Pre-reform Conditions, Intermediate Inputs and Distortions: Solving the Indian Growth Puzzle

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Abstract

This paper answers the puzzling questions that why under the similar set of economic conditions service sector in India grew while manufacturing could not and how economic reforms in 1990s accelerated the productivity growth. The paper provides a very innovative and convincing explanation. Two subtle but important *distortion-inefficiency* mechanisms, which work through distorting the intermediate input allocation, are identified in the paper. *Interaction* of policies of quantitative restrictions and inflexible labor laws resulted in lower than optimal materials per worker usage.*Combination* of high inflation and unavailability of credit exacerbated this factor distortion and lowered the productivity growth further.

Using panel data on Indian industries, I find underutilization of materials compared to labor until recently. This sub-optimal materials per worker usage lowers productivity growth. Productivity estimates are negatively related to labor growth and positively related to materials growth. Real wages and labor productivity are negatively related to materials inflation and this relationship breaks down after the capital market reforms in 1990s. Since these mechanisms work through intermediate inputs, service sector productivity is not affected as adversely. Estimates show that after 1990s firms have started over-substituting materials and capital relative to labor, which can explain the jobless growth in Indian manufacturing.

Keywords:

License Quota. Labor Laws. Price Change and Factor Substitution. Credit Constraints. Intermediate Inputs. Distortions and Productivity Growth.

JEL Classification:

B41, C43, D24, D45, J08, L6, M41, O4, O47, O53.

1 Introduction

It is often argued that Indian manufacturing sector never really took off. There is nothing equivalent of green revolution of 1960s in agriculture sector or the service sector boom of late 1990s. Hulten and Srinivasan (1978) [15] describe this absence of a period of consistent high growth rates by saying that Asian miracle has largely missed the Indian manufacturing. More recently, Fernandes and Pakes (2008) [12] document how value added in Indian manufacturing does not compare with other developing countries like China and Vietnam for the period between 1995 and 2005. Even within India, manufacturing growth performance is not similar to that of service sector. Using National accounts data, figure 1 shows GDP and output shares of manufacturing and service sectors in India for 1960-2002. The output of manufacturing grows during these 43 years but that growth is lower than the growth in services output which starts growing exponentially after 1990s. The contrast between these two sectors becomes clearer when looking at the output shares. Share of services has been growing continuously while manufacturing share remains almost constant. If we look at the sources of growth, the numbers present even more puzzling picture. Based on data from Bosworth and Collins (2008) [7], figure 2 compares the contribution of factors and TFP for manufacturing and services growth in India and China. Somewhat contrary to the often cited explanation of Indian manufacturing lagging because of closed capital markets, the growth of capital accumulation for the period between 1978 and 1993 in Indian manufacturing is same as the capital accumulation growth in Chinese manufacturing. It is the dismal TFP growth of 0.3% in Indian manufacturing which is responsible for the difference in output growth performances. During the same time-period TFP growth in service sector in India is 1.4%, almost 5 times the TFP growth in manufacturing. Effect of economic reforms in India is remarkable for both the sectors. After the reforms, TFP growth increases 3 times for Indian manufacturing and services. Improvement in growth performance of India after 1994 is mostly due to acceleration in TFP growth. TFP growth average between 1994 and 2004 is 1.1% per year for manufacturing sector and 3.9% per year for service sector.

Why is it that under similar set of economic environment service sector grew at remarkable rates while manufacturing sector did not? How did reforms in the 1990s change things and help in accelerating the productivity growth? What effect or improvement is this residual(TFP) growth capturing? This paper differs in its approach to answer these puzzling question by introducing two very crucial aspects which previous studies lack. First is the role of *intermediate inputs* which is missing from the discussion despite it being the most important differentiator between manufacturing and services production processes. Second innovation of this paper is to study the effect of *combinations* and *interactions* of policies which can be totally different from effects of policies separately. Adding these two dimensions provides a convincing and complete picture of Indian growth experience. The paper finds that the difference in growth performance of these two sectors is because manufacturing sector relies heavily on intermediate inputs while service sector does not. Interactions and combinations of policies (inflexible labor laws in presence of quota-permit system) and economic conditions (high inflation in presence of credit unavailability) in India created distortions resulting in production inefficiency. These mechanisms hampered the productivity growth by forcing manufacturing firms to operate at non-optimal intermediate input allocation. Economic reforms in 1990s helped in breaking the distortion by removing many of the restrictions and hence the inefficiency mechanisms disappeared. This paper provides detailed insights into these economic mechanisms which channeled the effect of government policies into firm productivity.

In economic growth literature importance of intermediate inputs or raw materials has been ignored. Interesting debate on role of "perspiration" or factor accumulation vs. "inspiration" or productivity improvements has overshadowed other important aspects. Almost all of the studies treat factor accumulation as synonymous to capital per worker growth. Materials are important inputs in the production process (more so in manufacturing than services). For registered Indian manufacturing the paper estimates that factor share of materials in the gross output production function is 0.6, *three times higher than capital share*. Studies on intermediate inputs have mostly been focused on how intermediate inputs should amplify the TFP growth due to aggregation. Role of intermediate inputs in promoting or (as I find in this paper) in restricting economic growth is not well understood. Ever since the re-emergence of growth literature after "Asian miracle", capital accumulation (along with alternative technological progress view) has been the favorite explanation and policy recommendation. But it seems unfair to devote all the attention to just one factor of production (capital) and ignore the more important materials input[1]. From a researcher's perspective, input factor that is in scarcity is the one that offers interesting insights into potential of an economy to increase the output. This can in part explain the

[1] Another reason for lack of studies on role of materials is that in National Accounts intermediate inputs balance out when aggregated over entire economy. Effect of imports (aggregated materials input) on growth has been studied. But this paper shows how such an effect works. The channels identified in the paper effect productivity and growth directly but operate through very subtle interaction of economic policies and conditions.

dominance of studies on the role of capital. But recent trends of surges in commodities prices driven by economic growth in India and China and of competition among different industries for the raw materials make a strong case for expanding our understanding of role of intermediate inputs or materials in the economic growth process. Using simple accounting, this paper shows that growth of both gross output and value added depends on materials per worker growth. This paper also finds that for Indian manufacturing material input was the limiting factor responsible for the observed low output growth. Estimates show that restricted materials per worker usage lowered the productivity and output growth in periods before the reforms.

Another issue with the earlier papers is that to attribute any estimated effect to a policy, researchers need to isolate it from other policies. But *ceteris paribus* assumption does come at a cost because interaction of different economic conditions may give rise to mechanisms or incentives that are totally different from the predicted outcomes of any individual condition. This is especially true in case of India, where different policies are not always coordinated together and are not necessary in synchronization. Rajan, Kochhar, Subramanian etal. [20] describe development policies India adopted after its independence as "idiosyncratic". The reason for manufacturing growth rates being relatively lower lies in the way Indian economy has evolved. By the time industrial growth started to become focus of five-year plans , India had already embraced the socialist model of planning. Government regulations and control became entwined with Indian industry including the notorious "license-raj" (the quota-permit system) and rigid labor laws. Besley and Burgess (2002) [3] show that pro-worker industrial dispute acts tend to lower the output, investment, productivity and (surprisingly) employment in manufacturing. Fernandes and Pakes (2008) [12] also find that labor is underutilized in states with more restrictive labor laws (e.g. amendment to the Industrial Disputes Act which made the firing of workers illegal except with previous permission from the appropriate state government).

The question that remains unclear is why do these supposedly "worker friendly labor laws end up reducing productivity and inducing underutilization". More importantly, why did these laws affect performance of manufacturing sector but not the service sector? This paper shows that it is because of the presence of additional (often ignored) policy of quota system. The economic mechanisms, arising from the interaction of the quota system with existing conditions and labor laws, distorted the usage of intermediate inputs that are very important in manufacturing production function (share of 0.6) and hence resulted in inefficiencies only in the manufacturing sector and not in the service sector.

Unfortunately, the effect of quota-permit system on Indian industry has not received its due attention. Mohammad and Whalley [18] discuss some of those licenses and other controls. Their estimates of the welfare loses from rent seeking in India are as high as 30% to 45% of GNP. The main sources of rent seeking were price controls and rationing. Das [11] finds out that the structure of import licensing remained restrictive and complicated throughout 1980s and even in early 1990s. Most important thing is that in general labor laws have not changed dramatically and economic reforms have focused more on removing these license regulations rather than labor rigidities. So the observed improvements in the performance is more likely to come from the removal of quote-permit system. It seems that researchers focussed on just the labor market regulation have been ignoring this simple observation.

The paper argues that it is the *combination* of these two different distortions (labor rigidity and input quota) which is impeding to productivity. An optimizing firm has to equate its labor and materials ratio such that marginal returns are equal to respective prices. But if due to labor laws it can not fire extra workers, it ends up needing more input to reach the optimal allocation. Even if we assume that it has access to credit, the firm can not buy enough input because of quota-permit distortion. Hence the firm ends up operating at *non-optimal* levels. Notice that by itself none of these policies lead to distorted allocation. Does input distortion affect productivity? Chand and Sen (1996) [9] find that liberalization of the intermediate-good sectors is better for TFP growth than liberalization of the final-good sectors. But there is no detailed study on why that is the case or any research into role of intermediate inputs in affecting productivity due to distorted economic conditions.

Furthermore, this *inefficiency mechanism* becomes more effective in reducing productivity when there is high inflation and less access to credit markets. This was exactly the case in India before the reforms, especially in 1970s. There are many studies on inflation-growth nexus. Barro (1995) [2] and Chari, Jones and Manuelli (1996) [10] show that lowering inflation increases the GDP growth rate. The link works through effecting returns to savings and thus capital accumulation. This paper provides a new perspective on role of inflation in affecting growth in Indian manufacturing. Inflation combined with credit unavailability forces firms to operate at non-optimal input allocation because they can neither reduce labor (due to labor laws) nor afford to buy materials (credit constrained and higher prices). The paper finds strong relationship between materials inflation and real wages (labor productivity) indicating presence of this channel.

The paper also contributes to two other streams of research, namely labor market regulations and import substitution policy. Ahsan and Pages (2007)

[19] find that in India pro-worker labor policies are associated with reduced productivity growth. Kruger (1997) [17] discusses how it was thought that import substitution in manufactures would be key to development. Bruton (1998) [8] compares earlier trend of import substitution to "new orthodoxy of outward orientation". The industrial quota permit policy in India was motivated by this import substitution view. Earlier explanations about both these observations, i.e. labor laws slowing growth and import substitution policies slowing growth, are based on calculating implicit costs or wasted resources. This paper finds a direct channel (intermediate inputs) and interesting mechanisms through which productivity is affected. The paper also shows how these policies interacted with each other and existing economic conditions unfavorably and ended up being responsible for lower productivity growth.

One of the major impact of economic reforms in India is in breaking these interactions by removing permit quotas and by making the credit easily available. Aforementioned *distortion-inefficiency* channels no longer remain relevant because firms are not restricted (in materials; labor firing restrictions have still not been removed). The paper finds that both the distortions in input allocation and the effect of these distortions in productivity growth reduce significantly after the reforms in 1990s. What is worrisome is that estimates show that firms have started over-substituting the materials relative to labor. This explain the mystery of jobless growth in Indian manufacturing. Firms are growing because of *material-deepening*, but they are avoiding hiring additional workers due to expected inflexibilities and legal issues. Like many other studies this finding calls for policy makers to look at the labor market regulations in India.

The rest of the paper is organized as follows. Indian economic environment and policies are discussed in next section. Paper shows basic growth accounting setup with materials and explains the interaction of these policies and their effect on productivity via distorted materials usage in section 3. Two sets of input distortion measures are calculated in section 4 and section 5 discusses the impact of these distortions on productivity estimates. The paper also talks about how reforms changed these mechanisms.

2 Pre-reform conditions in India

Industrial sector became the focus and one of the early goals of five-year plans of Indian government. Just like every other part of the economy, Indian manufacturing has experienced the evolution of policies and markets in last three decades. It has been subject of many productivity and policy research studies, but often for the wrong reasons. Because unlike other sectors and unlike manufacturing sectors in other developing countries, industrial sector in India did not register many years of consistent high growth until very recently. Even though manufacturing sector has not seen explosive growth like service sector, its share in the total output has grown during last 3 decades. GDP (at 1993-94 prices) of manufacturing has grown almost 10 times between 1960 and 2002. But unimpressive productivity and TFP growth rate estimates from various studies have portrayed Indian manufacturing as a stagnant sector with little effect of early stages of policy reforms. Das (2003) [11] finds a negative TFP growth over the period 1980-2000 and attributes this to structural factors. Madheswaran and Rath (2004) [21] argue that even though TFP in many industries improved, it was driven by technical progress and all technical efficiency changes were negative. Another branch of research tries to find the explanation for this relatively slower growth. The probable causes almost always include inflexible labor laws which make it difficult for firms to lay off worker. But the literature does not discuss three other equally important characteristics of the economic environment under which Indian firms were operating. First is that in addition to the usual import tariff, India also had quantitative restrictions on many of the commodities. Second is the inflation in 1970s which was very high. Third is the lack of easy access to credit for the firms. This paper explains how the combination of these three conditions and the labor market regulations led to non-optimal factor allocation in manufacturing which resulted in reduced productivity. It affected only the manufacturing sector because these inefficiency mechanisms worked through distortions in intermediate inputs usage.

2.1 High Inflation

Inflation has been consistently high in India. Annual average CPI inflation has been 8.2% per year between 1970 and 2003. Pre-90s and Post-90s inflation rate averages are 8.6% and 7.4%, both much higher than average inflation in industrialzed and newly industrialzed countries. For China the average of retail price inflation between 1978 and 2003 is around 5%.

Barro (1995) [2] in the study of 100 countries between 1960-1990 finds that increased inflation reduces GDP growth after accounting for country characteristics. Chari, Jones and Manuelli (1996) [10] explain this relation quantitatively using endogenous growth model. Changes in inflation rates affect real rate of return to savings and thus growth. But surprisingly none of the studies have looked into role of inflation on Indian growth. This is despite the fact that high price increases especially in 70s and 80s motivated many of the policy interventions.

Intermediate input prices have also experienced the same kind of high inflation through last three decades. The average annual inflation rate of materials prices is 7.5%. Using industry specific price index data from Central Statistical Organization, I calculate the average inflation rate for each of the 58 industries. The average inflation is higher than 7% per year for 53 of them with few industries experiencing price increases averaging more than 11% per year between 1973 and 2003.

Inflation matters in more ways that just the "shoe-leather costs". For example most business income tax systems are not indexed for inflation; i.e., depreciation allowances are not indexed to inflation so if inflation becomes high, the real deduction for depreciation becomes too low. Profits are way overstated, real tax burdens can exceed 100% and companies with lots of long life assets go bankrupt. This happened in the 1970s in the UK and other countries.

Despite these issues, it is true that inflation by itself does not have any direct neagative effect on productivity growth and even if it does, the effect on manufacturing and service sectors should be the same. But combined with limited access to credit market, high inflation in material prices forces firms to use less material per labor and hence reduces the productivity. Concurrent inflation in labor prices (increase in wages) combined with inability to reduce labor allocation makes this distortion (sub-optimal materials usage) worse and productivity growth lower. Inflation rates for both materials prices and for wages are very high. For the period between 1970 and 2003, annual nominal wage inflation in Indian manufacturing is 9.6% with nominal wage increase of 11.1% per year before 1990 and 7.1% increse per year after 1990.

2.2 Low Credit Availability

It was the currency crisis of 1991 in India that paved the way for broad set of reforms including capital market reforms. Before that credit markets were non-organized and underdeveloped. Figure 3 shows the lending rates of various countries using data from International Financial Statistics. For India, it is 16.5% for the entire decade of 80s, which is not only higher than developed countries like United States and Germany but also higher than other asian economies like Sigapore and Malaysia. Cost of borrowing is very high in India until late 90s. Credit markets were also underdeveloped. Table 1 shows stock market capitalization in 1990 and for India market capitalization as percentage of GDP is much lower than other countries.

Role of financial markets in economic growth has been discussed in many studies. King and Levine (1993) [16] find that various measures of financial development are strongly related to GDP growth. The relationship works by promoting efficient capital accumulation and thus increase in output. This paper discusses a more subtle yet direct role of finance in the context of Indian manufacturing. Consistent increase in input prices each period requires firms to look for credit if they want to keep operating at the same scale. Lack of credit arrangements would mean that firms need to pay at the beginning of the period while their output will be sold (even if at higher prices than last period) at the end of the period. Firms have the money from sale of output last period, but if materials' prices go up significantly it might not be enough for buying sufficient intermediate inputs or materials. This forces firms to use less materials per worker resulting in reduced output per worker and thus lower productivity growth.

Why don't firms operate at the new optimal allocation for the given prices? It might have been possible for firms to do that by reducing the labor as well. But unfortunately in India firing workers is not easy due to the government laws. So rather than providing the cushion against materials inflation and no credit availability by allowing adjustments in the labor input, workers in the firm make the situation worse because of nominal wage inflation. Not only did the firms fail to achieve their potential output, they have to pay more to their over-optimal workers. This continues the reduced productivity cycle in the next period: reduced growth due to distortion leading to less cash and inflation next period means more distorted materials usage again, and so on. It provides a convincing explanation for observed persistence of productivity slump in Indian manufacturing before mid 90s.

2.3 Inflexible Labor Laws

The *Industrial Disputes Act* 1947 states that "dismissal of an individual workman to be deemed to be an industrial dispute". This law has motivated many studies on role of labor market regulation in India. Labor regulation has become a standard part of the explanations for India's poor growth performance before mid-90s. Besley and Burgess (2002) [3] show that states which made amendments to this act in pro-worker direction experienced lower output and productivity in Indian manufacturing. They also find that pro-worker labor regulation is associated with increases in urban poverty. Fernandes and Pakes (2008) [12] use World Bank Investment Climate Survey data to show that conditional on firm productivity, other factors and factor costs faced by firm, labor is underutilized in Indian manufacturing in 2001 and 2004. The supposed explanation is that these inflexible labor laws restricting the firing of workers in India resulted in firms lowering their demand for labor. But none of the studies have looked into why this labor regulation affected productivity. Another important consideration missing from this "labor regulation leading to lower growth" literature is why did this regulation not hampered the growth in the service sector. The paper provides a clear economic explanation by showing that these labor friendly laws interacted with other economic conditions and policies. Because of these interactions firms were restricted to choose sub-optimal input allocation. This led to lower labor productivity and wage growth. Intermediate inputs or materials were the channels by which the policies interactions took place and hence the severity of the effect on growth is different between manufacturing and service sector.

Ahsan and Pages (2007) [19] discuss various types of labor laws in India, including Chapter Vb of amendment to Industrial Disputes Act which prohibits firms that employ more than 100 or more workers to retrench 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. Ahsan and Pages (2007) [19] find that regulations that impede employment adjustment are associated with negative effects on output. But all previous studies on estimating the effect of labor market regulation in India on growth have stressed mostly on the explanation that these regulations add implicit extra cost. Literature does not have much discussion on how that extra cost translates into lower productivity. The paper argues that there is another very important and interesting economic dynamics these labor laws generate. The number of workers in a firm becomes inflexible (can go only upwards) and when the amount of materials that is available to the firm is also restricted due to industrial policy of permit-quota, the input factor allocation in the manufacturing production process may become distorted (less than optimal materials per worker for the given prices). Firms have too many workers and too little materials. They are restricted on both dimensions. They can not reduce one (workers) easily and can not increase the other (materials) easily. Hence they are stuck to operate with this forced production inefficiency. The interaction of labor laws with quota permit policy can also explain why the productivity in Indian manufacturing is affected more badly than the productivity in the service sector.

2.4 Quantitative Restrictions - Quota Permit

In his 1978 book Bhagwati [4] talks in detail about quantitative restrictions which were the building block of industrial policy in India. These were guided by principal of *import substitution* and were justified by the aim of protecting the domestic producers. Commodities were divided into various categories and producers needed to apply for license for items not under OGL (open general license). Licenses were required for producing new products or expanding production capacities. Mohammad and Whalley (1984) [18] estimate that cost of these rent seeking policies in India was as high as 30% to 45% of GNP and it "put India in a different category altogether".

Despite being one of the most widely criticized policy choices, not many studies have tried to identify and estimate how this affected the growth in Indian manufacturing. Bhagwati (1970) [5] documents the industrial licensing scheme adopted in India after passage of The Industries (Development and Regulation) Act of 1951. There were separate license categories. CG (capital goods) license was required to import necessary capital goods. The AU (actual user) licenses issued to producers for imports of raw materials and intermediates 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 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.

Previous studies that have tried to measure the effect of this policy use the approach of estimating the cost in terms of wasted resources, time and opportunity cost. But the quota permit policy affected Indian industries in more ways than just increasing the fixed cost. These restrictions and license requirements meant that firms were not free to choose the raw materials and intermediate inputs freely based on the prices. This paper discusses far more important and direct effect of quota restriction on the labor productivity and its growth which has been ignored till now. Quota policy creates input distortions in presence of the inflexible labor laws which is not recognized when studying the policy in isolation. The distortion occurs because these two policies restrict the choice set of producers. Labor laws put a lower bound on the number of workers firms can chose in the output production process. Labor can only go up from the current allocation. Quantitative restrictions and permit license put an upper bound on the materials and intermediate inputs a firm can use. These two together create situations where a firm might be forced to operate at non-optimal allocation for the given prices. In general this would mean that firm is using less than optimal materials per worker. This paper measures the degree of restriction in choices by estimating the difference between the optimal and the actual allocation. This distortion and consequently its effect on productivity does not pertain to service sector. Because services production depend mostly on capital and labor and not so much on raw materials and intermediate goods which were restricted by these industrial licensing regime.

To get an idea of severity these restrictions one can look at the implied protection rates due to these quantitative restrictions. Bhagwati (1970) [5] estimates this by calculating the differences between the actual value-added and the hypothetical value-added with just the import tariffs. Estimated average protection rates due to quantity restrictions are four times as large as the protection rates due to actual import tariffs. In 1961-62 the protection rates due to quantitative restrictions are in 60% to 80% range when measured at domestic prices and even higher when measured at international prices. These estimates mean that value-added of industries was reduced by as much as 80% in 1961 due to these quantitative restrictions or put another way the value-added of Indian manufacturing would have been 80% higher if these restrictions were not present. The paper identifies the channels by which the restrictions resulted in reducing the value-added by so much. It is because quantitative restrictions interacted with worker-friendly labor laws forcing industries to operate at non-optimal input allocation which resulted in poor productivity growth and thus reduced value-added.

3 Interaction of policies via intermediate inputs

What is really interesting is the fact that these factors separately should have no affect on efficiency, but in presence of others they created economic mechanisms that hampered the growth. Second nice observation is that these mechanisms work through intermediate inputs and hence affect especially the manufacturing sector. The paper identifies following two channels which work via interaction of economic conditions mentioned earlier.

1. High Inflation in presence of Credit Unavailability
2. Quota Permit in combination with Labor Restriction

Inability to reduce workers combined with fixed quota of materials led many firms to operate with less than required (optimal) inputs. This distortion not only restricts the output, it also reduces the worker productivity. If due to technological improvement it becomes possible for a worker to convert more input into output than the last period, this technological progress will not translate into productivity improvement. The firm needs to either get permit to increases its materials quota or it will have to get approval for reducing the labor. Both of which lead to rent seeking by government officials and firms try to avoid it. Thus firms end up operating at the restricted allocation and do not experience the possible output and productivity growth.

This should show up as reduced materials usage compared to labor allocation. The paper measures the relative underutilization (and also estimates the under-substitution in each period that results in this underutilization).

The second mechanism of high input prices combined with difficult credit availability leads to inefficiency in similar kind of manner. Inflation might reduce output growth because input factors need to be paid at the start of the period while payment for output is received at the end of period.This means that a consistent and high inflation will lead to sub-optimal allocation (compared to low inflation case). The situation is more relevant when there is lack of capital market and/or interest rates are high (which is exactly how things were in India). If input prices go up, a credit constrained firm can no longer afford to buy the same amount of materials. This reduced materials usage lowers labor productivity. The paper checks the relationship of productivity estimates with materials growth and with labor growth.

3.1 Growth Accounting with Materials

Let us consider a simple extension of Solow's growth accounting model by including materials as input in the constant return to scale production function for gross output.

$$Y = AK^{\alpha}M^{\beta}L^{1-\alpha-\beta} \tag{1}$$

This can be rearranged in per-worker terms.

$$\frac{Y}{L} = A(\frac{K}{L})^{\alpha}(\frac{M}{L})^{\beta} \quad \Rightarrow y = Ak^{\alpha}m^{\beta} \tag{2}$$

Growth rate of output per worker between two periods can be expressed as following.

$$\Delta y = \Delta A + \alpha * \Delta k + \beta * \Delta m \tag{3}$$

Labor productivity growth is weighted sum of TFP growth, capital per worker growth and materials per worker growth. The third term in equation 3 which denotes *materials deepening* is the one that, although missing from the literature, can be of crucial importance in explaining economic growth in a country. Estimated values of $\beta = 0.6$, $\alpha = 0.2$ indicate that materials per worker is very important (more than capital per worker) in growth accounting.

To give credit to previous researchers, I admit that in value added production function only labor and capital should be used as input and hence ignoring role of materials growth seem justified. But let us see whether there is any relationship between gross output growth and value added growth. Assume that value added for the economy is Y_1 which is obtained by subtracting the value of intermediate inputs from gross output.

$$Y_1 = Y - P_M * M \tag{4}$$

$$y_1 = Ak^{\alpha}m^{\beta} - P_M * m \tag{5}$$

These simple accounting equations contradict the notion that value added production is independent of materials used or that materials per worker does not affect growth in value added. It highlights the cost of such a simplification. In fact, *Domar weights* and *Terms of Trade decomposition* methodologies take care of these issues regarding intermediate inputs [2]. But even though the effect of materials per worker in economic growth is clear from equation 5, this consideration is missing from most of the economic growth literature. The reason is that ideally this input should have been allocated to equate the returns between factors. Hence concentrating only on "extensive margin" (supposedly the capital input) of output growth makes sense in general. But government policy or in case of India, the interaction of government policies can distort this materials input allocation compared to other inputs. This has effect on growth that is even more important than the effect of often discussed capital-deepening. The paper defines and estimates some measures of this distortion by comparing it to the (hypothetical) optimal allocation.

3.2 Distortions and Inefficient Substitution

Presence of the channels, that transfer the effect of interaction of policies (labor laws in presence of quantitative restrictions) and economic conditions (high inflation with low credit access) to production process and hence economic growth, can be verified using the data. From production function estimates, one could identify whether the ratio of labor and materials is higher than or lower than the optimal $\frac{L}{M}$. Higher means either using a lot of labor (since firms can't fire them) or less material (due to quotas). The presence of these policies together is forcing firms to choose a sub-optimal input allocation. In fact this ratio can go either way, depending on whether firms already hired labor which they can't fire now OR expecting this trouble they hire less labor and use more material. It turns out that in India, after the import quota restrictions were lifted during the economic reforms, firms have stopped hiring labor and have instead increased the usage of materials.

[2]See Gupta (2008) [13] for detailed estimation results of growth in Indian manufacturing using these two methods.

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, labor L and materials M. A is the measure of production technology and other unobservable inputs. Optimization gives following first order conditions for input allocation in terms of price of labor w and price of materials p_M.

$$w \propto \frac{\partial Y}{\partial L} \tag{6}$$

$$\frac{(\frac{\partial Y}{\partial L})}{(\frac{\partial Y}{\partial M})} = \frac{w}{p_M} \tag{7}$$

For Cobb-Douglas production function equation 7 reduces to

$$\frac{\alpha_L}{\alpha_M}.\frac{M}{L} = \frac{w}{p_M} \tag{8}$$

In response to a positive technology shock, wages go up due to increased productivity. Since intermediate input prices are determined in the world market, optimality represented by equation 7 requires either $(\frac{\partial Y}{\partial L}) \uparrow$ or $(\frac{\partial Y}{\partial M}) \downarrow$. Under usual assumption of concavity, this can be achieved by either using more materials or using less labor. Quantitative restrictions does not allow firm to use more materials. Inflexible labor laws prohibit a firm from using less workers. The optimality represented in equation 7 is never acheived. So due to these frictions, gains from technological progress are not fully realized and firms are forced to operate at non-optimal factor allocation.

Using Annual Survey of Industries data between 1970-2003, I find robust estimates for production function parameters [3]. The paper also calculates the optimal $(\frac{M}{L})$ for all-industries and for each of the 58 industries using 3-digit NIC code panel data.

The second distortion mechanism operates through rising prices and limited access to credit markets. Let us consider the effect of high inflation in materials on factor allocation choice of a firm. In absence of credit it can no longer afford to buy same amount of materials due to increased price. The firm can still operate efficiently by shrinking its scale and lowering the labor input accordingly. But even that is not possible. Since it is difficult to fire extra workers most of the firms have to compromise on materials and end up having less materials allocated per worker. This causes the output to go down and hence reduces productivity growth. This effect is summarized in equation 9. The paper shows the presence of this channel by estimating the

[3] See Gupta (2008) [13] for detailed estimation results.

relationships of productivity growth with input growths and with materials inflation.

$$p_M \uparrow,\ \underline{L} \quad \Rightarrow \quad (\frac{M}{L}) \downarrow \quad \Rightarrow \quad (\frac{\partial Y}{\partial L}) \downarrow \tag{9}$$

The paper measures these period-wise substitutions between factors. For each year I also estimate all-industries and industry-specific output growth rates, input (K,L and M) growth rates and productivity (single-factor and total-factor) growth rates. These estimates and their relationships with different measures of distortions are discussed in next sections.

Most interesting point about these channels is that they operate via intermediate input distortions. Hence these mechanisms do not affect service sector because intermediate inputs are not that important in services production. In contrast, for Indian manufacturing the share of materials in gross output production function is around 0.6 much higher than the share of labor and capital. This is why Indian manufacturing growth rates are worse than that of services despite facing similar economic conditions and policies.

4 Measuring the Distortions

There have been few studies on trying to estimate the extent of distortions in factor allocation. Klenow and Hsieh (2007) [14] quantify the mis-allocation by comparing marginal products of labor and capital in industries in India and China with those in US. Fernandes and Pakes (2008) [12] estimate the underutilization of labor and capital across states in Indian manufacturing in 2001. I also use similar concept, but rather than estimating absolute values I measure distortions (under or over utilization) relative to other factor. One of the issue is that if one tries to measure the mis-allocation or under-utilization by amount of extra labor that will be required to justify the wages, he/she 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 for Cobb-Douglas specification (used in this and most of the other papers), this ratio based relative underutilization measure is directly related to the productivity growth. Another problem with earlier approaches is the implicit assumption that the 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 TFP estimate for that period. This seems harder to justify given that there are measurement errors and we are ignoring many of the inputs like education, economic conditions etc. I think that TFP residuals represent more of an estimated measure of unmeasurable and production technology is just a part of it. So it makes more sense to rely on changes in TFP or TFP growth rather than absolute value. Doing it in changes rather than levels avoids these issues. This is why paper also develops and estimates analogous measures for substitution between periods.

1. $OverUtilization = Actual\frac{L}{M}\ (Prices) - Optimal\frac{L}{M}\ (Prices)$
2. $OverSubstitution = Actual\frac{\Delta L}{\Delta M}\ (\Delta Prices) -\ Optimal\frac{\Delta L}{\Delta M}\ (\Delta Prices)$

The first measure estimates the extent of distortion by comparing factor allocations to the optimal value. The optimal value is an allocation that firms would choose if there were no frictions (e.g. quotas or labor laws) and it is obtained by finding output maximizing allocation using production function estimates. The paper calculates this optimal allocation ratio by equating the marginal product to price ratio of two factors at the given prices in that period. The substitution measure estimates the effect of these restrictions by finding how close firms are to the optimal response in substituting between factors. For example even if price of labor relative to materials goes up, firms can not reduce labor allocation due to inflexible labor laws. Moreover they can not increase materials input because of quota permit system. Hence the actual changes in input choices will be different from the optimal response and the second set of measures used in the paper captures this distortion.

Similarly, I also calculate over or under utilization and substitution of capital relative to labor and materials. These set of measures are also converted to ratios and distance from optimal. Another and perhaps most important difference from earlier methods is use of materials in the calculation of distortions. As earlier discussion shows, economic conditions in India forced manufacturing firms to choose suboptimal allocation in materials. Ignoring materials from the calculation especially when using gross output as output measure gives incorrect estimates [4]. Intermediate input distortions are also important in understanding how credit and labor market conditions affected the productivity via materials and hence lowering growth for manufacturing but not so for service sector. This paper uses production function estimates that are robust to simultaneity problem and selection bias. Another benefit of using the extra set of substitution distortions is that these do not depend on the parameter values (e.g. factor share in Cobb-Douglas).

Using data for all-industries, figure 4 plots the movement of actual vs. the optimal ($\frac{M}{L}$) ratio. Compared to 2003, actual materials per worker index is lower than what the optimal should have been for existing wages and

[4] See Gupta (2008) [13] for detailed results on different TFP estimates using various measures and different accounting methodologies.

materials' prices in each period. The paper finds that for the entire period (1970-2003) materials are on average 25% underutilized compared to labor and this average reduces by half (i.e. 12%) after the reforms in 90s. When estimating with 3-digit NIC code panel dataset, unweighted average underutilization of $(\frac{M}{L})$ over 58 industries is almost same as all-industries (24% for 1973-2003 period and 11% for post reform period 1991-2003).

Similarly, the estimates also show that compared to the labor, capital input is being over-utilized in the later periods. These results are similar to Fernandes and Pakes (2008) [12] who find over utilization of capital in 2001 and 2004. This happened because capital prices dropped significantly after 1990s and Indian manufacturing firms started over-substituting the capital especially relative to the labor. The reason why firms are choosing to do this is because reforms have not changed the labor laws. Firms still need to get government approval to fire workers and such approval is rarely given. Expecting these issues firms are preferring to over-substitute and hence over-utilize other factors (capital and materials) compared to what is optimal at the existing prices.

The paper finds that between two periods, some industries (specified by 3-digit NIC code) are over-substituting the materials relative to labor for the observed movement in prices. This observed presence of over-substitution of materials relative to labor in 70s and 80s 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) firms did not hire more workers. Firms do this due to one of the two reasons. Their input factor allocation is already distorted and materials are underutilized, so firms do not want to increase this distortion. Other reason might be that a forward-looking firm expects that in future it will not be able to get the extra materials required to make these workers more productive and neither will it be able to fire these workers if relative prices change again. So they choose not to hire extra workers even when it is optimal to do so at the existing prices. The estimated average of over-substitution of materials relative to labor for all-industries is around 3.6% per year. But this varies period-wise with average being 0.7% in 70s and 7.2% between 1996 and 2003. For the years after the reforms, this over-substitution of materials relative to labor is continuously increasing despite the fact that materials are no longer under-utilized relative to labor. This trend indicates producers' unwillingness to hire workers due to frictions and firing costs rather than their rush to reach the optimal relative materials allocation (which firms have already surpassed).

5 Impact on Productivity Growth

The widespread distorted input usage in Indian manufacturing adversely affected its growth performance. In the 33 years covered in the dataset (1970-2003), the average of gross output growth rates in Indian manufacturing is 6%. But materials usage grew at average of 6.5% during this period while average labor growth rate is just 1.1%. This lack on growth in labor input is what many believe is one of the major challenges facing Indian economy. Rajan, Kochhar etal. (2006) [20] ask whether India can foster growth in labor-intensive manufacturing. Bhalotra (1998) [6] criticizes the World Bank explnation of attributing decline in factory employment to acceleration in wages. But most studies wonder about this observed jobless growth in Indian manufacturing without offering any possible explanation. If we look at the period-wise averages of estimated growth rates as shown in table 2, we can see that firms are trying to avoid hiring workers due to perceived issues in firing them later and instead compensating for the lower materials per worker (underutilization estimated in last section) by continuously increasing their materials usage. This results in increased labor productivity growth which averages 6.2% for the sub-period 1981-1990 [5] and 6.9% for 1998-2003. These explnations are confirmed by looking into the relationship between distortion measures and productivity measures.

The interaction of quota permit and labor laws leads to less than optimal materials per worker and thus slows down the labor productivity growth. This mechanism is identified by finding the correlation between underutilization and productivity growth. Similarly, combination of high inflation in materials and less developed credit markets reduces the intermediate input usage in response to price increase which in turn results in lower labor productivity. This is recognized by looking at relationship of materials inflation with productivity and real wages. The paper estimates these two channels for both aggregate data (all-industries) and panel data consisting 58 industries based on 3-digit NIC code. Summary of main relationships for panel data are shown in tables 3 and 4 and are plotted in figures 5 and 6.

For both panel and aggregate data, underutilization of materials is negatively correlated to labor productivity and its growth rate. More interestingly, the underutilization of $(\frac{M}{L})$ is also negatively related to TFP growth. Labor productivity relation is simply an implication of distorted or farther from optimal input allocation. But why should TFP growth be affected by materials and labor usage is not obvious. One explanation can be that this

[5] How firms managed to acheive this increase even before the reforms? Materials and wage inflation went down slowly. Many of the items were put into Open General License category. Credit availibility kept improving over time.

underutilization gives rise to other inefficiencies as well. For example reorganizing the production process to work with less materials per worker, probably by running the machines fewer hours per week. Since firms know about this underutilization they might end up spending resources to remove or at least reduce it by applying for higher quotas. This becomes evident when looking at the relationship of input growth to productivity growth. Distortion measures (under utilization and substitution) are negatively related to TFP growth because of the nature of the policies. Labor is bounded by below and materials input has an upper bound. Since $(\frac{M}{L})$ is lower than optimal at existing prices, any change that makes this underutilization worse is going to increase the inefficiencies. That is why labor growth is negatively related to TFP growth and materials growth is positively related to TFP growth (because of $\uparrow$ & $\downarrow$ in distortions). In absence of proper causality result, one can also argue that whenever firms hired more workers they increased inefficiencies because of the implicit costs of labor market regulations (e.g. possibility of strikes, disputes).

Not surprisingly, labor productivity measured in net value added terms is negatively related to labor growth due to decreasing marginal product. What is interesting is that net value added productivity of labor is positively related to materials growth. This emphasizes the widespread underutilization in materials in Indian manufacturing. The reason OECD and other statistical agencies like value added in manufacturing is because it makes it easier to compare across hugely different industries (e.g. shoe making and chemical processing). In developed economies where materials or intermediate inputs allocation is not restricted and is therefore optimally allocated according to prices and wages, using value added is better. But in case of India, this approach has come at a cost of not recognizing these important distortions and their effects on productivity till now. When workers are allowed to use more materials they can not only produce more output but also add more value. Because total value added by a worker depends on how much value he adds in one unit of output and also on how many such units of output he produces. It will depend on materials being used if materials usage is restricted or non-optimal. For Indian manufacturing, this addition to value added by using more materials is being driven by the fact that firms are not able to equate the marginal products on the two factors due to interaction of policies.

Productivity growth measures are negatively related to under-substitution of materials relative to labor and positively related to growth in materials usage. Both of these set of results support the presence of *distortion-inefficiency* channels operating through interaction of policies. Under-substitution means worsening of distortion and hence lesser materials per worker which results in lower productivity growth. Increased materials usage helps in taking the input allocation closer to optimal and increases the productivity growth. Input price inflation is negatively related to real wage inflation. This is because in absence of credit availability rising materials prices mean less materials per worker and thus reduced labor productivity. This is reflected as change in the real wages. Over-utilization of capital relative to labor has positive correlation with labor productivity, which is the usual capital deepening effect.

6 Role of Reforms

India's current phase of economic reforms began in 1991 when government faced an exceptionally severe balance-of-payments crisis. Congress government at the time started short-term stabilization processes followed by longer-term comprehensive structural reforms. In 1991, government of India adopted *New Industrial Policy*. It abolished industrial licensing for all industries (except few), irrespective of the levels of investment. This industrial policy was supported by trade policy which removed import restrictions and liberalization of foreign direct investment as part of the multi-faceted gradual reform process. Ahluwalia (2002) [1] outlines and evaluates these set of structural reforms. Indias reform program also included wide-ranging reforms in the banking system and the capital markets relatively early in the process, with reforms in insurance introduced at a later stage.

These reforms broke down two major links in these mechanisms which were responsible for distorted input usage and lower productivity growth. Removal of quantitative restrictions means that firms are no longer forced to operate at sub-optimal level. Firms still can not 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, easy credit access means that firms can reach this optimal even in the periods of high inflation. Firms can borrow the 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 clearly show the positive impact of the reforms. After the reforms, materials growth average is around 7% per year between 1991 and 2003 for all-indutries. The effect of materials growth on labor productivity growth and TFP growth amplifies after 1991. The pooled OLS coefficient between materials growth and labor productivity growth is 0.7 for the subsample 1991-2003, more than double the value for entire timeperiod 1970-2003. I need to stress that these relationship coefficients should not be interpreted as signifying causality but more like importance of the correlation. The interpretation should be in line with variance decomposition type of analysis. So the increase in coefficient value implies that materials growth is becoming more important in labor productivity growth. Increase in import of various intermediate inputs driven by lifting of restrictions is shown in figure 8. Firms which were forced to operate at less than optimal $\frac{M}{L}$ ratio due to quota restrictions have now started moving towards their potential productivity by importing and using more intermediate input. Growth estimates in table 2 confirm that the material growth is responsible for most of the output growth in last subperiod (1998-2003). As mentioned earlier, some of the estimation results are contrary to the conventional wisdom that suggests that growth in net value added should not depend on materials at all. The paper finds that labor productivity growth and TFP growth measured in value added terms is also strongly correlated with growth in materials usage. This relationship becomes stronger after the reforms (pooled OLS coefficient is 0.48 for subsample of 191-2003 compared to 0.18 for entire timeperiod). Most interesting is the break down of the relationship between intermediate input inflation and real wages breaks down. The coefficient is close to zero and no longer significant after 1991. The reason is that this inflation productivity mechanism was being driven by low credit availability and reforms increased the credit availibility by liberalizing the capital markets.

Another important consequence of reforms is that restrictions applicable only to Indian manufacturing industries have been removed. Import quota and industrial licensing policies abolished during the reforms were applicable to the manufacturing and not to the services. So one of the differences between economic environment of manufacturing sector and service sector in India is gone. The other and now more relevant difference is use of unskilled versus skilled labor in production process.

6.1 Jobless Growth - What is left wanting?

Reforms did not remove labor market regulations. The reason might be political but it is definitely having an impact on Indian economy. The estimates show that firms have started over-substituting capital and materials compared to labor even though it is no longer necessary. Fernandes and Pakes (2008) [12] find underutilization of labor in 2001 which is a consequence of this over-substitution by Indian manufacturing firms. Figure 7 plots indexes of input usage for unit output. Most worrying is the trend in labor used per unit of output, which has gone down by more than 50% in years after the reform. Some of this reduction is due to productivity gains and better technology, but the index of materials used per unit of output is continously increasing. This points towards reluctance of firms to hire workers due to expected problems with labor laws. Firms are preferring to use extra materials and capital to avoid getting stuck with more workers forever since firms still can not fire workers. This explains the jobless growth in manufacturing because growth is coming from over-substitution of materials and capital.

Many economist have raised doubts about sustainability of impressive performance of Indian economy in the long run because of this jobless growth phenomena. I think labor market regulations will have to be addressed to provide incentives for firms to hire workers or at the very least the disincentives of hiring workers must be removed.

7 Conclusions

This paper provides interesting insights about economic growth in India. Negative TFP growth before the reforms was caused by forced distortions in intermediate input usage relative to labor due to policies of quota permit and labor laws. The recent jump in TFP growth is coming as the result of removal of restrictions on materials and thus firms' factor allocation moving towards the optimal. The role of intermediate input which has been ignored till now deserves greater attention given that it is the most important (highest factor share) input in manufacturing production.

Interaction of policies combined with high inflation and lower credit access was responsible for manufacturing growth being slower than services growth. One government policy may end up being counter-productive in presence of another policy. Hence gradualism approach to reforms should be applied with caution to make sure none of the reforms will interact adversely with previous reforms or existing policies. Labor market regulations that are supposed to ensure job safety are hurting workers, since firms are shying away from hiring new workers. TFP growth rates being slightly negatively correlated to labor growth rates is interesting and worth exploring result. Because it may be indicative of the structural inefficiencies in Indian labor market e.g. resistance to competition, job reservations, hiring and promotion by loyalty and age rather than skills. Finding more about this result and reforming the problems involved in labor policies seem to be the next logical step in the reform process.

References

[1] Montek S. Ahluwalia. Economic reforms in india since 1991: Has gradualism worked? *The Journal of Economic Perspectives*, 16(3):67–88, 2002.

[2] Robert J. Barro. Inflation and economic growth. NBER Working Papers 5326, National Bureau of Economic Research, Inc, October 1995.

[3] Timothy Besley and Robin Burgess. Can labour regulation hinder economic performance? evidence from india. STICERD - Development Economics Papers 33, Suntory and Toyota International Centres for Economics and Related Disciplines, LSE, February 2002.

[4] Jagdish Bhagwati. *Anatomy and Consequences of Exchange Control Regimes*. Ballinger Publishing Company for N.B.E.R., 1978.

[5] Jagdish Bhagwati and Padma Desai. *India: Planning for Industrialization*. Oxford University Press, London for O.E.C.D. Paris, 1970.

[6] Sonia R Bhalotra. The puzzle of jobless growth in indian manufacturing. *Oxford Bulletin of Economics and Statistics*, 60(1):5–32, February 1998.

[7] Barry Bosworth and Susan M. Collins. Accounting for growth: Comparing china and india. *Journal of Economic Perspectives*, 22(1):45–66, Winter 2008.

[8] H.J. Bruton. A reconsideration of import substitution. Center for Development Economics 156, Department of Economics, Williams College, 1998.

[9] Satish Chand and Kunal Sen. Trade liberalization and productivity growth: Evidence from indian manufacturing. Trade and Development 96/11, Australian National University, Department of Economics, September 1996.

[10] V.V. Chari, Larry E. Jones, and Rodolfo E. Manuelli. Inflation, growth, and financial intermediation. *Proceedings*, pages 41–58, 1996.

[11] Deb Kusum Das. Quantifing trade barriers: Has protection declined substantially in indian manufacturing? ICRIER, New Delhi Working Papers 105, Indian Council for Research on International Economic Relations, New Delhi, India, July 2003.

[12] Ana M. Fernandes and Ariel Pakes. Factor utilization in indian manufacturing: A look at the world bank investment climate surveys data. NBER Working Papers 14178, National Bureau of Economic Research, Inc, July 2008.

[13] Abhay Gupta. Looking beyond the methods: Productivity estimates and growth trends in indian manufacturing. In: Mimeo. University of British Columbia, 2008.

[14] Chang-Tai Hsieh and Peter J. Klenow. Misallocation and manufacturing tfp in china and india. NBER Working Papers 13290, National Bureau of Economic Research, Inc, August 2007.

[15] Charles R. Hulten and Sylaja Srinivasan. Indian manufacturing industry: Elephant or tiger? new evidence on the asian miracle. NBER Working Papers 7441, National Bureau of Economic Research, Inc, December 1999.

[16] Robert G King and Ross Levine. Finance and growth: Schumpeter might be right. *The Quarterly Journal of Economics*, 108(3):717–37, August 1993.

[17] Anne O. Krueger. Trade policy and economic development: How we learn. NBER Working Papers 5896, National Bureau of Economic Research, Inc, January 1997.

[18] S Mohammad and J Whalley. Rent seeking in india: Its costs and policy significance. *Kyklos*, 37(3):387–413, 1984. Blackwell Publishing Ltd.

[19] Carmen Pages and Ahmad Ahsan. Are all labor regulations equal ? assessing the effects of job security, labor dispute, and contract labor laws in india. Policy Research Working Paper Series 4259, The World Bank, 2007.

[20] Raghuram Rajan, Utsav Kumar, Ioannis Tokatlidis, Kalpana Kochhar, and Arvind Subramanian. India's pattern of development: What happened, what follows? IMF Working Papers 06/22, International Monetary Fund, February 2006.

[21] Badri Narayan Rath and S.Madheswaran. Productivity growth of indian manufacturing sector: Panel estimation of stochastic production frontier and technical inefficiency. Econometric Society 2004 Far Eastern Meetings 527, Econometric Society, August 2004.

	Mkt.Cap.(m US$)	$(\frac{\textbf{MktCap}}{\textbf{GDP}})$	$(\frac{\textbf{Value Traded}}{\textbf{GDP}})$
Germany	355073	22.2%	21.4%
Hong Kong	83397	111.5%	46.3%
India	38567	12.2%	6.9%
Korea	110594	43.8%	30.1%
Malaysia	48611	110.4%	24.7%
Singapore	34308	93.6%	55.4%
US	3059434	53.3%	30.5%

Table 1: Comparison of Stock Market Indicators in 1990

	Annual Growth Rate				
	1970-2003	**71-80**	**81-90**	**91-97**	**98-03**
Gross Output	6.0%	6.4%	6.6%	7.0%	3.2%
Labor	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%
Gross Output based measures					
Labor Productivity	4.9%	2.8%	6.2%	4.3%	6.9%
TFP	2.7%	2.9%	2.6%	-1.5%	7.4%
Net Value Added based measures					
Labor Productivity	3.2%	3.0%	3.6%	1.9%	4.3%
TFP	1.1%	3.4%	0.06%	- 3.6%	4.8%

Table 2: Period-wise Growth Rates: All Industries

Productivity (Y)	**Distortion (X)**	**Corr.**	**CoVar.**	**Pooled OLS β**
L Prod(GO)	Under-Util. M/L	-.69	-.29	$-.99^{**}$
	Over-Util. K/L	.6	.29	$.74^{**}$
L Prod(NVA)	Under-Util. M/L	-.26	-.15	$-.5^{**}$
	Over-Util. K/L	.29	.19	$.46^{**}$
L Prod G (GO)	Under-Sub. M/L	-.42	-.33	$-.5^{**}$
	Over-Sub. K/L	.18	.2	$.21^{10\%}$
L Prod G (NVA)	Under-Sub. M/L	-.3	-.28	$-.34^{**}$
	Over-Sub. K/L	.21	.25	$.36^{**}$
TFP G (GO/M)	Under-Util. M/L	-.31	-.27	$-.37^{**}$
	Over-Util. K/L	.2	.13	$.23^{NS}$
TFP G (NVA)	Under-Sub. M/L	-.26	-.21	$-.35^{*}$
	Over-Sub. K/L	.17	.13	$.19^{NS}$

Table 3: Inefficiency and Productivity Relations: 3-Digit NIC Industries Panel

Productivity (Y)	**Distortion (X)**	**Pooled OLS β**
Real Wage Inflation	Materials Inflation	-5.91** -8.6** (Before 1990) .003^{NS} (After 1990)
L Prod. G (GO)	Materials Inflation	-0.32**
L Prod. G (NVA)	Materials Inflation	-0.39^{NS}
L Prod. (NVA)	L Growth, M Growth	-0.39**, 0.11*
L Prod. G (GO)	L Growth, M Growth	-0.46**, 0.33** -0.73**, 0.7** (After 1990)
TFP G (GO/M)	L Growth, M Growth	-0.22**, 0.20** (After 1990)
L Prod. G (NVA)	L Growth, M Growth	-0.34**, 0.18** -0.43**, 0.48** (After 1990)
TFP G (NVA)	L Growth, M Growth	-0.23**, 0.12** -0.31**, 0.38** (After 1990)

Table 4: Prices, Distortions and Productivity: 3-Digit NIC Industries Panel

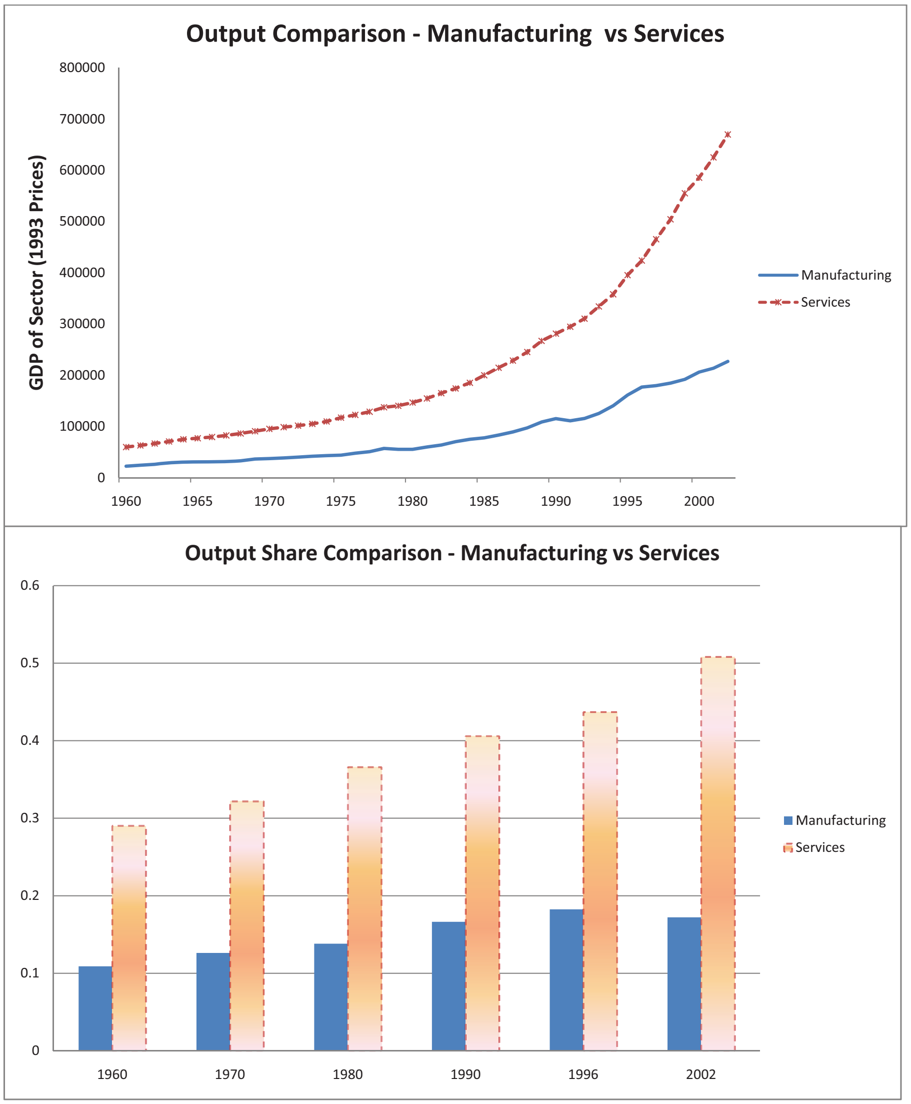
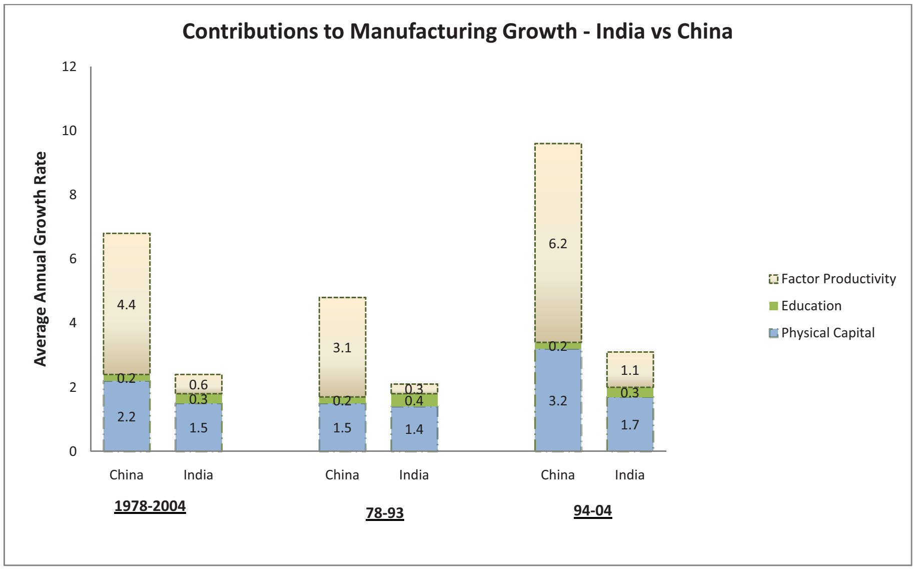


Figure 1: Growth Puzzle - Indian Manufacturing vs. Indian Services



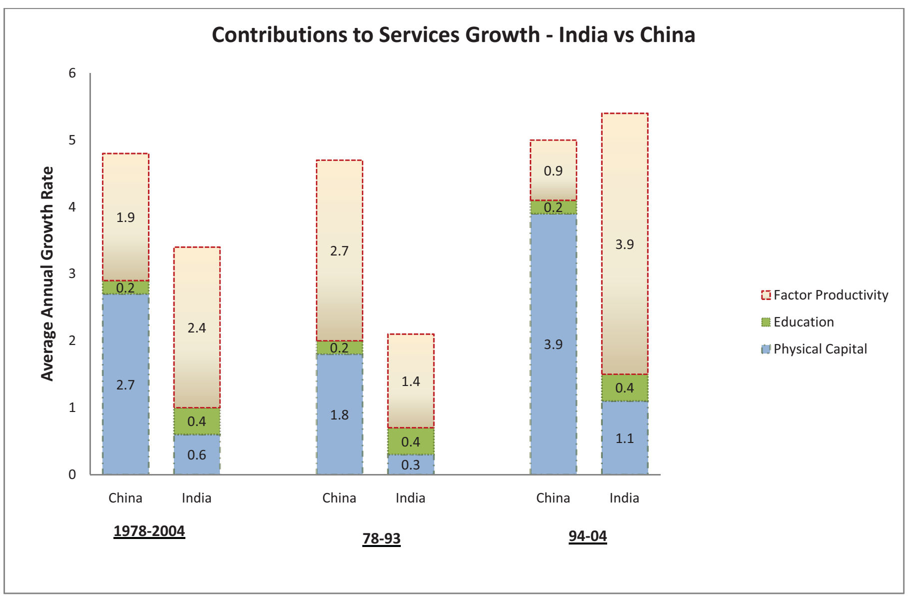


Figure 2: Growth Puzzle - Comparing TFP Contribution

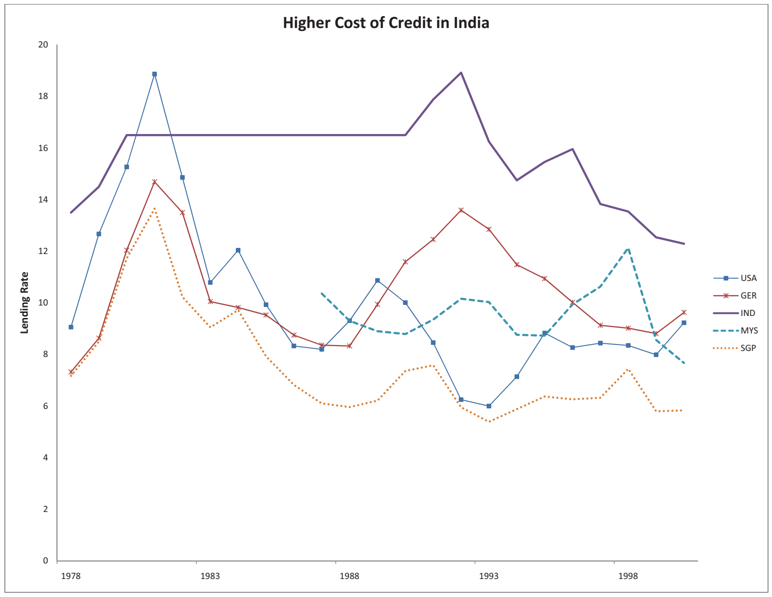


Figure 3: Cost of Borrowing - Lending Rates Comparison

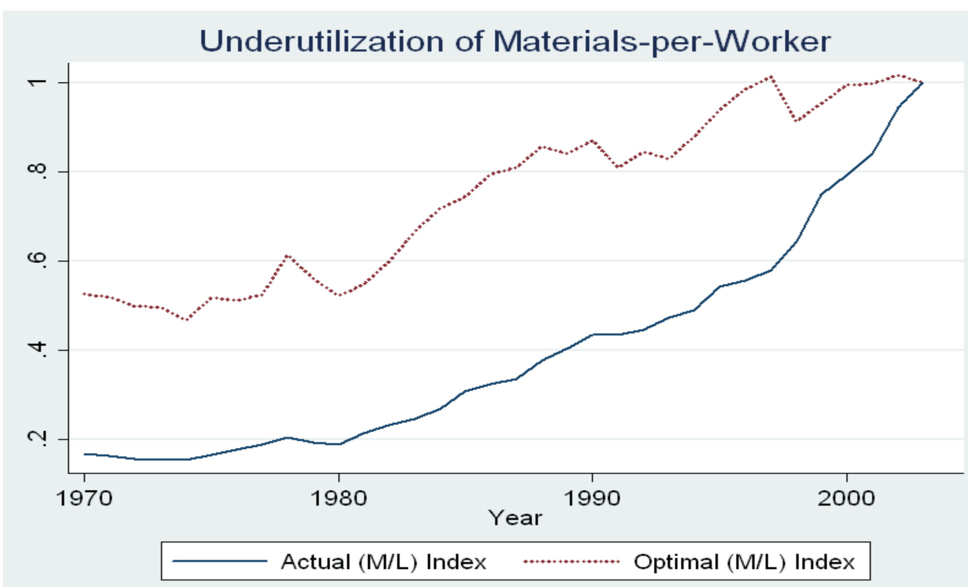


Figure 4: Underutilization of materials relative to labor

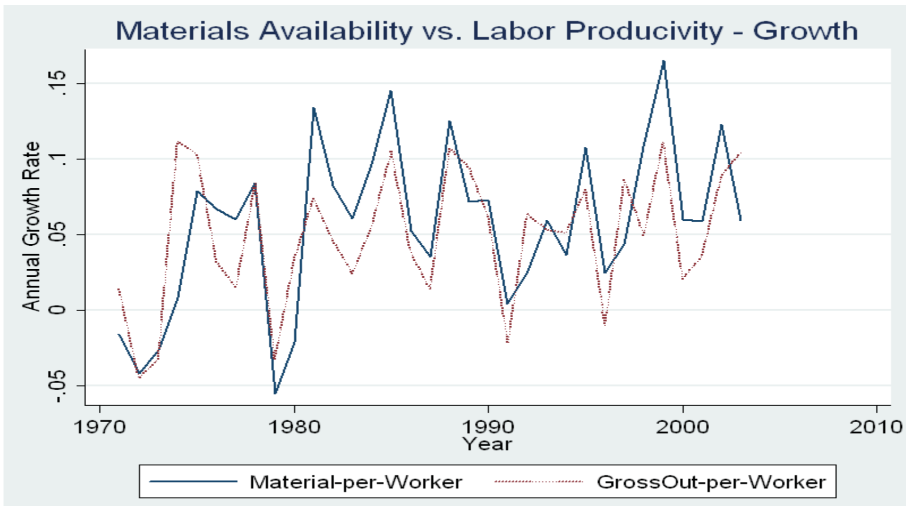


Figure 5: (M/L) Growth's relation to L Prod. Growth - All Industries

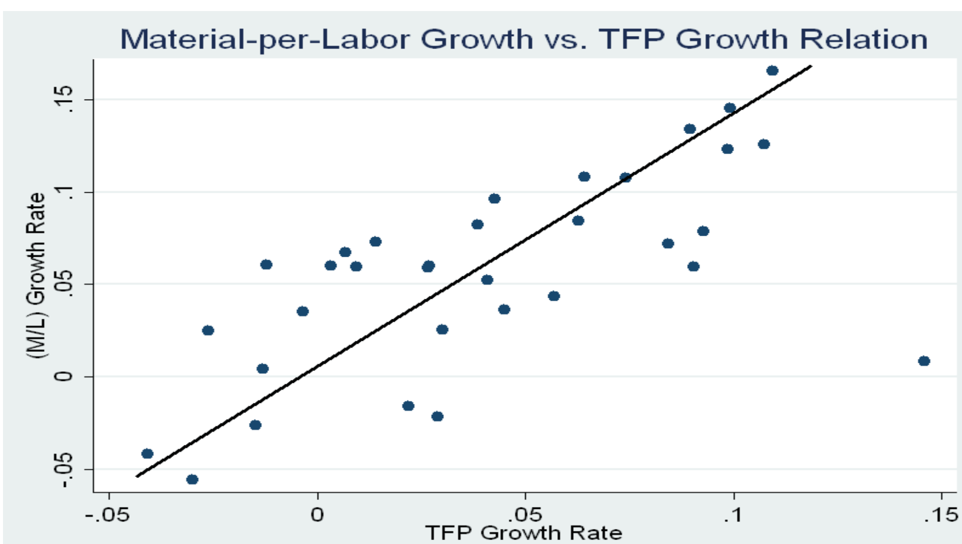


Figure 6: (M/L) Growth causing TFP Growth: 1970-2003 - All Industries

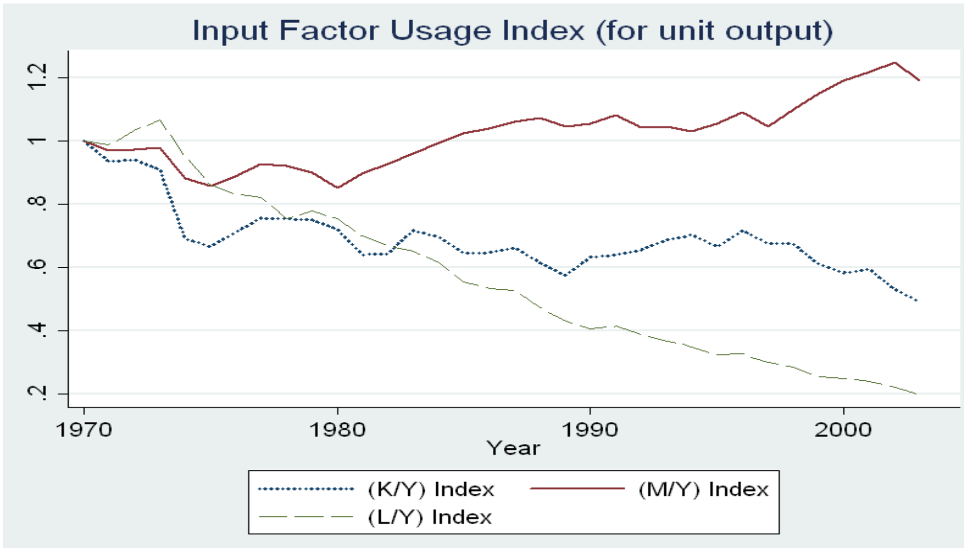


Figure 7: Changes in Input Usage for unit output

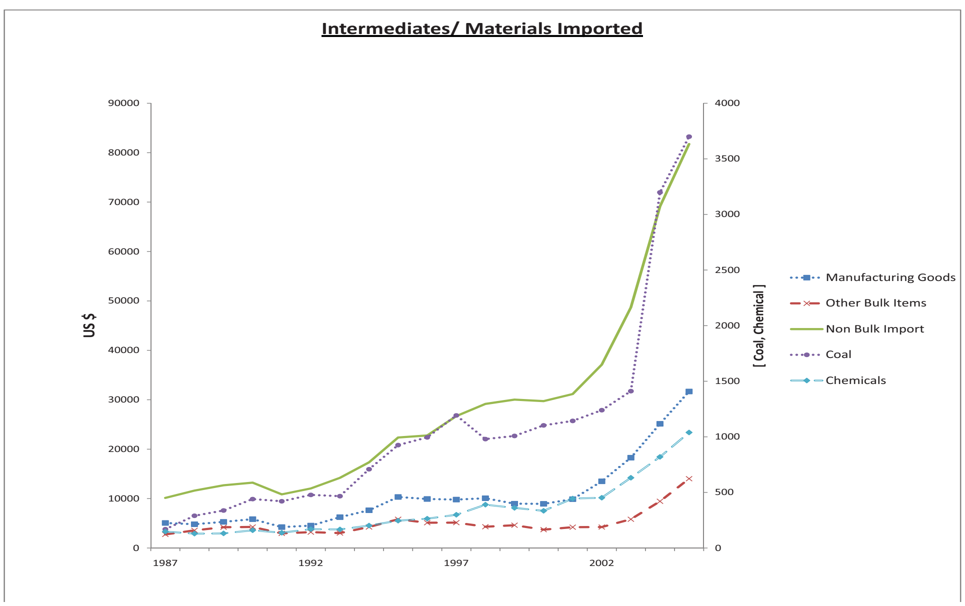


Figure 8: Jump in Intermediate Input imports

A Summary of Estimation Methodology

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

Gross output is deflated using sector specific price indexes data from Central Statistical Organization. Real net value added is calculated using double-deflation. Value of output is deflated using sector specific price indexes, materials input is deflated using wholesale price index for manufacturing, fuels is deflated using fuel and energy price index available from CSO. Additional input of business services is estimated by calculating its value by subtracting sum of material input and fuel input from total value of inputs. This business services input is deflated using consumer price index. Capital input is deflated using *user-cost approach*.

The paper estimates the productivity growth measures based on index number method which has the advantage of incorporating the effect of movements in factor shares. Fisher index is used for aggregating the input quantities. TFP growth is estimated as ratio of output growth and input quantity index growth. For gross output all three inputs (capital, labor and material) are used, while for value added only capital and labor inputs are used. Unit input requirement is the amount of each factor that is required to produce one unit of output.

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).

Production function is estimated using Olley-Pakes and Levinshon-Petrin methodologies on the panel dataset. These methods give robust estimates for labor, capital and material shares. Optimal $(\frac{L}{M})$, $(\frac{K}{M})$ and $(\frac{K}{L})$ ratios are calculated using the estimated factor shares and observed factor prices in corresponding periods. These are obtained by making ratios of marginal returns on the factors equal to their relative prices. Estimated underutilization is the difference between this optimal ratio and the actual ratio of inputs used in that period. Optimal relative substitution values are calculated using observed changes in factor prices between periods.

Please see Gupta (2008) [13] for detailed accounting and productivity results on Indian manufacturing.