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Indian Economic Growth

Lessons for the Emerging Economies

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Abstract

Can we use neoclassical growth model to single out the important transmission channels through which external factors or 'primitives' affected the Indian economy and caused the remarkable growth of the period 1982–2002? In this paper, we answer the question by applying the new technique of business cycle accounting to the Indian economy. Our results show us that the primary conduit of policies that brought about significant growth in India was productivity that registered an unprecedented increase particularly in the 1990s. Our results further indicate that changes in labour market frictions and investment market frictions did not play a significant role, though increased government consumption aided growth by propping up demand. In addition, we examine the effective tax rates in India and find that while investment taxes barely fluctuated, income tax rates were increasing throughout. We suspect other positive developments in the Indian economy overwhelmed the negative effect of increasing labour income taxes on growth. Our result suggests that any emerging country that aims to replicate the Indian experience would do well to formulate policies that target productivity, a lesson that seems consistent with the Japanese experience since the Second World War.

Keywords: business cycle accounting, India, growth, wedges, neoclassical growth, taxes

JEL classification: E13, E32

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1 Introduction

Since the last two decades, India's name has figured prominently amongst the list of emerging economies. After decades of slow growth, India entered into a new phase of economic reconstruction during the mid eighties and the nineties. In comparison to a measly 1% growth rate in the years following independence from the British Raj in 1947, Indian GDP per capita growth rate reached 1.5% in the eighties, still not quite up to the benchmark but not dismal either. The picture drastically changed in the nineties, when the growth rate of GDP per capita reached an average of 5%, much beyond the benchmark and a small miracle on its own.

This economic transition has been attributed to many factors among which the development of the software sector and a pro-liberalization approach of the government as opposed to a more centrally planned socialist approach of yesteryears has been hailed as the primary drivers of growth. 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 in favor of 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 hi-tech companies. It allowed Indian companies to start competing effectively on a global scale"[1]. 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". In a previous paper[2] we examined the role of technology or productivity growth in bringing about the economic miracle in India using a neoclassical framework following the growth accounting procedure of Edward Prescott and Finn Kydland (1982), where technology is treated as an external shock. However, in addition to merely identifying the macroeconomic fundamentals[3] that have played a role in Indian economic development, another issue of interest is "how" they affect the economy. Thus a study of numerically accounting for Indian economic growth is incomplete unless in addition to identifying the primary forces that were particularly successful in generating economic growth in India, we also identify the "transmission channels" through which these factors worked. In this paper, we concentrate on this second issue and this leads us to examine the growth of India during the eighties and the nineties through the lens of business cycle accounting. We further extend our analysis to see if changes in taxes played any role in generating increased growth by comparing the time series of tax rates in India with the results of our business cycle accounting.

The Business Cycle Accounting (henceforth BCA) procedure, a relatively new procedure[4] is based on the fundamental observation that there are primarily three channels or "wedges" through

[1] Quotation from speech delivered at the Indian Economy conference at Cornell in 2002.

[2] Chakraborty (2006)

[3] In technical jargon, the external forces or macro fundamentals that affect an economy causing a change in output is also referred to as a "primitive".

[4] Two seminal papers in this area is by Casey Mulligan (2002) and V.V. Chari, Patrick Kehoe and Ellen McGrattan (2002, 2006).

which any external friction or policy can affect an economy: through an impact on productivity, through an impact on labor market, and through an impact on investment market. For example, if we believe that economic liberalization and free market policies were the primary forces behind Indian economic growth, two obvious channels through which these policies affected the economy seems to be the productivity channel and the investment market channel where the frictions that made it costly for Indian firms to gain access to funds were considerably lessened if not completely eradicated. Economists also consider government spending to be an important channel through which government can directly affect the economy.

There are a couple of crucial points that one needs to keep in mind while conducting a business cycle accounting analysis for any economy. In an ideal world with no frictions, the economy would be able to achieve the first best outcome, or grow at a balanced growth rate as assumed in real business cycle literature. However, if an economy is subject to market frictions, these frictions would prevent the economy from achieving the first best outcome and the economy would move away from a balanced growth path. In a real business cycle model, on which the BCA procedure is based, these frictions or "wedges" would show up as distortions in the first order conditions. What BCA tells us is that there are primarily three ways (four if you consider government expenditure channel) through which external frictions affect an economy. If we knew the numerical value of the frictions exactly, then if we feed in all the frictions jointly in a benchmark real business cycle model, we should be able to replicate the data exactly. The question we are interested in is: which of these frictions play a major role in the economy? Here the trick is to allow for the frictions one by one to assess their importance by evaluating how well can a friction on its own replicate the data. This exercise is called "decomposition".

From a methodological perspective, to apply the BCA procedure to India, we take a neoclassical growth model and extend it to include time varying efficiency or productivity wedge that is the Solow residual, labor wedges that are modelled as labor income taxes, investment wedges that resemble taxes on investment expenditure and government wedges that is actually government spending. The solution of the model involves two parts: since the wedges represent external market frictions, there is no data available on them and we need to use the results of our model to calculate the wedges (this step is somewhat like back-calculating the value of frictions). The primary idea here is that the wedges summarize all possible frictions that affect the economy. Hence in theory the data on output, investment or labor that we observe is a function of these wedges. Since we know the data from National income accounts, we can use them and the policy functions from our model to calculate the wedges. Next, we feed in the time series of our model generated wedges one by one and in various frictions and check how well they match up with the observed output.

Our decomposition results show that primitives affected the Indian economy primarily by causing changes in productivity. Labor market frictions or investment market channel was not particularly important. The growth in productivity was also supported by increasing government expenditure that propped up demand. Comparing the Indian experience with that of Japan in the reconstruction period after the 2nd World War, the common channel of growth that one can identify is a productivity increase. Note that we are not saying that the primitives in form of increased impetus towards liberalization and pro-business policies were not important. In fact we are not commenting on the primitives at all at this point. Our premise is that whatever means (or primitives as we call them) any developing nation decides to implement, it would best serve to jump-start growth if it is directed to improve productivity. At least that is the lesson that the Indian miracle seems to teach us.

Note that the wedges or frictions that affect the first order conditions of our model, at least on the face value, resemble taxes. In other words, the impact of these frictions are similar to the impact of changing taxes, though the frictions represent much more than just taxes. They embody all forms of distortions that can affect an economy. For example, the labor wedge, on its face value, resembles a tax on labor income. An increase in the labor wedge is associated with an economic depression just like an increase in labor income tax would do. However, it is entirely possible that the labor income tax rates of the economy don't change much but other factors affecting the labor market do. For example, union bargaining for higher wages would result in a slow growth and would be captured by the "labor wedge" channel. The effect is thus similar to what would have happened had the labor income tax rates changed.

In this context, it is worthwhile to note that while the tax rates in an economy are not the be all and end all of wedges, they do comprise one of the important factor that show up as wedges in our model and can have far reaching consequences for the economy. In addition, they are the only market friction for which we have reliable data as provided by the government of a country. Hence, one natural curiosity is to see to what extent did changing tax rates affect an economy? For example, if we notice from our decomposition results that labor wedge is important in accounting for fluctuations in an economy, the natural question would be to what extent is it due to changes in labor income tax rates?

In context of India, note that neither labor wedge nor investment wedge turns out to be important in accounting for economic fluctuations in India. Does this imply that labor and investment taxes did not change? Or is it that the effect of changing labor and investment taxes were mitigated by opposing forces that shows up in our model as labor and investment wedge? To answer this question, we compute the effective labor and investment taxes for the Indian economy and find that while investment taxes did not change much, there was a steady increase in labor income taxes that by itself would have discouraged growth but were obviously overwhelmed by positive developments in the economy that kept the labor wedge in our model from worsening.

The rest of the paper is organized as follows: in Section 2 we outline our model. Section 3 discusses the methodology and the results. In Section 4 we present the results of comparing the wedges with the taxes and Section 5 concludes the paper.

2 Business Cycle Accounting

BCA procedure uses a standard growth model with four stochastic variables or wedges: *efficiency wedge* A_t , which appears like time varying productivity; the *labor wedge* τ_{nt} , which acts like a time varying tax on labor income, and the *investment wedge* τ_{xt} , which acts like a tax on investment expenditure. Further, per capita government expenditure g_t, is also considered as '*government wedge*', which can have a significant impact on the economy. Each of the wedges represent the overall distortion to the relevant first order conditions.

2.1 Theoretical model

We assume that the economy every period comprises of a measure N_t of identical and infinitely lived agents who are endowed with one unit of time that can be used for work and leisure. The economy also consists of measure one of identical firms that own the production process. For purposes of analysis, we assume that population grows at a constant rate η every period and is exogenously determined. We assume that there is one output that is produced and consumed in the economy. There is a government that collects income and investment taxes and uses the proceeds to finance government expenditure and transfers in such a fashion as to balance the government budget every period. Given the structure of the economy, we can summarize the problems facing the agents of the economy as:

2.1.1 Representative consumer's problem

The representative consumer in the economy chooses per period consumption c_t and labor l_t to maximize present discounted value of lifetime utility. The consumer receives income from two sources: labor income and rental income from capital. In addition, the consumer also receives some transfers from the government. The proceeds of the income and transfers are used to finance consumption and investment expenses. Further, the consumer has to pay income (τ_{nt}) and investment taxes (τ_{xt}) to the government at an exogenously determined rate. Thus the representative consumer's problem can be written as:

$$Max\ E_0 \sum_{t=0}^{\infty} \beta^t u(c_t, 1 - l_t)$$

$$\text{subject to:}$$

$$c_t + (1 + \tau_{xt})x_t \leq w_t l_t (1 - \tau_{nt}) + r_t k_t + Tr_t$$

$$k_{t+1} \leq (1 - \delta)k_t + x_t$$

$$\textit{nonnegativity constraints}$$

where k_t denotes per capita capital stock, x_t denotes per capita investment, after-tax labor income is $w_t l_t (1 - \tau_{nt})$ and rental income is $r_t k_t$ where w_t is the wage rate and r_t is the rental rate on capital stock, β is the discount factor, δ is the depreciation rate on capital stock, and Tr_t denotes transfers from the government received at period t.

2.1.2 Representative firm's problem

Every period, the representative firm produces a single output using labor and capital to maximize profits. Output is subject to an exogenously given production technology. Hence the representative firm's problem every period is given by:

$$\begin{gathered} Max\ y_t - w_t l_t - r_t k_t \\ \text{subject to:} \\ y_t \leq F(k_t, A_t l_t) \end{gathered}$$

where y_t denotes per capita output and A_t denotes productivity. For my analysis I assume that the production technology is labor augmenting. The long run rate of technical progress is denoted by $(1 + g_z)$.

2.1.3 Equilibrium

The equilibrium in this economy is given by a vector of price functions $\{w_t,\ r_t\}_{t=0}^{\infty}$ and a vector of allocation functions $\{c_t,\ l_t,\ k_{t+1},\ y_t\}_{t=0}^{\infty}$ such that the price and allocation functions satisfy the following equations every period:

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

$$y_t = F(k_t, A_t l_t) \tag{2}$$

$$\frac{u_{nt}(c_t, l_t)}{u_{ct}(c_t, l_t)} = (1 - \tau_{nt}) F_{lt}(k_t, A_t l_t) \tag{3}$$

$$\begin{gathered} \beta E_t u_{ct+1}(c_{t+1}, l_{t+1})\{F_{kt+1}(k_{t+1}, A_{t+1} l_{t+1}) + (1-\delta)(1+\tau_{xt+1})\} \\ = (1+\tau_{xt}) u_{ct}(c_t, l_t) \end{gathered} \tag{4}$$

where notations like $u_{ct},\ u_{nt},\ F_{lt},\ F_{kt}$ etc. denotes the first derivative of the utility function and production function with respect to different arguments like consumption, labor, and capital. Equation (1) represents the resource constraint faced by the economy every period and is the output market clearing condition. Equation (2) shows that output every period is subject to the production technology. Equation (3) equates the marginal rate of substitution between consumption and leisure to the after tax marginal return to labor, where in equilibrium, the marginal return to labor or the wage rate is equal to the marginal product of labor. Equation (4) is the inter-temporal equation taking into account the fact that in equilibrium, rental rate on capital is equal to the marginal product of capital. The four equations outlined above summarize the equilibrium conditions of the economy every period. Note that the time varying productivity and taxes on labor income and investment expenditure distort the first order conditions and keeps the economy from achieving the first best outcome.

2.2 Application to India

We want to apply the BCA technique to India to account for fluctuations in output during the period 1982 to 2002.

The steps involved in BCA accounting are twofold:

(1) Given the parameter values and the first order conditions, we derive the time series of the wedges.

(2) Once we have the realized values of the wedges, we feed in the wedges one by one and in various combinations to see to what extent our model matches the data[5]. This exercise is called decomposition.

In this paper, we simplify the original method of BCA by assuming that investment wedge τ_{xt} does not vary over time and let only productivity A_t, the labor wedge τ_{nt} and the government consumption wedge g_t vary. The logic of our exercise is described in the technical appendix, but the basic idea is that we assume initially that investment wedge is constant at its steady state value for simplicity. This assumption makes calculating the time series of the productivity and labor wedges easier as we do not have to first estimate how agents form expectations over time which is necessary to get the investment wedge. Assuming investment wedges to be constant circumvents this problem. Once we get the productivity and labor wedge series, we feed them in our model. If efficiency and labor wedges jointly can well replicate the data, it means that investment wedges did not play an important role and we were right in holding them constant at their steady state value. On the other hand, if even after feeding in efficiency and labor wedge, the model falls short of explaining the data, we argue that investment wedges (that our model assumes does not change) must in reality have varied and have played a major role in the economy. In the technical appendix, we discuss this method in greater detail and also explain how we derive the time series for the wedges.

For our exercise we need to specify the utility and the production functions and take into account the population growth rate while deriving the first order conditions. We assume a Cobb-Douglas production function and a standard monotonically increasing and strictly concave utility function represented by:

$$\begin{aligned} u(c_t, l_t) &= \frac{\left(c_t^{\alpha}(1-l_t)^{1-\alpha}\right)^{1-\sigma}}{1-\sigma}, \text{ when } \sigma \neq 1 \\ &= \alpha \log\ c_t + (1-\alpha)\log\ (1-l_t) \text{ when } \sigma = 1 \end{aligned} \tag{5}$$

$$y_t = k_t^{\theta}(A_t l_t)^{1-\theta} \tag{6}$$

The functional forms that we use are same as those used by Chari, Kehoe and McGrattan (2002) as well as by Prescott and Hayashi (2002). Note that on a balanced growth path, the variables c_t, k_{t+1}, y_t, and g_t grow at a rate $(1 + g_z)$. The model does not allow us to calibrate for the parameter values as we do not know the steady state value of the wedges. So our fist step for solving the model is to pick parameter values from literature. We assume β or the rate of time

[5] For details, please refer to the Technical Appendix.

preference to be .95 as is commonly used in business cycle literature. We take α to be .8251 and θ to be .36 from Chakraborty (2006) and we assume that depreciation rate $\delta = .25$ that we derive from the Indian tax code that allows non-residential corporations to claim tax relief for depreciated capital stock at a maximum depreciation rate of 25%. Once we have our parameter values, we can calculate the wedges from the first order conditions of the model and the data. Given the time series of the realized wedges, we are interested to get an intuitive idea of if they look promising in generating economic growth in India.

Let us begin by graphically demonstrating the evolution of GDP per capita over the period 1982 to 2002 with respect to a long term time trend of 1.5%. Figure1 graphically demonstrates the index of detrended GDP per capita. The way we arrive at this figure is by first detrending GDP per capita during 1982 to 2002 at the rate 1.5% which is the long term trend growth rate in India that we derived by taking the average growth rate of GDP per capita during 1960 to 2002. Then, we take the value of detrended GDP per capita in 1982 as 100 and recalculate the detrended GDP per capita in the following years with respect to 100. This gives us the index of detrended GDP per capita and is quite useful in charting how GDP per capita has performed over the years. From Figure1, we can summarize that GDP per capita has consistently grown above the trend growth rate in the eighties and the nineties and the rate of growth accelerated since 1991.

Next, we are interested to see whether efficiency or labor wedge could have played a role. We can also look at government consumption wedge that we are not plotting here for the sake of brevity. Figure2 plots the index of efficiency wedge, where we take the value of A_t in 1982 to be a 100. We find that productivity also grew during 1982 to 2002 with respect to the long term trend which at least intuitively is conducive to economic growth.

Figure3 plots the labor wedge, τ_{nt}. From Equation (3) note that an increase in labor wedge, or an increase in τ_{nt} is associated with labor becoming costlier and would therefore cause a drop in output. Given Figure (.3), note that except for between 1982 to 1983 when we find labor wedge declined, labor wedge has not changed much over the last two decades. Now keeping in mind that labor wedges represent labor market frictions that keep the economy from achieving the first best outcome, we should expect economic growth to be associated with a decline in value of labor wedge or a decline in labor market frictions. So, if labor wedge does not show any such decline, intuitively it could not have played a role in bringing about economic growth in India. As for the dramatic decline in 1982 to 1983, we attribute it to a data mis-specification as we find that labor data shows a dramatic shift in 1982 which cannot be attributed to any drastic shifts in labor market policy. Our belief is that labor market data reporting which has been consistent only after the mid eighties could have somehow contributed to this big jump, and so we do not take this seriously.

3 Decomposition

In this section we show the model outcomes generated by feeding in the realized values of the wedges one by one and in various combinations in our decision rules and evaluate how well they can approximate the macro data.

We solve for the decision rules of our model using the log-linearization techniques of Robert King, Charles Plosser and Sergio Rebelo (1988). The decision rules are derived as:

$$
\begin{bmatrix} \widetilde{k}_{t+1} \\ \widetilde{y}_t \\ \widetilde{l}_t \end{bmatrix} = PP * \widetilde{k}_t + QQ * \begin{bmatrix} \widetilde{A}_t \\ \widetilde{\tau}_{nt} \\ \widetilde{g}_t \end{bmatrix}
$$

where PP is a 3x1 matrix and QQ is a 3x3 matrix of coefficients where the log deviation of a variable z_t from its steady state value $\overline{z}$ is denoted by $\widetilde{z}_t$. The only exception in this specification is $\widetilde{\tau}_{nt}$ which is equal to $\tau_{nt} - \overline{\tau}_n$ where we follow Chari, Kehoe and McGrattan's (2002) specification. Note that given decision rule for capital $\widetilde{k}_{t+1}$, output $\widetilde{y}_t$ and labor $\widetilde{l}_t$ we can implicitly derive the decision rule for consumption $\widetilde{c}_t$ using the market clearing condition for final output.

We begin by first stating the correlations between output, efficiency wedge and labor wedge during the period 1982 to 2002. The correlation between GDP per capita and efficiency wedge is .98 and that between GDP per capita and labor wedge is .1. Given our model, we expect a positive correlation between productivity or efficiency wedge and output and that is supported by correlation figures. However the correlation between output and labor wedge is positive though small which indicates that frictions in labor market and output per capita moved in the same direction. This suggests that output increased despite of labor market frictions, not because of a decline in labor frictions in which case the observed correlation would have been negative. This begets the question: was the increase in productivity enough to account for the magnitude of increase in output?

To answer this question, we graphically depict the model outcomes feeding in various realizations of wedges in our model and comparing them with data. As Figure4 depicts the model outcome with efficiency wedge alone can very well replicate the output per capita observed in India, however the model outcome feeding in labor wedges cannot explain any of the observed data on output per capita.

If we feed in efficiency, labor and government wedges jointly in our model we can almost wholly account for observed output per capita in the data which leads us to conclude that investment wedges played a limited role if at all in the Indian economy during the eighties and the nineties. This result is consistent with the view that economic growth in India was a result of a sharp increase in productivity. Government expenditure, that continued to increase over the nineties, also helped by propping up demand. Labor market rigidities, on the other hand, were still prevalent and tempered growth to some extent.

To verify our analysis we also look at an alternative macro variable, the capital-output ratio (Figure5). The results are pretty similar to what we saw for output per capita. With efficiency wedges alone the model well replicates the data on capital-output ratio but feeding in labor wedges alone we cannot account for the observed capital-output ratio. However, feeding in efficiency, labor and government wedges jointly in the model, the model outcome closely replicates the data which supports our previous conclusion that economic development in India was a handiwork of increased productivity and increased government spending.

4 Tax rates and wedges

In the introduction, we mentioned that the labor and investment wedges in business cycle accounting at least on the face value resemble time varying labor income taxes and investment taxes respectively. We also noted that though market frictions other than policy induced changes in tax rates also affect the wedges, time varying tax rates by themselves can also affect the wedges and move the economy away from a balanced growth path. While it is difficult to get data for most frictions and we need to resort to using our model and available national income accounts data to back out the value of the wedges, we can independently get the data for tax rates and compare that with the model generated wedges. This analysis helps us with two issues: (1) it helps us answer to what extent are policy induced changes in tax rates responsible for the time varying wedges and the resulting effect on the economy (2) if the pattern of time varying taxes and wedges do not match up, it indicates a need for us to turn our attention to other possible sources of the frictions that have the potential to affect the wedges and hence the economy.

The results of our decomposition show that productivity wedges by themselves can almost wholly account for output increases in India during the period 1982 to 2002. This result itself tells us that there is a limited role of labor wedges or investment wedges. In fact the labor wedge (Figure3) shows little fluctuation except during 1982-1983 that we chalk up to data mis-specification.

Next, we plot the labor income tax rates from the Indian economy. The data is provided by the Reserve Bank of India[6]. In our model, we do not have heterogenous agents, where one group owns labor while the others are entrepreneurs, so we do not have a distinction between labor income taxes and corporate taxes. In our model, the representative agent owns all the income and is responsible for all the income taxes. While we do not have the effective tax rates per se, we need to calculate the time varying tax rates from the data on tax revenues and output. The data is split between central government revenue and the state government revenue. To calculate the labor income tax rates, we add the revenue from personal income taxes and the corporate taxes of both the central and state government and divide it by the output. The result is plotted in Figure6.

The effective labor income tax rates according to our measure has gone up steadily throughout the last two decades. This, by itself, would have put a damper on economic growth but when we compare this with the labor wedge in Figure3, we find that labor wedge does not show much fluctuations. This result indicates that while income tax rates in India might have been steadily increasing throughout the eighties and nineties, there were other changes in the economy that acted to counter the effect of rising labor income taxes and kept the labor wedge from deteriorating. Hence, even though the tax rates were increasing, the Indian economic growth continued unabated.

Next, we turn our attention to investment taxes. Now, our decomposition exercise also points to a limited role of investment wedges. Does this indicate that investment taxes did not change much, or was the impact of investment taxes overwhelmed by other frictions? While India does not have an explicit taxes on investment expenditure, from real business cycle literature, we know that we can use taxes on consumption expenditure as a proxy for investment taxes. To this end, we again turn to national income accounts data to calculate the effective tax rates. We take the indirect taxes net of subsidies as a proxy for our investment taxes and divide it by the private consumption expenditure to get the effective tax rates. We plot the result in Figure7. Note that the effective tax rates on investment do not show any significant trends except for a mild decline since 1994 that would have been conducive to economic growth.

Thus given the time series of taxes, we can conclude that while labor income taxes were rising, they did not cause a decline in the growth rate possibly due to overwhelming effects of other positive developments in the economy. The investment tax rates did not change much, thus it is consistent

[6] Data is available at the following link: http://www.rbi.org.in/scripts/Statistics.aspx

with the fact that we see a limited role of investment wedges, except since 1994, when a decline in investment tax would have been conducive to growth.

5 Conclusion

After decades of unremarkable growth following independence, Indian economy took off in the eighties and continued to grow well into the nineties. While a number of economists have suggested theories to explain this growth phenomenon, empirical studies that attempt a numerical growth accounting of India is at best limited. In an earlier paper (Chakraborty 2006), we had attempted to understand the role of technological progress, held by many as the primary reason for Indian growth using a neoclassical growth analysis.

In this paper, our attempt is to apply a comparatively new procedure of growth accounting called "Business Cycle Accounting (BCA)" procedure to India. Our objective is to figure out not the macro fundamentals or "primitives" that brought about economic growth in India but the "transmission channels" through which the primitives played a role. For example, if we establish that liberalization policies in the eighties and nineties generated the economic revolution, did liberalization policy act by increasing productivity, did they reduce frictions in the labor market thus encouraging growth or did liberalization policies break down investment market barriers? This paper helps us answer such questions. The BCA procedure is particularly suited for this job as it is based on the key observation that most primitives affect the economy through productivity, or the labor market or the investment market and neoclassical model can be used to study these frictions as the frictions resemble taxes at least on the face value. Thus by solving the neoclassical growth model and by inserting the frictions one by one and in various combinations we can decipher which frictions affected the economy the most and thereby understand the most important transmission channel of the primitive forces that affected the economy. Our results show that primitives affected the Indian economy primarily by causing changes in productivity. Labor market frictions or investment market channel was not particularly important. The growth in productivity was also supported by increasing government expenditure that propped up demand.

The lesson from the Indian growth experience therefore seems to be that targeting productivity would help jump-start growth for any emerging country that is in the same boat today as India was a decade ago. This lesson is not a radical one. It was also corroborated by the Japanese experience during the reconstruction period following the 2nd World War, and the Japanese fall from grace during the nineties. Prescott and Hayashi (2002) shows us that it was the drop in total factor productivity that knocked Japan off from its steady growth path that was a consistent feature it its almost three decades of growth. Note that in this paper, we are not identifying primitives that help jump-start growth. Instead, we focus on the often neglected *channel of growth.* Our argument is that government policies and regime changes that will be most successful in initially jump starting growth would be the ones that would work by increasing productivity. At least that is what the Indian and Japanese experience seems to teach us.

Looking back at the effective tax rates, we conclude that labor income taxes are increasing over time and by themselves would have slowed Indian growth rates though investment taxes do not show much changes. It is worthwhile, therefore, to explore other changes in the economic climate that affected the Indian economy through the labor wedge channel and kept the negative effect of increasing labor income taxes from overwhelming the economy. A decline in union bargaining activities would be a possible direction to look at, particularly in the private sector.

In our view future research should concentrate on the primitives that might have caused increases in productivity. It would also be interesting to look at micro data and provide evidence of such technical progress that in turn would help us target the improvement areas at a micro level.

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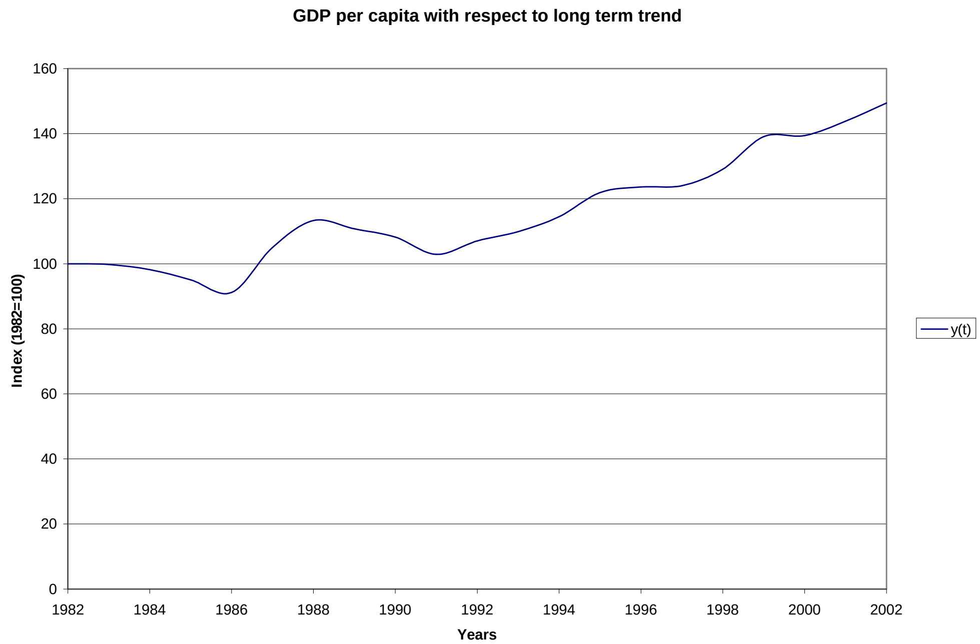

Figure 1: GDP per capita detrended at 1.5%

Note: We plot the GDP per capita after detrending it by the long term growth rate of 1.5%. The GDP per capita of 1982 is assumed to be 100 and we plot the index.

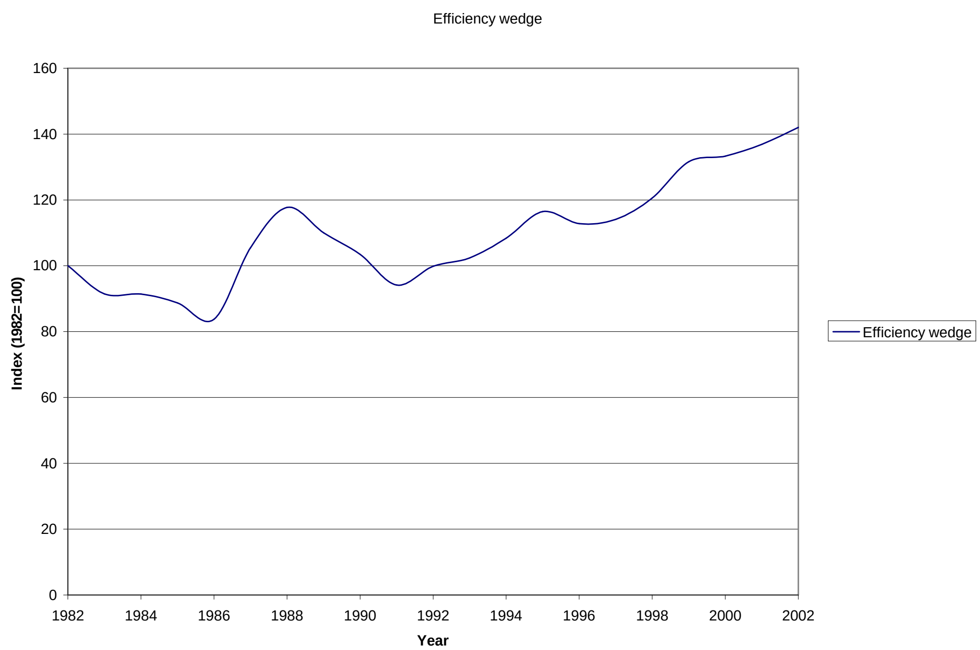

Figure 2: Realized efficiency or productivity wedge

Note: We plot the efficiency wedge as a Solow residual. Once again, the efficiency wedge in 1982 is assumed to be 100.

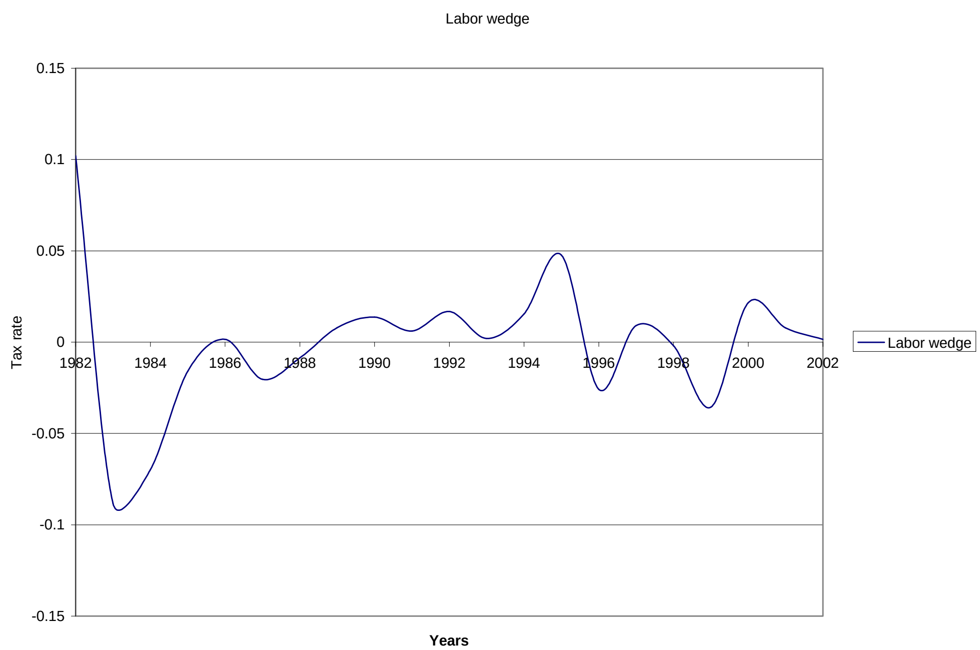

Figure 3: Labor wedge

Note: We plot the labor wedge as calculated from the data and our model.

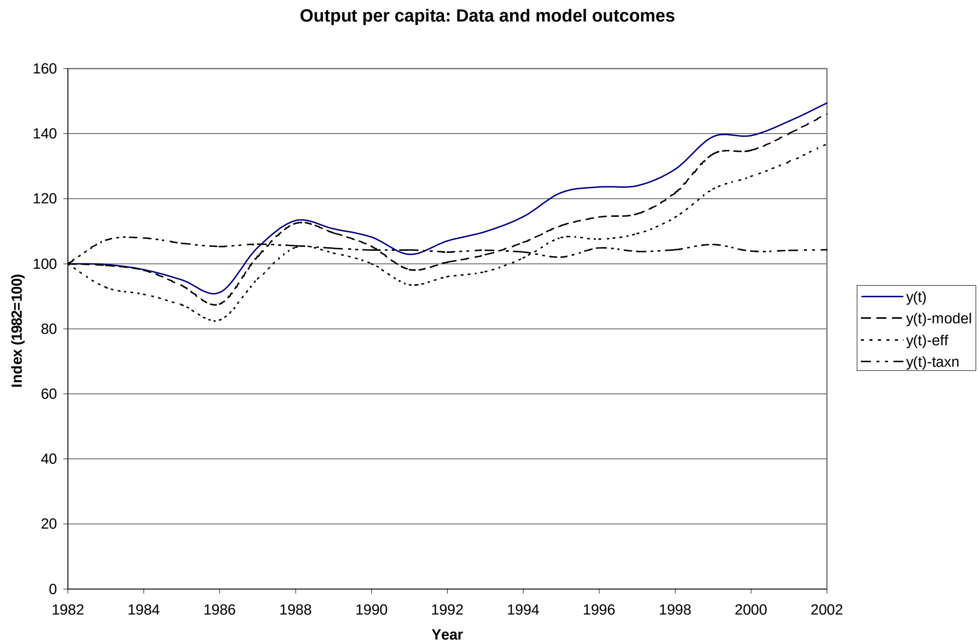

Figure 4: Output per capita: Data and Model outcomes

Note: We plot the GDP per capita from data and as generated by our model by feeding in efficiency wedge and labor wedge respectively (the legend reads y(t)-eff and y(t)-taxn)). Next, we feed in efficiency wedge, labor wedge and government consumption wedge jointly in our model and plot it (legend reads y(t)-model).

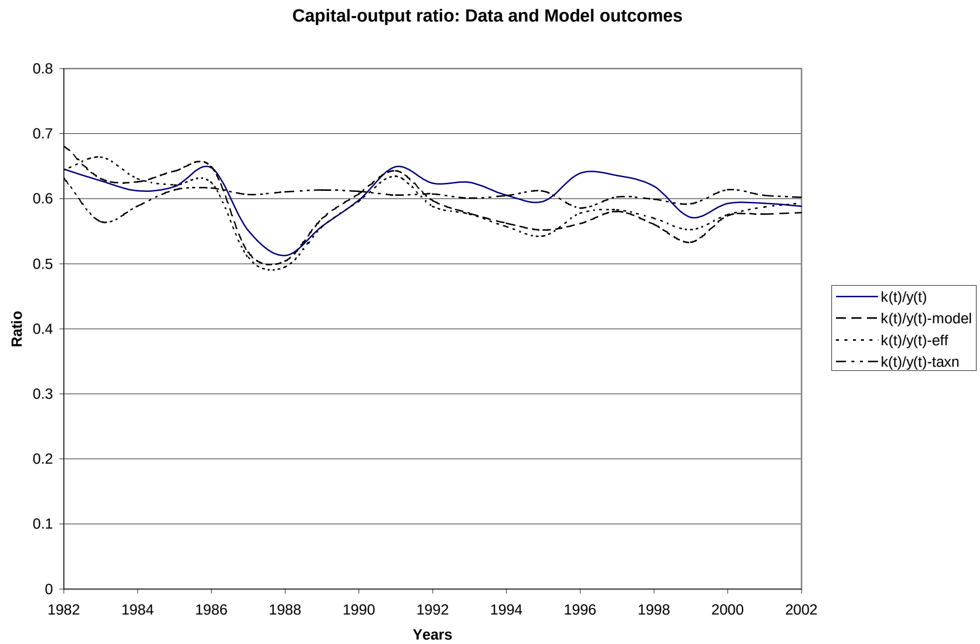

Figure 5: Capital-Output ratio Data and Model outcomes

Note: We plot the capital output ratio from data and as generated by our model by feeding in efficiency wedge and labor wedge respectively (the legend reads k(t)/y(t)-eff and k(t)/y(t)-taxn)). Next, we feed in efficiency wedge, labor wedge and government consumption wedge jointly in our model and plot it (legend reads k(t)/y(t)-model).

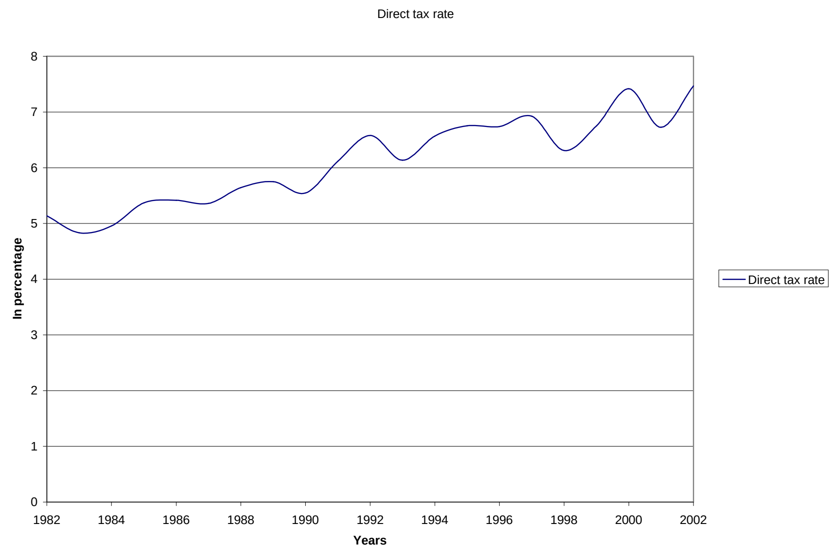

Figure 6: Direct tax rates

Note: We plot the labor income taxes from the data. It is measured as the ratio of the direct tax revenue of the central as well as state government to output.

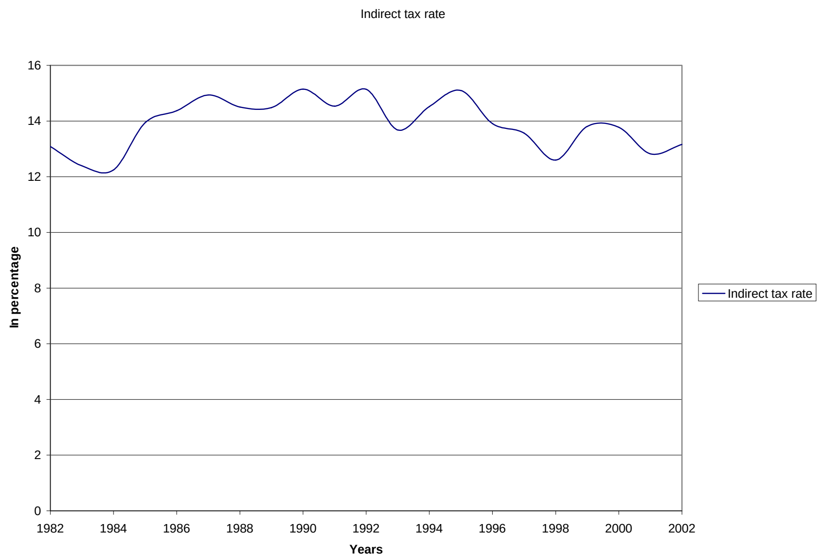

Figure 7: Indirect tax rates

Note: We plot the investment taxes from the data. It is measured as the ratio of the indirect tax revenue net of subsidies of the economy to the personal consumption expenditure.

TECHNICAL APPENDIX

The first order conditions of the model outlined in Equations (1) to (4) can be simplified to the following three equations by substituting the value of consumption c_t from Equation (1) and replacing it in Equations (3) and (4). Taking into account the population growth rate η, and discounting the model variables with respect to their long term trend $(1+g_z)$, the fundamental equations of our model reduces to:

$$\widehat{y}_t = F(\widehat{k}_t, \widehat{A}_t l_t) \tag{7}$$

$$\frac{u_{nt}(\widehat{c}_t(\widehat{y}_t, \widehat{x}_t, \widehat{g}_t),\ l_t)}{u_{ct}(\widehat{c}_t(\widehat{y}_t, \widehat{x}_t, \widehat{g}_t),\ l_t)} = (1-\tau_{nt})F_{lt}(\widehat{k}_t, \widehat{A}_t l_t) \tag{8}$$

$$\begin{gathered}\beta E_t u_{ct+1}(\widehat{c}_{t+1}(\widehat{y}_{t+1}, \widehat{x}_{t+1}, \widehat{g}_{t+1}),\ l_t)\{F_{kt+1}(\widehat{k}_{t+1}, \widehat{A}_{t+1} l_{t+1}) + (1-\delta)(1+\tau_{xt+1})\} \\ = (1+\tau_{xt})u_{ct}(\widehat{c}_t(\widehat{y}_t, \widehat{x}_t, \widehat{g}_t),\ l_t)(1+g_z)\end{gathered} \tag{9}$$

where I denote a variable z_t detrended by the long-term growth rate of technological development $(1+g_z)^t$ as $\widehat{z}_t$ where $\widehat{z}_t = \frac{z_t}{(1+g_z)^t}$.

Given the wedges $\widehat{A}_t,\ \tau_{nt},\ \tau_{xt}$, and $\widehat{g}_t$, the equations (7) to (9) solve for output, investment and labor in terms of the wedges. The BCA procedure involves feeding in the wedges one by one and in different combinations to see which wedges or combinations of wedges can best replicate the data. The accounting procedure has two parts: first we need to estimate the wedges from the data and then we feed in the wedges in our model to generate output, labor and investment. This later procedure is called decomposition. Note that by construction of the BCA procedure, if we feed in efficiency, labor, investment and government wedges in the model all together, then we will get back the data.

Taking into account the population growth rate, and the functional forms outlined in equations (5) and (6), equations (7) to (9) reduces to:

$$\widehat{y}_t = \widehat{k}_t^{\theta}(\widehat{A}_t l_t)^{1-\theta} \tag{10}$$

$$\left[\begin{array}{c}\left(\frac{1-\alpha}{\alpha}\right)\left(\frac{\widehat{y}_t - \eta(1+g_z)\widehat{k}_{t+1} + (1-\delta)\widehat{k}_t - \widehat{g}_t}{1-l_t}\right) \\ = (1-\theta)(1-\tau_{nt})\frac{\widehat{y}_t}{l_t}\end{array}\right] \tag{11}$$

$$\left[\begin{array}{c}\frac{\beta}{(1+g_z)}E_t\left(\frac{\widehat{y}_t - \eta(1+g_z)\widehat{k}_{t+1} + (1-\delta)\widehat{k}_t - \widehat{g}_t}{\widehat{y}_{t+1} - \eta(1+g_z)\widehat{k}_{t+2} + (1-\delta)\widehat{k}_{t+1} - \widehat{g}_{t+1}}\right)\left(\theta\frac{\widehat{y}_{t+1}}{\widehat{k}_{t+1}} + (1-\delta)(1+\tau_{xt+1})\right) \\ = (1+\tau_{xt})\end{array}\right] \tag{12}$$

where the value of σ is taken as 1.

Note that given parameter values we can solve equations (10) to (12) and get decision rules for output $y(t)$, labor $l(t)$, and capital stock next period $k(t+1)$ in terms of productivity or efficiency wedge $A(t)$, labor wedge τ_{nt}, investment wedge τ_{xt} and government consumption wedge $g(t)$. Once we get the decision rules, we can plug in the time series of the wedges one by one in our decision rules while holding other wedges constant at their steady state values and thereby account for the contribution of each wedge in generating the macro variables.

The problem here is that we do not have time series data available on productivity A_t, labor wedge τ_{nt}, and investment wedge τ_{xt} as they represent market frictions and are therefore intangible. So we need to use data from national income accounts and our equations to back out the values of these wedges. The job is relatively simple for efficiency wedge $A(t)$, and labor wedge τ_{nt} which we can derive given equations (10) and (11) and the time series data on output $y(t)$, labor $l(t)$, and capital stock next period $k(t+1)$.

The job is not so easy for calculating investment wedges τ_{xt} as it involves knowing not only the time series of aggregate macro data but also the expectations that people form about the future as equation (12) highlights. Researchers have used many variations to get around this problem. Chari, Kehoe and McGrattan (2003) hold efficiency and labor wedges constant at their steady state values and let investment wedges be whatever they should be so that they can replicate the investment data exactly to get an approximate idea for the series and then they iterate such that their model outcomes (feeding in all the wedges) can replicate the data exactly. Others, including Keiichiro Kobayashi and Masaru Inaba (2005) work with a deterministic form of the model to get around the problem of forming expectations.

What we do in our analysis is to hold the investment wedges constant at their steady state value. We then ascertain how much of the observed data can we generate with efficiency, labor and government wedges jointly. If after feeding in efficiency, labor and government wedges, we still have a large part of observed data still unexplained, then we can say that investment wedges must have played a significant role as by construction, the model is supposed to replicate the data exactly when all four wedges are fed in.

Thus with our simplification, the equations reduce to:

$$\widehat{y}_t = \widehat{k}_t^{\theta}(\widehat{A}_t l_t)^{1-\theta} \tag{13}$$

$$\left[\begin{array}{c} \left(\frac{1-\alpha}{\alpha}\right)\left(\frac{\widehat{y}_t-\eta(1+g_z)\widehat{k}_{t+1}+(1-\delta)\widehat{k}_t-\widehat{g}_t}{1-l_t}\right) \\ = (1-\theta)(1-\tau_{nt})\frac{\widehat{y}_t}{l_t} \end{array} \right] \tag{14}$$

$$\left[\begin{array}{c} \frac{\beta}{(1+g_z)}E_t\left(\frac{\widehat{y}_t-\eta(1+g_z)\widehat{k}_{t+1}+(1-\delta)\widehat{k}_t-\widehat{g}_t}{\widehat{y}_{t+1}-\eta(1+g_z)\widehat{k}_{t+2}+(1-\delta)\widehat{k}_{t+1}-\widehat{g}_{t+1}}\right)\left(\theta\frac{\widehat{y}_{t+1}}{\widehat{k}_{t+1}}+(1-\delta)(1+\overline{\tau_x})\right) \\ = (1+\overline{\tau_x}) \end{array} \right] \tag{15}$$

where $\overline{\tau_x}$ is the steady state value of investment wedge τ_{xt}.

Rearranging the terms, the equations can be written as:

$$\widehat{A}_t = \left(\frac{\widehat{y}_t}{\widehat{k}_t^{\theta} l_t^{1-\theta}}\right)^{\frac{1}{1-\theta}} \tag{16}$$

$$\tau_{nt} = 1 - \left[\begin{array}{c} \left(\frac{1-\alpha}{\alpha}\right) * \\ \frac{1}{(1-\theta)} * \frac{l_t}{\widehat{y}_t}\left(\frac{\widehat{y}_t-\eta(1+g_z)\widehat{k}_{t+1}+(1-\delta)\widehat{k}_t-\widehat{g}_t}{1-l_t}\right) \end{array} \right] \tag{17}$$

$$\overline{\tau_x} = 1 - \frac{\theta * \frac{\overline{y}}{\overline{k}}}{\frac{(1+g_z)}{\beta} - 1 + \delta} \tag{18}$$

where equation (18) is the steady state variation of equation (15) and helps us to get the steady state value of the investment wedge, $\overline{\tau_x}$. Off course, one can easily get the steady state value of the efficiency wedge and labor wedge that we denote by $\overline{A}$ and $\overline{\tau_n}$ respectively from the steady state version of equations (16) and (17). Note that given the data from National Income Accounts, equations (16) and (17) give us the time series of productivity $\widehat{A}_t$ and that of labor wedge τ_{nt}. Government consumption wedge g_t is taken from National Income Accounts.