

# Trend and Growth of Capital Stock in Bihar During 1980-2017

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## Abstract

This paper attempts to generate time series estimates of net fixed capital stock at disaggregate and aggregate level for Bihar for the period from 1980-81 to 2016-17 based on Kruger's Approach (2003) to estimate initial capital stock and then the Perpetual Inventory Method (PIM) for subsequent years. The estimates measure the extent to which production activity increases wealth and creates the conditions needed to continue the production of goods and services in future. Bihar underwent a massive accelerated growth performance in generation of capital stock in Aggregate since occurrence of turning point in 2005-06. Growth of capital stock in Secondary Sector was lower than the overall economy but that in Tertiary Sector specially Transport; Storage & Communication; Trade, Hotel & Restaurant witnessed higher growth pattern since occurrence of turning point in 2005-06. Primary Sector, which has about one-fifth share in capital stock, showed decelerated growth performance since occurrence of turning point in 2000-01. Since capital stock is known to be the engine of growth, decelerated growth performance of primary sector (mainly agriculture in Bihar) and lower growth performance in secondary sector (manufacturing, electricity & construction) is a matter of concern for policy makers in the light of need of strong agriculture sector for Food Security and industrial & infrastructure development. Decelerated trend in capital stock during Twelfth Plan is also a matter of concern for developing economy of Bihar. There is dire need to focus on reorientation of investment planning and strategy.

## Keywords

Net Fixed Capital Stock, Perpetual Inventory Method, Relative Growth Rate, Turning Points

## 1. Introduction

Capital is the basic input in production that provides a flow of services over several time periods, often lasting decades whose accumulation over time leads to capital stock. Fixed capital stocks is the most important indicator of the extent to which production activity increases wealth and creates the conditions needed to continue the production of goods and services in future. The quality and quantity of fixed capital influences not only the productivity of capital itself, but also that of labour and total output. It has two basic roles as measure of wealth and measure of contribution of capital to production.

Fixed capital stock comprises all durables, reproducible tangible fixed assets—such as residential and non-residential buildings, dams, irrigational & flood control projects, other constructional works, transport

equipments, machinery & equipments, breeding stocks, draught animals, dairy cattle, capital expenditure on land improvement, plantation, orchard development, a forestation, etc., which are used in production of goods & services. It also include uncompleted construction assets; inventories of goods producing industries, trade, other industries and government; finished and semi-finished goods and young livestock except breeding stocks, dairy cattle & like—which form part of the fixed assets. However, the durable assets in the hands of households which are not used for further production of goods and services such as automobiles, refrigerators, washing machines, furniture, sewing machines, etc., as well as fixed assets mainly meant for defense purposes do not form part of the fixed capital stock as these are assumed to have been consumed as soon as they are purchased. However, the construction works undertaken by the households and capital expenditures on residential dwellings for defense personnel, border roads, ordnance factories etc., form part of the fixed capital stock. Thus, the capital stock is a broad measure of the existing physical capital in an economy and it should increase as it develop and grows richer. The change in the capital stock is one of the fundamental ingredients of economic growth. It tells us that economies build up their capital stock—and therefore their real GDP—by devoting enough output to new investment to both replace worn out capital and then add some more.

Official estimates of Net Capital Stock and Net Fixed Capital Stock are compiled by the Central Statistical Office, Government of India. Details of methodology and sources of data used in preparation of these estimates have been documented in the publication, “National Accounts Statistics: Sources & Methods, 2012”. However, estimates of capital stock are not available at the state level for most of the states in India. Of course, measuring the capital stock has proved difficult and has generated raging controversy within the Economists & Statisticians. By and large, two methods are employed—an evaluation of stock of capital through direct surveys or the more indirect Perpetual Inventory Method (PIM). Dholakia (1974, 1977) conducted a detailed study on sources of growth for Indian Economy for which Capital Stock series was generated through PIM. Nehru & Dhareshwar (1993) described the derivation of a new database of physical capital stock estimates for a selected group of 92 developing and industrial countries from 1960 to 1990. Modified Harberger’s approach (1978) was considered as the most appropriate one—out of several alternative techniques evaluated for the estimation of an initial capital stock. Bosworth, Collins & Chen (1995) decomposed the growth of output per worker into the contribution from accumulation of physical and human capital, and from increase in total factor productivity (TFP). Many studies [Cororation & Caparas (1999); Pradhan & Barik (1999); Singh(2001); Wu & Xu (2002); Kruger (2003); Das (2004); Golder (2004); Liman& Miller (2004); Mussa(2006) ; and Rajeshwari (2008)] have dealt the construction of estimates of capital stock in the context of Indian and other economies, confined at the national level only. However, Singh & Kaur (2012) undertook the task of constructing time series estimates of capital stock for Punjab & Haryana states. The present study was undertaken with the objective of updating and constructing time series estimates of capital stocks for Bihar estimated earlier by Sinha & Verma (2015b) and examining long-term trend behavior therein.

## Data

1. Time series data on aggregated/disaggregated Gross State Domestic Product (GSDP) and Net State Domestic Product (NSDP) for Bihar were collected from the DES, Bihar for 1980-81 to 2016-17 and adjusted at constant prices (2011-12).
2. The DES, Bihar does not compile comparable data on Gross Capital Formation. However, Sinha & Verma (2015a) estimated Gross Fixed Capital Formation (GFCF) at constant prices (2004-05) for 2004-05 to 2011-12. Methodology used by Sinha & Verma (2015b) were adopted to obtain comparable series from 1980-81 to 2016-17 at 2011-12 prices. Aggregation were made into major sectors:
  - Primary (P): Agriculture; Forestry & Logging; Fishing.
  - Secondary (S): Manufacturing; Construction; Electricity, Gas, & Water Supply.
  - Tertiary (T1): Transport, Storage & Communication; Trade, Hotel & Restaurant.
  - Tertiary (T2): Banking & Insurance; Real Estate, Ownership of Dwelling & Business. Services; Public Administration.
  - Tertiary Aggregate (T): T1 + T2.
  - Aggregate Capital Formation: P + S + T.

## 2. Methodology

**2.1. Estimation of Capital Stock**

The Perpetual Inventory Method (PIM) has been used to estimate the value of physical capital stock of the overall economy of Bihar as well as of an individual sector. In practice, it involves in beginning with a benchmark stock value for capital held (at constant prices) to which year-by-year known additions to stock (i.e., capital formation at constant prices) as well as depreciations adjusted to constant prices are subtracted period-by-period. In this way, a series is obtained for the capital stock in a given sector/overall economy.

Initial capital stock (K0) was worked out for the year 1980, through the Kruger Approach (2003):

$$K_0 = [I_0 (1+g)/(g+d)] \dots\dots\dots(1)$$

Where, I<sub>0</sub>: Amount of Investment in the initial period.

g: Average annual compound rate of growth in Investment over the subsequent five years.

d: Depreciation rate.

Depreciation rate was estimated following Nehru & Dhareshwar (1993) Approach as:

$$d = \frac{(D/Y)r}{(I/Y) - (D/Y)} \dots\dots\dots(2)$$

Where D: GSDP-NSDP

Y: GSDP; I: GFCF

r: rate of growth of GSDP.

Net fixed capital stock (NFCS) of the subsequent years was obtained as:

$$K_t = (1-d). K_{t-1} + I_t \dots\dots\dots(3)$$

Where K<sub>t</sub>: Capital Stock at time t, and I<sub>t</sub> for investment at time period t.

**2.2. Trend Analysis**

An in depth treatment of the pace and pattern of growth in capital stock in Bihar were traced through curves of the best-fit chosen from amongst the following seven functional forms in each of the components of NFCS :

- Simple linear (SLR):Parabolic (PRB )
- Cubic(CUB): Exponential (EXP )
- Log-Linear (LLR ): Log-Cubic (LCB )
- Modified Exponential (MEX ).

Curves of the best-fit were identified by the highest value of the indicator I [Sethi (2008); Ware & Moon (1982)] given as:

$$I = 1.2 \emptyset - 0.2 [ \{ DW - 2 \} ] \dots\dots\dots(4)$$

Where DW stands for Durbin-Watson’s statistic; and  $\emptyset = 1 - (\text{Residual SS}/\text{Total CorrectedSS})$ . I is the co-efficient of predictability.

**2.3. Relative Growth Rate**

Relative growth rates for the components of NFCS were computed at different points of time so as to examine various alternative hypotheses regarding behavioral growth path traced by the component. In the so identified growth paths of the best- fit followed by different components of NFCS, turning points, if any, were detected by following the methodology as outlined by Sethi (2010).

**2.4. Turning Points**

The pattern and nature of relative growth rates as reflected in the previous section in respect of various component of net fixed capital stock indicate to identify (if any) turning points, and kinked growth rates at the points as well as pooled growth rates over the study span following, Boyce (1986) and Sethi (2010) approach. With one kink, growth rates in two segments of time series {Y<sub>t</sub>} on a given component of net fixed capital stock were worked out through the following equation:

$$\ln Y_t = \beta_0 + \beta_1(D_1t + D_2k) + \beta_2(D_2t - D_2k) + ut \dots\dots\dots(5)$$

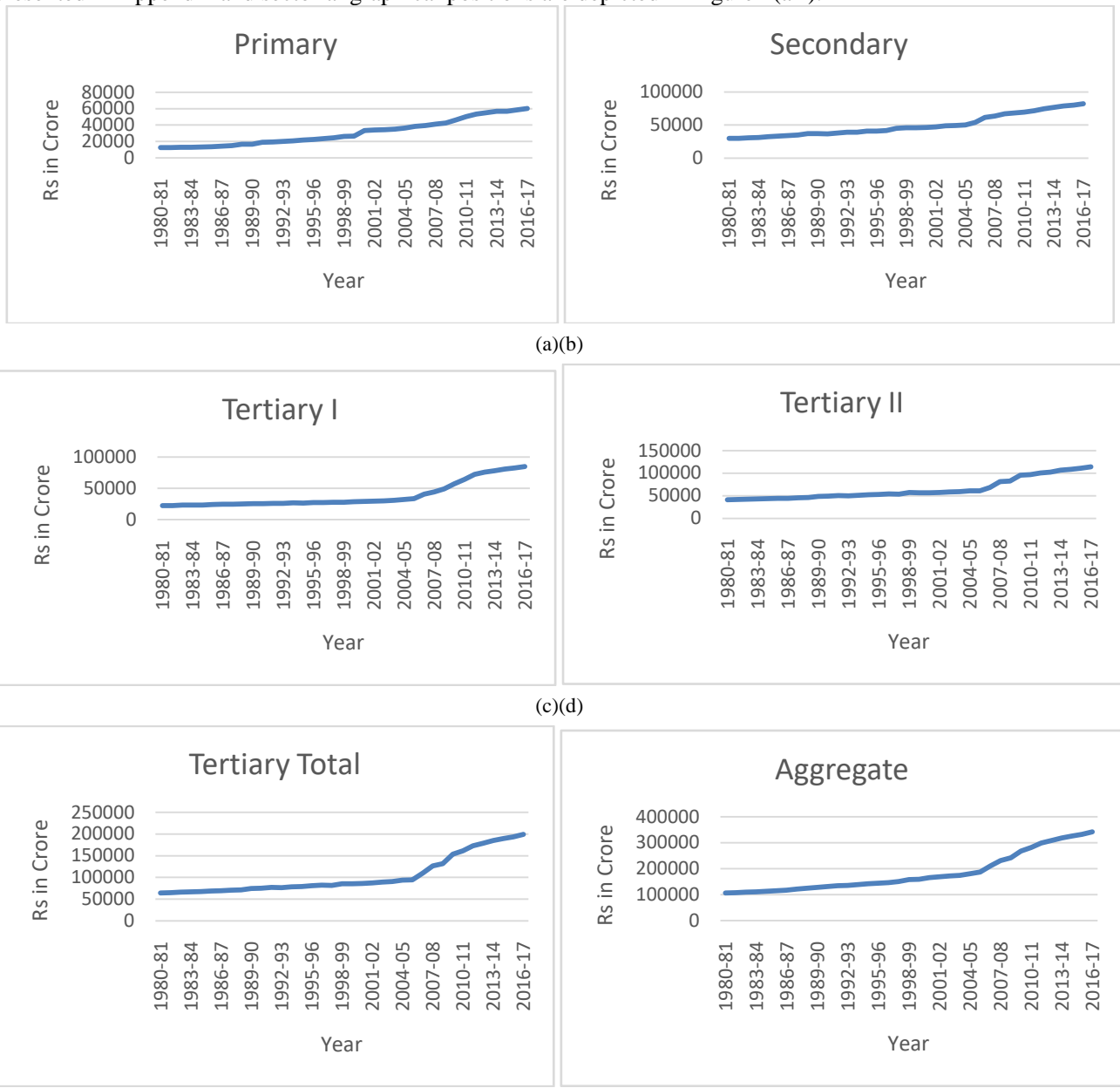
Where  $k$  is the point in time at which turning point occurred.  $D_1$  and  $D_2$  are dummies that assume the value 0 and 1 alternatively in first part and second part of the two segments. The OLS estimator of  $\beta_1$  &  $\beta_2$  in equation (5) could generate the kinked growth rates, while the pooled growth rate is generated by the OLS estimator  $\beta$  in the equation:

$$\ln Y_t = \beta_0 + \beta_1 t + u_t \dots \dots \dots (6)$$

Statistical significance of the growth rate was tested following Sethi (2008). Analysis was carried out through relevant computer programming.

### 3. Estimates of NFCS

Estimates of NFCS based on the methodology discussed in the previous section were generated for each of the components, viz., Primary, Secondary, Tertiary I, Tertiary II, Tertiary (Aggregate), & Aggregate have been presented in Appendix and sectorial graphical positions are depicted in Figure 1(a-f):



(e) (f)  
Figure 1

A broad look at these estimates indicates that the stock of capital in each of the activities, viz., primary; secondary; tertiary I; tertiary II; tertiary total; and aggregate has undergone growth—though at different pace and pattern. In primary sector, capital stock has grown from Rs 12624 crore in 1980-81 to Rs 60416 crore in 2016-17; yielding average annual growth rate of 4.72 percent. Capital stock in secondary sector and tertiary sector have shown average annual growth rate of 2.83 percent and 3.21 percent respectively—leading to average annual growth rate of overall average annual growth rate of overall capital stock in Bihar to 3.35 percent. Though a uniformly growing pattern was observed in each of the sectors, but the pace and pattern were studied in Table 1 and Table 2 for decadal and plan wise analysis.

**Table 1. Decadal average annual growth rate in Bihar by main sectors**

Decades	Primary	Secondary	Tertiary-I	Tertiary-II	Tertiary-Total	Aggregate
1981-91	4.26	2.44	1.37	1.47	1.44	2.09
1991-2001	5.69	2.03	1.31	1.68	1.55	2.39
2001-11	4.44	3.99	8.61	5.31	6.55	5.47
2011-17	4.23	3.66	8.23	5.13	6.21	5.14

Source: Authors' calculation

**Table 2. Plan wise average annual growth rate in Bihar by main sectors**

Five-Year Plan	Primary	Secondary	Tertiary-I	Tertiary-II	Tertiary-Total	Aggregate
Sixth	1.35	2.13	1.01	1.45	1.30	1.59
Seventh	5.73	3.42	1.73	1.27	1.40	2.48
Eighth	4.02	1.36	1.11	2.15	1.80	2.01
Ninth	8.98	2.87	1.78	1.08	1.31	3.10
Tenth	3.67	6.09	7.91	3.88	5.30	5.20
Eleventh	6.25	3.00	12.15	7.89	9.56	7.17
Twelfth	6.21	2.89	10.24	7.53	9.42	7.03

Source: Authors' calculation

Pace of growth during 1981-91 and 1991-2001 was slow but with relatively higher growth rate in primary sector. However, growth picked-up during 2001-11 with more focus on secondary sector and tertiary sector, while pace of growth reduced in primary sector. Slightly slower growth was noticed during truncated decade 2011-17 in all sectors. Plan wise analysis presented in Table 3 reveals that growth in capital stock was maximum during Tenth Plan in secondary sector and thereafter taken reverse turn while growth in capital stock in primary and tertiary sector were maximum during eleventh plan but growth trend slightly reduced during twelfth plan. Sector wise growth rates presented in Table 3 are graphically depicted below in Figure 1.

#### 4. Long-Term Trends in Components of NFCS:

The long term trend analysis has revealed that the behavioral growth path followed by the net fixed capital stock is indicated in Table 3.

Table 3 indicates computation for the best-fit paths in respect of NFCS from various sectors in Bihar. Primary Sector was most appropriately represented by ordinary cubic function (CUB). This equation was associated with the maximum value of Index ( $I = 1.078$ ) with a very high value of co-efficient of Predictability ( $\phi = 0.917$ ) out of seven equations tried. However, the accompanying value of D-W statistics (1.042), significantly less than 2 pointed towards the function to be infested with of auto correlated disturbance terms. The same (CUB) best fit path was identified to be prevalent in Aggregate Tertiary and Overall Economy. However, in respect of Secondary, Tertiary I and Tertiary II sectors cubic in logarithms (LCB) turned out to be the best fit function. Thus, the growth was either cubic or cubic on logarithms. Fit of long term trend path as indicated by maximum value of Index (I) and high value of co-efficient of predictability ( $\phi$ ) was very satisfactory for all the sectors. Thus, the generated time series on all the components of net fixed capital stock have propagated in a closely predictable manner.

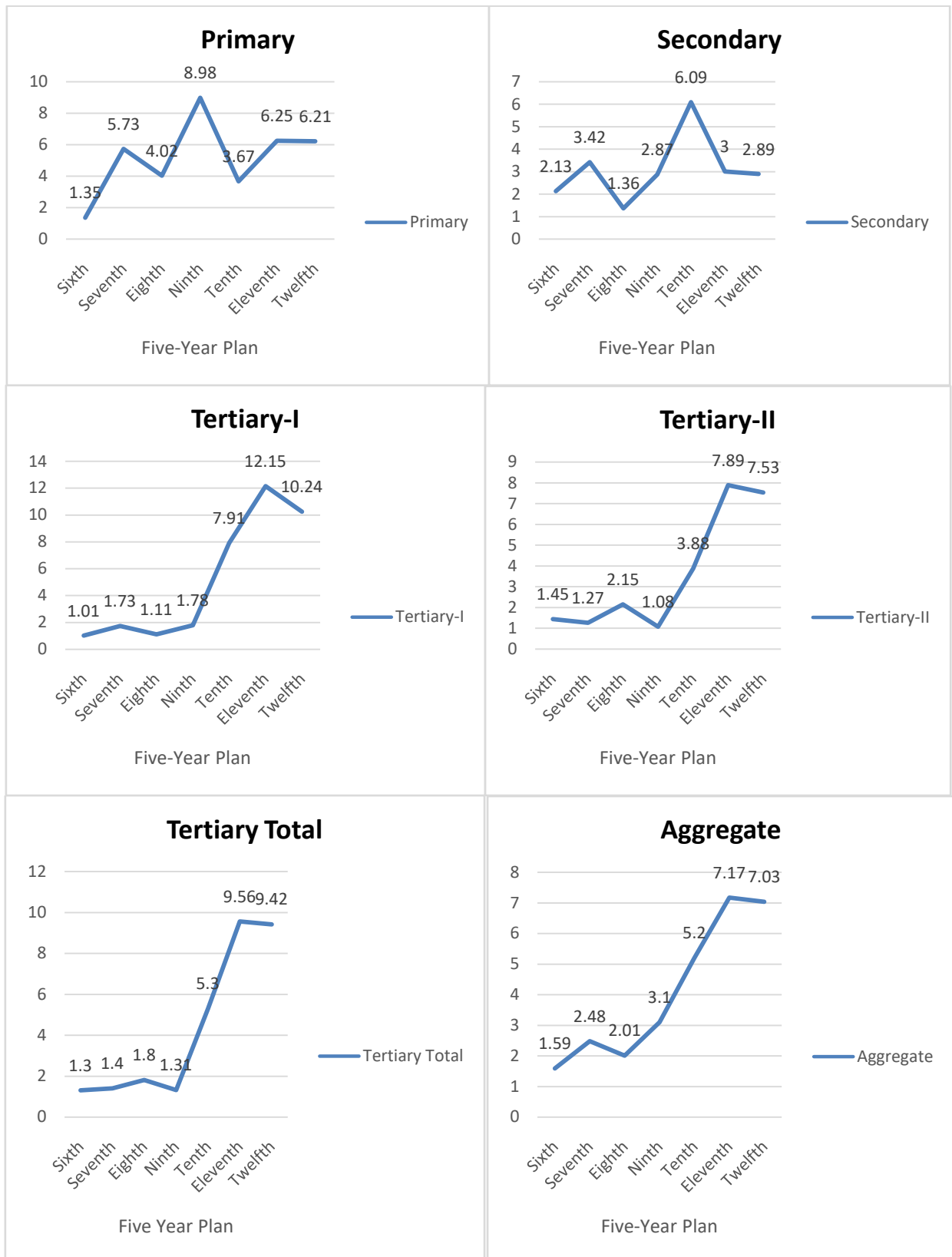


Figure 2

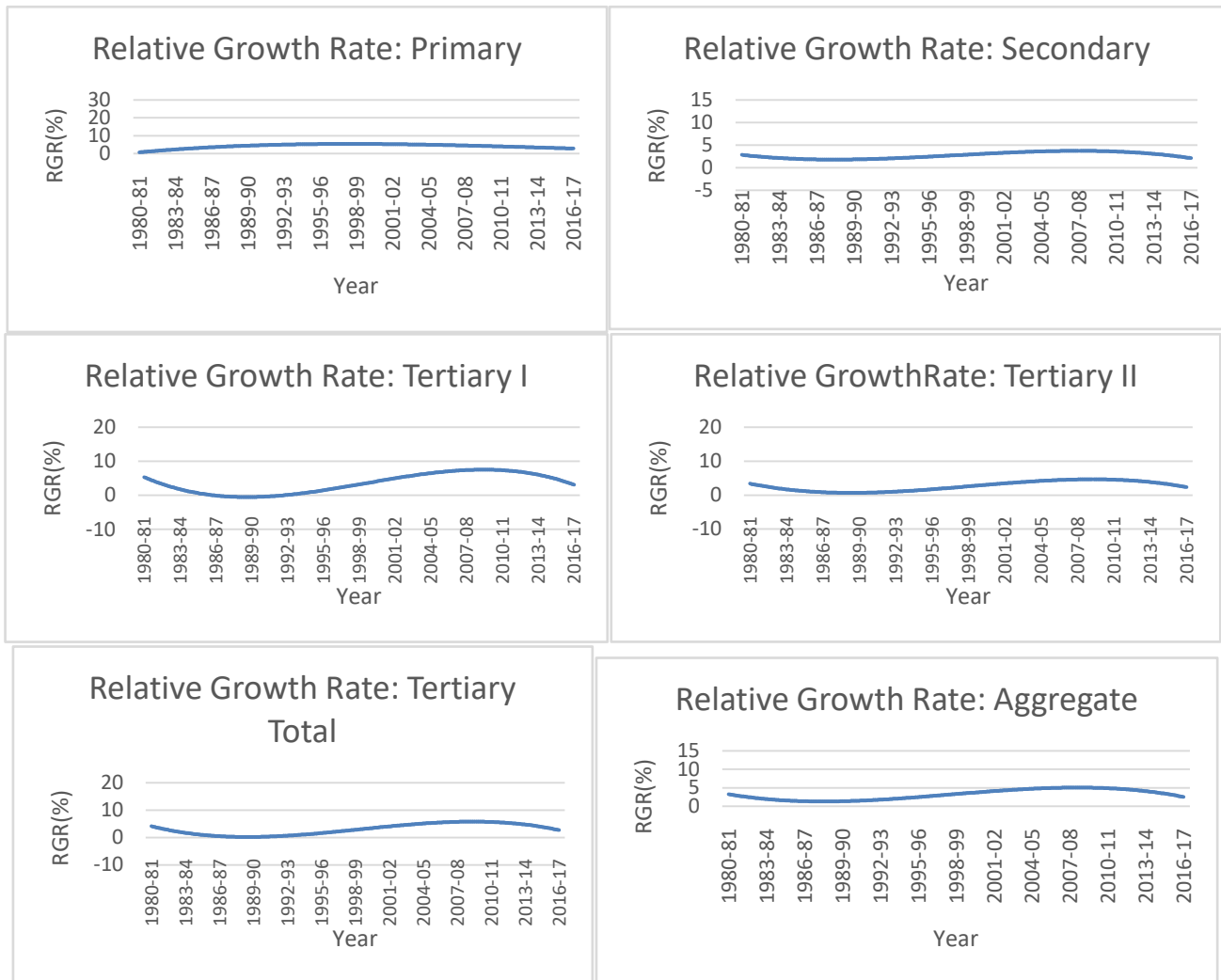
**Table 3. Best Fit Paths in respect of NFCS from various sectors—Bihar**

Sector	Equation of the Best-Fit.	Parameters of the Best-Fit Equation				Co-efficient	D-W Statistic	Index I
		b <sub>0</sub>	b <sub>1</sub>	b <sub>2</sub>	b <sub>3</sub>			
1	2	3	4	5	6	7	8	9
Primary	CUB	1.255	$3.012 \times 10^{-2}$	$6.901 \times 10^{-3}$	$-1.209 \times 10^{-4}$	0.917	1.042	1.078
Secondary	LCB	0.964	$-1.705 \times 10^{-2}$	$6.062 \times 10^{-3}$	$-1.709 \times 10^{-4}$	0.919	1.118	0.769
Tertiary I	LCB	1.016	$1.962 \times 10^{-2}$	$-8.556 \times 10^{-3}$	$-6.923 \times 10^{-4}$	0.926	1.289	0.953
Tertiary II	LCB	0.980	$3.972 \times 10^{-3}$	$4.501 \times 10^{-4}$	$-7.385 \times 10^{-4}$	0.903	1.563	1.139
Tertiary-total	CUB	0.996	$4.798 \times 10^{-3}$	$3.927 \times 10^{-3}$	$-5.512 \times 10^{-5}$	0.909	1.073	1.409
Aggregate	CUB	0.988	$1.498 \times 10^{-3}$	$6.219 \times 10^{-3}$	$-4.827 \times 10^{-5}$	0.901	1.636	1.191

Source: Author’s calculation

### 5. Relative Growth Rates in NFCS

Since the path of best-fit was either cubic or logarithm-cubic in various components of NFCS, either acceleration or deceleration hypothesis was prevalent in respect of growth in NFCS in Bihar at aggregated/disaggregated levels, Relative Growth Rates (RGR<sub>t</sub>) based on estimates of NFCS indicated in Appendix, versus time has been diagrammatically presented in Figure 3.



**Figure 3**

These diagrammatical representations of relative growth rates “RGR<sub>t</sub>” versus time “t” (Figure 3) indicate that the net fixed capital stock in Primary Sector of Bihar had no considerable acceleration but for the occasional bumps, while in Secondary Sector; Tertiary-1 Sector; & Tertiary-2 Sector of Bihar acceleration in growth up to 2005-6 could not be visualized—though apparent rapid acceleration thereafter also declined. Aggregate Net Fixed Capital Stock of Bihar grew almost at constant growth rate up to 2005-6, then with a higher growth rate up to 2011-12 and thereafter had a declining growth.

## 6. Turning Points

Table 4 indicates number of turning points, kinked growth rates and pooled growth rates in various components of NFCS.

**Table 4. Number of turning points, Kinked Growth Rates and Pooled Growth Rates in various components of NFCS**

Sector	Number of Turning Points	Year of Turning Points	Kinked Growth Rates in different segments	Pooled Growth Rates
Primary	2	1989-90, 2002-03	1 <sup>st</sup> Seg.: 3.27 <sup>**</sup> ; 2 <sup>nd</sup> Seg.: 5.31 <sup>**</sup> 3 <sup>rd</sup> Segment: 4.33 <sup>**</sup>	4.28 <sup>***</sup>
Secondary	2	1988-89, 2005-06	1 <sup>st</sup> Seg.: 2.06 <sup>**</sup> ; 2 <sup>nd</sup> Seg.: 2.29 <sup>**</sup> 3 <sup>rd</sup> Seg.: 5.14 <sup>***</sup>	3.24 <sup>**</sup>
Tertiary-1	1	2005-06	1 <sup>st</sup> Seg.: 1.61 <sup>*</sup> ; 2 <sup>nd</sup> Seg.: 13.79 <sup>***</sup>	4.23 <sup>***</sup>
Tertiary-2	1	2005-06	1 <sup>st</sup> Seg.: 1.55 <sup>*</sup> ; 2 <sup>nd</sup> Seg.: 8.63 <sup>***</sup>	3.42 <sup>**</sup>
Tertiary-Total	1	2005-06	1 <sup>st</sup> Seg.: 1.57 <sup>*</sup> ; 2 <sup>nd</sup> Seg.: 10.54 <sup>***</sup>	3.88 <sup>**</sup>
Aggregate	1	2005-06	1 <sup>st</sup> Seg.: 2.28 <sup>**</sup> ; 2 <sup>nd</sup> Seg.: 8.08 <sup>***</sup>	3.68 <sup>**</sup>

Source: Author's calculation

\*: Significant at 5% level; \*\*: Significant at 1% level; \*\*\*: Significant at 0.1% level.

Table 4 reveals that excepting Primary Sector, all other sectors had a turning point in the year 2005-6 that reflected accelerated growth performance. The average annual growth rate of NFCS changed from 2.29% to 5.14% in Secondary sector; 1.61% to 13.79% in Tertiary-1 sector; 1.55% to 8.63% in Tertiary-2 sector; 1.57% to 10.54% in Tertiary-Total sector; and 2.28% to 8.08% in Aggregate. The situation in Primary sector was just the opposite, as the second turning point that occurred in 2000-01 indicated decline in average annual growth rate of NFCS from 5.31% to 4.33%—which may be the result of recurrent wastage of capital stock in this sector due to frequent natural calamities affecting Bihar.

## 7. Conclusion

This paper fulfils the existing gap of non-availability of the estimates of Fixed Capital Stock for Bihar that could measure the extent to which production activity increases wealth and creates the conditions needed to continue the production of goods and services in future by following the standard approach in the literature for the period 1980-2017 and examine long term behavioral growth path therein. An important finding from this study is that Bihar underwent a massive accelerated growth performance in generation of capital stock in Aggregate (8.08% per annum) since occurrence of turning point in 2005-06. Growth of capital stock in Secondary Sector (5.14% per annum) was lower than the overall economy but that in Tertiary Sector (10.54% per annum) specially Transport; Storage & Communication; Trade, Hotel & Restaurant witnessed higher growth pattern since occurrence of turning point in 2005-06. Primary Sector, which has about one-fifth share in capital stock, showed decelerated growth performance since occurrence of turning point in 2000-01. Since capital stock is known to be the engine of growth, decelerated growth performance of primary sector (mainly agriculture in Bihar) and lower growth performance in secondary sector (manufacturing, electricity & construction) is a matter of concern for policy makers in the light of need of strong agriculture sector for Food Security and industrial & infrastructure development. Decelerated trend in capital stock during Twelfth Plan is also a matter of concern for developing economy of Bihar. There is dire need to focus on reorientation of investment planning and strategy.

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**Appendix: Estimates of NFCS in Bihar by main sectors (at 2011-12 prices). (Rs. Crore)**

Year	Primary	Secondary	Tertiary-I	Tertiary-II	Tertiary Total	Aggregate
1980-81	12624.570	29924.446	22374.580	41676.974	64051.554	106600.570
1981-82	12794.556	30047.444	22492.050	42286.436	64778.486	107620.486
1982-83	12956.250	30919.486	23065.580	42970.526	66036.106	109911.842
1983-84	13131.764	31092.236	23335.070	43535.764	66870.834	111094.834
1984-85	13319.716	32562.684	23290.846	44150.754	67441.600	113535.446
1985-86	13499.376	33488.624	23937.622	44500.400	68438.022	115426.022
1986-87	14417.024	34091.176	24396.446	44851.428	69247.874	117756.074
1987-88	15091.440	34936.960	24603.746	45882.400	70486.146	121896.546
1988-89	16643.426	37254.574	24934.044	46429.672	71308.436	125206.436
1989-90	16870.074	37027.926	25504.810	49061.000	74565.810	128463.810
1990-91	19153.138	36682.426	25647.156	49598.598	75245.754	131095.138
1991-92	19317.596	38035.404	25822.670	50857.600	76680.270	134033.270
1992-93	20091.516	39342.776	26057.610	50100.264	76157.874	135583.874
1993-94	20902.750	39214.250	26949.000	51305.368	78254.368	138371.368
1994-95	21882.588	40702.664	26538.546	52464.866	79003.412	141588.664
1995-96	22616.430	40955.570	27287.590	53207.000	80494.590	144066.590
1996-97	23525.786	41533.246	27228.164	54554.450	81782.614	146841.646
1997-98	24471.074	45122.300	27630.326	53907.674	81538.000	151131.374
1998-99	26450.098	46092.464	27926.074	57565.828	85491.902	158034.464
1999-2000	26479.120	46075.880	28766.330	56827.840	85594.170	159531.170
2000-01	33315.874	46513.974	29216.862	56941.164	86158.026	165987.874
2001-02	34178.242	47359.758	29598.294	57477.380	87075.674	168613.674
2002-03	34346.846	48711.354	30115.162	59097.084	89184.606	172270.446
2003-04	35044.756	49257.244	30869.734	59449.494	90319.228	174621.228
2004-05	36678.28	50375.282	32113.534	61239.184	93352.718	180406.280
2005-06	38430.656	54163.344	33375.300	61222.600	94597.900	187191.900
2006-07	39674.456	61706.300	40838.100	68823.600	109661.700	211042.456
2007-08	41193.274	63838.726	44374.638	81883.500	126258.138	231290.138
2008-09	42777.046	67234.300	49130.100	82643.600	131773.700	241785.046
2009-10	46290.090	68415.910	57353.000	95975.754	153328.754	268034.754
2010-11	50517.628	69716.372	64489.648	96878.200	161367.848	281601.848
2011-12	53730.778	71546.140	72458.260	100609.600	173067.860	298344.778
2012-13	55330.887	74516.410	75852.620	102906.732	178759.352	308606.649
2013-14	56841.142	76615.887	78258.262	106609.237	184867.499	318324.528
2014-15	57148.241	78715.615	80884.457	108975.726	189810.183	325674.039
2015-16	58641.826	80122.516	82488.754	111103.124	193591.878	332356.220
2016-17	60416.682	82221.321	84844.457	114301.433	199145.890	341783.893

Source: Authors' calculation.