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The Service Sector Revolution in India

A Quantitative Analysis

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Abstract

Following the economic liberalization in India, the service sector has gained prominence in the economy as it accounts for the largest share of GDP and, also that the share of this sector in GDP has been growing very rapidly. Empirical data reveal two significant trends in the service sector following liberalization in 1991: growth in service sector productivity and growth in services' trade. The objective of this paper is to build a simple three sector quantitative model which can capture the increase in the share of service sector in GDP after liberalization. Within the context of the model, there are two exogenous changes that occur across the two steady states years, 1980 and 1999: growth in sectoral total factor productivity (TFP) and increase in the level of trade in industrial and service sectors. The results from a counterfactual experiment reveal that shutting down sectoral TFP affects the ability of the model to capture the data trends whereas the absence of sectoral trade negligibly affects the results. Hence I conclude that services' productivity growth versus the increase in services' trade can better explain the value added growth observed in the Indian service sector across the two steady states.

Keywords: growth, trade, total factor productivity, services, India

JEL classification: O14, O41, O53

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1 Introduction

An empirical analysis of contemporary developed and some developing nations reveals significant differences in their growth patterns. For most industrialized nations, historical data reveal that at low levels of per capita income, the agricultural sector dominated the composition of output and employment. As these nations embarked on a path of rapid and sustained economic growth, resources were transferred from the agricultural sector to the manufacturing sector. Once the economy matured and reached the status of a high income nation, contribution of the service sector became more pronounced. Today, for some low income industrializing nations, this process of sectoral reallocation of economic activity, also known as *structural transformation*, looks different. In these countries, even at low levels of per capita income, the service sector is a significant source of growth and accounts for much of the economy's output and employment. Therefore, the role of the service sector has become more prominent at early stages of growth and development.

I conduct an empirical exercise to identify the set of low income, rapid growing, economies which exhibit the pattern of services led growth. A low income country is defined as a country with a level of GDP per capita less than 825 US $ in 1980[1]. Following this criterion, I identify 42 low income countries in 1980 and calculate their average growth rates of GDP per capita during the period 1980-2004. Table 7 in the appendix lists these countries in descending order of their growth rates, together with their respective GDP per capita in 1980. The average growth rate for the entire sample is 0.51 percent, owing to a large number of countries which witnessed negative growth rates during this time period. Amongst these countries, 17 countries experienced negative growth rates, while 11 countries grew at an average rate of 0-1 percent and 3 countries witnessed growth rates between 1-2 percent. My interest lies in choosing the rapid growing countries which witnessed average annual growth rates of GDP per capita in excess of 2 percent, which was the secular growth rate of the U.S. economy in the twentieth century[2]. The U.S. economy was the industrial leader throughout

[1] In 2004, The World Bank defined a low income country as a country which had a level of Gross National Income per capita less than 825 US $.

[2] Following Kehoe & Prescott (2002); they calculate the average growth rate of output per working-age person in the U.S. economy to be 2 percent in the twentieth century.

the twentieth century and hence the growth performance of the rapid growers is measured relative to the U.S. economy. I refer to these 11 countries as *Rapid Growers*. These countries include China, Thailand, Bhutan, India, Indonesia, Sri Lanka, Chad, Lesotho, Pakistan, Bangladesh and Nepal.

Next, I examine the performance of the three sectors, namely, agriculture, industry and services, in contributing to aggregate growth of output in these economies. It is well recognized that as an economy grows and witnesses structural transformation, growth proceeds at an uneven rate from sector to sector. Following Syrquin (1988), I examine the relation between aggregate and sectoral growth by differentiating with respect to time the definition of total output, $V = \sum V_i$ and expressing the result in growth terms:

$$g_V = \sum_i \rho_i g_{V_i}$$

where g_V and g_{V_i} are the growth rates of V and V_i, respectively, and the weights are sectoral output shares, $\rho_i = V_i/V$. The above equation expresses the contribution of each sector to aggregate GDP growth measured in terms of the average share of total GDP accounted by this sector, weighted by the growth rate of GDP in this sector.

For each of the 11 Rapid Growers, I decompose the growth rate of aggregate GDP using growth rates of sectoral output and shares of the sectoral output in GDP. Following this decomposition, I identify those low income, fast growing, countries which have witnessed service sector driven growth. Specifically, in these economies, the service sector has made the highest average contribution to aggregate growth during the 1980-2004 period. I classify them as *service sector* dominated countries. This set of countries includes India, Sri Lanka, Pakistan, Bangladesh and Nepal. Notably, all these countries have initiated economic and trade liberalization reforms. Amongst all these service sector led countries, India has witnessed the most rapid growth in GDP and in GDP per capita during the 1980-2004 period.

1.1 The Indian Economy

During the period 1980-2003, the average annual growth rate of the total output of the Indian economy was 5.6 percent while that alone of the service sector exceeded it at 7 percent. Specifically, the service sector accounted for about 38 percent of Indian output and 20 percent of Indian employment in 1980, and its share increased to account for 52 percent of total output and 28 percent of total employment by 2003. Over the same time period, per capita income increased from 220 constant 2000 US dollars to about 510 constant 2000 US dollars, but India is still classified as a low income country. As a result, the share of services in India's GDP has come to resemble that of a high income country, even though its per capita income remains that of a low income country.

The role of trade became more prominent in the Indian economy in the 1990s. A balance of payment crisis in 1991 forced India to undertake a formal liberalization. Indian data reveals that total trade as a percentage of GDP, nearly doubled from sixteen percent in 1980 to about thirty-one percent in 2003. Figure 1 and 2 depict the evolution of agricultural, manufacturing and services exports and imports respectively, as measured by their share in GDP. A look at the graph reveals that both agricultural exports and imports were small shares of GDP and were never in excess of 2 percent of GDP. Industrial exports show a clear increasing trend, growing from 3 percent of GDP in 1980 to about 9 percent of GDP in 2003. Similarly, industrial imports also increased from about 3 percent of GDP in 1980 to about 7 percent of GDP by 2003. In the service sector, exports were growing slowly till about mid 1990s, but following 1995 one observes a clear upward trend, increasing sharply from about 2 percent of GDP in 1995 to about 4 percent of GDP in 2003. Service imports also rose steadily until early 1990s, thereafter which their growth accelerated during the late 1990s and started slowing a little by 2000.

In order to measure how much of the growth in real output can be attributed to accumulation of factors of production, and how much of this increase can be attributed to growth in total factor productivity (TFP), I conduct growth accounting for the Indian economy at sectoral level. The data for this procedure have been collected and compiled to form a sectoral data base for India for the 1980-2003 period and are described in detail below.

Two empirical facts emerge from the Indian data analysis: growth accounting reveals that changes in total factor productivity (TFP) were the largest source of service sector value added growth, and second, trade statistics show a sharp acceleration in services' trade

Figure 1: Shares of Sectoral Exports, 1980-2003

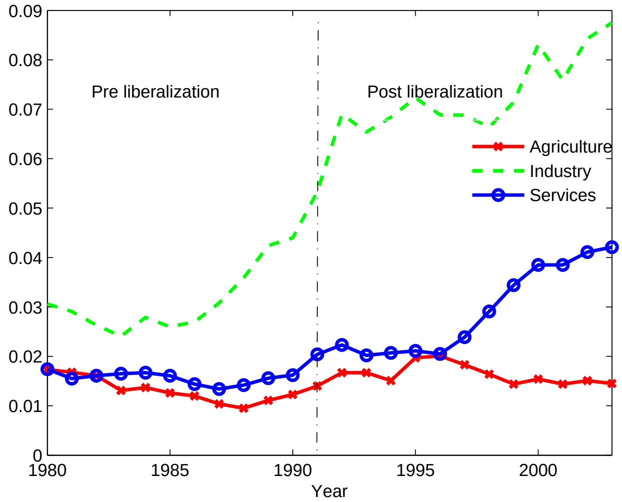
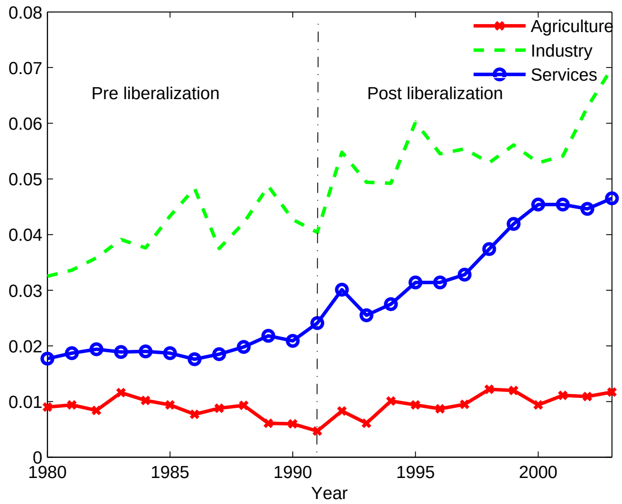


Figure 2: Shares of Sectoral Imports, 1980-2003



following liberalization in 1991. Motivated by these findings, in this paper, I build a simple three sector growth model with two main inputs: growth in sectoral TFP and trade in industry and services. The model is calibrated to the Indian sectoral data across two steady state years, 1980 and 1999, during which trade is balanced. The performance of the model is assessed on how closely can it replicate the sectoral composition of GDP and the allocation of sectoral labor across two steady state years, 1980 and 1999. In addition, the importance of each of the two exogenous changes is tested by conducting a counter factual experiment in which one change is allowed to operate while the other change is shut down. The results from the counterfactual indicate that productivity growth versus trade has a more important role in capturing the sectoral composition of GDP in India.

The rest of the paper is organized as follows. The next section discusses the growth accounting methodology, data and results. Sections 3 describes the model while the calibration procedure and results are explained in section 4 and 5 respectively. The counterfactual experiment and its results are discussed in section 6. The last section concludes and discusses possible extensions and ideas for future research.

2 Sectoral Growth Accounting

To gain further insight into the sources of growth in service sector value added, I conduct a growth accounting of value added for each of the sectors - agriculture, industry and services, for the 1980-2003 period. This exercise involves decomposing changes in value added into the portions due to changes in factor inputs and the portion due to changes in efficiency with which these factors are used, measured as total factor productivity (TFP) of a sector. To summarize, the results, indicate that changes in TFP are significant in accounting for value added growth in the service sector. Also, the growth of agricultural value added is largely accounted for by TFP growth. By contrast, the growth of industrial output is largely driven by the growth of factor inputs, primarily due to growth in capital. Additionally, I find that TFP growth rate in the service sector is the highest across the three sectors for the entire time period, primarily because it has grown at a very rapid rate after economic liberalization in 1991[3].

2.1 Methodology

This section describes the model of value added by sector used in the growth accounting procedure. The methodology for constructing the factor shares is described in the following sub section. I follow the standard methodology of growth accounting which involves decomposing output growth into TFP growth, capital growth and labor growth.

[3]Gross output by sector would also be analyzed, but data is unavailable.

The production function in each sector is assumed to be Cobb-Douglas with constant returns to scale. In particular, the function is described by

$$Y_{jt} = A_{jt} K_{jt}^{\nu_j} N_{jt}^{1-\nu_j} \qquad j \in \{industry, services\}$$

where ν_j and $1 - \nu_j$ represent the share of rental payments to capital and share of wage payments to labor in the total income of sector j, respectively. The agricultural production function has an additional input of land. The production function is accordingly modified as

$$Y_{at} = A_{at} K_{at}^{\nu_a} L_{at}^{\gamma_a} N_{at}^{1-\nu_a-\gamma_a}$$

The factor income shares in this sector are ν_a - capital income share, γ_a - share of rental income from land and $(1 - \nu_a - \gamma_a)$ - labor income share.

By differentiating the production function with respect to time, t, and dividing by Y_j, the growth rate of total factor productivity growth in sector $j = \{a, i, s\}$ can be estimated as

$$\frac{dA_j/dt}{A_j} = \frac{dY_j/dt}{Y_j} - \nu_j \frac{dK_j/dt}{K_j} - (1 - \nu_j - \gamma_j) \frac{dN_j/dt}{N_j} - \gamma_j \frac{dL_j/dt}{L_j} \qquad (1)$$

In industry and services, $\gamma_j = 0$ since land is not a factor of production in these sectors.

2.2 Data

In order to conduct growth accounting, data are collected for the three sectors - agriculture, industry and services - for the 1980-2003 period.

Real GDP: Data for sectoral real GDP are taken from the *Business Beacon, Center for Monitoring Indian Economy (CMIE)*. Agriculture includes forestry, logging and fishing; Industry consists of manufacturing, mining, electricity, gas and water supply, and construction, while Services include trade, hotel, transport, communication, finance, insurance, real estate, business services and social and personal services. All data are measured in constant 1994 Indian Rupees.

Capital Stock: The capital stock series are constructed using the Perpetual Inventory Method (PIM), where investment is measured using the gross fixed capital formation series and a constant depreciation rate of 5 percent. In each sector, the initial capital stock is the sectoral gross fixed capital stock in 1952. Using the PIM, the entire capital stock series for all sectors are constructed from 1952 to 2003. For my purpose, I use the capital stock series for the 1980-2003 period. All sectoral capital stock data are measured in constant 1994 Indian Rupees and are obtained from the *Central Statistical Organization (CSO)* of India.

Employment: India does not report the number of labor hours worked in each sector. Hence, I measure employment as the number of people working in each sector. Sectoral employment numbers are calculated using the definition of employment on a current daily status (cds) basis [4]. These data are constructed with the help of annualized growth rates of sectoral employment reported by Gupta (2002). In particular, this report presents sectoral employment numbers for the years 1983, 1987-88, 1993-94, 1999-2000 and 2001-2002 as well as the average annual growth rates for the intermittent years. Using these growth rates, I construct sectoral employment series for the 1980-2003 period.

Land: An estimate of land used in the agricultural sector is needed. Data series on gross sown area are used for this purpose. Gross sown area is defined as the sum of area covered by all individual crops including the area sown under crops more than once during a given year. It is also referred to as gross cropped area. These data are obtained from *Business Beacon, (CMIE)* from 1980 to 2001. For 2002 and 2003, gross sown area data have been taken from the Statistical Pocket Book, 2005 available from CSO, India[5].

Factor Income Shares: I follow Gollin (2002) and calculate factor shares by adjusting for income of the self employed. For the 1980-2003 period, CSO reports factor incomes from different sub sectors which comprise of Compensation of Employees (COE) and Operating Surplus (OS). In each sub sector, the COE and OS are further divided into two components, one part accruing from the organized sector and the second part as originating in the unorganized sector. I consider OS of the unorganized sector as Operating Surplus

[4]Details of the cds approach are provided in the data appendix.

[5]Note that this is incomplete - land is also used for cattle and large animals etc. but no estimates of these data are available. Not accounting for these in land estimates probably overestimates TFP growth in agriculture.

of private unincorporated enterprises (OSPUE). Then, using the second adjustment method followed by Gollin,[6] I compute labor income shares for different sub sectors. Using the share of each sub sector's output in the output of the agricultural, industrial and service sectors' as weights, I construct weighted labor shares for these three sectors. The share of capital income in the industrial and service sectors are deduced as residuals.

The share of rental income from land in agricultural income is taken to be 0.2 (average over the period 1980-1999) as reported by Sivasubramonian (2004). Consequently, the labor and capital shares are rescaled to sum to 1 minus the share of land.

I also conduct a sensitivity analysis of the growth accounting results by using two alternate sets of factor shares. The first set consists of sectoral labor shares computed using Global Trade Analysis Project (GTAP) data, as reported by Terry Roe. The second set assigns the customary value of one-third as the share of capital income and treats the residual as the share of labor income in the industrial and service sectors. For the agricultural sector, the capital income and labor income shares of one-third and two-thirds, are rescaled so that they sum to 1 minus the share of land, where the share of land is taken as 0.2.

2.3 Results

Table 1 reports the decomposition of average annual growth in real value added due to change in capital, labor, land and TFP in each sector. These results have been obtained using 'baseline' factor shares, calibrated from the CSO data. I refer to these results as 'baseline' results.

For the agricultural sector, the labor income share is 0.58, the share of land is 0.2 and the share of capital is determined residually as 0.22. The contribution of each factor is measured as the product of the factor share with the growth rate of the factor. During the 1980-2003 period, agricultural real value added grew at an average annual rate of 3.06 percent. The contributions of capital, labor and TFP were 19, 24 and 56 percent, respectively. Land made a negligible contribution of 1 percent during the entire period. In the

[6] Labor income share= Compensation of Employees/(Compensation of Employees+Operating Surplus of Incorporated Enterprise+Consumption of Fixed Capital)

pre liberalization period 1980-1990, real value added was growing at 4.23 percent, of which TFP growth accounted for 52 percent. After TFP, the contribution of labor was next largest at 29 percent, followed by capital which accounted for about 16 percent. Land made a small contribution of 3 percent. In the post liberalization period, growth in real value added decreased to about 2.02 percent and the contribution of TFP increased to account for 66 percent of real value added growth. Capital and labor accounted for 26 and 13 percent of growth, respectively, whereas the contribution of land was small and negative at -4 percent.

Table 1: Growth Accounting - Baseline Results

	Agriculture	**Industry**	**Services**
Factor share			
capital	0.22	0.55	0.44
labor	0.58	0.45	0.56
land	0.2		
Decomposition of average annual changes in real value added (%)			
Entire period 1980-2003			
Growth in real value added	3.06	6.14	6.95
due to capital	0.58	3.77	1.92
	(19.0)	(61.4)	(27.6)
due to labor	0.73	1.40	1.92
	(23.7)	(22.8)	(27.6)
due to land	0.03		
	(1.1)		
due to TFP	1.73	0.98	3.11
	(56.3)	(15.9)	(44.8)
Pre liberalization 1980-1990			
Growth in real value added	4.23	6.75	6.53
due to capital	0.68	4.08	1.49
	(16.0)	(60.5)	(22.9)
due to labor	1.22	1.93	2.31
	(28.8)	(28.6)	(35.3)
due to land	0.14		
	(3.4)		
due to TFP	2.19	0.74	2.73
	(51.8)	(10.9)	(41.8)
Post liberalization 1991-2003			
Growth in real value added	2.02	5.52	7.44

Table 1: (continued)

	Agriculture	Industry	Services
due to capital	0.52	3.51	2.26
	(25.9)	(63.6)	(30.3)
due to labor	0.26	1.05	1.58
	(12.7)	(19.0)	(21.3)
due to land	-0.09		
	(-4.4)		
due to TFP	1.33	0.96	3.60
	(65.9)	(17.3)	(48.4)

The number in parenthesis is the % contribution of the factor to real value added growth.

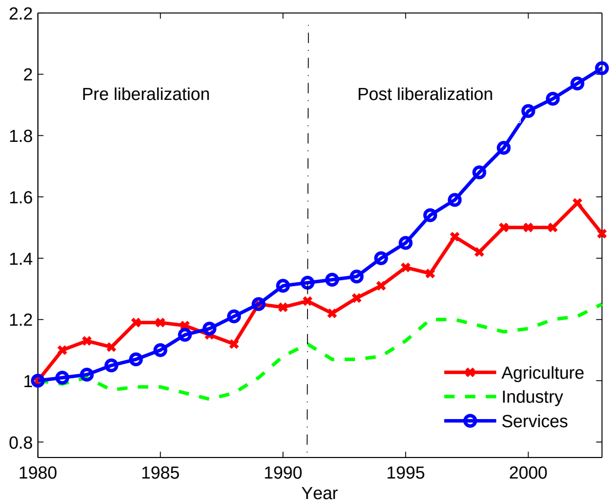
With respect to the industrial sector, the calibrated capital and labor shares are 0.55 and 0.45, respectively. Real value added in industry grew at 6.14 percent during the entire 1980-2003 period. The contribution of capital was the largest at 61 percent while that of labor was about 23 percent. TFP in industry made a relatively small contribution of 16 percent during this period. In the pre liberalization period, real value added was growing at 6.75 percent, of which capital made a significant contribution of 61 percent. The contribution made by labor was 29 percent, followed by TFP which accounted for a relatively small proportion, 11 percent. In the post liberalization period, growth of industrial real value added slowed down to 5.52 percent. Again, the contribution of capital was largest, accounting for about 64 percent of growth in real value added, followed by labor which made a contribution of 19 percent. In this period, the contribution of TFP increased to account for about 17 percent of real value added growth in this sector.

For the service sector, the shares of capital and labor income are calculated to be 0.44 and 0.56, respectively. During the 1980-2003 period, real value added grew at 6.95 percent, of which TFP accounted for 45 percent, followed by capital and labor which each accounted for about 28 percent of services' value added growth, respectively. In the pre liberalization period, real value added grew at 6.53 percent. The contributions of capital and labor were 23 and 35 percent, respectively, while that of TFP was about 42 percent. In the post liberalization period, service sector real value added grew at 7.44 percent. The contribution of capital increased to 30 percent while the contribution of labor decreased to about 21 percent in this period. TFP's contribution increased and TFP growth alone, in this period accounted for 48 percent of real value added growth.

Bosworth et al. (2007) conduct sectoral growth accounting for the Indian economy and find similar sectoral TFP growth rates for the 1980-2004 period. Their estimates of TFP growth rates in agriculture, industry and services are 1.1, 1, and 2.9 percent respectively. They do not calibrate factor shares but assume a capital share of 0.4 in industry and services. For agriculture, the factor shares are 0.5, 0.25, and 0.25 for labor, capital and land respectively. They have another factor input of human capital (education) in each sector. In spite of this additional input, my estimates of TFP growth rates are similar to their numbers, suggesting that education has not played a very significant role in contributing to the growth of sectoral real value added.

From Table 1 one observes that the service sector in India has witnessed very rapid TFP growth which exceeds TFP growth in the agricultural and industrial sectors for the 1980-2003 period, primarily because of the high growth it experienced in the 1991-2003 period. Figure 3 depicts the evolution of sectoral TFP from the initial time period, 1980, (the levels in all sectors have been normalized to unity) to 2003. It is further evident from the graph that the service sector witnessed the fastest rate of TFP growth throughout the sample period. In addition, the rate of TFP growth in services increased after 1991.

Figure 3: Sectoral TFP Levels, 1980-2003



In the Indian case, the finding of high TFP growth in services does not depend on the values of factor shares. I report results using two other sets of factor shares. Table 2 reports the results using the GTAP computed sectoral factor shares and table 3 presents the results using capital share values of one-third in the sectors. These results validate the finding that amongst the three sectors, TFP growth is highest in the service sector for the entire sample period, especially due to the high growth observed in the post liberalization period.

Table 2: Growth Accounting - GTAP Factor Shares

	Agriculture	**Industry**	**Services**
Factor share			
capital	0.21	0.61	0.5
labor	0.41	0.39	0.5
land	0.38		
Decomposition of average annual changes in real value added (%)			
Entire period 1980-2003			
Growth in real value added	3.06	6.14	6.95
due to capital	0.55	4.18	2.18
	(18.1)	(68.0)	(31.3)
due to labor	0.51	1.20	1.72
	(16.8)	(19.5)	(24.7)
due to land	0.06		
	(2.0)		
due to TFP	1.93	0.76	3.05
	(63.1)	(12.4)	(43.9)
Pre liberalization 1980-1990			
Growth in real value added	4.23	6.75	6.53
due to capital	0.65	4.52	1.70
	(15.3)	(67.0)	(26.0)
due to labor	0.86	1.67	2.06
	(20.4)	(24.7)	(31.5)
due to land	0.27		
	(6.5)		
due to TFP	2.45	0.56	2.77
	(57.9)	(8.3)	(42.5)
Post liberalization 1991-2003			
Growth in real value added	2.02	5.52	7.44
due to capital	0.51	3.90	2.56
	(25.2)	(70.6)	(34.4)

Table 2: (continued)

	Agriculture	**Industry**	**Services**
due to labor	0.18	0.90	1.41
	(8.9)	(16.3)	(19.0)
due to land	-0.17		
	(-8.5)		
due to TFP	1.50	0.72	3.47
	(74.4)	(13.1)	(46.6)

The number in parenthesis is the % contribution of the factor to real value added growth.

Table 3: Growth Accounting - Capital Share of One-third

	Agriculture	**Industry**	**Services**
Factor share			
capital	0.24	0.3	0.3
labor	0.56	0.7	0.7
land	0.2		
Decomposition of average annual changes in real value added (%)			
Entire period 1980-2003			
Growth in real value added	3.06	6.14	6.95
due to capital	0.63	2.07	1.31
	(20.7)	(33.7)	(18.8)
due to labor	0.70	2.19	2.39
	(22.9)	(35.7)	(34.5)
due to land	0.03		
	(1.1)		
due to TFP	1.69	1.88	3.25
	(55.3)	(30.6)	(46.8)
Pre liberalization 1980-1990			
Growth in real value added	4.23	6.75	6.53
due to capital	0.74	2.25	1.02
	(17.5)	(33.3)	(15.6)
due to labor	1.18	3.00	2.88
	(27.8)	(44.4)	(44.1)
due to land	0.14		
	(3.4)		
due to TFP	2.17	1.50	2.63
	(51.2)	(22.2)	(40.3)
Post liberalization 1991-2003			
Growth in real value added	2.02	5.52	7.44
due to capital	0.58	1.93	1.55
	(28.7)	(35.0)	(20.8)
due to labor	0.25	1.65	1.98
	(12.2)	(29.9)	(26.6)
due to land	-0.09		
	(-4.4)		
due to TFP	1.28	1.94	3.92
	(63.5)	(35.2)	(52.6)

The number in parenthesis is the % contribution of the factor to real value added growth.

3 The Model

There are three final goods, consisting of agricultural goods, industrial goods, and services, three primary factors - capital, labor, and land (in agriculture); and trade consisting of exports and imports of industrial goods and services. In addition, there is total factor productivity (TFP) growth in each sector and it is assumed that this growth rate is constant over the sample period. The production function for each final good displays constant returns to scale and is assumed to be Cobb-Douglas.

3.1 Technology

The model is set up in terms of per capita quantities for simplicity. Agricultural goods are produced using capital k_a, land l_a, and labor n_a as inputs; industrial goods and services are produced using capital and labor, k_i, n_i, k_s and n_s respectively. Time is discrete and on a per capita basis the production functions are

$$y_{at} = b_{at} k_{at}^{\theta} l_{at}^{\gamma} n_{at}^{1-\theta-\gamma} \quad (2)$$

$$y_{it} = b_{it} k_{it}^{\alpha} n_{it}^{1-\alpha} \quad (3)$$

$$y_{st} = b_{st} k_{st}^{\phi} n_{st}^{1-\phi} \quad (4)$$

where b_{jt} is the TFP level in sector $j = \{a, i, s\}$. The parameters $\theta, \gamma, \alpha, \phi \in (0, 1)$ and $\theta + \gamma \leq 1$. It is assumed that all firms behave competitively in all markets.

There are three market clearing conditions for produced goods:

$$c_{at} = y_{at} \quad (5)$$

$$c_{it} + k_{t+1} - (1-\delta)k_t + x_{it} = y_{it} + i_{it} \quad (6)$$

$$c_{st} + x_{st} = y_{st} + i_{st} \quad (7)$$

where c_{jt} is the consumption level in sector $j = \{a, i, s\}$ and i_{jt} and x_{jt} are the imports and exports in sector $j = \{i, s\}$ respectively. These conditions imply that while agricultural consumption is met entirely from domestic production, the sum of domestic output and imports of services equals the sum of domestic consumption and exports of services to the rest of the world. In the industrial sector, domestic output and imports of industrial goods together equal the sum of domestic consumption, investment and exports of industrial goods to the rest of the world.

There are also three market clearing conditions for primary inputs:

$$\begin{aligned} k_{at} + k_{it} + k_{st} &= k_t \\ n_{at} + n_{it} + n_{st} &= 1 \\ l_{at} &= 1 \end{aligned}$$

where labor supply per capita is normalized at unity and where l_{at} is the supply of land per capita, also normalized to unity.

There is a role for foreign trade. When calibrating the model, industrial net imports ($ni_{it} = i_{it} - x_{it}$) are fixed at a level chosen to match the data, and net exports of services ($nx_{st} = x_{st} - i_{st}$) are assumed to adjust. I make a simplifying assumption of trade being balanced in the steady state. Hence this implies that the net exports of services needed to pay for net imports of industrial goods are

$$p_{st} nx_{st} = p_{it} ni_{it} \tag{8}$$

where the price of the industrial good, p_i is given and assumed it to be unity at all dates. Then let $\{r_{kt}, R_{lt}, w_t, p_{at}, p_{st},\}$ denote the rental prices for capital and land, the wage rate, the price of the agricultural good, and the price of the service good, at date t, respectively.

3.2 Preferences

There is an infinitely-lived representative household endowed with one unit of time in each period. The lifetime utility function for the household is given by

$$\sum_{t=0}^{\infty} \beta^t U(c_{at}, c_{it}, c_{st})$$

where c_j is the consumption of good j ($j = a, i, s$) in period t and β is the discount factor. The per period utility function is given by

$$U(c_{at}, c_{it}, c_{st}) = ln(\omega_a c_{at}^{\epsilon} + \omega_i c_{it}^{\epsilon} + \omega_s c_{st}^{\epsilon})^{(1/\epsilon)}$$

with $\epsilon < 1$ and $\sum \omega_{j=a,i,s} = 1$. Thus, the elasticity of substitution between c_a, c_i and c_s is given by $\frac{1}{1-\epsilon}$.

The parameter, ϵ, plays an important role in generating structural change in models with differential TFP growth across sectors. Specifically, if consumption goods are complements, then, in the presence of differential TFP growth across sectors, resources are transferred to the sector experiencing the lowest TFP growth. But if consumption goods are substitutes, then resources are allocated to the sector witnessing highest TFP growth. The underlying reasoning is that the sector witnessing highest TFP growth also experiences the most rapid decline in the price of the good that it produces. If the goods are substitutes, the household increases its share of consumption expenditure on this relatively cheap good, and reduces the share of expenditure on the other goods. The household then demands more of the cheap good and reduces the demand for the relatively expensive good. As a result, when the two goods are substitutes, labor shifts into the sector where TFP growth is the highest. The converse is true when goods are complements. Since the growth accounting results reveal TFP growth to be largest in the service sector for India, and the data show that the output and employment of this sector have grown, I assume ϵ is < 1 and therefore assume that the three goods are substitutes in consumption.

The representative household faces the following maximization problem in each period

$$max \sum_{t=0}^{\infty} \beta^t U(c_{at}, c_{it}, c_{st})$$

subject to

$$p_{at}c_{at} + c_{it} + p_{st}c_{st} + k_{t+1} - (1-\delta)k_t = r_{kt}k_t + w_t n_t + R_{lt}l_{at} + p_{st}nx_{st} - ni_{it} \quad \forall \ t = 0, 1, ..\infty$$

given k_0, all prices, the net import level of industrial goods ni_i.

The above equations, together with assumptions that firms maximize profits and markets are perfectly competitive, provide a complete description of the model.

4 Calibration

The two years considered as steady states are 1980 and 1999. In these two years, the value of net imports of industrial goods (as a share of GDP) was approximately equal to the value of net exports of services (as a share of GDP). In other words, trade balance as a share of GDP was roughly small (-0.2 percent in 1980 and 0.7 percent in 1999) and hence I assume balanced trade in these two years [7].

To calibrate the model, I fix the level of net imports of industrial goods from the data and solve for the level of net exports of services, by using the balanced trade condition. Factor shares for each sector have been constructed as explained above. The TFP growth rates for each sector have been taken from the baseline growth accounting exercise[8]. The subjective discount factor, β, is calibrated to match the real interest rate in 1980 and the depreciation rate is set at 5 percent.

The remaining parameters - TFP levels in the initial period - b_{a0}, b_{i0}, b_{s0}; the weight on the agricultural and industrial good in the utility function - $\omega_a, \omega_i,$; and the parameter dictating the elasticity of substitution between the three goods - ϵ, are calibrated to minimize the sum of squared differences between the data and the model with respect to six targets in the initial steady state. These six targets are - the share of output in agriculture, the share of output in services, the share of employment in agriculture, the share of employment in services, the share of consumption expenditure on services and the relative price of the service good, all in 1980. Specifically, if $\hat{y}_{a0}, \hat{y}_{s0}, \hat{n}_{a0}, \hat{n}_{s0}, \hat{CS}_0, \hat{p}_{s0}$ are the model's prediction for the six targets and $y_{a0}, y_{s0}, n_{a0}, n_{s0}, CS_0, p_{s0}$ are the actual observations in the data, then I solve the following problem:

$$\begin{aligned}\{b_{a0}, b_{i0}, b_{s0}, \omega_a, \omega_i, \epsilon\} = arg \min_{\{x,y,z\}} \sum \{ & (\hat{y}_{a0} - y_{a0})^2 + (\hat{y}_{s0} - y_{s0})^2 + (\hat{n}_{a0} - n_{a0})^2 \\ & + (\hat{n}_{s0} - n_{s0})^2 + (\hat{CS}_0 - CS_0)^2 + (\hat{p}_{s0} - p_{s0})^2 \}\end{aligned} \tag{9}$$

In order to calibrate the above parameters, I need data on private final consumption expenditure as well as relative prices of service goods. *CMIE* reports disaggregated data for

[7] Agricultural trade as a share of GDP was relatively small for the sample period and hence I assume no trade takes place in this sector.

[8] TFP growth rates used here are for the period 1980-1999.

private final consumption expenditures. To construct sectoral consumption expenditure, I group the disaggregated final consumption expenditures under the three sectors, following Echevarria (1997)[9]. Since the industrial good is assumed to be the numeraire in the model, relative prices for the service goods are got by dividing the GDP deflator series for services with that of industry.

The parameter values are listed in the table below.

Table 4: Calibrated Parameters

Parameters	**Description**	**Values**
θ	capital share in agriculture	0.22
γ	land share in agriculture	0.2
α	capital share in industry	0.55
ϕ	capital share in services	0.44
b_{a0}	initial TFP level in agriculture	3.9
b_{i0}	initial TFP level in industry	1.1
b_{s0}	initial TFP level in services	1.9
g_{at}	growth rate of TFP in agriculture	0.0215
g_{it}	growth rate of TFP in industry	0.0078
g_{st}	growth rate of TFP in services	0.0302
β	discount factor	0.98
δ	depreciation rate	0.05
ω_a	weight on agricultural good	0.44
ω_i	weight on industrial good	0.19
ω_s	weight on service good	0.37
$1/(1-\epsilon)$	elasticity of substitution	4.3
ni_i (1980)	share of net ind. imports in GDP	0.0019
ni_i (1999)	share of net ind. imports in GDP	-0.015

5 Results

Table 5 reports the results for the two steady state years, 1980 & 1999. The model's predictions for the composition of output are good. The model predicts that 38 percent of output is attributable to agriculture in 1980, which is equivalent to what is observed in the

[9]Details of the classification methodology are provided in the data appendix.

data. In the industrial sector, the model slightly over predicts the output share at 29 percent while in the data the corresponding share is 24 percent. The share of output accounted by services is about 38 percent in the data and the model's prediction for this share is at about 33 percent for the initial steady state.

By 1999, agriculture's share of output reduces to about 28 percent, measuring closely to the share of 26 percent seen in the data. The model allocates about 29 percent of output in the second steady state to industry, roughly equal to the 27 percent observed in the data. With respect to services, the share of output accounted by this sector is about 42 percent as predicted by the model, a little less than the 46 percent seen in the data.

With respect to the allocation of labor in 1980, the model allocates the largest share of labor to agriculture, similar to what is observed in the data, although the model estimates this share at 41 percent while in the data the share is larger at 65 percent. The model allocates about 25 percent of labor to industry, more than the corresponding share of 15 percent observed in data. With respect to the share of labor in the service sector, the model predicts the share to be 34 percent in 1980, higher than the 21 percent observed in the data. Although the model cannot precisely capture the quantitative shares observed in the data, it does replicate the qualitative pattern of labor allocation in 1980 i.e. largest share of employment is accounted by agriculture, followed by services and then industry.

By the final steady state, the share of labor accounted by the agricultural sector decreases to about 30 percent; less than its data counterpart of 57 percent. In both the industrial and service sectors, the share of labor increases to 25 and 45 percent respectively, although these shares are higher than their data counterparts - 18 percent in industry and 26 percent in the service sector.

With respect to foreign trade, the model predicts the level of services' net exports to be small and slightly positive at 0.2 percent of GDP in 1980; in the data this share is small and negative at -0.03 percent of GDP. By the final steady state in 1999, the model predicts net exports of services to be negative and large, at 2.3 percent of GDP; the corresponding share observed in the data is about -0.7 percent of GDP.

Table 5: Results for the Two Steady States

	1980 DATA	1980 MODEL	1999 DATA	1999 MODEL
Composition of GDP				
Share in Agriculture	0.38	0.38	0.26	0.28
Share in Industry	0.24	0.29	0.27	0.29
Share in Services	0.38	0.33	0.46	0.42
Allocation of labor				
Share in Agriculture	0.65	0.41	0.57	0.30
Share in Industry	0.15	0.25	0.18	0.25
Share in Services	0.21	0.34	0.26	0.45
Share of service net exports in GDP	-0.0003	0.002	-0.007	-0.023

6 Counterfactual Experiment

The objective of this paper is to analyze the relative importance of two factors observed in the data with respect to service sector growth: the increase in services' trade that occurred after 1991, versus high TFP growth in the service sector. In this respect, I conduct two counter factual experiments. The first experiment allows TFP growth to take place in all three sectors but does not allow any trade to occur in industry and services. The second experiment allows trade to take place in the industrial and service sector but shuts down the growth of TFP in each of the sectors. In each experiment I examine the model's prediction for the change in the composition of GDP as well as the change in labor allocation in the second steady state 1999.

The results are displayed in tables 6. For ease of comparison, the data values and the original model's predictions for 1999 are reproduced in the table. A comparison reveals that labor allocation as well as composition of GDP does not change as one moves from an environment of trade to no trade. Hence, one observes that the absence of trade does not alter the sectoral composition of GDP as well as labor allocation in each sector, as compared to the results obtained from the original model.

The above inference does not apply in the case where TFP growth in each sector is ceased while trade takes place in the economy. In 1999, the model predicts a much larger share of output accruing in the agricultural sector at the expense of the service sector i.e. in the absence of productivity growth, the share of output in agriculture is about 38 percent, higher than data value of 26 percent. With respect to services, the share of output accounted by this sector is about 33 percent, falling short of the 47 percent observed in the data and the 42 percent predicted by the original model. The absence of TFP growth affects the industrial sector relatively less. Industrial share of output is about 29 percent as compared to the data value of 27 percent. The model allocates the largest share of labor to agriculture at 41 percent, followed by services (34 percent) and then industry (25 percent). The model predicts the same value of net exports of services (as a share of GDP) at -0.02 percent as that seen in the original model; this is higher than the share of -0.007 percent observed in the data.

Table 6: Counterfactual Experiment

	1999 DATA	**1999 ORIGINAL MODEL**	**NO TRADE**	**NO TFP GROWTH**
Composition of GDP				
Share in Agriculture	0.26	0.28	0.28	0.38
Share in Industry	0.27	0.30	0.30	0.29
Share in Services	0.47	0.42	0.43	0.33
Allocation of labor				
Share in Agriculture	0.57	0.30	0.30	0.41
Share in Industry	0.18	0.25	0.25	0.25
Share in Services	0.26	0.45	0.45	0.34
Share of service net exports in GDP	-0.007	-0.02	0.00	-0.02

7 Conclusion

Following the economic liberalization in India, the service sector has gained prominence in the economy as it accounts for the largest share of GDP and, also that the share of this sector in GDP has been growing very rapidly. Empirical data reveal two significant trends in the service sector following liberalization in 1991: growth in service sector productivity and growth in services' trade. The objective of this paper is to build a simple three sector quantitative model which can capture the increase in the share of service sector in GDP after liberalization. In particular, the model is assessed on how closely can it replicate the composition of output and allocation of labor for the three principal sectors of the Indian economy namely, agriculture, industry and services across two steady state years. Within the context of the model, there are two exogenous changes that occur across the two steady states: growth in sectoral TFP and trade in industrial and service sectors. A steady state is defined as a year in which the trade balance as a share of GDP is closest to zero. The two years which meet this criterion are 1980 and 1999.

The model developed here is successful in replicating the shares of sectoral output and the change in this sectoral composition across the two steady states. It can correctly capture the direction of structural change as the economy transforms from a situation where the agricultural sector dominates the GDP to a situation where the service sector gains primary importance. It cannot capture the shares of labor allocation in the two years. Although the model predicts a much larger level of net exports of services, it does estimate a negative level of net exports, similar to what is observed in the data.

The second focus of my analysis is to identify the relative importance of TFP growth versus trade in industry and services. This is done by shutting down one source of exogenous change and letting the other operate solely on its own. The results from the counterfactual reveal that shutting down sectoral TFP affects the ability of the model to capture the data trends whereas the absence of trade negligibly affects the results. The mechanical method of modeling trade limits the model's ability to address trading opportunities as a source of growth and is an avenue to be explored in the future. However, the simple quantitative model does show that TFP growth can replicate the sectoral composition of output and hence is a better candidate to examine the model's dynamic performance[10].

[10]See Verma (2008) for a thorough exposition of the model's dynamic performance.

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Table 7: Growth Rates of GDP per capita in Low Income Countries

Countries	1980 **GDP per capita less than** 825 **constant** 2000 **U.S.$**	**Average annual growth rate (%) of GDP per capita 1980-2004**
Rapid Growers: growth rate greater than 2%		
China	186.44	8.51
Thailand	804.48	4.58
Bhutan	263.65	4.12
India	222.05	3.76
Indonesia	396.63	3.50
Sri Lanka	441.86	3.29
Chad	147.26	2.34
Lesotho	309.65	2.34
Pakistan	327.43	2.31
Bangladesh	240.51	2.16
Nepal	140.08	2.11
Countries with growth rate greater than 1% but less than 2%		
Sudan	274.22	1.93
Mozambique	179.01	1.80
Burkina Faso	191.69	1.08
Countries with growth rate greater than 0% but less than 1%		
Kiribati	435.41	0.84
Mauritania	361.8	0.79
Guyana	819.41	0.79
Ghana	233.56	0.74
Senegal	405.53	0.53
Benin	292.44	0.47
Mali	220.22	0.302
Solomon Islands	597.09	0.26
Cameroon	638.19	0.15
Papua New Guinea	582.54	0.15
Gambia	327.21	0.12
Countries with growth rate less than 0%		
Kenya	435.24	-0.08
Malawi	161.7	-0.23
Guinea-Bissau	144.44	-0.23
Nigeria	425.32	-0.24

Table 7: (continued)

Countries	1980 **GDP per capita less than** 825 **constant** 2000 **U.S.$**	**Average annual growth rate (%) of GDP per capita 1980-2004**
Comoros	404.63	-0.29
Rwanda	280.35	-0.48
Burundi	126.36	-0.78
Zimbabwe	598.68	-1.12
Zambia	450.51	-1.21
Central African Republic	313.57	-1.37
Togo	346.28	-1.45
Madagascar	341.81	-1.66
Niger	245.5	-1.87
Haiti	802.62	-2.57
Sierra Leone	310.4	-2.82
Congo, Dem. Rep.	251.12	-4.29
Liberia	744.48	-7.02
All Countries: Average annual growth rate 0.51%		

Data Appendix

1. Classification according to current daily status approach (cds): The activity pattern of people particularly in the unorganized sector is such that a person might be pursuing more than one activity during a week and sometimes even during a day. In the current daily status, upto two activity statuses were assigned to a person on each day of the reference week. The unit of classification was thus half day in the cds. In assigning the activity status on a day, a person was considered working for the entire day if he had worked 4 hours or more during the day. If he had worked one hour or more but less than 4 hours, he was considered working (employed) for half day and seeking/available for work (unemployed) or not available for work (not in labor force) for the other half day depending on whether he was seeking /available for work or not. On the other hand, if a person was not engaged in any work even for one hour but was seeking or available for work for 4 hours or more, he was considered unemployed for the entire day. If he was available for work for less than 4 hours only, he was considered unemployed for half day and not in labor force for the other half of the day. A person who neither had any work to do nor was available for work even for half of the day was considered not in labor force for the entire day and was assigned one or two non-economic activity status codes. The aggregate of person days classified under the different activity categories for all the seven days gave the distribution of person days by activity category during an average week over the survey period of one year.

2. Expenditure on agriculture goods includes food, beverages, pan & intoxicant, tobacco & its products. Expenditure on industry includes clothing & footwear, gross rent, fuel & power, furniture and household, personal transport equipment and operation of personal transport equipment. Expenditure on services includes other services in furniture etc., medical care & health services, equipment, recreation, education & cultural services, miscellaneous goods & services, hotels & restaurants, & transport & communication minus the sum of personal transport equipment and operation of personal transport equipment.