The Shape of Growth Compatible Fiscal Consolidation

*by Michael Debabrata Patra, Samir Ranjan Behera, Harendra Kumar Behera, Shesadri Banerjee, Ipsita Padhi and Saksham Sood^*

Medium-term complementarities between fiscal consolidation and growth in India argue for prioritising the composition of government expenditure towards developmental expenditure (viz. health, education, skilling, digitalisation and climate risk mitigation). Employing a dynamic stochastic general equilibrium (DSGE) model, we find that targeting productive employment-generating sectors, embracing energy-efficient transition and investing in digitalisation could lead to a substantial decline in general government debt.

I. Introduction

The Interim Budget (IB), 2024-25 crowns turbulent five years of budget making. Artificial intelligence (AI) analysis – specifically, natural language processing (NLP)[1] – of the encomiums being showered on the IB throws up four terms that stand out as perhaps its defining characteristics: confidence; commitment; capex; and consolidation. The Budget speech lays out a path of annual reductions in the fiscal deficit while committing to sustaining the emphasis on capital expenditure through a period of transformative changes underway in the Indian economy.

In the literature, economic growth and fiscal consolidation are viewed as bound in a rictus of opposing tensions. The Keynesian tradition posits a short-term trade-off – lower spending and/or higher taxes reduce aggregate demand, thereby depressing economic growth (Kleis and Moessinger, 2016). This position is supported by empirical evidence from both advanced and emerging market economies (Carrière-Swallow, David and Leigh, 2021; Guajardo, Leigh and Pescatori, 2014; and Hernández de Cos and Moral-Benito, 2013). The extent of output losses associated with fiscal consolidation depends on the size of the fiscal multiplier. In the case of developing countries, the growth sacrifice could be higher as they are expected to have higher fiscal multipliers due to labour market rigidities, limited automatic stabilisers and smaller initial stock of public capital (IMF, 2014; Baxter and King, 1993).[2]

In the long term, fiscal consolidation can boost growth and improve equality (Balasundharam *et al.*, 2023). Successful consolidation would lead to a reduction in the financing needs of the government and lower long-term interest rates both of which crowd in private investment (Gupta *et al.*, 2005). It also creates fiscal space to finance more productive expenditures or growth-enhancing tax cuts (European Central Bank, 2010). Fiscal consolidation processes that protect public investment in physical and human capital, and targeted social spending to mitigate the impact on inequality are found to yield lasting growth dividends (Kim *et al.*, 2021). A green investment push in the form of revenue mobilisation through carbon pricing is also found to result in stronger growth in the long term (IMF, 2020).

Non-Keynesian effects of fiscal consolidation are also evident in lower sovereign risk premia which translates to lower real interest rates and consequently, higher demand and growth (Alesina and Ardagna, 2010). To the extent that consolidation eliminates the need for larger and potentially more disruptive adjustments in the future, consumers' expected future tax increases will be smaller than originally perceived, resulting in an increase in current private consumption (Giavazzi and Pagano, 1990).

^ The authors are from the Reserve Bank of India. The views expressed in this article are those of the authors and do not represent the views of the Reserve Bank of India.

[1] Dahiya, R. (2024). An NLP Analysis of the Budget (Forthcoming).

[2] Empirical evidence on these predictions is mixed as multipliers in developing countries could also be reduced by larger precautionary savings stemming from an uncertain macroeconomic environment, low efficiency of public expenditure, lower fiscal policy credibility and a large informal economy (Miyamoto *et al.*, 2020; Ilzetzki, Mendoza and Vegh, 2013; Colombo *et al.*, 2022).

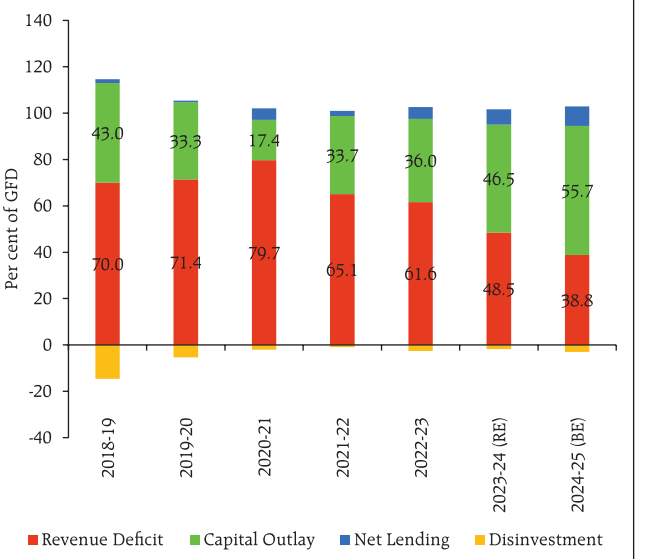
Against this backdrop and in the light of the commitments made in the IB, we quantify and incorporate these aspects into a general equilibrium model in which households, corporations and policy makers are interacting continuously – illustratively, households buy goods and services from corporations and the government, which translate into revenues for the latter two. Households also provide labour to the rest of the economy and receive incomes on which they pay taxes to the government which, in turn, makes transfers in the form of subsidies to households, and so on. To this general equilibrium model, we ask the question: if the government remains committed to the goals announced in the Interim Budget and directs some part of planned capex towards climate risk mitigation, reskilling/ upskilling the workforce and investing into the digital revolution, what would be the shape of fiscal consolidation?

The rest of the article is divided into four sections. Section II delves into the underlying fiscal dynamics of the Interim Budget that drive the fiscal consolidation process. Section III describes the alternative variables used for the analysis. Section IV lays out the key features of our dynamic stochastic general equilibrium (DSGE) model and presents the results. Section V sets out concluding observations.

II. The Underlying Fiscal Dynamics

The IB placed the revised estimate of the gross fiscal deficit (GFD) for 2023-24 at 5.8 per cent of GDP, lower than the budget estimate (BE) of 5.9 per cent. Reiterating its commitment to attain a GFD of 4.5 per cent of GDP by 2025-26, a GFD of 5.1 per cent of GDP has been budgeted in 2024-25 – a consolidation of 71 basis points over 2023-24 (RE). The IB also sustains the impetus provided to capital expenditure in the post-pandemic period, increasing its share to 3.4 per cent of GDP in 2024-25. The improvement in the quality of expenditure is reflected in the decline in the share of the revenue deficit to 38.8 per cent and an increase

Chart 1: Decomposition of GFD



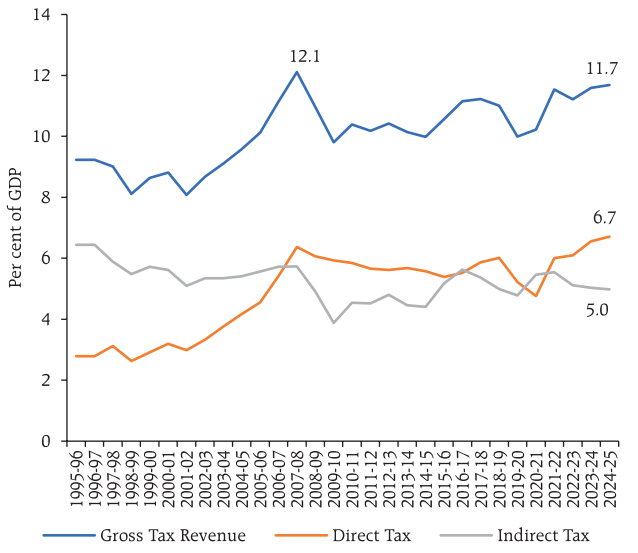
Source: Union Budget Documents.

in the share of capital outlay to 55.7 per cent of the GFD. This shift signifies that more than half of the borrowings are now directed towards the financing of capital expenditure, rather than the revenue deficit (Chart 1).

II.1 Receipts

The drive for fiscal consolidation is revenue-driven - the digitalisation of India's tax system has substantially improved tax collection by streamlining processes, enhancing transparency and promoting efficiency in filing, processing and scrutiny, leading to increased compliance and a widening of the tax base. Consequently, the tax-GDP ratio has increased from 10.1 per cent of GDP in 2013-14 to 11.7 per cent in 2024-25 (BE) (Chart 2). In 2023-24 (RE), gross tax revenue registered a buoyancy of 1.4, which is higher than the average of 1.1 during 2010-19. Revenue collection in 2023-24 was led by personal income taxes, which recorded a buoyancy of 2.5. In 2024-25, gross tax revenues are budgeted to increase by 11.5 per cent, indicating a buoyancy of 1.09 that is in alignment with the 10-year average (Table 1). In 2024-25, non-tax revenues are budgeted to increase by 6.4 per cent to ₹4.0 lakh crore.

Chart 2: Tax-GDP Ratio



Source: Union Budget Documents.

II.2 Expenditure

Total expenditure is budgeted to grow modestly in 2024-25 (BE), driven by restrained growth in revenue expenditure (Table 2). Infrastructure development is sustained through initiatives like the National Infrastructure Pipeline (NIP) and PM Gati-Shakti Mission. Consequently, the ratio of revenue expenditure to capital outlay (RECO), an indicator of the quality of expenditure, is budgeted to improve to an all-time low of 3.9 in 2024-25 (BE) (Chart 3).

Table 1: Tax Buoyancy

	Average Tax Buoyancy (2010-11 to 2018-19)	2022-23	2023-24 (BE)	2023-24 (RE)	2024-25 (BE)
1	2	3	4	5	6
1. Gross Tax Revenue	**1.11**	**0.79**	**0.99**	**1.41**	**1.09**
2. Direct Taxes	**1.03**	**1.11**	**1.00**	**1.94**	**1.24**
(i) Corporation Tax	0.92	1.00	1.00	1.32	1.24
(ii) Income Tax	1.27	1.25	1.00	2.54	1.25
3. Indirect taxes	**1.25**	**0.45**	**0.99**	**0.79**	**0.89**
(i) GST	-	1.35	1.14	1.43	1.11
(ii) Customs Duty	0.31	0.43	1.05	0.28	0.55
(iii) Excise Duty	0.91	-1.13	0.57	-0.51	0.48

Note: Calculations for 2023-24 (BE) are made over 2022-23 (RE).

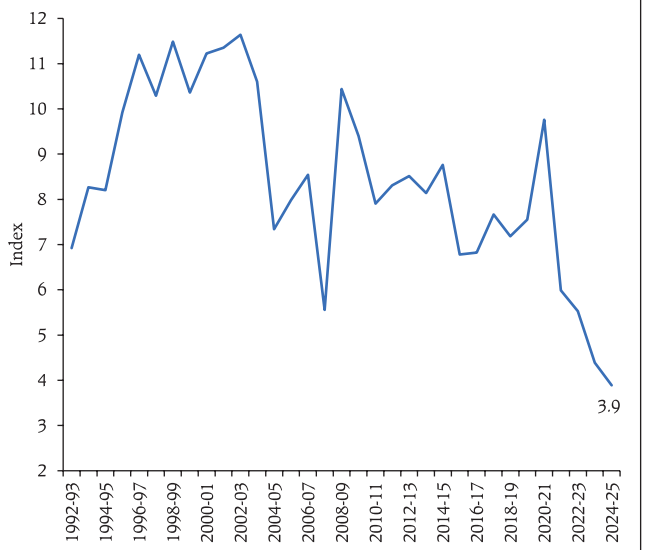
Table 2: Expenditure of Union Government

Item	₹ thousand crore				Growth Rate (per cent)	
	2022-23	2023-24 (BE)	2023-24 (RE)	2024-25 (BE)	2023-24 (RE)	2024-25 (BE)
1	2	3	4	5	6	7
1. Total Expenditure	4,193	4,503	4,490	4,766	7.1	6.1
2. Revenue Expenditure *(of which)*	3,453	3,502	3,540	3,655	2.5	3.2
(i) Interest Payments	929	1,080	1,055	1,190	13.7	12.8
(ii) Major Subsidies	531	375	413	381	-22.1	-7.8
Food	273	197	212	205	-22.2	-3.3
Fertiliser	251	175	189	164	-24.8	-13.2
Petroleum	7	2	12	12	79.5	-2.6
(iii) MGNREGA	91	60	86	86	-5.3	0.0
(iv) PM-KISAN	58	60	60	60	3.0	0.0
3. Capital Expenditure	740	1,001	950	1,111	28.4	16.9

Source: Union Budget Documents.

The IB has also announced the establishment of a corpus of ₹1 lakh crore to provide long-term financing at low or nil interest rates to the private sector to scale up research and innovation in sunrise domains. In order to encourage adoption of green energy and reduce reliance on fossil fuels, the IB has announced

Chart 3: Revenue Expenditure to Capital Outlay



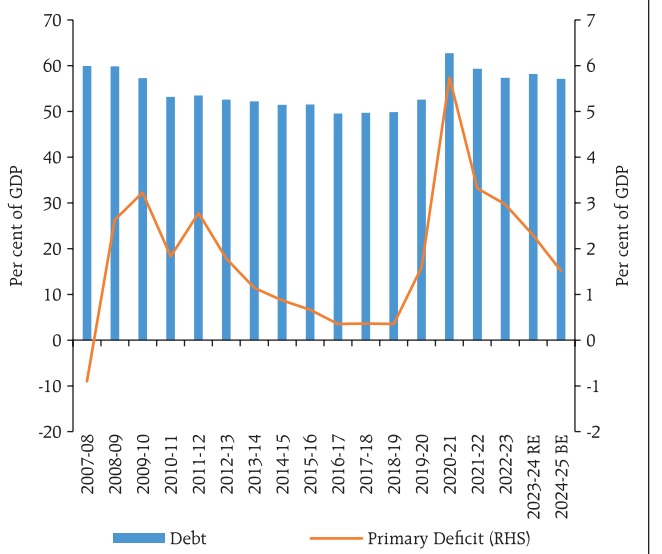
Source: Union Budget Documents.

a 'Rooftop Solarisation' scheme, with an outlay of ₹4,556 crore. This scheme aims to enable 1 crore households to obtain up to 300 units free electricity per month and save up to ₹18,000 annually from free solar electricity and selling the surplus to the distribution companies. The IB has also enhanced the target for the *Lakhpati Didi* scheme from 2 crore to 3 crore women to provide skill training to women self-help group (SHG) members.

II.3 Debt

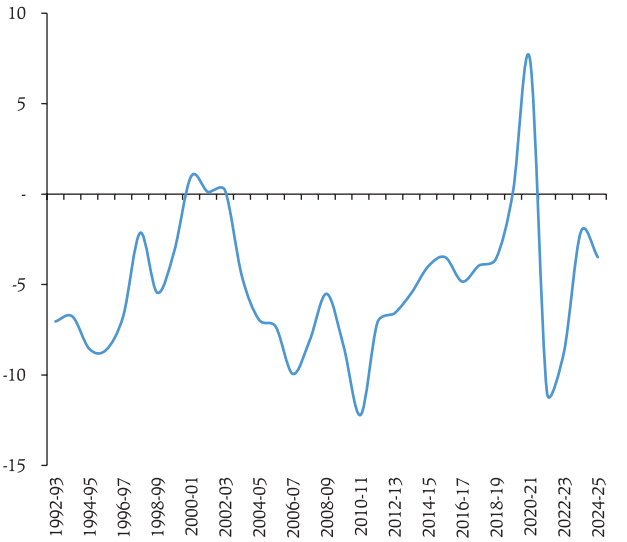
The outstanding debt of the Union government is budgeted to decline to 57.1 per cent of GDP in 2024-25 (BE) from 58.2 per cent of GDP in 2023-24 (RE) (Chart 4).[3] Going forward, with a favorable interest rate - growth differential (r *minus* g) and the primary deficit budgeted at 1.5 per cent of GDP in 2024-25 - down from 2.3 per cent of GDP in 2023-24 (RE) - the consolidation of the Union government's debt is expected to sustain (Chart 5). Two additional redeeming features are that more than 95 per cent of the outstanding debt is issued in domestic currency, which allays exchange rate risk; and the weighted average maturity of outstanding stock of dated securities stands at 12.2 years, mitigating rollover risk.

Chart 4: Union Government Debt



Source: Union Budget Documents.

Chart 5: Interest Rate Growth Differential



Source: Union Budget Documents.

III. Alternative Variables

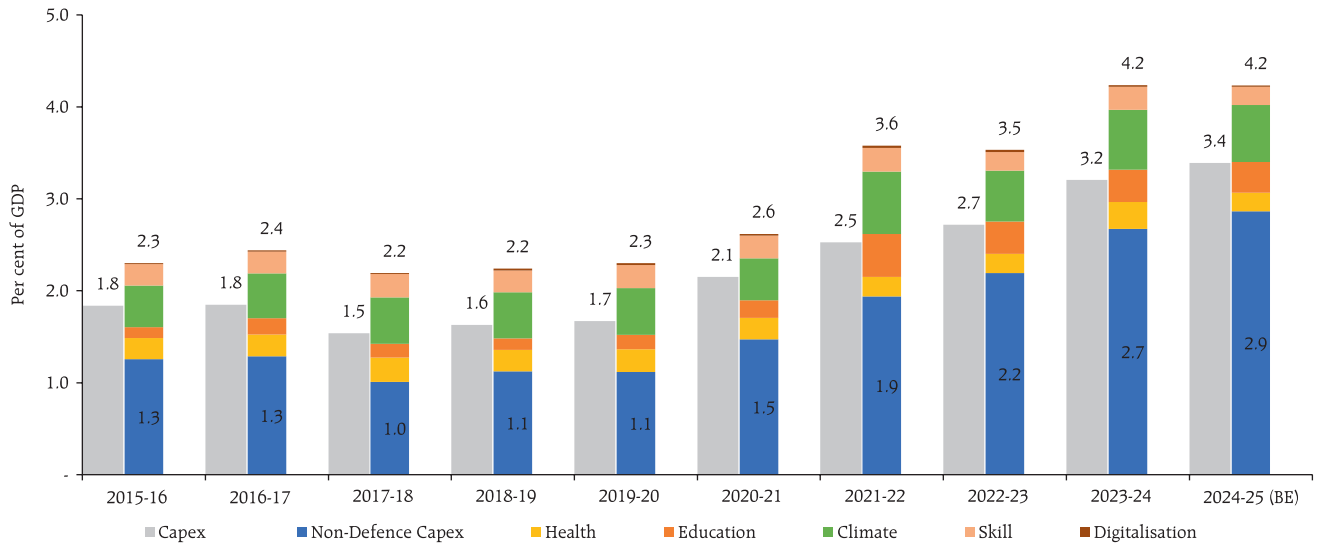
We take the public debt to GDP ratio as the variable of interest for measuring fiscal consolidation because it is comprehensive and not amenable to exogenous revenue bursts and/or unplanned expenditure cuts as a deficit variable is.

III.1 Redefining Capex

Recognising that some parts of capital expenditure are not strongly growth inducing while some parts of revenue expenditure can actually result in physical and human capital formation, we redefine capital expenditure to exclude defence and include social and economic expenditure covering allocations towards health, education, skilling, digitalisation and climate risk mitigation. We call this developmental expenditure (DE), which is budgeted at ₹13.9 lakh crore (4.2 per cent of GDP) in 2024-25 as against the provision of ₹11.1 lakh crore (3.4 per cent of GDP) for the traditionally defined capex (Chart 6).

[3] The general government debt ratio stands at 81.6 per cent of GDP in 2023-24 (BE).

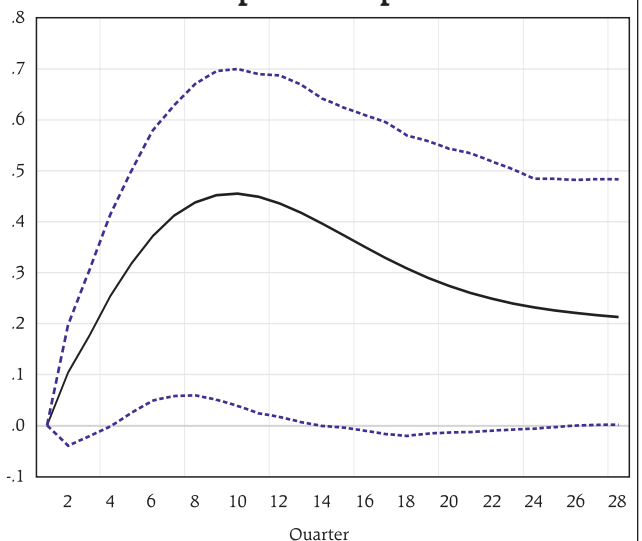
Chart 6: Capex *vis-a-vis* Developmental Expenditure



Source: Union Budget Documents.

A preliminary exercise in a vector autoregression (VAR) framework with real DE and real GDP shows that a one per cent rise in the former could have a cumulative multiplier impact that produces a 5 per cent rise in GDP over 4 years (Chart 7). The impulse response suggests that the GDP starts rising after 2 quarters and the impact becomes statistically significant after 4 quarters.

Chart 7: Response of GDP to one per cent rise in Developmental Expenditure



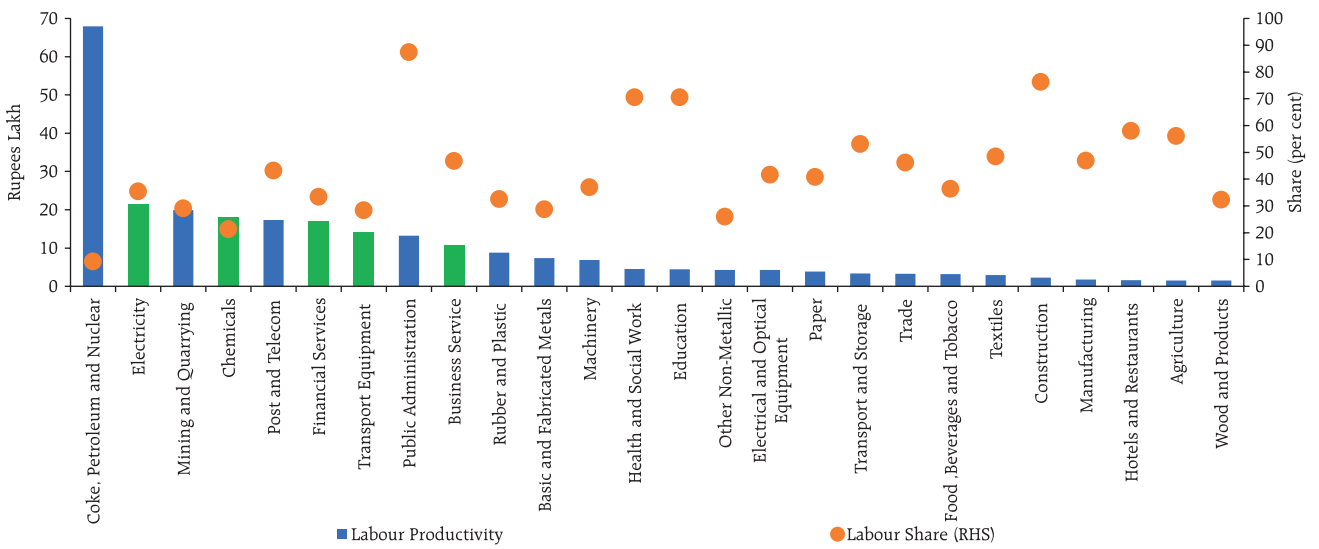
Source: Authors' estimates.

III.2 Reskilling/Upskilling the Labour Force

India's labour productivity is among the lowest relative to peers. As a result, labour's contribution in overall value added is only about 50 per cent in comparison with about 70 per cent in advanced countries. 55 per cent of the workforce is employed in agriculture and the construction sector, which have among the lowest productivities. As we enter an era of digitally driven knowledge-based economies, education and skill development are going to drive national competitiveness. Thus, it is imperative to prioritise skilling, upskilling and reskilling of the labour force to foster economic growth and employability, with special emphasis on women in the workforce. From the KLEMS database of the Reserve Bank of India (RBI)[4], five sectors (*i.e.*, chemicals and chemical products, financial services, business services, electricity, gas and water supply, and transport equipment) are identified for their

[4] The India KLEMS database, constructed by the Reserve Bank of India, consists of inputs (employment, labour quality, capital stock, capital composition, consumption of energy, material and services), output (gross value added; gross output) and total factor productivity (TFP) estimates from 1980-81 to 2021-22 for 27 industries.

Chart 8: Labour Productivity and Labour Share



Sources: India KLEMS Database; and Authors' estimates.

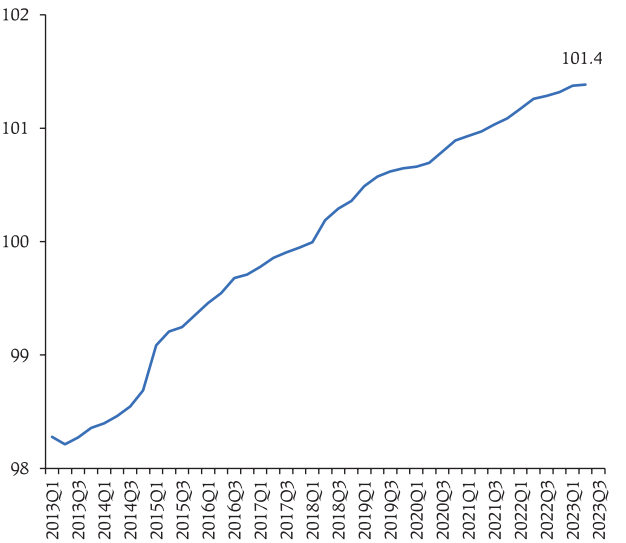
demonstrated higher labour productivity with a significant contribution of labour to overall output of the sector (Chart 8). A uniform 5 per cent rise in employment (including training and skilling) in these sectors for one year could contribute to more than one percentage point rise in GDP growth over the forecast horizon 2024-31.

III.3 Investing in Digitalisation

Digitalisation can increase economic efficiency and competitiveness, creating new businesses and products, increasing financial inclusion, improving governance and reducing disparities. Deep penetration of telecom and internet, the Pradhan Mantri Jan-Dhan Yojana to connect people with bank accounts, creation of a unique identity number - *Aadhar* - for each resident and exponential growth in digital financial transactions combined with the focus on developing digital public infrastructure have laid the foundations of India's digital economy – the India stack. Digitalisation increases productivity of both labour and capital, and thereby engenders a faster growth in total factor productivity.

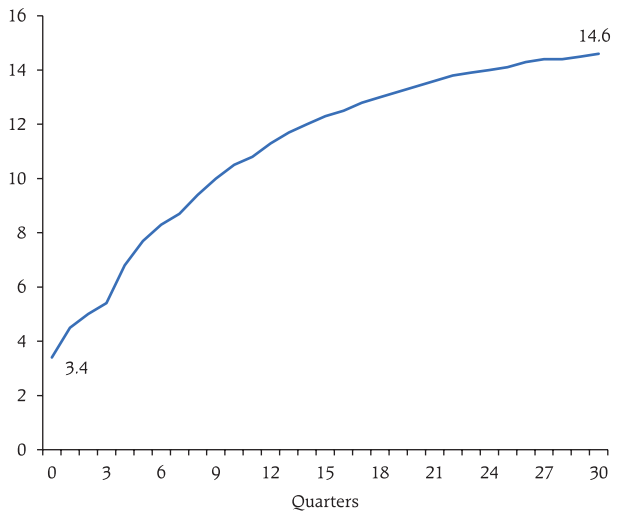
We employ a dynamic factor model (DFM) to construct a time-varying index of digitalisation by extracting a common factor from data on all digital payments, number of internet users, number of mobile phone subscriptions, number of QR codes generated per 100 persons, credit to the software industry, investment in ICT (information and communication technology) and people employed in the ICT sector (Chart 9).

Chart 9: Digitalisation Index



Source: Authors' estimates.

Chart 10: Cumulative Dynamic Multiplier of Digitalisation



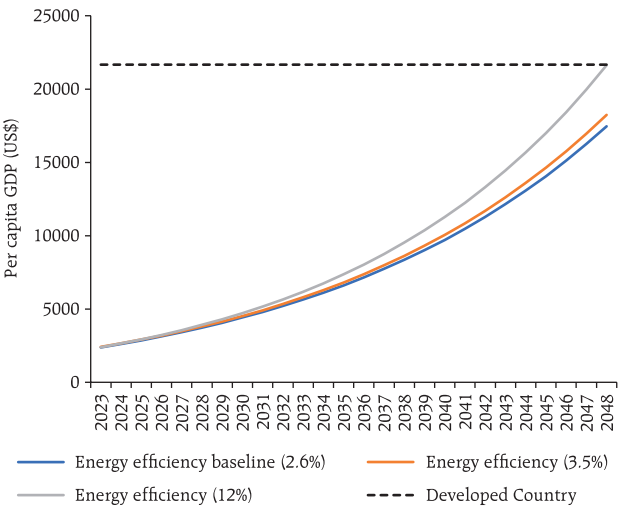
Source: Authors' estimates.

We find that a one per cent rise in real DE increases digitalisation by 0.02 percentage points. A growth of 10.4 per cent in DE (as budgeted for 2024-25) can cause digitalisation to grow by 0.2 per cent. The impact and dynamic multipliers of digitalisation on the economy is estimated by using an auto-regressive distributed lag (ARDL) model. The impact multiplier on GDP is found to be 3.4 in response to a one per cent increase in digitalisation (Chart 10)[5]. The cumulative dynamic multiplier is estimated from the model at 15 in the long run. A growth of 0.2 per cent in the digitalisation index can raise GDP growth by about 130 bps in a year and by 2.8 percentage points over seven years.

III.4 Energy Efficiency

India has committed to achieve net zero emission target by 2070 for which the dependence on consumption of fossil fuel needs to be cut down. India has been able to reduce the energy intensity of GDP steadily due to both structural changes in the economy and technological efficiency. Based on the emission factors of different sources of energy, it has been estimated that a one per cent increase in the share of renewable energy in the energy mix reduces CO_2 emissions by around 0.63 per cent (RBI, 2023). India has made significant strides in renewable installed capacity and its share in total installed capacity is at 42 per cent (including large hydro). Based on several initiatives that have been taken towards climate risk mitigation and technological upgradation during recent years[6], if the annual allocation towards climate mitigation is increased in a manner that 33 per cent of the annual allocation is invested in green energy augmenting technology every year, it will add to GDP growth by 10 basis points every year and 0.5 percentage points over the forecast horizon. As the horizon is lengthened, more gains accrue in terms of GDP growth. In the short-run, there may be a trade-off between climate mitigation and economic growth. In the medium term, however, there is no trade-off – mitigating climate risks is unequivocally beneficial for economic progress (Chart 11).

Chart 11: Per Capita GDP Path under Different Energy Efficiency Scenario



Source: Authors' estimates.

[5] It may be noted that it took five years period for digitalisation to increase by one per cent.

[6] Using an environmental Solow-type growth model, it has been shown that India's objective of becoming an advanced economy by 2047 is possible by enhancing the labour augmenting and energy augmenting technology growth by 10 per cent and 6 per cent, respectively (RBI, 2023).

IV. The Model and Results

We consider a closed economy dynamic stochastic general equilibrium (DSGE) model comprising households, firms, the banking system, the fiscal authority and the central bank (Chart 12).

Households are of two types: one category has multiple sources of income from labour, interest earned from bank deposits, government bonds and dividends from the ownership of firms; the other category survives on labour income and direct transfers. On the production side, firms use labour, capital and energy as inputs in a competitive market environment. Banks intermediate all financial transactions among economic agents. Using the policy rate as its key instrument, the central bank follows an interest rate rule featuring interest rate smoothing and stabilisation of CPI inflation around its target and GDP growth around its trend. The fiscal authority uses alternative policy instruments such as spending on public consumption, transfers, investment on public capital goods, tax on labour income and private consumption. The issuance of government bonds constitutes public debt which is held by households and commercial banks. The government services its debt along with periodic interest payments. All the agents are rational and interact with each other in a dynamic environment. We solve the model to investigate the likely path of the debt to GDP ratio over the period 2024-25 to 2030-31 and explore alternative paths under four scenarios (Chart 13). Scenario 1 envisages the effect of an increase (5 per cent) in the employment level in relatively productive sectors as delineated in Section III.2. Scenario 2 considers the impact of a rise in energy efficiency. Scenario 3 explores fiscal policy intervention through capex towards greater digitalisation of the economy. Scenario 4 combines all the above outcomes simultaneously.

Chart 12: Interplay among Building Blocks of the DSGE Model

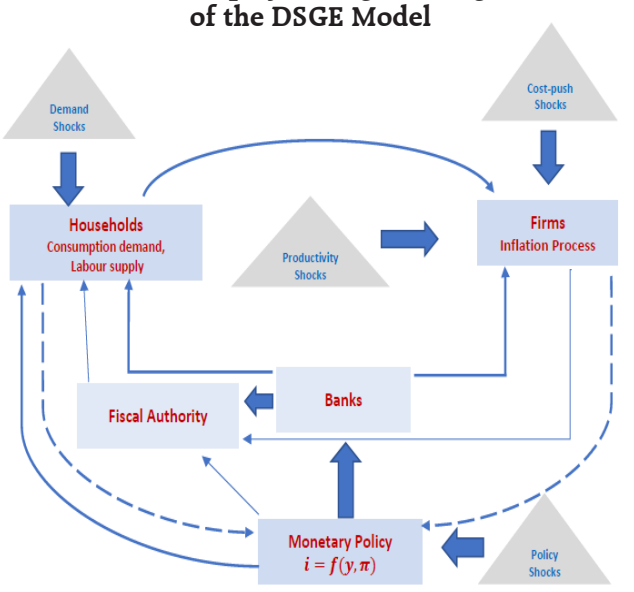
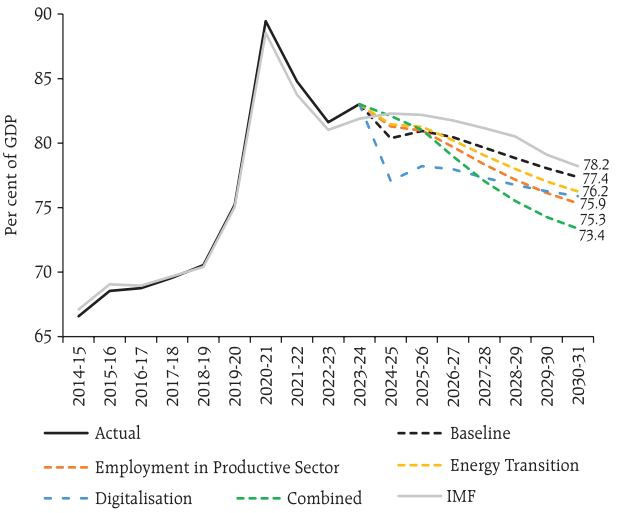


Chart 13: Projected Path of General Government Debt



Source: Authors' estimates.

Our baseline projection[7] suggests that the debt-GDP ratio will chart a secular decline, reaching 77.4 per cent in 2030-31. In scenario 1, the debt-GDP ratio rises in the short-run, capturing the short-run trade-off, but falls thereafter to 75.3 per cent by 2030-31. Scenario 2 is similar to Scenario 1 in that the choice of energy-efficient transition is subject to short-run

[7] In the baseline, real GDP growth is projected at 7.3 per cent per annum during the forecast period. CPI inflation is projected at 4.3 per cent per annum and remains stable at that level for the alternative scenarios.

pain but it yields long-run gains by reducing the debt-GDP ratio to 76.2 per cent by 2030-31. In Scenario 3, digitalisation impacts the fiscal consolidation path through higher levels of productivity, taking the debt-GDP ratio at 75.9 per cent at the end of the forecast period. Scenario 4 combines all the measures and shows that the debt-GDP ratio declines to 73.4 per cent by 2030-31.

V. Conclusion

Policy wielders always face the trilemma of balancing climate goals, debt sustainability and operational feasibility within the political mandate (IMF Fiscal Monitor, 2023). The trade-offs are starker for developing countries for which developmental priorities dominate. We argue on the basis of our empirical findings in a general equilibrium framework that medium-term complementarities between judicious fiscal consolidation and growth outweigh the short-run costs. Spending on social and physical infrastructure, climate mitigation, digitalisation and skilling the labour force can yield long-lasting growth dividends.

Our simulations reveal that the general government debt-GDP ratio swerves below the projected path set out by the IMF in its latest Article IV consultation report for India[8]. With recalibration of government expenditure, the general government debt-GDP ratio is projected to decline to 73.4 per cent by 2030-31, around 5 percentage points lower than the IMF's projected trajectory of 78.2 per cent. This is noteworthy as the debt-GDP ratio is projected to rise from 112.1 per cent in 2023 to 116.3 per cent in 2028 for advanced economies and from 68.3 per cent to 78.1 per cent for emerging and middle-income countries. It is in this context that we reject the IMF's contention that if historical shocks materialise, India's general government debt would exceed 100 per cent of GDP in the medium-term and hence further fiscal tightening is needed.

[8] Staff Report for the 2023 Article IV Consultation for India; IMF Country Report Number 23/426; December 2023.

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Annexure

Annex I: Interim Union Budget 2024-25: Key Fiscal Indicators									
	₹ thousand crore					Per cent of GDP		Growth Rate	
	2021-22	2022-23	2023-24 (BE)	2023-24 (RE)	2024-25 (BE)	2023-24 (RE)	2024-25 (BE)	2023-24 (RE)	2024-25 (BE)
1	2	3	4	5	6	7	8	9	10
1. Direct Tax	1,408	1,660	1,823	1,945	2,199	6.6	6.7	17.2	13.1
(i) Corporation	712	826	923	923	1,043	3.1	3.2	11.7	13.0
(ii) Income	673	808	873	990	1,120	3.3	3.4	22.5	13.1
2. Indirect Tax	1,301	1,394	1,538	1,492	1,632	5.0	5.0	7.0	9.4
(i) GST	698	849	957	957	1,068	3.2	3.3	12.7	11.6
(ii) Customs	200	213	233	219	231	0.7	0.7	2.5	5.8
(iii) Excise	395	323	339	308	323	1.0	1.0	-4.5	5.0
3. Gross tax revenue (1+2)	**2,709**	**3,054**	**3,361**	**3,437**	**3,831**	**11.6**	**11.7**	**12.5**	**11.5**
4. Assignment to States	898	948	1,021	1,104	1,220	3.7	3.7	16.5	10.4
5. NCCD Transfers	6	8	9	9	9	0.0	0.0	10.0	7.3
6. Net tax Revenue (3-4-5)	1,805	2,098	2,331	2,324	2,602	7.8	7.9	10.8	11.9
7. Non-tax Revenue	365	285	302	376	400	1.3	1.2	31.7	6.4
(i) Dividends and Profits	161	100	91	154	150	0.5	0.5	54.5	-2.9
(ii) Interest Receipts	22	28	25	32	33	0.1	0.1	14.1	4.2
8. Revenue Receipts (6+7)	**2,170**	**2,383**	**2,632**	**2,700**	**3,001**	**9.1**	**9.2**	**13.3**	**11.2**
9. Non-debt Capital Receipts	39	72	84	56	79	0.2	0.2	-22.4	41.1
(i) Miscellaneous Capital Receipts	15	46	61	30	50	0.1	0.2	-34.8	66.7
(ii) Recovery of Loans	25	26	23	26	29	0.1	0.1	-0.6	11.5
10. Total Receipts (8+9)	**2,209**	**2,455**	**2,716**	**2,756**	**3,080**	**9.3**	**9.4**	**12.2**	**11.8**
11. Revenue Expenditure	**3,201**	**3,453**	**3,502**	**3,540**	**3,655**	**11.9**	**11.2**	**2.5**	**3.2**
(i) Interest Payments	805	929	1,080	1,055	1,190	3.6	3.6	13.7	12.8
(ii) Major Subsidies	446	531	375	413	381	1.4	1.2	-22.1	-7.8
Food	289	273	197	212	205	0.7	0.6	-22.2	-3.3
Fertilizer	154	251	175	189	164	0.6	0.5	-24.8	-13.2
Petroleum	3	7	2	12	12	0.0	0.0	79.5	-2.6
12. Capital Expenditure (i + ii)	**593**	**740**	**1,001**	**950**	**1,111**	**3.2**	**3.4**	**28.4**	**16.9**
(i) Capital Outlay	534	625	837	807	940	2.7	2.9	29.2	16.4
(ii) Loans & Advances	58	115	164	143	172	0.5	0.5	24.2	19.8
13. Total Expenditure (11+12)	**3,794**	**4,193**	**4,503**	**4,490**	**4,766**	**15.1**	**14.5**	**7.1**	**6.1**
14. Fiscal Deficit (13-10)	**1,585**	**1,738**	**1,787**	**1,735**	**1,685**	**5.85**	**5.14**	**-0.2**	**-2.8**

Model Appendix: Analytical Framework of DSGE Model

In Section IV, we present a stylised model of a closed economy that serves as an instrument to analyse the dynamics of debt. The model includes various building blocks, namely the household sector (HH), employment agency (EA), intermediate goods (IG) producing firms, final goods (FG) producing firms, capital goods (CG) producing firms, banking sector, the government and the central bank. The decision-making process of the agents and policy authorities is presented below.

A.1 Household Sector

The economy is populated by a continuum of households distributed over a unit interval and indexed by $j \in [0, 1]$, in which ψ_r is the proportion of Ricardian consumers, who are financially included and can smooth out their consumption intertemporally, while $(1 - \psi_r)$ is the proportion of Non-Ricardian households excluded from the financial market participation.

A.1.1 Ricardian Households

The representative Ricardian household derives utility from its consumption $(C_{j,t}^R)$ subject to habit formation, deposit holding $(D_{j,t})$, and incurs disutility from labour supply $(N_{j,t}^R)$. Its utility function is as follows:

$$U\left[C_{j,t}^R, N_{j,t}^R, \left(\frac{D_{j,t}}{P_t}\right)\right] = \left[(1-\sigma_h) ln\left(C_{j,t}^R - \sigma_h C_{t-1}^R\right) - \left(\frac{{N_{j,t}^R}^{1+\sigma_R}}{1+\sigma_R}\right) + ln\left(\frac{D_{j,t}}{P_t}\right)\right] \quad \ldots(1)$$

where, σ_h is the degree of habit formation, σ_R is the inverse of Frisch elasticity of labour supply of the Ricardian households. The expected present value of lifetime utility of the Ricardian household is:

$$E_t \sum_{t=0}^{\infty} \beta^t \, U\left[C_{j,t}^R, N_{j,t}^R, \left(\frac{D_{j,t}}{P_t}\right)\right] \quad \ldots(2)$$

where, $\beta \in (0,1)$ is the discount factor. The household faces a sequence of budget constraint:

$$(1+\tau_t^c) P_t C_{j,t}^R + D_{j,t} + B_{j,t}^H = (1-\tau_t^x) W_t^R N_{j,t}^R + (1+i_{t-1}^D) D_{j,t-1} + (1+i_{t-1}^G) B_{j,t-1}^H + \widetilde{\Omega}_t^{RH} \quad \ldots(3)$$

where, τ_t^c and τ_t^x are the proportional tax rates on consumption and labour income, respectively, paid by the household to the fiscal authority; $B_{j,t}^H$ is the government bond holding of the household; i_t^D, and i_t^G are the interest rate received from the deposit holding and government bond holding, respectively. The household owns the firms partially and hence, it receives a part of their profits $(\widetilde{\Omega}_t^{RH})$[7].

The representative Ricardian household maximises the present value of lifetime expected utility with respect to $\left\{C_{j,t}^R, N_{j,t}^R, D_{j,t}, B_{j,t}^H\right\}_{t=0}^{\infty}$ subject to the sequence of budget constraints.

A.1.2 Non-Ricardian Households

A representative Non-Ricardian household consumes the final good $C_{j,t}^{NR}$ and supplies labour $N_{j,t}^{NR}$ to the employment agency in the competitive labour market at the wage rate W_t^{NR}. Apart from their wage earning, they receive a lump-sum transfer payment (TR_t), covering different forms of benefits and allowances for subsistence, from the fiscal authority. This transfer payment is an exogenous policy variable decided by the government. Besides, the public consumption expenditure (G_t) adds utility to these households and the size of that effect is captured by $\alpha_g \in [0, 1]$.

The Non-Ricardian household maximises the following utility function:

$$U\left(C_{j,t}^{NR}, N_{j,t}^{NR}\right) = \left[ln\left(C_{j,t}^{NR} + \alpha_g G_t\right) - \left(\frac{{N_{j,t}^{NR}}^{1+\sigma_{NR}}}{1+\sigma_{NR}}\right)\right] \quad \ldots(4)$$

subject to their budget constraint:

$$(1+\tau_t^c) P_t C_{j,t}^{NR} = W_t^{NR} N_{j,t}^{NR} + P_t TR_t \quad \ldots(5)$$

and makes optimal choice for $C_{j,t}^{NR}$ and $N_{j,t}^{NR}$. σ_{NR} is the inverse of Frisch elasticity of labour supply of the non-Ricardian households.

(Contd.)

[9] Given the presence of public sector units (PSUs) and public sector banks (PSBs) in the economy, we assume that the government owns the firms and banks partially. Hence, a portion of profit of the firms and banks is reaped by the government in the form of non-tax revenue. The rest of it accrues to the Ricardian households.

Model Appendix: Analytical Framework of DSGE Model *(Contd.)*

A.2. Producers

A.2.1 Employment Agency

Given the presence of two types of household agents, we consider a labour packer, alternatively employment agency, who aggregates two different types of labour using a CES-type aggregator, and converts into a uniform effective labour input as in Banerjee (2013). Additionally, we assume that the labour supplied by the Ricardian households is more efficient (skilled) than that of the non-Ricardian households (unskilled) as in Hnatkovska and Lahiri (2020). This skill gap is modelled by an efficiency wedge between Ricardian to Non-Ricardian labour and captured by the parameter $\mu_r(>1)$. The technology for effective labour production is specified as:

$$N_t = \left[\psi_r^{\frac{1}{\varrho}}(\mu_r N_t^R)^{\left(\frac{\varrho-1}{\varrho}\right)} + (1-\psi_r)^{\frac{1}{\varrho}} N_t^{NR}{}^{\left(\frac{\varrho-1}{\varrho}\right)}\right]^{\frac{\varrho}{\varrho-1}} \quad \ldots(6)$$

where, $N_t^R = \int_0^1 N_{j,t}^R dj$ and $N_t^{NR} = \int_0^1 N_{j,t}^{NR} dj$. Using the expenditure minimisation exercise, the economy-wide aggregate nominal wage (W_t) is derived as:

$$W_t = \left[\psi_r \left(\frac{W_t^R}{\mu_r}\right)^{(1-\varrho)} + (1-\psi_r) W_t^{NR}{}^{(1-\varrho)}\right]^{\left(\frac{1}{1-\varrho}\right)} \quad \ldots(7)$$

A.2.2 Capital Goods Producing Firms

In a perfectly competitive environment, at the beginning of each period t, capital goods producers buy last period's undepreciated capital stock from the intermediate goods producing firms $(1-\delta_k)K_{t-1}$ at a price $P_t^k\left(=P_t Q_t^k\right)$. In addition, they purchase an amount of I_t^k units of the final goods from retailers at a price of P_t. The producers face quadratic investment adjustment cost and investment specific technology shock $\left(\chi_t^{I^k}\right)$. Hence, the law of motion of capital stock is given by:

$$K_t = (1-\delta_K)K_{t-1} + \left[1 - \frac{\vartheta_k}{2}\left\{\left(\frac{I_t^k}{I_{t-1}^k}\right) - 1\right\}^2\right] \chi_t^{I^k} I_t^k \quad \ldots(8)$$

where, ϑ_k represents investment adjustment cost, $\chi_t^{I^k}$ is investment specific technology shock. The optimisation problem of capital goods producing firms can be written as:

$$\max_{I_{t+s}^k} E_t \sum_{s=0}^{\infty} \Lambda_{t,t+s}\left[Q_{t+s}^k\{K_{t+s} - (1-\delta_k)K_{t+s-1}\} - I_{t+s}^k\right] \ldots(9)$$

The optimal choice for private investment $\left(I_t^k\right)$ by the capital goods producers pins down the dynamics of real price of capital goods (alternatively, asset price) denoted by Q_t^k in our model economy.

A.2.3 Intermediate Goods Producing Sector

In this sector, a generic i^{th} firm is solving the problem of optimal combination of inputs and capacity utilisation subject to a Cobb Douglas-type production technology. The representative firm minimises its production cost subject to the production technology in a perfectly competitive environment with marginal cost pricing. It makes the choice for borrowing from the commercial banks to cover (a) the cost for purchasing capital at the beginning of the period, and (b) a fraction (κ_w) of wage bill that needs to be paid to the labours before the production starts. Additionally, it incurs a quadratic cost of capacity utilisation denoted by $\psi(u_t)$ for variations in the capacity utilisation (u_t). The profit function of the IG firm (Π_t^{IG}) is given by:

$$\Pi_{i,t}^{IG} = P_t^D Y_{i,t}^D + (1-\delta_k)P_t^K K_{i,t-1} - (1+\kappa_w i_t^L)\, W_t N_{i,t}$$
$$-(1+i_{t-1}^L)P_{t-1}^K K_{i,t-1} - P_t^E E N_{i,t} - P_t^K \psi(u_t) K_{i,t-1} \quad \ldots(10)$$

where, the production function $\left(Y_{i,t}^D\right)$ and cost of capacity utilization $(\Psi(u_t))$ are as follows:

$$Y_{i,t}^D = \chi_t^{TFP}\left(u_t K_{i,t-1}\right)^{\alpha_k} E N_{i,t}^{\alpha_o}\left(\chi_t^{LAT} N_{i,t}\right)^{1-\alpha_k-\alpha_o} K_t^{g^{v_g}} \quad \ldots(11)$$

$$\psi(u_t) = \psi_a(u_t - 1) + \frac{\psi_b}{2}(u_t - 1)^2 \quad \ldots(12)$$

The optimal choice of the firm yields the demand for capital, labour, energy input and capacity utilisation, and determines the return from the capital, respectively. In this optimisation problem of IG firms, χ_t^{TFP}, χ_t^{LAT} and P_t^E are considered as the time-varying exogenous variables driving the total

(Contd.)

Model Appendix: Analytical Framework of DSGE Model *(Contd.)*

factor productivity, labour augmenting technology and energy price, respectively[8].

A.2.4 Final Goods Producing Firms

Competitive distributors package the intermediate goods (Y_t^D) to deliver final goods (Y_t) to the household using the following CES technology:

$$Y_t^D = \left[\int_0^1 Y_{i,t}^{D\,\frac{\chi_{D,t}-1}{\chi_{D,t}}}\, di\right]^{\frac{\chi_{D,t}}{\chi_{D,t}-1}}$$

where, $\chi_{D,t}$ is the exogenous time-varying elasticity of intra-sectoral substitution across the differentiated products. The firm chooses its price in a monopolistically competitive environment with one-to-one conversion from $Y_{i,t}^D$ to $Y_{i,t}$. The goods are differentiated due to packaging with different brands at zero cost. These differentiated final goods are sold at price $P_{i,t}$. The price setting problem can be written as:

$$Max_{P_{i,t}} E_t \sum_{t=0}^{\infty} \Lambda_{0,t} \left[\begin{array}{c} \left(\frac{P_{i,t}}{P_t}\right) Y_{i,t} - mc_t^D Y_{i,t} - \\ \frac{\vartheta_{pd}}{2}\left\{\frac{P_{i,t}}{P_{i,t-1}} - (1+\pi_{t-1})^{\theta_{pd}}(1+\pi)^{1-\theta_{pd}}\right\}^2 Y_t \end{array} \right] \quad ...(13)$$

where, mc_t^D is the real marginal cost of intermediate goods, the consumer price index (CPI) is defined as: $P_t = \left[\int_0^1 P_{i,t}^{1-\chi_{D,t}}\, di\right]^{\frac{1}{1-\chi_{D,t}}}$; the gross rate of CPI inflation is defined as: $\left(\frac{P_t}{P_{t-1}}\right) = (1+\pi_t)$; and π denotes steady-state level of CPI inflation rate. ϑ_{pd} denotes the price adjustment cost and θ_{pd} is the size of past inflation indexation. The above optimisation problem is solved subject to the sequence of demand constraints:

$$Y_{i,t} = \left(\frac{P_{i,t}}{P_t}\right)^{-\chi_{D,t}} Y_t \quad ...(14)$$

The price of final goods is subject to the mark-up shock due to presence of exogenously time-varying price elasticity of demand $(\chi_{D,t})$.

A.3. Banking Sector

Following Anand et al. (2014), we incorporate the banking sector into our model. The representative bank $j \in [0,1]$ intermediates in all financial transactions among the economic agents which includes deposit collection (D_t) and catering the demand for credit $(L_t = \kappa_w W_t N_t + P_t^k K_t)$. It works using two branches, namely retail branch and wholesale branch.

A.3.1 Retail Branch

The retail branch operates in a monopolistically competitive environment and set (a) the deposit rate for differentiated deposit contracts for the households, and (b) the lending rate for the IG firms, subject to interest rate adjustment costs. While solving their optimal interest rate setting problem, they face upward sloping deposit supply function and downward sloping loan demand function.

A.3.2 Wholesale Branch

The wholesale branch, on the other hand, decides on the allocation of financial resources in a competitive environment subject to the institutional mandate of cash reserve ratio (α_c), statutory liquidity ratio (α_s) and the capital adequacy ratio requirement (κ_b). It has a law of motion for its own net worth and incurs an exogenous time varying loan monitoring cost (χ_t^{rp}) in proportion to the size of total loan. The wholesale unit has the access to borrow from the central bank at interest rate i_t^C which we consider as the policy rate in the model. The branch makes optimal choice for (a) selling of deposit contract to the retail deposit branch; (b) selling of loan contract to the retail loan branch, and (c) borrowing from the central bank subject to balance sheet constraint.

From the optimisation exercise of the wholesale branch and retail branch, one can derive the relationships between (i) the retail lending rate (i_t^L) and policy rate, and (ii) retail deposit rate (i_t^D) and policy rate – which serve the basis for bank lending

(Contd.)

[10] For an empirically plausible analysis, we disaggregate the productivity shock into two components, namely shocks to total factor productivity and labour augmenting technology, and dissect their differential impacts on the business cycles.

Model Appendix: Analytical Framework of DSGE Model *(Concld.)*

channel and interest rate transmission mechanism in the model.

A.4. Central Bank

The central bank uses policy interest rate (i_t^c) as the key instrument for conducting its monetary policy. It follows a Taylor-type interest rate rule as given below.

$$\left(\frac{1+i_t^C}{1+i^C}\right) = \left(\frac{1+i_{t-1}^C}{1+i^C}\right)^{\rho_C} \left[\left(\frac{1+\pi_{t+1}}{1+\pi}\right)^{\varphi_\pi} \left(\frac{Y_t}{Y_{t-1}}\right)^{\varphi_y}\right]^{1-\rho_C} exp\{\chi_t^{i^c}\} \quad ...(15)$$

where, ρ_c is interest rate smoothing parameter, φ_π is inflation stabilising coefficient and φ_y is output growth stabilising coefficient, and $\chi_t^{i^c}$ is the monetary policy shock.

A.5. Fiscal Authority

In case of fiscal authority, the nominal budget constraint of the government is:

$$B_t^H + B_t^C + \tau_t^x W_t^R N_t^R + \tau_t^c P_t C_t + P_t LS_t + \tilde{\Omega}_t^G = (1 + i_{t-1}^G)(B_{t-1}^H + B_{t-1}^C) + P_t G_t + P_t TR_t + P_t I_t^{kg} \quad ...(16)$$

where, $G_t = g_y Y_t \chi_t^G$, $TR_t = tr_y Y_t \chi_t^{TR}$, $I_t^{kg} = ikg_y Y_t \chi_t^{I^{kg}}$. χ_t^G, χ_t^{TR}, $\chi_t^{I^{kg}}$, τ_t^x and τ_t^c – all are exogenous forcing processes for public spending, payments for benefit transfer to non-Ricardian consumers, spending for capital expenditure, tax rate on labour income of the Ricardian households, and tax rate on private consumption, respectively. Lumpsum taxes (LS_t) are assumed to be set in reaction to the evolution of debt to GDP ratio. $\tilde{\Omega}_t^G$ denotes the non-tax revenue of the government as per its share in the production system and banking sector. The interest rate on government bonds (i_t^G) is set as per the following rule:

$$(1 + i_t^G) = \left[1 + \chi_B \left(\frac{B_t^H + B_t^C}{P_t Y_t}\right)\right](1 + i_t^C) \quad ...(17)$$

where, $B_t^C = \alpha_s D_t$ follows from the binding constraint of SLR to the commercial banks holding a portion of the deposit in the form of government bond; B_t^H appears from Ricardian household's government bond holding; $\left(\frac{B_t^H + B_t^C}{P_t Y_t}\right)$ defines the movements of the public debt to GDP ratio and χ_B denotes the risk premium on the government bonds. Further, we assume that the law of motion of the public capital goods evolves in the following way:

$$K_t^g = (1 - \delta_g) K_{t-1}^g + I_t^g \quad ...(18)$$

A.6. Closing the Model

Under the assumption of symmetric equilibrium and using market clearing conditions of the factor markets, goods market and credit market, the model is closed with the following resource constraint that specifies the aggregate demand of the underlying economy:

$$Y_t = C_t + I_t^k + G_t + I_t^{kg} + \Psi_t^C \quad ...(19)$$

where, Ψ_t^C includes all forms of quadratic adjustment costs involved in price setting, interest rate setting, investment adjustment, bank capital adequacy ratio requirement; the loss of economic resources due to variable capacity utilisation of IG firms, loan monitoring cost and managerial cost of the commercial banks.

A.7. Exogenous Shocks

We have twelve forcing variables which follow AR(1) process with the exogenous shocks: $\{\xi_t^{tfp}, \xi_t^{lat}, \xi_t^i, \xi_t^p, \xi_t^{rp}, \xi_t^g, \xi_t^{\tau^x}, \xi_t^{\tau^c}, \xi_t^{tr}, \xi_t^{i^c}, \xi_t^{ikg}, \xi_t^{en}\}_{t=0}^{\infty}$, that drive the aggregate dynamics of our model.

A.8. Solving the Model

All the decision rules derived from the first principle of the dynamic optimisation and the resource constraints are taken together and log-linearised around the steady state of the respective variables. Using a plausible set of parameterisation, the linearised system of equations is solved. The calibrated parameters are in line with Indian macroeconomic data, economic characteristics and policy mandates.