COMPARATIVE PERFORMANCE OF INDIAN AND CHINESE MANUFACTURING INDUSTRIES, 1980-2004

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Abstract

This study examines the comparative productivity performance and the race between India and China in 1980-2004. It compares the level of real output, capital-labour ratio and total factor productivity in individual industries between the two economies, and investigates the gap between the two in dynamics with China as the benchmark, and identifies Indian industries that have experienced the fastest catch up with, or have been overtaken by, their Chinese counterparts since the early reforms.

Following the ICOP PPP approach, we firstly construct the 1995-benchmark sector-of-origin measure of India/China UVRs with industrial census data in the two countries. Secondly, we construct time series data on labour employment, net capital stock and real output for individual Indian and Chinese industries. The PPP converters are then used to convert the capital stock and output value of individual industries in the two countries into a common numeraire for the aforementioned level comparisons.

The results show that the relative price levels in India are below that of China for most of the manufacturing branches and at the sectoral level. Both labor productivity and total factor productivity levels are above the level of China for most of the period since 1980 and it is only since 2000 the study finds the TFP level in China to be above that of India. A distinguishing feature of these results is that the high levels of labour productivity are indeed driven by high levels of capital intensity which may not be sustainable in the long run. The results also show that there are significant variations to these general conclusions when focused on different manufacturing branches.

SECTION 1: INTRODUCTION

In a recently completed study by the Asian Development Bank (ADB, 2007) on purchasing power parities and real gross domestic product comparisons covering 23 countries in the Asia-Pacific region, China and India together accounted for a massive 64 percent of the total GDP of the participating countries.[1] These countries also account for nearly a third of the global population. Over the last decade, China and India have posted spectacular growth rates in GDP and per capita incomes though China has experienced relatively stronger growth rates. According to the World Bank sources(WDI, 2007), Chinese real gross domestic product grew at a rate of 9.5 per cent per annum and 8.6 percent per annum for the sub-periods 1983-1993 and 1993-2003 respectively. Chinese annual GDP per capita increased at rates of 7.9 percent and 7.6 percent per annum over the two sub-periods. In contrast, Indian GDP rew at 5.4 percent and 5.9 percent and annual GDP per capita grew at 3.3 percent and 4.2 percent in the respective sub-periods.

The long-term sustainability of these high growth rates in these countries will depend upon the structure and productivity performance of different sectors of the economy. It is essential to look at the structural composition of growth. Growth theories since Adam Smith (1776) have emphasized that the structural transformation from a predominantly agrarian economy to a predominantly urban and industrial economy provides a causal contribution to the growth process. Lewis (1954) followed the Classical economists in depicting agriculture as a sector of diminishing returns and industry as a sector of increasing returns, although Ranis and Fei (1961) emphasized the importance of agricultural productivity gains in dualistic growth processes. Hirschman (1958) went even further than Lewis by suggesting that industrial investment with backward and forward linkages provides the key to breaking the shackles of a low productivity equilibrium. And Chenery and Syrquin (1975) provide the first comprehensive empirical analysis of structural change, amply documenting the evolution from agricultural predominance, rising industrial production (typically light industry followed by heavier and more sophisticated industrial production later on), followed by an increase in services in the final stages of development. The modern growth empirics literature has also tended to find that larger initial shares of manufacturing, and smaller shares of agriculture or mining, are associated with faster subsequent growth in per capita GDP (see, for example, the review in Durlauf et al. 2005).

But whilst rapidly developing countries may typically follow this evolution from agriculture, to light industry, to heavy/sophisticated industry, and, finally, to a noticeable rise in the share of services in GDP, individual countries may obviously depart from this average pattern to a substantial degree. India and China provide important case studies in this context. In a broad sense these countries were obviously comparable in 1980, since both countries were of similar size and similar levels of development, as measured by GDP per capita (in PPP), or socio-economic indicators such as life expectancy, literacy rates, rural population shares and industrial structure. Moreover, these countries both

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[1] Japan and South Korea are not included in the Asia-Pacific regional comparisons as they are both included in the OECD group for purposes of the 2005 International Comparison Program. Shares of China in the regional GDP would be much lower when both of these countries are included.

experienced rapid growth accelerations at about this time (Hausman, et al. 2005). But one difference which many observers have stressed is the much greater importance of services growth in India's acceleration as opposed to China's more traditional path of industry-led structural transformation.

These claims may be examined by considering trends in shares of valued added based on constant local currencies, as well as trends in valued added per worker. Value added data at a sectoral level are sourced from the World Bank (WDI 2007), while employment data for the per capita measures is sourced from the respective countries' national statistical agencies. These data – summarized in Appendix Table A.1 – do indeed suggest that China has thus far followed the typical Chenery-Syrquin transformation. As per a 'typical' country entering the middle income stage of development, industry still comprises the largest share of domestic product (47.5% in 2005), although services' share (39.9%) is rapidly converging to that of industry (which is not surprising given China's astonishingly fast rate of aggregate GDP growth). According to these data, industry has also easily been the fastest growing sector in China in labour productivity terms, increasing by more than 500 percent between 1980 and 2005, whilst services value added per worker increased by slightly more than 200 percent, and agriculture slightly less than 200 percent.

In contrast, India has experienced much faster productivity growth in services (increasing by almost 200 percent) than in industry (which increased by just over 120%), while Indian agricultural growth has been modest at best. And despite having a lower aggregate productivity than China – and hence presumably being at an earlier 'stage' of development - the Indian economy in 2005 is indeed heavily dominated by services (54.4%), with industry's share still surprisingly small (27.3%). Moreover, agriculture is still a substantial sector in valued added terms (18.3%), but especially in terms of employment shares since agriculture still employs about 60% of the workforce.[2] Bosworth and Collins (2007) examine in detail sector specific performance and emphasise the differential roles played by the industrial and services sectors in China and India.

The spectacular growth performance in China and India has attracted the attention of economists and analysts alike. Many studies have examined the role and contribution of the economic reform process and the differing nature of the growth and development policies pursued in these two countries. It is generally recognized that the relative growth and productivity performance of the two countries varies across different sectors. The main focus of this paper is on the relative performance in the manufacturing sector. Hulten and Srinivasan (1999) conclude that Indian manufacturing performance is sound and in line with the general experience of the Asian Tigers. Nagraj (2005) studies the industrial growth in China and India making use of the recently available industrial output series for China by Wu (2002) and concludes that the size and growth of India's industrial sector and exports are modest in comparison with China. However, Nagraj

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[2] Although recent evidence suggest that rural livelihood diversification may mean that a large amount of an agricultural worker's activity in fact takes place in nonagricultural activities.

(2005) concludes that the Indian performance is supported by a firm microeconomic, legal and institutional framework and concludes that with sizeable increase in public investment in infrastructure India may be able to close the gap.

Bosworth and Collins (2007) in their recent study conduct detailed growth accounting of the performance of agriculture, industry and services sectors in India and China. They do not find evidence to suggest any deceleration in TFP growth in Chinese industry in the recent years. The weak performance of industry in India, especially in comparison with its services sector, is highlighted in their study.

Herd and Dougherty (2007) reviews the growth prospects and concludes that there are a large number of growth accounting studies on China (OECD, 2005; Chow and Li 2002; IMF, 2003; and Holz (2006)) and on India (Pallikara, 2004; Rodrik and Subramanian, 2004; Singh and Berry (Year??); Sivasubramonian, 2004; and Ghosh and Narayana, 2005). They recognize that there are "few studies that have explicitly compared China with India using a directly comparable framework or given attention to measurement issues".

Direct comparisons of output and productivity are difficult as the output aggregates and capital stock estimates are all expressed in national currency units and valued at the prevailing domestic prices. Therefore it is necessary to convert the nominal aggregates in national currency units using properly constructed measures of purchasing power parities (PPPs) for the manufacturing sector. These PPPs reflecting the general price levels in the sector need to be constructed for different manufacturing branches and the sector as a whole. It is also necessary to construct PPPs for capital goods for used in the conversion of capital stock estimates.

A major exception to Herd and Dougherty (2007) conclusion is the recent work of Lee, Rao and Shepherd (2007) which attempted a direct comparison of the level of output and labour productivity in the manufacturing sector in China and India by computing PPPs for the manufacturing sector. Adopting the standard approach used in International Comparisons of Output and Productivity (ICOP) studies pioneered by Angus Maddison at the University of Groningen, Lee et al (2007) presents results based on the benchmark year 1984-85 which show a clear divergence in labour productivity with India lagging behind since early 1990's.

There are three major aspects of the work of Lee, Rao and Shepherd (2007) that deserve further attention. The first and foremost is that their work and findings are based on a benchmark year which is nearly two decades old. The price structures that underpin the comparisons, and the resulting purchasing power parities, may have shifted. Therefore there is an urgent need to make use of more recently available data. The second aspect concerns the fact that the prices used in the 1984-85 benchmark comparison in the case of China do not reflect market prices and prices at that time are more like administered prices. As the standard index number theory requires that the price data reflect market prices, it would be useful to check if their findings would hold when more recent price data from China are used. The third aspect is that the Lee, Rao and Shepherd (2007)

study mainly focused on comparable labour productivity estimates for China and India, expressed in Chinese yuans, and the trends in labour productivity. Thus there is considerable scope for expanding their study to explicitly account for capital intensity that could be a factor explaining differential levels and trends in labour productivity.

The main objective of the paper is to undertake a comprehensive study involving a direct comparison of the levels of output and productivity in China and India that redresses the three main areas where the work of Lee et al (2007) could be improved. The current study makes use of the 1994-95 industrial census data[3] from China and India and also makes of capital stock[4] data necessary for making comparisons of total factor productivity levels and trends in these two countries. The paper presents the preliminary findings of the study with the new benchmark.[5]

The paper is organized as follows. Section 2 provides an overview of the size and structure of the manufacturing sector in China and India. Section 3 focuses on data related issues with special attention to the conceptual and measurement issues associated with the measurement of output, labour and capital stock. The brief section 4 describes the aggregation methodology used in the derivation of purchasing power parities for converting output aggregates. Section 5 presents the main findings of the study and Section 6 provides some concluding remarks.

SECTION 2: MANUFACTURING SECTORS IN CHINA AND INDIA

This section provides a brief description of the manufacturing sector and its composition in China and India. China and India have different economic systems and industrial structures especially in the areas of ownership and size categorization. In terms of ownership in China, the State-owned industries contributed most towards industry value output. In India, most of the industry output is from non-state industries. This ownership characteristic is the principal distinguishing feature of Chinese industry. In term of size, in China, firms are classified either on the basis of output capacity or value of capital assets, whereas in India, classification of industry size is based on the number of persons engaged. In India, small-scale enterprises are those enterprises which employ up to 9 persons (in establishments using power) or up to 19 persons where power is not used. Those establishments which fall outside this definition are referred to as large-scale establishments. In China list of enterprises falling into each size category (large, medium and small) can be found in the China Industrial Economic Statistical yearbook 1994. The coverage used for this study in the case of India refers to registered manufacturing.

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[3] This is the most recent data set available which could provide price and quantity data necessary for the comparisons.

[4] The study makes use of the recent work by Wu on the measurement of capital stock in Chinese industry. Wu (2002) provides a preliminary account of the measurement issues and the results of Wu's efforts are reflected in the capital stock series, constructed at the branch level, are used in this study.

[5] The project work is still in progress and some of the results presented in the paper are subject to changes in the future.

Table 1 shows details of the Registered Manufacturing firms for the years 1995 and 2004 in China and India. In India, there has been a 30% increase in the number of factories over the period. While the output and value added aggregates are in current prices, it is possible to compare the structure and composition of the manufacturing sector. A significant increase in the share of is evident in the Electrical Equipment and Machinery branches with a corresponding decline in the share of Food which dropped from 9% to 2.6% and from 20% to 8.5% to the year 2004.

In contrast in China, it is difficult to compare the number of enterprises in 1995 and 2004 due to differential coverage in the two years. Chemicals and Basic Metals have the largest share in gross value added in both years. Share of Electronics has grown from 5.2% in 1995 to 9.8% in 2004.

It is evident from the two tables presented here that there are significant differences in the composition of the sector by manufacturing branches in the two countries. Over the last decade, 1995 to 2004, the structure of the sector and shares of different branches have also changed significantly.

TABLE 1

NUMBER OF FACTORIES, GVO AND GVA IN INDIAN AND CHINESE MANUFACTURING INDUSTRIES, 1995 AND 2004

Indian Registered Manufacturing Number of factories, GVO and GVA, 1994-95 and 2004-05

	Registered Manufacturing 1995* (million current rupees)						Registered Manufacturing 2004 (million current rupees)					
	No. of Factories	%	GVO	%	GVA	%	No. of Factories	%	GVO	%	GVA	%
1 Food	23,562	18.8	874,801	14.8	119,940	9.0	21,160	13.2	1,495,198	7.2	107,507	2.6
2 Tobacco	7,229	5.8	53,286	0.9	15,708	1.2	6,093	3.8	505,113	2.4	95,774	2.3
3 Textile	13,743	11.0	595,137	10.1	111,228	8.3	16,464	10.3	2,253,764	10.9	464,104	11.4
4 Apparelling	5,696	4.5	150,873	2.6	35,335	2.6	2,028	1.3	110,218	0.5	19,837	0.5
5 Wood products	3,792	3.0	16,512	0.3	3,938	0.3	2,329	1.5	129,101	0.6	19,736	0.5
6 Paper & printing	6,141	4.9	192,782	3.3	53,368	4.0	7,444	4.6	344,364	1.7	72,152	1.8
7 Leather	1,944	1.6	59,288	1.0	10,195	0.8	5,657	3.5	348,974	1.7	70,084	1.7
8 Rubber & plastic	6,217	5.0	200,244	3.4	37,743	2.8	7,935	4.9	1,014,125	4.9	273,965	6.7
9 Petroleum & coke	714	0.6	403,938	6.8	66,277	5.0	2,507	1.6	53,902	0.3	12,411	0.3
10 Chemicals	9,206	7.3	893,901	15.2	267,059	20.0	990	0.6	2,363,444	11.5	345,790	8.5
11 Non-metallic mineral	11,546	9.2	220,486	3.7	68,625	5.1	7,225	4.5	521,976	2.5	90,378	2.2
12 Basic metals	6,820	5.4	765,825	13.0	174,219	13.0	16,736	10.4	2,377,518	11.5	609,332	14.9
13 Metal products	7,984	6.4	149,389	2.5	36,266	2.7	3,224	2.0	585,248	2.8	115,272	2.8
14 Machinery	8,645	6.9	351,259	6.0	93,876	7.0	18,804	11.7	2,424,956	11.8	558,806	13.7
15 Electrical	5,659	4.5	404,706	6.9	101,210	7.6	29,593	18.5	3,700,737	17.9	853,692	20.9
16 Transport vehicles	4,106	3.3	476,641	8.1	119,405	8.9	3,857	2.4	1,500,314	7.3	222,532	5.4
17 Other manufacturing	2,277	1.8	87,957	1.5	21,254	1.6	8,263	5.2	904,732	4.4	157,487	3.9
Total	125,281		5,897,025		1,335,644		160,309		20,633,684		4,088,858	

Source: CSO, Annual Survey of Industries 1994-95 and 2004-05.

Note: *1995 refers to 1995-96.

Chinese Manufacturing Number of factories, GVO and GVA, 1995 and 2004

		Manufacturing 1995 (100 million current RMB)						Manufacturing 2004 (100 million current RMB)					
		No. of Factories	%	GVO	%	GVA	%	No. of Factories	%	GVO	%	GVA	%
1	Food & Beverage	61,560	13.4	5,196	10.7	1,061	8.7	23,094	9.0	13,685	7.8	3,750	8.2
2	Tobacco	423	0.1	1,004	2.1	613	5.0	210	0.1	2,596	1.5	1,883	4.1
3	Textile	25,686	5.6	4,604	9.5	898	7.4	24,192	9.4	10,356	5.9	2,544	5.6
4	Appareling	20,007	4.3	1,470	3.0	347	2.9	12,029	4.7	3,996	2.3	1,126	2.5
5	Wood products	24,240	5.3	632	1.3	152	1.2	8,042	3.1	2,541	1.4	667	1.5
6	Paper & printing	29,326	6.4	1,426	2.9	356	2.9	12,612	4.9	4,571	2.6	1,276	2.8
7	Leather	10,468	2.3	974	2.0	201	1.7	6,393	2.5	2,766	1.6	721	1.6
8	Rubber & plastic	23,918	5.2	1,748	3.6	363	3.0	15,437	6.0	6,009	3.4	1,500	3.3
9	Petroleum & coke	2,734	0.6	2,028	4.2	561	4.6	2,019	0.8	8,927	5.1	1,699	3.7
10	Chemicals	35,092	7.6	5,591	11.5	1,410	11.6	25,004	9.7	18,147	10.4	5,117	11.2
11	Non-metallic mineral	61,278	13.3	3,018	6.2	900	7.4	19,960	7.8	7,460	4.3	2,296	5.0
12	Basic metals	11,920	2.6	5,033	10.4	1,355	11.1	12,441	4.8	22,936	13.1	6,080	13.3
13	Metal products	30,728	6.7	1,651	3.4	384	3.2	14,131	5.5	5,158	2.9	1,315	2.9
14	Machinery	48,332	10.5	4,122	8.5	1,119	9.2	31,493	12.3	13,590	7.8	3,719	8.1
15	Electrical	19,671	4.3	2,594	5.4	604	5.0	16,145	6.3	11,233	6.4	2,802	6.1
16	Electronic	7,997	1.7	2,530	5.2	635	5.2	9,161	3.6	22,260	12.7	4,488	9.8
17	Instruments	5,637	1.2	426	0.9	123	1.0	3,916	1.5	2,193	1.3	575	1.3
18	Transport vehicles	19,445	4.2	3,303	6.8	805	6.6	11,824	4.6	13,796	7.9	3,429	7.5
19	Other manufacturing	22,429	4.9	1,071	2.2	268	2.2	8,896	3.5	3,064	1.7	787	1.7
	Total	460,891		48,421		12,156		256,999		175,283		45,775	

Source: China Industrial Census 1995, China Economic Census Yearbook 2004

Note: The data coverage is "Industrial Enterprises With Independent Accounting Systems" for 1995 and

"All State-owned and Non-state-owned Industrial Enterprises above Designated size" for 2004

SECTION 3: DATA CONSTRUCTION AND CONCEPTUAL ISSUES

3.1 Coverage

Before discussing data and conceptual issues, it is necessary to define the study period, the nature of manufacturing industries, and the standard of industrial classification for both the Indian and Chinese data.

This study covers the period 1980-2004 for which the required industry-level data are available for both countries. The year 1995 is the benchmark year for purposes of compiling PPPs for the manufacturing sector. Note that the annual data for China are simply calendar year data; whereas for India they refer to the fiscal year data beginning in April each year and ending in March in the following year (e.g. 1980 for India refers to April 1980 to March 1981).

In this study, the nature of manufacturing refers to the organization of production and legal status. Strictly speaking, the manufacturing activities in this study should be organized in legally incorporated firms, operating production with modern technology and being able to keep basic accounting books. Available national data are not compiled with the same nature. However, we find that it is reasonable to match the Indian *registered* manufacturing with the Chinese manufacturing enterprises *at/or above the designated size*. Indian manufacturing is made up of "registered" and "unregistered" manufacturing. Registered manufacturing covers all factories or establishments employing 10 or more workers, and using power, and 20 or more workers, but not using power. Unregistered manufacturing is made up of small-scale industries and traditional or cottage industries.[6] The registered manufacturing in India largely should conform to the required nature of manufacturing in this study. In China, manufacturing enterprises that are currently classified as "at/above designated size" are largely the same as those which were classified as "independent accounting units (IAUs) at/above the township level" before 1998. They include all state owned enterprises (SOEs), which are, notably, not confined to the size criterion, plus non-SOEs with minimum 5 million yuan annual sales. They all are legally incorporated, able to maintain accounting books, and make regular report to the national statistical system.

In this study, we re-classify all manufacturing activities into 19 industries as defined in Table 2. This re-classification takes two procedures. First, we conduct necessary adjustment to ensure that the basic data are consistent with the latest classification in India and China, respectively. This means that for India we have to reconcile two revisions of the National Industrial Classifications (NIC) in 1987 and 1998, whereas for China we have to reconcile three revisions of the Chinese Standard of Industrial

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[6] It consists of three groups of manufacturing establishments — 'directory manufacturing establishments' (DME), 'non-directory manufacturing establishments' (NDME) and 'own-account manufacturing enterprises' (OAME). The concept of unregistered manufacturing is provided for a clearer understanding of the make-up of the Indian manufacturing sector although it is not covered in the current study.

Classifications (CSIC) in 1985, 1994 and 2002. Second, we conduct further adjustment to match the data from the two countries. In this exercise, although we focus on 2-digit industries, we have to use 3-digit level data in the matching wherever necessary and data are available. Although data limitation cannot warrant a perfect match (see the notes to Table 2), the final classification used for the two countries is basically satisfied for analytical purpose.

TABLE 2

CLASSIFICATION OF MANUFACTURING INDUSTRIES IN THIS STUDY

	Industry
1	Food products and beverages
2	Tobacco products
3	Textiles: all types of yarns and fabrics
4	Wearing apparel except fur apparel
5	Wood products: sawmill products, furniture and fixtures
6	Paper products, printing and publishing
7	Leather: fur and leather goods including fur apparel
8	Rubber and plastic products
9	Petroleum and coal products
10	Chemicals: basic chemicals, fertilizers, synthetic chemicals and medicine
11	Non-metallic mineral products: Stone, clay, and glass products
12	Basic metals: Basic and fabricated, ferrous and non-ferrous metal products
13	Metal products
14	Machinery and equipment
15	Electric equipment
16	Electronic and telecommunication equipment
17	Instruments and office equipment
18	Transport vehicles and equipment
19	Other manufacturing

Notes:

1) "Manufacture of computing machinery" is included in the manufacturing of "electronic and telecommunication equipment" for both countries, except for the Indian data since 1998 which cannot be separated from "instruments and office equipment".

2) "Manufacture of weapons and ammunition" is included in "machinery and equipment" in the Indian data. In the Chinese data it is never clear whether weapons are included and in which industry, except for a few years. We assume that this industry is captured by "other manufacturing". While this treatment may not make "machinery and equipment" and "others" fully compatible between the two countries, the latter industry is more affected as it is much smaller than the former and in the case of China it is often treated as a "residual". For this reason, we tend to drop "others" in analysis of individual industries.

3.2 Indian Data

The concepts and national accounting practices used by the Central Statistical Organisation (CSO) in Indian manufacturing are consistent with the System of National Accounts. These are described in the CSO (1989) publication "National Accounts

Statistics: Sources and Methods, 1989". Treatment to the available input and output data are described below.

Output

Indian gross value added (GVA) is defined by the production approach as described in the national accounts as well as in the Annual Survey of Industries (ASI). It is estimated by taking the difference of value of output at ex-factory prices and the corresponding value of input at purchasers' prices. However, the ASI reported value added are only available in net terms, or net value added (NVA) as used in the ASI, which does not include the current year capital consumption or depreciation. We then add the value of depreciation from the same report to NVA to obtain GVA for each year. The so-constructed time-series of 1980 to 2004 for each industry are in million current rupees. They are then deflated using the producer price index (PPI) drawn from the *Handbook of Statistics on Indian Economy*,[7] to obtain the 1995 constant rupee denoted series (Table A2).

Labour

The concept of labour used in this study adopts the man-days approach. That is, we define a "standard worker" works for 300 working days a year. This follows that by assigning 8 hours worked per working day, a "standard worker" works for 2400 hours per year. This approach allows us to convert employment data compiled in different ways in the Indian and Chinese labour statistics to the same standard. In the ASI data set there are no data on hours worked, but data on man-days worked. According to the Indian industrial concept of man-days, it is the total number of days worked and number of days paid for during the accounting year. It is obtained by summing-up the number of persons of specified categories attending in each shift over all the shifts worked on all days.

Unfortunately, the ASI stopped publishing the data on the total man-days worked after 1996. We then have to assume that the number of man-days per worker in 1997-2004 is the same as that in 1996. This is fairly acceptable as the number of man-days per worker became vary stable after 1985 (302 days in 1980 compared with 269 in 1980 and 308 on average in 1994-96). We can obtain the number of man-days *actually* worked per worker employed for each year by dividing the number of total man-days worked by the number of total workers employed.[8] Finally, the estimated number of total man-days worked for each industry over the period 1980-2004 is divided by 300 (the *standard* number of man-days worked per worker) to obtain the number of "standard workers" employed (Appendix Table A2).

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[7] The Handbook is published by the Reserve Bank of India. Data used are obtained from various issues, available via www.indiastat.com.

[8] Note that we use the ASI data on "number of workers" not data on "number of employees" as the latter became unavailable after 1997. We feel reasonable to argue that the former is a very close proxy for the latter.

Net Capital Stock

The data on net capital stock in the study are the fixed capital data available in the ASI data set. The ASI defines "fixed capital" as the depreciated value of fixed assets owned by the factory as on the closing day of the accounting year. It includes land (including lease-hold land), buildings, plant and machinery, furniture and fixtures, transport equipment, water system and roadways and other fixed assets such as hospitals, schools etc. used for the benefit of factory personnel. Ideally, TFP studies should omit the land from capital stock as it does not directly go into the production process towards value added. However, lack of information prevents the exclusion of the land. More importantly, as we argued below when discussing the Chinese data problem, non-industrial fixed assets, such as dwellings, hospitals and schools attached to the factories, should be excluded from the industrial fixed assets because by nature they belong to the fixed assets of services. But we have no information that helps identify and remove the amount of non-industrial fixed capital. However, we believe, though arguable, that the problem in India is not as serious as in China because of different nature of the industrial system back to the pre-reform period (need to be discussed further…). Thus the net capital stock should be a qualified proxy for the capital services in Indian manufacturing.

The ASI net capital stock figures are only available at current prices. Appropriate capital stock deflators had to be used to deflate the current price series into constant price series. Since there are not any price surveys on fixed asset investment, we have to rely on the PPI by industry reported in the national accounts. We assume that the price of fixed assets investment is affected by prices of building materials, machinery and equipment. To compensate for any influencing factor that may not be picked up by the two categories, we also include the PPI for total manufacturing. The finally used deflator is derived by taking the geometric mean of the PPI of "total manufacturing", "non-metallic mineral products", and "machinery and equipment". The results are reported in Appendix Table A2.

3.3 Chinese Data

Although China in principle fully switched to the System of National Accounts (SNA) in 1992 and has since continuously improved its national accounts through surveys and censuses, some of the concepts and national accounting practices used by the National Bureau of Statistics (NBS) are to some extent still influenced by the old material product system (MPS) (see Xu, 1999, for a full account of the differences). In this study, we use and update the data constructed by Wu in some of his earlier studies (Wu, 2002a, 2002b, 2007; Wu and Yue, 2007). Further efforts are made to re-construct the official output data, to standardize the employment data, and to revise the net capital stock, as given below.

Output

A major concern from this process would be how accurate the so constructed GVA is. In his comprehensive review, Wu (2000, pp. 479-484) discusses how methodological and

institutional factors that might have exaggerated industrial output. Methodologically, China's long practice of the Soviet-style "comparable price" approach underestimates inflation because it requires enterprises to report their output at some "constant price" that was set ten years ago and tended to ignore new products appeared after the base year. Institutionally, heavy government involvement in business and administratively managed data reporting system induce distorted incentives for firms and local officials to exaggerate performance.

There have been a number of important empirical studies attempting to make alternative estimates using various approaches, such as physical output index (Wu, 2002a), alternative price indices (Wu, 2000; Woo, 1998; Ren, 1997; Jefferson et al., 1996), and energy consumption approximation (Adams and Chen, 1996). Despite different results, all appear to support the upward bias hypothesis for the official data. Wu's index based on physical output data is perhaps most independent of official growth estimates.[9] However, since Chinese industrial statistics are based on enterprises rather than establishments, product-based output estimates may not closely match the statistics on labour and capital stock for all industries. In this study, we still base our output data construction on the official data but choose alternative price indices to moderate the over-reporting effect on the output.

We obtain the nominal GVA of individual industries from the industrial statistics published in *China Industrial Economic Statistics Yearbook* by the Department of Industrial and Transportation Statistics (DITS), NBS. However, there are no GVA data for the period before 1993 or before China shifted to SNA, but data on the net value of output (NVO) complied following the MPS concept (for details see Wu, 2000). We adjust NVO to GVA by adding back estimated capital consumption (see discussion in estimation of capital stock below). After comparing official PPIs with the implicit "comparable price indices" (CPPIs) for individual industries, derived from nominal GVO and GVO at different constant prices by industry, we choose PPIs as deflators to deflate GVA because they suggest higher price levels than CPPIs. See Appendix Table A2 for the results.

Labour

Chinese official data on industrial employment have severe flaws. Before 1998 unemployed workers still remain on the payroll in all SOEs largely due to political reason. Non-industrial staffs working in education, medical care, commercial outlets, and social and political organizations are inherent in the official industrial statistics. There have never been regular, systematic surveys on hours worked, even though institutional working hours per week have been changed several times. Direct use of officially reported numbers employed would be very misleading. Adopting the approach used in Wu and Yue (2007), we first convert numbers employed, published in *China Industrial*

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[9] Wu (2002a) constructed a Laspeyres quantity index for major industrial branches in 1949-97 using time series data on 200 major industrial products and value added weights from China's 1987 Input-Output Table. His estimates suggest an annual industrial GDP growth of 8.7% in 1978-97, compared with the official rate of 12%. Using the same approach, Maddison and Wu (2006) update Wu's earlier estimates showing an annual industrial GDP growth of 9.8% in 1978-97, compared with the official rate of 11.5%.

Economic Statistics Yearbook by DITS and the 1995 Industrial Census and the 2004 National Economic Census, to hours worked based on institutional working hours, standard working hours due to different shift arrangements across industries, and assumptions for possible extra or overtime hours. We then remove non-industrial employees based on occupational structure of industries provided by censuses. Note that this is only applied to SOEs and collective enterprises, not foreign invested enterprises. The results on "hours worked" are further converted to the standardized "man-days worked" and further to the standardized "numbers employed", just as we did in processing the Indian employment data. The results are reported in Appendix Table A2.

Net Capital Stock

As discussed in Wu (2002b and 2007), an often made and significant mistake in constructing capital stock is the direct use of official statistics on "investment in fixed assets" as the investment variable in estimating capital stock with the perpetual inventory method (PIM).[10] By the official definition, "investment in fixed assets" refers to the "workload" of fixed asset investment activities in value rather than the ownership transfer-based purchase of fixed capital as defined by SNA. This is regarded as the key difference between SNA and the Chinese system in measuring fixed asset investment (Xu, 1999, pp.62-63). Apparently, the official investment series represents a flow of activities that mix investment in fixed capital and in inventories (work-in-process). As correctly noted in Chow (1993, p.816), the work performed in the "investment in fixed assets" may not produce results that meet standards for fixed assets in the *current* period. In fact, some of the work (investment projects) may take many years to become qualified for fixed assets and some may never meet the standards, hence be completely wasted, which is a typical phenomenon in all centrally planned economies and still true in some state projects in the post-reform era in China.

Official statistics also include capital stock series as end-year "original value of fixed assets" based on accounting data reported by enterprises. It embodies a mix of newly invested buildings, equipment and machinery, with the value of the existing stock at acquisition prices. Two problems arise from directly adopting it as a proxy for capital stock: inaccurate valuation and improper coverage. Firstly, it is impossible to find a deflator that can correctly deflate a capital stock mixed with assets purchased in different periods. Secondly, like the official data on investment the stock series also includes residential and non-industrial structures. A pioneer study by Chen et al. (1988) derives annual investment flows from the official stock to bypass the first problem, and removes residential buildings to solve the second problem. Yet, it has underestimated the annual flows by ignoring the effect of scrapings (equipment or structures that had been disposed during the year in question) and unconditionally accepted the official depreciation method.

Following Wu's earlier work (2002b) and recent update (2007), we estimate net capital stock in 1995 constant yuan through the following procedures. First, we derive annual flow of investment by subtracting the last from the current end-year stock and adding

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[10] For example, see Young (2000), Huang et al. (2002), Hu and Khan (1997) and Li at el (1992).

back the value of scrapings by an assumed scraping function and timing (details to follow…). Second, based on the information on type of fixed assets in investment as surveyed by Ministry of Finance (MoF), we identify and remove non-industrial assets from the so-derived investment flow. Third, we construct deflators for individual industries using detailed (6-digit) annual asset evaluation data for the period 1984-2000, compiled by MoF et al. (2002), and PPI for building materials and machinery (taking a geometric mean) for the period 2001-05. Lastly, in the PIM exercise, we adopt the initial stock level from the China's 1950 asset survey and re-valuation (Wu, 2007). We feel justified to assume a geometric function of depreciation that reflects changes in economic efficiency of different types of fixed assets (Hulten and Wykoff, 1981). Thus, as depreciation (δ) of an asset equals to its declining-balance rate (R) divided by its service-live (T), we need to estimate proper R and T for equipment and structures of each industry. In this study, we adopt the BEA estimates of declining-balance rates for major industrial equipment and structures as given in Kaze and Herman (1997, pp.72-3) that are mainly based on the empirical work by Hulten and Wykoff (1981). To gauge the service lives of assets in Chinese manufacturing, we rely on three sources of information including the depreciation rates (by the straight-line approach) used since 1963 by MoF, a detailed list of the standard service lives for fixed assets issued by the State Council in 1985 (No. 63 Circular), and a new regulation on service lives by MoF in 1992 (No. 574). The results are reported in Appendix Table A2.

SECTION 4: METHODOLOGY

4.1 Measuring Purchasing Power Parities (PPPs)

The current study adopts the industry-of-origin approach refined by the International Comparisons of Output and Productivity (ICOP) project at the University of Groningen. The basic data required are the prices and quantities for manufacturing products. Essentially, such basic data are drawn from industrial censuses of each country.

The data sources of India and China used in the matching exercise for the year 1995 were drawn from the Annual Survey of Industries 1994-95 and the Third National Industrial Census of the PRC 1995, respectively. For India, the Annual Survey of Industries provides value output and quantity details for each manufactured product in the registered manufacturing sector. While producer prices may not be available, the average price (ie. unit values) of manufactured products can be derived by taking the ratio of value output over the quantities. For China, the process is not as direct as the Indian data. Majority of the matchings were based on the quantities and value output of the "independent accounting units (IAUs) at/above the township level while the rest used a combination of the Hitotsubashi price list and selected prices from Maddison-Wu's China-US 1997 study. The current study also had the option to use the quantities and value output for all independent accounting units at township level and above which were provided in the Third National Industrial Census of the PRC 1995. However derivation of unit values based on this dataset is unreliable due to the inconsistencies in the coverage of enterprises of the quantity set with the value output set.

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The data for the IAUs at/above the township level of Chinese enterprises covered 531 items, of which two had no quantities. Close inspection of this dataset showed that there was no food and beverages industry. In order to include such products into the matching exercise, the quantities of the independent accounting units at township level and above drawn from the Third National Industrial Census of the PRC and the prices drawn from the Hitotsubashi price list were used. The latter contained 2000 plus items and after a thorough check on the product list of the census with the Hitotsubashi price list, approximately 320 plus items were identified to have both quantities and price.

The following notations are used in this section. Let q and p refer to quantity and price, respectively and *Ch* and *In* represent China and India respectively, with China as the base country. Subscript *i* refers to manufactured product, *j* refers to the type of industry, and *k* refers to the type of branch. In the current study and also in standard ICOP studies, prices are in fact unit value ratios (UVRs) as they are derived from data on values and quantities for broad categories of goods. A distinction is made between UVRs and PPPs. UVRs in this study refer to product level price information and PPPs refer to price levels at an aggregated level, e.g. manufacturing industries and branches. The PPPs are derived using a "pyramid" type approach which consists of three stages. The first stage involves the derivation of industry-specific PPPs based on prices of manufactured products belonging to a particular industry are aggregated using output or sales quantities. The second stage uses these industry-specific PPPs and aggregated to yield branch level PPPs for the manufacturing sector. Finally, the third stage uses these branch-level PPPs and aggregated to derive a single PPP for the whole manufacturing sector.

Industry-specific PPPs (Stage 1)

Let p_{ij} and q_{ij}, respectively, denote the prices and quantities of manufactured products belonging to industry *j* that are considered to have matching specifications and quality. For all "matched products" which are considered as typical of the industry to which they belong, the Laspeyres and Paasche indices are derived as follows:

$$(1) \qquad \text{Laspeyres Index} = \frac{\sum_i p_{ij}^{Ch} q_{ij}^{In}}{\sum_i p_{ij}^{Ch} q_{ij}^{Ch}} = PPP_j^{Ch,In(Ch)}$$

$$(2) \qquad \text{Paasche Index} = \frac{\sum_i p_{ij}^{In} q_{ij}^{In}}{\sum_i p_{ij}^{Ch} q_{ij}^{In}} = PPP_j^{Ch,In(In)}$$

Taking the geometric average of the Laspeyers and Paasche indices derives the Fisher Index expressed as follows:

$$(3) \qquad PPP_j^{Ch,In} = \sqrt{PPP_j^{Ch,In(Ch)} \times PPP_j^{Ch,In(In)}}$$

The Fisher index number formula is used to compute PPPs at the industry level. The choice of the Fisher index is largely guided by the number of desirable statistical,

axiomatic and economic–theoretic properties resulting in labels like the "ideal index" and the "superlative index" (Diewert, 1992).

Branch Level PPPs (Stage 2)

For manufacturing branch k, PPPs of the matched industries belonging to that particular branch are aggregated using the value output-share weights observed in China and India. Thus for branch k PPP, these are expressed as follows:

$$(4) \qquad PPP_k^{Ch,In(Ch)} = \frac{\sum_j \left[GVO_j^{Ch(Ch)} \times PPP_j^{Ch,In(Ch)} \right]}{\sum_j GVO_j^{Ch(Ch)}}$$

$$(5) \qquad PPP_k^{Ch,In(In)} = \frac{\sum_j GVO_j^{In(In)}}{\sum_j \left[GVO_j^{In(In)} \Big/ PPP_j^{Ch,In(In)} \right]}$$

where $PPP_k^{Ch,In(Ch)}$ is based at the Chinese gross value of output (GVO) weights and $PPP_k^{Ch,In(In)}$ is based at Indian GVO weights. The geometric average, consistent with the Fisher index, is used in computing the branch PPPs and expressed as follows:

$$(6) \qquad PPP_k^{Ch,In} = \sqrt{PPP_k^{Ch,In(Ch)} \times PPP_k^{Ch,In(In)}}$$

Essentially, the ICOP approach advocates the use of value added as weights. The current study is however limited to only the use of industry value output as weights since Chinese data do not provide value added at the industry level.

Manufacturing PPP (Stage 3)

Derivation of manufacturing PPP follows a similar approach to Stage 2 whereby this time aggregation of PPPs are from branch level to total manufacturing rather than from industry to branch level as described in Section 4.2. Base country weights are used to derive the Laspeyres index while the alternate country quantities valued at base prices are used to derive the Paasche indices. In turn, the geometric average of the Laspeyres and Paasche indices derives the total manufacturing PPP.

The manufacturing PPP is derived as value output-share weighted averages of branch level PPPs and as the geometric average of the PPPs derived using the formulae in (4) and (5). The product matches are determined by considering detailed data from the manufacturing censuses of these two countries. The matching exercise identified 98 matched items. Of the 98 items matched, Chinese matched coverage value of output was 49% of its manufacturing gross value of output, in Chinese prices. For India, this was 24% in Indian prices. Table 3 below compares the coverage attained in this study with the coverage ratios obtained in past ICOP studies.

TABLE 3
COMPARISONS OF MATCHED COVERAGE AMONGST ICOP STUDIES

(a)	Benchmark year	Number of matched products	Ratio of value output of matched items to manufacturing gross value output (%)	
			Base country	Alternate country
Current study	1995	98	49	24
India/China	1985	95	65	44
Indonesia/Australia	1987	112	22	41
India/USA	1975	108	9.6	19
Japan/USA	1987	190	20	19
Korea/USA	1987	192	21	37
Australia/USA	1987	178	15	23
China/USA	1985	67	19	37
China/USA	1987	66	17	36

(a) The country name that comes first is the alternate country and the country name after that is the base country.
Source: India/China study from Lee, Rao and Shepherd (2007), p. 395. Indonesia/Australia study from Szirmai et al. (1995), p. 18. India/USA study from Van Ark (1993), p. 157. Japan/USA study from Pilat (1994), p. 242. Korea/USA study from Pilat (1994), p. 265. Australia/USA study from Pilat et al. (1993), p. 52. China/USA study using as 1985 benchmark year from Szirmai and Ren (2000), p. 48. China/USA study using as 1987 benchmark year from Wu (2001), p. 174.

The number of matched products in the current study is less than in most of the ICOP studies involving comparisons of countries at similar levels of development, such as Japan/USA and Korea/USA. However, a more important indicator is the percentage of total gross output covered by the matched products. In terms of the coverage ratios, the current study is still better in coverage for China except when compared with the India/China 1985 study. However, coverage for India is much less than some of the ICOP studies. More significant is the drop in coverage of the current study's coverage compared to the India/China 1985 study. A main reason for this drop in coverage is that the 1985 study involved grouping of Indian manufactured products in order to match with the Chinese products which were general in description. The manufacturing census for China provided data for products in a grouped form. For example, data are provided for the quantity and value of production of item "shoes" where as in the Indian case data are provided for specific items within the group, e.g., men's shoes, ladies shoes, etc. The current study however focused only on item-by-item match and avoided any aggregation procedure. Another possible explanation for this reduced coverage could be that there is a widening gap in economic development between India and China thus resulting in a dissimilar nature in the manufactured products from 1985 to 1995.

PPPs for Capital Stock Comparisons

In this study, real aggregates of manufacturing output for China and India are derived by converting national currency aggregates into Chinese yuans using PPPs for Indian rupees. In order to derive estimates of total factor productivity it is necessary to convert capital stock figures in nominal values into real values using a PPP suitable for capital equipment. A PPP for this purpose has been constructed using the weighted average of PPPs for "building materials" and "machinery".

Using PPPs for gross output and value added it is possible to output measures expressed in Chinese yuans along with data on employment and real capital stock measures it is possible to measure labour productivity and to compare levels and trends in total factor productivity (TFP).

4.2 Measuring Comparative TFP

The conversion of both gross value added and net capital stock data into industry-of-origin PPPs enables us to make comparisons of labour productivity levels, capital-labour ratio and TFP in manufacturing between India and China. While the comparisons of labour productivity levels and capital-labour ratio are straightforward, the way in which we have calculated comparative TFP levels demands some explanation. For simplicity, we assume a constant return-to-scale Cobb-Douglas production function for individual manufacturing industries in India and China so that the relative levels of TFP in India to China can be expressed as

$$(7) \qquad \frac{A_{i,t}^{IN}}{A_{i,t}^{CH}} = \text{Exp}[\ln \frac{Y_{i,t}^{IN}}{Y_{i,t}^{CH}} - \overline{\alpha} \ln \frac{L_{i,t}^{IN}}{L_{i,t}^{CH}} - (1-\overline{\alpha}) \ln \frac{K_{i,t}^{IN}}{K_{i,t}^{CH}}]$$

where Y is gross value added, L is number of workers, K is net capital stock, A is the level of total factor productivity (TFP), $\overline{\alpha} = \frac{1}{2}(\alpha^{IN} + \alpha^{CH})$ is the unweighted average of the output elasticities of India (superscript *IN*) and China (superscript *CH*), and subscripts *i* and *t* denote manufacturing industry and time.

To explain the sources of TFP, the above equation can be rewritten in capital-intensity form,

$$(8) \qquad \frac{A_{i,t}^{IN}}{A_{i,t}^{CH}} = \text{Exp}[\ln \frac{Y_{i,t}^{IN}/L_{i,t}^{IN}}{Y_{i,t}^{CH}/L_{i,t}^{CH}} - (1-\overline{\alpha}) \ln \frac{K_{i,t}^{IN}/L_{i,t}^{IN}}{K_{i,t}^{CH}/L_{i,t}^{CH}}].$$

The difference in TFP performance between India and China can therefore be defined as the difference between the relative labour productivity level and the relative capital intensity level multiplied by the output elasticity of capital (Wolff, 1991; Timmer, 1999).[11]

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[11] See E.N. Wolff, "Capital formation and productivity growth over the long-term", *American Economic Review*, 1991, 81 (3), pp.565-579. Also Timmer, *The Dynamics of Asian Manufacturing*.

Given the input and output data we have constructed, the key question here is what income share that should be used to weight the factor inputs. In this study, instead of following most studies adopting arbitrary weights for labour and capital (40 vs. 60 percent or the other way round) that are based on cross-country experiences in the long run, we choose to use the share of total labour compensation (wage bills plus welfare payments) in the gross value added of each industry, from which we derive the share of compensation for capital as the residual, which can be described as a pseudo input-output table approach towards factor payments. For the Indian labour compensation shares, we use the ASI data on total compensation paid to employees in nominal terms and divide it by GVA at current rupee. For the Chinese labour compensation shares, we first calculate directly reported total wages and welfare payments for each industry, and then reconcile the results with Chinese input-output tables (using the proportion of manufacturing at/or above designated size) for benchmark years, filling the gaps where no input-output tables available by interpolations. The results are divided by GVA at current yuan.

SECTION 5: EMPIRICAL RESULTS

5.1 Purchasing Power Parities (PPPs)

Table 4 presents purchasing power parities showing the number of Indian rupees equivalent to 1 yuan computed using the methodology outlined in Section 4. The PPP for the manufacturing sector is 3.36 rupees per yuan compared to the official exchange rate o 3.88 rupees. This implies that the price level for the manufacturing sector is 13% lower in India compared to price level in China. The table also shows that PPPs for different manufacturing branches differ significantly. This means that when one is interested in real output and productivity comparisons it is important to make use of PPPs that are relevant to particular manufacturing branches. Using a single PPP, derived for the whole manufacturing sector, for different manufacturing branches can bring in distortions reflecting differences in branch-specific PPPs.

TABLE 4
PURCHASING POWER PARITIES AND RELIABILITY INDICATORS BY MANUFACTURING BRANCH, INDIA/CHINA, 1995

	PPP (Rupees/Yuan)			Relative Price level	Coefficient of variation		Matched output as % of total		Number of
	Indian quantity weights	Chinese quantity weights	Geometric Average	(China=100)	Indian quantity weights	Chinese quantity weights	India	China	product matches
Food Products	2.50	2.68	2.59	66.67	0.321	0.299	45.5	75.4	12
Beverages	3.02	3.14	3.08	79.36	0.739	0.709	37.0	100.0	2
Tobacco	2.29	2.29	2.29	59.02	n.a.	n.a.	26.5	100.0	1
Textile Products	4.45	4.28	4.36	112.39	0.456	0.474	37.9	38.4	5
Wearing apparel	3.14	3.14	3.14	80.86	n.a.	n.a.	11.8	48.6	1
Wood,Furniture,Etc.	2.00	3.36	2.59	66.86	0.922	0.550	25.5	31.4	3
Paper & Printing,Etc.	4.16	4.13	4.14	106.77	0.088	0.088	5.9	54.7	2
Leather & Fur Products	3.20	3.16	3.18	82.00	0.491	0.497	0.7	52.6	2
Chemicals,Etc.	4.16	5.11	4.61	118.84	0.578	0.470	19.2	24.8	18 (a)
Rubber, Petroleum,Etc.	3.50	4.04	3.76	96.88	0.382	0.331	4.7	93.2	7
Non-Metallic Products	4.49	4.34	4.41	113.78	0.500	0.518	45.8	77.6	7
Basic Metal Industries	5.15	4.97	5.06	130.45	0.233	0.239	11.8	43.3	4
Metal Products	3.02	3.79	3.38	87.09	0.555	0.442	7.2	28.8	5
Non-Elect.Machinery,Tools & Parts	3.04	3.28	3.16	81.35	0.398	0.358	1.7	20.7	9
Electrical Machinery	3.26	3.62	3.43	88.47	1.078	0.949	28.4	84.2	8
Transport Equipments	3.17	2.99	3.08	79.31	0.376	0.399	12.1	48.7	5
Other Manufacturing	2.62	3.80	3.16	81.33	1.120	0.771	6.3	17.5	7
Total Manufacturing	3.26	3.47	3.36	86.72			24.1	49.5	98
Exchange Rate			3.88						

(a) Two matches in this branch are petroleum related products.

Table 4 provides interesting additional information. The relative price levels vary a great deal across different manufacturing branches with the lowest price level for Tobacco (59%) to a high level of 130% for Basic Metal Industries. Generally prices are lower in India for simply manufactured branches like Food, Beverages and Wood and Furniture,. However in the case of more elaborately manufactured goods like Chemicals, Non-metallic Products and Basic metal industries the price level in India is higher than that in China. These results could be significantly different and India would be expected to have higher relative prices in many other sectors if PPPs were computed for a more recent year like 2005[12].

Table 4 also provides details of the coverage and various measures of reliability by manufacturing branches. A measure of reliability associated with the PPP for each branch is given by the coefficient of variation (cv). The cv's are at reasonable levels indicating that PPPs are based on UVRs exhibiting a low level of variation.[13] The last column of the table shows the number of matches, and therefore UVRs on which the branch level PPPs are based. The coverage ratios are generally lower for India, the main reason for this is due to the nature of detail available within the manufacturing census data. Overall, the coverage is quite good in the case of China but is somewhat low at around 25%. Notwithstanding this, the low values for the coefficient of variation provide an indication that the resulting PPPs are reliable.

5.2 Gross Value Added, Employment and Capital Stock

In this section, we present growth rates of real output, labour and capital stock as well as labour productivity and total factor productivity in China and India. The nominal aggregates (gross value added and capital stock) in national currency units are first converted into yuans using appropriate PPPs. The converted real aggregates are then extended to cover the time series using the national deflators.[14]

In Tables 5, 6 and 7 we present annual growth rates in value added, employment and capital stock for the manufacturing sector as a whole and for the constituent manufacturing branches. In order to facilitate presentation, these are presented for specific sub-periods.

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[12] Consistency between the PPPs for the 1995 benchmark with extrapolated value of PPP from the 1985 benchmark reported in Lee et al (2007) will be examined as a part of this study.

[13] Caution should be exercised in interpreting these results when the PPPs are based on a small number of matches.

[14] Detailed series by the branch level are available from the authors upon request.

Table 5

Annual Growth of Gross Value Added in Registered Indian Manufacturing and Chinese Independent accounting units (IAUs) at/above the township level (In percentage at 1995 Chinese yuan)

	Total manufacturing		Food & Beverage		Tobacco		Textiles		Apparel		Wood products		Paper & printing		Leather products		Rubber & plastic		Petroleum & coke	
	China	India	China	India	China	India	China	India	China	India	China	India	China	India	China	India	China	India	China	India
1980-1985	8.96	6.29	11.05	13.35	13.13	10.33	7.81	5.26	13.94	10.88	5.21	-7.05	8.12	1.63	11.32	3.07	9.94	10.14	4.28	7.80
1986-1990	3.75	11.37	8.31	10.70	9.48	18.57	1.34	14.61	4.16	25.56	-7.18	20.58	1.97	12.74	2.80	27.44	3.89	14.32	0.18	5.44
1991-1995	2.98	14.65	3.56	14.23	0.74	-1.36	-2.56	7.52	12.34	32.67	11.99	5.98	1.73	13.51	13.49	3.96	-0.28	17.11	-9.14	22.26
1996-2000	9.55	-4.35	8.37	2.02	7.65	13.76	6.80	2.09	7.16	-1.67	4.68	6.63	8.95	13.53	5.28	5.72	10.39	-30.81	-2.94	-4.78
2001-2004	23.47	14.12	17.96	0.92	15.79	-6.02	19.76	5.68	16.49	11.82	25.50	-3.61	19.87	15.30	20.28	-8.41	18.81	-5.28	14.17	42.84

	Chemicals		Non-metallic mineral		Basic metals		Metal products		Machinery		Electrical equipment		Electronics/ICT		Instruments		Transport vehicles		Other manufacturing	
	China	India	China	India	China	India	China	India	China	India	China	India	China	India	China	India	China	India	China	India
1980-1985	8.91	4.71	9.80	12.70	6.25	10.69	9.33	7.06	10.29	9.89	13.46	-5.91	17.70	5.60	7.78	-0.46	13.31	5.22	8.97	19.87
1986-1990	7.86	9.34	0.66	15.32	2.42	17.84	4.04	15.10	0.91	8.72	5.60	4.96	10.07	-6.49	-0.01	-1.04	6.39	9.00	5.11	-1.72
1991-1995	0.10	19.84	4.10	7.94	-0.45	12.88	7.41	16.73	1.32	19.05	9.96	13.41	17.09	6.21	8.31	15.52	14.27	16.06	8.11	23.55
1996-2000	10.91	-5.70	3.13	-5.51	10.13	-12.41	7.90	1.54	5.80	-8.40	15.30	-19.31	25.87	-4.31	12.60	4.03	11.40	-15.93	4.63	17.28
2001-2004	20.84	16.66	21.04	8.76	28.52	36.63	22.91	5.40	30.45	14.71	26.17	12.03	28.88	15.64	31.95	13.20	27.23	13.98	13.37	3.50

Table 6

Annual Growth of Employment in Registered Indian Manufacturing and Chinese Independent accounting units (IAUs) at/above the township level (In percentage)

	Total manufacturing		Food & Beverage		Tobacco		Textiles		Apparel		Wood products		Paper & printing		Leather products		Rubber & plastic		Petroleum & coke	
	China	India	China	India	China	India	China	India	China	India	China	India	China	India	China	India	China	India	China	India
1980-1985	4.90	1.17	9.29	3.37	6.25	-1.00	9.76	-1.56	13.12	3.01	9.20	-0.43	6.74	0.05	8.55	5.16	11.89	2.57	6.36	9.38
1986-1990	2.29	2.04	1.12	4.37	5.69	5.73	4.71	-0.64	1.61	12.29	-2.70	-1.64	4.31	0.78	3.28	9.31	3.53	5.67	10.96	5.39
1991-1995	1.41	4.89	1.41	4.04	-1.52	0.46	-3.81	4.29	16.51	16.38	7.22	4.65	-0.21	4.53	23.01	4.81	5.48	7.09	2.07	5.27
1996-2000	-3.57	-2.73	-6.59	-1.44	-0.63	-1.07	-7.49	-1.23	-0.28	-0.13	-7.63	-6.59	-2.91	-4.70	0.48	2.78	1.37	-23.71	0.29	-1.71
2001-2004	3.16	3.88	-0.54	1.52	-6.54	-0.95	3.68	2.18	2.82	11.74	10.71	1.21	0.19	1.24	8.17	1.17	5.23	4.28	3.66	5.12

	Chemicals		Non-metallic mineral		Basic metals		Metal products		Machinery		Electrical equipment		Electronics/ICT		Instruments		Transport vehicles		Other manufacturing	
	China	India	China	India	China	India	China	India	China	India	China	India	China	India	China	India	China	India	China	India
1980-1985	3.80	2.73	5.98	3.55	2.73	1.78	7.27	-0.82	-2.64	2.36	10.53	0.71	5.41	10.84	2.23	-0.38	4.47	0.29	-2.38	0.80
1986-1990	5.77	3.22	-0.54	0.36	4.98	-0.72	0.95	6.16	6.56	2.00	-6.47	9.52	-0.35	-6.61	-9.92	5.65	-8.98	-0.99	4.77	9.28
1991-1995	-0.34	6.34	-1.40	3.10	6.47	5.68	2.45	5.52	-11.83	4.18	4.75	2.88	9.40	4.54	6.43	5.33	10.39	5.79	6.86	13.16
1996-2000	-1.64	0.74	-12.68	-0.73	-3.36	-3.02	-2.48	0.56	-5.12	-3.50	5.95	-12.32	7.49	-7.71	3.33	1.47	0.74	-12.55	-7.88	3.61
2001-2004	-0.65	1.88	-3.31	4.08	3.10	2.44	0.82	6.86	3.55	8.57	8.59	8.74	14.91	9.12	-6.40	11.73	2.94	8.64	3.97	13.93

Table 7

Annual Growth of Net Capital Stock in Registered Indian Manufacturing and Chinese Independent accounting units (IAUs) at/above the township level (In percentage at 1995 Chinese yuan)

	Total manufacturing		Food & Beverage		Tobacco		Textiles		Apparel		Wood products		Paper & printing		Leather products		Rubber & plastic		Petroleum & coke	
	China	India	China	India	China	India	China	India	China	India	China	India	China	India	China	India	China	India	China	India
1980-1985	7.44	7.11	15.12	5.07	21.28	21.65	14.83	8.25	19.13	7.96	12.68	2.25	9.54	4.27	12.78	6.83	13.77	10.09	5.99	24.10
1986-1990	10.47	11.89	13.41	11.73	20.91	0.38	13.69	8.35	14.08	19.46	9.28	7.98	10.59	3.96	14.00	19.02	12.35	20.24	20.52	7.43
1991-1995	14.45	19.27	15.88	19.01	22.28	7.04	8.68	23.32	18.98	32.55	13.49	23.16	15.69	18.44	19.58	20.83	15.23	22.34	16.70	16.13
1996-2000	2.67	2.27	1.17	4.80	8.96	10.88	-2.50	6.83	1.65	-3.85	2.96	2.08	7.54	0.27	-1.60	3.39	3.49	-36.28	9.36	18.19
2001-2004	10.45	2.13	8.54	2.72	3.63	0.70	11.06	0.69	9.25	9.85	14.68	1.09	11.43	0.83	12.00	-1.20	15.78	6.22	2.95	1.34

	Chemicals		Non-metallic mineral		Basic metals		Metal products		Machinery		Electrical equipment		Electronics/ICT		Instruments		Transport vehicles		Other manufacturing	
	China	India	China	India	China	India	China	India	China	India	China	India	China	India	China	India	China	India	China	India
1980-1985	7.17	2.99	11.60	19.25	3.66	5.79	8.23	3.71	2.74	11.23	6.97	3.69	8.71	12.93	5.74	8.17	3.32	4.22	35.53	2.41
1986-1990	11.08	14.03	10.00	6.39	7.95	15.99	11.43	18.87	6.23	9.70	13.97	17.09	10.71	11.98	6.68	17.28	7.08	3.18	14.64	10.56
1991-1995	13.57	23.12	16.52	15.94	17.10	16.24	16.73	23.88	6.75	14.52	16.93	18.04	17.27	16.27	15.47	19.30	16.63	18.22	26.81	40.16
1996-2000	4.78	4.88	-0.94	3.80	3.37	1.25	0.24	-1.46	-2.78	0.93	3.85	-3.78	12.07	3.24	-2.78	8.99	3.74	-11.39	-2.70	7.66
2001-2004	8.41	-6.08	10.75	-1.79	11.08	6.70	6.65	0.98	10.25	13.47	10.21	7.72	22.42	18.19	15.69	27.23	9.35	1.09	-2.61	-15.57

The study period has seen strong growth in value added in manufacturing sector in China as well as in India, especially for the last period 2001-2004. This period appears to show acceleration in growth in both countries but with China showing much higher growth than India. Employment growth appears to be much lower compared to growth in value added implying strong growth in labour productivity in both countries. Of particular note here is the negative growth in employment in manufacturing in both countries during the period 1996-2000. During the period 1980 to 1995, India has posted a higher growth in net capital stock in manufacturing sector compared to China. However, in the most recent period of 2001-2004 capital stock growth in China has been well above that shown for India.

Results for specific manufacturing branches shows considerable variation in the growth rates observed in India and China. Presence of negative growth rates of employment in several branches and for several sub-periods for both China and India are worth noting. This compares with fairly strong growth rates for capital stock, particularly in the case of China. These variations in growth rates are likely to produce interesting trends (??) in productivity growth in these countries.

5.3 Partial and Total Factor Productivity in Manufacturing Sectors of China and India – by branches

Table 8 presents labour productivity (Y/L) measure for India expressed relative to China (=100). These measures are presented at 5-year intervals starting from 1980 and ending in 2004. A quick perusal of the column for real output shows that the size of the manufacturing sector in India is a lot smaller and the relative size is decreasing and it is at a low 10.7% of that of China in 2004. Given the comparable populations sizes of these economies, the relative size of the manufacturing sectors could be a major factor determining the overall growth performance of these two countries and the figures are not very encouraging in the Indian case. It appears that in the case of India, there has been an over emphasis on the services sector and what are the implications of the relatively small size of the manufacturing sector is a matter for debate and consideration.

At the sectoral level, Indian labour productivity is above that of China for all the years except for 2004. In 2004, Indian labour productivity just dipped below that of China. A possible explanation of higher labour productivity is probably due to higher capital intensity (K/L). However, since 1995 the relative performance of India seems to be on the decline. In 1995 productivity in India was about two-and-half times that in China but steadily declined to be slightly below that in China in 2004. This shows a catch-up by China in terms of labour productivity.

Productivity performance appears to vary across various branches. In 1985, China had higher labour productivity in Textiles, Apparels, Rubber and Plastics, Basic Metals and Metal products. By 2004, China has achieved higher labour productivity in Transport Vehicles, Electronics and ICT equipment in addition to the sectors already listed. This performance is quite significant in view of the very high labour productivity levels found

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for India in the year 1995. Therefore, over the last decade the Chinese productivity performance has been quite spectacular.

Though labour productivity is higher in India compared to China in a number of manufacturing branches, it is clear from Table 8 that higher labour productivity is in a large measure due to higher capital intensity. This may not be sustainable as is evident from the trends in the more recent period. In order to assess these aspects it is best if focus is turned to levels and growth in total factor productivity (TFP

Figure 1:
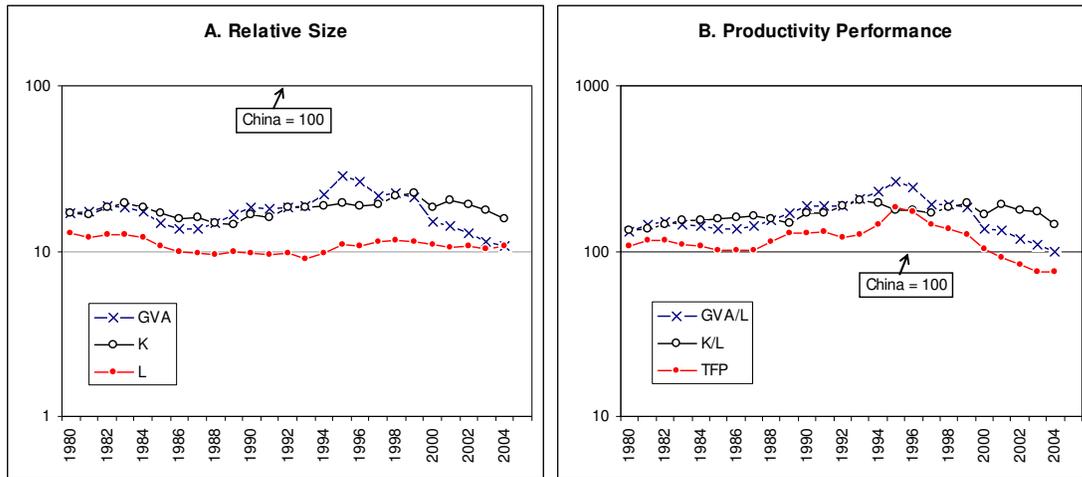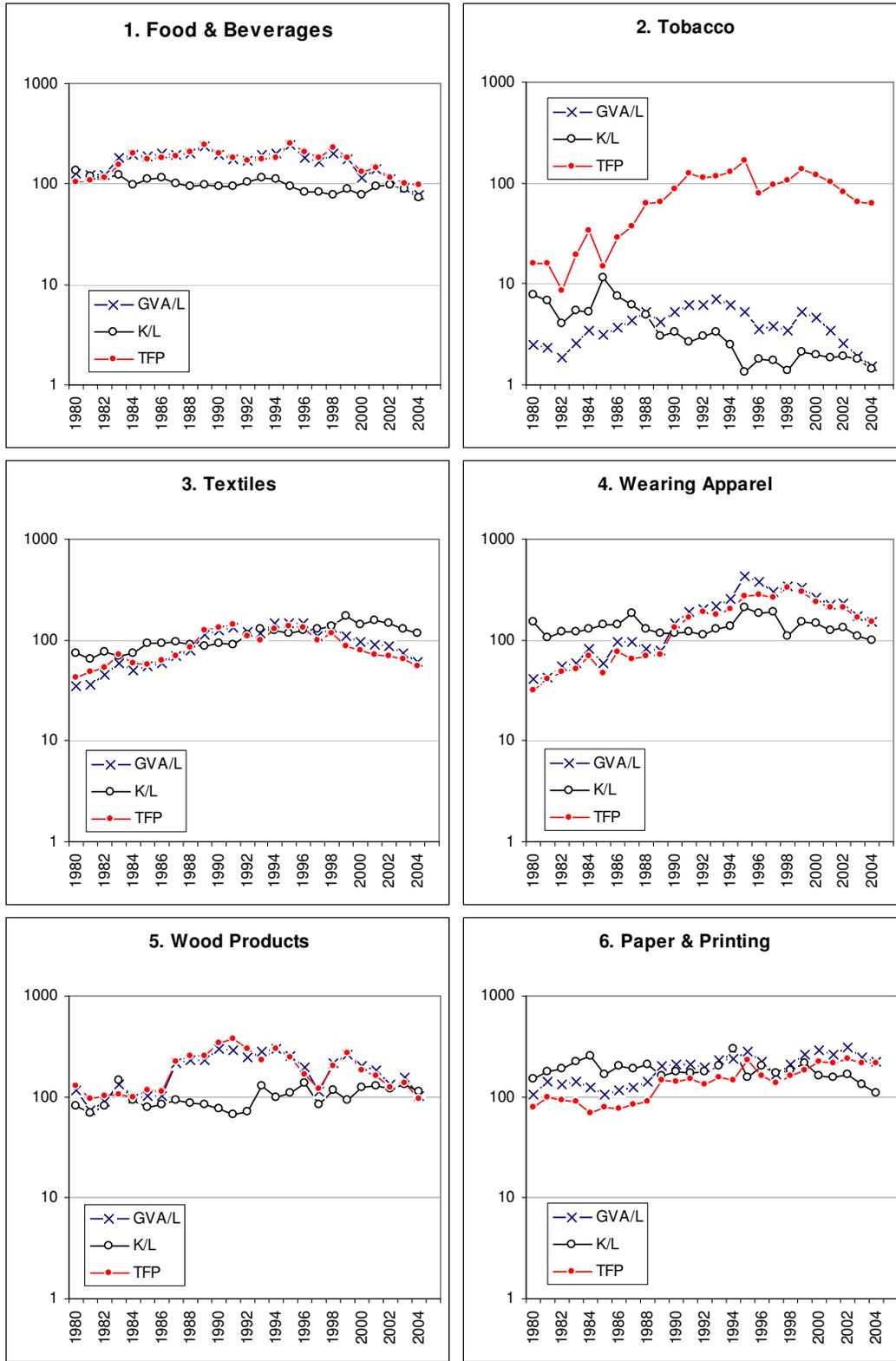Relative Manufacturing Performance in India and China, 1980-2004
(China = 100)

Figure 1 shows that the manufacturing sector in India is relatively small compared to India and it is declining over the last decade. This is largely due to a significant growth in manufacturing in China over this period. However, during the same period the relative level of labour used remained constant.

The productivity performance shown in Figure 1 B shows some interesting trends. For most of the study period, until 2000, TFP level in India is above the level of China. In contrast labour productivity in India, while maintaining a level above that of China, has shown a decline since 1995. Capital intensity observed in India is at a level well about China. It appears that the reforms in China have had a significant effect in lifting total factor productivity and Chinese TFP has attained levels above that of India since 2000.

In a series of tables and graphs, we present detailed branch level results. Tables 9 and 10 provide detailed results for selected years. While there is a picture that is consistent with the manufacturing sector as a whole, there are differences in the performance of different branches.

Figure 2 presents branch-specific trends in relative levels of labour productivity, capital intensity and total factor productivity.

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Figure 2 India/China Comparative Labour Productivity, Capital-Labour Ratio and TFP (China=100)

7. Leather & Products

8. Rubber & Plastics

9. Petroleum & Coke

10. Chemicals

11. Building Materials

12. Basic Metals

13. Metal Products

14. Machinery

15. Electrical Equipment

16. Information & Communication Eq.

17. Instruments & Measuring Eq.

18. Transportation Eq.
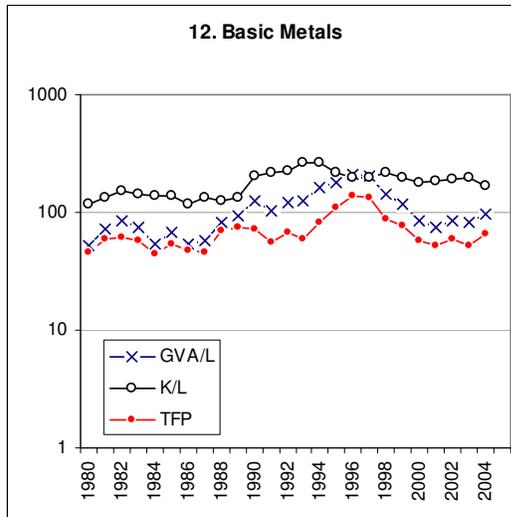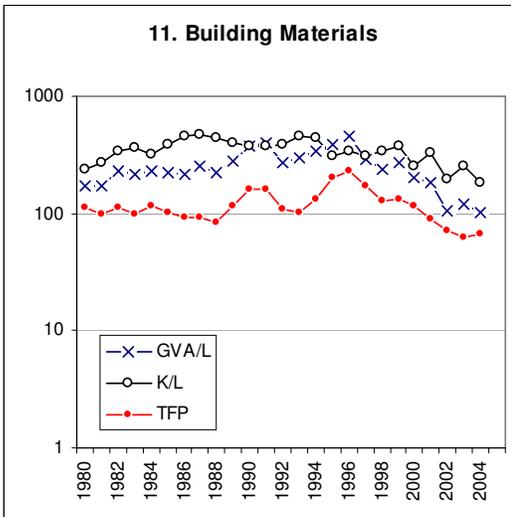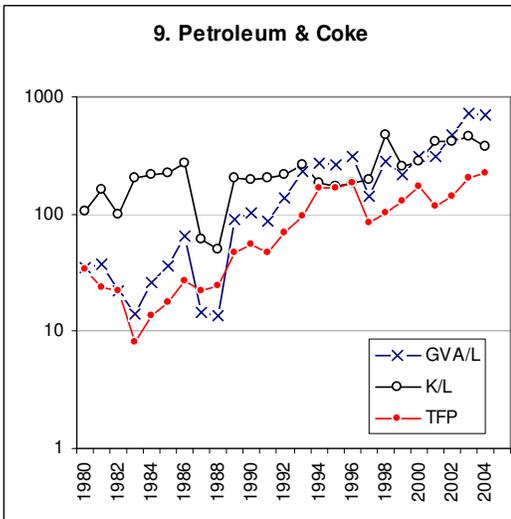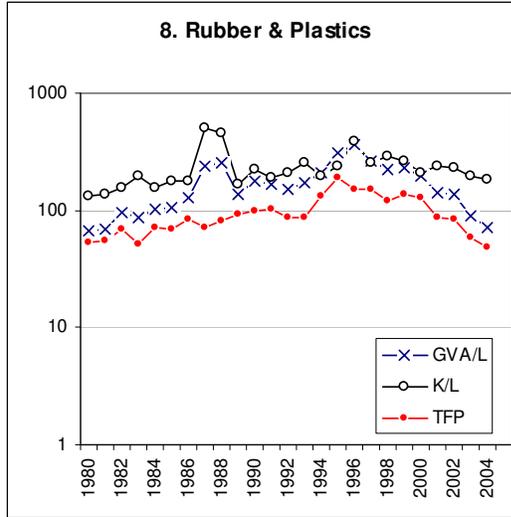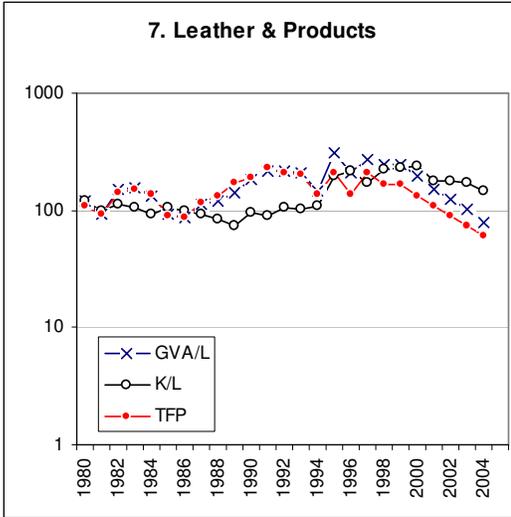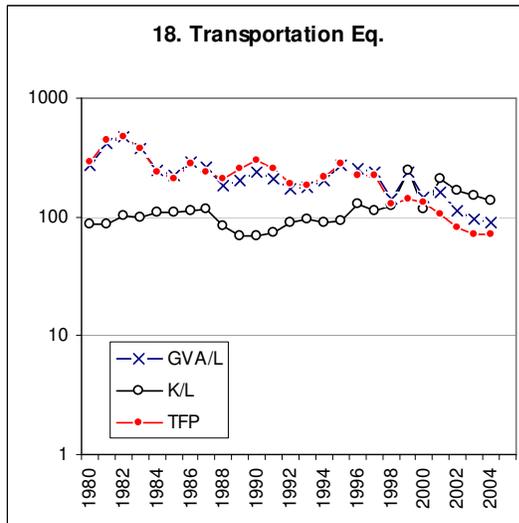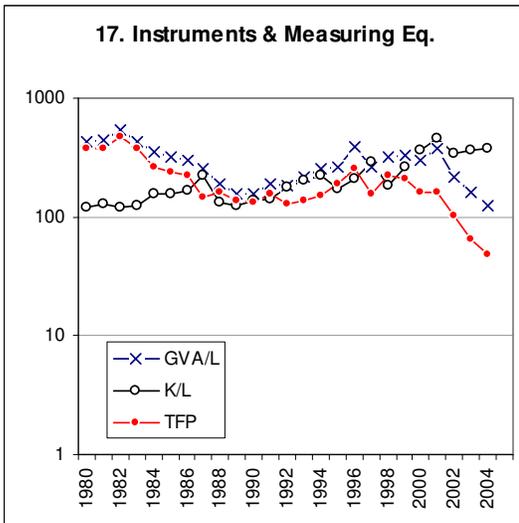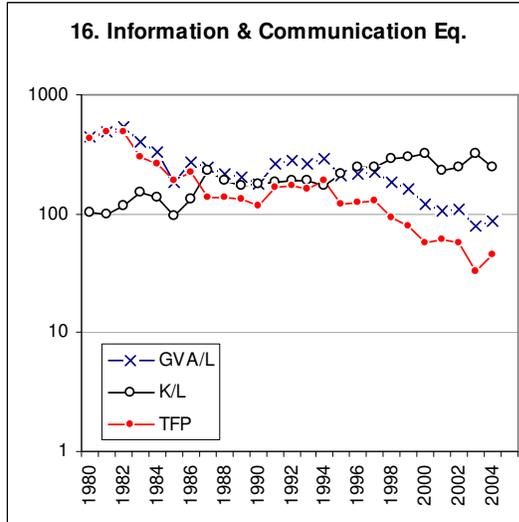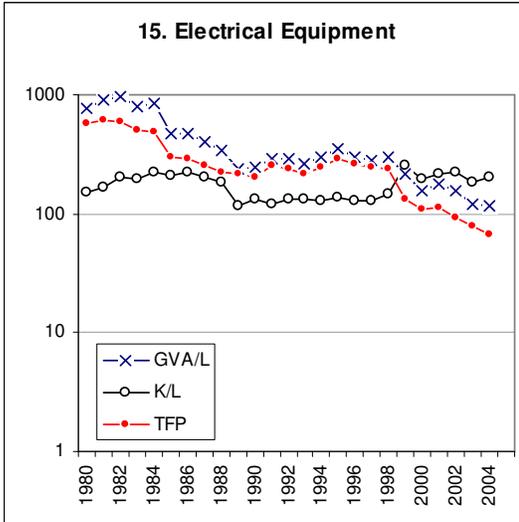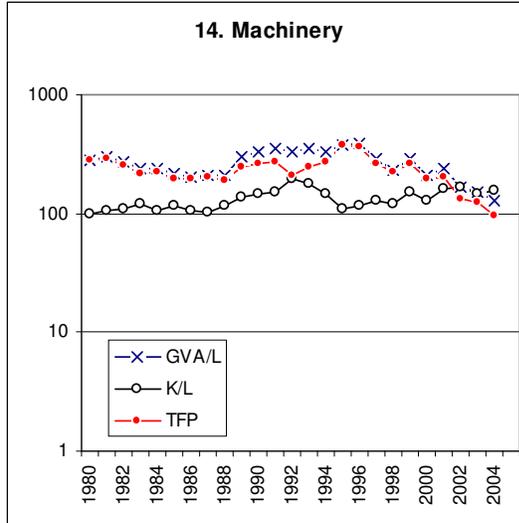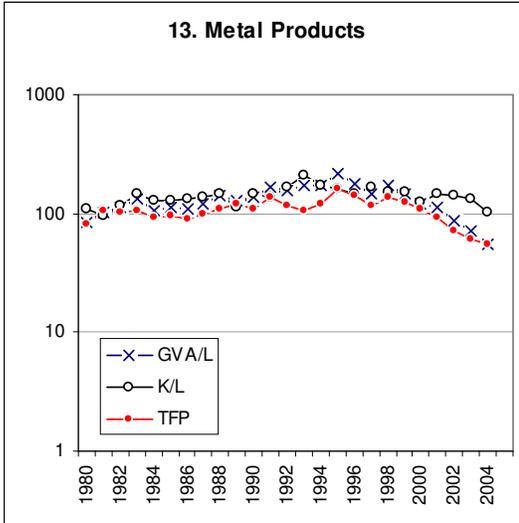
In the case Food and Beverages, Indian TFP levels have been well above the levels seen for China for most of the study period, TFP levels in these two countries appear to converge by the year 2004. In contrast, TFP in Tobacco in China has been well above that in India though there appears to be a steady convergence in the more recent years. In the textiles, China has maintained a higher level of TFP for most of the period and in more recent years TFP growth seems to be higher relative that in India. The case of Wearing Apparel, in contrast, is quite interesting. At the beginning of the study period, China had a TFP which is nearly double that in India but Indian TFP had overtaken China by 1990 but appears to converge to Chinese TFP level in more recent years. In the case of Paper and Printing, India seems to maintain a level higher than that of China.
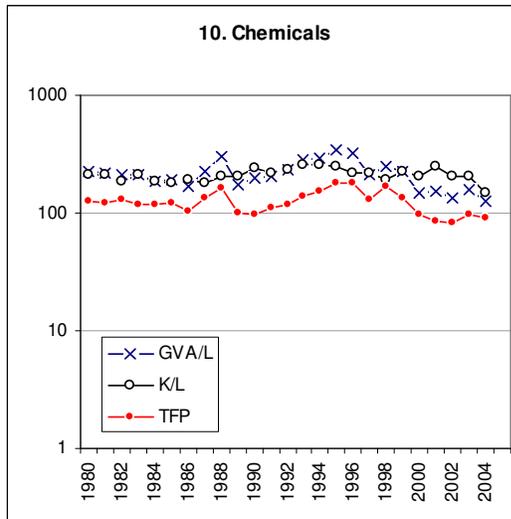
The productivity performance of China in more elaborately transformed manufacturing branches like Metal Products, Machinery, Electrical Equipment, Information and Communications Equipment, and Instruments and Measuring Equipment. In most of these branches, TFP growth in China has outpaced growth in India and in some cases the disparity in TFP growth has been quite spectacular.

The differences in relative TFP levels and growth in some of these more important manufacturing branches may have significant ramifications for the growth trajectories achieved by these two giant economies. Most of the commentaries to date have focused on more macro-level performance but it appears that what is observed at the branch level in the manufacturing sector may have important implications.

Table 8
Real Output, Labour-Output ratio and Capital-Labour ratio, 1980, 1985, 1990, 1995, 2000 and 2004

	1980			1985			1990			1995			2000			2004		
	Y	Y/L	K/L	Y	Y/L	K/L	Y	Y/L	K/L	Y	Y/L	K/L	Y	Y/L	K/L	Y	Y/L	K/L
1 Food & Beverage	26.7	126.2	136.1	30.0	190.3	110.6	31.2	193.5	94.9	42.9	242.1	95.6	26.6	115.8	78.5	17.9	78.1	74.0
2 Tobacco	6.4	2.5	7.9	5.6	3.1	11.5	10.3	5.4	3.3	11.2	5.2	1.3	10.9	4.7	2.0	4.2	1.5	1.4
3 Textiles	13.4	35.2	73.3	11.8	54.6	92.9	19.7	125.6	91.5	28.4	144.1	114.8	22.9	95.3	142.5	11.3	61.3	117.7
4 Apparel	4.2	41.4	150.5	3.6	58.8	142.8	11.6	145.7	115.6	32.4	433.1	209.4	20.2	263.8	146.9	14.4	149.9	98.2
5 Wood products	8.9	115.3	82.4	4.8	101.1	79.2	13.8	300.5	77.4	10.0	255.2	108.2	9.3	205.2	126.1	3.8	100.8	112.1
6 Paper & printing	19.5	104.2	153.0	14.1	105.3	164.2	22.5	207.3	177.9	36.2	280.1	158.2	33.8	288.2	160.7	24.1	223.3	108.5
7 Leather products	13.9	118.8	119.0	9.2	93.2	104.8	19.9	182.7	95.1	15.9	309.2	196.6	10.8	196.4	241.7	4.2	78.5	148.1
8 Rubber & plastic	8.6	66.0	132.9	8.7	106.3	176.2	15.4	179.7	223.0	27.6	309.6	235.4	6.7	193.9	212.6	6.2	71.7	182.6
9 Petroleum & coke	4.3	35.0	105.7	5.2	35.9	224.7	9.4	100.8	198.5	25.6	264.4	172.2	26.4	306.6	282.3	67.7	697.2	372.9
10 Chemicals	26.0	221.6	207.8	21.1	189.4	177.8	18.3	197.2	240.4	41.1	342.8	245.5	19.3	148.0	201.9	14.4	124.5	149.6
11 Non-metallic mineral	7.3	174.0	237.3	8.4	227.1	392.7	12.9	372.3	382.1	17.3	385.8	309.8	14.7	204.0	258.0	8.8	102.9	182.7
12 Basic metals	11.1	51.6	118.4	13.9	67.6	138.2	20.2	123.9	201.9	26.6	179.1	218.0	11.2	84.8	177.9	11.2	96.5	167.2
13 Metal products	10.0	85.2	108.1	8.9	114.0	129.2	11.4	135.8	145.9	19.5	214.2	163.5	12.9	121.4	123.0	5.9	55.1	101.5
14 Machinery	10.4	280.8	97.8	10.2	214.4	116.4	11.5	335.1	145.4	24.4	381.8	107.4	13.1	208.4	128.3	7.8	128.5	154.6
15 Electrical equipment	87.3	774.0	150.7	33.2	480.3	209.0	26.6	246.5	133.0	33.0	357.0	135.7	6.7	157.8	194.4	6.1	116.4	200.7
16 Electronics/ICT	46.4	437.8	101.1	25.3	182.2	95.1	12.7	177.4	177.9	11.5	208.6	213.6	3.0	120.6	315.4	1.7	85.7	242.8
17 Instruments	22.9	424.0	121.1	15.2	320.1	155.9	13.7	155.3	135.6	23.6	266.9	169.7	16.6	301.1	361.2	10.0	124.3	373.5
18 Transport vehicles	53.3	268.0	85.5	35.6	220.4	110.3	52.1	237.0	69.4	48.2	271.4	94.2	12.9	146.0	117.7	10.7	90.8	136.4
19 Other manufacturing	7.7	899.7	1835.6	13.3	1322.7	298.7	3.0	293.5	208.6	10.5	792.6	250.7	9.7	414.2	164.7	8.5	197.9	154.0
Total	16.8	130.4	133.0	14.7	137.5	157.6	18.3	187.8	171.2	28.5	260.9	177.6	15.0	135.5	166.4	10.7	98.8	145.6

Note:

1 Indian output were converted into 1994-95 Chinese yuan based on PPPs derived from Table 4.

2 Indian capital figures were converted into 1994-95 Chinese yuan based on weighted average PPPs of 'Building and non-metallic mineral products' and 'Machinery and transport equipment'.

3 Labour (based on "standard mandays" - 300/year)

Table 9
Annual Growth of Gross Value Added, Net Capital Stock, Employment and Total Factor
Productivity in Indian and Chinese Manufacturing Industries
(Value measured at 1995 constant price in national currency; employment measured in standardized unit)

	India				China			
	GVA	Labour	Capital	TFP	GVA	Labour	Capital	TFP
	1980-1992				1980-1992			
Total manufacturing	8.9	1.5	10.3	2.0	8.1	3.9	9.7	-0.1
Food & beverages	11.7	3.2	9.7	4.4	11.2	5.5	14.7	-1.1
Tobacco	17.7	4.2	12.3	9.3	11.5	6.5	24.4	-12.5
Textiles	8.7	-1.1	9.3	5.2	6.4	7.1	14.2	-5.8
Wearing apparel	24.9	6.2	13.5	13.9	11.5	8.2	18.7	-3.6
Wood products	5.0	-0.7	5.5	2.2	2.9	3.7	11.3	-5.3
Paper & printing	7.5	0.7	6.9	3.4	7.0	5.6	10.6	-2.0
Leather & products	13.7	5.5	11.4	5.0	9.5	6.9	14.0	-1.9
Rubber & plastics	13.6	4.4	14.8	1.9	9.2	7.7	14.2	-3.6
Petroleum & coke	12.7	6.7	16.3	-1.9	3.3	9.7	12.7	-9.2
Chemicals	8.5	3.3	8.8	1.1	10.0	5.1	9.5	1.2
Non-metallic materials	11.2	1.9	14.7	0.7	8.1	2.9	11.1	0.7
Basic metals	10.8	1.6	11.1	3.2	5.5	4.0	7.9	-1.7
Metal products	10.9	1.1	10.7	4.2	8.8	4.3	10.3	0.5
Machinery	8.8	0.7	10.5	2.3	8.0	1.2	4.7	4.4
Electrical equipment	1.1	2.9	8.9	-5.6	11.2	4.3	11.6	1.4
Infor. & comm. Eq.	5.8	0.1	13.7	-2.7	13.9	3.9	12.0	3.8
Instruments	3.2	3.4	14.4	-6.6	6.2	-0.8	6.2	2.3
Transport equipment	7.6	0.1	6.3	4.4	11.9	0.3	6.3	7.4
	1993-2004				1993-2005			
Total manufacturing	6.5	1.0	7.1	1.0	12.6	0.6	9.5	7.4
Food & beverages	6.6	1.0	7.7	0.8	12.9	-0.8	8.6	8.1
Tobacco	-0.2	-0.1	7.6	-5.7	9.2	-2.7	11.6	-1.3
Textiles	3.4	-0.1	7.7	-1.4	8.8	-1.8	6.2	7.0
Wearing apparel	9.9	6.8	9.3	1.4	13.0	5.7	10.0	6.4
Wood products	6.0	0.7	11.7	-1.6	17.7	2.9	10.8	12.2
Paper & printing	11.1	-0.6	7.0	6.7	11.7	-0.5	12.5	8.1
Leather & products	-0.1	3.0	6.1	-5.1	15.6	8.8	9.8	6.3
Rubber & plastics	3.5	3.0	9.0	-4.1	11.3	3.6	11.0	4.2
Petroleum & coke	14.1	1.6	15.5	-0.1	-0.3	1.7	11.5	-8.5
Chemicals	6.2	1.3	5.6	1.4	11.0	0.3	9.1	5.7
Non-metallic materials	6.1	1.5	8.0	-0.4	8.9	-4.7	8.3	7.7
Basic metals	5.6	-1.0	3.9	2.8	11.8	1.9	10.7	5.0
Metal products	6.4	2.7	5.8	1.7	15.0	1.0	8.8	10.5
Machinery	6.9	1.0	6.1	2.5	12.0	-3.0	4.4	13.5
Electrical equipment	3.0	1.1	7.8	-2.9	18.1	6.5	10.7	9.1
Infor. & comm. Eq.	2.1	-0.3	8.9	-4.3	25.2	10.7	18.8	9.2
Instruments	11.3	3.8	13.9	0.6	17.9	5.2	9.7	10.3
Transport equipment	5.6	0.4	8.7	-0.4	16.3	4.7	10.8	8.4

Table 10
Contribution to the Growth of Gross Value Added in Indian and Chinese Manufacturing Industries
(Value measured at 1995 constant price in national currency; employment measured in standardized unit)

	India				China			
	GVA	Contribution by (%)			GVA	Contribution by (%)		
	% p.a.	Labour	Capital	TFP	% p.a.	Labour	Capital	TFP
	1980-1992				**1980-1992**			
Total manufacturing	8.9	6.5	71.3	22.2	8.1	12.3	89.0	-1.4
Food & beverages	11.7	9.6	53.2	37.2	11.2	12.8	96.6	-9.5
Tobacco	17.7	11.4	36.2	52.4	11.5	1.3	208.2	-109.5
Textiles	8.7	-7.4	47.3	60.1	6.4	31.7	159.7	-91.4
Wearing apparel	24.9	8.5	35.8	55.7	11.5	25.0	106.1	-31.1
Wood products	5.0	-5.7	61.8	43.9	2.9	52.9	228.9	-181.8
Paper & printing	7.5	4.2	50.8	45.0	7.0	24.5	104.7	-29.2
Leather & products	13.7	18.0	45.9	36.1	9.5	26.0	93.6	-19.6
Rubber & plastics	13.6	9.6	76.5	13.9	9.2	16.7	122.5	-39.1
Petroleum & coke	12.7	9.5	105.3	-14.8	3.3	17.2	360.6	-277.8
Chemicals	8.5	10.1	76.9	13.0	10.0	8.7	78.9	12.4
Non-metallic materials	11.2	5.6	88.4	6.0	8.1	16.7	74.2	9.1
Basic metals	10.8	5.6	65.0	29.4	5.5	13.0	117.5	-30.5
Metal products	10.9	4.3	56.8	38.9	8.8	15.3	79.5	5.2
Machinery	8.8	3.2	70.3	26.5	8.0	4.8	40.2	55.0
Electrical equipment	1.1	98.8	517.5	-516.4	11.2	9.4	77.9	12.7
Infor. & comm. Eq.	5.8	0.8	146.0	-46.8	13.9	6.8	65.5	27.7
Instruments	3.2	42.9	262.3	-205.2	6.2	-4.4	67.4	37.0
Transport equipment	7.6	0.7	41.5	57.8	11.9	0.8	36.6	62.6
	1993-2004				**1993-2005**			
Total manufacturing	6.5	3.9	81.3	14.7	12.6	2.2	39.2	58.5
Food & beverages	6.6	4.3	83.1	12.5	12.9	-2.6	39.5	63.2
Tobacco	-0.2	13.7	-2714.7	2801.1	9.2	-2.2	116.7	-14.5
Textiles	3.4	-1.3	142.9	-41.7	8.8	-11.2	31.2	80.0
Wearing apparel	9.9	21.3	64.7	14.0	13.0	34.9	15.8	49.4
Wood products	6.0	4.2	123.2	-27.5	17.7	11.0	20.4	68.6
Paper & printing	11.1	-1.8	41.9	59.9	11.7	-2.7	34.0	68.8
Leather & products	-0.1	-1088.4	-4246.4	5434.8	15.6	28.3	31.4	40.3
Rubber & plastics	3.5	20.4	198.1	-118.5	11.3	16.4	46.3	37.3
Petroleum & coke	14.1	1.2	99.2	-0.4	-0.3	-189.0	-2420.9	2709.9
Chemicals	6.2	3.9	74.2	21.9	11.0	1.3	47.0	51.6
Non-metallic materials	6.1	5.8	101.3	-7.1	8.9	-28.4	42.5	85.9
Basic metals	5.6	-4.3	53.6	50.7	11.8	7.4	49.8	42.8
Metal products	6.4	15.1	58.4	26.4	15.0	3.5	26.8	69.7
Machinery	6.9	5.0	58.8	36.2	12.0	-19.5	7.7	111.8
Electrical equipment	3.0	10.4	185.2	-95.7	18.1	15.3	34.2	50.5
Infor. & comm. Eq.	2.1	-4.2	305.3	-201.1	25.2	14.4	49.1	36.4
Instruments	11.3	10.7	84.1	5.2	17.9	13.9	28.6	57.6
Transport equipment	5.6	2.6	103.7	-6.3	16.3	13.3	35.5	51.2

Tables 9 and 10 present simple growth accounts for different manufacturing branches. The first column shows the growth in value added and the contribution of labour, capital and productivity growth are presented in the remaining columns. Results are reported for all the manufacturing branches. There are several very large figures are recorded for the contributions of labour, capital and productivity for a number of branches. In all these cases, the main reason for these large figures is the near zero growth in value added, and therefore should be discounted or treated with caution. These results suggest that capital is the main contributor to growth in value added. Also worth noting is the larger contribution of productivity (TFP) to growth in value added in the case of China for the recent period of 1993 to 2004.

6. Conclusions

The main objective of the paper is to undertake a comparative assessment of the productivity performance in manufacturing in India and China. The paper makes use of the most recent data set available for the benchmark year 1994-95 in deriving unit value ratios and purchasing power parities for converting value added figures from nominal values into a common currency unit. The price data used in this paper are expected to more accurately reflect market prices than what were used in Lee et al (2007) which were based on 1984-85 price data when the Chinese prices are more akin to administered prices. A notable feature of the present study is that it provides estimates of capital stock for the manufacturing sector as well as for various manufacturing branches. A PPP for converting capital stock was constructed on the basis of price data for machinery and equipment which makes it possible to construct labour and total factor productivity measures. The study also provides a time series for the period 1980-2005 constructed using various types of price deflators available from national sources.

The results show that the relative price levels in India are below that of China for most of the manufacturing branches and at the sectoral level. Both labor productivity and total factor productivity levels are above the level of China for most of the period since 1980 and it is only since 2000 the study finds the TFP level in China to be above that of China. A distinguishing feature of these results is that the high levels of labour productivity are indeed driven by high levels of capital intensity which may not be sustainable in the long run (*both countries are forced into a race fueled by investment which is not sustainable in the long run*). In most of the manufacturing branches, TFP levels and growth have been more spectacular in the case of China in the more recent period since 2000.

The results presented in the paper show that the manufacturing sector in India in real terms is small relative to the size of China and its relative size has been decreasing. Given comparable population levels in these two countries, these differences and divergence in size and productivity shown in this paper may have interesting implications for the growth trajectories of these two countries over the next decade.

The present paper presented preliminary results from a large-scale project which is due to be completed early in 2008. The attention will now focus on the interpretation of the results obtained and efforts will be channeled into the integration of the current findings

and placing it in the current literature and debates on productivity performance of China and India.

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Appendix Table A.1

Sectoral value added shares (% of GDP) in India and China, 1980 and 2005.

		1980	2005
Agriculture	India	38.9	18.3
	China	30.1	12.6
Industry	India	24.5	27.3
	China	48.5	47.5
Services	India	36.6	54.4
	China	21.4	39.9

Trends in sectoral value added per worker in India and China, 1980 to 2005.

		1980	2005	Percentage change	Percentage change per annum
Agriculture	India	277	414	49.6	1.9
	China	231	634	175.0	6.7
Industry	India	861	1900	120.8	4.6
	China	809	5066	526.3	20.2
Services	India	1104	3203	190.1	7.3
	China	1019	3190	213.2	8.2

Source: World Development Indicators (2007)

Appendix Table A.2

(A) Gross Value Added in Indian and Chinese Manufacturing Industries
(In million 1995 PPPs)

	1980		1985		1990		1995		2000		2004/05	
	India	China	India	China	India	China	India	China	India	China	India	China
Total manufacturing	84,737	504,348	116,063	789,494	181,366	991,441	347,959	1,222,082	313,859	2,097,228	523,223	6,001,650
Food & beverages	7,593	28,440	14,804	49,420	23,691	76,004	45,572	106,147	52,423	197,263	65,644	492,483
Tobacco	1,117	17,418	1,872	33,576	5,929	57,404	6,859	61,260	10,806	98,716	7,724	199,746
Textiles	7,782	58,158	10,126	85,948	19,612	99,481	25,507	89,845	32,809	143,044	32,431	362,952
Wearing apparel	311	7,416	536	14,892	2,225	19,113	11,263	34,729	11,189	55,333	15,278	133,517
Wood products	722	8,109	507	10,524	1,135	8,234	1,518	15,151	2,552	27,322	2,762	95,535
Paper & printing	3,389	17,346	3,677	26,032	6,888	30,598	12,882	35,552	20,963	62,078	31,851	164,553
Leather & products	617	4,454	719	7,843	2,080	10,432	3,204	20,147	3,354	31,023	2,856	87,558
Rubber & plastics	1,386	16,067	2,301	26,412	4,981	32,379	10,041	36,343	5,124	76,435	9,938	187,251
Petroleum & coke	2,411	55,468	3,561	68,718	7,251	76,766	14,374	56,133	12,571	47,690	55,900	78,650
Chemicals	13,624	52,330	17,237	81,698	23,259	127,228	57,920	141,038	50,649	262,326	79,154	642,451
Non-metallic materials	2,700	37,120	5,095	60,607	8,647	66,770	15,545	89,991	16,982	115,383	20,691	286,294
Basic metals	9,411	84,558	16,065	115,602	27,768	137,151	35,995	135,533	23,159	206,886	64,958	685,749
Metal products	1,228	12,254	1,747	19,543	2,955	25,984	7,493	38,394	8,612	66,724	9,543	208,002
Machinery	5,428	51,946	8,900	86,881	10,863	94,697	27,349	111,916	20,455	155,650	35,584	570,988
Electrical equipment	12,359	14,152	9,199	27,736	9,758	36,675	19,909	60,382	9,060	134,825	20,728	439,019
Infor. & comm. Eq.	3,687	7,950	4,878	19,259	3,319	26,229	7,323	63,500	5,904	199,725	9,543	702,860
Instruments	1,182	5,163	1,155	7,616	1,028	7,512	2,894	12,255	3,899	23,468	6,988	90,059
Transport equipment	9,101	17,059	11,817	33,186	19,335	37,087	38,805	80,512	18,631	144,909	44,605	470,512
Other manufacturing	691	8,940	1,867	14,001	643	21,697	3,505	33,254	4,717	48,428	7,046	103,473

(B) Net Capital Stock in Indian and Chinese Manufacturing Industries
(In million 1995 PPPs)

	1980		1985		1990		1995		2000		2004/05	
	India	China	India	China	India	China	India	China	India	China	India	China
Total manufacturing	116,677	681,153	166,486	988,004	280,509	1,682,128	660,345	3,407,587	755,204	4,110,664	916,934	6,739,352
Food & beverages	9,500	33,000	12,240	70,287	21,354	139,636	50,158	295,845	61,551	341,908	75,056	499,658
Tobacco	294	1,463	869	4,241	853	13,304	1,159	40,758	3,170	68,897	3,063	83,213
Textiles	11,816	42,411	17,848	89,036	25,142	175,143	70,234	310,566	99,553	290,188	90,250	455,249
Wearing apparel	580	3,799	863	9,887	1,920	20,796	8,517	54,313	7,232	64,231	8,503	103,146
Wood products	440	6,911	492	13,030	731	20,592	1,722	40,532	2,848	49,631	3,521	94,888
Paper & printing	5,883	20,507	7,281	33,047	11,069	57,326	24,020	117,339	32,085	170,375	31,448	316,876
Leather & products	504	3,631	709	6,878	1,426	13,738	3,418	33,802	4,421	33,236	4,010	59,013
Rubber & plastics	2,274	13,096	3,765	26,066	9,666	50,637	22,133	105,365	9,777	133,003	36,567	248,777
Petroleum & coke	2,510	19,129	8,377	25,805	10,916	58,698	24,258	145,489	58,340	240,395	100,307	330,416
Chemicals	25,466	104,309	29,569	149,319	55,706	249,981	143,032	486,347	167,792	637,193	142,347	971,164
Non-metallic materials	4,793	48,324	12,549	86,314	19,275	145,016	42,579	306,952	60,001	322,333	67,607	479,169
Basic metals	29,923	117,106	39,975	140,589	75,594	229,204	163,671	506,335	145,188	618,244	174,781	1,088,510
Metal products	1,900	14,962	2,288	22,578	4,855	39,748	12,873	86,421	12,349	94,416	13,505	145,386
Machinery	5,519	151,718	9,675	173,956	11,768	236,430	22,771	331,278	25,369	313,633	39,705	463,169
Electrical equipment	3,289	19,336	3,954	27,404	8,088	56,326	15,892	126,745	13,492	162,975	24,485	271,443
Infor. & comm. Eq.	1,632	15,246	3,117	23,568	5,351	42,178	12,826	108,583	15,460	200,086	23,174	558,371
Instruments	563	8,611	847	11,475	1,894	15,850	4,802	31,983	6,048	30,346	15,359	59,280
Transport equipment	9,573	56,211	11,821	66,347	14,413	94,330	33,697	201,467	27,748	267,788	58,920	439,750
Other manufacturing	218	1,383	246	8,176	489	23,195	2,582	77,469	2,781	71,783	4,325	71,874

(C) Numbers Employed in Indian and Chinese Manufacturing Industries
(In 1000 standardized employees, defined as 300 man-days per year)

Industry	1980 India	1980 China	1985 India	1985 China	1990 India	1990 China	1995 India	1995 China	2000 India	2000 China	2004/05 India	2004/05 China
Total manufacturing	4,868	37,782	5,160	48,260	5,548	56,970	6,763	61,964	5,800	52,536	6,614	64,603
Food & beverages	592	2,799	701	4,453	814	5,054	963	5,432	898	3,913	979	4,762
Tobacco	274	107	260	146	381	198	429	199	449	192	444	161
Textiles	1,360	3,579	1,258	5,829	1,241	7,904	1,372	6,967	1,187	4,931	1,167	6,443
Wearing apparel	80	792	93	1,527	141	1,763	280	3,740	280	3,649	385	4,195
Wood products	58	754	57	1,195	51	1,104	59	1,506	46	1,012	59	1,706
Paper & printing	220	1,175	221	1,646	226	2,078	279	2,158	227	1,935	221	2,118
Leather & products	46	397	60	609	85	779	108	2,092	117	2,126	129	2,641
Rubber & plastics	98	748	111	1,355	146	1,708	198	2,222	84	2,422	239	2,859
Petroleum & coke	25	202	40	278	49	526	60	619	53	615	68	765
Chemicals	316	2,689	362	3,252	406	4,384	550	4,594	566	4,336	557	5,117
Non-metallic materials	270	6,457	322	8,706	319	9,181	385	8,603	338	4,683	411	4,894
Basic metals	458	2,124	501	2,435	517	3,167	622	4,195	477	3,613	489	4,384
Metal products	153	1,303	147	1,875	172	2,052	212	2,327	223	2,094	248	2,430
Machinery	284	7,630	319	6,687	305	8,898	355	5,545	284	4,505	352	5,946
Electrical equipment	123	1,094	128	1,853	176	1,631	193	2,087	110	2,584	202	4,104
Infor. & comm. Eq.	89	838	153	1,099	80	1,123	104	1,872	74	3,015	86	4,932
Instruments	30	547	29	612	41	462	54	610	54	984	72	956
Transport equipment	368	1,848	373	2,311	365	1,657	479	2,697	267	3,032	394	3,501
Other manufacturing	23	2,697	24	2,394	33	3,301	60	4,499	68	2,895	112	2,688