The Journal of World Economic Review; Vol. 12 • No. 1 • (June 2017)

Modern India and Its Growth Miracle: A Neoclassical Analysis

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ABSTRACT

After decades of slow growth since Independence from the British Raj, Indian economy registered its own small miracle, when growth rate of GDP per capita surpassed the long term growth rate of many advanced economies. What caused this miracle? In this paper, we search for an answer in the neoclassical growth model. We use productivity as measured by Solow residual as our exogenous shock. Our idea is to quantitatively measure the extent to which fluctuations in productivity can account for observed fluctuations in macro economic aggregates in India if we control for variable capacity utilization. We find that exogenous fluctuations in productivity can well account for fluctuations in output especially during the boom period after 1991. However, fluctuations in productivity alone are not enough to generate macro aggregates close to data. We do need to take into account changes in capacity utilization which seems to have played a major role in India especially before 1991.

JEL Classification Code: *E13, E32, O11.*

1. INTRODUCTION

If you are a student of history studying the evolution of human civilization, you will find Indian civilization occupying a pride of place amongst the earliest developed civilizations of the world. However, unfortunately, such a position in the annals of development economics has long eluded India. In fact, for economists, India is a country which despite its enormous natural resources has only managed to gain a place as a developing "third-world" country in any development report. However, since the eighties, the scenario has been changing. Within a span of two decades, Indian economy has rapidly transformed itself from a poor economy known more for its uncontrollable population growth to an economy viewed by many as the new miracle. A brief look at the growth rate of GDP per capita bears testimony to this fact. During the period 1960 to 1979, the growth rate of GDP per capita stood at 1.1%. Since 1980, the growth rate has increased to 3.8%, which is higher than the long term growth rate of 2% observed in many industrialized countries including United States.

In this paper, I ask the question "To what extent can changes in productivity quantitatively account for the observed changes in real macroeconomic aggregates if we take into account fluctuations in capacity utilization?" The common understanding is that the Indian economy saw an unprecedented spurt of software development, which coupled with drastic changes in policy encouraging free markets and liberalization led to a rapid growth in productivity. This development, coupled with the fact that India is traditionally a cheap labor market, which now became a source of skilled labor, at least in the software arena, led to increases in output per capita. In an earlier paper, I used a neoclassical growth model where productivity was modeled as a residual of contributions of capital stock and labor in output. The results indicated that fluctuations in productivity thus calculated almost wholly accounted for fluctuations in real macroeconomic aggregates like output per capita, capital-output ratio and labor. However, one component that was not taken into account was fluctuations in capacity utilization. Therefore, the question that remains is that would productivity still almost wholly account for fluctuations in output per capita if we take into account variable capacity utilization? This paper aims to resolve this unanswered question.

At this point it is necessary to see why it might be important to control for capacity utilization. There are a number of papers which show us that incorporating capacity utilization in the production function often reduces the significance of TFP in accounting for observed macroeconomic variables. Studies by Susanto Basu (1996), Craig Burnside, Martin Eichenbaum and Sergio Rebelo (1995) amongst others highlight the importance of taking into account capacity utilization in accounting for business cycles. This paper also takes a similar approach. What we are mainly interested in is a study of the Indian growth experience through the lens of neoclassical economics. Literature in this area has been comparatively sparse, though much debate has ensued as to what caused India's small miracle? There are quite a few papers which agree with the contribution of Indian IT sector as the catalyst of economic growth. On one hand we have Nirvikar Singh (2004) who argues the important role played by the Indian IT sector in promoting growth. This view, perhaps not surprisingly, finds great support among the IT pioneers of India. NR Narayan Murthy, Chairman of Infosys, one of the fastest growing IT companies that originated in India hails the changing climate in India by arguing that "... the economic reforms of 1991 changed the Indian business context from one of state-centered, control orientation, to a free, open market orientation – especially for hitech companies. It allowed Indian companies to start competing effectively on a global scale" at the Indian Economy Conference at Cornell University (2002). On the other end of the spectrum, we have Dani Rodrick and Arvind Subramanian (2004) who investigate "... a number of hypotheses about the causes of this growth – favorable external environment, fiscal stimulus, trade liberalization, internal liberalization, the green revolution, public investment – and find them wanting." They argue that "... growth was triggered by an attitudinal shift on the part of the national government towards a pro-business (as opposed to pro-liberalization) approach." So, it is probably safe to surmise that the debate as to the cause of growth is very much alive.

We take an alternative approach to the entire question by trying to quantitatively account for the extent to which the growth rate of GDP per capita can be explained by growth in aggregate productivity, if we take into account changing capacity utilization during this period. To this end, we use a dynamic general equilibrium model with exogenous productivity and exogenous capacity utilization. Our objective is to see how output per capita, investment per capita and labor responds to an exogenous change in productivity.

The approach used in this paper was popularized by Finn Kydland and Ed Prescott (1986). The economy is modeled as a dynamic general equilibrium where the only source of exogenous shock is the exogenous change in productivity. The neoclassical approach of Kydland-Prescott considers productivity in the simplest form: changes in Total Factor Productivity (TFP) as the residual of output after accounting for capital and labor contributions. In this sense, the approach does not provide any insight as to the sources of productivity growth or sectors where the growth might have originated. It is simply meant to capture if such exogenous changes in TFP can substantially explain changes in macro-economic aggregates if TFP is the only exogenous shock to hit the economy. In this paper, productivity is calculated as a residual of capacity utilization (and not merely capital) and labor. This is the only difference between Kydland and Prescott's approach and this paper. Do the results differ significantly?

Our results show that indeed the results are different. When we do not account for capacity utilization, productivity growth can almost wholly account for observed changes in output per capita. However, if we take into account capacity utilization, productivity alone can at best explain only 75% of the fluctuations in output per capita. Ignoring the role of capacity utilization thus would overemphasize the role of TFP fluctuations.

The rest of the paper is organized as follows: in section 2, we provide an outline of the Indian economy since 1960 to 2004. In section 3, we outline the model. In this section, we also outline the methodology that we apply to solve the model for the policy variables, including the calibration technique to solve for the model parameters. Section 4 provides a summary of the results. Section 5 concludes the paper.

2. THE INDIAN ECONOMY

Our period of analysis is 1982 to 2003. We begin with an analysis of national accounts during this period. The variables of interest to us are output per capita, capital-output ratio and the evolution of labor throughout the period. In keeping with the tradition of neoclassical analysis, our population is the working age population, that is, population aged 15 to 64 years. Further, we are interested in seeing how the macro aggregates of the Indian economy diverged from the balanced growth path values of these aggregates. We would have liked to go back in time and perform the analysis for India since its independence from the British rule in 1947. However, one of the problems that we encounter is that data on labor hours is restricted to be available only from 1982 onwards. Consequently, we summarized the earlier period in numbers and plot the evolution of the economy since 1982. We assume that the long term growth rate of Indian economy is the average growth rate of GDP per capita over the period 1960 to 2002 which is 1.5%. We detrend per capita output, capital stock and government expenditure by 1.5% and report the results. We further report the observed labor hours.

2.1 Output Per Capita and Capital-Output Ratio

GDP per capita not only grew well below trend during the period 1960 to 1980, it grew progressively worse during this period. However, since 1980, the GDP per capita has staged a recovery. Since 1987, the per capita growth rate of GDP has consistently been above 1.5% till the present period. Figure 2.1.1 shows GDP per capita with respect to a 1.5% trend between 1982 and 2002.

We also trace the evolution of capital-output ratio since 1980 in Figure 2.1.2. Capital output ratio is increasing throughout the period of consideration, except for a brief decline during 1986 to 1988. A brief note that we need to keep in mind in interpreting the capital output ratio is that we do not have the explicit data on capital output ratio of the economy. In absence of such a ratio, we pick the depreciation rate to be 25%, the rate allowed by the Indian tax code on physical capital and use the national income accounts data on investment per capita to calculate the capital stock data using perpetual inventory method.

Figure 2.1.1
Output Per Capita-Discounted at 1.5%

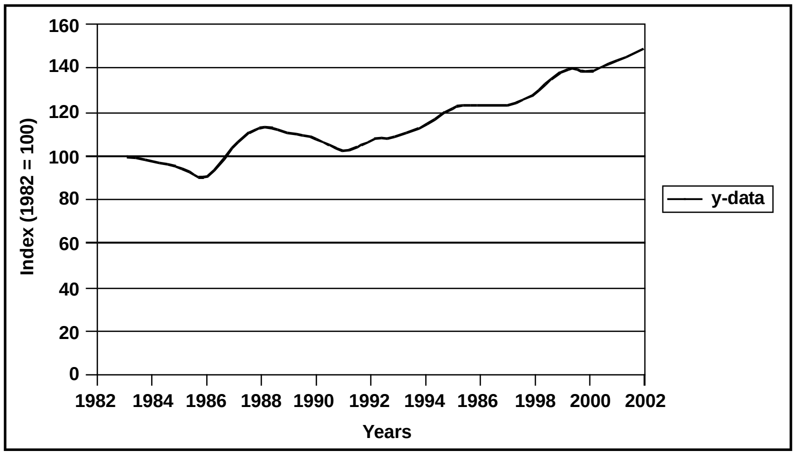
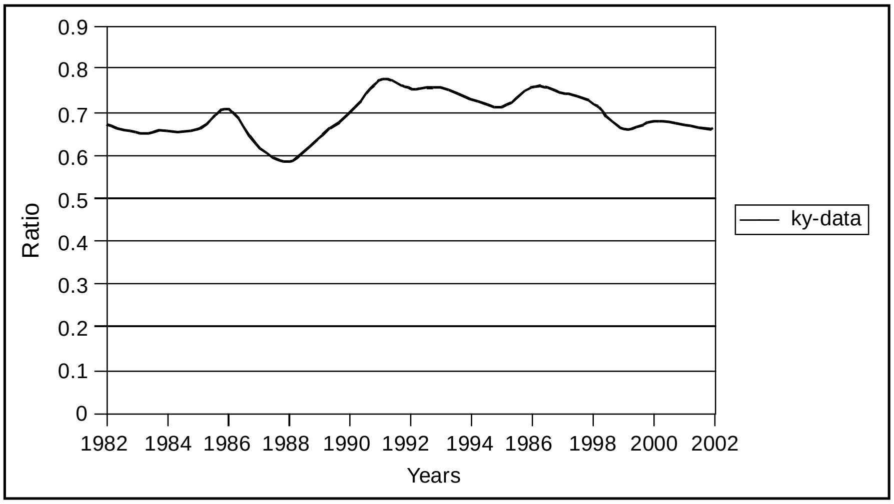


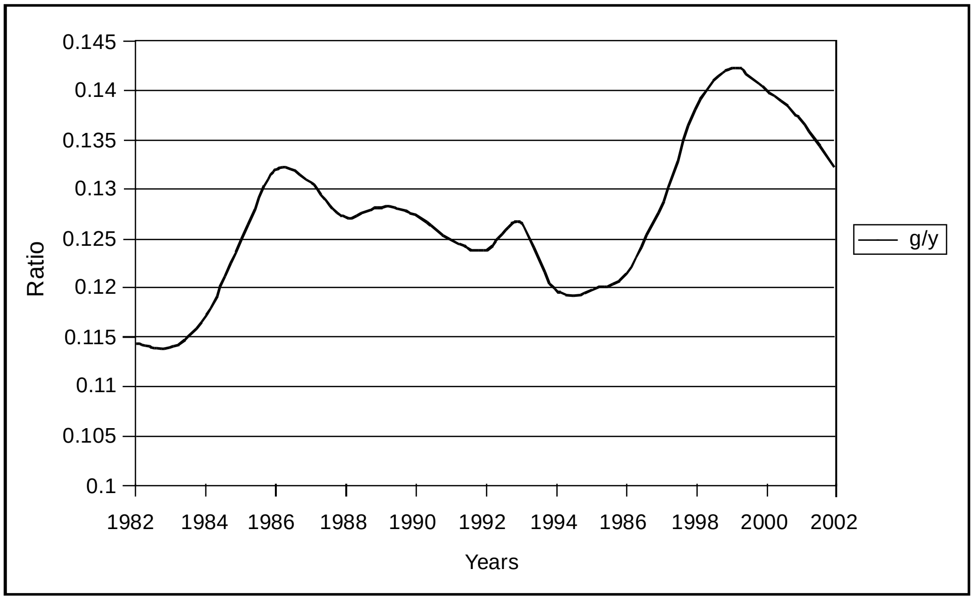
Figure 2.1.2
Capital-Output Ratio



2.2 Share of Government Expenditure in GDP

What is also interesting in the Indian context is the observed ratio of Government expenditure to GDP. We find that share of government expenditure in GDP increased since 1960 throughout the eighties. The share fell briefly during the early part of the nineties. Government has played a major role in Indian development since the planning period following Independence in 1947 and fiscal policy has been a big part of it. The problem that plagued India is that increased government expenditure could not translate into increased economic growth. The trend in government expenditure since 1982 is captured in Figure 2.2.1.

Figure 2.2.1
Govt. Expenditure as a Ration of Output



2.3 Employment and Labor Hours

Tracing the evolution of employment and labor hours in India possesses an unique challenge. The data on employment is available only from the organized sector and in India a large proportion of the population is either self-employed or employed in the unorganized sector. Similarly, data on labor hours is only restricted to the organized sector. We can gather data on working population as a percentage of total population from Bureau of Labor Statistics. The years for which it is available is 1982 onwards. Our definition of working population is population aged 15 to 64 years. Further we have data on percentage unemployed. We calculate employment by subtracting unemployed from working population. As for labor hours, we assume that any labor has 100 hours a week at his or her disposal. We calculate actual hours worked as a ratio of maximum possible hours at the disposal of workers, which is 100. For our analysis, hours worked is taken as hours worked in manufacturing.

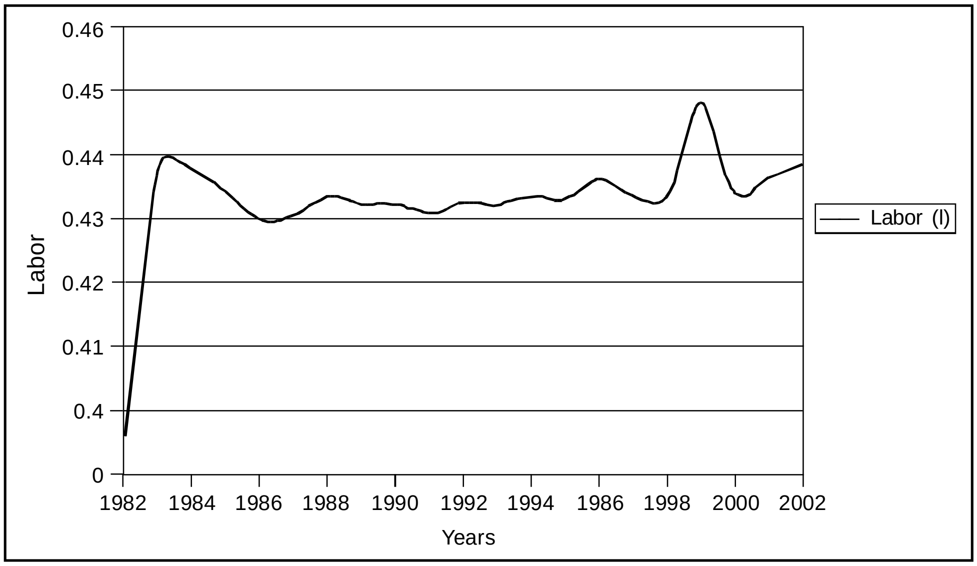
We denote labor as

$$l(t) = \frac{E(t) * H(t)}{N(t) * 100}$$

where $\frac{E(t)}{N(t)}$: employment as a fraction of working population and

$\frac{H(t)}{100}$: actual hours worked as a fraction of total hours

Figure 2.3.1
Labor (l)



From our analysis, we find that $l(t)$ increases from .4 to .44 between 1982 to 2002. This is depicted in Figure 2.3.1.

3. INDIAN ECONOMY FROM A GROWTH THEORY PERSPECTIVE

3.1 Model Description

Our model economy consists of a continuum of infinitely lived identical agents of measure N_t. We assume that at every period t population grows at a constant rate of η. The representative agent has one unit of time endowment every period. They value consumption and leisure and earn wage and rental income. They spend their after tax income on consumption and save the rest in the form of capital stock that is used for future production. We assume taxes to be lump sum. Further, we assume there is just one good produced in the economy that is used for consumption and investment. The consumer maximizes the present discounted value of lifetime utility subject to the budget constraint. Thus the economic problem of the consumer is to choose consumption and labor every period such that the present discounted value of lifetime utility is maximized subject to a budget constraint. Therefore, the representative consumer's problem can be written as:

$$Max \sum_{t=0}^{\infty} \beta^t u(c_t, 1 - l_t)$$

subject to:

$$1. c_t + k_{t+1} - (1 - \delta) k_t \leq w_t l_t + r_t k_t - t_t \ \forall t$$

$$2. \textit{nonnegativity constraints}$$

where c_t is the consumption in period t, lt denotes labor in period t, k_t denotes capital in period t, w_t is the wage rate in period t, r_t is the rental rate in period t, and t_t denotes per capita lump sum taxes. We further denote the rate of time preference as β. The rate of depreciation of capital stock is denoted by δ.

In addition to a measure N_t of consumers, the economy also consists of an infinite number of identical firms which own the production technology. As mentioned before, we assume that there is just one good being produced, consumed and invested every period. The objective of a representative firm in this economy is to maximize profits subject to the given production technology. Therefore, the representative firm's problem can be written as:

$$\begin{gathered} Max\; y_t - w_t l_t - r_t k_t \\ subject\ to: \\ y_t \leq F(u_t, k_t, l_t, z_t)\ \forall t \end{gathered}$$

where y_t: denotes output in period t, u_t: denotes capacity utilization and z_t: denotes productivity.

Apart from consumers and firms, the economy also has a government that collects tax revenue and uses it to finance government expenditure. We assume that the government budget is balanced so that aggregate government expenditure every period G_t is equal to the lump-sum taxes, T_t. Further, the resource constraint of the economy every period is given by:

$$c_t + k_{t+1} - (1-\delta)k_t + g_t \leq y_t$$

where g_t denotes per capita government expenditure.

The equilibrium in the economy can be summarized as consisting of a set of allocations, $\{c_t, l_t, k_{t+1}, y_t\}_{t=0}^{\infty}$ and a set of prices $\{w_t, r_t\}_{t=0}^{\infty}$ such that the representative consumer maximizes present discounted value of lifetime utility subject to the budget constraint and non-negativity constraints as outlined in consumer's problem; the representative firm maximizes profits every period subject to a given production technology. Further, every period the government maintains a balanced budget and the resource constraint is satisfied.

3.2 Solution Procedure

To solve the model, we first have to decide on the functional forms. For purposes of our analysis we assume that the utility function is of the form:

$$u(c_t, l_t) = \log c_t + \alpha_1 \log(1 - l_t).$$

We further assume that the production function is Cobb-Douglas with labor augmented technology:

$$F(u_t, k_t, l_t) = (u_t k_t)^{\theta} (z_t l_t)^{1-\theta}.$$

Note that our production function is different from the usual Cobb-Douglas specification in that it takes into account variable capacity utilization, u_t. We solve for the first order conditions using the functional forms specified above. Further, we also take into account population growth in our derivation of model solution.

Now the representative consumer's problem reduces to:

$$Max \sum_{t=0}^{\infty} (\beta\eta)^t (\log c_t + \alpha_1 \log(1 - l_t))$$

$$\textit{subject to}:$$

$$1.c_t + \eta k_{t+1} - (1-\delta)k_t \leq w_t l_t + r_t k_t - t_t \;\forall t$$

$$2.\textit{nonnegativity constraints}$$

The firm's problem reduces to:

$$Max\; y_t - w_t l_t - r_t k_t$$

$$\textit{subject to}:$$

$$y_t \leq (u_t k_t)^{\theta}\,(z_t l_t)^{1-\theta}\;\forall t$$

and government's problem remains the same. The resource constraint reduces to:

$$c_t + \eta k_{t+1} - (1-\delta)k_t + g_t \leq y_t$$

We solve the model using the technique of log linearization around the steady state as popularized by King, Plosser and Rebelo (1988). In order to do so we have to transform the model variables by discounting them with the long term growth rate g_z so that we can calculate the steady state variables. The model can be summarized by the following first order conditions, where hat denotes a variable discounted by the long term growth rate, for example $\hat{x}_t = \frac{x_t}{(1+g_z)^t}$:

$$1.\frac{\alpha}{1-\theta} : \frac{\hat{w}_t(1-l_t)}{\hat{c}_t}$$

$$2.\beta E_t \frac{\hat{c}_t}{\hat{c}_t + 1}\{\hat{r}_{t+1} + 1 - \delta\} = (1+g_z)$$

$$3.(1-\theta) = \frac{\hat{w}_t l_t}{\hat{y}_t}$$

$$4.\theta = \frac{\hat{r}_t k_t}{\hat{y}_t}$$

$$5.\hat{y}_t \leq (u_t \hat{k}_t)^{\theta}\,(z_t l_t)^{1-\theta}$$

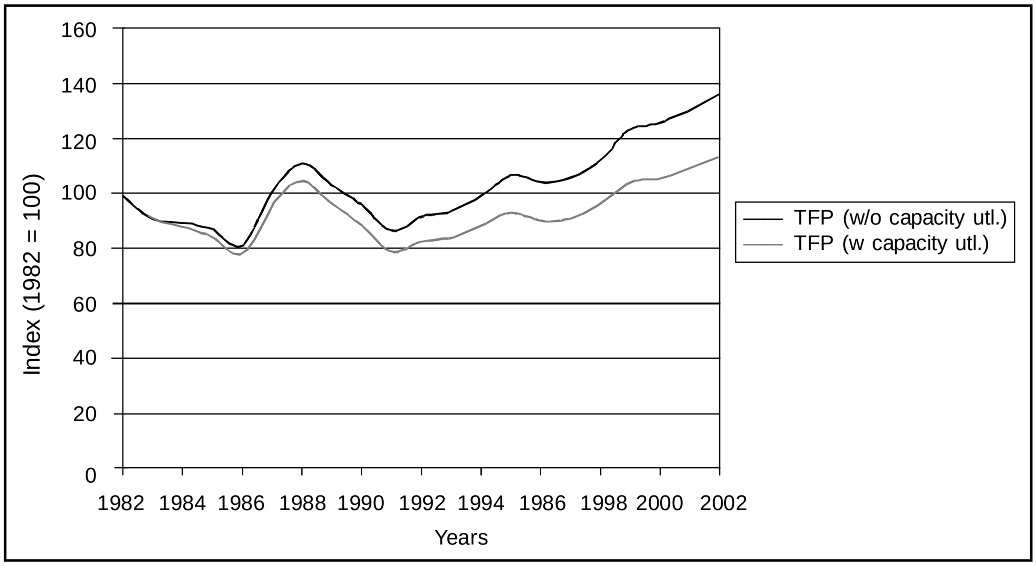
$$6.\hat{c}_t + \eta(1+g_z)\hat{k}_{t+1} - (1-\delta)\hat{k}_t + \hat{g}_t \leq \hat{y}_t$$

For our model solution, we first need to calibrate the model (i.e. find the parameter values) such that the moments of the model variables match the moments of the data. We therefore start the next section by a description of our data sources.

3.3 Data Description and Model Calibration

The data is collected from World Bank database of World Development Indicators. We collect the labor data from Bureau of Labor Statistics. The labor data for India is only available from 1982 onwards. Given the data restrictions, we restrict the data analysis to the period 1982 to 2002. For capacity utilization, we use the time series data on energy kilo-watt hour use per capita from World Development Indicators as a proxy. In Figure 3.3.1, we graphically represent TFP measured after taking into account capacity utilization and without taking into account capacity utilization. We find that between 1982 to 1991, average TFP (without taking into

Figure 3.3.1
Total Factor Productivity



account capacity utilization) falls at a rate of 1.04%, however in the latter period, average growth rate of TFP between 1992 and 2002 grows at a rate of 4.21%. If we take into account changes in capacity utilization, the growth rate of TFP is reduced. Now, between 1982 and 1991, TFP registers an average decline by 2.15% and it registers an average growth at the rate of 3.38% between 1992 and 2002. This is to be expected given that capacity utilization grows at an average rate of 2.03% between 1982 and 1991, however the growth rate reduces to 1.42% in the latter period. This explains why changes in TFP are less drastic if we incorporate changes in capacity utilization in our production function.

Moments of the data (taking averages of the period 1982 to 2002):

Table 1
Moments of the Data, Average Over the Period 1982 to 2002

$c/y = .7$
$x/y = .18$
$wl/y = .64$
$l = .43$
$\eta = .0235$
$g_z = .015$

We assume that the long run growth rate $(1 + g_z)$ is 1.5% which is the long run growth rate of the Indian economy. Another problem that we have mentioned in section 2.1 is that we do not have the capital output ratio of the economy. In absence of such a ratio, we pick the depreciation rate to be 25%, the rate allowed by the Indian tax code on physical capital. As for the share of GDP going to labor, we assume the share to be .64 as often used in growth literature. We can conduct robustness check on our solution for different parameter combinations. The calibrated parameters of the model reduces to:

Table 2
Calibrated Value of Model Parameters

$\theta = .36$
$\alpha = 1.21$
$\beta = .77$
$\delta = .25$

Once we calibrate the parameters of the model, we can find the steady state values which enables us to log-linearize the model. As mentioned earlier, we want to use the King, Plosser and Rebelo (1988) technique to solve for the policy parameters. When we log-linearize the equations our system reduces to:

$$7.\ \tilde{y}_t - \theta * \tilde{k}_t - \theta * \tilde{u}_t - (1-\theta) * (\tilde{z}t + \tilde{l}_t) = 0$$

$$8.\ \tilde{y}_t - \left(\frac{c}{y}\right) * \tilde{c}_t - \eta * (1+g_z)\frac{k}{y}\tilde{k}_{t+1} + (1-\delta) * \frac{k}{y}\tilde{k}_t - \frac{g}{y}\tilde{g}_t = 0$$

$$9.\ \frac{\alpha}{1-\theta}\tilde{y}_t - \frac{\alpha}{1-\theta}\tilde{c}_t - \frac{y}{cl}\tilde{l}_t = 0$$

$$10.\ \theta\frac{y}{k}E_t(\tilde{y}_{t+1} - \tilde{k}_{t+1}) + \frac{1+g_z}{\beta}E_t(\tilde{c}_t - \tilde{c}_{t+1}) = 0$$

where $\tilde{x}_t$ denotes the log deviation of a variable x_t from its steady state value. To derive the policy functions we will employ the Method of Undetermined Coefficients. In equations (7) to (10) there are three control variables: $\{\tilde{y}_t, \tilde{c}_t, \tilde{l}_t\}$, one endogenous state variable, $\tilde{k}_t$ and three exogenous state variables, $\tilde{u}_t$, $\tilde{z}_t$ and $\tilde{g}_t$. For our analysis, we assume that log deviation of capacity utilization from its steady state value $\tilde{u}_t$, log deviation of productivity from its steady state value $\tilde{z}_t$ and log deviation of government expenditure from its steady state value, $\tilde{g}_t$ follow a Vector Autoregressive process of order one, such that:

$$11.\ \tilde{u}_{t+1} = \rho_u * \tilde{u}_t + \epsilon_{ut+1}, \epsilon_{ut} \sim n(\epsilon_u, \sigma_u^2)$$

$$12.\ \tilde{z}_{t+1} = \rho_z * \tilde{z}_t + \epsilon_{zt+1}, \epsilon_{zt} \sim n(\epsilon_z, \sigma_z^2)$$

$$13.\ \tilde{g}_{t+1} = \rho_g * \tilde{g}_t + \epsilon_{gt+1}, \epsilon_{gt} \sim n(\epsilon_g, \sigma_g^2)$$

The solutions to our unknowns will take the form:

$$13: \tilde{y}_t = \tilde{y}(\tilde{s}_t, \tilde{k}_t)$$

$$14: \tilde{c}_t = \tilde{c}(\tilde{s}_t, \tilde{k}_t)$$

$$15: \tilde{l}_t = \tilde{l}(\tilde{s}_t, \tilde{k}_t)$$

$$16: \tilde{k}_{t+1} = \tilde{k}(\tilde{s}_t, \tilde{k}_t)$$

$$\textit{where}$$

$$\tilde{s}_t = (\tilde{u}_t, \tilde{z}_t, \tilde{g}_t)$$

Or translating in matrix form:

$$\tilde{v}_t = RR * \tilde{k}_t + SS * \tilde{s}_t$$

$$\textit{where}$$

$$\tilde{v}_t = (\tilde{y}_t, \tilde{c}_t, \tilde{l}_t)$$

$$\tilde{k}_{t+1} = PP * \tilde{k}_t + QQ * \tilde{s}_t$$

4. SOLUTION

4.1 Growth Accounting

We start by the results of a simple growth accounting exercise. We can use the production function and a little mathematical manipulation to decompose growth rate in output per capita into four parts:

$$y_t = (u_t k_t)^{\theta} (z_t * l_t)^{1-\theta}$$

$$\Rightarrow y_t^{1-\theta} = \left(\frac{u_t k_t}{y_t} \right) - (z_t * l_t)^{1-\theta}$$

$$\Rightarrow y_t = \left(u_t \frac{k_t}{y_t} \right) - (z_t * l_t)$$

$$\textit{where}$$

u_t : capacity utilization

$\frac{k_t}{y_t}$: capital output ratio

z_t : TFP factor

l_t : labor factor

Given the trend in productivity, we can divide the time period in two parts: 1982 to 1991 and 1991 to 2002.

Table 3
Average Growth Rate of Variables and Their Decomposition

Year	*1982:1991*	*1991:2002*
Output growth rate	.5%	3.47%
Capital output growth rate	1.92%	–1.42%
TFP growth rate	–2.15%	3.38%
Capacity utilization growth rate	2.03%	1.42%
Labor growth rate	–.21%	.16%

Table 3 points out to a rather interesting phenomenon. We find that growth rate of output per capita was driven by growth rate of capacity utilization and capital output growth rate during the period 1982 to 1991. However, since 1991 growth rate of output per capita is driven by TFP growth rate. We therefore next trace the transition dynamics with respect to TFP factor. For our analysis, we take $\rho_z = \rho_g = \rho_u = :95$. We have already solved for policy variables and calculated TFP as a Solow Residual. We solve for the policy functions using the standard Uhlig toolkit, which gives us the relevant coefficients. We now feed in the TFP process in our model and estimate the model's estimation of output, capital-output ratio, and labor.

The policy functions are summarized by the matrices as listed in Table 4:

Table 4
Coefficients of Policy Functions as Calculated by Uhlig Toolkit

PP =	0.6145		
QQ =	[0.5141,	–0.0352;	.2892]
RR =	[0.28,	.4994,	–.1250]
	0.7035	0.0438	.3957
SS =	0.5295	0.0763	.2978
	0.0992	0.0685	.0558

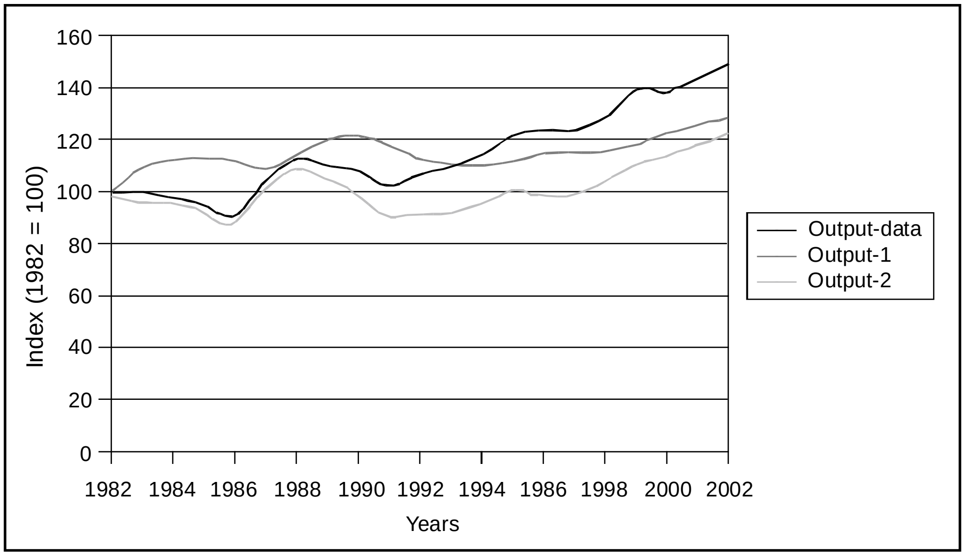
4.2 Transition Dynamics

The objective of the analysis is to quantitatively estimate the impact of productivity shocks on the Indian economy. We further use our analysis to account for the evolution of GDP per capita in the Indian economy since 1982 using TFP as the exogenous factor. In other words, during 1982 to 2002 if TFP was the only exogenous factor that deviated from its balanced growth path value, how would GDP per capita, capital-output ratio and labor evolve?

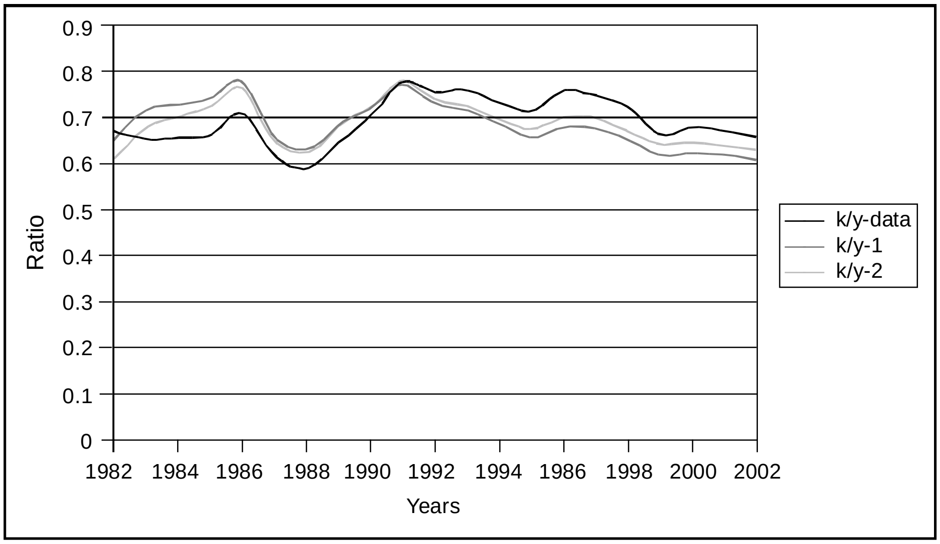
We perform our analysis under two cases: one where we do not take into account changes in capacity utilization when measuring TFP and the second when we measure TFP as a residual of capacity utilization, capital and labor services.

In our analysis, we divide the period of study into two sub-periods as we did for growth accounting: 1982:1991, and 1991:2002. We find that the average growth rate of output per capita with respect to a 1.5% trend was .5% during 1982 to 1991 but increased to 3.5% since 1991. Feeding in our first measure of TFP (without taking into account capacity utilization), we find that our model predicts an average rate of decline in output per capita by –.06% (with respect to a 1.5% trend) during the first sub-period and 3.72% during the second sub-period. If we measure TFP taking into account capacity utilization, then our model shows an average decline in output per capita with respect to a 1.5% trend by .7% during 1982 to 1991 and an average growth of output per capita by 3.38%. Thus our results show a reduced role of TFP if we take into account capacity utilization. This result is supported by our model's results regarding capital-output ratio. According to data, capital output ratio was .67 on average during the first sub-period and .52 during the latter period. A model without taking into account capacity utilization shows a capital output ratio of .7 during the period 1982 to 1991 and .66 during 1991 to 2002. If we take into account capacity utilization ratio, capital output ratio is .69 during the first sub-period and .68 during the second sub-period. However, note that our model does not trace the evolution of labor very well. This is a common problem with empirical application of a neoclassical growth model and not due to the specification of productivity. One can observe the above results in Figures 4.2.1 to 4.2.3

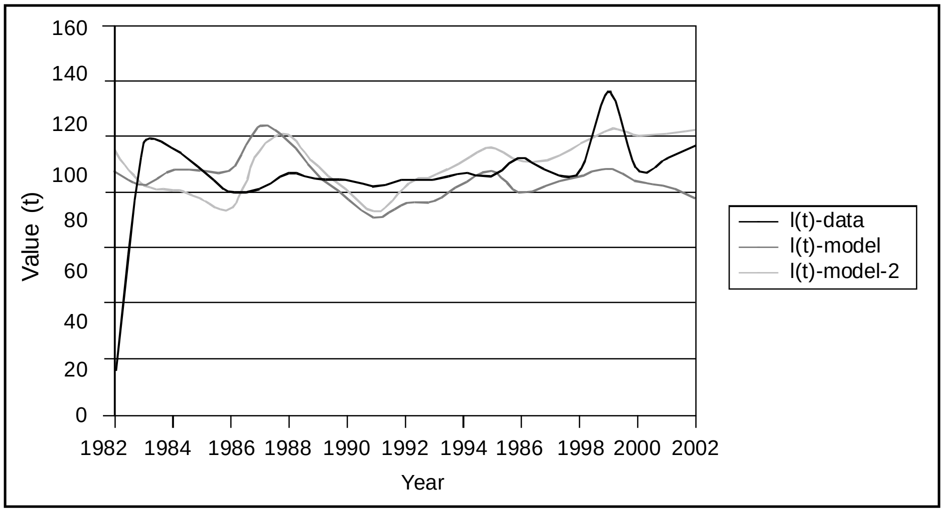
Figures 4.2.1
Output Per Capita



Figures 4.2.2
Capital Output Ratio

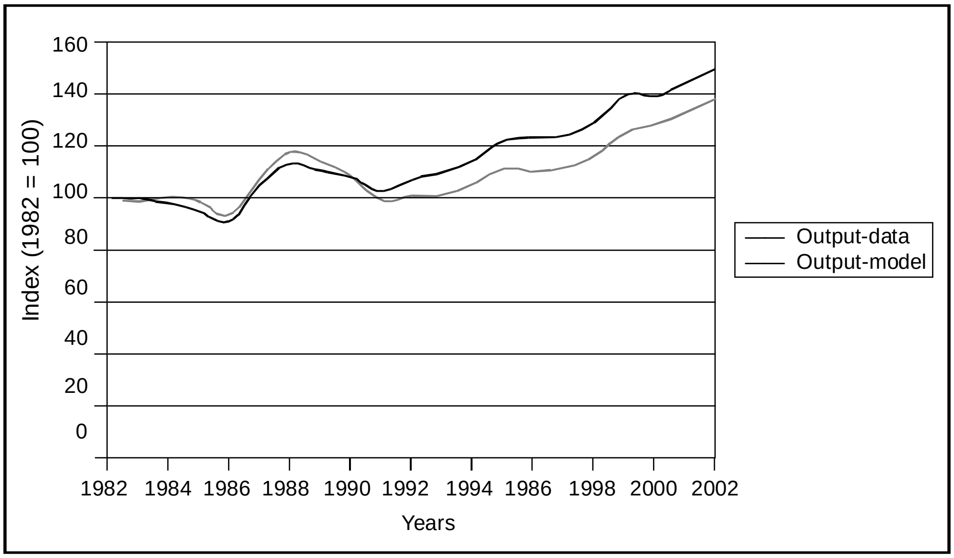


Figures 4.2.3
Labor



In summarizing the results of all the sub-periods, we can deduct that productivity did play an important role in the evolution of Indian economy since 1991. In the period 1982 to 1991 however productivity was actually falling. Out-put per capita would have registered a negative growth rate if not for increases in capacity utilization. However, since 1991, TFP growth has

Figures 4.2.4
Output Per Capita



picked up and it played a pivotal role in improving the performance of the Indian economy. As to a comparison of TFP performance in a model with capacity utilization with a model without capacity utilization,if we do not take into account capacity utilization, then fluctuations in TFP overestimate the changes in output per capita especially till 1994. Taking into account capacity utilization, TFP changes in our model generate output per capita pretty close to data as shown in Figure 4.2.1. As expected, output per capita generated by a model where TFP is the residual of the contributions of capital, labor and capacity utilization, is less than output per capital in a model where TFP is generated without taking into account capacity utilization. If we include both TFP changes and changes in capacity utilization, our model can account almost wholly for output per capita as we find in Figure 4.2.4.

5. CONCLUSION

The performance of the Indian economy since independence from the "British Raj" in 1947 has been dubbed by Dani Rodrick as "Hindu growth". The term highlights an economy that is not a miracle, neither a debacle. But since early eighties, Professor Rodrick was proved wrong as Indian economy started booming and the growth rate of GDP per capita registered an average 3.8% increase between 1991 and 2002 which has surpassed the long term growth rate of 2% of the developed economies.

In this paper, our aim was to quantitatively account for the performance of the Indian economy since 1982 from a growth theory perspective. We employed the technique of growth accounting pioneered by Prescott and Kydland and Prescott (1986) who feed in exogenous technical shocks to a growth model after calibrating the model parameters to match moments of the data. At the crux of the analysis is the idea that if there was no deviation of technology from its steady state path economy would be at equilibrium. As technology deviates from steady state value, macroeconomic aggregates also respond to technical deviations by deviating from their steady state values. To what extent can technological fluctuations alone account for movements in macro aggregates? In our model we compare two possible measures of TFP: one in which TFP is measured without taking into account changes in capacity utilization and the second in which TFP is the residual of contributions of capital, labor as well as capacity utilization in output.

We applied the technique of growth accounting using a neoclassical growth model to India during the period 1982 to 2002. The period restriction is because of the availability of employment and hours data which we get only from 1982 onwards.

Our results indicate that productivity as measured by TFP did play an important role in the Indian economy especially during the booming years after 1991. In the previous period, however, TFP actually registers a decline which would have also caused a fall in growth rate of output per capita with respect to a 1.5% long term trend if not for increasing capacity utilization. Simple growth accounting shows that capacity utilization increased during this period which might be a factor in preventing a sharp output drop.

Our paper opens up many interesting questions, as it looks at the Indian economy from a growth theory perspective. We do not explore the primitives behind TFP fluctuations which we take as exogenous. Growth theory as used in this paper is limited in that it also does not include other channels of shocks like financial frictions or labor market frictions. An extended model like Business Cycle Accounting of V. V. Chari, Patrick Kehoe and Ellen McGrattan (2002) would provide richer answers. Another possible research direction might be to investigate the causes behind the TFP increase since 1992 which may be related to a booming software industry. Micro-level analysis of software industry data might provide the key to a TFP boom in India.

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