Productivity Growth in India

B. N.Goldar, D.K. Das, A. A. Erumban
and Suresh Aggarwal
India-KLEMS Project

Presentation at the First Asia KLEMS conference
July 27, 2011, Tokyo, Japan

Outline of presentation

- India KLEMS project – objectives, scope
- Past productivity research in India – how India KLEMS differs from past research
- Construction of time series on value added and labour income share for KLEMS sectors
- Construction of time series on labour and capital inputs
- Estimates of productivity growth

India KLEMS – objectives and scope

Aim of the India-KLEMS Project

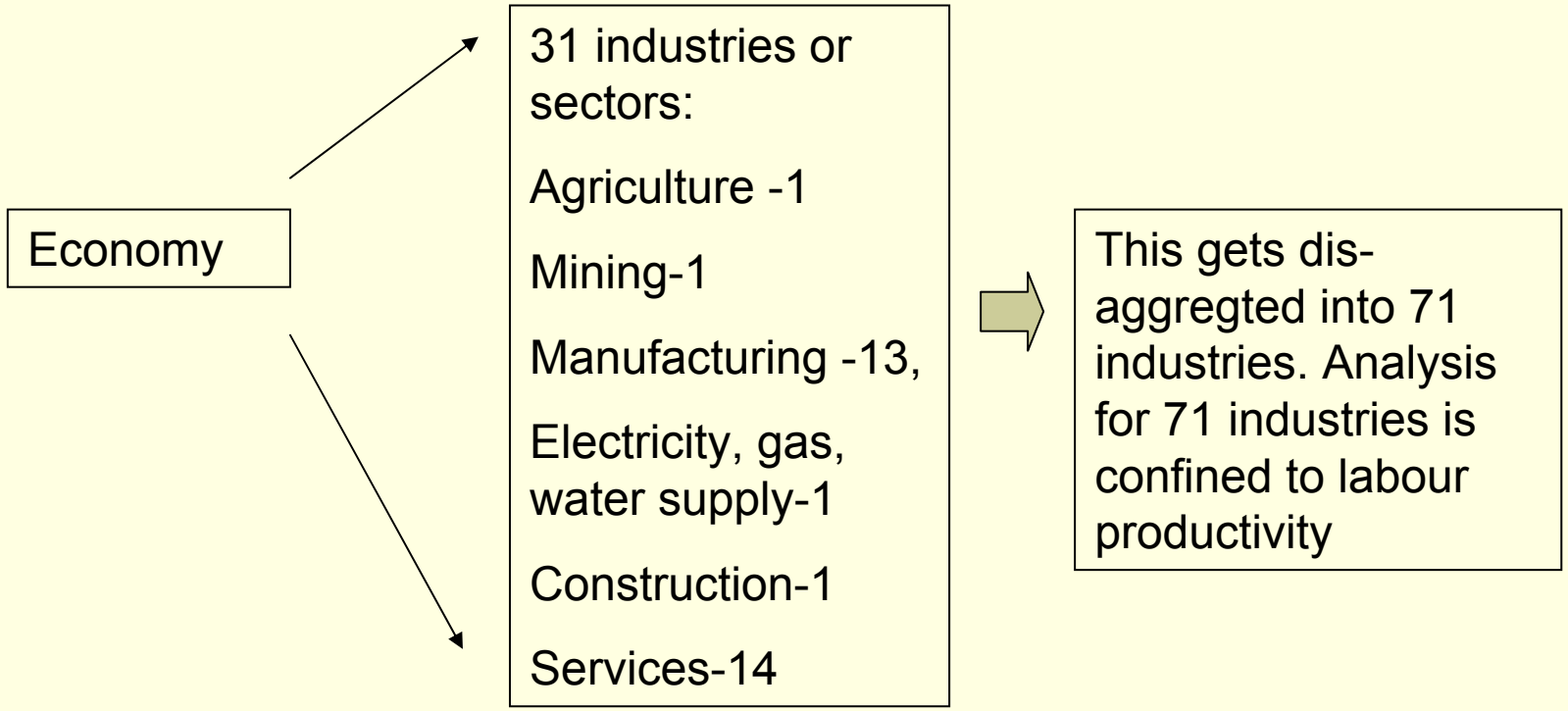
- To undertake research on India's productivity growth at the economy and sectoral level through creation of a database on indicators of economic performance;
- To generate high quality time series on output and inputs in various sectors of the economy consistent with the *National Accounts*;
- To create a productivity database for India that would be comprehensive and internationally comparable.

Participating Agencies

- The Project is being implemented by the Indian Council for Research on International Economic Relations (ICRIER) with financial support from the Reserve Bank of India (RBI).
- The project is getting data/ research/ intellectual support from:
  - Central Statistical Organization (CSO), Government of India;
  - Groningen Growth and Development Center, University of Groningen, Netherlands
- A team comprising members from the RBI and experts from the CSO is working closely with the ICRIER research team.

Time Duration

- Time duration of the Project is three years: 2009-10, 2010-11, and 2011-12.
- It has three phases of one year each.
  - **Phase I**: Construction of time series data on Value Added, Labour input, and Capital input, and value added based productivity estimates for 31 sectors of the economy
  - **Phases II and III**: Time series on Materials, Energy and Services Inputs, and gross output based productivity estimates for 31 sectors of the economy, and labour productivity estimates for 71 sectors of the economy.


Economy
31 industries or sectors:
Agriculture -1
Mining-1
Manufacturing -13,
Electricity, gas, water supply-1
Construction-1
Services-14
This gets dis-aggregted into 71 industries. Analysis for 71 industries is confined to labour productivity

S.No.	KLEMS-industries
1	**Agriculture, Hunting, Forestry and Fishing**
2-17	**Industrial sector**
2	Mining and Quarrying
3-15	Manufacturing sector
3	Food Products, Beverages and Tobacco
4	Textiles, Textile Products, Leather and Footwear
5	Wood and Products of Wood
6	Pulp, Paper, Paper Products, Printing and Publishing
7	Coke, Refined Petroleum Products and Nuclear Fuel
8	Chemicals and Chemical Products
9	Rubber and Plastic Products
10	Other Non-Metallic Mineral Products
11	Basic Metals and Fabricated Metal Products
12	Machinery, nec.
13	Electrical and Optical Equipment
14	Transport Equipment
15	Manufacturing, nec; recycling
16	Electricity, Gas and Water Supply
17	Construction
18-31	**Service sector**
18-21	Trade
18	Maintenance and Repair of Motor Vehicles and Motorcycles; retail sale of fuel
19	Wholesale Trade and Commission Trade
20	Retail Trade
21	Hotels and Restaurants
22	**Transport and Storage**
23	**Post and Telecommunication**
24	**Financial Intermediation**
25	Real Estate Activities
26	**Renting of machinery & equipment and other business activities**
27	Public Administration and Defence; Compulsory Social Security
28	**Education**
29	Health and Social Work
30	Other Community, Social and Personal Services
31	**Private Household with Employed Persons**

Coverage and Methodology

- The output, input and productivity series cover the period, 1980 onwards. Current estimates cover the period, 1980 (1980-81) to 2004 (2004-05).
- An attempt is being made to extend the series to a more recent year, 2007-08.
- The project follows, by and large, EU KLEMS in regard to sectoral classification, theoretical underpinnings of the empirical analysis, methodologies and project strategies.
- But, the India KLEMS project has created some additional disaggregated estimates that are relevant to India. For instance, manufacturing industries are split into the organized (10+ worker) and unorganized components (below 10 workers).

Tornqvist index

- The Tornqvist index is used to combine different components of labour to a measure of growth in labour input.
- Similarly, different types of capital assets are combined to form a measure of growth in capital input using the concept of capital service.
- The computed rates of growth in inputs for different industries are combined to form estimates at higher level of aggregation (e.g., manufacturing sector, or the economy). In this case too, the Tornqvist index is applied.

Two sets of TFP estimates at the aggregate level

- Set -1
- Simple aggregation of value added, labour persons, and capital stock. Tornqvist aggregation of labour quality index.
- Estimates comparable to those of earlier studies for India.

- Set-2
- Tornqvist aggregation of labour persons and quality.
- Capital service input instead of stock, and Tornqvist aggregation of capital services.
- Simple aggregation of value added.

Past Productivity Research for India

Past productivity research

- There have been a good deal of research on productivity growth in the Indian economy.
- While bulk of the past productivity research has been for the manufacturing/ industrial sector, there have been a number of studies on productivity growth in agriculture and services, and the economy as a whole.
- Productivity studies that have considered the entire economy and its major sub-sectors are akin to and hence more relevant to the India KLEMS project.
- Such studies include: Dholakia (2002), Sivasubramaniam (2004), Virmani (2004), Jorgenson and Vu (2005), Bosworth, Collins and Virmani (2007), Bosworth and Collins (2008), and Bosworth and Maertens (2010).

TFP growth rate in the Indian economy: Findings of past productivity research

Dholakia (2002)	1960-1985	0.79
	1985-2000	2.85
Sivasubramonian (2004)	1980-1990	2.02
	1990-1999	2.01
Virmani (2004)	1980-1991	2.5
	1992-2003	3.6
Jorgenson and Vu (2005)	1989-1995	2.06
	1995-2003	2.49
Bosworth, Collins and Virmani (2007)	1983-1993	1.7
	1993-1999	2.8
	1999-2004	2.0
Bosworth and Collins (2008)	1978-1993	1.1
	1993-2004	2.3
Bosworth and Maertens (2010)	1980-1990	2.2
	1990-2000	1.8
	2000-2006	2.1

The estimates are mostly around 2 to 2.5% per annum

How India KLEMS differs from past productivity research for India

- Comprehensive coverage
- International comparability
- Better theoretical basis for growth accountancy – inclusion of services input
- More accurate measurement of inputs – incorporating changes in labour quality, changes in the composition of capital assets, and growing use of ICT

Construction of value added series and labour income share series

Value Added Series: Data and Methodology

- Data: NAS (National Accounts Statistics), ASI (Annual Survey of Industries) and NSSO surveys on unorganized manufacturing
- Methodology:

- Step 1: Concordance of classification between NAS and the 31-KLEMS (NIC-1970, 1987, 1998 and 2004)

- Step 2: Adjustment of Financial Intermediation Services Indirectly Measured (FISIM).

  NAS: Output net of FISIM at the aggregate level (Manufacturing, Trade and Other services)

  Allocation of FISIM according to sectoral GDP shares.

- Step 3: ASI and NSS surveys [45th round (1989-90), 51st round (1994-95) 56th round (1994-95) and 62nd round (2005-06)] to split NAS industries

KLEMS Industries concordance with NAS industries

NAS	KLEMS Industry List	Methodology
Rubber, Petroleum Products etc. (23 + 25)	Coke, Refined Petroleum Products and Nuclear Fuel (23)	ASI and NSSO NSSO: constant share for all the years in between the two consecutive rounds and take the series backwards to arrive at individual sector results
	Rubber and Plastic Products (25)	
Basic Metals (271+272+2731+2732)	Basic Metals and Fabricated Metal Products (27+ 28)	
Metal Products and Machinery (28+29+30)	Machinery, nec (29)	' do'
Electrical Machinery (31 + 32)	Electrical and Optical Equipment (30 to 33)	
'Other manufacturing' in NAS includes (33+369)	Manufacturing nec; recycling(369)	' do'
Trade	Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel (18)	NAS provides distribution from 1999-2000 to 2007-08. Further, Series is extended backward based on the share in 1999-00
	Wholesale and Commission Trade (19)	
	Retail Trade (20)	
Real estate, ownership of dwellings & business services' in NAS	Real Estate Activities (25)	NAS provides data from 1999-00 on-wards. Linearly backward interpolated
	Renting of Machinery & Equipment and Other Business Activities (26)	

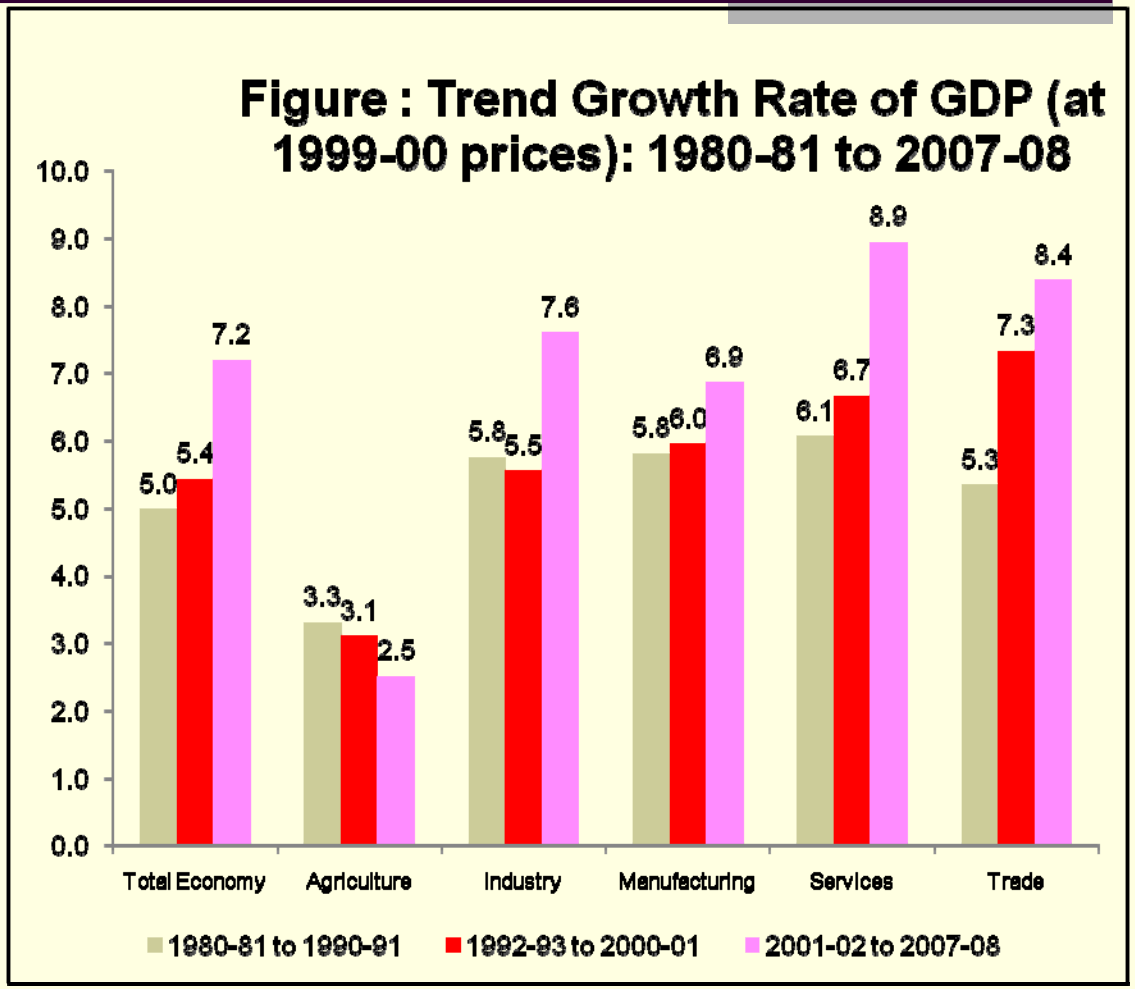
Note: Manufacture of fabricated metal products (28) ; Manufacture of machinery and equipment n.e.c (29); Manufacture of office, accounting and computing machinery (30); Manufacture of electrical machinery and apparatus n.e.c. (31) ; Manufacture of radio, television and communication equipment and apparatus (32) ; Manufacture of medical, precision and optical instruments (33).

Trends and Patterns of Value Added

Figure : Average Growth Rate of GDP (at 1999-00 prices): 1980-81 to 2007-08
(Figures in *per cent per annum*)

- Marked Acceleration in growth performance of Economy despite the slows down during 1997-98 to 2002-03
- The growth in service sector is reasonably high and consistent: Trade sector performance is remarkable
- Fluctuation of growth performance in Industrial sector
- There is continuous decline in the growth rate of GDP in Agricultural sector

Share of services in GDP has increased from 40% in 1980 to 52% in 2007



Value Added Share (in per cent) within the service sector: 1980-81 to 2007-08

RBI (2002):

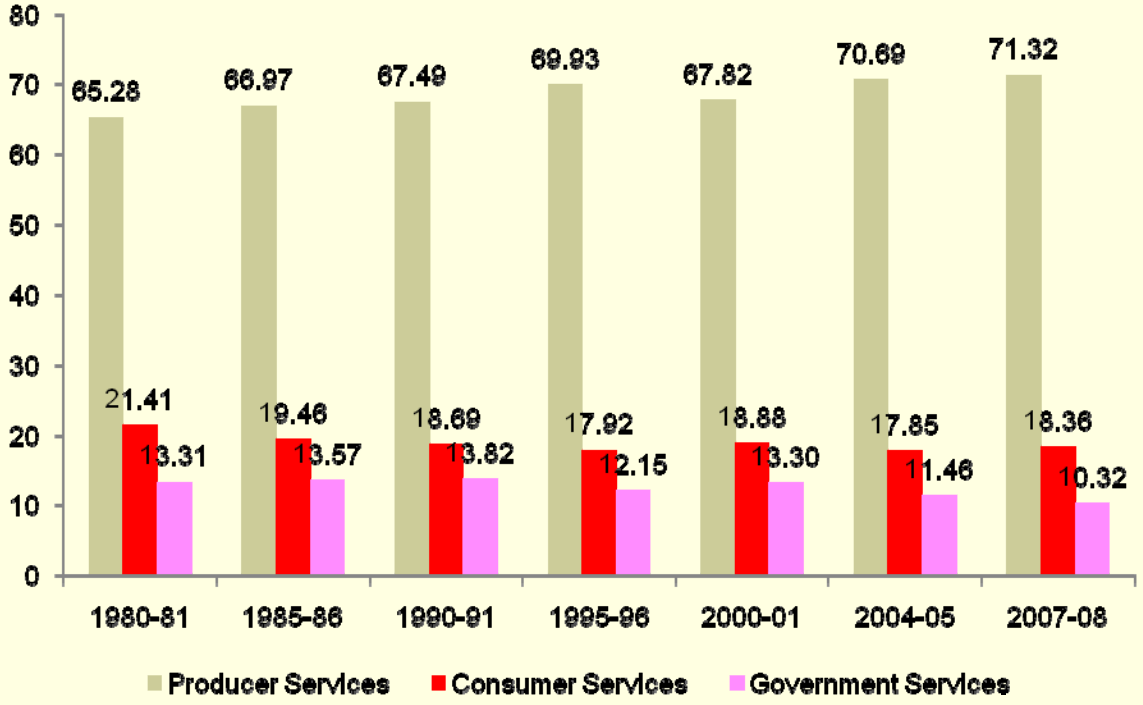
Producer services: Trade, Transport & communication, banking & insurance, and real estate, ownership of dwelling & business services

Consumer services: Hotels & restaurants and other services

Government services: Public administration and defence

Producer services dominate and their share within services value added is growing.

Figure : Value Added Share (in per cent) within the service sector: 1980-81 to 2007-08



Construction of Time Series on Labour Income Share in Value Added

- Manufacturing Sector: computations based on ASI and NSSO
- Labour Share = Emoluments/GVA, computed for organized and unorganized manufacturing separately
- Combined on the basis of weights of share of GVA in Registered and un-registered Manufacturing sector

- Non-Manufacturing Sector: computations based on NAS, NSSO and Estimated GVA
- Labour Share = [Compensation of Employees (CE) + Labour income of Self-employed]/GVA
- NDP at factor cost= CE+OS+MI [available from NAS]
- Self-employed wages = (wage per day) * (employment in terms of number of days employed)

Note: labour income of self employed is based on estimated wage equations and data on consumption expenditure of such households

Trends in labour income share

	1980-90	1992-2000	2001-07
Agriculture	0.91	0.67	0.82
Mining &Quarrying	0.39	0.39	0.31
Manufacturing	0.39	0.32	0.28
Electricity	0.50	0.31	0.39
Construction	0.87	0.82	0.79
Trade	0.51	0.38	0.37
Hotels & Restaurant	0.67	0.49	0.50
Transport & Storage	0.68	0.55	0.49
Communication	0.58	0.32	0.39
Banking & Insurance	0.56	0.40	0.37
real estate, ownership of dwelling and business services	0.14	0.28	0.28
Public administration	0.85	0.85	0.87
other services	0.83	0.69	0.66
Economy	0.65	0.53	0.53

In manufacturing and several other sectors, the income share of labour in value added has come down

Construction of Time Series on Labour input

Major tasks in creating a Data Base on Labour

- Construct a Time Series of Employment [number of persons] from 1980 to 2004 [A]
- Prepare a Labour Quality Index from 1980 to 2004 [B]
- Derive a Time Series on Labour Input for the period 1980 to 2004 [=A*B]

Major Sources of Data Used

- For all sectors of the economy:
  - Employment and Unemployment Surveys (EUS) by **National Sample Survey Organization** (NSSO) and Population Census.

    The two are Household/Individual specific
- Manufacturing Sector disaggregation:
- Organized Manufacturing industries - **Annual Survey of Industries (**ASI)
- Unorganized Manufacturing industries - Residual

Time Series on Number of persons employed

- In India, the number of persons employed may be estimated from Census and/or from EUS
- While Census has been held every ten years, NSSO has conducted both major (or Quinquennial) and thin (or Annual) rounds of EUS

Employment Unemployment Survey (EUS)

- Major (Quinquennial) Rounds of EUS: 32nd (1977-78), 38th (1983), 43rd(1987-88), 50th(1993-94), 55th (1999-00) and 61st(2004-05)
- Thin (Annual) Rounds: 45th(1989-90) to 60th (2004), 62 and 64th (2007-08)
- EUS uses Usual Status [Usual Principal Status(UPS) and Usual Principal & Subsidiary Status (UPSS)], Current Weekly Status(CWS) and Current Daily Status (CDS) measures for Quinquennial (or major) rounds and Usual Status & CWS for annual (thin) rounds

Method used for estimating employment

- For India KLEMS, employment estimates are based on UPSS.
- Since different rounds of EUS use different National Industrial Classification (NIC), so a Concordance between India KLEMS and NIC-1970, 1987 and 1998, required for all the 31 sectors, was done.
- Guided by the suggestions of experts, only the 5 Quinquennial rounds have been used, for constructing the time series.

Method used for estimating employment

- The interpolation from the major rounds was done for the period 1980-81 to 2004-05 assuming constant yearly growth rate between two major rounds.

Estimation of Employment

Employment has been computed as follows:

I. Work Participation Rates (WPRs) by UPSS from EUS are applied to the corresponding period's population of Rural Male, Rural Female, Urban Male and Urban Female to find out the number of workers in the four segments

II. The 31-industry distribution of Employment from EUS is applied to the number of workers in step I to obtaine L_{ij} for each industry where i=1 for rural and 2 for urban areas, and j=1 for male and 2 for female

Contd….

III. From the major rounds separate interpolation of L_{ij} was done from 1983-2004 for rural male, rural female, urban male and urban female to obtain the respective time series for all 31 sectors.

IV. For extrapolation backward to 1980-81 to 1982-83, the interpolation of the broad industrial classification of 32nd round (1 to 8) and 38th round is used as control totals.

V. Total persons in a year were obtained for each industry as the sum of the Lij over gender and areas, $\Sigma_i \Sigma_j L_{ij}$

Labour Quality Index: Methodology

Broadly there are two approaches

- First, through years of education
  - Problem is that it ignores variation across industry, gender, age, level of education, etc and gives uniform rate of quality improvement for each year of education.
- Jorgenson's Approach
  - It incorporates all compositional changes

The methodology given by Jorgenson, et al (1987), which imvolves the Tornqvist translog index, has been used in the study, except that due to data limitations only educational composition of workers has been considered.

Earnings Data for estimating labour quality

- To construct the labour quality index, data on earnings are needed.
- NSSO's EUS provides earnings data for only regular- salaried workers and casual workers
- The issue was how to estimate earnings of self employed -- the present study has taken two approaches:

Contd…

- First, a Mincer Wage equation has been estimated and sample selection bias has been corrected for by using Heckman's two step procedure – the equation is then used to get an estimate of the earning of each self-employed person in the sample.
- Secondly, earnings of self employed have also been estimated from the monthly consumption expenditure of these households

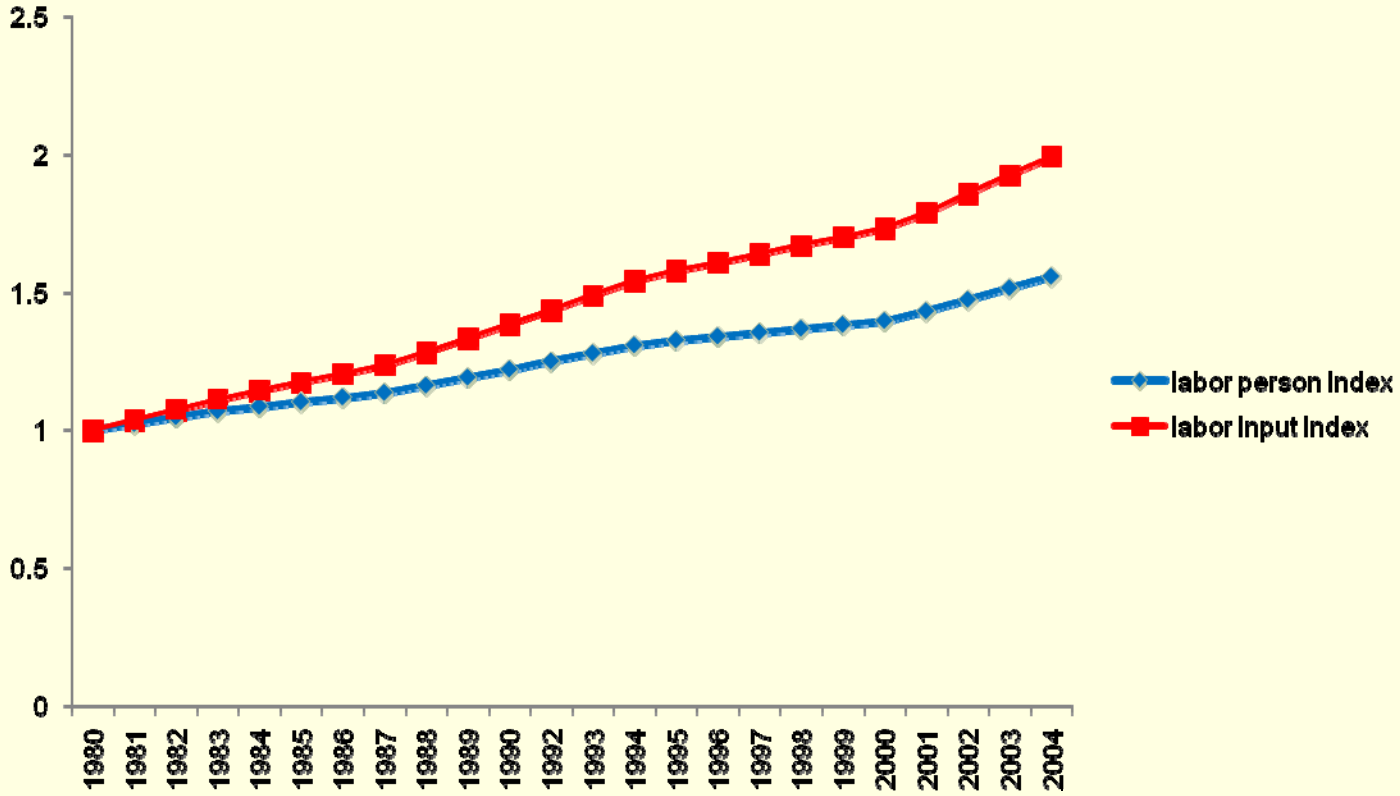
The lower of the two alternate estimates of earnings is taken to be the earnings of a self employed person.

Labour input index

The labour input index is obtained in the following way:

- From the series on persons employed, an employment index is constructed
- The index of employment is multiplied by the index of labour quality (reflecting education) to derive the index of labour input.

Labour input index, Indian economy, 1980-2004



Construction of Time Series on Capital Input

Measuring Capital input for India KLEMS

Capital services Methodology (Jorgenson)

- Capital service growth rates ($\Delta ln\ K_t$) are arrived at as the weighted growth rate of individual capital stock ($\Delta ln\ K_{k,t}$) where the weights are the compensation share of each asset type, averaged across current and previous period , i.e.

$$\Delta \ln K_t = \sum_k \bar{v}^K_{k,t} \Delta \ln K_{k,t}$$

where weights are

$$v^K_{k,t} = \frac{p^K_{k,t} K_{k,t}}{p^K_t K_t} \text{ ; and } \bar{v}^K_{k,t} = \frac{\left(v^K_{k,t} + v^K_{k,t-1}\right)}{2}$$

where $p^K_{k,t}$ is the investment price of asset k.

Construction of capital services, Data requirements

- Capital stock by asset type (Perpetual Inventory Method)
  - Time-series on gross investment by asset type
  - Time-series on investment prices by asset type
  - Depreciation profile by asset type
  - An estimate of benchmark capital stock

- Compensation share by asset type
  - Rental prices
    - Rate of return
    - Depreciation rates by asset type
    - Investment prices by asset type
  - Capital stock by asset type

Data sources for measuring Capital Input

- **National Accounts Statistics, CSO**
  - Asset wise Gross Fixed Capital Formation (GFCF) at current prices, 1950-2007
  - 9 broad sectors, separately for Public and Private sectors
- **Annual Survey of Industries for organized manufacturing**
  - Gross fixed capital in historic prices (Bt)
  - Depreciation (Dt)
  - Gross fixed capital formation, total (across all assets)
  - Gross value of assets by asset types
    - GFCF= *Actual additions (newly purchased, purchased second hand and own construction) during the year;* **minus** *deduction and adjustment during the year* **plus** *depreciation adjustment for discarded assets during the year by asset types*
    - *Differs from past studies which used aggregate capital stock using perpetual inventory method, disregarding the asset composition (e.g. Ahluwalia, 1986 and 1991; Goldar, 1986; Rao,1996; Balakrishnan and Pushpangadan, 1994; Das, 2004), where investment is defined as Bt-Bt-1 +Dt.*
  - Time-series 1964-2007, with some breaks
- **NSSO surveys on unorganized manufacturing**
  - Net additions to fixed capital stock
  - Rounds 45th (1989-90), 51st (1994-95), 56th (2000-01) and 62nd (2005-06)

Final Asset Classification in India KLEMS- an overview

Asset in basic source	NAS	ASI	NSSO	KLEMS
Transport Equipment	**X**	**X**	**X**	**Transport**
Machinery & Equipment	**X**	**X**	**X**	**Machinery**
Land		X	X	Excluded
Construction	**X**	**X**	**X**	**Construction**
Non-residential structures	X			Construction
Residential structures	X			Construction
Other assets			X	Machinery

- **Census Adjustment to ASI data**
  - **Census/factory ratio in 1973 is used to covert investment series prior to 1973, in order to ensure temporal comparison**

- **NAS adjustment to both ASI and NSSO data**
  - **All data are redistributed across industries and assets, in such way that the aggregates are consistent with published NAS totals for the relevant sectors.**

Estimating capital stock by asset type

- Current price GFCF (I) series by 31 industries and 3 asset types.
- NAS deflators for machinery, transport and construction separately
- Depreciation rates (δ), based on assumed lifetimes in NAS (double declining balance rate)

Asset	Depreciation rate (%)
Buildings	1.25
Transport Equipments	5.00
Machinery (including ICT)	4.00

- Initial Capital stock approximated by published net fixed capital stock from NAS.
  - If asset/industry wise initial stock is not available, industry/asset distribution of GFCF is used.

,

Estimating capital stock by asset type

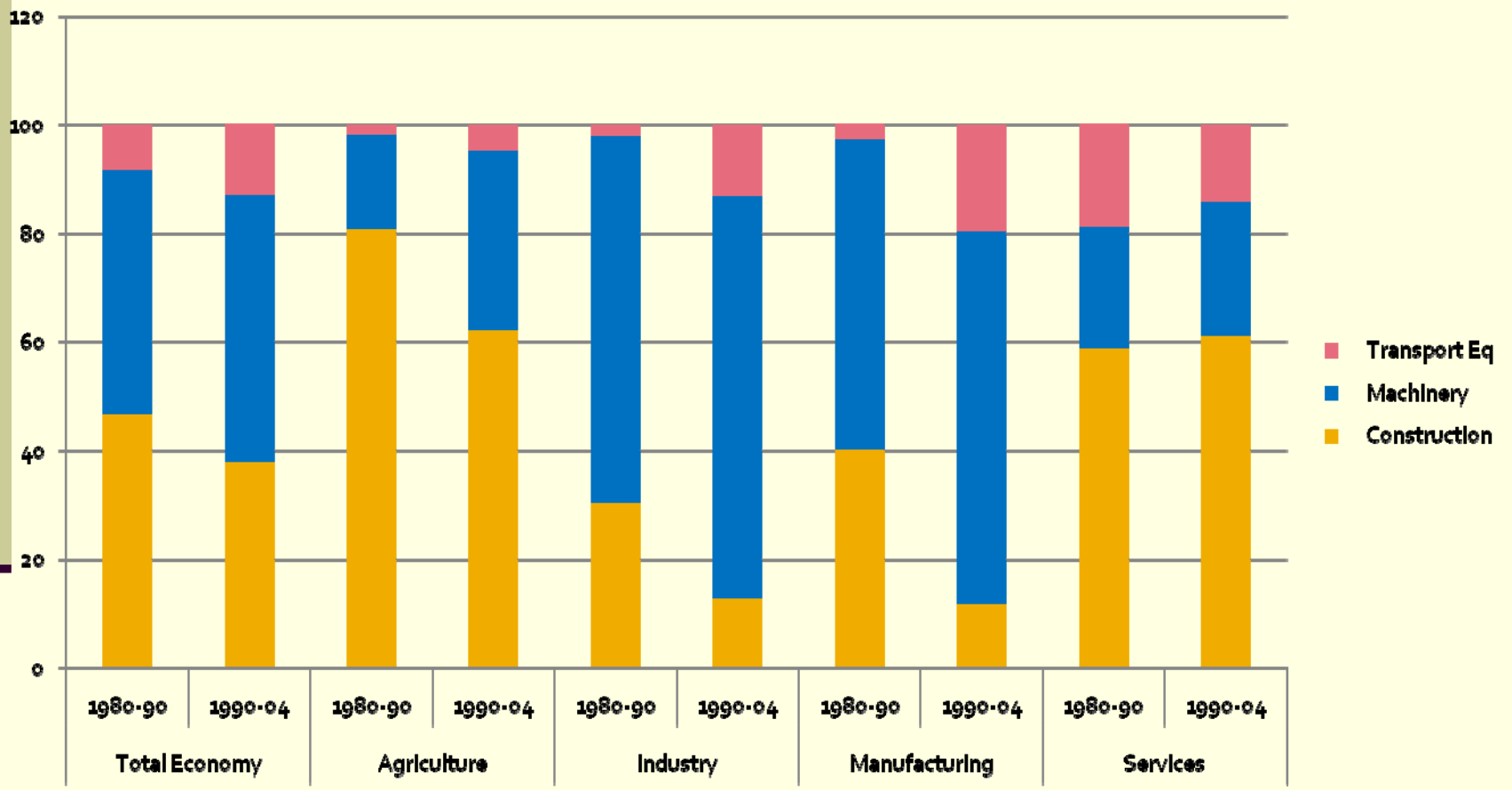
- Time-series of capital stock in asset k (Sk), for any given industry is computed using PIM

$$S_{k,T} = S_{k,T-1}(1-\delta_k) + I_{k,T}$$

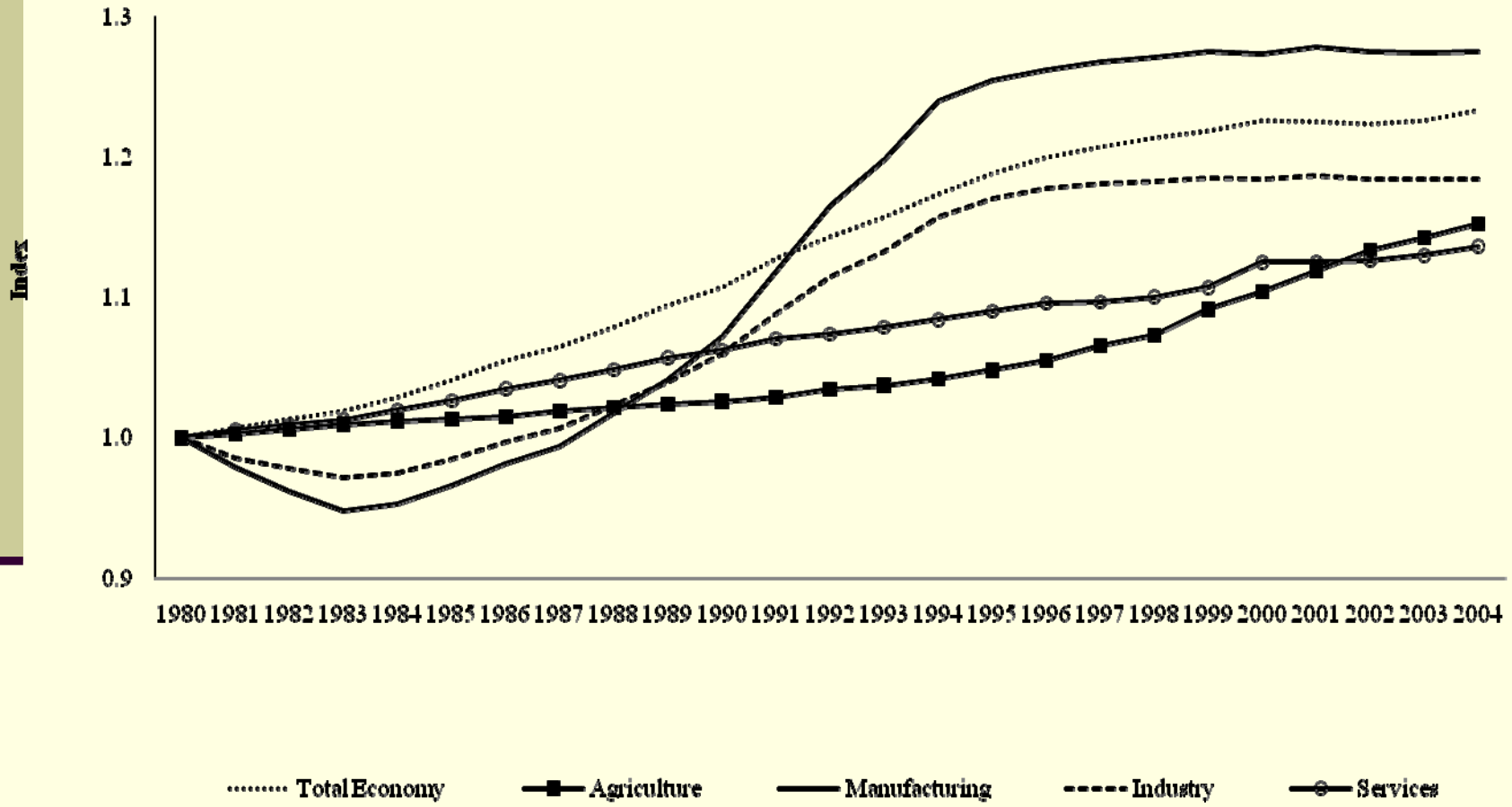
- And rental prices are computed using investment prices, depreciation rates & an external rate of return proxied by average of government securities and prime lending rate as

$$p^K_{k,t} = p^I_{k,t-1} i^*_t + \delta_k p^I_{k,t}$$

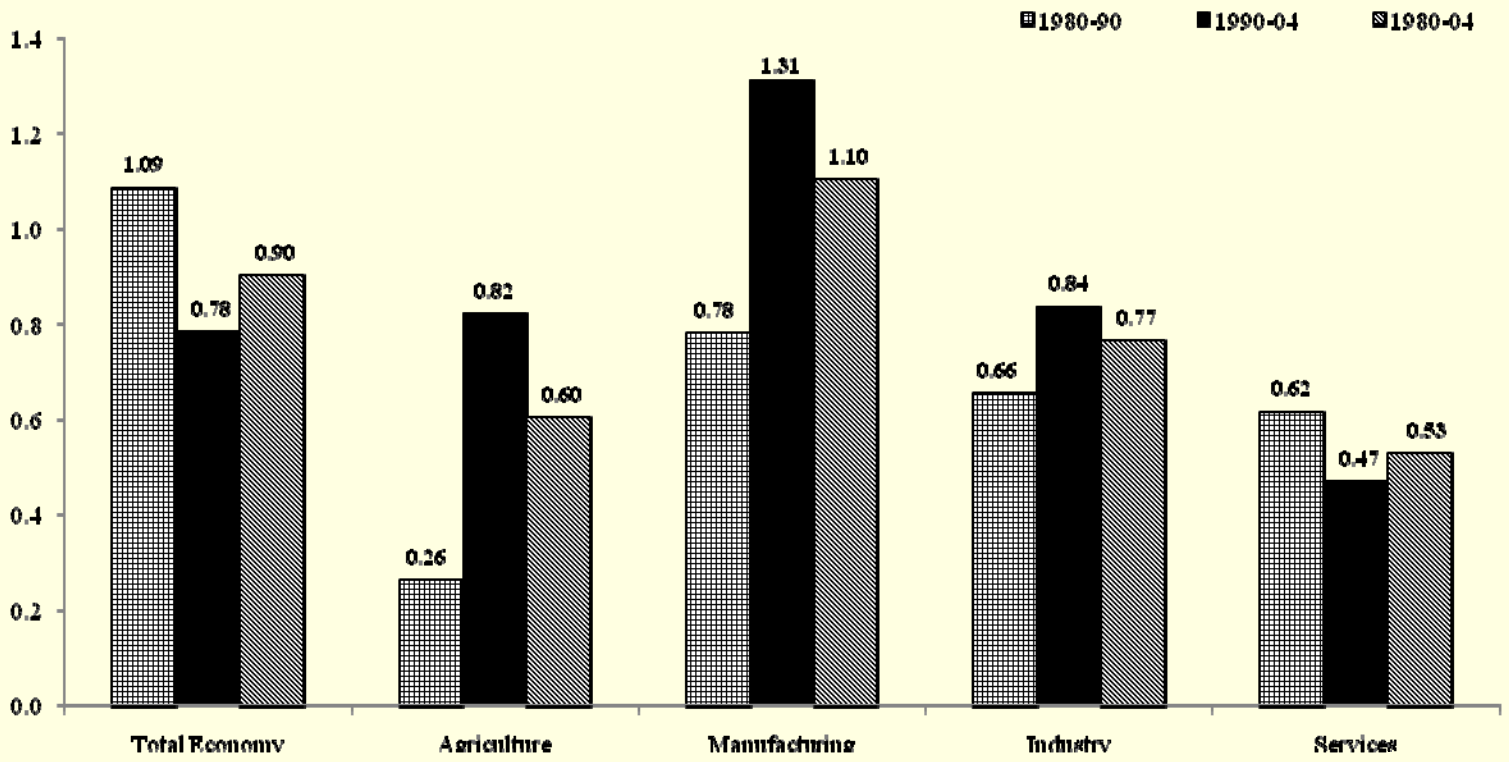
Composition of Investment: Increasing Equipment share



Growth of Capital Services relative to Capital Stock (1980=1)

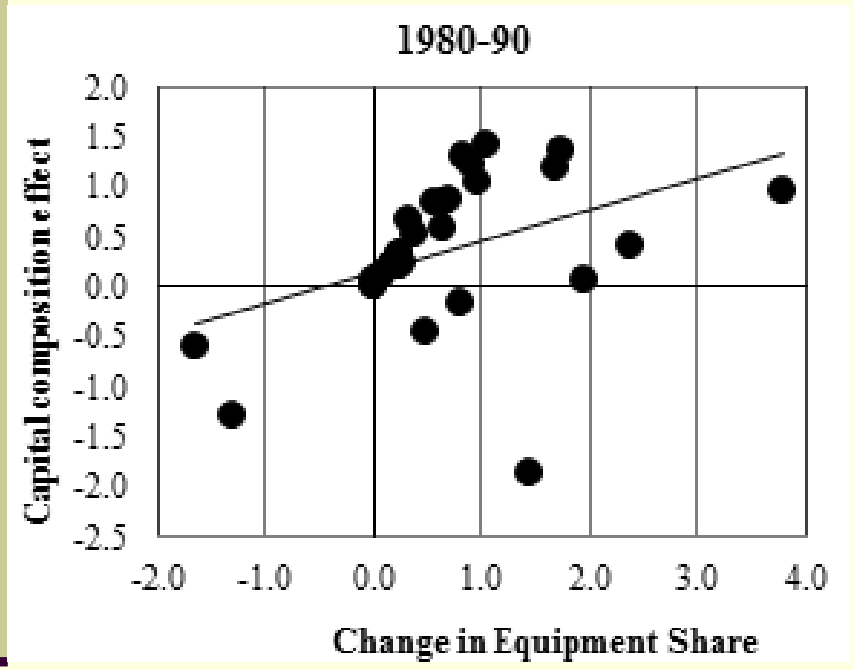


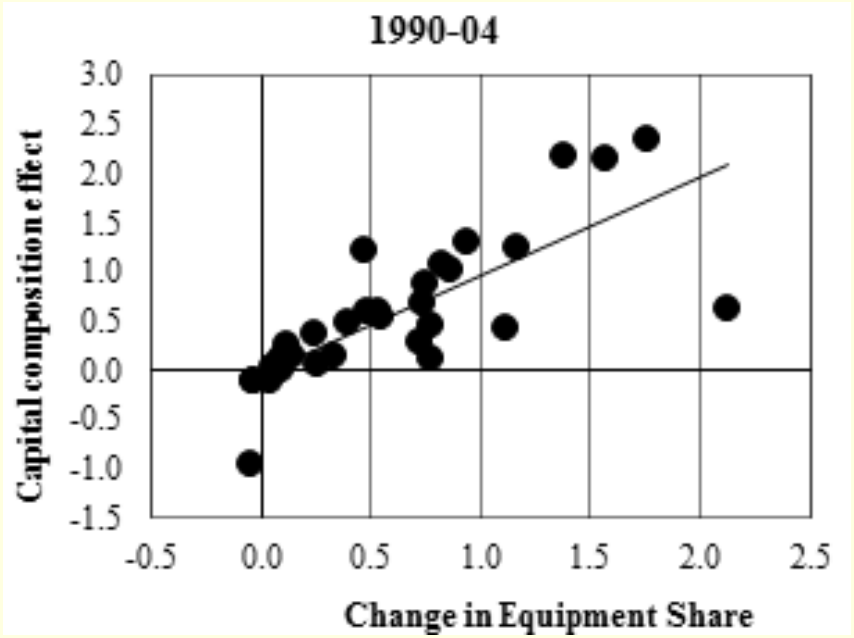
Capital composition effect, 1980-2004



- Capital services grows faster than capital stock in all the sectors, with more prominent growth in the 1990s, except in the service sector
- Service sector had increasing share of construction investment during this period

Equipment investment and capital composition effect, 31 KLEMS industries





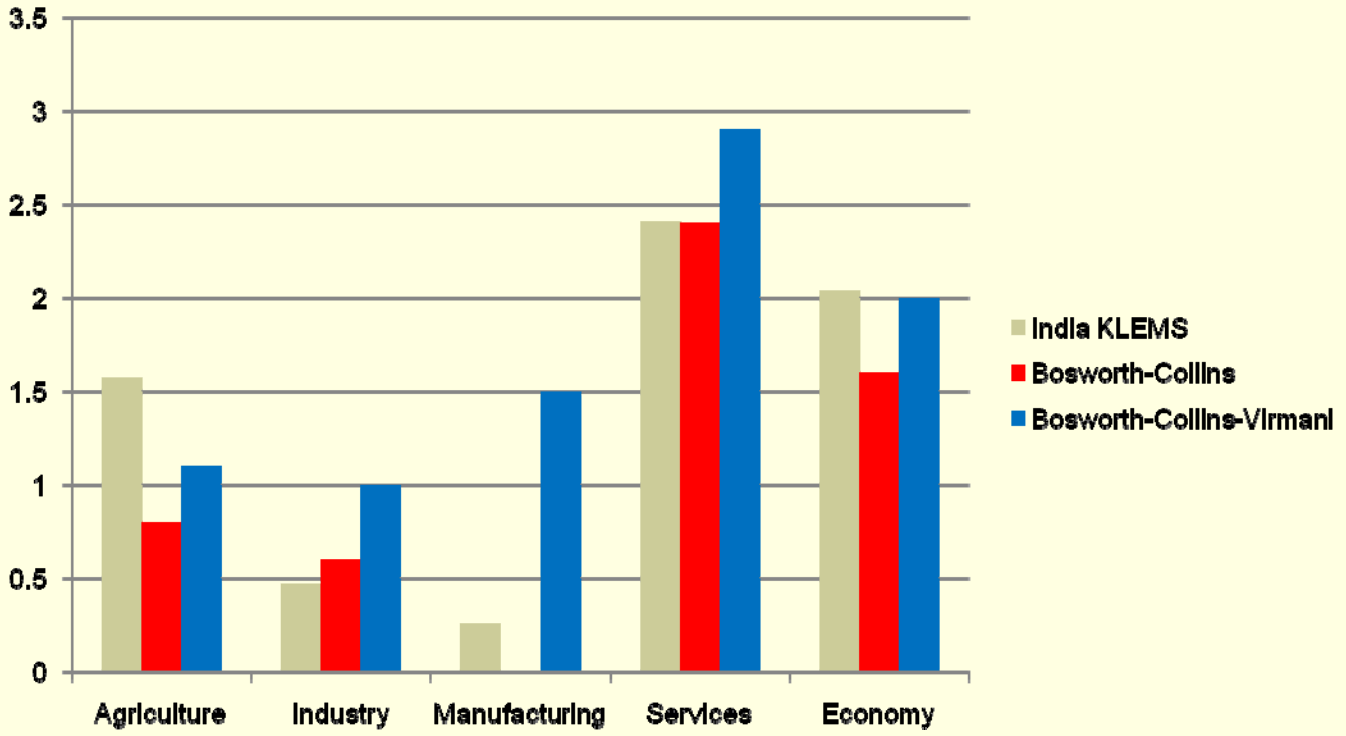
•More industries with increasing equipment share and high composition effect in the post-1991 period

- Capital services grow faster than capital stock in almost all sectors, reflecting the increasing share of equipment capital
- This will have serious implication for productivity measurement, as conventional measure of capital stock will overestimate the contribution of TFPG to GDP growth.
- Attempts will be made to
  - Develop a series of ICT investments, and distinguish between ICT and non-ICT capital
  - Get more appropriate depreciation rates
  - Use of internal rate of return, and conduct sensitivity analysis

Productivity growth estimates

Comparison with the TFP growth estimates of Bosworth-Collins and Bosworth-Collins-Virmani

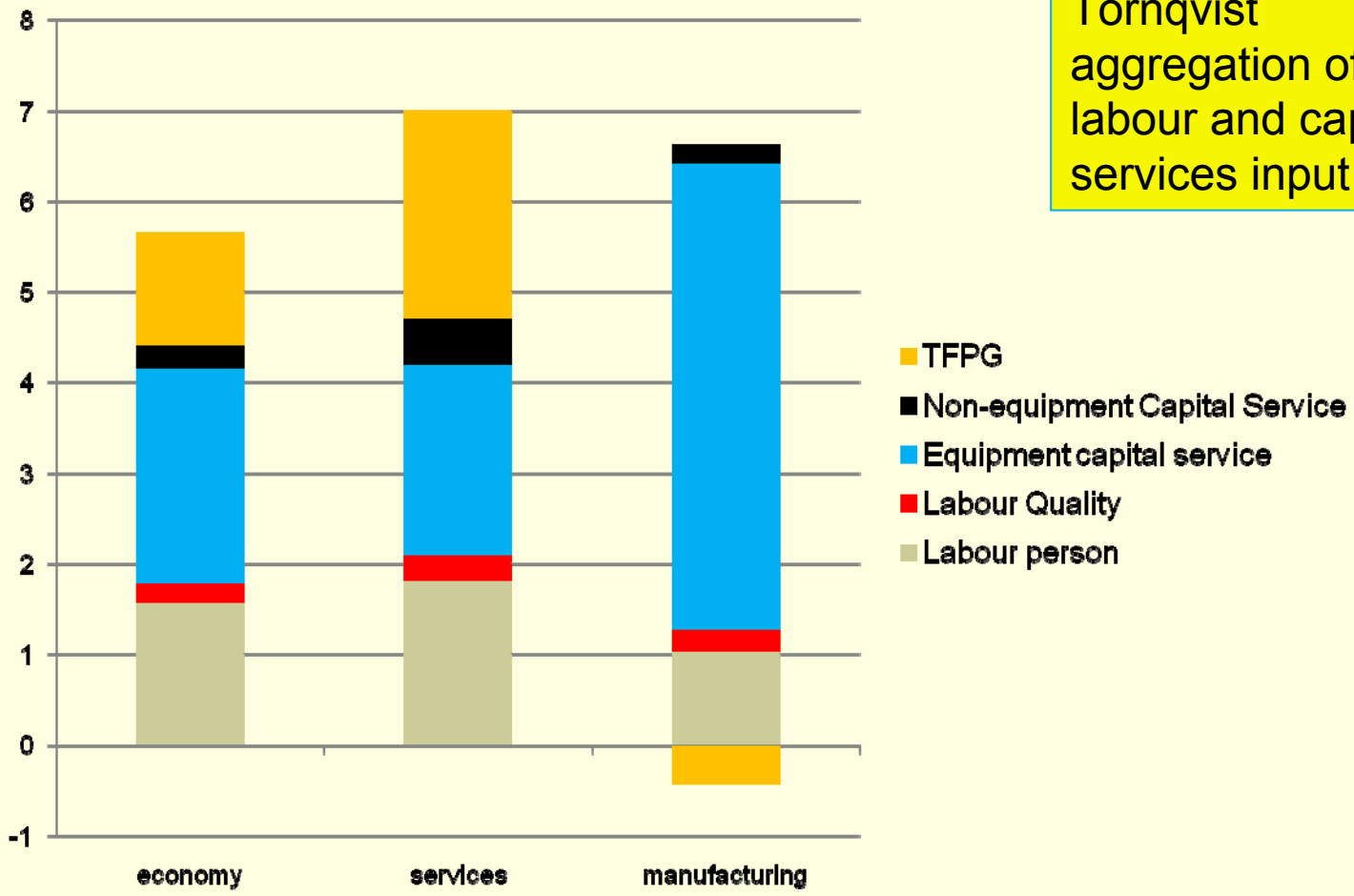
Period: 1980-2004, % per annum



Estimates based on simple aggregation of persons and capital stock. India KLEMS TFPG estimates for manufacturing and industry are lower because actual labour income shares are used whereas BC and BCV take the elasticity as 0.6.

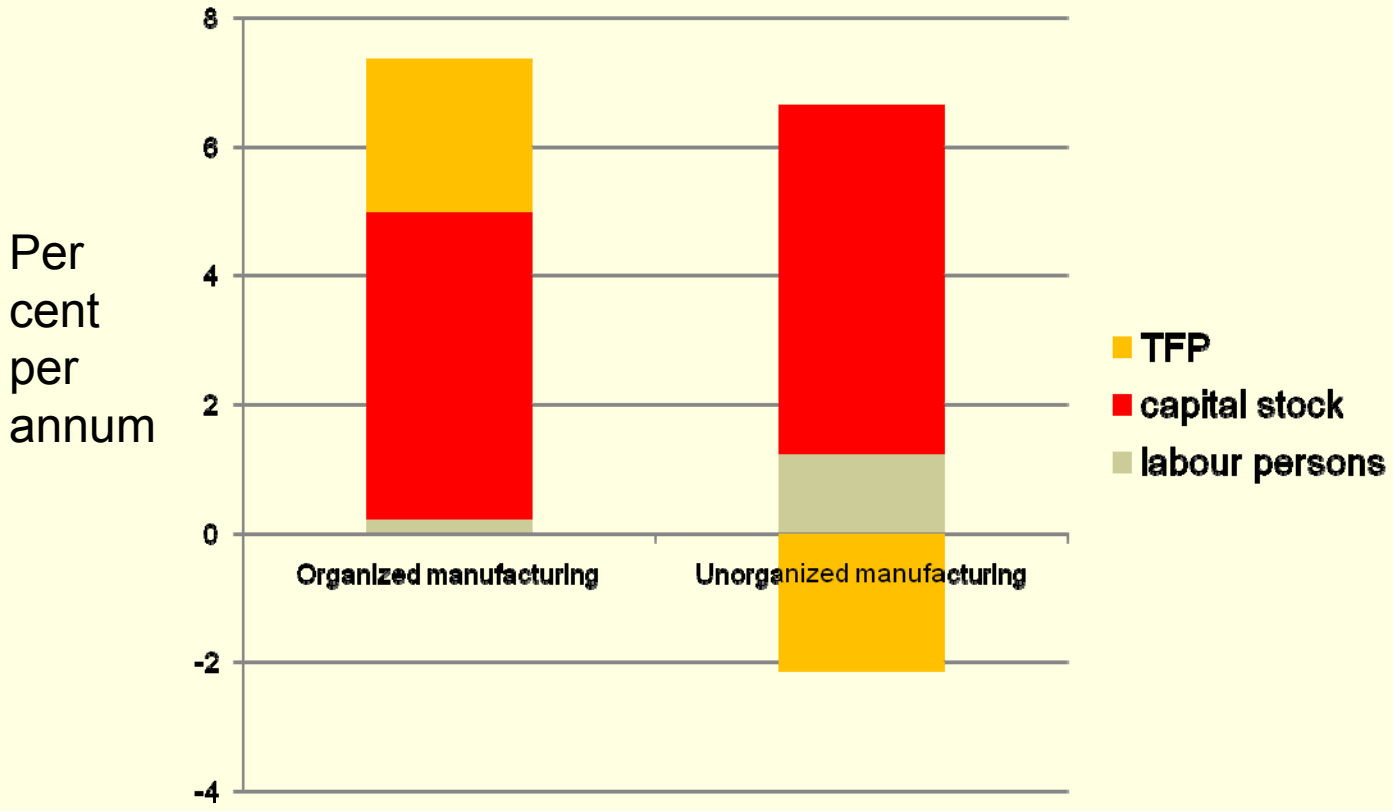
Sources of value added growth, 1980 to 2004

Per cent per annum



Tornqvist aggregation of labour and capital services input

Sources of value added growth in organized and unorganized manufacturing, 1980-2004



Thank You