How Do China and India Compare in Post-Reform Growth and Productivity Performances?

Harry X. Wu
Co-authored with K. L. Krishna, Deb Kusum Das, and Pilu Chandra Das

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Agenda

- Motivation
- Methodology
- Data (largely skipped…)
- Comparative results
- Next?

Motivation: Why China vs. India?

- Both: Unprecedented transition-induced rapid catch up
- Both: Impact of sheer size and magnitude on the world economy, China, then followed by India
- Yet, structural differences: manufacturing vs. services, and
- Institutional differences: democracy vs. totalitarian
- Productivity concerned…

- Benefitted by their market-oriented reforms, the world's two most populous countries, China and India, with 1.39 and 1.34 billions of population respectively, have changed, and are still changing, the landscape of the world economy at a very high speed.
- According to the Total Economy Database (TED) constructed by The Conference Board (TCB) that uses alternative GDP estimates for China, following Maddison and Wu (2008), measured in 1990 G-K PPPs, over the period 1990-2015 China grew by 7.5% p.a., whereas India grew by 6.4% p.a.
- The two economies also appeared to be most resilient to GFC and its long recessional aftermath. Over the period 2008-2015 India performed even better than China by maintaining its previous 6.4% annual growth rate, whereas China decelerated to 5.8%, compared to the rest of the world 2.7% p.a.

- By the same 1990 G-K PPP yardstick following Maddison (2001), China and India overtook Japan in the size of GDP in 1995 (#2) and 2006 (#3), respectively.
- However, while the world is paying a serious attention to their fast speed of catching up with an enormous size effect, their true productivity performances have been somewhat ignored.
- Yet, by the time of overtaking Japan, China achieved only 10.6 percent of Japan's level of per capita GDP and 10.1 percent of Japan's level of labor productivity. In the case of India, the ratios are similar or slightly better, 11.8 and 14.2 correspondingly.
- In sharp contrast, when Japan surpassed Germany in 1967 it achieved 82.2 percent of Germany's level of per capita GDP and 75.5 percent of Germany's level of labor productivity (TCB 2016).

- There is a tendency in literature to show an unrealistically high TFP growth in the case of China compared to that in the case of India.
  - Bosworth and Collins (2008) find that over the period 1978-2004, China's TFP growth was 4.6% p.a. vis-à-vis India's 1.6% p.a.
  - Jorgenson and Vu (2005) show that during the period 1989-1995 China's TFP growth was 6.3 percent per annum compared to India's 2.1 percent per annum, but during the period 1995-2003 the two economies converged to the same rate of TFP growth at 2.5 percent per annum.

- While some researchers questioning the quality of the official data especially the likelihood of exaggerating growth (Maddison and Wu 2008; Bardhan 2010), some show institutional obstacles to productivity growth… e.g.
  - Hsieh and Klenow (2009) use micro data on manufacturing establishments to measure the potential extent of misallocation in China and India using the US economy as a benchmark.
  - When capital and labour are hypothetically reallocated to equalize the marginal products across plants to the extent observed in US, they find that manufacturing TFP would gain by 30-50 percent in the case of China and 40-60 percent in the case of India.

Methodology

- In this study, we adopt the Jorgensonian aggregate production possibility frontier function approach (APPF) in growth accounting
- The Key differences between aggregate production function APF and APPF
  - APF is (implicitly) aggregated in constant-price shares and treats industries homogenously i.e. assuming that they face the same factor prices and subject to the same production function
  - APPF is (explicitly) aggregated in nominal shares and quantifies individual industries that may face different factor costs
- Furthermore, APPF incorporating the Domar aggregation approach takes into account input-output links through intermediate inputs

- Specifically, we follow the growth accounting methodology as developed by Dale Jorgenson (1966) and its application and further development in Jorgenson, Gollop and Fraumeni (1987) and more recently in Jorgenson, Ho and Stiroh (2005) (EU/KLEMS, O'Mahony and Timmer, 2009).
- It is based on APPF where the gross output (not value added) of an industry *j* is a function of capital, labour, intermediate inputs and technology, indexed by time T, that is (eq.1)

$$Y_j = f_j(K_j, L_j, X_j, T)$$

- Under the assumptions of competitive factor markets, full input utilization, and constant returns to scale, the growth of output can be expressed as the cost-share weighted growth of all inputs and technological change: (eq.2)

$$\Delta \ln Y_{jt} = \bar{v}_{jt}^{K} \Delta \ln K_{jt} + \bar{v}_{jt}^{L} \Delta \ln L_{jt} + \bar{v}_{jt}^{X} \Delta \ln X_{jt} + \Delta \ln A_{jt}^{Y}$$

  - Note that this is also our framework for the data construction

- …where $\bar{v}_{jt}^{K} = \frac{P_{jt}^{K} K_{jt}}{P_{jt}^{Y} Y_{jt}}$ $\bar{v}_{jt}^{L} = \frac{P_{jt}^{L} L_{jt}}{P_{jt}^{Y} Y_{jt}}$ $\bar{v}_{jt}^{X} = \frac{P_{jt}^{X} X_{jt}}{P_{jt}^{Y} Y_{jt}}$
- and $\bar{v}_{jt}^{K} + \bar{v}_{jt}^{L} + \bar{v}_{jt}^{X} = 1$
- The right-hand side of each equation indicates the proportion of output growth accounted for with growth in capital services, labour services, intermediate inputs, respectively.
- Next, we have to consider the aggregation problem
- Following JHS (2005), we introduce the Domar weights that take into account the productivity effect of the upper-stream on the down-stream industries (an accumulative effect)

- Since aggregation is a value-added concept, eq.2 can be rewritten as eq.3

$$\Delta \ln Y_j = \bar{v}_j^V \Delta \ln V_j + \bar{v}_j^M \Delta \ln M_j$$

- where V_j is the real value-added in j and v_j^V is the nominal share of value-added in industry gross output.
- If now rearranging eq.2 and eq.3, we can obtain an expression for the sources of industry value-added growth in eq.4

$$\Delta \ln V_j = \frac{\bar{v}_j^K}{\bar{v}_j^V} \Delta \ln K_j + \frac{\bar{v}_j^L}{\bar{v}_j^V} \Delta \ln L_j + \frac{1}{\bar{v}_j^V} v_j^T$$

- Since (eq.5) $$\Delta \ln V = \sum_j \bar{w}_j \Delta \ln V_j$$

- Combining eq.4 and eq.5, we introduce Domar weights (Domar 1961), i.e. a ratio of each industry's share in total value-added to the proportion of the industry's value-added in its gross output and yield a new expression of aggregate value-added growth by weighted contribution of industry capital, labor and TFP growth in eq.6:

$$\Delta \ln V \equiv \sum_j \overline{w}_j \Delta \ln V_j = \sum_j \left(\overline{w}_j \frac{\overline{v}_j^K}{\overline{v}_j^V} \Delta \ln K_j + \overline{w}_j \frac{\overline{v}_j^L}{\overline{v}_j^V} \Delta \ln L_j + \overline{w}_j \frac{1}{\overline{v}_j^V} v_j^T \right)$$

where 1) the share of factor income in the gross output of industry *j is* $v_{K,j}$ and $v_{L,j}$; 2) the size of industry *j* value-added in aggregate value added is w_j; 3) industry *j* value-added ratio is $v_{V,j}$, i.e. the share of *j*'s value-added in *j*'s gross output. Here, w_j / $v_{V,j}$ is the Domar weights.

- Since (eq.7) $$v^T \equiv \sum_j \overline{w}_j \Delta \ln V_j - \overline{v}^K \Delta \ln K - \overline{v}^L \Delta \ln L$$

- Combining eq.6 and eq.7, we have Domar-weighted TFP growth and reallocation effect of K and L in eq.8:

$$
\begin{aligned}
v^T = & \left(\sum_j \frac{\overline{w}_j}{\overline{v}_j^V} v_j^T \right) \\
& + \left(\sum_j \overline{w}_j \frac{\overline{v}_j^K}{\overline{v}_j^V} \Delta \ln K_j - \overline{v}_K \Delta \ln K \right) \\
& + \left(\sum_j \overline{w}_j \frac{\overline{v}_j^L}{\overline{v}_j^V} \Delta \ln L_j - \overline{v}_L \Delta \ln L \right)
\end{aligned}
$$

Data Construction

- The data reconstruction follows the KLEMS principles.
- For China, the KLEMS database is part of the on-going China Industry Productivity (CIP) Database Project. It is beyond the scope of this study to go through a long history of the data research. We thus refer interested readers for details to three working papers by Wu (2015) on capital input, Wu and Ito (2015) on output and prices, and Wu, Yue and Zhang (2015) on labor quantity and compensation matrices. A brief introduction to data is provided in Wu (2016a).
- For India, it is part of the on-going India KLEMS Database Project, which is explained in details in Das et al. (2016). Interested readers should see studies on capital input in Erumban and Das (2013), and work on employment in Aggarwal and Erumban (2013).
- Due to some data constraints for the time being, the nature unit of employment is measured in hours worked in the case of China and in numbers employed in the case of India. Besides, the constant price measured values are in 1990 prices in the China CIP/KLEMS data and in 2004 prices in the Indian KLEMS data, which may introduce some biases.

Industry Grouping

- 27 industries are categorized into ten groups …
  - Agriculture
  - Mining
  - Light manufacturing
  - Intermediate input materials
  - Electricals and ICT
  - Machinery and motor vehicles
  - Utilities
  - Construction
  - Market services
  - Non-market services

RESULTS AND DISCUSSION

TABLE 1
SOURCES OF GROSS OUTPUT GROWTH BY INDUSTRY GROUP IN 1981-2011: CHINA VIS-À-VIS INDIA
(Gross output-weighted as percentage points of annual GO growth)

	GO	L	K	M	*TFP*	GO	L	K	M	*TFP*
			China					India		
1. Agriculture	5.88	-0.03	2.73	2.74	*0.44*	2.87	0.31	1.43	0.65	*0.49*
2. Mining	7.53	0.45	3.82	5.46	*-2.21*	5.21	0.86	4.03	1.74	*-1.42*
3. Light manufacturing	11.27	0.31	2.15	7.77	*1.04*	6.72	0.27	0.99	5.33	*0.14*
4. Intermediate materials	11.48	0.24	2.25	8.43	*0.56*	7.83	0.19	1.21	6.04	*0.39*
5. Electricals & ICT	20.70	0.45	2.28	13.63	*4.35*	10.45	0.50	1.11	7.16	*1.68*
6. Mach. & motor vehicle*	15.23	0.15	1.56	10.06	*3.45*	8.85	0.44	1.22	6.42	*0.77*
7. Utilities	10.02	0.23	2.94	7.33	*-0.49*	7.30	0.57	1.38	4.11	*1.23*
8. Construction	10.86	1.28	1.20	8.24	*0.14*	6.73	1.89	0.83	5.56	*-1.55*
9. Market services	9.97	1.14	4.35	5.43	*-0.95*	8.07	1.30	2.92	2.92	*0.93*
10. Non-market services	8.20	1.93	4.53	4.47	*-2.73*	5.91	1.50	1.85	1.47	*1.09*

FIGURE 1
INPUT CONTRIBUTION TO GROSS OUTPUT GROWTH BY INDUSTRY GROUP, PERIOD AVERAGE OF 1981-2011: CHINA VIS-À-VIS INDIA
(Gross output growth = 100%)

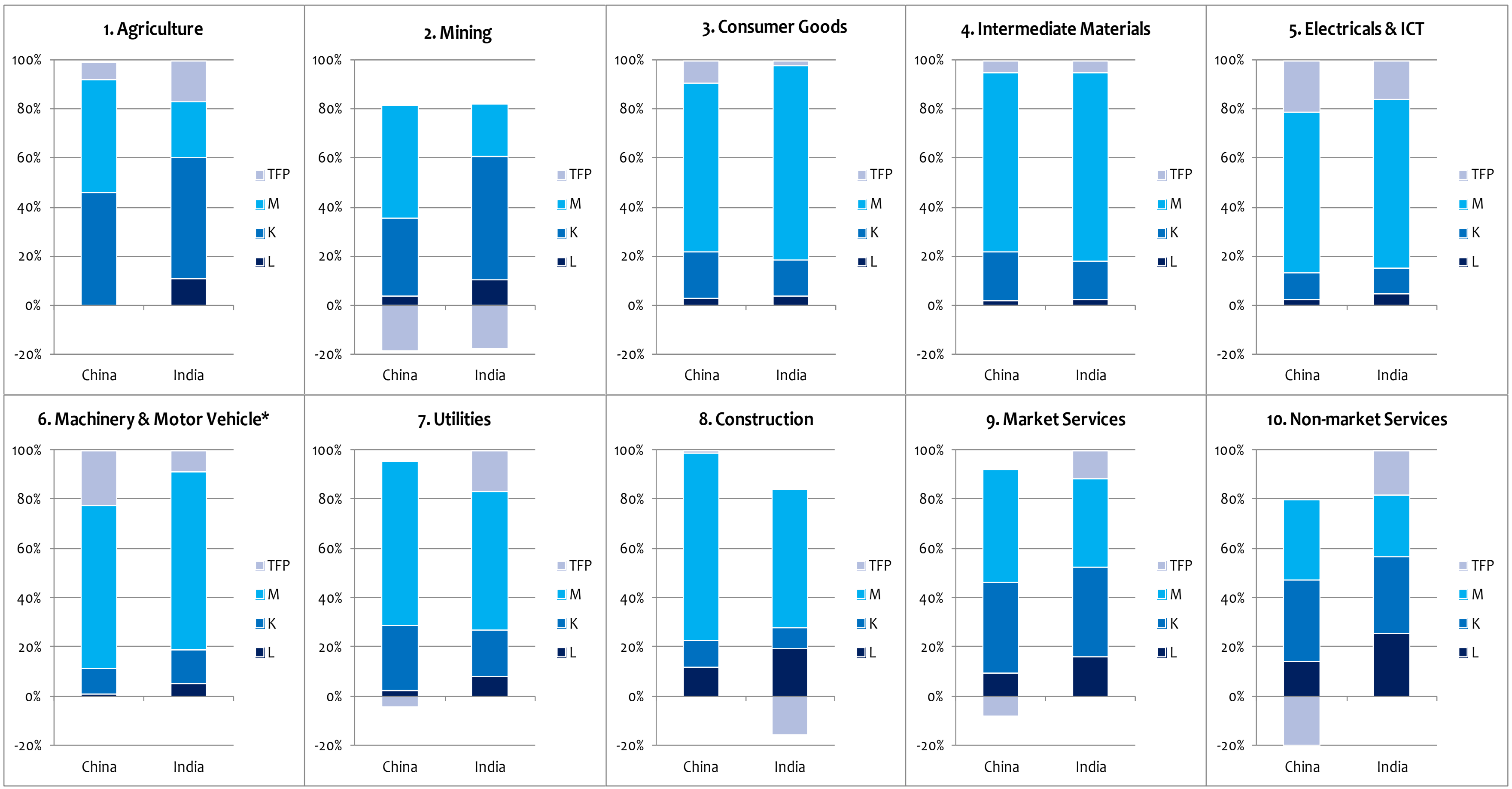


FIGURE 2
CHANGE IN TOTAL FACTOR PRODUCTIVITY FROM 1981 TO 2011 BY INDUSTRY GROUP: CHINA VIS-À-VIS INDIA (1981 = 100)

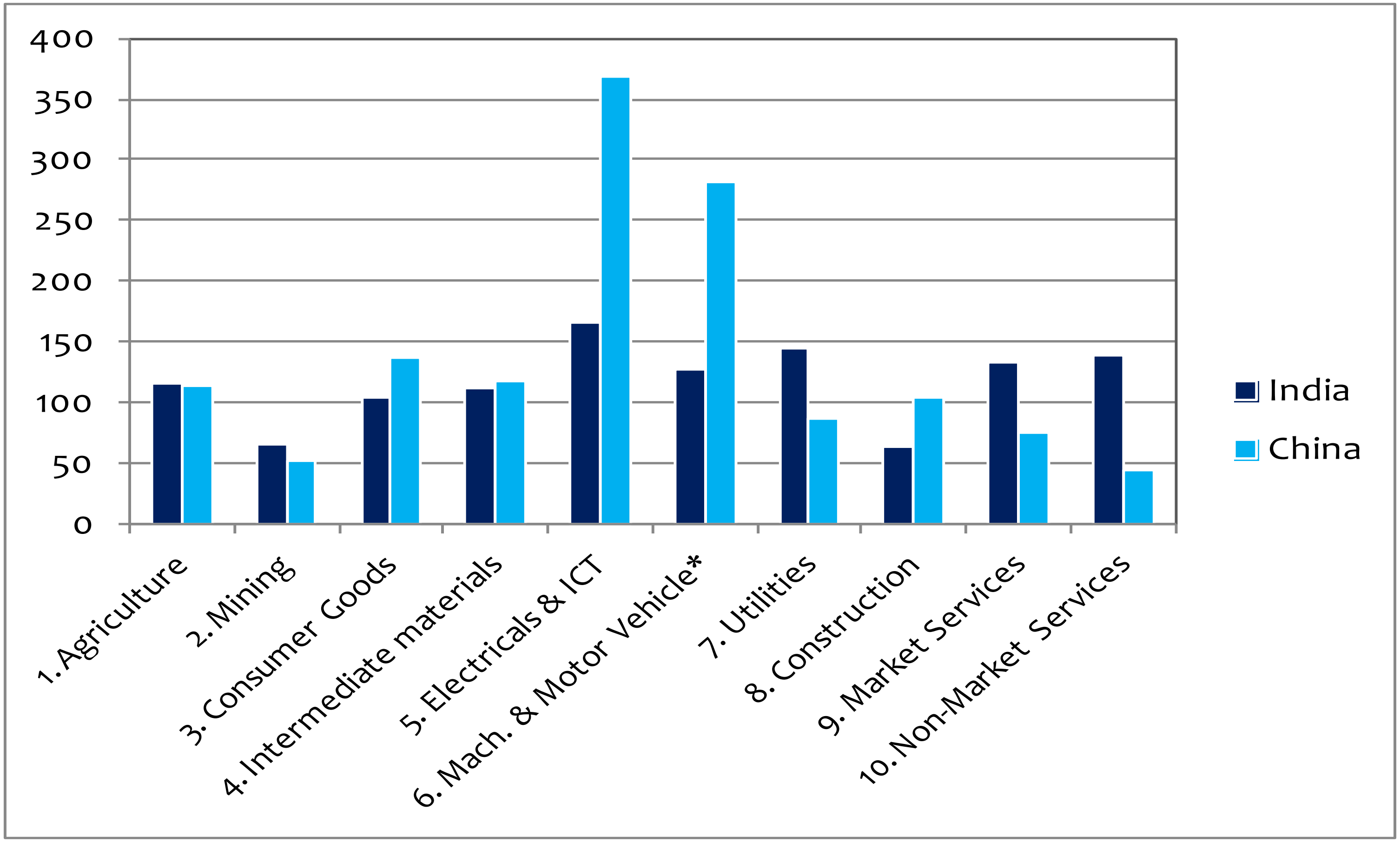


TABLE 2A

CHINA: SOURCES OF AGGREGATE VALUE-ADDED GROWTH, 1981-2011

(Contributions are share-weighted growth rate in percent)

	1981-1991	1991-2001	2001-2007	2007-2011	*1981-2011*
	Industry contributions to value-added growth				
Value-added growth (%)	8.81	8.85	11.37	9.37	*9.41*
1. Agriculture	*1.73*	*1.31*	*0.37*	*0.11*	*1.10*
2. Mining	*-0.04*	*0.17*	*-0.14*	*0.19*	*0.04*
3. Light manufacturing	*1.19*	*1.79*	*1.66*	*1.23*	*1.49*
4. Intermediate materials	*0.97*	*1.90*	*1.41*	*1.40*	*1.42*
5. Electricals & ICT	*0.82*	*0.87*	*1.02*	*0.75*	*0.87*
*6. Machinery & motor vehicles**	*1.10*	*0.77*	*1.15*	*0.73*	*0.95*
7. Utilities	*0.33*	*0.01*	*0.62*	*0.43*	*0.30*
8. Construction	*0.52*	*0.49*	*0.56*	*0.50*	*0.52*
9. Market services	*1.61*	*1.25*	*3.56*	*3.17*	*2.09*
10. Non-market services	*0.58*	*0.29*	*1.17*	*0.85*	*0.64*
	Factor contributions to value-added growth				
Value-added growth (%)	8.81	8.85	11.37	9.37	*9.41*
- Capital input:	*5.83*	*7.01*	*9.45*	*10.83*	*7.61*
- Stock	5.83	7.08	9.54	10.82	7.65
- Capital quality (composition)	-0.00	-0.07	-0.08	0.01	-0.04
- Labor input:	*1.12*	*1.12*	*0.59*	*0.77*	*0.97*
- Number (homogenous)	1.07	0.69	0.54	-0.60	0.61
- Labor quality (composition)	0.06	0.43	0.05	1.37	0.36
- Aggregate TFP	*1.86*	*0.72*	*1.32*	*-2.22*	*0.83*

TABLE 2B
INDIA: AGGREGATE VALUE-ADDED GROWTH AND SOURCES OF GROWTH, 1981-2011
(Contributions are share-weighted growth rate in percent)

	1981-1991	1991-2001	2001-2007	2007-2011	*1981-2011*
	Industry contributions to value-added growth				
Value-added growth due to (%)	4.87	5.83	7.75	7.16	*6.07*
1. Agriculture	*0.78*	*0.89*	*0.51*	*0.64*	*0.75*
2. Mining	*0.20*	*0.08*	*0.08*	*0.08*	*0.12*
3. Light manufacturing	*0.38*	*0.38*	*0.34*	*0.65*	*0.41*
4. Intermediate materials	*0.59*	*0.36*	*0.81*	*0.74*	*0.58*
5. Electricals & ICT	*0.12*	*0.09*	*0.14*	*0.19*	*0.13*
*6. Machinery & motor vehicles**	*0.13*	*0.20*	*0.40*	*0.35*	*0.24*
7. Utilities	*0.18*	*0.22*	*0.22*	*0.09*	*0.19*
8. Construction	*-0.00*	*0.13*	*0.81*	*0.33*	*0.25*
9. Market services	*1.24*	*2.32*	*3.58*	*2.88*	*2.28*
10. Non-market services	*1.25*	*1.16*	*0.84*	*1.22*	*1.13*
	Factor contributions to value-added growth				
Value-added growth due to (%)	4.87	5.83	7.75	7.16	*6.07*
- Capital input:	*2.75*	*3.03*	*4.34*	*4.79*	*3.43*
- Stock	2.30	2.74	4.02	4.50	*3.09*
- Capital quality (composition)	0.45	0.29	0.32	0.29	*0.35*
- Labor input:	*1.83*	*1.42*	*1.35*	*1.15*	*1.51*
- Number (homogenous)	1.04	0.83	0.72	0.39	*0.82*
- Labor quality (composition)	0.79	0.60	0.63	0.75	*0.69*
- Aggregate TFP	*0.28*	*1.38*	*2.05*	*1.22*	*1.13*

FIGURE 3
CONTRIBUTION TO AGGREGATE VALUE-ADDED GROWTH OVER SUB-PERIODS, 1981-2011:
CHINA VIS-À-VIS INDIA
(Value-added growth = 100)

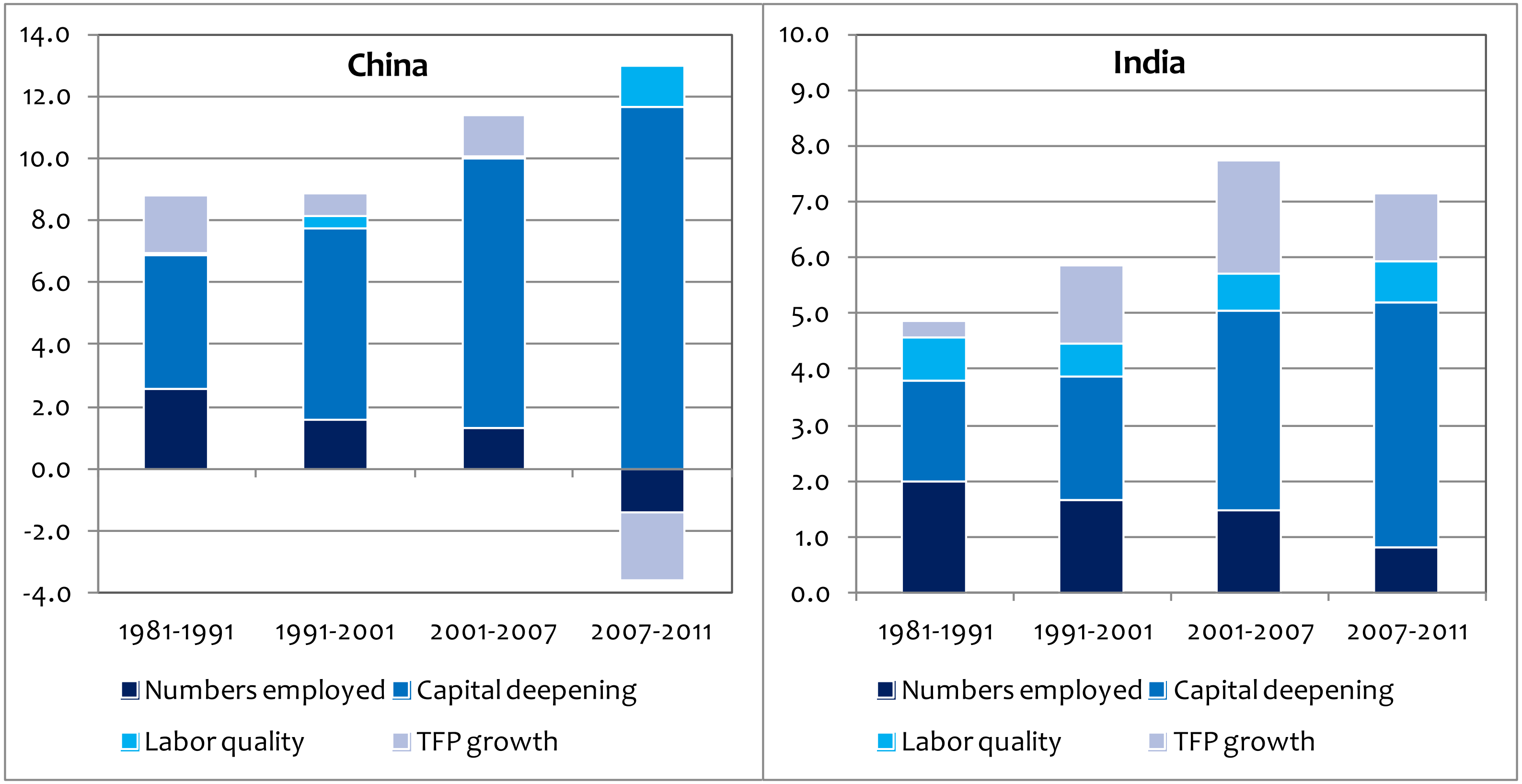


FIGURE 4
INDEX OF AGGREGATE TOTAL FACTOR PRODUCTIVITY GROWTH IN 1981-2011: CHINA VIS-À-VIS INDIA
(1981 = 100)

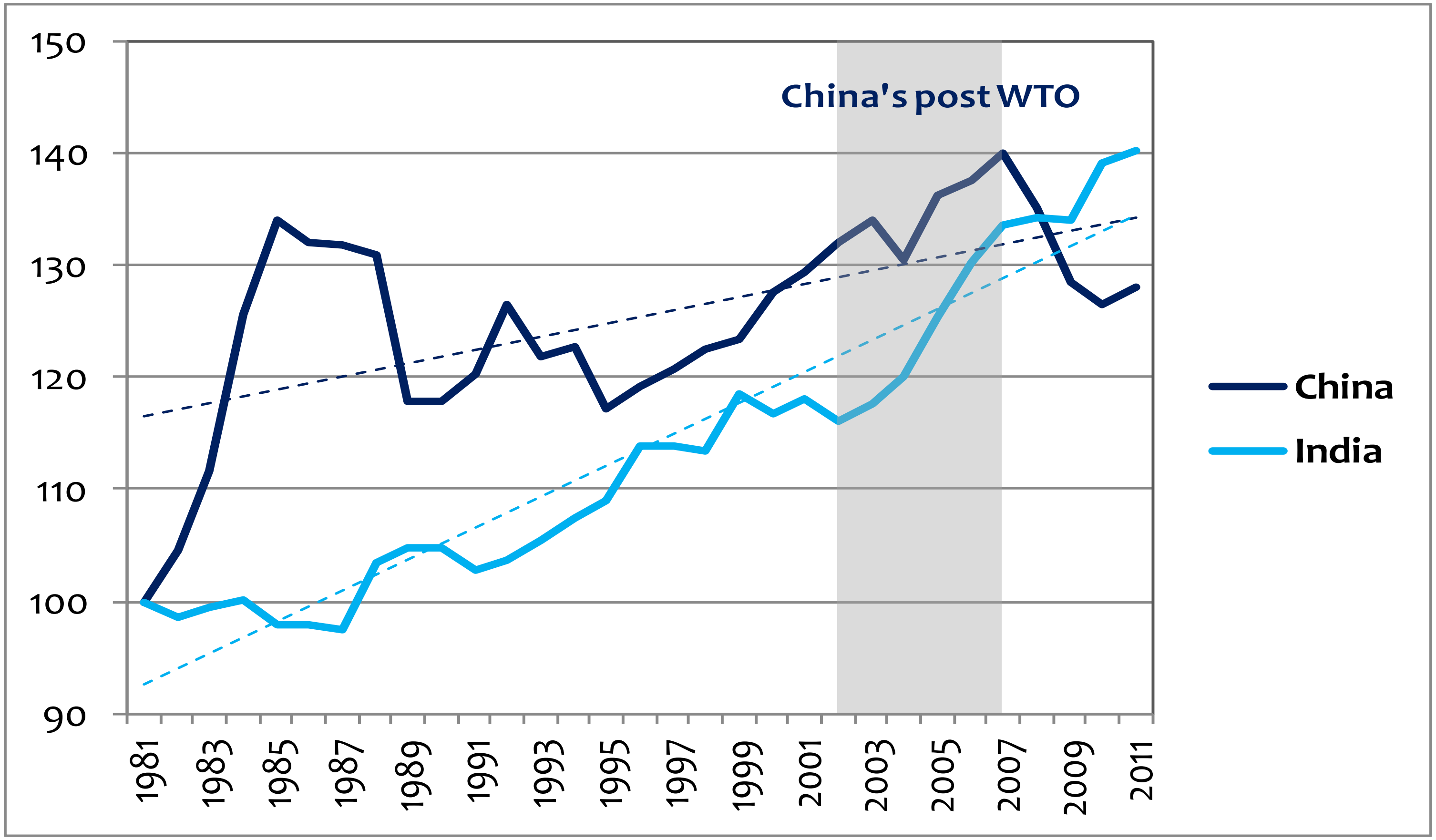


TABLE 4A
CHINA: DOMAR-WEIGHTED TFP GROWTH AND REALLOCATION EFFECTS, 1981-2011

(TFP growth in percent per annum and contribution in percentage points)

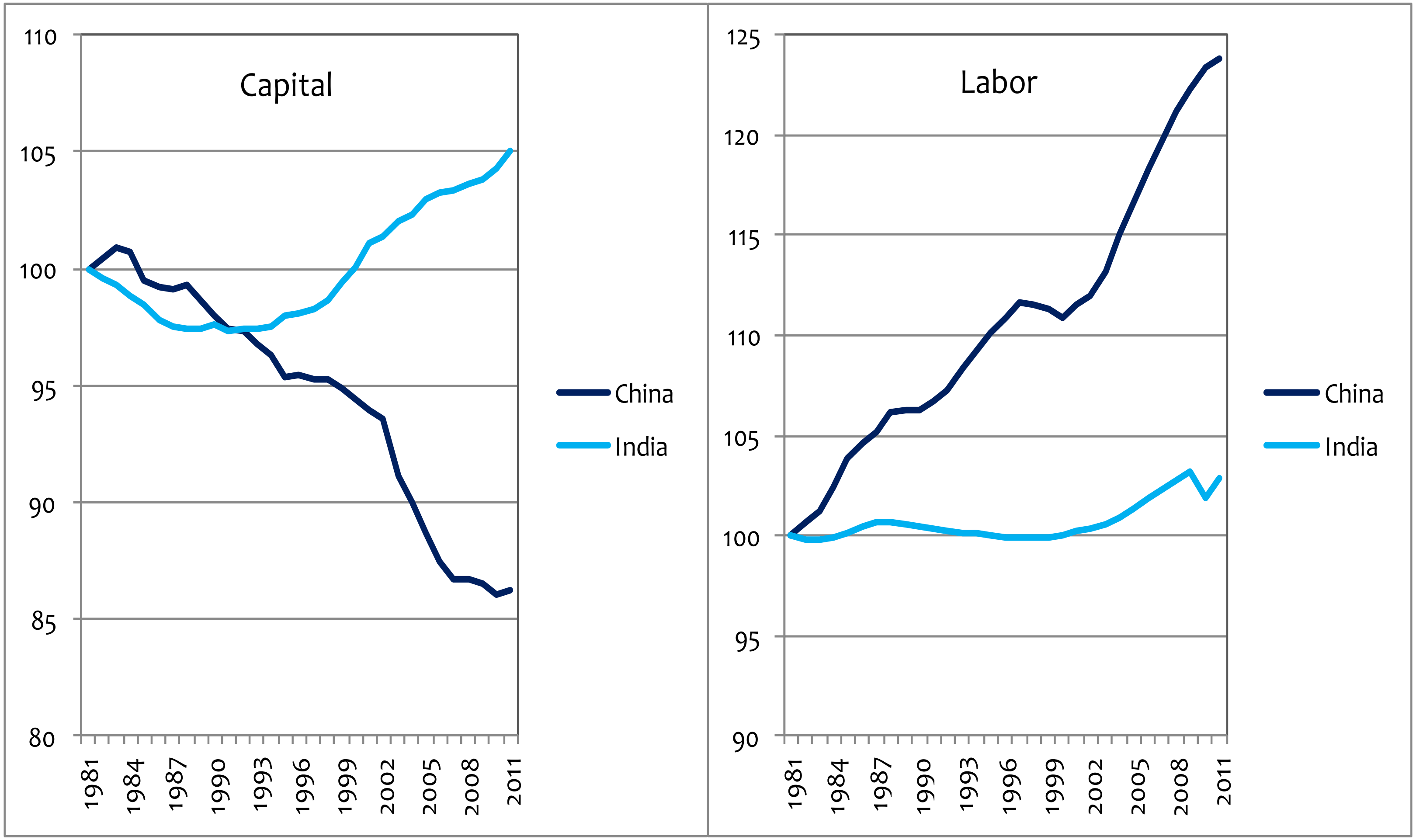
	1981-91	1991-01	2001-07	2007-11	*1981-11*
Aggregate TFP growth	1.86	0.72	1.32	-2.22	0.83
1) Domar-weighted TFP growth	1.47	0.63	1.47	-2.90	0.61
1. Agriculture	*0.89*	*0.46*	*-0.18*	*-0.68*	*0.33*
2. Mining	*-0.43*	*-0.00*	*-0.71*	*-0.36*	*-0.33*
3. Light manufacturing	*-0.17*	*0.92*	*0.67*	*0.13*	*0.40*
4. Intermediate materials	*-0.22*	*1.02*	*0.10*	*-0.40*	*0.23*
5. Electricals & ICT	*0.57*	*0.56*	*0.40*	*0.14*	*0.47*
*6. Machinery & motor vehicles**	*0.84*	*0.58*	*0.56*	*-0.03*	*0.58*
7. Utilities	*0.07*	*-0.32*	*0.21*	*0.18*	*-0.01*
8. Construction	*0.07*	*-0.06*	*0.17*	*-0.17*	*0.02*
9. Market services	*0.19*	*-1.27*	*1.22*	*-0.32*	*-0.16*
10. Non-market services	*-0.34*	*-1.25*	*-0.98*	*-1.41*	*-0.92*
2) Reallocation of K (ρ^K)	-0.26	-0.36	-1.34	-0.15	-0.49
3) Reallocation of L (ρ^L)	0.65	0.44	1.19	0.83	0.71

TABLE 4B
INDIA: DOMAR-WEIGHTED TFP GROWTH AND REALLOCATION EFFECTS, 1981-2011

(TFP growth in percent per annum and contribution in percentage points)

	1981-91	1991-01	2001-07	2007-11	*1981-11*
Aggregate TFP growth	0.28	1.38	2.05	1.22	*1.13*
1) Domar-weighted TFP growth	0.52	1.02	1.34	0.67	*0.87*
1. Agriculture	*0.12*	*0.30*	*-0.00*	*0.27*	*0.18*
2. Mining	*-0.05*	*0.03*	*-0.16*	*-0.11*	*-0.05*
3. Light manufacturing	*0.01*	*-0.01*	*-0.00*	*0.43*	*0.06*
4. Intermediate materials	*0.18*	*-0.10*	*0.39*	*0.15*	*0.13*
5. Electricals & ICT	*0.06*	*0.04*	*0.09*	*0.10*	*0.06*
*6. Machinery & motor vehicles**	*-0.03*	*0.07*	*0.20*	*0.18*	*0.08*
7. Utilities	*0.04*	*0.14*	*0.14*	*-0.04*	*0.08*
8. Construction	*-0.30*	*-0.26*	*-0.05*	*-0.47*	*-0.26*
9. Market services	*-0.01*	*0.42*	*1.01*	*-0.29*	*0.30*
10. Non-market services	*0.49*	*0.39*	*-0.27*	*0.43*	*0.30*
2) Reallocation of K (ρ^K)	-0.27	0.37	0.37	0.42	*0.16*
3) Reallocation of L (ρ^L)	0.03	-0.01	0.35	0.13	*0.09*

FIGURE 5
FACTOR REALLOCATION EFFECTS ON TFP GROWTH IN 1981-2011: CHINA VIS-À-VIS INDIA
(1981 = 100)



Next?

- Data…
- Some institutional narrative…