Indian Manufacturing Productivity: What Caused the Growth Stagnation before the 1990s?

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ABSTRACT

This article addresses the question of why productivity growth in Indian manufacturing was slow in the pre-reform period and analyzes how economic reforms in the 1990s accelerated productivity growth. The answer lies in two subtle but important distortion-inefficiency mechanisms, which affected productivity growth by distorting intermediate input allocation. The interaction of quantitative restriction policies and inflexible labour laws resulted in lower than optimal materials per worker usage. The combination of high inflation and unavailability of credit exacerbated this factor distortion and lowered productivity growth further. Using a panel dataset on Indian industries, this article finds widespread underutilization of materials compared to labour until recently, and this sub-optimal materials per worker usage lowered productivity growth.

RÉSUMÉ

Cet article cherche à déterminer pourquoi la croissance de la productivité dans la fabrication en Inde a été lente dans la période préalable à la réforme et il analyse comment les réformes économiques des années 90 ont accéléré la croissance de la productivité. La réponse tient à deux mécanismes subtils mais importants de manque d'efficacité et d'effet de distorsion, qui ont eu des répercussions sur la croissance de la productivité en créant un effet de distorsion sur la répartition des intrants intermédiaires. L'interaction entre les politiques de restrictions quantitatives et les lois rigides sur la main-d'œuvre ont entraîné une utilisation inférieure au niveau optimal des matériaux par travailleur. L'inflation élevée et la non-disponibilité du crédit ont ensemble exacerbé cet effet de distorsion des facteurs et ont fait diminuer davantage la croissance de la productivité. Au moyen d'un ensemble de données recueillies au moyen de panels sur les industries indiennes, on constate une sous-utilisation généralisée des matériaux comparativement à la main-d'œuvre jusqu'à récemment, et cette utilisation sous-optimale des matériaux par travailleur a fait diminuer la croissance de la productivité.

THE SLOW PRODUCTIVITY GROWTH in Indian manufacturing before the late 1990s is cited as one of the major reasons why the Indian economy could not achieve high rates of economic growth. Indian manufacturing productivity growth was slower compared to that in other Asian economies like China and Vietnam, as shown in Fernandes and Pakes (2008). But more interestingly, the relative

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performance of the manufacturing sector in India was poor compared to the Indian services sector. Chart 1 shows output and output shares of manufacturing and services in India for 1960-2002. Manufacturing output grew during these 42 years, but that growth was slower than the growth in services output, which starts growing exponentially in the 1990s. The contrast between these two sectors becomes clearer when looking at their shares of total output. The share of services jumped from 0.29 in 1960 to 0.50 in 2002, while the share of manufacturing went from 0.11 to 0.18 in 2002.

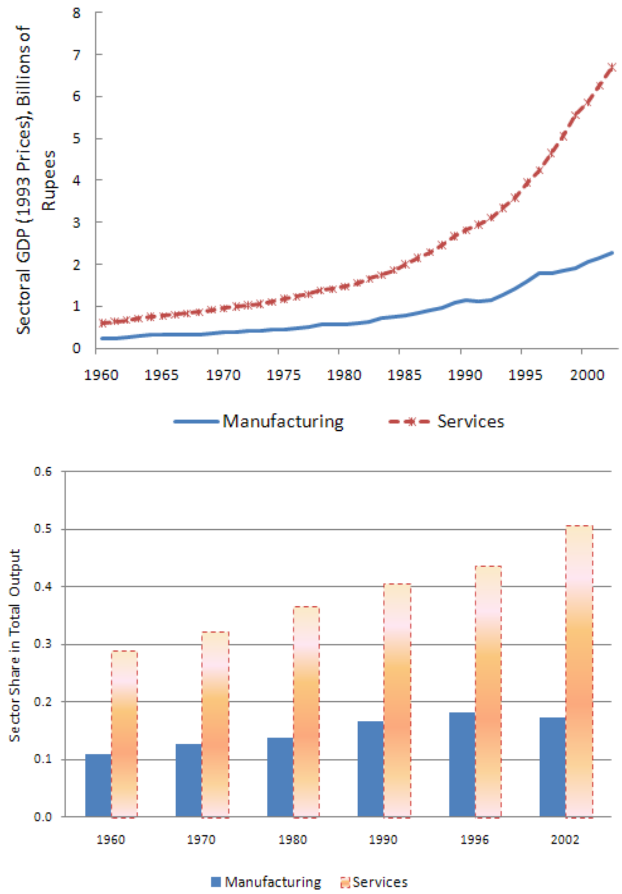
Why is it that under a similar economic environment the service sector grew at remarkable rates while the manufacturing sector did not? How did reforms in the 1990s spur productivity growth in the manufacturing sector? This article differs from previous articles[2] in its approach to answering these questions by introducing two new factors. First, the role of intermediate inputs is examined, as this is missing from the discussion despite being the most important difference between manufacturing and services production processes. Second, this article studies the effects arising from the combination and interaction of policies, which can be totally different from the individual effects of policies. Adding these two dimensions provides new insights into the Indian economic growth experience.

By taking this appraoach, this article finds that the difference between the growth performance of the manufacturing and the service sector is caused by the greater reliance of the former on intermediate inputs. Interactions and combinations of policies (inflexible labour laws in the presence of a quota-permit system) and economic conditions (high inflation in the presence of credit unavailability) in India created distortions resulting in production inefficiency. These mechanisms hampered productivity growth in manufacturing by forcing firms to operate at non-optimal intermediate input allocation. Economic reforms in the 1990s helped reduce these distortions by removing many of these restrictions and, as a result, the mechanisms that caused inefficiency disappeared. This article discusses the economic mechanisms through which government policies affected manufacturing productivity at the firm level.

To estimate the effect of a given policy, one needs to isolate it from other policies. But the *cet-*

Chart 1

Output and Output Shares of Manufacturing and Services in India, 1960-2002



2 See Basu and Maertens (2007) for a survey of some of the explanations for economic growth in India after the reforms.

eris paribus assumption comes at a cost, because the interaction of different economic conditions may give rise to mechanisms or incentives that are totally different from the predicted outcomes of any single policy. This is especially true in the case of India, where different policies are not always coordinated or synchronized. Rajan *et al* (2006) argue that the development policies adopted after India's independence can be described as "idiosyncratic". In fact, the reason manufacturing growth is relatively slower lies in the way the Indian economy has evolved. By the time industrial growth started to become the focus of five-year plans, India had already embraced the socialist model of planning. Government regulations and control greatly influenced Indian industry through the notorious "license-raj" (the quota-permit system) and rigid labour laws. Besley and Burgess (2004) show that pro-worker industrial dispute regulation tend to lower output, investment, productivity and employment in manufacturing. Fernandes and Pakes (2008) also find that labour is underutilized in states with more restrictive labour laws (e.g. an amendment to the Industrial Disputes Act which made the firing of workers illegal except with previous permission from the appropriate state government).

Why do these worker-friendly labour laws end up reducing productivity and inducing the underutilization of labour? This article shows that it is because of the presence of the additional (and often ignored) policy of a quota system. The interaction of the quota system with existing conditions and labour laws created economic mechanisms that distorted the usage of intermediate inputs, which are very important in manufacturing production (a share of 60 per cent of gross output). This non-optimal allocation of intermediate inputs resulted in inefficiencies in the manufacturing sector.

Unfortunately, the effect of the quota-permit system on Indian industry has not received its due attention. Mohammad and Whalley (1984) discuss some of those licenses and other controls. Their estimates of the welfare losses from rent seeking in India are as high as 30-45 per cent of GNP. The main sources of rent seeking were price controls and rationing. Das (2004) finds that the structure of import licensing remained restrictive and complicated throughout the 1980s and even in the early 1990s. In general, labour laws have not changed dramatically and economic reforms have focused on removing these license regulations rather than labour rigidities. This indicates that the observed improvements in productivity performance stem mostly from the removal of the quota-permit system and the reason for differences in pre-reform and post-reform performance is directly related to this quota system.

This article argues that the combination of the two distortions caused by labour-rigidity and the materials-quota were impeding productivity growth. An optimizing firm has to equate its labour and material ratio such that marginal returns are equal to the respective prices. But if a firm cannot fire extra workers due to the labour laws, it ends up requiring more material to reach its optimal allocation. However, the firm cannot buy extra materials because of quota-permit restrictions. Hence, the firm ends up operating at *non-optimal* levels. In isolation, none of these policies would have resulted in a distorted allocation.

This mechanism also explains the result observed by Chand and Sen (2002) that the liberalization of intermediate-good sectors is better for TFP growth than the liberalization of final-good sectors.

This article also provides another perspective on the role of inflation in affecting growth in Indian manufacturing. Inflation combined with credit unavailability forced firms to operate at non-optimal input allocation because they could neither reduce labour (due to labour laws) nor afford to buy materials (due to credit constraints and significant increase in materials prices due to inflation). This article finds a strong relationship between materials inflation and real wages (labour productivity) indicating the presence of this channel.

These results provide new perspectives for policymakers regarding two widely used industrial policies: labour market regulations and import substitution regimes. Ahsan and Pages (2007) find that in India pro-worker labour policies are associated with reduced productivity growth. Kruger (1997) discusses how it was thought that import substitution in manufactures would be the key to development. Earlier explanations about both these observations, i.e. labour laws slowing growth and import substitution policies slowing growth, are based on calculating implicit costs or wasted resources. This article finds a direct channel (intermediate inputs) and the distortion mechanisms through which productivity is affected.

One of the major impacts of economic reforms in India was to break these interactions by removal of permit quotas and by increasing credit availability. The *distortion-inefficiency* mechanisms described above no longer remain relevant because the firms are not restricted when choosing their material input allocation (layoff restrictions have still not been removed). This article finds that the distortions in input allocation and their effect on productivity growth fell significantly after the reforms in the 1990s. It also shows that firms have started over-substituting materials relative to labour. This explains the phenomenon of jobless growth in Indian manufacturing. The firms are producing more output because of this material-deepening, but they are avoiding hiring additional workers to avoid future inflexibilities and legal issues. Like many other studies, these findings call for the policy makers to take another look at the existing labour market regulations in India.

Industrial Economic Policies in India before 1991

The industrial sector became the focus and one of the early goals of the Indian government's five-year plans. Just like every other part of the economy, Indian manufacturing has experienced an evolution of policies in the last three decades. It has been the subject of many productivity and policy research studies, but often for the wrong reasons. Unlike other sectors in India and unlike manufacturing sectors in other developing countries, the manufacturing sector in India did not register many years of consistent high growth until very recently. GDP (at 1993-94 prices) in manufacturing grew almost 10 times between 1960 and 2002. But the unimpressive labour productivity and TFP growth estimates from various studies have portrayed Indian manufacturing as a stagnant sector that is little affected by the early stages of policy reform. Das (2004) finds the TFP growth over the period of 1980-2000 to be negative and attributes this to structural factors.

Inflexible Labour Laws

The *Industrial Disputes Act* of 1947 states that the "discharge, dismissal, retrenchment or termination" of an individual workman by an employer "shall be deemed to be an industrial dispute". This law has motivated many studies on the role of labour market regulation in India. Labour regulation has become a standard part of the explanations for India's poor growth performance before the 1990s. Besley and Burgess (2004) show that Indian states which made additional amendments to this act in favour of workers experienced lower output and productivity in manufacturing. They also find that pro-worker labour regulation is associated with increases in urban poverty. Fernandes and Pakes (2008) use World Bank Investment Climate Survey data to show that conditional on firm productivity, factor costs and other factors faced by firms, labour was underutilized in Indian manufacturing in 2001 and 2004. The supposed explanation is that these inflexible labour laws restricting the firing of workers in India resulted in firms lowering their demand for labour. Ahsan and Pages (2007) discuss various types of labour laws in India, including Chapter V(b) of the amendment to the Industrial Disputes Act which prohibits firms that employ 100 or more workers from retrenching without permission from the state. There are around 45 pieces of central legislation covering various aspects of employment as well as a large number of state laws. Even shifting the weekly schedules or days offs without notice could be in non-compliance to the labour legislation. Ahsan and Pages (2007) find that regulations that impede employment adjustment are associated with negative effects on output.

Quantitative Restrictions: Import Permit Quota

Jagdish Bhagwati (1978) examined in detail the quantitative restrictions which were the building blocks of industrial policy in India. These were guided by the principle of import substitution and were justified by the aim of protecting domestic producers. Commodities were divided into various categories and producers needed to apply for specific licenses for items not under open general license (OGL). Licenses were required for producing new products or expanding production capacities. Mohammad and Whalley (1984) estimate that the cost of these rent seeking policies in India was as high as 30-45 per cent of GNP and it "put India in a different category altogether" in terms of the extent of distortions.

Despite being one of the most widely criticized policy choices, not many studies have tried to identify and estimate how this quota system affected the growth in Indian manufacturing. Bhagwati and Desai (1970) document the industrial licensing scheme adopted in India after the passage of the Industries (Development and Regulation) Act of 1951. There were several separate license categories. A capital goods (CG) license was required to import necessary capital goods, while actual user (AU) licenses, issued to producers for imports of raw materials and intermediate goods, had items specified in considerable detail to ensure that only the approved production would be made feasible. This also required that value and/or quantity limits were specified for the listed importables on each license. These licenses even specified the composition and the source of the goods and were non-transferable between firms and even between plants within a firm. This licensing system was inefficient since it lacked any evaluation criteria and there were large administrative costs and delays.

Other Economic Conditions: High Inflation and Low Credit Availability

Inflation has been consistently high in India. Annual average CPI inflation has been 8.2 per cent per year between 1970 and 2003. The pre-1990s and post-1990s inflation rate averages were 8.6 per cent and 7.4 per cent respectively, both much higher than average inflation in industrialized and newly industrialized countries. In China, the average retail price inflation between 1978 and 2003 was around 5 per cent. Intermediate input prices have also experienced the same kind of high inflation throughout the last three decades. The average annual inflation rate of materials prices was 7.5 per cent.

Using industry specific price index data from India's Central Statistical Organization, we calculate average inflation rates for output in all 58 industries. The average inflation is higher than 7 per cent per year for 53 industries, with a few industries experiencing price increases averaging more than 11 per cent per year between 1973 and 2003. During this period, the annual nominal wage inflation in Indian manufacturing was 9.6 per cent; 11.1 per cent per year before 1990 and 7.1 per cent per year after 1990.

It was the currency crisis of 1991 in India that paved the way for a broad set of reforms including capital market reforms. Prior to that, credit markets in India were unorganized and underdeveloped. Chart 2 shows the lending rates of various countries using data from the IMF's International

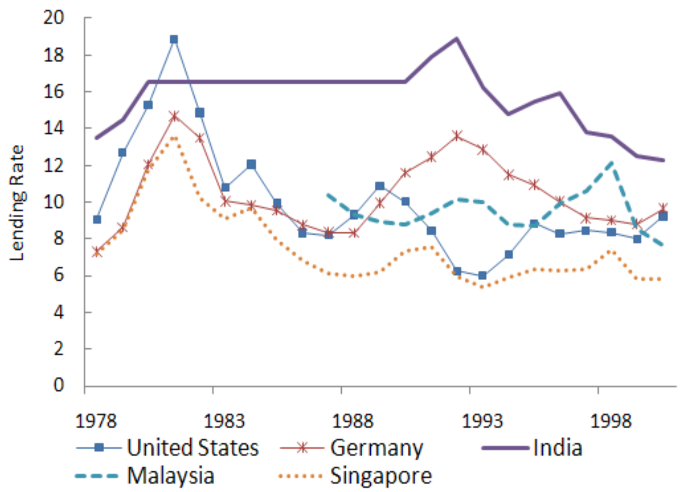
Table 1

Stock Market Indicators in 1990, India and Other Countries, 1990

	Market Capitalization (billions US$)	Market Cap. / GDP (per cent)	Value Traded / GDP (per cent)
India	38.6	12.2	6.9
Malaysia	48.6	110.4	24.7
Korea	110.6	43.8	30.1
Singapore	34.3	93.6	55.4
Hong Kong	83.4	111.5	46.3
Germany	355.1	22.2	21.4
United States	3,059.4	53.3	30.5

Chart 2

Lending Rates in India and Other Countries, 1978-2000



Financial Statistics. For India, lending rates were 16.5 per cent for the entire decade of the 1980s. They were not only higher than in developed countries such as United States and Germany, but also higher than other Asian economies like Singapore and Malaysia. Interest rates, which denotes the cost of borrowing, remained very high in India until late 1990s. Capital markets were also underdeveloped. Table 1 shows stock market capitalization in 1990 for different countries. For India, market capitalization as percentage of GDP was much lower than for other countries.

Role of Intermediate Inputs in Manufacturing Growth

To see the role of the materials-per-worker ratio in output growth in manufacturing, let us consider a simple extension of Solow's growth accounting model by including materials as an input in the constant return to scale production function.

$$Y = AK^{\alpha}M^{\beta}L^{(1-\alpha-\beta)} \qquad (1)$$

where Y stands for output, K for capital, L for labour, A is a measure of the production technology and other unobservable inputs, α is the capital share in output and β is the materials share in output.

This can be rearranged in per-worker terms as

$$\frac{Y}{L} = A\left(\frac{K}{L}\right)^{\alpha}\left(\frac{M}{L}\right)^{\beta} \equiv y = Ak^{\alpha}m^{\beta} \qquad (2)$$

where k stands for capital per worker and m is materials per worker.

Hence labour productivity growth between two periods can be expressed as following.

$$\Delta \ln y = \Delta \ln A + \alpha \times \Delta \ln k + \beta \times \Delta \ln m \qquad (3)$$

Hence, labour productivity growth is the sum of TFP growth and the contributions of capital per worker growth and materials per worker growth. The last term in Equation 3 denotes *materials-deepening*, which receives little attention in the literature, even though it can be of crucial importance in explaining output growth of the manufacturing sector. The estimated values of input shares for Indian manufacturing are $\alpha = 0.2$ and $\beta = 0.4$, indicating that materials per worker is very important for the gross output of the Indian manufacturing sector.

Value-added (VA), which is widely used as the output measure in industry-wide analysis, is obtained by subtracting the real intermediate inputs (M) from real gross output (Y).

$$VA = Y - M \equiv VA = AK^{\alpha}M^{\beta}L^{(1-\alpha-\beta)} - M \quad (4)$$

or in per-worked terms,

$$va = Ak^{\alpha}m^{\beta} - m \quad (5)$$

where va stands for value added per worker, and m is materials-per-worker.

Hence the labour productivity growth (using value-added) is given by

$$\Delta va = \Delta y - \Delta m \quad (6)$$

The above equation contradicts the notion that value added productivity growth is independent of materials used. A change in the materials-per-worker ratio between two time-periods affects labour productivity growth even if the output is measured using a value-added concept. In fact, some methodologies try to highlight the importance of intermediate inputs, e.g. Domar weights and terms-of-trade decomposition. But the general consensus is that if we are measuring the output as value added, we do not have to worry about the intermediate inputs. As shown in Equation 6, this is clearly a simplification, as it assumes that the materials-per-worker ratio remains constant between periods.

The importance of raw materials has not been studied widely in the Indian manufacturing productivity literature. The reason is that ideally this materials input should have been allocated to equate the returns between the materials and labour; and hence value-added productivity growth should have been independent of the materials input. But this has not been the case with Indian manufacturing. Government policy, or to be more specific the interaction of government policies, distorted the materials input allocation compared to the labour input and this had a negative effect on productivity growth. This article defines and estimates some measures of this distortion by comparing the observed materials-per-worker ratio to the (hypothetical) optimal materials-per-worker ratio for the given materials' prices and wage levels.

Input Distortions and Productivity

The presence of channels that transfer the effect of policy interactions (labour laws in the presence of quantitative restrictions) and economic conditions (high inflation with low credit access) to the production process in Indian manufacturing can be verified using the data. From production function estimates, one can identify whether the value of materials-per-worker is higher than or lower than the optimal $\left(\frac{M}{L}\right)$. A lower $\left(\frac{M}{L}\right)$ means the firm is either operating with less than the desired materials input (due to a quota) or with more than optimum number of workers (since the firms cannot lay-off workers).

We can see how these *distortion-inefficiency* channels work in different scenarios by considering a simple production model $Y = F(A, K, L, M)$; where output Y is produced using capital K, labour L and materials M. A is the measure of production technology and other unobservable inputs. The optimization gives the following first order conditions for input allocation in terms of price of labour w and price of materials P_M.

$$w = \frac{\partial Y}{\partial L} ; \frac{\frac{\partial Y}{\partial L}}{\frac{\partial Y}{\partial M}} = \frac{w}{P_M} \quad (7)$$

For the Cobb-Douglas production function, this condition can be written as

$$\frac{\alpha L}{\alpha M} \bullet \frac{M}{L} = \frac{w}{P_M} \quad (8)$$

In response to a positive technology shock, there is upward pressure on wages due to increased productivity. Since imported materials prices (P_M) are determined in the world market, the optimality can only be achieved by either using more materials or using less labour. In India, however, the quantitative restrictions do not allow a firm to use more materials, and the inflexible labour laws prohibit a firm from using fewer workers. As a result, the optimal materials-per-worker ratio is not achieved. Due to these frictions, the gains from technological progress are not fully realized and firms are forced to operate at non-optimal factor allocations.

The distortion worsens in the presence of rising prices and limited access to credit markets. Let us consider the effect of high inflation in materials on the factor allocation choice of a firm. In absence of credit, the firms may find it difficult to buy the same amount of materials as in the last period due to increased prices. The firm can still operate efficiently by shrinking its scale and reducing labour input according to its budget. But even that is not possible. Since it is difficult to layoff workers, the firms have to compromise on materials and must operate at a lower materials per worker ratio than in the last period. This causes the output to go down and hence reduces productivity growth.

$$P_M \uparrow,\ \underline{L} \implies \left(\frac{M}{L}\right) \downarrow \implies \left(\frac{\partial Y}{\partial L}\right) \downarrow \quad (9)$$

Substitutability between Materials and Labour: An Example

One of the main differences between manufacturing industries and services industries is that manufacturing primarily changes the physical characteristics of a good. Unlike the substitutability between capital and labour, materials and labour have limited substituability in manufacturing. The increased capital input in the form of machinery makes some of the workers redundant. But one cannot use labour input in place of the materials that are required to create the final output. Materials and labour inputs are still substitutable in the sense that firms can outsource some of the process of converting to the final good. Rather than producing some intermediate materials themselves, they might directly buy it from other firms. For most of the manufacturing industries, however, the actual production function of their final output is Leontief in terms of the intermediate materials requirements.

Let us consider the example of a car manufacturer. The final good, a car, is made by combining different intermediate goods like engines, airbags, and tires. The production function would be

$$Y = F[K, L, M] = F[S(K, L), N(M)] \quad (10)$$

where, $S(K, L)$ = Scale of Production
$N(M)$ = Maximum number of Cars that could be made using M.

The function $N(M)$ has the following Leontief form:

$$N(M) = \min\left(engines,\ \frac{tires}{4},\ steering\ wheel,\ brake\ pedal,\ \frac{airbags}{2},\ \ldots\right) \quad (11)$$

This *materials upper-bound* function N(M) is not relevant in cases where the material input is not the limiting factor and hence only the scale S(K,L) matters. In these cases, the concept of value-added by capital and labour can explain the output growth correctly. But in the case of India, N(M) had an upper bound due to import quota restrictions. Indian manufacturing firms could have reduced their scales S(K,L) accordingly, but labour laws made that difficult.

Table 2 provides a simple example of how these restrictions would harm a typical car manufacturer by denying it the benefit of technological advances. Note that even after the reforms the manufacturer is not reaching the growth potential. The firms are not hiring more workers even when it is optimal to do so, because they are worried about firing restrictions and extra costs.

Productivity Estimation Methodology

The estimates used in this article are based on the Annual Survey of Industries (ASI) data version 2 released by the Economic and Political Weekly Research Foundation.

The Annual Survey of Industries is the principal source of industrial statistics in India. It provides data on various vital aspects of registered factories such as employment, wages, invested capital, capital formation, inputs, gross output, depreciation

Table 2
Productivity Growth in Indian Manufacturing – An Example

Scenario	Optimal Response	L & M Restrictions (Pre-Reform)	Only L Restrictions (Post-Reform)
Baseline	L-Prod. = 1 Car/Worker. L ¦ = 100 Workers. M = 100 Engines. 400 Tires. Y = 100 Cars.		
Positive Technology Shock.	L-Prod. = 1.2 Cars/Worker. L ? (depending on wage increase and labour supply, assume 110). M = 132 Engines. 528 Tires. Y = 132 Cars. Y Growth = 32%.	$\overline{M}$ = 100 Engines. 400 Tires. (fixed due to permit quota) L ´ (no incentive to increase the workers) Y = 100 Cars. L-Prod. = 1 Car/Worker. Y Growth = 0%	L ´ (still many disincentives to increase the workers) M = 120 Engines. 480 Tires. Y = 120 Cars. L-Prod. = 1.2 Cars/Worker. Y Growth = 20%.

and value added, etc. It covers all factories registered under Sections 2m(i) and 2m(ii) of the Factories Act, 1948 i.e. those factories employing 10 or more workers using power, and those employing 20 or more workers without using power. The dataset is created from these surveys and has 31 variables for the years from 1973 to 2003. The article uses both aggregate level data and industry level data for 58 industries based on the 3-digit national industry classification (NIC) code.

Industry-specific price deflators are taken from the wholesale price index series provided by India's Central Statistical Organization (CSO). GDP, GDCF deflators and interest rate series were available from the Reserve Bank of India publication titled *Handbook of Statistics of the Indian Economy.*

Real value added is calculated using double-deflation. Gross output is deflated using sector-specific price indexes, materials inputs are deflated using the wholesale price index for manufacturing and fuels are deflated using the fuel and energy price index available from CSO. The business services input is estimated by subtracting the sum of materials and fuel from the total value of inputs. This business services input is deflated using the consumer price index. The capital input is generated using the user-cost approach.

This article estimates the unit-input requirement, which is the amount of each factor that is required to produce one unit of output in each year. It also estimates the productivity growth measures based on an index number method which has the advantage of incorporating the effect of changes in factor shares. A Fisher index is used for aggregating the input quantities. TFP growth is estimated as the ratio of output growth and input quantity index growth. For gross output all three inputs (capital, labour and materials) are used, while for value added only capital and labour inputs are used.

$$X(t+1, t) = Fisher\ Quantity\ Index\ (Q^{t+1}, P^{t+1}, Q^{t}, P^{t}) \qquad (12)$$

$$TFP = \frac{Y(t+1, t)}{X(t+1, t)}$$

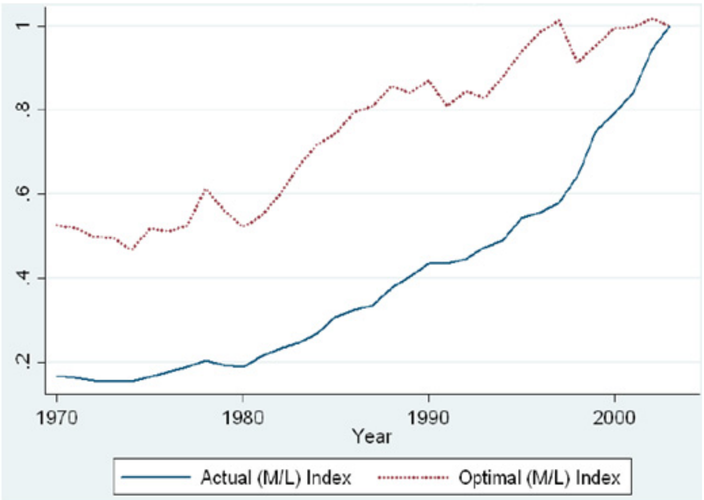
The above set of estimates are calculated for all-industries data (time period 1970-2003) and for panel dataset using 3-digit National Industrial Classification (NIC) codes (time period 1973-2003).

Estimating Distortions

There have been few studies which estimate the extent of distortions in factor allocation. Hsieh and Klenow (2007) quantify this factor misallocation by comparing marginal products of labour and capital in industries in India and China with those in the United States. Fernandes and Pakes (2008) estimate the underutilization of labour and capital across states for Indian manufacturing in 2001. This article uses a similar concept, but rather than estimating absolute values, it measures the distor-

Chart 3

Actual and Optimal Material-per-Labour Ratios (M/L) in Indian Manufacturing, 1970-2003



tions (under- or overutilization) relative to the other factors.

We believe this is a superior approach. If one tries to measure the misallocation or underutilization of factors by the amount of extra labour that will be required to justify the wages, one is assuming that capital is already optimally allocated, which defeats the purpose of this counter-factual exercise. Measuring the relative distortions does not depend on these assumptions and, as shown earlier for a Cobb-Douglas specification, this ratio-based relative underutilization measure is directly related to productivity growth.

Another problem with earlier approaches is the implicit assumption that TFP estimates represent the unit-production-values, i.e. if one amount of each input is employed, the output will be equal to the value of estimated TFP for that period. This is hard to justify since there are measurement errors and many of the unmeasured inputs such as education and economic conditions are also included in the TFP estimates. Therefore, it makes more sense to base the analysis on TFP growth, as is done in this article, rather than on the absolute values of TFP estimates.

Using ASI data, the production function for Indian manufacturing is estimated using Olley-Pakes and Levinshon-Petrin methodologies on the panel dataset. These methods give robust estimates for the labour, capital and material shares. The optimal $\left(\frac{K}{L}\right)$ and $\left(\frac{M}{L}\right)$ ratios are calculated using the estimated factor shares and observed factor prices in the corresponding periods. These are obtained by making the ratios of marginal returns on the factors equal to their relative prices. The estimated underutilization is the difference between this optimal ratio and the actual ratio of inputs used in that period.

$$\text{Underutilization} = \text{Optimal}\left(\frac{M}{L}\right)(\text{Prices}) - \text{Actual}\left(\frac{M}{L}\right) \quad (13)$$

Similarly, the optimal relative substitution values are calculated using observed changes in factor prices and factor allocations between two time-periods. The under-substitution is the difference between the optimal and the actual changes of relative factor allocations.

$$\text{Under-Substitution} = \text{Optimal } \Delta\left(\frac{M}{L}\right)(\Delta\,\text{Prices}) - \text{Actual } \Delta\left(\frac{M}{L}\right) \quad (14)$$

Underutilization of Materials and Productivity Growth in Indian Manufacturing

Using data for all-industries, Chart 3 plots the movement of the actual versus the optimal $\left(\frac{M}{L}\right)$ ratio. Compared to 2003, the actual materials-per-worker index is lower than what the optimal should have been for the existing wages and materials' prices in each year. We find that for the entire period (1970-2003) materials were on average 25 per cent underutilized compared to labour and this average is reduced by half (i.e. 12 percentage points) after the reforms in the 1990s. When estimating the underutilization of materials with a 3-digit NIC code panel dataset, the unweighted average underutilization of $\left(\frac{M}{L}\right)$ over 58 industries is almost the same as the all-industries average (24 per cent for the 1973-2003 period and 11 per cent for the post-reform period of 1991-2003).

Similarly, the estimates show that compared to labour, capital input is being over-utilized in the later periods. These results are similar to those of Fernandes and Pakes (2008), who found overutilization of capital in 2001 and 2004. This overutilization happened because capital prices dropped significantly after 1990s and Indian manufacturing firms started over-substituting capital relative to labour. One explanation for this trend might be the fact that the reforms did not change the labour laws. A firm still needs to obtain government approval to layoff workers and such approval is rarely given. Expecting these issues, firms prefer not to hire the workers and over-substitute other factors (capital and materials) compared to what is optimal at the existing prices. This leads to the observed overutilization of capital.

This article finds that some industries (specified by their 3-digit NIC code) are over-substituting the materials input relative to labour input. This observed presence of over-substitution of materials relative to labour in the 1970s and 1980s does not imply that few firms somehow got around the licensing requirements. It simply means that even when wages went down (relative to materials prices) the firms did not hire more workers. The firms might have done this for two reasons. Their input factor allocation was already distorted and materials were underutilized, so the firms did not want to increase this distortion. Another reason might be that these forward-looking firms knew that in the future they would not be able to obtain the extra materials required to make these workers more productive and neither would they be able to fire these workers if relative prices change again. Thus, they chose not to hire extra workers even when it was optimal to do so at the existing prices.

The estimated average of over-substitution of materials relative to labour for all-industries is around 3.6 per cent per year. But this varies by period, with the average being 0.7 per cent in the 1970s and 7.2 per cent between 1996 and 2003. For the years after the reforms, this over-substitution of materials relative to labour is continuously increasing despite the fact that the materials are no longer underutilized relative to labour. This trend indicates that producers are unwilling to hire workers due to labour market inflexibilities and firing costs, which should be a concern for Indian policymakers.

The period averages of estimated growth rates are shown in Table 3. We can see that firms have been continuously increasing their materials usage much faster than their labour input usage. This

Table 3

Growth Rates in Indian Manufacturing by Period

(average annual rate of change in per cent)

	1970 – 2003	70 – 80	80 – 90	90 – 97	97 – 03
Gross Output	6.0	6.4	6.6	7.0	3.2
Labour	1.1	3.6	0.4	2.7	-3.7
Capital	3.6	3.8	4.4	8.7	-3.9
Materials	6.5	4.8	8.8	6.9	5.4
Value-Added	4.4	6.4	4.1	4.7	0.9
Using Gross-Output					
Labour Productivity	4.9	2.8	6.2	4.3	6.9
TFP	1.3	2.4	2.2	-0.8	2.8
Using Value-Added					
Labour Productivity	3.2	3.0	3.6	1.9	4.3
TFP	2.3	4.6	4.2	-2.2	4.8

Chart 4

Change in Productivity Growth between 1981-90 and 1990-2000 by Average Materials-Gross Output Ratio for 3-Digit Industries

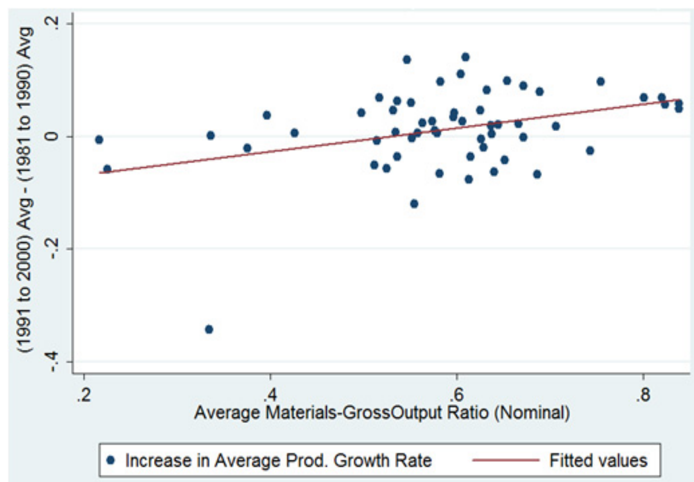
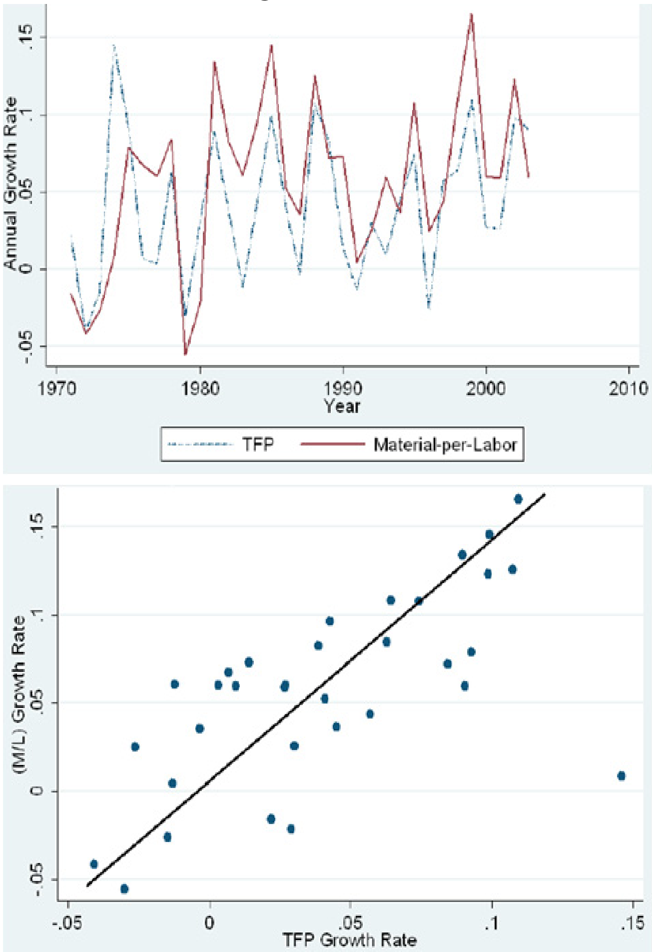


Chart 5
Material-per-Labour Growth and TFP Growth in Indian Manufacturing



results in increased labour productivity growth, averaging 6.2 per cent per year for the 1980-90 sub-period and 6.9 per cent for 1997-2003 as the firms try to move towards an optimal materials-per-worker allocation.

The estimates in Table 3 show that the immediate impact of the reforms was negative, as both labour productivity growth and TFP growth slowed down in the 1990-97 period. But if we look at the jump in labour and capital imput growth during these years, the estimates make sense. Since the industrial reforms coincided with the opening of capital markets in 1991, Indian manufacturing units started expanding due to easier access to capital irrespective of their productivity. But once capital markets developed and competition from foreign firms increased, the resources started flowing from inefficient units and industries to more efficient ones (this reallocation is sometimes called *churning*). The government disinvestment initiative also helped in this process. The result was a 3.2 per cent annual average growth in gross output between 1997 and 2003, despite using less capital stock and fewer workers.

To verify whether the abolition of industrial licensing helped to remove these distortions, this article estimates the industry-wide average productivity growth in the years preceding and following the reforms. Chart 4 presents the results based on a 3-digit industrial panel data according to the average materials to gross output (nominal) ratio for manufacturing. The industries using more materials should have faced higher distortions and hence should have benefitted more from the removal of the restrictions. The scatter-plot in Chart 5 confirms this. It shows the increase in 10-year average annual productivity growth rates between post and pre reform periods (i.e. 1990 to 2000, and 1981 to 1990) is higher for industries that use materials more heavily.

In the Indian manufacturing sector, the interaction of the quota permit system and labour laws led to sub-optimal materials-per-worker usage and thus slowed down labour productivity growth. This mechanism is identified by finding the correlation between underutilization and productivity growth. Similarly, the combination of high inflation in materials and less developed credit markets reduced the intermediate input usage in response to price increases, which in turn resulted in lower labour productivity. This second mechanism is recognized by looking at the relationship of materials inflation with productivity and real wages. This article estimates these two channels using aggregate data (all-industries) and panel data consisting of 58 industries based on 3-digit NIC code. The summary of the main relationships for the

Table 4

Distortions and Productivity Correlations, 1970-2003, 3-Digit NIC Code Panel

Productivity Measure (Y)	Distortion Measure (X)	Corr.	Co-Var.	Pooled OLS β
Lab. Prod. (GO)	Under-Util. M/L	-0.69	-0.29	-0.99***
	Over-Util. K/L	0.6	0.29	0.74***
Lab. Prod. (Val-Add)	Under-Util. M/L	-0.26	-0.15	-0.5***
	Over-Util. K/L	0.29	0.19	0.46***
Δ Lab. Prod. (GO)	Under-Subs. M/L	-0.42	-0.33	-0.5***
	Over-Subs. K/L	0.18	0.2	0.21*
Δ Lab. Prod. (Val-Add)	Under-Subs. M/L	-0.3	-0.28	-0.34***
	Over-Subs. K/L	0.21	0.25	0.36***
Δ TFP (GO)	Under-Util. M/L	-0.31	-0.27	-0.37***
	Over-Util. K/L	0.2	0.13	0.23
Δ TFP (Val-Add)	Under-Subs. M/L	-0.26	-0.21	-0.35**
	Over-Subs. K/L	0.17	0.13	0.19

*10% significance level ** 5% significance level *** 1% significance level

Table 5

Factor Inputs, Prices and Productivity, 1970-2003, 3-Digit NIC Code Panel

Productivity Measure (Y)	Input/Price Measures (X)	Pooled OLS β
Real Wage Inflation	Materials Inflation	-5.91***
		-8.6*** (73-90)
		0.003 (91-03)
Δ Lab. Prod. (GO)	Materials Inflation	-0.32***
Δ Lab. Prod. (Val-Add)	Materials Inflation	-0.39
Lab. Prod. (Val-Add)	L Growth, M Growth	-0.39***, 0.11**
Δ Lab. Prod. (GO)	L Growth, M Growth	-0.46***, 0.33***
		-0.73***, 0.7*** (91-03)
Δ Lab. Prod. (Val-Add)	L Growth, M Growth	-0.34***, 0.18***
		-0.43***, 0.48*** (91-03)
Δ TFP (GO)	L Growth, M Growth	-0.22***, 0.2*** (91-03)
Δ TFP (Val-Add)	L Growth, M Growth	-0.23***, 0.12***
		-0.31***, 0.38*** (91-03)

*10% significance level ** 5% significance level *** 1% significance level

panel data is shown in Table 4 and Table 5; and the estimates are plotted in Chart 5.

For both panel and aggregate data, underutilization of materials is negatively correlated to labour productivity levels and growth. More interestingly, the underutilization of ($\frac{M}{L}$) is also negatively related to TFP growth. The labour productivity relation is simply an implication of distorted input allocations. But it is not obvious why TFP growth should be affected by materials and labour usage. One explanation can be that this underutilization gives rise to other inefficiencies as well. For example, to work with less material input per worker, the production process needs to be reorganized and machines run fewer hours per week. This change in schedule can cause disruption and lower productivity.

The distortion measures (underutilization and under-substitution) are negatively related to TFP growth because of the nature of the Indian government's policies. Labour is bounded by below and material input has an upper bound. Since ($\frac{M}{L}$) is lower than the optimal at existing prices, any change that makes this underutilization worse is going to increase the inefficiencies. That is why labour growth is negatively related to TFP growth and materials growth is positively related to TFP growth.

Labour productivity measured in value-added terms is negatively related to labour growth due to decreasing marginal product. The estimates show that even value-added labour productivity is positively related to materials growth. This highlights the importance of material input for the manufacturing sector performance. The reason for this finding is the widespread underutilization in materials in Indian manufacturing resulting from the presence of restrictive industrial policies. An increase in the growth rate of materials helps to reduce this distortion and enables workers to increase their value-added.

The estimates show that the measures of productivity growth are negatively related to under-substitution of materials relative to labour and positively related to growth in materials usage. These results support the presence of distortion-inefficiency channels operating through the interaction of policies. The under-substitution leads to the worsening of input distortion, and hence using less material inputs per worker, resulting in lower productivity growth. An increase in materials usage helps to bring the input allocation closer to optimal and increases productivity growth. This article also finds that intermediate input (materials) price inflation is negatively related to real wage growth. This negative correlation occurs because in the absence of credit availability, the rising materials prices mean fewer materials per worker and thus reduced labour productivity. This lower labour productivity means a drop in real wages. The overutilization of capital relative to labour has a positive correlation with labour productivity, which is the usual capital-deepening effect.

Role of Economic Reforms

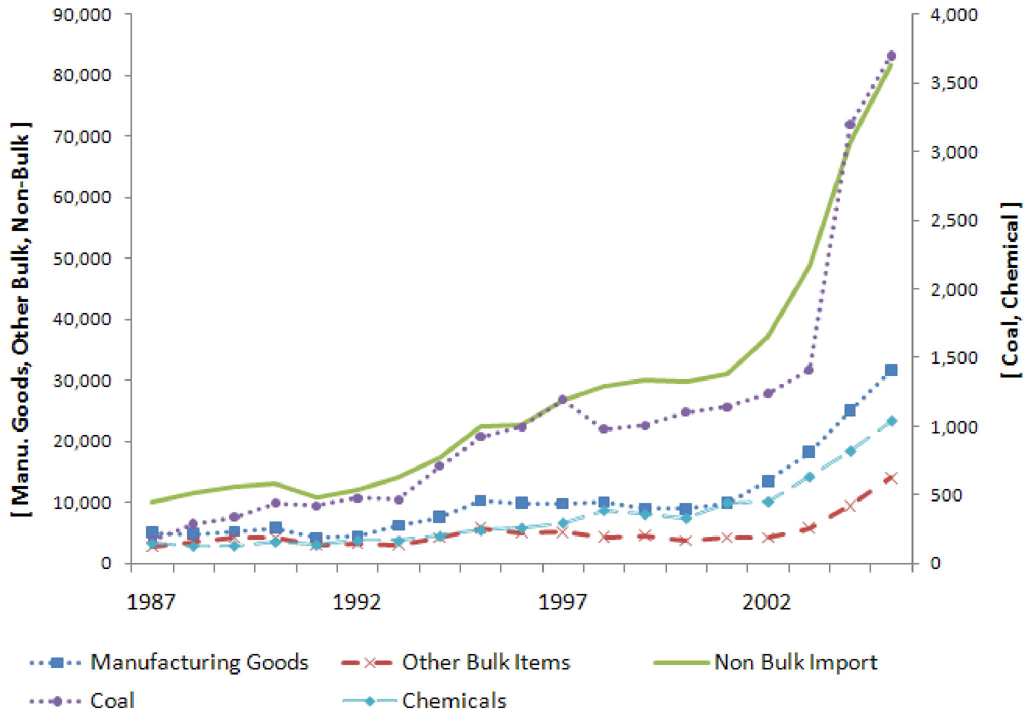
India's current phase of economic reforms began in 1991 when the government faced an exceptionally severe balance-of-payments crisis. The Congress government at the time started short-term stabilization processes followed by longer-term comprehensive structural reforms. In 1991, the government of India adopted the *New Industrial Policy*. It abolished industrial licensing for almost all industries, irrespective of the levels of investment. This industrial policy was supported by trade policy that removed import restrictions and liberalized foreing direct investment as part of the multi-faceted gradual reform process. Ahluwalia (2002) outlines and evaluates these sets of structural reforms. India's reform program also included wide-ranging reforms in the banking system and capital markets relatively early in the process, with reforms in insurance introduced at a later stage.

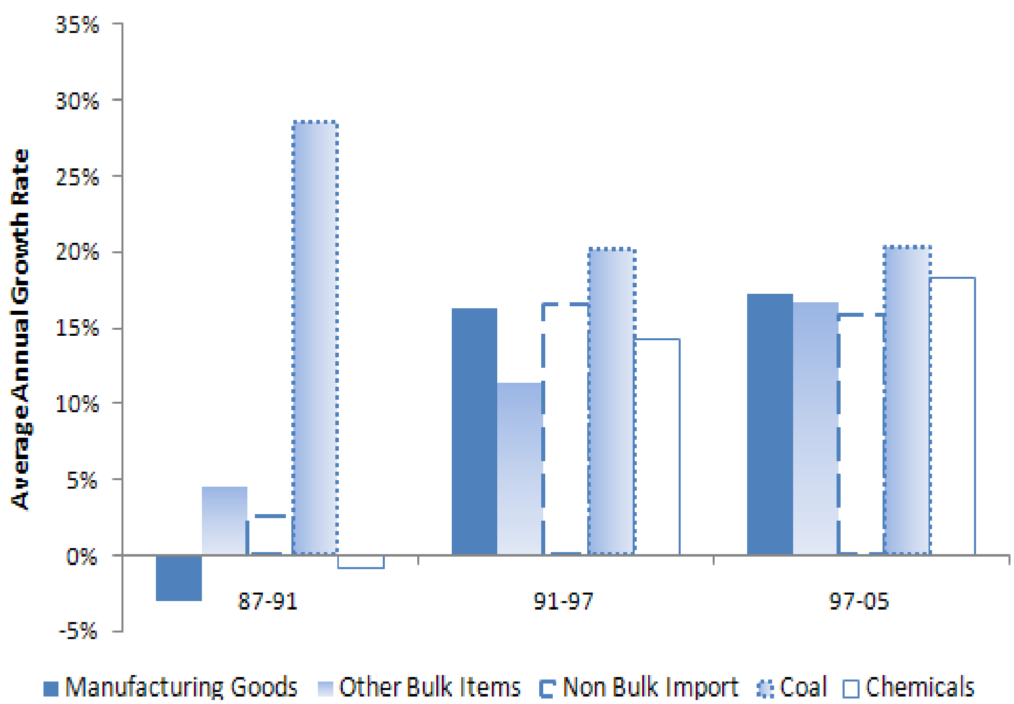
These reforms broke down two major links that were responsible for distorted input usage and lower productivity growth. The removal of quantitative restrictions meant that firms were no longer forced to operate at a sub-optimal level. Firms still cannot reduce the number of workers, but they can increase the intermediate inputs usage (and capital usage) and make the allocation optimal for given prices. Similarly, improved credit access meant that firms could reach this optimal allocation even in periods of high inflation. Firms can borrow money, use the optimal inputs and repay the loan after selling the output (because higher intermediate input prices usually mean that output prices are also higher).

The estimated growth rates and relationships among them in Tables 3 and 4 clearly show the positive impact of the reforms. After the reforms, materials growth averaged around 7 per cent per year between 1991 and 2003 for all-industries. The effect of materials growth on labour productivity growth and TFP growth amplified after 1991. The pooled OLS coefficient between materials growth

Chart 6

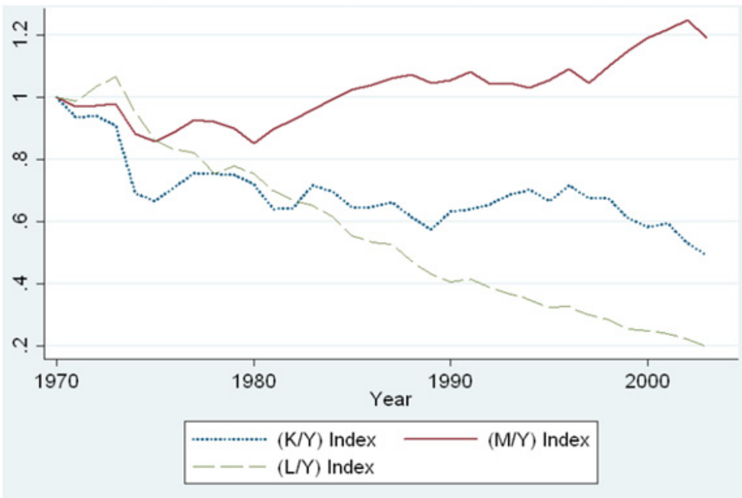
Imports of Intermediate Inputs in India – Levels and Growth Rates, 1987-2005





and labour productivity growth is 0.7 for the sub-sample 1991-2003, more than double the value for the entire time period of 1970-2003. The increase in coefficient value implies that materials growth is becoming more important in labour productivity growth.

Chart 7
Input/Output Ratios in Registered Indian, Manufacturing, 1970-2003



As mentioned earlier, some of the estimation results run contrary to the conventional wisdom which suggests that growth in net value added should not depend on materials at all. This article finds that labour productivity growth and TFP growth measured in value added terms are strongly correlated with growth in materials usage. This relationship becomes stronger after the reforms (pooled OLS coefficient is 0.48 for subsample of 1991-2003 compared to 0.18 for the entire time period). The relationship between intermediate input inflation and real wages breaks down after the reforms. The coefficient is close to zero and no longer significant after 1991. The explanation is that the inflation-productivity mechanism was being driven by low credit availability. Reforms increased the credit availability by liberalizing capital markets.

Another important consequence of the economic reforms was that one of the restrictions that only applied to the manufacturing industry was removed. The import quota and industrial licensing policies abolished during the reforms were more relevant to the manufacturing sector than the service sector. In recent years, the growth rates of the manufacturing sector have been higher than the service sector growth rates; this was something very uncommon in the years before the reforms.

Did Import Quotas Lead to Underutilization and Bottlenecks?

The quantity restrictions were only applicable to imported goods. But there were no controls on buying intermediate inputs from within the country. It will be prudent to make a distinction between imported and domestic materials input and then re-do the whole analysis. The underutilization and its negative effect on Indian manufacturing productivity should exist only for imported materials. Unfortunately, the ASI dataset does not have the split between domestic and imported materials.

We can look at two different trends which indicate that the imported intermediate inputs were the real bottlenecks in Indian manufacturing. The actual production process of many manufacturing industries can be characterized as a Leontief specification, where production involves transforming the input. In such industries, output - and thus labour productivity - becomes restricted by the least freely available input. In the presence of an import permit-quota system, the least freely available inputs were imported intermediate goods.

If imported inputs were the bottlenecks, the removal of these restrictions would lead to an increase in demand for these inputs without corresponding increase in the other inputs. That is exactly what happened in Indian manufacturing. As shown in Table 3, the materials input grew at the average annual rate of 6.9 per cent and 5.4 per cent for the 1990-97 and 1997-2003 periods respectively. The corresponding average growth rate for labour input were 2.7 per cent and -3.7 per cent. Chart 6 shows the growth in imported raw materials and intermediate inputs. There is a distinct jump after the reforms. The growth rates of all the imported items other than coal increased significantly. Indian manufacturing firms that were previously forced to operate at less than optimal $(\frac{M}{L})$ ratio due to quota restrictions started moving towards their potential productivity by importing and using more intermediate inputs.

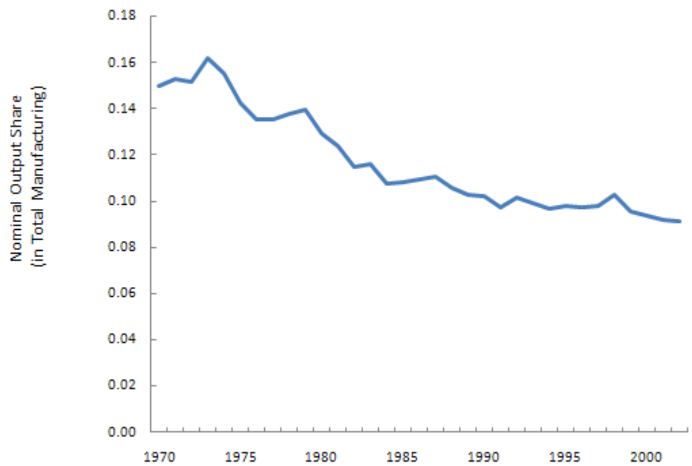
The continuous increase in the material content of output, as shown in Chart 7, indicates that Indian manufacturing is becoming more specialized or high-end. But the production of (low value) intermediate goods is not being outsourced to the unorganized manufacturing sector in India, as both output share and output growth rates of the unorganized manufacturing sector have declined in the years after the reforms (Chart 8).

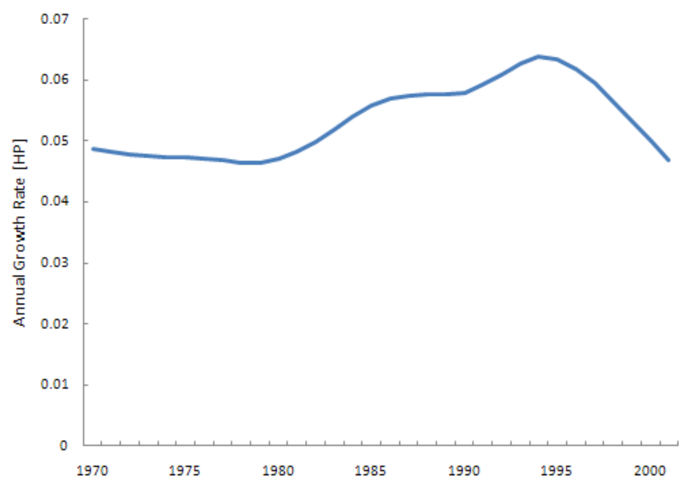
This reaffirms the belief that only the imported intermediate-inputs were the bottlenecks. The Indian manufacturing firms were not restricted in their access to raw materials and intermediate-inputs that were domestically available. But these goods were not perfect substitutes for the quota-restricted imported intermediate inputs. The production functions of manufacturing firms (e.g. chemical, semi-conductors, electronics, and specialized goods) often have Leontief type complementarities between intermediate inputs and labour input. The restrictions on these goods created a bottleneck that choked the productivity growth in Indian manufacturing.

In fact, the concurrent trends of the increase in the growth rates of imported intermediate goods and the decrease in the growth rates of unorganized manufacturing output are consistent with the mechanisms discussed. Since there were no restrictions on buying domestically produced raw materials, which were often bought by the unorganized manufacturing sector, the reforms had no direct effect on these firms. But the firms in the organized sector, which were previously using the (imperfect) substitutes produced domestically by the unorganized sector, started reducing their reliance on these domestic goods after the reforms and started importing the desired intermediate inputs.

Chart 8

Share and Growth Rate of the *Unorganized* Manufacturing Sector in India, 1970-2003





This is why the output growth rate of the unorganized sector fell in the late 1990s.

Conclusion

This article has shown how the import permit-quota system in the presence of inflexible labour laws resulted in input distortions in Indian manufacturing that had negative effects on productivity growth. The role of intermediate inputs in the manufacturing sector deserves greater attention, especially for developing countries. Even though the reforms have abolished import restrictions in

India, labour laws are still unchanged. Indian manufacturing firms are shying away from hiring workers, which is not socially desirable. India has a huge pool of unskilled workers and the need to move them out of the unproductive agricultural sector is becoming more urgent. Policymakers should reconsider these labour laws in view of the fact that they are hindering employment growth and leading to jobless output growth in Indian manufacturing.

The evidence of the mechanisms identified in this article would be more robust if the data on imported and domestic materials input were included in the analysis. In the absence of such data, one could try to rank the industries based on their imported input requirements and then see whether the effects are more severe in the industries that use a larger share of imported materials. Another important dimension in analyzing the results is the production function complementarities between materials and labour. We should see more prominent results in industries which have Leontief type production processes.

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