.77	0.53	Madhya Pradesh	0.78	0.42
Uttaranchal	0.80	0.45	Gujarat	0.79	0.43
Haryana	0.79	0.47	Daman & Diu	0.80	0.46
Delhi	0.79	0.52	Dadra & Nagar Haveli	0.81	0.46
Rajasthan	0.79	0.48	Maharashtra	0.79	0.51
Uttar Pradesh	0.78	0.45	Andhra Pradesh	0.78	0.48
Bihar	0.80	0.46	Karnataka	0.79	0.43
Sikkim	0.82	0.47	Goa	0.79	0.46
Arunachal Pradesh	0.81	0.46	Kerala	0.79	0.46
Nagaland	0.81	0.47	Tamil Nadu	0.79	0.48
Manipur	0.78	0.44	Pondicherry	0.80	0.48
Tripura	0.80	0.5	Andaman & Nicobar	0.76	0.46
Meghalaya	0.79	0.38	Telangana	0.78	0.46
Assam	0.80	0.38	Jharkhand	0.79	0.45
West Bengal	0.79	0.42	Orissa	0.78	0.43

Source: Author's compilation from ASI and NSSO data

Figure 2: State and Sector Wise TE

Source: Table 8

4.4. Tobit Analysis

In order to empirically validate the factors contributing towards the technical (in)efficiency of the firms located across the formal and informal sectors, two separate regression analysis have been conducted. Given the peculiarity of these two sub-sectors different variables have been identified for both formal and informal sub-sectors using Wald test of joint significance. The results of the same are presented in Table 10.

Table 10: Hypothesis Testing for Inefficiency Parameters

Year	Null Hypothesis	Chi-Square Value	Degrees of Freedom	Decision
Formal Sector	$\delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = 0$	61.08***	6	Reject
Informal Sector	$\delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = 0$	39.21***	6	Reject

Source: Author's Estimation from ASI and NSSO Data

Based on the results of Wald test, the independent variables impacting the TE of the firms across the formal and the informal sub-sectors is presented in Table 11. Analyzing the formal sector first, it can be seen that the relationship between capital (lk) and TE is negative and significant. As pointed by the stochastic frontier analysis, the formal sector in India is relatively capital intensive and the amount of capital combined with labor and raw-materials is limited. The investment made by the firms in capital is limited and thus the current and existing stock of capital is found out to be insufficient and contributing negatively to the overall TE of the firms in the formal sub-sector. The production costs of the firm (lpc) as defined in section 3, has a positive and significant relationship with TE of the firms pan-India. As firms tend to maintain a low production cost the TE tends to vary positively with it. It can be inferred from the coefficient of the production cost that the

firms located across the formal sector have an edge in keeping their production costs under check, thus, enhancing the overall firm performance.

Table 11: Tobit Regression Analysis

	(Formal Sector)	(Informal Sector)
	<i>te</i>	<i>te</i>
te		
l_k	-0.0105*** (0.0301)	-
l_pc	0.2072*** (0.0454)	-
l_sup	-0.0628*** (0.0040)	-
l_wd	-0.0884*** (0.0023)	-
D1	0.0142*** (0.0020)	0.0394*** (0.0013)
D2	0.0111*** (0.0014)	0.190*** (0.0024)
l_ko	-	0.2204*** (0.0031)
l_py	-	0.0261*** (0.0005)
l_ec	-	0.1012*** (0.0021)
D3	-	-0.0238*** (0.0014)
_cons	0.6961*** (0.0129)	-0.1602*** (0.0053)
var(e.te)	0.0079*** (0.0005)	0.0324*** (0.0001)

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Author's compilation from ASI and NSSO data

There exists a strand of literature (Agarwal & Lenka, 2018; Prabhu & Jain, 2015b; Sahasranamam & Sud, 2016) that points out the lack of entrepreneurial spirit (or skills) in India. The regression analysis in the current study establishes a negative and significant relationship between the supervisory staff, (which is a proxy for the entrepreneurship) in India and the mean TE. It can be inferred from the findings that the firms in India in general lack entrepreneurial skills. The most dynamic feature of the modern day industrialization is entrepreneurship (Parker, 2018). However, the firms in India reflect low levels of entrepreneurial presence. As such the TE of the firms remain depressed. The coefficient of

0.6 highlights the considerable role and extends of entrepreneurial skills in influencing the TE of the firms.

The current number of working days ascribed to the firms in the formal sector of India shows a negative contribution towards the TE. The coefficient of -0.8 shows a considerable negative impact. It can be inferred that the firms in India need to stick to the schedule which is an important determinant of TE and overall firm performance. The firms in India need to enhance the overall business and production routine in order to stick to the maximum number of working days following a strict protocol.

D1 is the binary dummy equaling 1 if a firm has in house R&D unit and 0 otherwise. The coefficient though very low but significant and positively related to the TE of the firm highlights the importance of having a firm specific R&D unit. Studies like (Ananthram & Chan, 2021; Prabhu & Jain, 2015a; Shepherd et al., 2020) among many others highlight the importance and positive returns of the firm specific R&D including the theory on 'jugaad'. (Majeed et al., 2021b) is a novel attempt in this analysis highlighting the nature and features of the firm specific R&D in India. The coefficients of the current study show that the TE of the firms in India is positively influenced by the innovations and adjustments made at the firm level collectively under the head of R&D. D2 is a binary dummy taking value=1 if the ownership of the firm is 'Individual proprietorship' and 0 otherwise. This variable is associated with timely decision making as the deciding powers are vested in one hand (of the owner). The coefficient of the variable is positive and significant indicating a positive relationship between timely decision making and TE of the firms.

In the informal sector, one of the fundamental variables influencing the TE is the capital owned by the units. Most of the firms in the informal sector do not own any capital. The firms that do show exceptionally well outcomes own some part or all of the (simple) capital used in their production process. Table 11 presents a positive and highly significant relationship between TE of the firms in the informal sector and the amount of capital owned by the firms. Studies like (Darbi et al., 2018; De Paula & Scheinkman, 2007; Mishra, 2021) among others validate the limited presence of capital and owned capital in the informal sector. In light of the empirical evidences like these, the study finds that use of owned capital contributes positively towards the TE of the firms located in this sub-sector. The informal sector in general is notoriously famous for operating in the absence of paid labor (Amaral & Quintin, 2006b). The axiom of exploitation associated with the informal sector by the neo-classical theory to an extent is discredited with the same (Clelland, 2020; Fast et al., 1999). However, the evolving informal sector in India has been reflecting unexpected processes and outcomes. One such outcome is the steady growth trend towards hiring (paid) labor to undertake production (Bhattacharya & Kesar, 2018b). The regression analysis in the present study validates the positive and significant contribution of the hired labor in the production processes of the informal sector. The proxy for the hired labor in the analysis is the variable reflecting the 'direct payment made to workers' by the unit undertaking production. Validation of the hiring of labor by informal sector

points towards a positive growth of the informal sector with steadily increase in employment with positive returns.

The use of electricity (l_{ec}) in the informal sector shows a positive and significant contribution towards the TE of the firm. Evidences throughout the industrialization process of India, including (Allcott et al., 2016; Rud, 2012) among others show that the electricity shortage in the Indian industry cause a decrease in revenue, profit and producer's surplus among other variables. The plant size gets distorted because of lack to access to relevant source of energy and the economies of scale suffer as well over the due course of time. The findings of the current study validate a positive role of electricity as a source of energy in the informal sector. (Nagaraj & Kapoor, 2022) contend that the informal sector runs its productive operation on the electricity designated for households or on stolen electricity. Some stimulations run by hitherto studies including Allcott (2016) show that uninterrupted and dedicated electricity has the potential to substantially increase the positive outcomes across the firms in India. As such it can be validated that informal sector in India runs on electricity but the current amount is insufficient and inaccessible.

D1 is a dummy for male ownership. It takes value=1 if the firm under study is owned by a male and 0 otherwise. 82% of the firms under study in the informal sector in India are men owned. In other developing economies, that are currently performing better than India, the informal sector is showing a growing trend of women dominance as men are transitioning to the formal sector from the Informal sector (Batsalelwang & Dambe, 2015; Bonnet et al., 2019; Majeed & Rashid, 2023; Muzvidziwa, 2015). The coefficients from the current analysis show a positive and significant contribution of the male owned firms towards an enhanced TE. Given the stage of development that India currently is in, the informal sector might maintain male dominance for time to come till these firms in the informal sector grow enough to march towards formalization. D2 is a dummy variable taking value =1 if the enterprise type is 'own account' and 0 otherwise. From the data set under analysis, it is observed that 57% firms in the Indian informal sector are own-account enterprise while 43% are establishments (with hired workers). The former type of enterprise is taken as a proxy for the entrepreneurial nature of the unit as the owner himself works in the firm. The study shows that this type of ownership highly contributes towards the increase in the TE of the firms. It is one of the reasons that the informal sector in India is growing is this entrepreneurial nature of the firms. People work full time in their own account enterprises and always try to devise ways to work better and efficient. The use of locally available resources and help further enhances the outcomes of such units.

D3 is a dummy to highlight the main problem of most of the enterprises. It takes value =1 if the main problem faced by the enterprise is a decrease in the demand for the output so produced by the unit. The negative coefficient of the same signifies a market failure. The firms in the informal sector in India often fail to find a suitable market to sell their output. Being marginal in nature, such issues force these units to either shut down or bear the brunt of loss costing them everything. Since the informal sector is left totally outside the

policy shadow in India and at the same time is hidden in its potential and scope it might be facing this problem till relevant policy interventions are set in place.

5. Conclusion and Policy Recommendations

The present study is a detailed analysis of the formal and the informal (sub)sectors of the Indian economy. The study reviews a precise thread of literature on the formal and the informal sectors of the Indian economy. It goes on to analyze some broad descriptive statistics deriving data from the ASI and the NSSO for the formal and the informal industrial sub-sectors respectively. On the methodological front, the study is based on two step estimation of the SFA. Two separate SFPF are estimated for the formal and the informal industrial sub-sectors. The findings reveal that the formal sector is labor intensive while the informal sector relies heavily on the availability of the raw-materials in order to undertake production. Capital on an average is found to be deficient across the whole Indian industry. Based on the SFPFs, the TE is predicted for both the sub-sectors. It is found out that the formal sector pan-India has a mean TE of 79% while the informal sector works at 45% TE. The TE of the informal sector is found out to be quite appreciable given that the sector has been operating on its own and it can be validated that the informal sector in India is growing quite sustainably, contributing positively to the economic outcomes. It can be concluded that the formal and the informal sub-sectors of the Indian industry co-exist in a mutually reinforcing and constructive way having developed a number of backward and forward linkages. The informal sector by its very nature in the Indian economy is not going to end/vanish anytime soon, instead it is expected to grow, employing more people and enhancing the amount and quality of total output produces in the economy.

Based on the results of regression analysis, the present study arrives at some policy recommendations. Indian industry still needs a big policy push from the government. At a disaggregated level, the formal sector firms in general must be pushed towards the attainment of a better capital stock in order to arrive at a superior labor-capital mix. The supply chain management is still weak in India and it needs inducing factors strengthening it booth at the policy and the firm level. The entrepreneurial skills of the youth bulge need a shape and direction in order to create a lot of human capital motivated to become self-employed. Indian firms to a great extend lack the discipline of proper work culture; it needs to be inculcated properly and steadily. The findings of the study highlight the lack of firm specific R&D. Push factors need to be introduced at various levels to motivate the formal sector firms towards investing in localized R&D. The informal sector firms need a policy shadow; not in terms of fiscal considerations but developmental goals. The sector is facing energy crisis and market failure. The government instead of its attempts to formalize the informal sector at the moment must focus on the growth and productivity of the informal sector firms. These firms are in dire need of affordable fuel and accessible markets to begin with.

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