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AN AGGREGATE-LEVEL MACRO MODEL FOR THE INDIAN ECONOMY

Naoyuki Yoshino, Rajendra N Paramanik,
K U Gopakumar, Farhad Taghizadeh-Hesary,
Ma. Laarni Revilla, and K E Seetha Ram

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Naoyuki Yoshino is Professor Emeritus at Keio University, Tokyo, Japan and Director of the Financial Research Center, Financial Services Agency, Japan. Rajendra N Paramanik is an Assistant Professor at the Department of Humanities and Social Sciences of the Indian Institute of Technology, Patna, India. K U Gopakumar is an Assistant Professor at the Department of Economics of the Sri Sathya Sai Institute of Higher Learning, Prasanthi Nilayam, India. Farhad Taghizadeh-Hesary is an Associate Professor of Economics at Tokai University, Tokyo, Japan. Ma. Laarni Revilla is a Research Associate at the Asian Development Bank Institute (ADBI), Tokyo, Japan. K E Seetha Ram is a Senior Consulting Specialist for Capacity Building and Training Projects at ADBI and Visiting Professor at the Center for Spatial Information Science of the University of Tokyo, Japan.

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Please contact the authors for information about this paper.

Emails: yoshino@econ.keio.ac.jp, rajendra@iitp.ac.in, gopakumarku@sssihl.edu.in, farhad@tsc.u-tokai.ac.jp, mlrevilla@adbi.org, kseetharam@adbi.org

Asian Development Bank Institute
Kasumigaseki Building, 8th Floor
3-2-5 Kasumigaseki, Chiyoda-ku
Tokyo 100-6008, Japan

Tel: +81-3-3593-5500
Fax: +81-3-3593-5571
URL: www.adbi.org
E-mail: info@adbi.org

Abstract

This research piece is an empirical attempt to model the Indian economy at an aggregate level with annual data, ranging from 1980 to 2019. The major theoretical premise of the paper mimics the New Keynesian framework, which is based on the microeconomic foundations of Keynesian economics. The paper proposes a whole economic structure in the form of nine equations. Aggregate demand is modeled with the help of four equations, representing consumption, private investment, exports, and imports. Aggregate supply assumes the form of a simple neoclassical production function where labor, capital, and exogenous technical progress are considered as inputs. Further, inflation is assumed to follow a New Keynesian representation whereas the LM curve has its standard form with income and short-term rate of interest as its determinants. Subsequently, a linking equation, expressing long-run interest rates as a function of short-term interest rates and government investment, is proposed to unify monetary policy and fiscal policy to goods markets. Finally, tax is estimated as a function of per capita income.

A structural equation model is employed for the empirical analysis and findings support the theoretical expectations. Consumption follows the absolute income hypothesis and private investment is governed by the accelerator principle. Further, the negative sign of nominal interest rates in the investment function confirms an inverse relation between the former and private capital formation. Exports are found to be influenced by world income, exchange rates, and government capital formation, and import demand is determined by domestic income, the difference between domestic and international inflation, and the lagged exchange rate.

From the policy perspective, this paper suggests the suitability of fiscal and monetary policies for increasing growth in the Indian economy. However, the effectiveness of expansionary fiscal policy is observed to have a larger impact on growth than easy monetary policy. This inference is drawn mainly on the basis of a simulation exercise for the proposed structural equation model.

Keywords: New Keynesian model, structural equation model, Indian economy

JEL Classification: C36, E1, E270

Contents

1. INTRODUCTION

India embarked on a major reform to liberalize its economy in the year 1991. But there had been a gradual and effective policy-level effort to loosen import and business controls since the 1980s, which reached its culmination a decade later. India's growth story has been rewritten since then and prior to the current pandemic; India was the fifth-largest economy in terms of size and the fastest trillion-dollar emerging economy in the world. This paper is an empirical attempt to chronicle this four-decades-long dynamic growth in a comprehensive macroeconomic framework, and it also offers a suitable policy prescription to enhance economic growth through appropriate fiscal and monetary policy measures.

To attain our aforementioned objectives, we segregated the whole economy into eight major components, each represented by an equation. This holistic framework is premised considerably on New Keynesian theoretical philosophy, where a simple Keynesian consumption function is included along with an investment function, which is motivated by the accelerator principle. However, an augmented version of the Phillips curve is proposed, which incorporates backward-looking inflation expectation to corroborate the Indian experience where inertia plays an instrumental role in deciding the future dynamic of inflation. A two-stage least squares technique, a variant of the structural equation model (SEM), is employed for the analysis in which equations for consumption expenditure, private capital formation, external sector comprising import and export, supply side of the economy, inflation dynamic, tax collection, and money demand function are considered. Further, a bridge equation is also proposed that unifies the fiscal and monetary policy variables in the proposed framework. Finally, to assess the model's efficacy in predicting the effect of expansionary monetary and fiscal policy interventions, a simulation is carried out for the past 10 years from FY2009–2010 through 2018–2019. This is done by reducing the interest rate and increasing government capital formation as well as government consumption expenditure, respectively.

Empirical findings from the simulation suggest the effectiveness of both fiscal and monetary policies.[1] Expansionary monetary policy, as envisaged by a 100-basis point reduction in the short-term interest rate, leads to around a 4% increase in GDP. On the other hand, increases in two variables, namely government consumption expenditure and public capital formation, are considered as fiscal stimuli. Results indicate that a 10% rise in government consumption expenditure results in a 19.65% increase in output, whereas a 10% higher public capital formation raises output by 24.23%. The fiscal stimulus and economic growth are only sustainable if this can also generate revenue through tax collection. In both cases, tax collection increases by around 50%. Given that tax collection is already low in India, this increase is not surprising.

1.1 Macroeconomic Overview of the Indian Economy Since 1980

The Indian economy's growth trajectory has been experiencing a gradual and consistent evolution since the 1980s. This dynamic growth can be mainly attributed to change in economic policies, adopted in different phases during the last four decades. A brief snapshot of India's macroeconomic performance during this 40-year period is presented in Table 1. Internal factors, coupled with global attributes, led this journey

[1] The effectiveness of the policies is judged by the average percentage change in the respective variable of interest when compared to its actual value.

to a distinct destination where India has been recognized as growing from an underdeveloped economy to a promising emerging power on the global economic platform. During the period 1980–1990, the rate of growth accelerated to an unprecedented level of 5.8% and this figure was surpassed by as few as eight out of 113 countries in the world. Post liberalization, during the period 1990–1995, the growth rate marginally dipped to 4.70% due to structural changes, but it witnessed a further surge in the last five years of the previous century, i.e., up to 6.84%, followed by a consistent 5.65% growth during the first five years of the new millennium. From 2005 to 2010, the quinquennial growth rate of GDP is estimated at an all-time high of 6.92%. This was the phase in its history when the Indian economy recorded annual y-o-y growth rates close to 8% consistently for about eight years, from the fiscal year (FY) 2003–04 to FY2010–11, except for FY2008–09. Following the 2008 subprime market crisis and its global impact, the Indian economy experienced a downward trend in output growth in successive years. This decay was further aggravated by the adverse impact of poor implementation of structural reforms, like demonetization in 2016 and GST in 2017. However, many argue in favor of the long-term benefits of such reforms, which can only be judged in the due course of time.

Table 1: Macroeconomic Indicators: Quinquennial Averages from 1980 through 2020

	GDP Growth Rate (%)	**Government Investment Rate** (%)	**Private Investment Rate** (%)	**Private Savings Rate** (%)	**Inflation** (%)	**Fiscal Deficit to GDP** (%)
1980–81 to 1984–85	5.47	10.27	8.57	13.32	9.38	5.67
1985–86 to 1989–90	5.91	10.36	8.76	16.69	8.00	7.44
1990–91 to 1994–95	4.70	8.69	12.31	20.27	10.65	6.09
1995–96 to 1990–00	6.84	7.10	15.63	22.67	6.84	5.35
2000–01 to 2004–05	5.65	6.08	17.70	27.79	4.03	5.08
2005–06 to 2009–10	6.92	7.43	26.46	33.32	7.44	4.45
2010–11 to 2014–15	6.60	7.68	30.32	32.43	7.34	4.84
2015–16 to 2019–20	6.72	7.69	27.76	29.71	3.35	3.60

A granular look at different components of aggregate-level output is a very revealing and informative exercise in assessing the dynamic growth of the Indian economy. Though lately India has been experiencing a consumption-led growth, its initial economic propulsion was fueled by the private investment rate, which consistently rose from a meager 8.57% for the period 1980–1985 to 30.32% in 2010–2015. At the same time, public investment in India witnessed a secular downward trend, mainly caused by a sharp decline in infrastructure investment by government at varying levels, including state and central. The emergence of a middle class and transition in the demographic profile led to higher consumption in the last decade and brought down the otherwise strong resilient factor and strength of the economy, i.e., private saving. It registered steady growth from 13.23% in 1980–1985 to an enviable 33.23% in 2005–2010, cushioning its financial system against the global turmoil during the 2008 crisis. After the introduction of GST and demonetization, both the saving rate and the private investment

rate declined, to 29.71% and 27.76%, respectively, during the period 2015–2019.

Further, on the fiscal front, India's policy follows an orthodox stance to maintain a low level of fiscal deficit, which has ranged between its maximum value of 7.44% during the period 1985–1990 and its lowest one of 3.60% from 2015 to 2020. Global experience suggests that any emerging nation like India is always susceptible to inflationary shocks, mainly caused by structural factors. Although India's experience with high inflation, averaging around 9.5%, during the first one and half decades after 1980 was painful, it steered its monetary policy devices efficiently to contain inflation to a more comfortable level of an average of 6.41% in the subsequent two decades, i.e., between 1995 and 2015. The nation's Apex Bank fixed a target level of a 4% inflation rate for a painless growth, and there is evidence of success and optimism in that direction since inflation was as low as 3.35% for the period 2015–2020.

However, towards the end of FY2019–2020 and thereafter, like every other country across the globe, the Indian economy was severely hit by the Covid-19 crisis. The y-o-y growth of GDP in the first quarter of fiscal year 2020–2021 has declined by 23.9%. The performance of various sectors reveals that all sectors except the agricultural sector have shown a declining trend in Q1 2020–2021. The growth rates in service components like construction, trade, transport, and tourism have declined by about 50%. The manufacturing and mining industries have marked 39.3% and 23.3% declines, respectively. On the expenditure side, the investment rate during Q1 2020–2021 has been as low as 22%, compared to an average of 30% in the past 10 years. Amidst this, the retail inflation in India has also surged significantly with its rates touching 7.61% in October 2020 the highest in the last six years. These signs are worrying as the monetary policy has already taken an expansionary stance to mitigate the crisis. On the fiscal front, the crisis has had a significant impact on deficits. According to the controller of general accounts (CGA) reports for September 2021, the fiscal deficit for the first two quarters has already reached 114% of the annual estimate for FY2020–2021.

2. DATA AND MODEL

2.1 Data and Their Definitions

The aggregate-level macroeconomic model for the Indian economy is estimated for the time period from 1980 through 2019. The year 1980 marks the inception of gradual liberalization policies for the Indian economy.

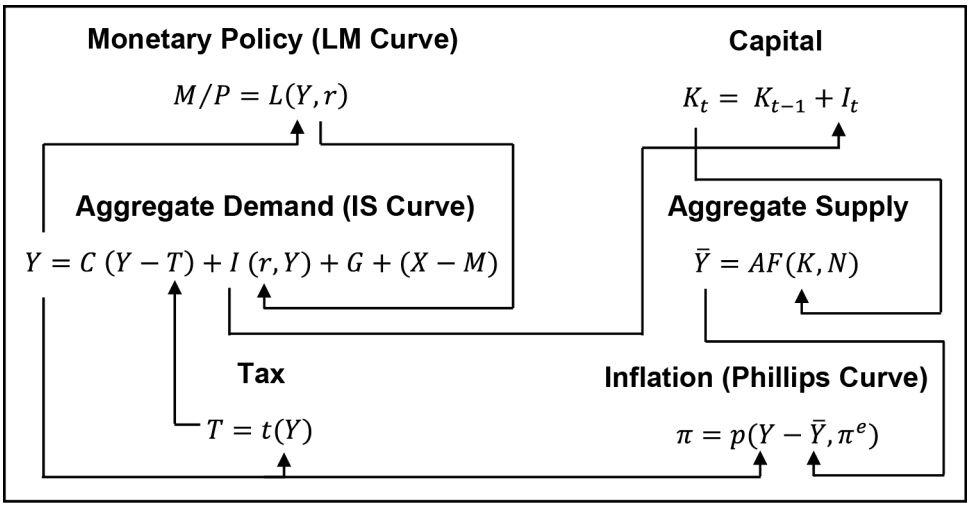
The rate of inflation is calculated as the growth rates of the GDP deflator at 2011–2012 prices. Further, the inflation expectation is calculated as the difference between the rate of inflation and the targeted rate of inflation at 4%. All the components of GDP and other variables taken at real prices follow the 2011–2012 base year. Aggregate supply in the economy is taken as the long-run trend in the growth rates of real GDP derived using the Hodrick-Prescott (1997) filter. In the absence of a definite variable to capture technological growth for the time period, a linear time trend accounts for the technological growth. Capital stock in the economy is the real net capital stock in all three of the agriculture, industry, and service sectors combined. Labor is proxied by the ratio of the number of people in the working age population to the whole population. The short-term rate of interest is the call money rate (CMR) and lending rates represent the long-term interest rates. Money stock is the M3 and is the stock of money accounted on the last Friday of March for the respective financial year. Real money stock is M3 divided by

the deflator. Private savings are the total of household and private corporate savings. Food grain production is the total production of rice, wheat, coarse cereals, and pulses in a given year. Exchange rates are the value of the Indian rupee vis-à-vis the SDR based on the value of a basket of currencies, namely the US dollar, euro, yen, pound sterling, and renminbi. Forex reserves are foreign exchange reserves held by India at the end of the financial year. Tax is the total direct and indirect tax collected by the central and state governments. The growth rate of global real GDP is taken from the World Bank National Accounts data and the growth rate of World CPI from the International Monetary Fund's international finance and statistics files.

2.2 The Theoretical Framework of the Analysis

The basis of the theoretical framework for our study follows the New Keynesian macroeconomic approach presented in Figure 1. Aggregate demand is the basic goods market identity; it represents the IS curve. The total expenditure on output (Y) can be expressed as private consumption expenditure (C), gross investment by government and public (I), government consumption expenditure (G), and net exports $(X - M)$. In line with the Keynesian argument, consumption behavior fits into the absolute income hypothesis. Investment follows the accelerator principle, where it changes with acceleration of demand (Clark 1917). Further, exports and imports may be brought into this system to account for the performance of the external sector. The exchange rate could turn out to be important here. The money market is introduced through the LM curve specification. The rate of interest (r) and level of income (Y) link the goods and money market.

Figure 1: Framework of the Model



Bringing in the key concept of the New Keynesian approach, i.e., the absence of full employment equilibrium, aggregate supply is $(\bar{Y})$. In the Indian scenario, it is likely that there could be a mismatch between aggregate supply and demand and thus it is important to model them separately (Pandit 2000). Aggregate supply takes the form of a simple neoclassical production function developed by Solow (1957). It is a function of labor (L) and capital (K) along with exogenous technological progress (A). The rate of inflation is represented as a function of past inflation expectations (π^e) and output gap $(Y - \bar{Y})$. This follows the New Keynesian Phillips curve representation of the rate of

inflation with lagged inflation and rational expectations proposed by Galí and Gertler (1999). Finally, tax collection is a function of income (Y).

Under the New Keynesian principles, economies may fail to attain the full employment equilibrium because of market failures and imperfections (Mankiw and Romer 1995**)**. Under such circumstances, macroeconomic stabilization through fiscal and monetary policies by the government is important. In the goods market, higher government expenditure can lead to higher income levels through the multiplier process. In the money market, this would in turn increase the interest rates because of the higher money demand induced by higher income. With higher interest rates, in the goods market, there would be contraction in investments as $I' < 0$. However, if we consider the multiplier-accelerator model (Samuelson 1939), higher income through the multiplier and then via the accelerator can compensate for this fall in investments. Finally, when it comes to expansionary fiscal policy, deficits are attached to the growth process. This could be harmful if the former is not effectively managed. In the model with $t' > 0$, we could measure the sustainability of the expansionary fiscal policies. Tax buoyancy is critical.

Expansionary monetary policy can be exogenously introduced through lower interest rates. Alternatively, according to the LM curve, higher money supply at given price levels could push interest rates low to maintain money market equilibrium. In any case, lower interest rates in the money market could induce higher investments, leading to higher levels of output in the goods market. It should also be noted that investments could add to the existing capital stock, which in turn determines the level of aggregate supply. In India, with its economic activity being mostly supply driven, the level of capital stock is crucial when one thinks of aggregate supply (Krishnamurthy 2002).

2.3 The Empirical Framework for SEM

Based on the theoretical model, illustrated in Figure 1, the empirical framework for our work is presented in the form of nine equations. In the following equations, variables with the prefix (Z) indicate representation of the variable in real terms. The first four equations capture the components of aggregate demand viz consumption, private capital formation, exports, and imports. Government capital formation and government final consumption expenditure are deliberately not estimated and considered exogenous. These factors are later introduced as policy variables for the simulation exercises. The consumption function follows a simple Keynesian framework, where it is determined by the current disposable income (ZY_d). Private investment is determined by private savings (GDS_{pvt}), long-term nominal interest rates (ROI^{LR}), and the accelerator $(ZY_t - ZY_{t-1})$ accounting for an increase in investment because of excess demand. Exports are driven by exchange rate (EXR), world GDP (ZY_{world}), and government capital formation (ZI_{Govt}). Import demand is explained by domestic GDP (ZY), exchange rate (EXR), forex reserves $(FOREX)$, and the difference between domestic and world inflation $(\pi - \pi^{int})$. Forex reserves are taken as a proxy indicating the capacity to import.

$$C_t = \beta_1 + \beta_2(Y_{d_t}) \quad \ldots 1$$

$$I_{pvt_t} = \alpha_1 + \alpha_2\left(GDS_{pvt_t}\right) - \alpha_3\left(ROI_t^{LR}\right) + \alpha_4(Y_t - Y_{t-1}) \quad \ldots 2$$

$$ZEX_t = \theta_1 + \theta_2\left(ZY_{world_t}\right) + \theta_3(EXR_t) + \theta_4(ZI_{Govt}) + \theta_5(ZEX_{t-1}) \quad \ldots 3$$

$$ZIM_t = \vartheta_1 + \vartheta_2(ZY_t) - \vartheta_3(EXR) + \vartheta_4\left(\pi - \pi^{int}\right) + \vartheta_4(FOREX_t) \quad \ldots 4$$

Once the aggregate demand is estimated, we turn to determinants of supply. Taken as the long-run trend in the growth rate of real GDP, Equation 5 estimates supply ($\bar{ZY}_t$) as a function of technological growth captured by the linear time trend ($TECH$), real capital stock (ZK), and labor (L).

$$\bar{ZY}_t = \mu_1 + \mu_2(TECH) + \mu_3(ZK_t) + \mu_4(L_t) \quad \ldots 5$$

Equation 6 estimates inflation in the New Keynesian Phillips curve form. Output gap ($ZY_t - \bar{ZY}_t$) accounting for excess demand, backward-looking expectations captured by lagged inflation expectations ($\pi_{t-1} - \bar{\pi}_{t-1}$), exchange rate ($EXR$), and food grain production (QFG) are taken as the major determinants. $\bar{\pi}_{t-1}$ is taken as fixed at 4%, the mandatory inflation target stipulated by the RBI. Exchange rate depreciation adds to the export cost and thus measures imported inflation, and food grain production accounts for possible supply shocks from the agricultural sector.

$$\pi_t = \varphi_1 + \varphi_2(ZY_t - \bar{ZY}_t) + \varphi_3(\pi_{t-1} - \bar{\pi}_{t-1}) + \varphi_4(EXR_t) + \varphi_4(QFG_t) \quad \ldots 6$$

Real money demand takes the traditional form of accounting for transaction and speculation demand. Assuming money market equilibrium and exogenously fixed money supply, the change in demand for money is a function of short-term nominal interest rates (ROI^{SR}) and domestic income (ZY) as follows.

$$\frac{M_t}{P_t} = \gamma_1 - \gamma_2({ROI_t}^{SR}) + \mu_3(ZY_t) \quad \ldots 7$$

$${ROI_t}^{LR} = \delta_1 + \delta_2({ROI_t}^{SR}) + \delta_3(NI_{Govt_t}) \quad \ldots 8$$

Linking the money market and goods market, we have Equation 8 estimating long-term nominal interest rates as a function of nominal short-term interest rates (ROI^{SR}) and government capital formation at basic prices (NI_{Govt}). Government spending is expected to drive up the long-turn interest rates through higher government borrowings or by raising the short-term interest rates to clear money market disequilibrium because of increased transaction demand. Revenue generation is an important aspect of public policy, the absence of which can lead to debt crisis. We have total tax collection by central and state government determined by per capita nominal GDP (NY_{PC}). The per capita GDP is considered over the total GDP as the former could indicate the distribution of GDP. This is presented in Equation 9.

$$TAX_t = \tau_1 + \tau_2(NY_{PC_t}) \quad \ldots 9$$

Finally, the complete structure of the SEM can be expressed as follows:

$$\begin{bmatrix} C_t = \beta_1 + \beta_2(Y_{d_t}) \\ I_{pvt_t} = \alpha_1 + \alpha_2\left(GDS_{pvt_t}\right) - \alpha_3\left({ROI_t}^{LR}\right) + \alpha_4(Y_t - Y_{t-1}) \\ ZEX_t = \theta_1 + \theta_2\left(ZY_{world_t}\right) + \theta_3(EXR_t) + +\theta_4(ZI_{Govt}) + \theta_5(ZEX_{t-1}) \\ ZIM_t = \vartheta_1 + \vartheta_2(ZY_t) - \vartheta_3(EXR) + \vartheta_4(\pi - \pi^{int}) + \vartheta_4(FOREX_t) \\ \bar{ZY}_t = \mu_1 + \mu_2(TECH) + \mu_3(ZK_t) + \mu_4(L_t) \\ \pi_t = \varphi_1 + \varphi_2(ZY_t - \bar{ZY}_t) + \varphi_3(\pi_{t-1} - \bar{\pi}_{t-1}) + \varphi_4(EXR_t) + \varphi_4(QFG_t) \\ \frac{M_t}{P_t} = \gamma_1 - \gamma_2\left({ROI_t}^{SR}\right) + \mu_3(ZY_t) \\ {ROI_t}^{LR} = \delta_1 + \delta_2\left({ROI_t}^{SR}\right) + \delta_3\left(NI_{Govt_t}\right) \\ TAX_t = \tau_1 + \tau_2(NY_{PC_t}) \end{bmatrix} \quad \ldots 10$$

Equation 10 presents the complete structure of the SEM, which corresponds to the theoretical model presented in Figure 1 earlier. Examples of such structures include those developed by Yoshino and Taghizadeh-Hesary (2015), Galí (2010), and Galí and Gertler (2007). Given the SEM, one could possibly look at the effectiveness of monetary and fiscal policy in affecting the real GDP. Expansionary monetary policy can be introduced through a reduction in short-term interest rates (ROI^{SR}), which would further bring down the long-term interest rates $\left(ROI_t{}^{LR}\right)$, leading to higher private investment (I_{pvt_t}) and the multiplier effect from thereon. Fiscal policy can be introduced through two of its instruments, one aimed at improving asset creation through government capital formation (ZI_{Govt}) and the other relating to government consumption expenditure $(GFCE)$.

3. EMPIRICAL RESULTS

Before estimating the equations, the stationarity of the variables is tested using the augmented Dickey-Fuller (1979) test (ADF) and the results are presented in Table 2. It should be noted that the variables, except for the short-term interest rates, long-term interest rates, and real money demand, are converted to y-o-y growth rates and are then used for estimation. Variables with $\dot{(\ )}$ indicate the growth rate. Real money is taken as y-o-y change and the interest rates are in percentages.

Table: 2: Test for Stationarity

Variable	T-Statistics (p-value)	Inference
$Z\dot{C}$	–10.11 (0.00)	I (0)
$Z\dot{I}_{Pvt}$	–4.69 (0.00)	I (0)
$Z\dot{I}_{Govt}$	–4.92 (0.00)	I (0)
$Z\dot{E}X$	–4.86 (0.00)	I (0)
$Z\dot{I}M$	–5.31 (0.00)	I (0)
$Z\dot{Y}$	–5.02 (0.00)	I (0)
$Z\dot{Y}_d$	–4.90 (0.00)	I (0)
$N\dot{I}_{Govt}$	–5.00 (0.00)	I (0)
$Z\dot{Y}_{PC}$	–4.31 (0.00)	I (0)
$Z\overline{Y}$	–16.52 (0.00)	I (0)
$G\dot{D}S_{pvt}$	–5.41 (0.00)	I (0)
π	–3.38 (0.06)	I (0)
$\pi - \pi^{int}$	–4.53 (0.00)	I (0)
ROI^{LR}	–3.40 (0.05)	I (0)
ROI^{SR}	–3.57 (0.04)	I (0)
$\Delta ZM3$	–3.58 (0.04)	I (0)
$E\dot{X}R$	–4.56 (0.00)	I (0)
$Q\dot{F}G$	–12.24 (0.00)	I (0)
$Z\dot{K}$	–6.06 (0.00)	I (0)
$\dot{L}$	–4.25 (0.00)	I (0)
$FO\dot{R}EX$	–3.96 (0.01)	I (0)
$T\dot{A}X$	–5.37 (0.00)	I (0)
$Z\dot{Y}_{world}$	–4.72 (0.00)	I (0)

All the variables are found to be stationary at levels. For equations where the variables are in their growth rate form, the coefficients can be explained in their log form using the identity $dY/Y = d(\log Y)$. The system of equations is estimated using the two-stage least squares (2SLS) method, which addresses the endogeneity problem of our independent variables. The one-year-lagged exogenous variables serve as the instrument variables (IVs). In particular, the IVs include lagged values of world GDP, exchange rate, short-term interest rate, private savings, international inflation, capital formation by government, reserves, food grain production, working population as a percentage of the total population, and time trend. These variables satisfy the two validity tests for IVs. First, they satisfy the exclusion restriction since the lagged IVs are not expected to be highly correlated with the outcome variable. Second, they satisfy the correlation condition since the coefficients in the first stage are shown to be statistically significant. In the estimated equations, the figures in parentheses denote the t-statistics. Overall, we can see that the coefficients are significant and have reasonable levels of R squared expected from an IV 2SLS estimation. Except for a few cases, the estimated equations also have fairly acceptable levels of Durbin-Watson test statistics, confirming the absence of serious autocorrelation in error terms. The estimated SEM is presented in Table 3.

At the outset, we note that all the variables in the model are statistically significant except for the growth rate of food grain production in the inflation equation. The components of aggregate demand viz consumption, private investment, and imports are significantly determined by domestic GDP. In the case of consumption, the coefficient of disposable income is marginal propensity to consume (MPC) and is positive and significant as expected. Growth rates of GDP enter private investment through the accelerator function, where the impact on investment is found to be positive. Thus, any exogenous increase in government spending through capital formation or government consumption expenditure would indirectly drive private investment through the coefficient of accelerator. Apart from this, long-term nominal interest rates[2] and private savings are also found to be significant in driving private investment. The strong and significant impact of savings in the investment function is important in the Indian context, where both the investment rate and the saving rate are found to have been declining in t recent times. This points towards the need for structural reforms in reviving private investment.

The positive and significant coefficient for government capital formation in the export equation is important. It explains the need for a revival of public investment in capacity building, which could drive exports apart from the growth in world GDP and exchange rates. Being a net importer and a price taker in the world market, with capital account convertibility and current account deficit, India's ability to devalue its currency to encourage exports is limited and may not be sustainable in the long run. In this context, the role of government investment is even more prominent. Import demand is driven by domestic GDP, inflation differentials, lagged exchange rate, and lagged value of forex reserves. The lagged coefficient for exchange rates may corroborate the well-known J-curve phenomenon, where the effect of depreciation of the exchange rate on imports is delayed.

[2] In the investment function, it was nominal interest rates that were found to be significant and not the real interest rates. This seems to be contradictory to the accumulated wisdom. However, in the Indian case, with inflation generally high, the resulting low real interest rates have not stimulated investments and growth (RBI 2013). The study also points to the response from representatives of various industries and commercial banks suggesting the importance of nominal interest rates over the real interest rates in determining firm-level investments. Our intuition is that real interest rates resulting from lower nominal interest rates may be more relevant to growth than low real rates as a result of high inflation.

Table 3: Estimated Equations

Variables	Notation	Coefficients
1. Consumption expenditure	$\dot{ZC}$	
Constant		0.38
Disposable income	$\dot{ZY}_d$	0.83 (4.66) ***
		R-Squared: 0.48 DW-Stat: 1.94
2. Private capital formation	$(\dot{ZI}_{Pvt})$	
Constant		1.97
Private savings	$(\dot{GDS}_{pvt})$	1.91 (5.91) ***
Long-run rate of interest	(ROI^{LR})	-1.65 (-2.64) ***
Accelerator	$(\dot{ZY}_t - \dot{ZY}_{t-1})$	1.44 (2.04) **
		R-Squared: 0.57 DW-Stat: 2.16
3. Exports	$(\dot{ZEX})$	
Constant		–7.67
Lagged world GDP	$(\dot{ZY}_{world_{t-1}})$	2.85 (2.52) ***
Exchange rate	$(\dot{EXR})$	0.37 (1.98) **
Lagged govt. capital formation	$(\dot{ZI}_{Govt_{t-1}})$	0.41 (2.05) **
Lagged exports	$(\dot{ZEX}_{t-1})$	0.45 (1.84) *
		R-Squared: 0.23 DW h stat: –0.22
4. Imports	$(\dot{ZIM})$	
Constant		–17.78
Lagged exchange rate	$(\dot{EXR}_{t-1})$	–0.56 (–2.79) ***
Growth of real GDP	$(\dot{ZY})$	2.92 (1.94) *
Inflation differential	$(\pi - \pi^{int})$	1.24 (2.04) **
Lagged forex reserves	$(\dot{FOREX}_{t-1})$	0.21 (3.42) ***
		R-Squared: 0.37 DW-Stat: 1.99
5. Supply	$(\dot{Z\overline{Y}})$	
Constant		3.98
Technology	$(Tech)$	0.18 (8.37) ***
Lagged real capital stock	$(\dot{ZK}_{t-2})$	0.10 (4.33) ***
Labor	$(\dot{L})$	1.21 (2.47) ***
		R-Squared: 0.92 DW-Stat: 1.50
6. Inflation	(π)	
Constant		3.98
Lagged output gap	$(\dot{ZY}_{t-1} - \dot{Z\overline{Y}}_{t-1})$	0.54 (2.16) **
Lagged inflation expectation	$(\pi_{t-1} - \overline{\pi}_{t-1})$	0.74 (6.62) ***
Exchange rate	$(\dot{EXR})$	0.12 (3.31) ***
Lagged food grain production	$(\dot{QFG}_{t-1})$	–0.08 (–1.55)
		R-Squared: 0.69 DW-Stat: 2.11
7. Real money demand	$(\dot{ZM3} - \dot{ZM3}_{t-1})$	
Constant		5297.80
	(ROI^{SR})	–524.70 (–4.57) ***
	$(\dot{ZY})$	343.50 (2.60) ***
		R-Squared: 0.38 DW-Stat: 1.18
8. Long-term interest rates	(ROI^{LR})	
Constant		3.00
Short-term rate of interest	(ROI^{SR})	0.91 (6.59) ***
Nominal govt. capital formation	$(\dot{NI}_{Govt})$	0.19 (2.28) **
		R-Squared: 0.47 DW-Stat: 1.37
9. Tax collection	$(\dot{TAX})$	
Constant		4.92
Growth of per capita nominal GDP	$(\dot{NY}_{PC})$	0.80 (2.25) **
		R-Squared: 0.24 DW-Stat: 1.88

Note: Values in parentheses next to coefficients are t-values.

***, **, and * indicate significance at 1%, 5%, and 10%, respectively.

India's opportunity in its demographic dividend is captured through a positive and significant role of labor in determining output. The coefficient of labor is not just positive but more than one, which shows that supply is highly elastic to level of employment. Apart from labor, technology and capital stock are also found to drive supply positively.

The result from the Phillips curve representation of inflation is in line with theoretical expectations. The positive coefficient of the output gap signifies an upward-sloping supply curve, indicating a larger output gap leading to higher rates of inflation. Lagged inflation expectations capture current inflation as a function of past expectations. The general understanding is that inflationary experiences would further add to an inflation spiral, thus the positive coefficient is as expected. In our case, the lagged expectations are calculated as $(\pi_{t-1} - 4)$, where 4% is the targeted rate of inflation fixed by the Reserve Bank of India. The positive coefficient of exchange rates confirms the case of imported inflation. Being a net importer, it is not surprising that international prices are passed on to domestic prices through exchange rates. Though negative, the insignificance of growth in the food grain production in the Indian story of inflation is surprising. A possible explanation for this could come from the inflation experiences in recent times, where even food price inflation in India has been found to be structural, driven by demand factors.

The estimated equation for real money demand is as expected. Long-term interest rates are almost in tandem with short-term interest rates. The government's capital formation in nominal terms is also found to positively influence the long-term interest rates. This is a crucial link from the fiscal policy and the monetary policy to the goods market and the money market. Based on the structure of the SEM, expansionary monetary policy can push down the long-term interest rates, leading to higher output in the goods market. In the money market, it would lead to higher money demand on account of higher GDP and lower interest rates. On the other hand, higher capital formation by government would raise the interest rates, leading to lower private investment. However, the final impact of government expenditure of any kind would depend on the coefficient of the accelerator and MPC. This would be taken up later. Finally, we have tax collection positively determined by per capita nominal GDP. It is only natural that higher income with better distribution would increase tax collection either through direct or indirect taxes.

3.1 Policy Simulation from SEM

Once the model is estimated, we turn to checking the effectiveness of monetary and fiscal policy on real GDP (ZY). The real GDP can be calculated from the model using the identity $\mathrm{ZY} = \mathrm{ZC} + \mathrm{ZI}_{\mathrm{Pvt}} + \mathrm{ZI}_{\mathrm{Govt}} + \mathrm{ZGFCE} + \mathrm{ZEX} - \mathrm{ZIM}$. The complete SEM with identities and calculation of (ZY) is presented in Appendix 1. However, before moving to policy simulations, we also look at the validity of the results by comparing the actual and estimated values of ZY obtained from the model. Figures 2 and 3 suggest that the estimated values of ZY and y-o-y growth rates of ZY are fairly close to their actual values except for a few years. With respect to growth rates of ZY, it should be noted that the estimated value correctly predicts the turning points in the data except for a few years, i.e., 1996, 2009, and 2016. Here, it is worth mentioning that in 1996 and 2009 the Indian economy was adversely affected by the East Asian crisis and the global financial crisis, respectively. And 2016 marked the year of demonetization in India. With respect to the validity of these results, we also note that the root mean square percentage error for both ZY and y-o-y growth rates of ZY was satisfactory at 5.11% and 0.78%, respectively.

Figure 2: Actual ZY vs. Estimated ZY

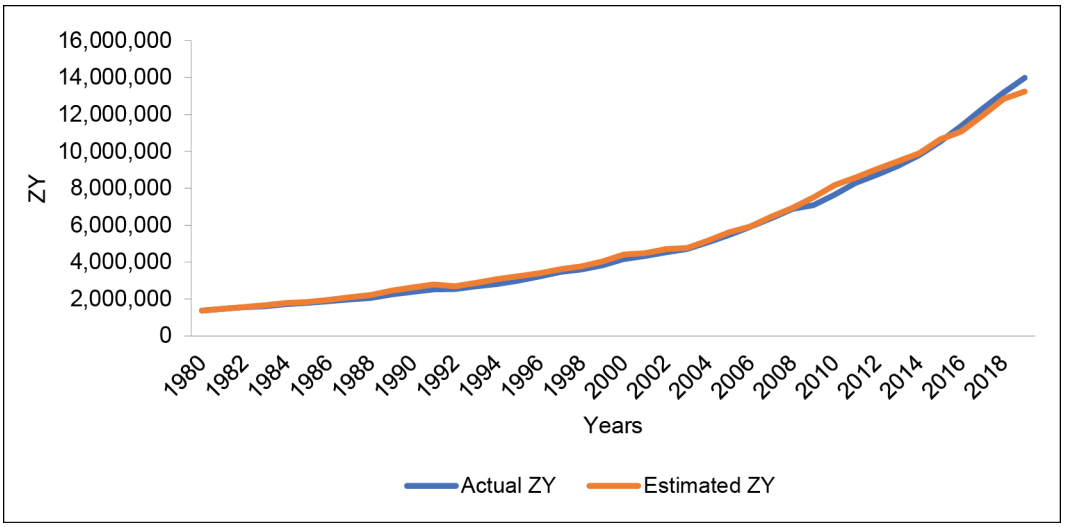
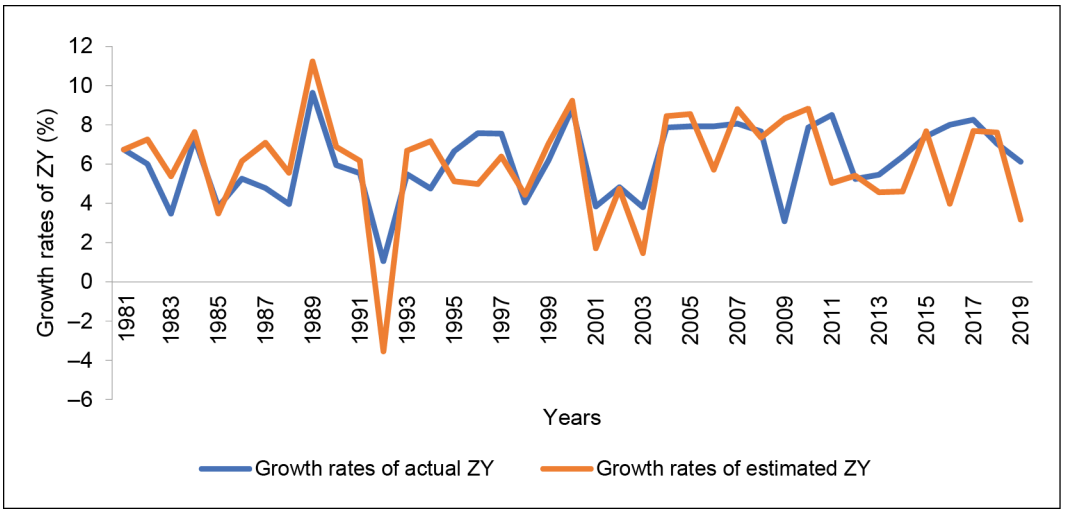


Figure 3: Growth Rates of Actual ZY vs. Growth Rates of Estimated ZY

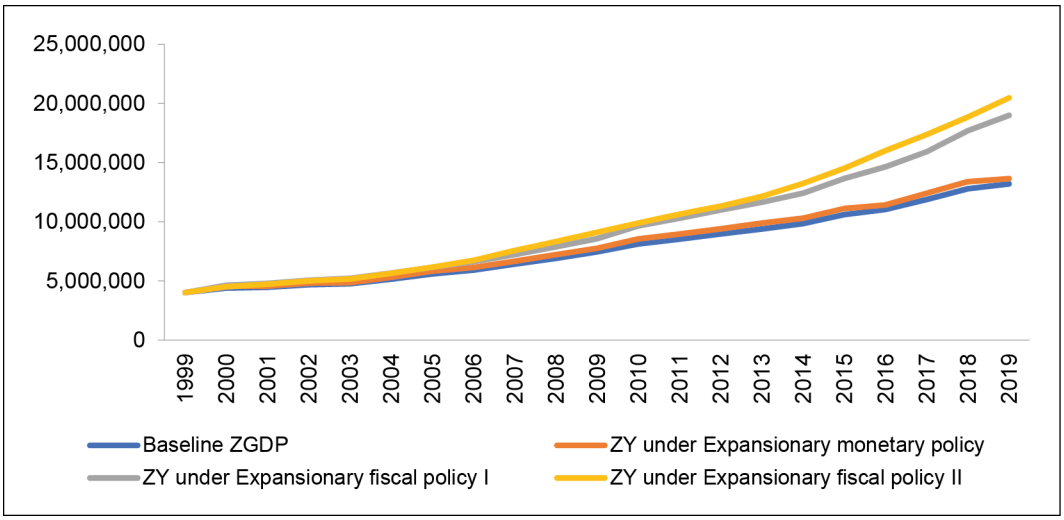


In light of these results, we have undertaken the following simulation exercises:

1. Expansionary monetary policy – where the short-term rate of interest is lower than the actual rate by 100 basis points
2. Expansionary fiscal policy I – where the rate of growth of real government consumption expenditure is increased by 10%.
3. Expansionary fiscal policy II – where government capital formation is taken 10% higher than the existing level.

In all three cases, we expect real GDP to increase. The results are as follows. Figure 4 presents the simulated value for ZY for real vis-à-vis baseline ZY from FY2000 to 2001 onwards.

Figure 4: Results from the Simulation Exercises



The results are in line with expectations. In all three cases, the simulated value of ZY is found to increase when compared to the baseline ZY values. A 100-basis point reduction in the short-term rate of interest increases ZY by an average of 3.98%, whereas with a 10% increase in government final consumption expenditure and government capital formation, compared to baseline ZY, the simulated values for ZY are higher by an average of around 19.65% and 24.23%, respectively. Quite naturally, the impact of government capital formation is found to be stronger on ZY when compared to the influence of an increase in government private consumption expenditure and a reduction in interest rates. While lower interest rates drive ZY through higher private investment, expansionary fiscal policy has a direct bearing on ZY through the multiplier process. Moreover, since government capital formation is also a major determinant of exports, it could push ZY through higher exports too. The relative dominance of fiscal policy could be explained by the structure of the Indian economy. From a theoretical perspective, given the slope of the LM curve, fiscal policy is more effective when it is initiated at a low level of output compared to full employment equilibrium. In the Indian scenario, a closer observation of the output gap $(ZY_t - Z\bar{Y}_t)$ reveals the gap being negative on many occasions, indicating growth actual output being lower than the long-run trend.

The sustainability of expansionary fiscal policy is assessed by the tax buoyancy. Under fiscal policy I and II, the total tax collection is found to increase by an average of around 51.23% and 59.33%, respectively. It should be noted that the increase in tax collection shows a higher percentage increase when compared to ZY on account of the lower base for the former. Finally, with respect to the trade-off between growth and inflation, we find expansionary fiscal policies driving inflation higher when compared to the impact of lower interest rates. Inflation is on average 4% higher under fiscal expansion when compared to just about 0.40% under lower interest rates. This again corroborates the Indian scenario, where inflationary pressures from expansionary fiscal policies are quite dominant.[3]

[3] Examples of this could be inflation arising from monetized deficits during the late 80s and early 90s and the episode of food inflation during the period 2006–2011 when the inflation was widely regarded as demand driven. It was mainly due to a rural wage spiral caused by MGNREGA and stimulus to tackle recession (Rangarajan and Sheel 2013; Reddy 2013).

4. CONCLUSIONS

The current study is an attempt to capture the macroeconomic dynamics in India at an aggregate level. The study covers annual data from 1980 through 2019. The theoretical underpinnings of our analysis follow the New Keynesian framework based on the microeconomic foundations of Keynesian economics. The aggregate behavior of the economy is captured through nine equations forming the SEM. Aggregate demand is modeled under its four components, namely consumption, private investment, exports, and imports. Under this framework, government expenditure and government capital formation are considered exogenous. Aggregate supply takes the form of a simple neoclassical production function driven by labor, capital, and exogenous technical progress. The rate of inflation is taken as a function of output gap, past inflation expectations, and exchange rate. This follows New Keynesian Phillips curve representation. The LM curve specification is determined by income and short-term rate of interest. Linking monetary policy and fiscal policy to the goods market, long-run interest rates are determined by short-term interest rates and government investment. Finally, tax is estimated as a function of per capita income.

The results from our empirical results support the theoretical expectations. Consumption follows the absolute income hypothesis. We also find evidence of private investment being driven by the accelerator. This is in tune with results obtained by Jangili and Kumar (2010). Further, the negative sign of nominal interest rates in the investment function depicts an inverse relation between the former and private capital formation. Exports are driven by world income, exchange rates, and government capital formation, whereas import demand is a function of domestic income, the difference between domestic and international inflation, and lagged exchange rate.

The positive coefficient for the output gap in the Phillips curve formulation confirms the case of a positively sloped supply curve. In the Indian context, our results corroborate earlier studies like Paul (2009), Dua and Gaur (2010), and Goyal and Tripathi (2015).

Finally, the paper offers suitable policy prescriptions for fiscal and monetary authorities to revive the economy. The effectiveness of such policies is evident from the simulation results of our proposed model. An expansionary fiscal policy in comparison to that of a monetary one is critical to the Indian economy's structure since investment growth, induced by lower interest rates, lost its steam in propelling output due to several frictions and a weaker transmission mechanism. This necessarily implies the need to focus on prudent fiscal stances so as to steer the economy toward a sustainable growth trajectory in the future.

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APPENDIX 1: COMPLETE MODEL WITH IDENTITIES AND DEFINITIONS

1 Estimated Model

$$\dot{ZC} = 0.38 + 0.83^{*}\, \dot{ZY_d}$$

$$\dot{ZI_{Pvt}} = 1.97 + 1.91^{*}\, \dot{GDS_{pvt}} - 1.65^{*}\, ROI^{LR} + 1.44^{*}(\dot{ZY_t} - \dot{ZY_{t-1}})$$

$$\dot{ZEX} = -7.67 + 2.85^{*}\, \dot{ZY}_{world_{t-1}} + 0.37^{*}\, \dot{EXR} + 0.41^{*}\, \dot{ZI}_{Govt_{t-1}} + 0.45^{*}\, \dot{ZEX}_{t-1}$$

$$\dot{ZIM} = -17.78 - 0.56^{*}\, \dot{EXR}_{t-1} + 2.92^{*}\, \dot{ZY} + 1.24^{*}(\pi - \pi^{int}) + 0.21^{*}\, \dot{FOREX}_{t-1}$$

$$\dot{Z\bar{Y}} = 3.98 + 0.05^{*}\, Tech + 0.10^{*}\, \dot{ZK}_{t-2} + 1.21^{*}\, \dot{WRKPOP}$$

$$\pi = 3.98 + 0.54^{*}(\dot{ZY_{t-1}} - \dot{Z\bar{Y}_{t-1}}) + 0.74^{*}(\pi_{t-1} - \bar{\pi}_{t-1}) + 10.12^{*}\, \dot{EXR} - 0.08^{*}\, \dot{QFG}_{t-1}$$

$$ROI^{LR} = 3.00 + 0.91^{*}\, ROI^{SR} + 0.19^{*}\, \dot{NI}_{Govt}$$

$$\Delta(M/P) = 5297.08 + 524.69^{*}\, ROI^{SR} + 343.50^{*}\, \dot{ZY}$$

$$\dot{TAX} = 4.92 + 0.80^{*}\, \dot{NY_{pc}}$$

2 Definition and Identities

GDP and Its Components

$$\mathrm{ZC} = ((\dot{\mathrm{ZC}}/100 + 1) * \mathrm{ZC}_{t-1})$$

$$\mathrm{ZI}_{\mathrm{Pvt}} = ((\dot{\mathrm{ZI}}_{\mathrm{Pvt}}/100 + 1) * \mathrm{ZI}_{\mathrm{Pvt}_{t-1}})$$

$$\mathrm{ZI}_{\mathrm{Govt}} = ((\dot{\mathrm{ZI}}_{\mathrm{Govt}}/100 + 1) * \mathrm{ZI}_{\mathrm{Govt}_{t-1}})$$

$$\mathrm{ZGFCE} = ((\dot{\mathrm{ZGFCE}}/100 + 1) * \mathrm{ZGFCE}_{t-1})$$

$$\mathrm{ZEX} = ((\dot{\mathrm{ZEX}}/100 + 1) * \mathrm{ZEX}_{t-1})$$

$$\mathrm{ZIM} = ((\dot{\mathrm{ZIM}}/100 + 1) * \mathrm{ZIM}_{t-1})$$

$$\mathrm{ZY} = \mathrm{ZC} + \mathrm{ZI}_{\mathrm{Pvt}} + \mathrm{ZI}_{\mathrm{Govt}} + \mathrm{ZGFCE} + \mathrm{ZEX} - \mathrm{ZIM}$$

$$\dot{\mathrm{ZY}} = \left((\mathrm{ZY} - \mathrm{ZY}_{t-1}) - \mathrm{ZY}_{t-1}\right) * 100$$

$$\mathrm{ZY}_d = (\mathrm{ZY} - \text{Direct tax})$$

$$\dot{ZY_d} = \left(\left(\mathrm{ZY}_d - \mathrm{ZY}_{d_{t-1}}\right) - \mathrm{ZY}_{d_{t-1}}\right) * 100$$

$$\mathrm{NY} = (\mathrm{ZY} * \mathrm{P})/100$$

$$\mathrm{NY}_{\mathrm{PC}} = (\mathrm{NY}/\mathrm{POPULATION})$$

$$\dot{\mathrm{ZY}_{\mathrm{pc}}} = \left(\left(\mathrm{NY}_{\mathrm{PC}} - \mathrm{NY}_{\mathrm{PC}_{t-1}}\right) - \mathrm{NY}_{\mathrm{PC}}\right) * 100$$

Prices and Inflation

$$\mathrm{P} = ((\pi/100 + 1) * \mathrm{P}_{t-1})$$

$$\bar{\pi} = (\pi - 4)$$

Capital Stock

$\mathrm{NI_{Pvt}} = (\mathrm{ZI_{Pvt}} * \mathrm{P_{Ipvt}})/100$

$\mathrm{NI_{Govt}} = (\mathrm{ZI_{Govt}} * \mathrm{P_{Igovt}})/100$

$\mathrm{NI} = \mathrm{NI_{Pvt}} + \mathrm{NI_{Govt}}$

$\mathrm{NK} = (\mathrm{NK_{t-1}} + \mathrm{NI} - \mathrm{Depreciation})$

$\mathrm{ZK} = (\mathrm{NK/P}) * 100$

$\dot{\mathrm{ZK}} = \left((\mathrm{ZK} - \mathrm{ZK_{t-1}}) - \mathrm{ZK_{t-1}}\right) * 100$

$\mathrm{P_{Ipvt}}$ and $\mathrm{P_{Igovt}}$ are respectively deflator for private investment and govt. investment

Tax Collection

$\text{Direct Tax} = (\text{Direct Tax Ratio} * \text{Tax})/100$

$\text{Tax} = ((\dot{TAX}/100 + 1) * \mathrm{Tax_{t-1}})$

$\text{Direct Tax Ratio} = (\text{Direct Tax/Tax}) * 100$