Multiple Structural Breaks in India's GDP: Evidence from India's Service Sector

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Abstract:

This paper takes a comprehensive investigation into India's service sector, the main growth engine for Indian economy over past two decades. First, the paper deals with the endogenous multiple structural break developed by Bai Perron (1998, 2003). Here both the models of pure and partial structural breaks propounded by Bai and Perron are considered. Second, using the Boyce method (1986) of estimating kinked exponential models for growth rate, the growth rates in different regimes are calculated. Third, the sequential t ratio estimation method due to Banerjee, Lumsdaine and Stock (1992), Zivot Andrews (1992) and extended by Lumsdaine and Pappel(1997) is used. This paper extends the Lumsdaine and Pappel(1997) methodology further to the consideration of three possible breaks in the series.

In this paper, the data used is the components of subsector of services GDP and GDP at constant prices (at 2004-05 prices) at factor cost. The source is based solely from CSO's National Accounts Statistics(NAS), NAS 2004-05 base year back series, between the entire period from 1950-51 to 2009-2010. Using the Bai Perron methodology, there is very little difference in the estimation of the break dates in the pure and the partial break tests. Using the Boyce method, the growth rates are highest mainly the third and fourth regime at the sectoral level and at the aggregate level. Using the methodology used by Banerjee Lumsdaine and Stock (1992) and the extended Lumsdaine Papell test (1997), the presence of unit root in the data, irrespective of the presence of structural break, cannot be negated. The paper concludes with broad four regimes of growth of India's GDP and the corresponding growth of subsectors of services in its process.

Keywords: Endogenous structural breaks, Unit Root, Service sector Growth, Indian economy,

JEL Classifications: C1, C22

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Introduction

India's growth performance has been diverse yet fascinating. From a slow growing nation in the 1950s until 1980s, India moved to a high growth path in terms of real GDP following the initiation of the economic reforms in 1991. Despite serious downturn in recent years due to the onset of global recession, India in recent years has become the second fastest growing nation in the world, second only to China, and this has been continuing systematically over the years. The growth processes in the Indian economy and its change over time, both sectorally and spatially, are major issues of economists and policy makers.

India was designated as an agricultural country with a highest share of agricultural output initially just after independence. In her bid to accelerate economic growth, India introduced in her second five year plan a strategy of heavy-industry led growth, popularly known as the Nehruvian-Mahalanobis strategy. However, a discourse subsequently exists on the phenomenon of services rather than industry accounting for an extraordinary large share of the expansion of non-agricultural output in India. Service sector growth picked up in the 1980s, accelerated in the 1990s, and further accelerated after 2000-01, when it averaged 8.8% per annum. Interestingly, since 2005-06, it has been growing at the rate of 9.8% per annum, though in 2010, it decelerated negligibly due to the onset of global recession. The emergence of services as the most dynamic sector in the Indian economy has in many ways been phenomenal.

This paper takes a comprehensive investigation into India's service sector, the main growth engine for Indian economy over past two decades. This paper is divided into five sections. Section I considers a selective survey of literature regarding India's service sector growth. Section II discusses the overall macro perspective of India's Service Sector Experience. Section III discusses the data used and the method of multiple structural break used by Bai-Perron (1998,2003) and the corresponding unit root tests used by the sequential t ratio estimation by Banerjee, Lumsdaine and Stock (1992) and Zivot and Andrews (1992) extended by the Lumsdaine and Papell (1997). Section IV gives a detailed interpretation of the results of the tests

on structural change in India's service sector growth. Section V summarises the conclusion of the study.

Section I: A Selective Literature Survey on Service Sector Growth in India

The standard format of change during economic development, as suggested by development theorists, has been movements from the primary to secondary to tertiary sector activities. In common parlance, the activities of the primary and secondary sectors is described respectively as extractive and transformative in nature. All remaining diverse residual activities are grouped together under tertiary sector. Since the most common feature of this sector is, that they do not result in any material product, they are defined as services.

As economy develops, the share of agricultural sector reduces and manufacturing increases, and at a later stage, the share of service activities expands. In the process of economic growth, Kaldor (1967) suggested that manufacturing sector is the engine of growth, as the potential for productivity growth is highest in this sector. He provided the theoretical rationale for the patterns of structural change that Kuznets (1955) had observed in the case of advanced countries during the process of their economic development. Kuznets (1966) also suggested on the basis of the empirical evidences from developed countries that tertiary sector expands in relative terms only after the secondary sector has already acquired dominance both in terms of value-added and work-force in the process of rapid industrialization. When the relative size of industry predominate the other sectors, the tertiary sector then acquires significance in value-added and work-force composition. As the consumption demand for commodities gets saturated, after a considerable rise in per capita income originating from the commodity-producing sector, the demand for services increases. But in context of developing countries, the phenomenon of a relatively large tertiary sector could be evident much before the secondary sector could acquire a reasonable size of at least one-third in terms of value added or work force.

It is comparatively easy to analyse the shift in favour of the tertiary sector in context of developed countries as a standard transition of development theory (following the rapid progress in industrialization, the demand for several services grows faster, which in turn reduces the share of the secondary sector in the total product of the economy). But in case of developing countries,

the dominance of tertiary sector before the secondary sector's relative size could outweigh that of other sectors, gives rise to several concerns. Though it is relatively easy to build a theory of development, it becomes extremely difficult to categorise services because of its diverse and heterogeneous nature.

According to traditional development theory, share of services in GDP is supposedly linked with development of the country. From an analytical point of view, the contribution of tertiary sector to the overall economic growth has been criticized by numerous economists. However, there were several others who emphasize its importance, particularly observing the recent trend in the tertiary sector's growth and the expansion, especially in the post globalization period in India. In India, some paradoxical developments are observed due to a rapid transition from agriculture to services with industry lagging behind. Many studies have engaged to explain this paradox. A recent study done by the World Bank by Gordon and Gupta (2004) suggested that in the last 10 years, the growth of GDP has been largely substantiated by the growth of the service sector. The studies were pursued in the Indian context started with Bhattacharya and Mitra, (1989), (1990), (1991) and (1997), Datta, (1989) and Mitra, (1989). Some of the subsectors within the tertiary sector, which are crucial for the growth of industry and the rest of the economy, like transport, storage and communication, and financial and business services, have been expanding during this period. Hence, the question arises whether services can play the engine of growth?

Bhattacharya and Mitra (1989) stated that higher the discrepancy between the industry and agriculture growth, the higher is the growth of services across Indian states, implying that higher levels of per capita income originating from industrialisation leads to higher demand for services. In a later work Bhattacharya and Mitra (1990) argued that a wide disparity arising between the growth of income from services and commodity producing sector tends to result in inflation. This is particularly so if the tertiary sector value added expands because of rising income of those who are already employed and not due to income accruing to the new additions to the tertiary sector work force. In other words, if expansion in value added and employment generation both take place simultaneously within the tertiary sector, there will be a commensurate increase in demand for food and other essential goods produced in the manufacturing sector. However, if the expansion of the tertiary sector results only from the rise

in income of those who are already employed in this sector, the additional income would create demand for luxury goods and other imported goods since the demand for food and other essential items has already been met (Bhattacharya and Mitra, 1989, 1990).

Using data on a cross section of developed and developing economies over the period from 1950-2005, Eichengreen and Gupta (2009) identified two waves of service sector growth: first wave as a country moves from 'low' to 'middle' income status, and second wave as it moves from 'middle' to 'high' income status. According to them, the first wave primarily consists of traditional services, whilst the second wave comprises modern services. The greater importance of the second wave from middle income to higher income countries is observed to be more evident in economies which are relatively open to trade.

Moreover, in the literature on structural break in India's GDP, several studies like Nagraj (1990), (1991), Dholakia (1994), Panagaria (2004), Wallack (2004) Nagraj (2006), Nayyar (2006), Balakrishnan & Permeshwaran (2007, 2007a), Dholakia (2007), Dholakia & Sapre (2011) attempted to examine the question of structural breaks in the long-term trend growth of the Indian economy at an aggregate and sectoral level. The identification of structural breaks in the growth path is essential for analysing the changes and for evaluating the impact of shifts in policy regimes in the economy. The results of these studies have established on some specific break dates and hence there has been a disagreement about the impact of the shifts in policy regime in the country.

In recent times, there has been much discussion about the trend break in India's growth rate of GDP (DeLong, 2003; Wallack, 2004; Rodrick and Subramanian, 2004; Virmani, 2004; Sinha and Tejani, 2004). DeLong (2003) argued that the growth rate accelerated from the traditional 'Hindu' growth rate during the rule of the Rajiv Gandhi-led Congress government in the mid-1980s. This, he associated with the economic reforms that took place during Rajiv Gandhi's tenure. Wallack (2004) makes an attempt to econometrically determine the dates on which shifts in the growth rate could have taken place. As far as GDP growth is concerned, she finds that 1980 was the most significant date for the break, whereas the break in GNP growth took place in 1987. She finds a significant break in the trade, transport, storage and communication growth

rate in 1992, but fails to find statistically significant break dates for the primary and secondary sectors as well as public administration, defence and other services. Pangariya (2004), countering DeLong, argues that the growth in the 1980s was fragile and unsustainable. On the other hand, the more systematic and systemic reforms of the 1990s gave rise to more sustainable and stable growth. Sinha and Tejani (2004) argue that the period around 1980-81 marked the break in growth in India's GDP. They argue that the major factor behind the growth in the 1980s was improvements in labour productivity, propelled by imports of higher quality machinery and capital goods. All the above papers implicitly contain an evaluation of economic policy from independence to the onset of economic reforms at some date, even though authors differ about the specific dates. Some, like Pangariya, would like to place the beginning of reforms in the 1990s, while others like Sinha and Tejani would extend it backwards to the early 1980s. The general evaluation of economic policy between 1951 and the author-specific trend break date is overall pessimistic, with the possible exception of DeLong (2003).

As stated earlier, macroeconomists in India have generally not taken into account structural breaks in various time series including all aggregate macro variables. However, for some important series like growth in real GDP, there has been a discussion regarding the timing of the structural break. One contention is that there was a structural break in 1980-81 in the case of India's aggregate real GDP. There are studies that have dated the break dates differently. DeLong (2003) argues that the growth rate accelerated from the traditional "Hindu" growth rate during the mid-1980s. Wallack (2004) finds that for GDP growth, 1980 was the most significant date for the break. A significant break in the trade, transport, storage and communication growth rate happened in 1992, but no break for the primary and secondary sectors. Rodrick and Subramanian (2004) computed, using the procedure described in Bai and Perron (1998, 2003), the optimal one, two, and three break points for the growth rate of four series: per capita GDP computed at constant dollars and at PPP prices, GDP per worker, and total factor productivity. In all four cases, they find that the single break occurs in 1979. Panagariya (2004) has found that the reforms of the 1990s gave rise to more sustainable and stable growth. He points to the large annual fluctuations in growth rates in the 1980s compared to smaller fluctuations in the 1990s, as evidence in support of his 'unsustainability' argument. Balakrishnan and Parmeswaran (2007) identify 1979-80 as the single break date for GDP. For different sectors individually also break

dates have been specified. Srivastava et al., (2009) identified structural breaks in most macroeconomic series in India. Dholakia and Sapre (2011) argues that use of different sample periods and different values of "h" can lead to different break dates and endogenous determination of break dates using the Bai-Perron methodology may not necessarily lead to unique answers. 1978 was the only common break date with different values of h. These are the highlights of the survey on literature on structural break of economic growth in India.

Section II: India's Service Sector Experience: Overall Macro Perspective

A striking feature of India's growth performance over the past decade has been the strength of the service sector. The preponderance of services over industry is not a recent phenomenon for the Indian economy but has been in place since the beginning of the 1950s. A debate subsequently exists on the phenomenon of services rather than industry accounting for an extraordinary large share of the expansion of non-agricultural output in India. However, broadly three major turning points of growth rates has been referred to and questioned by various economists over time. The first one is associated with independence and the transition from the colonial era to the "Hindu rate of growth". The slow Indian growth rate is better attributed to the Government of India's rigid interventionist policies and it is from this modern economic growth in India is described. The second turning point is around 1980, after which the Indian economy appears to have moved to a higher trend growth of 5.5-6% per annum. However, the early 1990s brought with it the third turning point with growth rates ranging from 8-9%. In this paper the focus is on these turning points of growth, suggesting that these growth patterns were different resulting from the pattern of structural change in output in these periods.

As discussed in the preceding section, when the role of services in Indian growth became quite huge, it was described as "disproportionality" or "excess growth of services" (Bhattacharya & Mitra, 1989, 1990, 1991). Later, the term coined was "services revolution" (Gordon & Gupta, 2004). The phenomenon provoked a lot of debate regarding the determinants explaining it and its long-term sustainability (Papola, 2006; Banga,2005; Joshi, 2004). All these resulted to the question: *"Is India revolutionising a new pattern of growth where services can play the role engine of growth, just like the same role played by industry for other countries in the past?"*

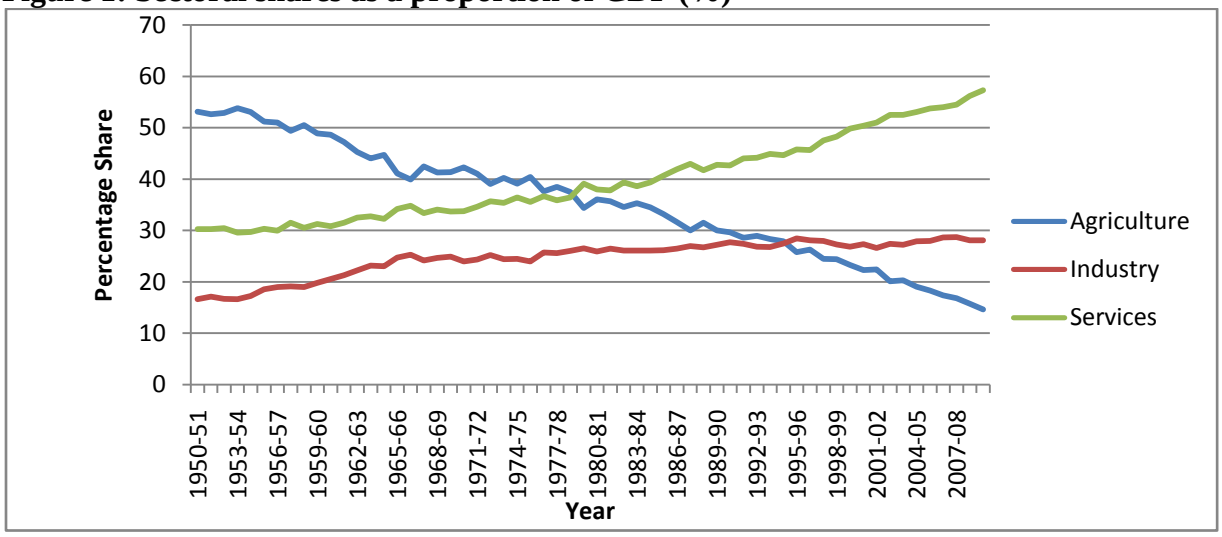
With all these controversies and different points of view, there is very little doubt that this outstanding growth of services makes the structural change in India different and special similar to few other developing nations of the world. The most important feature is the premature nature of the transition to a services dominated economy at an exceptionally low level of per capita income before attaining a higher level of industrialisation.

This section takes into consideration the sectoral shares and growth of different components of GDP. The data sources used is based solely from Central Statistical Organisation's National Accounts Statistics (NAS), 2004-05 base year series, NAS2011, NAS 2008 and 2009 and the NAS 2004-05 base year back series, between the entire period from 1950-51 to 2009-2010.
The analysis of structural change in output is based on the division of economy in to agriculture-industry-services. The demarcation of the industrial sector from the services sector, has again led to certain debates. Thus, while Kuznets (1957) included transport and communication in industry, Clark (1940)put even construction in services. The general practice, however, is to include construction in industry, along with mining and quarrying, and manufacturing, and all other non-agricultural activities including transport and communication in services. The choice of classification scheme is important because it can affect the conclusions one draws about the pattern of structural changes accompanying growth. However, without going into much of debate, the usual definition drawn by the Central Statistical Organisation (CSO) is used as a standard practice.

An overall macroeconomic view of India's GDP at the broad level reveals that the share of the service sector in GDP has shown a considerable and persistent increase in India since independence. The analysis of the sectoral composition of GDP for the period 1950-2010 brings out the fact that there has taken place 'tertiarisation' of the structure of production in India. During the process of growth over the years 1950-51 to 2009-2010, the Indian economy has experienced a change in production structure with a shift away from agriculture towards industry and service sector. Figure 1 gives a clear representation of the percentage share of the contribution of agriculture, industry and services as a proportion to real GDP at 2004-05. Agriculture has declined drastically over the years (around 55% in 1950-51 to 15% in 2009-10); industry has risen but not substantially (from around 15% in 1950-51 to 27% in 2009-10), while

services contributed enormously during this period (29% in 1950-51 around 58% in 2009-10). During the 1950's it was the primary sector which was the dominant sector of the economy and accounted for the largest share in GDP. However the whole scenario changed subsequently, and especially in the 1980's, the service sector emerged as the major sector in the economy in terms of production share in the 1990s and thereafter.

Figure 1: Sectoral shares as a proportion of GDP (%)



Source: Handbook of Statistics on Indian Economy, Reserve Bank of India
National Accounts Statistics, Central Statistical Organisation
Note: The contribution of sectoral shares as a percentage of GDP is taken at factor costwith 2004-05 as base year.

When the annual growth rate of GDP at factor cost at 2004-05 prices and that of services are calculated, it is evident that both the services sector growth and GDP growth has more or less increased over time. It is definitely observed that the service sector growth has outpaced aggregate GDP growth in almost all successive years from 1950-51 to 2009-10 (Table 3.1).Thus the growth of the services sector in India may be considered to have shown an enormous rise since the mid-1980s and subsequently increased by leaps and bounds thereafter in the post globalisation era.

The service sector emerged as the major sector of the economy both in terms of growth rates as well as its share in GDP in 1990s. Going back to the growth performance of Indian economy since independence, the agricultural sector showed an acceleration during the initial years after independence and continued till the 1980s, but then decelerated, while the industrial sector

displayed an early expansion followed by a stagnation during the mid-1960s and did not just speed up over the years. It is to be noted here that while agriculture and manufacturing sectors have experienced phases of deceleration, stagnation and growth, the service sector has shown a uniform increasing growth trend during the period 1950-51 to 2009-2010.

Table 1: Share of agriculture, industry, services in GDP and decadal growth rates

Year	1950-51 Share in GDP	1960-61 Share in GDP (Average Decadal Growth)	1970-71 Share in GDP (Average Decadal Growth)	1980-81 Share in GDP (Average Decadal Growth)	1990-91 Share in GDP (Average Decadal Growth)	2000-01 Share in GDP (Average Decadal Growth)	2009-10 Share in GDP (Average Decadal Growth)
Agriculture	55.28	50.81 (2.55)	44.31 (2.51)	37.92 (1.26)	31.37 (4.41)	23.89 (3.24)	15.68 (2.42)
Industry	15.08	18.75 (5.15)	22.10 (6.47)	24.04 (3.64)	25.92 (5.97)	25.80 (5.64)	26.78 (7.85)
Services	29.64	30.43 (3.71)	33.59 (4.84)	38.04 (4.44)	42.71 (6.53)	50.31 (7.28)	57.53 (8.80)
GDP	100	100 (3.30)	100 (4.00)	100 (2.91)	100 (5.62)	100 (5.68)	100 (7.22)

Source: Handbook of Statistics on Indian Economy, Reserve Bank of India
National Accounts Statistics, Central Statistical Organisation

Note: The contribution of sectoral shares as a percentage of GDP is taken at factor cost with 2004-05 as base year.

India's service sector growth has been stable enough and continuously above overall GDP growth, pulling up the latter since 1997-98. According to the Economic Survey, 2010-2011, the ratcheting up of the overall growth rate (compound annual growth rate [CAGR]) of the Indian economy from 5.7 per cent in the 1990s to 8.6 per cent during the period 2004-05 to 2009-10 was to a large extent due to the acceleration of the growth rate (CAGR) in the services sector from 7.5 per cent in the 1990s to 10.3 per cent in 2004-05 to 2009-10. The services sector growth was significantly faster than the 6.6 per cent for the combined agriculture and industry sectors annual output growth during the same period.

To analyse what are the reasons behind the enormous increases in the amount of services, it becomes necessary to identify the performance of each individual subsector of service and their contribution towards this service revolution. Some services have been particularly important for this improving performance in India. Software is one sector in which India has achieved a remarkable global brand identity. Tourism and travel related services and transport services are also major items in India's services. Besides these, the potential and growing services include many professional services, infrastructure related services, and financial services.

The emergence of services as the most dynamic sector in the Indian economy has in many ways been a revolution. The various subsectors that comprises of the services sector, their respective share in services GDP, their average annual growth rates gives us an illustration of which of the subsector of services is growing fast and which isn't. In India, the national income classification given by Central Statistical Organisation is followed. In the National Income Accounting in India, service sector includes the following:

(1) Trade, hotels and restaurants (THR)

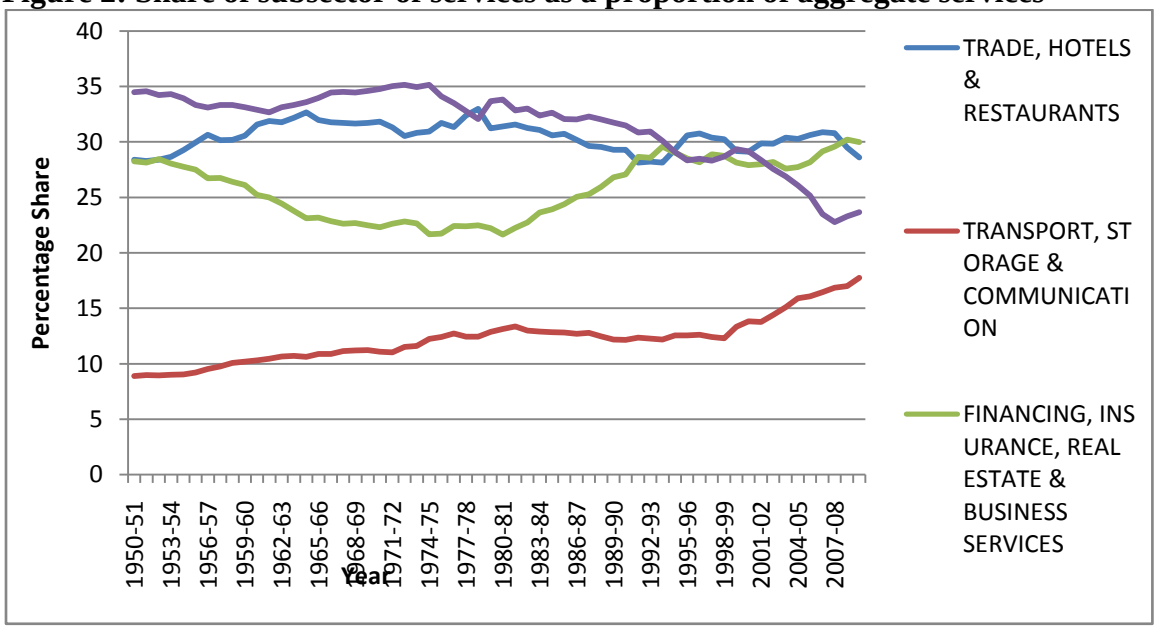
(2) Transport, storage and communication

(3) Financing, Insurance, Real Estate and Business Services

(4) Community, Social and Personal services

It is observed from Figure 2 that almost all broad sub sectors have grown over time, but the pick-up was high in financing, insurance, real-estate and business services followed by trade, hotels and restaurants. There has been an increase in the transport, storage and communication but the community, social and personal services have remained stagnant.

Figure 2: Share of subsector of services as a proportion of aggregate services



Source: Handbook of Statistics on Indian Economy, Reserve Bank of India
National Accounts Statistics, Central Statistical Organisation.

Note: The sectoral share of sub-services as a proportion to services is taken at factor cost with 2004-05 as base year.

A clearer view is observed when we consider the share of the subsectors of services in services GDP at factor cost at 2004-05 prices. Figure 2 shows that the share of subsectors like trade hotel and restaurants have remained more or less consistent over the period from 1950-51 to 2009-10. The share of transport, storage and communication has increased many fold i.e from 8.88% in 1950-51 to 17.73% in 2009-10. The share of financing, real estate have increased over the period under consideration with a decrease somewhere in between, but it has captured almost 30% share of the service sector over the years. The share of community, social and personal services, however, has shown a considerable decrease over the concerned period. It has somewhat decreased from 35% from 1950-51 to 23% in 2009-10. This sector which happened to be the main foundation of service sector mainly growth of services during the 1950s happened to have lost its importance in terms of productivity especially during the post-globalisation era.

The share of subsectors in aggregate GDP like transport, storage and communication and banking, insurance and business services have increased substantially. These two broad subsectors are considered as the modern dynamic components of India's service sector. The other two sectors like trade, hotel and restaurants and community, social and personal services have shown in decrease in its share in aggregate GDP. These two subsectors are generally defined as the traditional components of services. The dyanamic components are primarily instrumental in the growth of India's service sector, while these traditional components somewhat donot influence much to the growth of India's service sector.

Table 2: Share of Subsector of services in India's services GDP and aggregate GDP

Sector	1970-71 Share in Services GDP (Share in GDP) {Average Annual Decadal Growth Rate}	1980-81 Share in Services GDP (Share in GDP) {Average Annual Decadal Growth Rate}	1990-91 Share in Services GDP (Share in GDP) {Average Annual Decadal Growth Rate}	200-01 Share in Services GDP (Share in GDP) {Average Annual Decadal Growth Rate}	2009-10 Share in Services GDP (Share in GDP) {Average Annual Decadal Growth Rate}
Trade, Hotel, Restaurants	31.84 (10.5) {5.18}	31.42 (11.89) {4.31}	29.29 (12.4) {5.93}	29.19 (14.55) {7.48}	28.60 (16.39) {8.22}
Transport, Storage, Communication	11.08 (3.6) {5.83}	13.12 (4.93) {5.84}	12.17 (5.18) {6.04}	13.32 (6.64) {7.49}	17.73 (10.16) {13.17}
Banking, Insurance and Business Services	22.29 (7.41) {3.21}	21.6 (8.1) {4.31}	26.79 (11.41) {8.67}	28.12 (14.02) {8.05}	29.97 (17.17) {9.23}

Community, Social and Personal services	34.77 (11.56) {5.24}	33.81 (12.73) {4.13}	31.73 (13.51) {5.90}	29.35 (14.63) {6.46}	23.68 (13.56) {6.77}

Source: Handbook of Statistics on Indian Economy, Reserve Bank of India
National Accounts Statistics, Central Statistical Organisation.
Note: The share and growth of subsector of services in services and GDP is calculated with 2004-05 as base year.

The service sector has been in the driver's seat of the engine of growth registering CAGR of 8% in the last seventeen years, which has been mainly contributed by the financing, insurance, real estate and banking services (FIRB) and transport, storage and communication sectors (TSC).But the rate of growth of various subsectors expectedly reveal that financial services shows the fastest rate of growth, followed rather closely by trade, hotels and restaurants. The rate of growth in transport, storage and communication sector, though not very high shows a major hike 2001-2002 onwards. Community and personal services (CSP) shows the lowest rate of growth among the subsectors of services. The growth of these segments has been the result of opening of trade, liberalisation policies of the government, and increased disposable income in the hands of the people and changing consumer attitude and lifestyle.

However, these broad macroeconomic data though provides for more than a somewhat cursory supposition of the forces at work and certainly do not make a definitive statement on the nature of services growth. Therefore, a detailed analytical research is required to examine the forces involved in such a high growth in the service sector in India especially in the post liberalisation era.

Section III: Methodology of determination of Multiple Structural Breaks

It is now a standard practice to verify the stationary property of time series data before analysis. Therefore it is appropriate to examine whether the series is stationary or not with the help of unit root test. There are a number of methods of unit root tests, namely Dickey-Fuller test, Augmented Dickey Fuller test, Phillips Perron test, etc. all of which have become very popular and important. But it needs to be mentioned at this point that there has been increasing trend in improving the methodology of unit root test as well. For instance, Perron (1989) shows that the test of unit roots that do not follow a structural break, if there is instead structural break(s), are

biased in favour of non-stationarity. Therefore it is necessary to examine whether any structural break is present in the series.

The three steps involved in the whole exercise of estimating the time trend of services. First, the structural break test has been tested for the data series on services following the methodology suggested by Bai and Perron (1998). Then the presence of unit root with structural break including the break point has been tested using the methods suggested by Banerjee, Lumsdaine and Papell (1992) and Lumsdaine and Stock (1997). Finally the trend growth rate of GDP, services and sub-sectoral services are estimated using the Boyce (1986) method in various sub-periods.

Test for structural Break: Bai-Perron Test

Both the statistics and economics literature contains a vast amount of work on the issues related to structural change, most of it specifically designed for the case of a single change. But most macroeconomic time series usually can contain more than one structural break. The econometrics literature has witnessed recently an upsurge of interest in extending procedure to various models with unknown breakpoint. With respect to the problem of testing for structural change, recent contribution include the treatment by Andrews (1993a, 1993b), Andrews, Lee, & Ploberger (1994, 1996) and Bai and Perron (1998,2003). In this section, the Bai and Perron (1998) method in order to examine if there are any structural break in the series. To that effect, Bai and Perron (1998) recently provide a comprehensive analysis of several issues in the context of multiple structural change models and develop some tests which preclude the presence of trending regressors. This test is helpful in the changes present and also it endogenously determines the points of break with no prior knowledge.

The details of the methodology on structural break may be found in Bai and Perron (1998). We consider the following linear regression with m breaks (m+1 regime):

$$y_t = x_t' \beta + z_t' \delta_j + \mu_t, t = T_{j-1}, \ldots\ldots\ldots\ldots T \qquad 1$$

(j=1,……,m+1, T_0=0 and T_{m+1}=T)

where y_t is the observed dependent variable, $x_t \in \Re^p$ and $z_t \in \Re^q$ are vectors of covariates, β and δ_j are the corresponding vectors of coefficients with $\delta_i \neq \delta_{i+1} (1 \leq i \leq m)$ and μ_t is the error term at time *t*. The break dates $(T_1, \ldots, T_m)$ are explicitly regarded as unknown. It may be noted that this is a partial structural change model insofar as β doesn't shift and is effectively estimated over the entire sample. Then the purpose is to estimate the unknown regression coefficients and the break dates, that is to say $(\beta, \delta_1, \ldots\ldots \delta_{m+1}, T_1, \ldots, T_m)$, when T observations on (y_t, x_t, z_t) are available. Note that this is a partial change model in the sense that β is not subject to shifts and is effectively estimated using the entire sample.

Bai and Perrron (1998) built a method of estimation based on the least square principle. For an m-partition $(T_1, \ldots, T_m)$, denoted $\{T_j\}$, the associated least square estimator of δ_i is obtained by minimizing the sum of squared residuals $\sum_{i=1}^{m+1} \sum_{t=Ti-1}^{Ti} [y_t - x_t' \beta + z_t' \delta_j]^2$

under the constraint $\delta_i \neq \delta_{i+1} (1 \leq i \leq m)$. Let $\hat{\delta}(\{T_j\})$ be the resulting estimate. Substituting it in the objective function and denoting the resulting sum of squared residuals as $S_T(T_1,\ldots,T_m)$, the estimated break dates $(\hat{T}_1, \ldots\ldots \hat{T}_m)$ are such that

$$(\hat{T}_1, \ldots\ldots \hat{T}_m) = \arg \min_{T_1 \ldots\ldots T_m} S_T(T_1, \ldots\ldots Tm) \quad (2)$$

where the minimisation is taken over all partitions $(T_1, \ldots, T_m)$ such as $T_i - T_{i-1} \geq [\varepsilon T]$. The term $[\varepsilon T]$ is interpreted as the minimal number of observations in each segment. Thus the breakpoint estimators are global estimators are global minimisers of the objective function. Finally, the regression parameter estimates are obtained using the associate least-squares estimates at the estimated m-partition, $\{\hat{T}_j\} i, e. \hat{\delta} = \hat{\delta}(\{\hat{T}_j\})$

The Test Statistics

Several tests for structural change have been proposed in the econometrics literature. These tests can be classified into two groups: a) tests for single structural change; and b) tests for multiple structural breaks. Here the focus is on multiple structural breaks. In this context, Bai and Perron

(1998) consider estimating multiple structural changes in the linear model and developed three tests.

Test of Structural Stability versus an Unknown Number of Breaks

Bai and Perron (1998) also consider tests of no structural change against an unknown number of breaks given some upper bound M for m. The following new class of tests is called double maximum tests and is defined for some fixed weights $\{a_1 \ldots\ldots\ldots\ldots a_m\}$ as

$$D\max F_T(M, q, a_1, \ldots\ldots\ldots\ldots a_M) = \max_{1\le m\le M} a_m \sup_{(\lambda 1,\ldots\ldots\ldots \lambda m)\in \Lambda\varepsilon} F_T(\lambda_1,\ldots\ldots\ldots \lambda_M : q)$$

$$= \max_{1\le m\le M} a_m F_T(\hat{\lambda}_1,\ldots\ldots\ldots \hat{\lambda}_M : q) \quad 3$$

The weights $\{a_1 \ldots\ldots\ldots a_m\}$ reflect the imposition of some priors on the likelihood of various numbers of structural breaks. Firstly, they set all weights equal to unity, i.e. $a_m=1$ and label this version of the test as $UDmaxF_T(M,q)$. Then they consider a set of weights that the marginal p-values are equal across values of *m*. The weights are then defined as $a_1=1$ and $a_m= c(q, \alpha, 1)/c(q, \alpha, m)$ for $m>1$, where α is the significance level of the test and c(q, α, m) is the asymptotic critical value of the test $\sup F_T(\lambda_1,\ldots\ldots\ldots \lambda_n : q) \in \Lambda_\varepsilon F_T(\lambda_1,\ldots\ldots\ldots \lambda_n : q)$. This version of the test is denoted as $WD\ maxF_T(M, q)$.

A Sequential Test

The last test developed by Bai and Perron (1998)is a sequential test of *l* versus *l*+1 structural change:

$$\sup F_T(l+1/l) = \{S_T(\hat{T}_1,\ldots\ldots\ldots \hat{T}_l) - \min_{1\le i\le l+1} \inf_{\tau\in\Lambda_{i,\eta}} S_T(\hat{T}_1,\ldots\ldots, \tau, \hat{T}i_{-1},\ldots\ldots\ldots\ldots\ldots\ldots .\hat{T}_l)\} / \hat{\sigma}^2 \quad 3.4$$

where,

$$\Lambda_{i,n} = \{\tau; \hat{T}_{l-1} + (\hat{T}_l - \hat{T}_{l-1})\eta \le \tau \le \hat{T}_l + (\hat{T}_l - \hat{T}_{l-1})\eta\},$$

$S_T(\hat{T}_1,\ldots\ldots, \hat{T}i_{-1}, \tau, \hat{T}_i \ldots\ldots\ldots\ldots\ldots\ldots .\hat{T}_l)$ is the sum of squared residuals resulting from the least squares estimation from each m-partition $(T_1,\ldots\ldots\ldots\ldots..T_m)$ and $\hat{\sigma}^2$ is a consistent estimator of σ^2 under the null hypothesis.

The asymptotic distributions of these three tests are derived inBai and Perron (1998) and the asymptotic critical values are tabulated in Bai and Perron (1998, 1993) for ε = 0.05 (M=9), 0.10 (M=8), 0.15(M =5), 0.20(M=3), and 0.25 (M=2).

Selection Procedure

A preferred strategy to determine the number of breaks in a set of data is to first look at the *UDmaxF_T(M,q)* test to see if at least a structural break exists. The number of breaks can then be decided based upon an examination of the supF_T (*l*+1/*l*) statistics constructed using the break date estimates obtained from a global minimisation of the sum of squared residuals (i.e. m breaks are selected such that the tests supF_T (*l*+1/*l*) are non-significant for any *l*>*m*). Bai and Perron (2003) conclude that this method leads to the best results and is recommended for empirical applications. Further if the estimation allows for a change in all the parameters i.e. the intercept and the slope it is said to be a pure structural break model.

Kinked Exponential Models for Growth Rate Estimation

Next, after having determined the breakpoints by the Bai and Perron (1998) test, the calculations of the sub-period growth rates are examined using the kinked semi-logarithmic trend equation used by Boyce (1986). The usual technique for estimating growth rates in the sub-periods of a time series is to fit separate exponential trend lines by ordinary least squares to each segment of the series. These trend lines are likely to be discontinuous, which can result in anomalies such as sub-period growth rates which can exceed, or are less than, the estimated growth rate for the period as a whole. Discontinuities between segments of a piece-wise regression can be eliminated via the imposition of linear restrictions. In the case of log-linear models, such an approach yields kinked exponential functions which provide a better basis than conventional estimates for intertemporal and cross-sectional growth rate comparisons. Kinked exponential models with one, two and multiple kink points are derived. These can be easily estimated with standard OLS regression packages by using composite independent variables.

For the generalized kinked exponential model for *m* sub-periods and *m - 1*kinks. Let the kink points be denoted as $k_1,\ldots\ldots,k_{m-1}$, and the sub-period dummy variables as $D_1,\ldots\ldots,D_m$. The unrestricted model for joint estimation of the sub-period growth rates, with no continuity requirement imposed, is given by,

$$\ln y_t = a_1 D_1 + a_2 D_2 + \ldots\ldots\ldots + a_m D_m + (\beta_1 D_1 + \beta_2 D_2 + \ldots\ldots\ldots + \beta_m D_m)t + u_t. \qquad 5$$

Appling the appropriate *m-1* linear restrictions,

$$a_i + \beta i k i = a_{i+1} + \beta_{i+1} k i. \qquad 17$$

$$\text{for} \quad \text{all } i = 1,2,\ldots\ldots,\ m-1 \qquad (6)$$

we obtain the generalized kinked exponential model:

$$\ln y_t = a_1 + \beta_1(D_1 t + \sum_{j=1}^{m} D_j k_1) + \beta_2(D_2 t - \sum_{j=2}^{m} D_j k_1 + \sum_{j=3}^{m} D_j k_2) \ldots\ldots\ldots$$
$$+ \beta_i(D_i t - \sum_{j=i}^{m} D_j k_{i-1} + \sum_{j=i+1}^{m} D_j k_i) + \ldots\ldots\ldots + \beta_m(D_m t - D_m k_{m-1}) + u_t. \qquad (7)$$

The number of sub-periods into which a given time series can be meaningfully partitioned will vary from case to case, depending upon such considerations as the amount of instability, the presence of cyclical fluctuations and the a priori grounds for expecting growth rates to change. The single-kink and two-kink models can be readily derived as special cases.

For two breaks double kink semi-logarithmic trend equation is given by,

$$\ln y_t = a_1 + \beta_1(D_1 t + D_2 k_1 + D_3 k_1) + \beta_2(D_2 t - D_2 k_1 - D_3 k_1 + D_3 k_2) + \beta_3(D_3 t - D_3 k_3) + u_t. \qquad (8)$$

where D_i for all i = 1,2,3 is a dummy taking a value 1 in the i^{th} subperiod and 0 otherwise, K_1 and K_2 are the time points respectively at which the structural breaks have supposedly occurred.

For 3 breaks, the triple kink semi-logarithmic trend equation is given by,

$$\ln y_t = a_1 + \beta_1(D_1 t + D_2 k_1 + D_3 k_1 + D_4 k_1) + \beta_2(D_2 t - D_2 k_1 - D_3 k_1 - D_4 k_1 + D_3 k_2 + D_4 k_3)$$
$$+ \beta_3(D_3 t - D_3 k_2 - D_4 k_2 + D_4 k_3) + u_t. \qquad (9)$$

where D_i for all i = 1,2,3,4 is a dummy taking a value 1 in the i^{th} sub-period and 0 otherwise, K_1, K_2 and K_3 are the time points respectively at which the structural breaks have supposedly occurred.

Based on this method, the sub period growth rates of services and subsector of services are calculated. The novelty of this approach of calculating growth rates is that it not only uses the break points years but also uses the time points where the structural breaks have occurred.

Unit Root Test

Unit root tests are based on the implicit assumption that the deterministic trend is correctly specified. Unit root tests, namely DF test, ADF test, PP test, etc are important but there has been increasing trend in improving the methodology of unit root test as well. Nelson and Plosser (1982) found evidence that in favour of unit root hypothesis for 13 out of 14 long-term annual macro series. Perron(1989) suggested that the observed unit root behaviour have been a failure to account for any structural break in the data. Perron(1989) argued that if there is a break in the deterministic trend, the unit root test's results are misleading, i.e., under the break the unit root tests can treat trend stationary process as a difference stationary process. Perron(1989) develops a method of test of unit roots in the presence of structural break. The analysis was done with an exogenous break. Accordingly, he challenged the findings of Nelson and Plosser (1982) and he reversed the Nelson and Plosser conclusions of 10 f the 11 series. Perron's paper started a controversy about the effect of trend breaks on unit root tests and again his study was criticized on the ground that he assumed the break point to be known.

The presence of a unit root in each of the macroeconomic series is tested using the Augmented Dicky and Fuller (1979) test. The ADF test constructs a parametric correction for higher-order correlation by assuming that the series follows an AR(k) process and adding lagged difference terms of the dependent variable to the right-hand side of the test regression:

$$\Delta y_t = c + \alpha y_{t-1} + \sum_{j=1}^{k} d_j \Delta y_{t-j} + \varepsilon_t \qquad 10$$

$$\Delta y_t = c + \alpha y_{t-1} + \beta t + \sum_{j=1}^{k} d_j \Delta y_{t-j} + \varepsilon_t \qquad 11$$

Equation (10) tests for the null of a unit root against a mean-stationary alternative in y_t where y refers to the time series examined and Equation (11) tests the null of a unit root against a trend-stationary alternative. The term $\Delta y_{t-j}$is introduced as lagged first differences to accommodate serial correlation in the errors. The lag length through the 't sig' approach as shown by Ng and Perron (1995) are used which produces test statistics which have better properties in terms of size and power than when the lag length is selected with some information-based criteria.

Further, Zivot and Andrews (1992) and Banerjee, Lumsdaine and Stock (1992) tested for unit root incorporated an endogenous break point into the model specification and they showed Perron's conclusions are reversed. Zivot and Andrews(1992) use a sequential test, derive the asymptotic distribution, they fail to reject the unit root hypothesis for four of ten series for which Perron rejected the unit root null. Banerjee, Lumsdaine and Stock (1992) (BLS, henceforth) apply a variety of recursive, rolling and sequential tests endogenising the break point to different international data. For the present study this BLS test for unit root is used. Here it can be mentioned this test cannot be used to find the break point, or whether there is any break in the series at all. This test can be used to test the unit root hypothesis independent of structural break. The power and size consideration of this BLS test has been given in their paper.

The BLS test is structured as:

Model I: $y_t = \mu_0 + \mu_1 t + \alpha y_{t-1} + B(L)\Delta y_{t-1} + e_t \; ; t = 1,2,\ldots\ldots, T$ 12

where*B(L)* is a polynomial of order p, with the roots of *1-B(L)L* outside the unit circle. Under the null hypothesis, $\alpha=1$ and $\mu_1=0$.

When the model is estimated by OLS without restricted onμ_0,$\mu_1$or α, the t statistic testing$\alpha=1$is the standard Dickey Fuller (1979) test for a unit root against a trend stationary alternative.

Model II: $y_t = \mu_0 + \mu_1 \tau_{1k}(k) + \mu_2 t + \alpha y_{t-1} + B(L)\Delta y_{t-1} + \omega' x_{t-1}(k) + e_t \; ; t = 1,2,\ldots\ldots, T$ 13

Unlike Model I, this model allows for an additional m vector of regressors, $x_{t-1}(k)$, which are assumed to be stationary with a constant zero mean. The deterministic regressor, $\tau_{1k}(k)$ captures the possibility of shift or jump in the trend at period k. Following Perron (1989), consider two cases:

Case A(shift in trend): $\tau_{1k}(k) = (t-k)1(t > k)$

and Case B (shift in mean): $\tau_{1k}(k) = 1(t > k)$

where 1(.) is the indicator function. For Case A the "changing growth" model the t statistic testing $\mu_1=0$ provides the information about whether there has been a shift (or change in slope) in the trend. For Case B, (Perron's "crash" model), this t statistic provides information about whether there has been a jump or break in the trend.

Based on different tests used, three test statistics are examined under recursive tests. These are the maximum Dickey- Fuller statistic, $\hat{t}_{DF}^{\max} = \max_{k_0 \le k \le T} \hat{t}_{DF}(\frac{k}{T})$; and the minimal Dickey Fuller Statistic $\hat{t}_{DF}^{\min} = \min_{k_0 \le k \le T} \hat{t}_{DF}(\frac{k}{T})$; and $\hat{t}_{DF}^{diff} = \hat{t}_{DF}^{\max} - \hat{t}_{DF}^{\min}$. For these, $\hat{t}_{DF}(\frac{k}{T})$, that is the full sample Dickey Fuller statistic is computed as the t statistic testing $\alpha=1$ in the regression estimated over $t = 1,2,....., k$. Given the presence of breakpoints confirmed by Bai-Perron test and the presence of unit roots confirmed by the BLS test, the presence of unit root in the presence of structural break is ascertained by an extension of the Zivot and Andrews (1992), i.e. the Lumsdaine and Papell (1997) test, where break dates are not determined exogenously. Lumsdaine and Papell (1997) (LP hereafter) extended the Zivot and Andrews methodology of two breaks. The methodology can be extended to three or more breaks.

As illustrated by the above equations, a constant and a linear time trend in ADF test regression is selected to be included. Phillips and Perron (1988) propose an alternative (nonparametric) method of controlling for serial correlation when testing for a unit root. The PP method estimates the non-augmented DF test equation [Equation (10) and (11) without $\sum_{j=1}^{k} d_j \Delta y_{t-j}$ term on RHS], and modifies the t-ratio of the α coefficient so that serial correlation does not affect the asymptotic distribution of the test statistic. For comparison purposes, we also perform the PP tests and report their results in addition to the generally favoured ADF test.

A problem common with the conventional unit root tests such as the ADF, DF-GLS and PP tests, is that they do not allow for the possibility of a structural break. Assuming the time of the break as an exogenous phenomenon, Perron showed that the power to reject a unit root decreases when the stationary alternative is true and a structural break is ignored.

Zivot and Andrews (1992) proposed a variation of Perron's original test in which they assume that the exact time of the break-point is unknown. Instead a data dependent algorithm is used to proxy Perron's subjective procedure to determine the break points. Following Perron's characterisation of the form of structural break, Zivot and Andrews proceeded with three models

to test for a unit root: (i) model A, which permits a one-time change in the level of the series; (ii) model B, which allows for a one-time change in the slope of the trend function, and (iii) model C, which combines one-time changes in the level and the slope of the trend function of the series. Hence, to test for a unit root against the alternative of a one-time structural break, Zivot and Andrews use the following regression equations corresponding to the above three models.

$$\Delta y_t = c + \alpha y_{t-1} + \beta t + \gamma DU_t + \sum_{j=1}^{k} d_j \Delta y_{t-j} + \varepsilon_t \quad (14)$$

$$\Delta y_t = c + \alpha y_{t-1} + \beta t + \theta DT_t + \sum_{j=1}^{k} d_j \Delta y_{t-j} + \varepsilon_t \quad (15)$$

$$\Delta y_t = c + \alpha y_{t-1} + \beta t + \gamma DU_t + \theta DT_t + \sum_{j=1}^{k} d_j \Delta y_{t-j} + \varepsilon_t \quad (16)$$

where DU_t is an indicator dummy variable for a mean shift occurring at each possible break-date (TB) while DT_t is corresponding trend shift variable. Formally,

$$DU_t = \begin{cases} 1 \ldots\ldots if\ t > TB \\ 0 \ldots otherwise \end{cases}$$

$$DT_t = \begin{cases} t - TB \ldots\ldots if\ t > TB \\ 0 \ldots\ldots\ldots otherwise \end{cases}$$

The null hypothesis in all the three models is $\alpha=0$, which implies that the series $\{y_t\}$ contains a unit root with a drift that excludes any structural break, while the alternative hypothesis $\alpha<0$ implies that the series is a trend-stationary process with a one-time break occurring at an unknown point in time. The Zivot and Andrews (1992) method regards every point as a potential break-date (TB) and runs a regression for every possible break-date sequentially. From amongst all possible break-points (TB), the procedure selects as its choice of break-date (*TB*) the date which minimizes the one-sided t-statistic for testing $\hat{\alpha}$ $(=\alpha - 1) = 1$. According to Zivot and Andrews (1992), the presence of the end points cause the asymptotic distribution of the statistics to diverges towards infinity. Therefore, some region must be chosen such that the end points of the sample are not included. Zivot and Andrews (1992) suggest the 'trimming region' be specified as (0.15T, 0.85T), which is followed here.

Lumsdaine and Papell (1997) test considers the behaviour of sequences of the Dickey-Fuller (1979) t tests for a unit root. It is similar to the spirit to the sequential tests for changing in the coefficients of BLS (1992), in case there is only one structural break. LP computed a statistic using the full sample allowing two shifts in the deterministic trend at distinct unknown dates. The model considered here is the extension of the Zivot Andrews model (Model C), using the following equation:

$$\Delta y_t = \mu + \beta t + \theta DU\,1_t + \gamma DT_t + \omega DU\,2_t + \psi DT\,2_t + \alpha y_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-i} + \varepsilon_t \qquad 17$$

where $t = 1,2,\ldots\ldots, T$ and c(L) is the lag polynomial of unknown order k and 1-c(L)L has all its unit roots outside the unit circle, the null hypothesis of non-stationarity is examined against the alternative of stationary with two break. Here, $DU1_t$and $DU2_t$ are the indicator dummies for a mean shift occurring at times TB1 and TB2 respectively and $DT1_t$ and $DT2_t$ are the corresponding trend shift variables. That is,

$DU\,1_t = 1(t > TB1)$, $DU\,2_t = 1(t > TB2)$, $DT\,1_t = (t - TB1)1(t > TB1)$ and $DT\,2_t = (t - TB2)1(t > TB2)$

and k is the lag length decided on the basis of the AIC or SBC criteria. The test is extended to three structural breaks, in this chapter.

Section IV: Results and Interpretation

In this section, the breakpoints in specialised services, services and GDP are estimated using this methodology. For each individual variable, the model is characterized as:

Pure Structural break model: $y_t = c_j + \beta_j t + \rho_j y_{t-1} + u_t, t = T_{j-1},\ldots\ldots\ldots\ldots T$ 18

Partial Structural break model: $y_t = c_j + \beta_j t + \rho y_{t-1} + u_t, t = T_{j-1},\ldots\ldots\ldots\ldots T$ 19

Therefore, the two structural breaks model differ in the way that in the generalized case, the break is taken into consideration with a variable deterministic trend coefficient β and autoregressive parameter ρ. The partial structural break model is restricted in the sense that it assumes the autoregressive parameter, ρ, to be constant.

In order to detect for the structural breaks, the steps suggested by Bai and Perron stated above are followed. First, the UDMAX and WDMAX statistics, which are double maximum tests, where the null hypothesis of no structural breaks is tests against the alternative of an unknown number

of breaks, are calculated. As stated above, the tests are used to determine if at least one structural break is present. Subsequently, the sup $F_T(0|l)$ which is a series of Wald tests for hypothesis of 0 breaks vs. l breaks are calculated. In the implementation of the procedure, a maximum up to 4 breaks is allowed and a trimming ε=0.05 which corresponds to each segment having at least 12 observations. If these tests show evidence of at least one structural break, then the number of breaks can be determined by the SupF(l+1/l). If the test is significant at the 5 per cent level, l+1 breaks are chosen.

This table provides the results following this procedure for specialised services and GDP. It may be observed that the *SupF(0|l),* the UDMAX and WDMAX tests are all significant indicating that each series contains at least one break in its structure. Consequently, the number of breaks can be determined using the sequential test sup F_T (l+1/l). The results show that the value of the sup *F(0|l)* test is statistically significant at the 5% level of significance for all l. The sequential Sup *F(l+1/l)* is statistically significant up to l=3 for log value of specialised services and GDP. The break dates of each series are provided in the Tables 3 and 4.

The results of the pure structural change model by Bai and Perron (1998, 2003) is presented in Table 3.

Table 3: Results of the Bai Perron Pure Structural Break Model (1998, 2003)

	Trade, hotel and Restaurants	**Transport, Storage and Communi-cation**	**Banking Insurance and Financial Services**	**Community Social and Personal Services**	**Total Services**	**GDP**
Udmax	36.80*	27.74*	45.75*	20.53*	42.93*	44.11*
Wdmax	56.85*	41.32*	70.67*	31.72*	50.06*	51.43*
SupF$_T$(0|1)	20.19*	20.36*	16.19*	13.95	39.86*	26.79*
SupF$_T$(0|2)	20.65*	27.74*	21.04*	18.65*	42.94*	44.11*
SupF$_T$(0|3)	25.20*	18.75*	28.58*	18.49*	33.50*	33.19*
SupFT(0|4)	36.80*	26.75*	45.75*	20.53*	32.39*	29.09*
SupF$_T$(2|1)	23.88*	32.62*	23.54*	24.59*	46.83*	25.15*
SupF$_T$(3|2)	22.06*	14.13	23.54*	26.78*	14.27	20.11*
SupF$_T$(4|3)	3.13	21.44*	25.37*	20.24*	34.19*	20.11*
Sequential	3	2	4	0	2	3
Estimated break dates with m=4	**(1964-65, 1978-79, 1993-94)**	**(1963-64, 1998-99)**	**(1965-66, 1980-81, 1988-89, 1999-2000)**	No break	**(1964-65, 1999-2000)**	**(1982-83, 1990-91, 2001-02)**

Notes: The number of breaks (in our case, four) has been determined according to the sequential procedure by Bai and Perron(1998), at the 5% size for the sequential test Sup F_T(l+1/l). SupF statistics estimated using Bai and Perron(1998,2003) methods, with Gauss mode available by Bai and Perron.

*: significant at the 5% level.

The results of the pure break model reveal that the first break in India's GDP occurred at 1982-83. The next two breaks as evident from economic policy change in India are at 1990-91 and 2001-02. However, the first break in the subsector of services and aggregate services as a whole comes within the period 1963-1966, with the community, social and personal services sector exhibiting no such break. This confirms the fact that the break in services GDP came long before the break in GDP. It also points out that the service sector in India is not necessarily led by economic reforms of 1991. The second break in services occurred at the beginning of the new millennium, almost after a decade of the initiation of the reforms. However, it needs to be mentioned that an aggregation of these services actually does not give a lucid picture because of the diverse nature and the significance of the different subsector of services in the development of the country. It is better to consider each of the sub-sectors of services individually and see their growth pattern.

The partial form of the structural break model as proposed by Bai and Perron (1998, 2003) is summarised in Table 4.

Table 4: Results of the Partial Structural Break Model by Bai Perron (1998, 2003)

	Trade, hotel and Restaurants	**Transport, Storage and Communi-cation**	**Banking Insurance and Financial Services**	**Community Social and Personal Services**	**Total Services**	**GDP**
Udmax	19.66*	21.80*	21.07*	26.70*	32.84*	23.82*
Wdmax	30.63*	26.51*	33.30*	41.21*	46.88*	28.02*
$SupF_T(0\|1)$	18.33*	19.65*	15.24*	13.01*	32.84*	16.25*
$SupF_T(0\|2)$	19.66*	21.80*	21.07*	16.26*	24.78*	23.82*
$SupF_T(0\|3)$	19.39*	15.83*	15.61*	26.70*	28.78*	18.39*
$SupF_T(0\|4)$	19.20*	16.62*	20.87*	25.83*	29.38*	17.51*
$SupF_T(2\|1)$	22.57*	32.92*	22.76*	20.89*	18.04*	27.59*
$SupF_T(3\|2)$	9.01	30.93*	16.29*	16.05*	13.00	23.86*
$SupF_T(4\|3)$	6.69	20.69	16.29*	13.67	35.25*	23.86*
Sequential	2	3	3	3	2	3
Estimated break dates with m=4	**(1964-65, 1993-94)**	**(1963-64, 1973-74, 1991-92)**	**(1980-81, 1988-89, 1999-2000)**	**(1971-72, 1990-91, 1999-2000)**	**(1964-65, 1999-2000)**	**(1978-79, 1990-91, 2001-02)**

Notes: The number of breaks (in our case, four) has been determined according to the sequential procedure by Bai andPerron (1998), at the 5% size for the sequential test Sup $F_T(l+1/l)$. SupF statistics estimated using Bai and Perron (1998, 2003) methods, with Gauss mode available by Bai and Perron.

*: significant at the 5% level.

The results of the pure and partial structural tests appear somewhat similar, except for community, social and personal services (CSP), which has no break in the pure form but has three breaks in the partial form. For the rest, for example trade, hotel and restaurants, the first break and the last break is in the same year, except that there is another break at 1978-79 in the case of a pure structural break. Again for the banking, insurance and the financial services the first break occurs at 1965-66 in the pure form, all the other three breaks are same in both pure and partial models. For GDP, the first structural break occurs at 1982-83 in the pure form while it occurs at 1978-79 in the partial form, the rest of the breakpoints being similar in both the models. The partial structure of the model is taken for further analysis as in this model not all parameters are subject to shifts, it considers only the change of intercept. The results are found to be consistent with that of the economic policy of India. Following the tables, it is evident that the first structural change is India's GDP growth has been brought about in 1978-79, whereas the break in aggregate services sector has occurred much earlier in 1965-66. However, services being so diverse in nature, aggregate services do not really match with the time at which the first break in GDP occurred. But, the break in 1965-66 is brought about by a break in trade, hotel and restaurants and transport, storage and communication and community, social and personal services. The first break in financial services is somewhat commensurate with the time of break with that of GDP.

Several studies like Nagraj(1990,1991), Dholakia(1994), Panagariya(2004), Wallack (2004), Nayyar (2006), Balakrishnan and Permeshwaran (2007), Dholakia (2007) have addressed the problem of estimation of structural break in the long term trend growth of the Indian economy at the aggregate and the sectoral level. Our results are found to be similar with the growth of GDP in India by Balakrishnan and Permeshwaran (2007). Our results have been little different from their results because of a different base year period and the length of the period under study. Even Wallack (2004) found that the first structural break in India's GDP growth rate to be at 1980-81. However, a recent article by Dholakia & Sapre (2011) considers the endogenous estimation of break dates is sensitive of changes in the base year and the length of the partition using Bai Perron model.

Next, having found out the break points, the sub-period growth rates in the different sectors in the growth regimes in India are calculated. The model put forward by Boyce (1986) as a kinked exponential model for estimating growth gives the results illustrated in Table 5. The growth rates are very high in the last regime in all the sectors except for community, social and personal services.

Table 5: Results of sub-period growth rates using the Boyce method (1986)

Sectors	Regime 1	Regime 2	Regime 3	Regime 4
Trade, Hotel Restaurants	**5.12** (1950/51-1964/65)	**4.94** (1965/66-1993/94)	**9.12** (1994/95-2009-10)	
Transport, Storage Communication	**9.59** (1950/51-1963-64)	**0.48** (1964/65-1973-74)	**6.91** (1974/75-1991/92)	**9.36** (1992/93-2009-10)
Banking Insurance and Financial Services	**4.28** (1950/51-1980/81)	**4.71** (1981/82-1988/89)	**7.89** (1989/90-1999/2000)	**4.50** (2000/01-2009/10)
Community, Social and Personal Services	**4.63** (1950/51-1971/72)	**4.81** (1972/73-1990/91)	**4.07** (1991/92-1999/2000)	**3.55** (2000/01-2009/10)
Total Services	**3.67** (1950/51-1964/65)	**5.69** (1965/66-1999-2000)	**10.5** (2000/01-2009/10)	
GDP	**3.81** (1950/51-1978/79)	**5.62** (1979/80-1990/91)	**7.93** (1991/92-2001/02)	**6.42** (2002/03-2009/10)

Note: The growth rates are significant at the 1% level.

The last two growth regime shows a huge growth rate in GDP, services as well as subsector of services. For the banking insurance and financial services and GDP, the third regime showed the highest level of growth. For the community social and personal services, the growth rate has been more or less similar for all the regimes.

Table 6 considers the results of the recursive unit root test advocated by Banerjee, Lumsdaine, and Stock (1992). The test cannot find the break point, nor does it confirm whether there is any break in the series at all. This test can be used to test the unit root hypothesis on the presence or absence of break. The test confirms the presence of unit root for the log values of the series of sub-sector of services. Therefore the log values of the series of all the sub-sector of services are non-stationary.

Table 6: Results of the unit root test by Banerjee, Lumsdaine and Stock (1992)

Series	$t_{DF}^{\max}$	$t_{DF}^{\min}$	t_{DF}^{diff}
Trade, Hotel Restaurants	3.26	-1.29	4.55

Transport, Storage Communication	1.80	-2.46	4.26
Banking Insurance and Financial Services	4.63	-1.97	6.60
Community, Social and Personal Services	2.61	-2.94	5.55
Total Services	14.05	-1.53	15.58
GDP	3.95	-1.25	5.20
5% critical values	-1.99	-4.33	3.65

Tables 7a and Table 7b consider the results used by unit root test by Lumsdaine and Papell (1997) in the presence of two structural breaks and three structural breaks respectively. The critical value of the test with two structural breaks at 95% given by LP is -6.82. Given the critical value we fail to reject the null hypothesis for both the series. Both these series are therefore non-stationary.

This LP test can be extended to three or more breaks. But the problem is that the critical values of the t ratio of the coefficient of Y_{t-1} for three breaks are not available from their paper. A subsequent paper by Aitkins (2002) have found out the critical values for three or more breaks through a Monte Carlo simulation for calculating the presence of unit roots in the inflation and interest rates in Canada and United States.

Table 7a: Results of the unit root test of Lumsdaine Pappel (1997) [2 breaks]

Series with two breaks	TB1 TB2	α	θ	γ	ω	ψ	k
Trade, hotel, restaurants	1964 1993	-0.27 (-2.91)d	2.82 (2.95)	-0.02 (1.34)	0.03 (2.51)	-0.0002 (-0.56)	1
Total Services	1964 1999	-0.05 (-0.77)d	0.603 (0.82)	0.002 (1.23)	-0.015 (-1.39)	-0.090 (-1.16)	1

Table 7b: Results of the unit root test of Lumsdaine Pappel (1997) [3 breaks]

Series with three breaks	TB1 TB2 TB3	α	θ	γ	ω	ψ	δ	μ	k
Transport, Storage and Communication	1963 1973 1991	-0.382 (-4.11)d	-0.019 (-1.19)	-0.0005* (-3.39)	0.032* (2.21)	0.0005* (3.26)	-0.0398* (-2.42)	0.0003* (5.44)	3
Banking, Insurance and Financial Services	1980 1988 1999	-0.465 (-4.06)d	0.013 (0.84)	0.0005* (4.08)	0.0244 (1.26)	-0.0025* (-2.21)	-0.0351* (-2.07)	0.00017 (0.26)	2
Community, Social and Personal Services	1971 1990 1999	-0.225 (-2.43)d	-0.0234 (-1.92)	0.00003 (1.18)	-0.0255 (-1.53)	0.0008 (1.60)	-0.011 (-0.58)	-0.0007 (-1.13)	1

GDP	1978 1990 2001	-0.0924 (-4.62)d	-0.0268 (-1.70)	0.0002 (4.77)	-0.0083 (-0.42)	0.00007 (0.96)	-0.043* (-2.02)	0.00015* (2.12)	2

Notes:

1. Variables are in log forms
2. Critical values at 95%: -3.80 for single break[by Perron(1989)], -6.82 for two breaks[by Lumsdaine and Papell (1997)], -7.45 for three breaks [by Aitkens (1999)]
3. Lag length is selected on the basis of AIC and SBC criteria
4. Figures in parentheses indicate t statistics
5. 5% level of significance is indicated by *

For the three breaks model, the critical value at 95% is -7.45. Given the critical value we fail to reject the null hypothesis for the series on the logarithmic values of transport, storage and communication, banking, insurance and financial services, community social and personal services and GDP. As a result, the logarithmic values of GDP, services and components of services are found to be non-stationary in spite of presence of one or more breaks. Therefore, Lumsdaine Papell methodology corroborates the earlier findings of the BLS test that unit roots do exist in the series of GDP, services and all the components of service.

Therefore the post-independence process of growth of India's GDP and structural change in India has thereby gone through four phases:

Phase 1: 1950s to late 1980s: In this phase, acceleration in growth and structural change was driven chiefly by the agricultural and industrial sector till mid 1960s and later on by the slackening of the momentum of industrial growth. With the strategic industrial policy of the Second Plan, better known as the Nehruvian-Mahanobis model on heavy industry led growth, the demand for transport and communication services through spread of railways and telephones increased during this time. The public administration and defence were the main contributors of the service sector during this phase. Other sectors like retail trade, transport and communication also showed a growth rate, relatively high as the public sector. The conservative economic policies of the government during this phase were the reason for this nature of economic growth.

Phase 2: 1980s to early 1990s: The main factor that contributed to the acceleration of growth rates since the 1980s are the government withdrew some constraints on big business to expand, and encouraged them to areas hitherto reserved for the public sector. The government liberalised

credit for big borrowers, gave tax concession to large investors, and allowed the private sector to borrow directly from the public. The shift towards a more service dominated pattern of growth happened in this phase as a fallout of the government liberal policies. The rising share of public sector was the main source of increasing share of services in GDP during this period. Among the service sector components, community, social and personal services were those that developed during this period in conjunction to the earlier phase.

Phase 3: 1990s to 2000: This phase brought about the private organized sector led crucial strengthening of services dominated growth trajectory as a consequence to the earlier phase. This may be due to the fallout of the economic reforms initiated in the early 1990s. The opening up of the economy along with the increased investments, growing consumption and the outsourcing boom boosted the growth of the software sector. The banking sector reforms of 1992 and 1995 formulated major policies in the financial sector as a part of the liberalisation process such as providing licenses to private sector banks, opening of the insurance sector, etc. Real estate sector development has been backed by both demand factors such as unfulfilled demand of dwelling units and lack of infrastructure and supply side factors such as increased rationalisation of tax structure, reduced borrowings cost and tax benefits to loan seekers, etc. The highest growth in banking and finance met the demand for personal loans, thereby leading to real estate boom. The car industry, like real estate developed during this period, with increased benefits to loan takers and improved post purchase services. Again, with the liberation policies of the government, in a regime of no control, manufacturing activity was taken over by China, as they produced goods cheaper than home produced goods.

Early 2000 to 2010: This phase brought about an increase in GDP via infrastructure like construction, transport, communication and business services in conjunction to the earlier phase. With the innovations in transport storage and communications and financial services there has been an upsurge in services GDP. The tourism industry that includes hotels and restaurants has witnessed good times on account of increased passenger traffic (business and leisure). The communication sector is one of the fastest growing sectors domestically. India’s teledensity has improved but it is still low as compared to other developing nations. India's mobile subscriber

base has increased manifold and low tariffs enhance higher usage to give a further impetus to growth.

This periodisation of India's post-independence economic history therefore points towards the importance of going beyond relating the dynamics of the Indian economy to the degree to which the prevalent economic policy regime was restrictive or liberal in different periods. Therefore India's economic growth is a long term story related to constraints embedded in her economic structure, which neither the actual interventions nor liberalisation have been able to eliminate. It is these constraints that need to be investigated towards proper understanding of the peculiarity of Indian economic change.

These are some of the important explanation posed by the post-independence experience of growth and structural change. The growth performance of India has moved from its earlier version of State-led industrialisation in the public sector under an import-substituting regime to a more globalised export-oriented framework with least interventions by the State and more reliance on market-based allocations. The fact that this acceleration was not rooted in industrialisation but rather a shift towards services only adds to the difficulties of policy shift based explanations. This is especially because the initial service orientation of growth till the 1990s was related to an expanding public sector, while the post 1990s is actually the shift from public sector to private sector driven growth of services, and the decisive shift of the private organized sector towards services. Thus, the role of the private sector in growth becomes prominent from the mid-1990s, but it only reinforced an already existing tendency towards service dominated growth. Moreover, given the direct and indirect role of the public sector in the development of many of the areas of rapid service growth, there may exist other deeper continuities between the 1980s and later. All these, do suggest that economic policy was important to the Indian story of economic change, whether the prevailing policy regime has been restrictive or liberal.

Section V: Conclusion

In a nutshell, this paper focuses on the turning points of growth, suggesting that these growth patterns were different resulting from the pattern of structural change in output in these periods.

This paper uses annual data of the components of GDP to determine endogenously the most important years when structural breaks occurred and simultaneously test for the unit root hypothesis in the presence of these breaks in GDP, services and subsector of services for the Indian economy from 1950-51 to 2009-10. Based on the multiple structural breaks model of Bai and Perron (1998, 2003), the post-independence Indian GDP growth structure has been broadly defined into four regimes. The high GDP growth in the last two decades has been brought about by the dominant components of the service sector mainly, transport, storage and communication and banking, insurance and financial services. However, trade, hotel and restaurants in the last decades have also high growth rate. It is only community, social and personal sector which has shown a consistently low growth throughout decades. The subsequent unit root test by BLS (1992) and Lumsdaine and Papell (1997) corroborates that fact in spite of the presence of multiple structural breaks, all of these series are non-stationary at levels. The growth rates of the sub-sector of services and GDP as a whole showed that the growth in the post globalisation era is India has been massive as compared to the earlier regimes. However, the first break in services came long back as compared to that of GDP and the second break in services actually occurred almost a decade after the initiation of the economic reforms of the early 1990s. On the whole, the break in service sector growth started much after the commencement of reforms, and therefore may not be considered as an effect of liberalisation. But in case of fastest growing specialised services like banking, insurance and financial services the structural break has more or less matched with the break in GDP, establishing that this sector in particular had the positive fallout of liberalisation in India.

The paper answers the basic research question to relating to services sector growth and its structural transformation posed at the beginning of this paper. The structural transformation for predominantly agrarian economy to a services orientation is therefore, seen first in 1978-79 followed by early 1990s. It is largely observed the service sector boom have grown manifold in post globalisation India mainly due to the growth in banking, insurance, real estate, financial services and transport, storage and communication. The banking sector reforms formulated major policies in the financial sector like giving licenses to private sector banks as part of the liberalisation process, opening of the insurance sector, etc. This growth is also attributed to the

liberalisation policy of the government, along with the increased investments, growing consumption and the outsourcing boom boosted the growth of the software sector. The communication sector is one of the fastest growing sectors domestically. India's teledensity has improved but it is still low as compared to other developing nations. India's mobile subscriber base has increased manifold and low tariffs enhance higher usage to give a further impetus to growth. The intersectoral dynamics of the broad sectors of agriculture, industry and services necessitates that services serve as an input in industrial sector in India. The demand for services is not only driven by the manufacturing sector in India but also is absorbed largely by the external sector. The gigantic amount of services exports is growth augmenting in the long run for India. Therefore, services somewhat has played the role of engine of growth in the Indian economy, specifically in post liberalisation era.

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