BENDING THE CURVE:
2025 FORECASTS FOR ELECTRICITY DEMAND BY SECTOR AND STATE IN THE LIGHT OF THE COVID-19 EPIDEMIC

–Thomas Spencer

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

The COVID-19 epidemic has thrown the global economy into freefall. In order to curtail the spread of the Coronavirus, countries implemented lockdowns of their economies. In China, South Korea, Australia, New Zealand, and Europe, the growth of the virus has been more or less curtailed and formal lockdowns have been eased. Even here, however, high frequency indicators show that their economic activity has generally not yet rebounded to pre-crisis levels. In China, the source of COVID-19 and the first country to effectively contain the outbreak, economic activity remains about 10 percentage points below the level of last year, according to the *Financial Times*' China Economic Activity Index.[1] In Europe, daily electricity demand is still about 10 to 15 percentage points below the level of last year.[2] In the United States, Latin America, and India, the virus continues to spread rapidly. In emerging countries, where the virus has continued to spread, lockdown was either not pursued initially, or has largely been relaxed out of economic necessity. Economic recovery, however, will depend on controlling the virus, as a degree of self-imposed restrictions on economic activities is likely to continue as long as the COVID-19 virus continues to spread.

Beyond the next few months, assessing the mid-term economic implications over the next few years is an exercise fraught with much uncertainty. The mid-term damage to the economy will depend on the duration and severity of economic restrictions, short-term policies to mitigate the impact, the underlying health and structure of the economy, and longer-term policies to promote economic recovery. Nonetheless, despite the uncertainty, policymakers and business strategists are in need of frameworks for analysing potential future scenarios for different sectors.

The objective of this paper is to provide a framework for thinking through the mid-term impact of the COVID-19 on the Indian power sector. It is structured in five sections. The first section presents some theoretical considerations of the channels by which a short-term demand shock, like the COVID-19 virus, can impact longer-term growth trends. The second section foregrounds essential data on the state of the Indian economy going into the shock; it also discusses the historical link between economic activity and electricity demand in India. The third section covers the economic scenarios for India to 2025, and a framework for forecasting sectoral electricity demand for each major state on the basis of these scenarios. The fourth section presents the conclusions of these forecasts. The final section concludes with the key messages coming out of the preceding analysis. An online dataset accompanying this paper provides open access to the scenario results.

Evidence from Theory and History: Mid-term Effects of the COVID-19 Shock

How do short-term demand shocks affect mid-term growth trends? The COVID-19 has acted as a rapid and substantial shock to aggregate demand. Overnight, consumers could not go out and spend; shops and retail establishments were closed. Logically, however, one might think that this demand will recover as soon as the lockdown is eased. Afterall, nothing in the fundamentals of the economy changed as a result of the COVID-19 crisis, it was simply put in a kind of 'suspended animation'. However, two considerations militate against such a sanguine view of a return to normalcy once the epidemic is over. We can call these – the mathematics of catch up and economic scarring.

[1] Details available at https://www.ft.com/content/e5879009-f451-4a54-9374-03472f2c4085

[2] Details available at https://www.bruegel.org/publications/datasets/bruegel-electricity-tracker-of-covid-19-lockdown-effects/

The mathematics of catch up

The Indian economy is expected to contract in absolute terms in calendar year 2020, the first such contraction in 40 odd years.[3] After a contraction like this, GDP needs to grow at above trend rates in subsequent years, in order to catch up to the level it would have been in the absence of the shock. Let us illustrate this with a small example (see Figure 1). Imagine an economy with a hypothetical GDP of 150 billion dollars, growing at an inflation adjusted trend rate of 4% per year. An economic shock hits and GDP contracts by–4% in year 0. Thereafter, in all scenarios, GDP growth rebounds to 6% in year 1 after the shock. For the following years, GDP growth reverts to a trend of 4% in one scenario, 10% above trend in another (4.4% year-on-year growth), and so on up to a scenario of sustained growth of 25% above trend (5% year-on-year growth). In only the last of these scenarios does GDP catch up to and overtake the pre-crisis trend levels within the 8 years, following the shock.

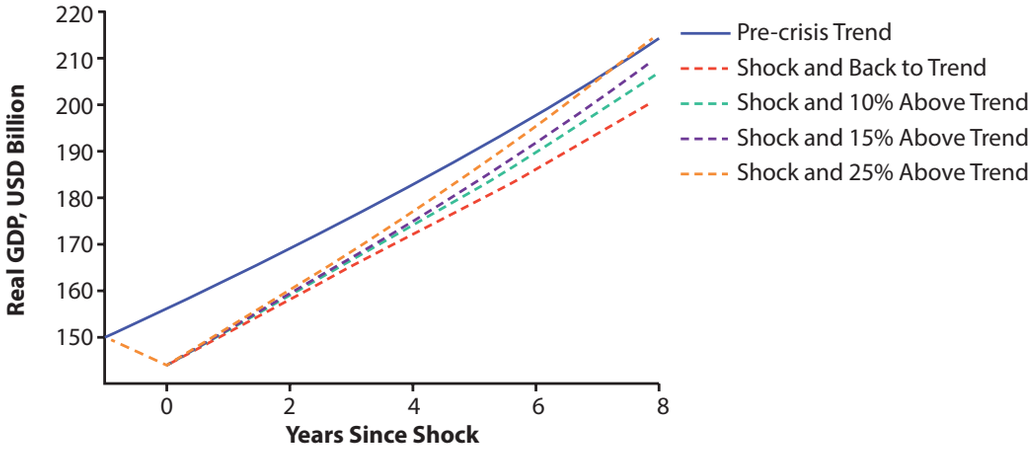

Figure 1: Scenarios of economic recession and catch up

This understanding of the long-term impact of short-term recessions on GDP levels is important in a sector with long-term investment decisions, like the electricity sector. In such sectors, investment decisions are made relative to *expectations of mid-term demand levels*. A large short-term shock can have substantial implications for mid-term levels of economic activity, unless it is followed by growth rates that are above the pre-shock trend by a substantial amount and for a substantial period. A one-time rebound in growth in the year after the contraction is not enough to bring output back to its trend level, because it occurs on a base that is smaller and relative to a trend level that continued to grow in the counterfactual. However, as the next section shall elucidate, there is substantial theoretical and empirical evidence that economic growth is typically lower after recessions than before.

Economic scarring

There are a number of channels by which short-term recessionary shocks can lead to longer-term economic scarring. These are elaborated upon as follows.

Debt: During a recession, incomes contract while borrowings often increase in order to make up for the loss in income. The debt levels of households, firms, and governments increase. In the post-recession period, a greater share of income needs to go into servicing this debt (assuming there is no restructuring) and not into productive

[3] According to the Penn World Table Version 9.0, India's GDP contracted by –0.8% in 1982. To find a contraction of the likely magnitude as the 2020 recession, we have to look back to the oil shock of 1978–1979, during which India's GDP contracted by –1.6% and –6.7%, respectively (Feenstra 2015).

investment or consumption. For example, during the Global Financial Crisis, the private non-financial sector debt of India rose from 38% of GDP in 2007 to 43% in 2008, and up to 51% in 2013. Since then, the subsequent deleveraging has been a drag on India's growth rate.[4]

Human capital loss: Periods out of the labour market can lead to an erosion of skills and know-how, particularly for young people unlucky enough to be entering the labour market during a recessionary period. There is evidence that economic downturns can lead to persistent lower entry in labour markets, and reduced outcomes in terms of wages and job quality for new entrants to the labour market during the period of downturn.[5]

Investment and innovation: During recessions, demand declines and the utilization factor of productive capacities decreases. At the same time, firms' balance sheets become stressed, as their revenues decline, borrowings increase, and free cashflow is used to pay down debt. In addition, a generalized economic uncertainty prevails. In such circumstances during economic downturns, firms typically cut back on investment, including in innovation search. Since investment and innovation drive longer-term productivity growth, reduced investment can have a negative impact on the longer-term trend rate of growth. This is evident in the case of India, where the investment share of GDP fell by 7.5 percentage points from its peak in 2010 of 34% of GDP to 26% of GDP in 2017.[6]

Reduced entry of new firms and exit of existing firms: If the recession is bad enough and long enough, and policymakers are unable to mitigate the impact on firms, some firms may end up insolvent and be forced to close. Firm closure may lead to loss of productive capacities, if the intangible firm-specific capital is destroyed with the closure of the firm, or if the productive capital cannot be salvaged and put to use in another firm. Likewise, during recessions, there may be less entry of new, innovative firms, as economic resources for firm creation are scarce, and risk appetites lower due to lower aggregate demand and general uncertainty.

Economic theory has long held an overly simplistic model of general equilibrium around a long-term growth rate driven by the supply-side of the economy. In this model, short-term shocks to demand do not affect the long-term growth rate. However, it is now generally accepted, based on both empirical and theoretical considerations that this model is too simplistic.[7] There is substantial evidence that economic recessions do have longer-term, persistent negative implications for economic growth rates and longer-term levels of output. For example, Cerra and Saxena reviewed the economic experience of more than one hundred countries over the last 60 to 70 years and found that economic growth is typically lower by 0.45–0.8 percentage points in the first year after the recession, and still 0.3–0.4 percentage points lower four years after the recession.[8] Slower growth rates result in a persistent loss of output in the order of 5 to 15 percentage points relative to the pre-crisis trend, depending on the nature of the recession.

The mathematics of catch up implies that the GDP needs to grow persistently faster than the pre-recession trend rate in order to catch up to the pre-recession trend level. However, economic history and theory suggest that faster-than-trend post-crisis growth is rare, and indeed, recessions often leave persistent economic scarring and lower post-recession growth.

Evidence from the Recent History of India

Macroeconomy

Having reviewed some evidence from economic theory and history, we now turn to India's recent past. It is well known that India's GDP growth rate had been slowing for some time leading up to the COVID-19 crisis. What does

[4] Based on data from the global debt database of the IMF, refer to IMF (2020)
[5] Refer to Romain Duval (n.d.)
[6] Based on data from Penn World Table, refer to Feenstra (2015)
[7] Refer to Beinhocker (2007)
[8] Refer to Cerra and Saxena (2017)

this imply for the underlying strength of the economy, and the prospects of rapid recovery after the COVID-19 lockdown eases? These are some of the questions which will be discussed in this section.

Figure 2 shows the annualized quarterly growth of India's GDP from fiscal year 2004–2005 to fiscal year 2019–2020, and the quarterly investment share in GDP over the same period. Prior to the Global Financial Crisis of 2008–2009, India's GDP was growing at an annualized rate of greater than 8% per year. The Global Financial Crisis led to a sharp but brief fall in the GDP growth rate, which subsequently recovered in financial year 2010–2011. After 2010–2011, the GDP growth rate slowed substantially to 4–6%, as the Indian economy came under prolonged stress from the persistent high fiscal deficit, high global oil prices, governance issues that raged at the time, and pressure on the exchange rate and balance of payments. But even after this period, the growth rate never really recovered to its pre-Global Financial Crisis trend, with the GDP growth rate in the period 2011–2019 about 1.6 percentage points below that of the period 2004–2011. As is evident, one of the proposed channels for the persistence in economic shocks, namely investment, has also declined as a share of GDP.

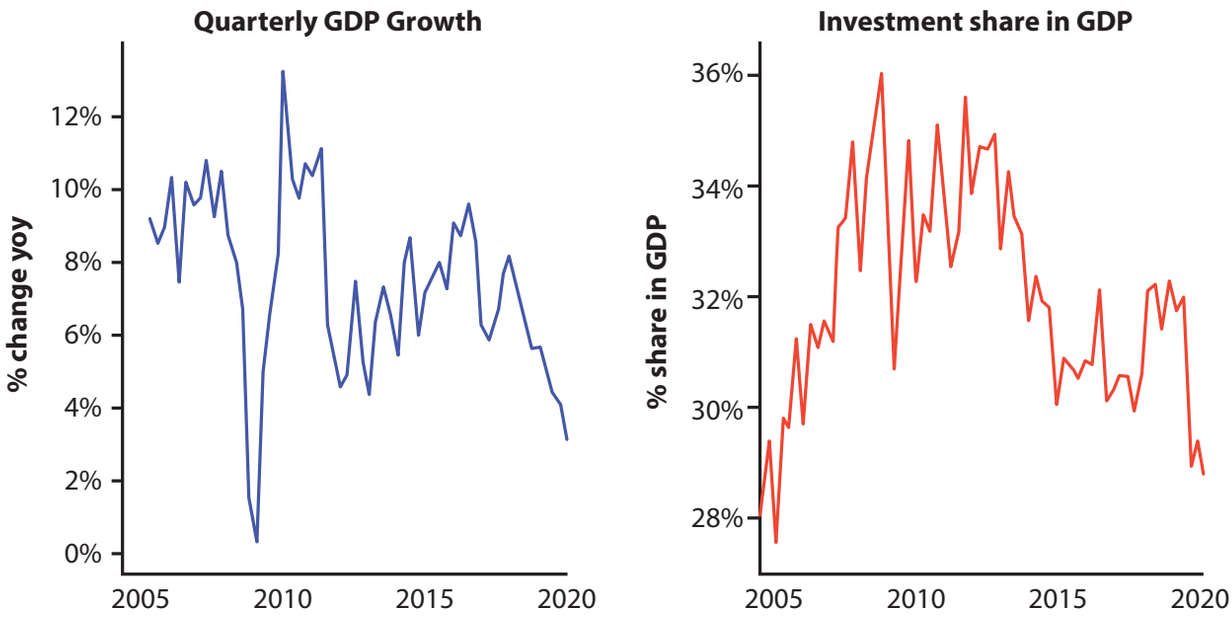

Figure 2: Annualized quarterly GDP growth and quarterly investment share in GDP, 2004–2005 to 2019–2020

Source: Dataset available from (RBI 2020). 2004–2005 prices have been inflated to 2011–2012 prices for the years 2004–2005 to 2010–2011.

The previous evidence raises the question: what has driven the drop off in Indian GDP growth, and what does it mean for the future? We can distinguish between three different theories competing within the Indian policy and academic discourse. Let us briefly survey them.

The 'Unfinished Reforms' Theory

According to this theory, the reform agenda that had been pursued since 1990 petered out after roughly the mid-2000s. Major critical reforms related to land acquisition, labour relations, public sector unit (PSU) governance and privatization, urbanization and urban governance, infrastructure development, export strategy and industrial competitiveness, education and healthcare, agriculture, and financial sector governance were not undertaken comprehensively or aggressively enough over the previous 10 to 20 years. The growth boom of the mid-2000s had reaped the windfall of the previous decade of reforms, but growth stalled when the reformist drive waned. This

theory has been presented in a narrative form with attention to the people and political decisions by journalist Puja Mehra,[9] and in academic detail by economist Vijay Joshi.[10]

The 'Financial Crisis' Theory

According to this theory, by former Chief Economic Advisor, Arvind Subramanian,[11] India never really recovered from the shocks of the Global Financial Crisis and the subsequent period of economic stress from 2011–2012 to 2013–2014. During the lead up to the Global Financial Crisis, the rapid build-up in investment (seen in Figure 2) was accompanied with rapid credit growth, which reached an annualized rate of 38% in 2005–2006 in nominal terms.[12] The subsequent shock of the Global Financial Crisis and the 2011–2013 'perfect storm' of high oil prices, high fiscal deficit, and governance issues related to large infrastructure projects led to a dramatic drop in industrial investment and a pile-up of bad loans in the banking sector. This is the Twin Balance Sheet Crisis noted by Subramanian. Subsequently, a second bubble built up in the course of the 2010s, namely in the Non-banking Financial Company (NBFC) and the real estate sectors. The Twin Balance Sheet Crisis became a Quadruple Balance Sheet Crisis, and India's growth stalled as the financial sector withdrew from extending credit, and the industrial, infrastructure, and real estate sectors paid down debt and withheld further investments.[13]

The 'Unbalanced Structure of Growth' Theory

This theory is associated notably with the National Institute of Public Finance and Policy (NIPFP) Director, Ratin Roy.[14] According to this theory, India's economic growth story has not been inclusive enough, excluding the vast swathe of the Indian population from productive jobs and preventing the transition of labour out of agriculture and into more productive sectors. The fundamental driver for this is the unbalanced structure of India's economy, with growth tilted towards capital-intensive manufacturing sectors and skill-intensive, export-oriented services sectors. In turn, it is proposed that this unbalanced structure of growth is driven by deep fundamentals in India's political economy, in particular we can cite:

- Labour-intensive manufacturing is squeezed between technological trends of increasing automation; geo-economic trends of a mercantilist and highly competitive China; and domestic sources of non-competitiveness, including the aforementioned lacunae in the domestic reform agenda.
- Bias in the Indian educational system towards top-class but very narrow tertiary education, and low-quality primary and secondary education.[15] India's labour force thus skewed towards high quality, English-speaking graduates fit for the export-oriented business services sector, or the few jobs available in the capital-intensive manufacturing sector; and the poorly educated masses who cannot find employment in the labour-intensive manufacturing sector (which is itself increasingly automated and thus skill-intensive).
- A 'slow and messy' process of urbanization, which raises the costs and lowers the benefits of India's rural workforce migrating to seek non-farm employment in India's cities.[16] We can get a sense of this by looking at the difference between India and China – in 1978, India was more urbanized than China; today, China is three times more urbanized than India.

We can get a sense of this theory by looking at the structure of India's economy and employment over the last 40 odd years (see Figure 3). Over the course of the last 40 years, the share of high-productivity services and manufacturing in total value added increased from 13% to 33%, while its share in employment grew from only

[9] Refer to Mehra (2019)
[10] Refer to Joshi (2016)
[11] Refer to Subramanian and Felman (2019)
[12] This is outstanding non-food bank credit from scheduled commercial bank, Table 45 in the *Handbook of Statistics on Indian Economy*, RBI (2020)
[13] Refer to Subramanian and Felman (2019)
[14] Refer to Roy (2019)
[15] Refer to Broadberry and Gupta (2010)
[16] Refer to Tumbe (2016)

5% to 8%. On the other side of the coin, the output share of agriculture declined from 42% to 15%, while its employment share declined from 69% to 41%. In other words, the ratio of employment share to output share for agriculture actually increased across this period from 1.6 in 1980 to 2.6 in 2016, while the ratio of employment share to output share of the high productivity services and manufacturing sector declined from 0.4 to 0.2. These phenomena are interlinked – the absence of low-skilled non-agricultural jobs, and the bias towards a high-capital-intensity, high-skill growth structure, have 'marooned' too much of the Indian population in the low-productivity farming sector.

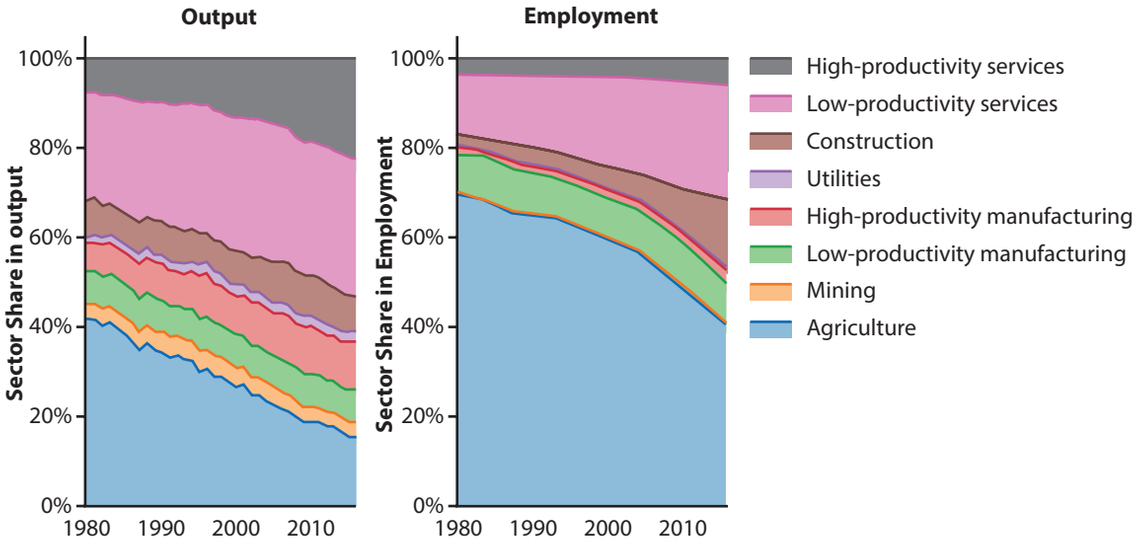

Figure 3: The sectoral composition of output and employment

Source: Based on data from RBI (2019). A cut-off of 50 crore gross-value added per 1000 employees as a measure of labour productivity has been used to classify manufacturing and services sectors as low or high productivity.

Towards a Synthesis

The aforementioned theories are not mutually exclusive; indeed, they are complementary for understanding the predicament in which the Indian economy found itself before the COVID-19 crisis. Most importantly, they suggest that the framing of the pre-COVID-19 slowdown as either cyclical or structural is beside the point. The slowdown may have been induced by repeated cyclical shocks such as the Global Financial Crisis, and the 2011–2012 to 2013–2014 balance of payments and fiscal deficit stress, as well as demonetization and GST implementation. But these cyclical shocks revealed deep underlying structural fragilities in India's political economy and development model, in particular, the non-inclusive structure of growth and the lagging reform agenda.

India was on a fragile economic footing before COVID-19 is not in question. But the combined cyclical and structural nature of this fragility suggests that it will not be easy to regain lost growth momentum after the COVID-19 shock.

Electricity demand

The preceding discussion raises the question: do we see evidence of the aforementioned slowdown in Indian economic activity in Indian electricity demand? Answering this question may provide clues as to the evolution of demand in the light of a significant shock to the economy due to COVID-19. Figure 4 shows the growth rate of electricity demand (smoothed as a three-year rolling average) and the growth rate of real gross-value added

(GVA). Clearly, both at the aggregate level as well as the sectoral level, the general pattern in both indicators is consistent with the previous discussion. After rapid growth leading up to the Global Financial Crisis, both sectoral GVA and sectoral electricity demand growth began to decelerate. The one exception to this is the case of residential electricity demand, which has shown some resistance to the general growth deceleration witnessed in other sectors. The consequences of this demand slowdown are well-known, such as, low-capacity utilization factors, a build-up of non-performing assets, and a slowdown in new capacity additions in thermal generation.

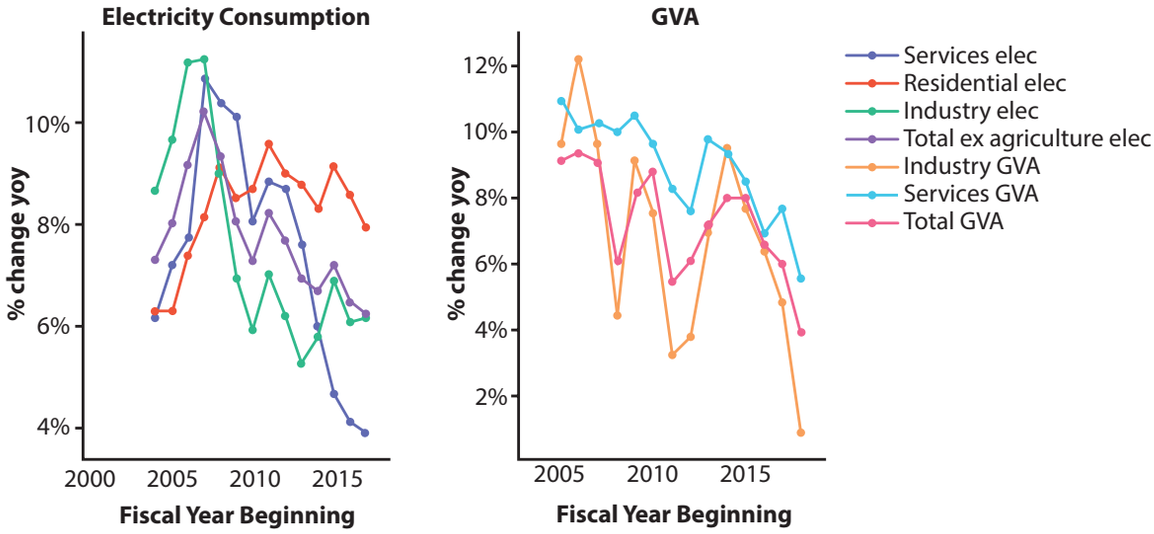

Figure 4: Pattern of sectoral electricity demand growth and sectoral economic activity growth

Note: Services electricity demand includes commercial, other, and public lighting. Industry includes high and low tension, and public utilities.

Source: Based on data from RBI (2019), CEA (various years).

A Framework for Forecasting Electricity Demand

Developing the macroeconomic forecast

Short-term Forecasts for India's GDP

Amid so much uncertainty, it is challenging to develop a macroeconomic scenario for India out to the mid-term, say 2025. The solution lies in seeing 'scenarios' not as forecasts, but as internally consistent, plausible but contrasting possible futures, which can be used to explore the possible 'outcome space' of complex and uncertain forces. It is in this vein that we develop the macroeconomic scenarios in this paper.

First, we can examine the forecasts of other agencies. Figure 5 shows the GDP forecasts of various multilateral agencies brought out in the few months after the COVID-19 outbreak. The thick black line represents the forecast of the IMF from the October 2019 edition of the *World Economic Outlook*. This can be treated as the pre-COVID baseline, although it appears a little on the optimistic side given the sharp slowdown in growth, seen over the last eight quarters preceding March 2020. Two 2020 forecasts from the IMF are presented, one from April 2020 right at the beginning of the COVID-19 crisis, and another from June 2020. Between these forecasts, the estimated 2020 GDP growth for India was revised downward from 1.8% to –4.5%, a downward revision of more than six percentage points. The OECD forecast dates from June 2020, and encompasses two scenarios: one in which the economic lockdown is brief and contained ('OECD_2020_Single_Hit'); and another, in which the economic lockdown is prolonged and repeated, with the flare-up in Coronavirus cases ('OECD_2020_Double_Dip'). In the former scenario, the GDP contracts by –3.7% in 2020, before growing by 7.9% in 2021. It is worth noting that even with this sharp rebound in 2021, the projected GDP in this scenario remains well below (by almost 10%)

the expected level of GDP for 2021 under the pre-COVID baseline. This goes to the point made previously in the section – 'The mathematics of catch up'. Even a sharp recovery in the growth rate in 2021 does not entail that GDP would attain the pre-crisis trend level, because this growth occurs on a smaller base after the contraction of 2020, and versus a counterfactual that has continued to grow.

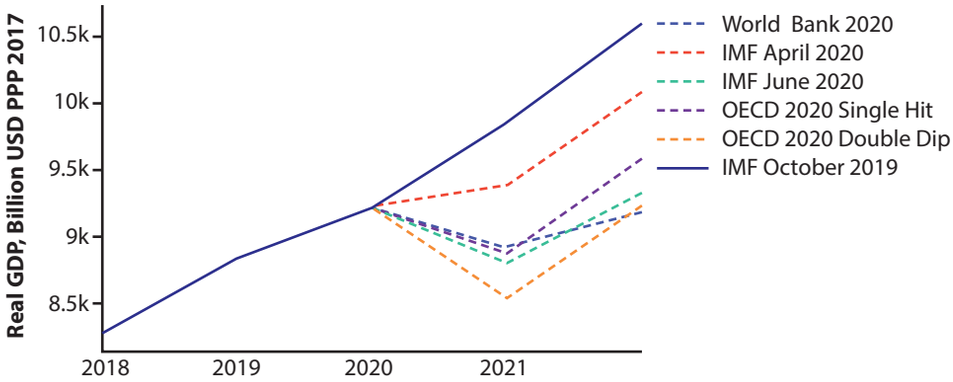

Figure 5: Short-term GDP forecasts for India from various multilateral agencies.

Source: Based on data from World Bank (2020), IMF (various years), and OECD (2020)

The OECD double-dip scenario is more dire. It sees the GDP contracting by –7.2% in 2020, and rebounding by 8% in 2021. But again, even with this rebound, the level of 2021 GDP is still only 0.2% above the 2019 level. We must, thus, be very careful of interpreting sharp post-recession rebounds as a return to the status quo ante. The final projection comes from the World Bank's *Global Economic Prospects* from June 2020. This sees India's GDP contracting by –3.2% in 2020 and only growing by 3.1% in 2021. Clearly, this is a scenario with more durable economic damage and a downward revision to India's growth potential in the short term.

Table 1 provides an overview of recent forecasts of India's GDP growth by agencies, including State Bank of India, and domestic ratings agencies. These converge around a contraction of around 6% for Indian GDP for fiscal year 2020–2021. In other words, domestic agencies tend to be more pessimistic about the extent of the contraction in Indian GDP in the current year, situating themselves at the bottom end of the spectrum of forecasts by international agencies presented in Figure 5.

Table 1: Indian agencies' forecasts for GDP growth in 2020

Agency	2020 Forecast	Month and Source (hyperlink)
SBI	–6.8% (for FY2020–2021)	May 2020
ICRA	–5% (for FY2020–2021)	May 2020
CARE Ratings	–6.4% (for FY2020–2021)	July 2020
CRISIL	–5% (for FY2020–2021)	May 2020

Source: Based on news reports given in the hyperlinks.

Mid-term Scenarios for India's GDP

In this section, we set out our mid-term scenarios for India's GDP to 2025. The scenarios are as follows.

Baseline Scenario: In this scenario, we assume a contraction in India's economy of –6.4% in fiscal year 2020, spread roughly evenly between the services and industry sector; the agricultural sector is assumed to grow by 2%. Thereafter, growth rebounds strongly in 2021, on the lower base, with total GVA registering a 7.9% growth. Subsequently, the sectors settle back into their trend growth rate, which is assumed to be 2.5% for agriculture, 6% for industry, and 7.5–8% for services.

L-shaped Scenario: This scenario assumes a steeper contraction in 2020, and more damage to India's mid-term growth potential. GVA contracts by –7.4% in 2020, and rebounds by 6.6% in 2021. Thereafter, the sectors settle down into a more muted trend growth rate, which is about 15% to 20% lower for the industry and services sectors, compared to the Baseline Scenario (i.e. about 5% year-on-year for industry and 6.5% to 7.0% year-on-year for services). The agriculture sector is assumed to be unaffected and continues to grow at the baseline rate of 2.5%.

V-shaped Scenario: This scenario is more optimistic, assuming a contraction of –5.5% in 2020, and a recovery to 9% in 2021. Thereafter, sectoral GVA resumes at previously mentioned trend growth rates, at about 15% to 20% above the Baseline Scenario (i.e. about 7% year-on-year for industry, and about 9% year-on-year for services).

The growth rate tables for each scenario are given in full in the Annex, and made available for download with the dataset accompanying this paper.

Figure 6 shows the results of these scenarios in terms of all-India aggregate GVA, and compares them with the historical trend. By 2025, the Indian economy remains 11% below the counterfactual pre-COVID trend in the Baseline Scenario, 17% below the counterfactual in the L-shaped Scenario, and 7% below the counterfactual in the V-shaped Scenario. Clearly, the COVID shock implies a persistent downward revision to expected levels of the Indian GDP out to the mid-term. By implication, it also indicates a persistent downward revision to expected levels of Indian electricity demand.

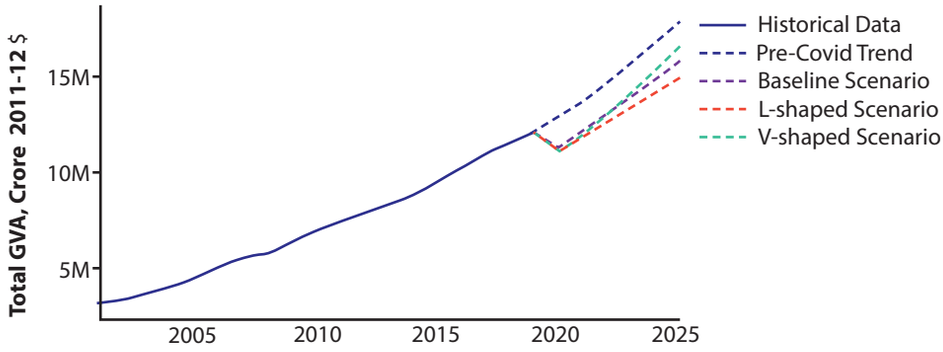

Figure 6: Aggregate GVA forecasts in three scenarios, all-India level

Modelling state-level electricity demand

The previous sections set out the hypotheses that:

- the COVID shock was likely to be persistent in terms of its impact on India's GDP, if only because of the challenging mathematics of catch up, but also because of the likelihood of a reduced trend rate of growth (economic scarring);
- electricity demand growth rate has also followed the general pattern of softening growth seen in India's GDP growth rate.

In the light of these observations, it can be expected that a revised GDP outlook for India will lead to a revised electricity demand outlook at the all-India level. However, it is also important to get a sense of how this breaks down at state level, as it is at state level that policy and investment decisions will occur that must be informed by up-to-date expectations of demand growth. These decisions include tariff determinations, capacity expansion plans, and so on. Moreover, it is not just a question of the level of demand growth but also its overall composition. Because of the prevalent cross-subsidy from industry and service sectors to residential and agricultural sectors, it is of prime importance to understand the potential evolution of the composition of demand in the future. If the commercial and industry sectors are disproportionately hit *over the mid-term* and not just during the time of the lockdown, then the financial position of the distribution sector is even more fragile than currently understood and the unsustainability of the current cross-subsidy framework all the more pressing.

Thus, we must project both state-wise and category-wise electricity demand across the mid-term.

In order to do so, we first assume that the states' current shares in overall all-India economic activity don't change across the projection period. Generally speaking, this assumption is borne out by recent economic history, where states' shares in all-India economic activity have been changing only gradually. This assumption removes the need to make state-specific economic projections, and the all-India projections can simply be downscaled to the state level according to the historical share of the state in question. This approach, however, may somewhat overstate the projected economic share (and hence electricity demand forecast) for states, whose share has been decreasing over time, and vice versa for states with a historically increasing share in all-India economic activity.

Once we have the state-level projections for sector-wise and total GVA, we use a state-specific and sector-specific econometric model to project electricity demand across the forecast period. The independent variable is sectoral GVA, and the dependent variable is sectoral electricity demand. In order to better reflect the national accounts categories of agricultural, industrial, and services GVA, we group the Central Electricity Authority's electricity demand categories, as elaborated upon in the subsequent paragraphs of this paper.

The industry sector comprises high- and low-tension industrial consumers and utilities. Services comprise the commercial sector, the 'other' sector, and public lighting. We relabel domestic as residential demand, and the regressor for residential sector demand is the total GVA. Generally speaking, the econometric model provides a good statistical fit for the historical period, which was 2001–2002 to 2016–2017 (the last year of available data from the RBI for state-level sectoral GVA).

The exception to the good statistical fit of the econometric model was the agricultural sector, where for some states, statistical fit was poor. It is well known that agricultural consumption is generally unmetered, and might be overestimated or used to 'hide' T&D losses,[17] and thus, this poor fit is not surprising. Nonetheless, we still use agricultural GVA as the independent variable in our forecasts, as time-series forecasts do not necessarily fit the historical data better. Taking this approach to agricultural demand forecasts did not result in any structural break from the (already noisy) historical trend of agricultural demand. Nonetheless, the results for this sector need to be interpreted with this caveat in mind. In order to avoid some of the data quality issues that affect certain smaller states, we project electricity demand for the 10 largest electricity-consuming states, and the all-India level in aggregate. We treat Andhra Pradesh and Telangana as a single aggregate, due to the absence of historical data before the bifurcation. The model is based on electricity demand at the end-use level, excluding T&D losses, and is for grid demand only, excluding captive power. We use the model to project electricity demand from 2017–2018 to 2019–2020 based on actual data for all-India GVA, broken down to state level as per the states' historical shares in all-India economic activity. It should thus be noted that electricity demand figures given in the public dataset accompanying this paper are model results based on actual GVA data, and not actual electricity consumption data. After 2019–2020, the projections based on our economic scenarios begin, and run until fiscal year 2025–2026.

[17] See for example the discussion of this issue in Spencer (2018).

Results

Public dataset and planned revisions

First and foremost, we envisage this work as a public dataset that can be used by policymakers, businesses, and experts to get a sense of the potential outcomes for electricity demand in the mid-term, based on uncertain but contrasting scenarios. The full results are available for download alongside this report.[18] This dataset contains:

- Historical and scenario data for the economic variables driving our model, for each state that we cover and the all-India level
- Historical and scenario data for electricity demand for each sector, for each state that we cover and the all-India level
- Summary graphics for each state and the all-India level

Having built this model, we are fully cognizant of the fact that the economic landscape of the post-COVID world is rapidly evolving. Our understanding of some of the structural changes in society and economic organization that COVID-19 may induce will no doubt evolve over time as well. It is possible for example, that we will see a sustained and material move to work-from-home, online retail, supply-chain reorganization, and so on. With this in mind, we intend to update this model on a regular basis, in the order of every four to six months, and issue a new set of results in the light of these revisions. Therefore, the results of the current exercise should be interpreted with this in mind.

Headline results for all-India level

Figure 7 shows the headline results of this exercise. In the Baseline Scenario, total demand by 2025 is about 1403 TWh, which is in the order of 172 TWh, or 11%, below the level implied by the pre-COVID trend. In the L-shaped Scenario, total demand is 258 TWh, or 16%, below the level implied by the pre-COVID trend. Even in the V-shaped Scenario, total demand is still 75 TWh, below the pre-COVID trend. Demand decline relative to the pre-COVID trend is relatively evenly spread between the three sectors of industry, services, and residential, although the services sector is more impacted than the industry sector. The understanding of the breakdown of effects between sectors is likely to change as our understanding of the economic and social implications of the COVID-19 crisis evolves. In this case, we have not taken into account possible structural breaks, such as, increased work-from-home or online retail. Exploring such scenarios could be a topic for future research with this model.

[18] Add [link]

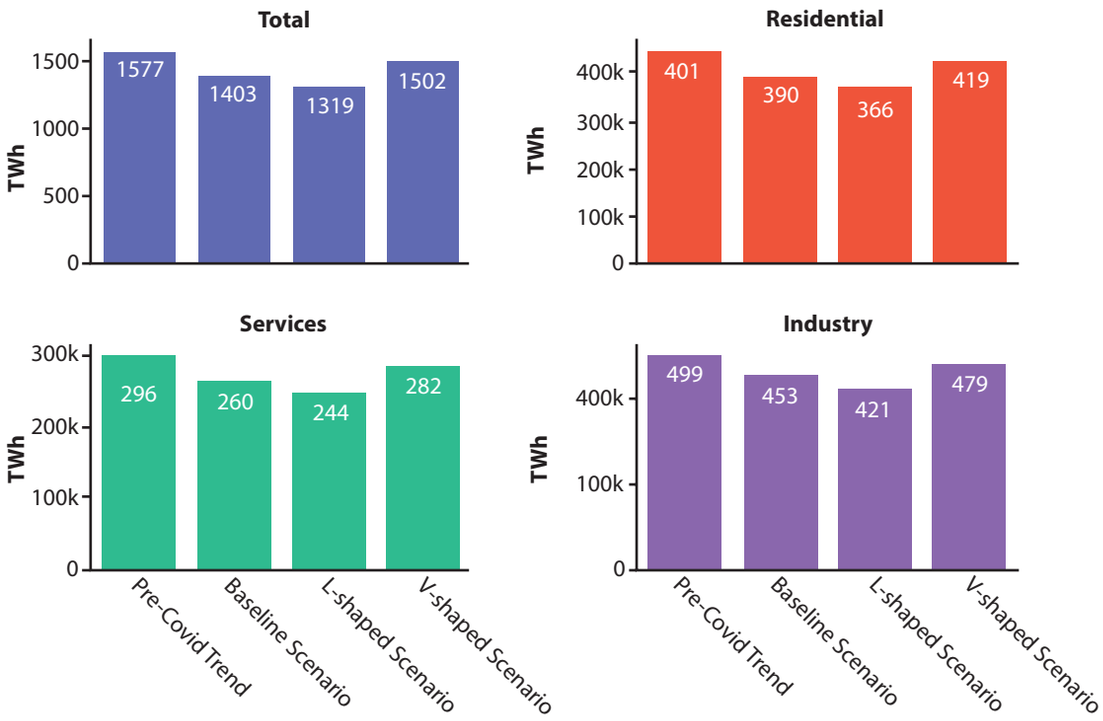

Figure 7: All-India electricity demand in aggregate and by sector (2025)

Our pre-COVID baseline was already lower than the official forecasts of the *19th Electric Power Survey (EPS)*, published in January 2017. This study had a projected electricity demand at all-India level of 1644 TWh for fiscal year 2025–2026. This compares with our pre-COVID trend forecast of 1577 TWh (a difference of about 4%). Compared to the *19th EPS*, our Baseline Scenario is 14.7% below the forecast of the *19th EPS*, while our L-shaped Scenario is a full 20% below the *EPS* forecast for fiscal year 2025–2026.

Headline results at state level

Figure 8 shows the headline results at state level, only for the Baseline Scenario and only for total electricity consumption. These need to be interpreted with caution, as they depend on the breaking down of the all-India macroeconomic scenario to the state level, based on the methodology of equal historical shares previously described. The results are also driven by individually fitted econometric models for each sector in each state, based on the last 15 years of historical data. The sensitivity of these models to changes in the independent variable, sectoral economic activity, may differ depending on the relationship implied by the historical data. The quality of this historical data also differs somewhat state to state.

The results should, thus, be seen as only possible indicators of orders of magnitude and key relationships.

The key point to note is that all states see a level of durable demand decline, relative to the pre-COVID trend outcome for 2025, in the order of 5–15%. More affected states appeared to be those with large shares of industry and commercial consumers (Gujarat, Maharashtra, Karnataka, although Tamil Nadu is an outlier here), or rural states such as Bihar, where the historical data showed a strong relationship between growing state domestic product and growing residential consumption. States where farming is a large share of demand (Punjab, Uttar Pradesh) appeared less impacted. Smaller, richer states such as Delhi and Kerala were less affected, possibly because the already high level of electricity consumption per capita resulted in less elasticity of consumption to increased economic activity in the historical data.

These results give a sense of orders of magnitude, and stress the need for revised, state-specific demand estimates to be developed by within-state agencies. What is clear is that all states can expect to be impacted by a sustained decline in demand growth relative to trend.

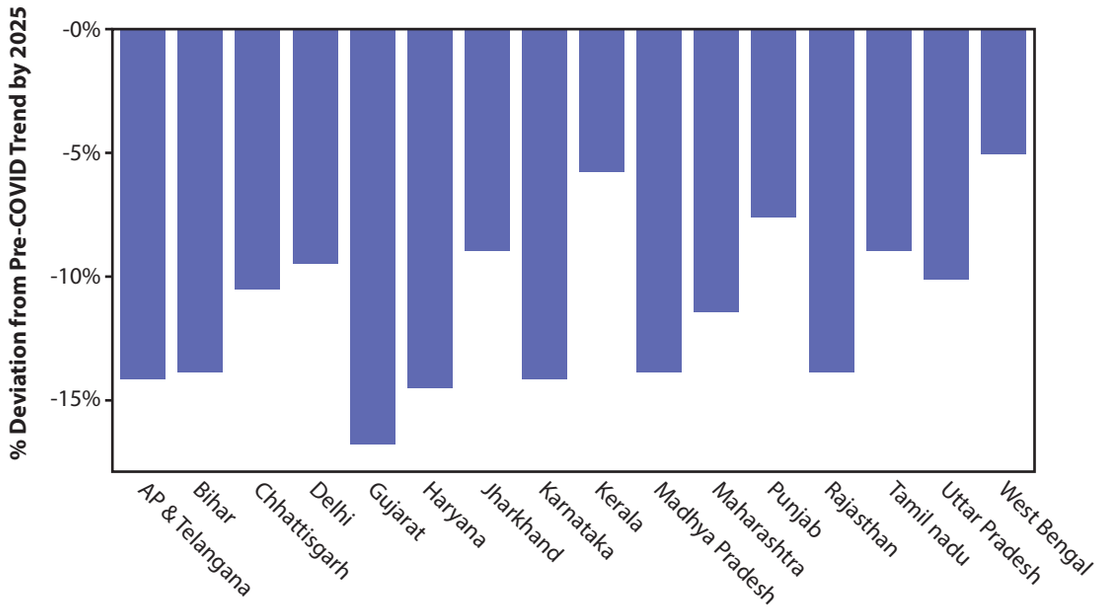

Figure 8: 2025 total demand in Baseline Scenario, as a percentage deviation from the pre-COVID trend

Conclusion and Discussion

The motivation for this paper was fourfold.

First, it appears increasingly likely that India's GDP growth will be significantly impacted by the COVID-19 epidemic. Repeated downward revision to forecasting agencies' estimates for India's 2020 GDP bear testament to this. Second, economic history and theory tell us that economic recessions typically leave behind a degree of economic scarring and slower growth in subsequent years. At the same time, the 'mathematics of catch up' implies that recovering the pre-COVID trend level of GDP requires sustained, substantially faster post-recession economic growth. This appears unlikely. Third, economic growth has driven India's electricity demand over the past 10–15 years. It is thus inevitable that the downward revision in India's growth pathway will have implications for India's electricity demand pathway. Fourth, official forecasting frameworks, like the Electric Power Survey, are traditionally produced only every five or six years, and they use a methodology based on data that is several years old and ignores economic drivers of electricity demand.[19] This is problematic in a time of rapid and uncertain change, when policy decisions related to tariffs, procurement, and investment and retirement must be taken on the basis of demand forecasts that have been superannuated overnight by a sudden and large-scale change in circumstances.

It is in order to bridge the gap that these forecasts have been produced and placed in the public domain. The approach adopted has the advantage of the speed with which forecasts can be produced and revised, as well as the ability to project state-level and sector-wise demand. However, there are also a number of shortcomings that must be highlighted again. These are as follows.

[19] The main volume of the Electric Power Survey (EPS) uses the so-called 'partial end-use' method, based on trend growth rates for key end-use sectors. These trend projections are not based on any macroeconomic scenario. The 19th EPS included a later volume, released two years after the main volume, which did use an econometric forecasting technique, and several growth scenarios, but this is not the main scenario used in planning documents at the centre and state levels.

- We do not investigate potential structural change, which will change the relationship between economic activity and demand, including factors such as increased work-from-home, online retail, changes in global value chains, and so on.
- Our state-level economic scenarios are based on assumptions that historical shares in all-India economic activity remain constant. Generally speaking, this assumption is valid, and an alternative approach of developing state-specific economic projections would be a large undertaking in itself.
- Historical econometric models between state-level sectoral economic activity and state-level sectoral electricity consumption are based on historical economic and consumption data, which has a certain 'noisiness' for some sectors and some states. Although the econometric models used to project demand generally had a good fit for all sectors (except agriculture) and all states, there are a few exceptions to this observation, particularly for the smaller states.

The results of this analysis make it clear that we can expect a substantial and persistent impact on the demand trajectory of India. Downward revision, relative to the pre-COVID trend for electricity demand, in the order of 10% should be expected over the next four to five years. Decisions on procurement, investment, retirement, tariff setting, and DISCOM financial health need to be seen in this light. More severe scenarios, entailing a downward revision in demand of greater than 15% relative to trend, cannot be excluded, and are potentially becoming likelier.

Annex: All-India Macroeconomic Scenarios

Table 2: Baseline Scenario, GVA growth

Year	Agriculture (GVA)	Industry (GVA)	Services (GVA)	Total (GVA)
2020	2.0%	–8.0%	–7.0%	–6.4%
2021	2.5%	8.0%	9.0%	8.0%
2022	2.5%	6.0%	7.5%	6.5%
2023	2.5%	6.0%	8.0%	6.8%
2024	2.5%	6.0%	8.0%	6.8%
2025	2.5%	6.0%	8.0%	6.9%

Table 3: L-shaped Scenario, GVA growth

Year	Agriculture (GVA)	Industry (GVA)	Services (GVA)	Total (GVA)
2020	2.0%	–9.2%	–8.0%	–7.4%
2021	2.5%	6.4%	7.7%	6.7%
2022	2.5%	4.8%	6.4%	5.5%
2023	2.5%	4.8%	6.8%	5.7%
2024	2.5%	4.8%	6.8%	5.7%
2025	2.5%	4.8%	6.8%	5.8%

Table 4: V-shaped Scenario, GVA growth

Year	Agriculture (GVA)	Industry (GVA)	Services (GVA)	Total (GVA)
2020	2.0%	–6.8%	–6.0%	–5.5%
2021	2.5%	9.2%	10.8%	9.4%
2022	2.5%	6.9%	9.0%	7.7%
2023	2.5%	6.9%	9.6%	8.0%
2024	2.5%	6.9%	9.6%	8.1%
2025	2.5%	6.9%	9.6%	8.1%

Bibliography

Beinhocker, E. 2007. *The Origin of Wealth: The Radical Remaking of Economics and What It Means for Business and Society.* Cambridge, Mass.: Harvard Business School.

Broadberry, S. and Gupta, B. 2010. The historical roots of India's service-led development: A sectoral analysis of Anglo-Indian productivity differences, 1870–2000. *Explorations in Economic History* 47(3): 264–278.

CEA. Various years. *General Review,* New Delhi: Central Electricity Authority, Ministry of Power, Government of India.

Cerra, V. and Saxena, S. C. 2017. *Booms, Crises, and Recoveries: A New Paradigm of the Business Cycle and Its Policy Implications,* Washington DC: International Monetary Fund.

Feenstra, R. C. R. I. a. M. P. T. 2015. The Next Generation of the Penn World Table. *American Economic Review* 105(10):3150–3182.

IMF. 2020. *Global Debt Database.* Details available at https://www.imf.org/external/datamapper/datasets/GDD; last accessed on 7 July 2020.

IMF. Various years. *World Economic Outlook,* Washington DC: International Monetary Fund.

Joshi, V. 2016. *India's Long Road: The Search for Prosperity Kindle Edition.* London: Allen Lane.

Mehra, P. 2019. *The Lost Decade (2008–18): How India's Growth Story Devolved into Growth Without a Story.* New Delhi: Penguin Random House.

OECD. 2020. *World Economic Outlook,* Paris: Organisation for Economic Development and Cooperation.

RBI. 2019. *India KLEMS Database,* Mumbai: Reserve Bank of India.

RBI. 2020. *Database of the Indian Economy.* Details available at https://dbie.rbi.org.in/DBIE/dbie.rbi?site=statistics; last accessed on 7 July 2020.

Romain Duval, M. E. D. F. n.d. *Labour Force Participation Hysteresis in Industrial Countries: Evidence and Causes,* Paris: OECD.

Roy, R. 2019. Demand Supply and Growth Slowdowns. *Business Standard* (6):12.

Spencer, T. 2018. *Analysing and Projecting Indian Electricity Demand to 2030,* New Delhi: The Energy and Resources Institute (TERI).

Subramanian, A. and Felman, J. 2019. *India's Great Slowdown: What Happened? What's the Way Out?,* Cambridge, Mass: Centre for International Development and Harvard University.

Tumbe, C. 2016. *Urbanisation, demographic transition, and the growth of cities in India, 1870–2020,* London: International Growth Centre, LSE and Oxford University.

World Bank. 2020. *World Development Indicators.* Details available at http://databank.worldbank.org/data/reports.aspx?source=wdi-database-archives-%28beta%29; last accessed on 8 July 2020.

World Bank. 2020. *World Economic Prospects,* Washington DC: World Bank.

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