OXFORD ECONOMICS

India: Alternative energy pathways

February 2016

A report for Shakti Foundation

OXFORD ECONOMICS

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Executive Summary

- This report seeks to assess the economic implications of alternative low carbon development paths in India. We first examine the current growth constraints on Indiaôs economy, and quantitatively assess the impacts of relieving those constraints on growth and emissions. Next, we present two alternative scenarios that aim to balance Indiaôs development and emissions goals.
- Indiaôs supply-side constraints, particularly in energy, transportation, and agriculture, keep prices higher than they otherwise would be, limiting the central bankôs flexibility to boost growth in the near-term. Fiscal policy is similarly constrained due to an improving but still elevated budget deficit. Slow growth and high inflation have made it difficult for Indiaôs highly-leveraged corporate sector to repay loans, leading to rising levels of bad debt in the financial system and limiting banksôability to expand credit. Though improving global conditions and a depreciating rupee have boosted exports, supply-side constraints hinder exportersôability to meet external demand, and even with the decline in the rupee Indian firms remain uncompetitive.
- Many of the near-term constraints on growth are the result of structural deficiencies in the Indian economy which, if not addressed, will constrain long-run growth as well. The quality of infrastructure in India is poor, particularly in the power sector; the labour market is rigid and inefficient; labour productivity is low due to low education levels and poor public health; and corruption and public sector inefficiency discourage investment and foster public distrust in the governmentôs ability to implement needed reforms.
- Quantitative analysis of the key growth constraints facing the Indian economy suggest that while there is no single ñmagic bulletòreform, a targeted, ambitious, and well-executed reform agenda could substantially boost growth potential both in the short and long-term, to around 7.5% per annum.

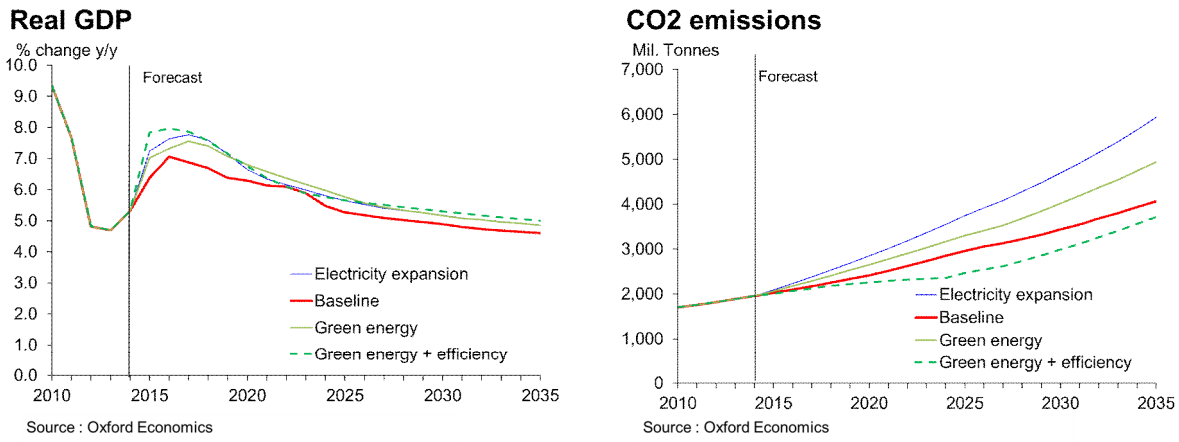
Figure 1: Impact of relaxing key growth constraints in India

Key Indicators
Period average
unless otherwise noted

	RDGP growth (%)			CPI inflation (%)	Government balance (% of GDP)	Government Debt in 2035 (% of GDP)	Current account balance (% of GDP)	Carbon emissions in 2035 (mtCO2)
	2015-19	2020-35	2015-35					
Baseline	6.7	5.2	5.6	4.7	-3.0	37.2	-2.5	4,066
Electricity expansion	7.5	5.5	6.0	4.6	-2.8	33.6	-3.8	5,935
Infrastructure investment	7.5	5.6	6.1	4.6	-2.8	33.5	-3.6	4,363
Institutional quality	6.9	5.9	6.2	4.5	-2.7	31.4	-3.1	4,373
Labour force participation	6.8	6.5	6.6	5.0	-2.8	29.5	-3.0	4,584
Energy subsidies	6.4	5.3	5.6	4.5	-1.9	23.7	-2.3	4,067
All constraints relaxed	7.4	7.6	7.5	4.6	-1.8	21.1	-3.0	6,857

- In an age of increasing concern about the potentially devastating impacts of climate change, India has set ambitious goals to reduce its emissions intensity. Given the countryôs size and development objectives, according to some projections it is expected to account for nearly 35% of the increase in global emissions over the next two decades.[1] The results of our constraints analysis suggest that the growth agenda could significantly hamper the countryôs emissions goals.
- As an alternative, we assess the macroeconomic impacts of two low-carbon development paths for India. These scenarios aim to balance Indiaôs key development goalsð faster growth, universal energy access, energy securityð with the goal of reducing its emissions intensity.
- In the first scenario, we focus on the power sector, assessing the impacts of a shift to renewables-based generation while simultaneously expanding generation capacity and electricity access. In the second, we build on the first scenario by incorporating assumptions around demand-side energy efficiency across sectors.
- The results of both scenarios suggest that Indiaôs growth goals need not come at the expense of its environmental goals; higher GDP growth can be achieved with a dramatically slower growth rate for emissions.

Figure 2: Alternative scenario results, GDP and emissions



[1] Based on projections in the IEA 2013 World Energy Outlook

1 Introduction

Indiaôs spectacular growth in the mid 2000ôsð real GDP growth topped 9% per year from 2005 to 2007ð propelled the country into the economic ñfast laneò alongside China and the other so-called BRIC economies. Nevertheless the country continues to lag its other large emerging market peers in its development, and growth since the financial crisis and resulting recession has yet to recapture the previous highs. This is in large part due to structural problems in the Indian economy, including supply-side bottlenecks in key sectors such as power and transport, widespread corruption, and inefficient bureaucracy. The 2014 general elections delivered a clear mandate in favour of the pro-development Bharatiya Janata Party (BJP), and the new government has set about a reform agenda it hopes will deliver sustained 8%+ growth rates.

A key part of the new governmentôs development agenda is to in improve Indiaôs energy security. India is heavily dependent on energy imports, and one-quarter of its citizens lack access to electricity. The government has pledged to expand domestic coal production to reduce imports, and is aiming to achieve universal access to electricity in the country within the decade.

In an age of increasing concern about the potentially devastating impacts of climate change, Indiaôs development must necessarily be balanced with the need for all countries to reduce their carbon footprint. Despite being the worldôs second most populous nation, India is fourth in total emissions (behind China, the US, and the EU), with per capita emissions roughly 15% of US levels and less than half that of China. Still, given the countryôs size and development objectives, it is expected to account for nearly 35% of the increase in global emissions over the next two decades.[2] The government has set several ambitious targets to increase Indiaôs renewable energy production, but these appear to be contingent on India securing financial and technical assistance from abroad, and it remains to be seen how its commitment might waver should output growth fail to improve.

This report seeks to assess the economic implications of a low carbon development path in India. We first examine the current growth constraints in the Indian economy, and quantitatively assess the impacts of relieving those constraints on growth and emissions.

Next, we present two alternative scenarios that aim to balance Indiaôs development and emissions goals. The rest of the paper is organized as follows:

- Section 2 outlines the theoretical underpinnings of our baseline forecast for India, identifying the key constraints on growth and offering an assessment of the outlook;
- Section 3 reviews the baseline forecast in detail with a discussion of key economic aggregates.

[2] Based on the IEA World Energy Outlook 2013 New Policies Scenario.

- Section 4 offers a quantitative assessment of the potential impacts of addressing the key growth constraints outlined in section 2;
- Section 5 presents two low carbon development scenarios for India that are designed to lower its carbon intensity while still achieving its key development goals;
- Section 6 discussed some potential co-benefits of a low-carbon development strategy;
- Section 7 offers some concluding remarks.

2 Defining a baseline scenario for India

After years of impressive performance, growth in India slowed substantially in the years following the global recession of 2008-09. Despite slow growth inflation is remains high, and twin deficits in the fiscal and current accounts leave India exposed to potentially fickle foreign capital flows. The pro-business Bharatiya Janata Party (BJP) campaigned on an economic reform platform in 2014 and rode strong anti-incumbent sentiment to a historic landslide victory, securing enough parliamentary seats to form a majority government. However, reforms have progressed slowly, and India faces a number of challenges that may continue to constrain growth both in the short and long-run.

2.1 Theoretical framework

In assessing the outlook for India it is helpful to review the theoretical explanations for what drives economic growth. Fundamentally an economy can only produce as much as its resources will allow. Economic theory primarily focuses on two economic inputs (or "factors of production"), labour and capital, the quantity and productivity of which determine, along with available technology, an economy's output potential.

In the short-run, however, the factors of production are largely fixed: meaningful changes to the labour supply (its size, its level of education) or capital stock occur slowly over time, and new technologies take time to be developed and absorbed.

Consequently, short-run growth is predominantly determined by changes in aggregate demand:

$$AD = C + I + G + X - M$$

where C is private consumption, I is investment, G is government expenditure, X is exports, and M is imports. Temporary fluctuations in employment, prices, interest rates, or changes to government policies or external economic conditions can all influence near-term economic growth. Economies can operate below or even above potential in the short-run as the level of employment fluctuates in response to changes in the business cycle.

Short-run deviations from full employment output tend to be temporary. An economy operating above potential, for instance, will experience inflation as wages rise in response to tight labour market conditions. Inflation would also prompt the central bank to raise interest rates which would reduce domestic demand and cause the exchange rate to appreciate. The combination of price increases (caused by the rise in wages), rising interest rates and a stronger currency would cause both domestic demand (consumption, investment) and net exports to fall, triggering an adjustment in employment and output back down to equilibrium levels. An economy operating below potential should see prices and interest rates fall, which over time will stimulate greater investment, consumer spending, and hiring to bring the economy back to full employment.

In the long-run, all economies are constrained by their potential output; the transition mechanism highlighted above ensures that countries cannot consistently produce more or less than their capacity allows. Consequently, growth in the long-run is thought to be driven by growth in the economy's productive potential, which is determined by labour, capital, and technology:

Labour supply: Growth in the labour supply can result from both population growth and increases in the labour force participation rate, i.e. the share of the working age population that is in work or actively seeking work. More important for raising living standards are factors affecting the productivity of the labour supply, such as health and education levels, which tend to improve individuals' productive potential, raise per capita output, and so increase real wages and improve living standards.

Capital stock: Growth in the capital stock results from public and private investment in infrastructure, machinery, and technology. Factors that encourage investment– low and stable inflation, openness to foreign direct investment, a well-functioning banking and capital markets system– will support growth of the capital stock in the long-run.

Total-factor productivity: Though changes in TFP are difficult to measure, this generally refers to innovation in technology, institutional structure, and management that improves the productivity of all of the factors of production. The factors driving changes to TFP are intertwined with those driving improvement in the quality of labour and capital: a more educated population, for example, will likely be more innovative and able to absorb and adapt new technologies developed abroad. Investment in research and science and technology, as well as institutional factors that support such investment (openness to trade and technological spillovers from abroad, low levels of corruption in government and private business, a well-functioning legal and intellectual property regime) are important factors that contribute to the growth of an economy's innovative capacity.

2.1 The outlook for India

2.1.1 Short-run

In the recent past India has been plagued by high inflation despite growth slowing in recent years. Much of this is driven by food inflation, which accounts for nearly 50% of the CPI basket and is largely the result of supply-side bottlenecks such as poor infrastructure in the agricultural and transport sectors. Inadequate irrigation facilities mean that farmers are heavily dependent on the monsoon rains for a good harvest. The lack of storage facilities, bad roads and inefficiency in the public sector mean that even the crop that is produced is not fully distributed. By some estimates, 40% of the total value of India's annual food production is wasted[3] before it can reach consumers. None of these issues can

[3] *India wastes more farm food than China: UN*. Hindustan Times. Sept. 11 2013.

be corrected in the short-term, and the risk that a disappointing monsoon will exacerbate food price inflation is high.

The fiscal authorities are similarly constrained. Until 2013, the governmentôs budget deficit was teetering at dangerous levels, with India narrowly avoiding a sovereign credit rating downgrade to junk status. Although the deficit has now fallen from around 6.5% in 2011 to less than 5%, it is still uncomfortably high. As a result the government retains little flexibility to increase spending to boost growth in the near-term; it could, however, boost long-term potential by prioritizing capital spending, but the need to meet fiscal targets means this would require politically difficult cuts to current spending such as food and energy subsidies.

Indiaôs corporate sector is now highly leveraged, with many companies having borrowed on the assumption that the economy would keep on growing by around 8% annually. This is indicative not only of a level of over- optimism among Indian corporations, but also the shortcomings of Indiaôs financial system, where capital markets play little role in financing Indian firms[4] and state banks dominate lending.[5] According to the IMF, Indiaôs debt-to-equity ratio is 83%, the highest among all emerging markets and surpassed only by Greece and Italy. Slow growth and high inflation have made it difficult for borrowers to repay loans, leading to rising levels of bad debt in the financial system. RBI Governor Raghuram Rajan has warned that public sector banks face challenges in terms of their capital needs, asset quality, and profitability. The RBI assesses that the total capital requirement of public sector banks between 2014 and March 2019 (when India is expected to enforce Basel III regulatory rules) is INR 4.15 trillion (around 4% of GDP), of which around INR 1.43 trillion will need to be raised from equity holders. As the majority stakeholder in the sector, the government will have to contribute INR900 billion to the equity total if it intends to maintain its current stake in the banking sector.[6] Given fiscal constraints, this will be difficult. The banking sector remains key to the investment climate as companies need straightforward access to credit to fund investments. The deterioration of bank balance sheets, and looming need for recapitalization, will limit banksôability to lend and businessesôability to invest.

Exports are gradually picking up, with stronger global demand and the depreciation of the rupee feeding through. But relative to other emerging markets, Indiaôs performance remains poor as a result of the weak domestic situation. Supply side problems such as weak infrastructure in power and

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[4] Since 2008 just 3% of Indiaôs capital investment was financed through equity markets, and as of 2011 outstanding corporate bonds were just 1% of GDP compared to 9% in China and 22% in the U.S according to the BIS.

[5] More than two-thirds of banking system assets are concentrated in state banks, which are compelled both by law and through political pressure to direct credit to ñpriority sectorsò and influential firms.

[6] *Financial Stability Report: Issue No. 9*. Reserve Bank of India. June 2014

transport are constraining producersô ability to fully compete in international markets.

2.1.2 Long-run

Many of the near-term constraints on growth are the result of structural deficiencies in the Indian economy which, if not addressed, will constrain long-run growth as well.

The power sector

A chronic shortage of electricity is perhaps Indiaôs largest infrastructure challenge. The World Economic Forumôs 2013-14 Global Competitiveness Rankings put the quality of Indiaôs electricity supply at 111th out of 148 countries. Despite the progress that has been made in expanding electric generation and access to electricityð according to the World Bank generating capacity has tripled since 2003 and three-quarters of the population now has an electricity connectionð Indiaôs power supply remains inadequate and unreliable. More than 300 million Indians still live without electricity, despite two-thirds of them living in villages considered ñelectrified.ò

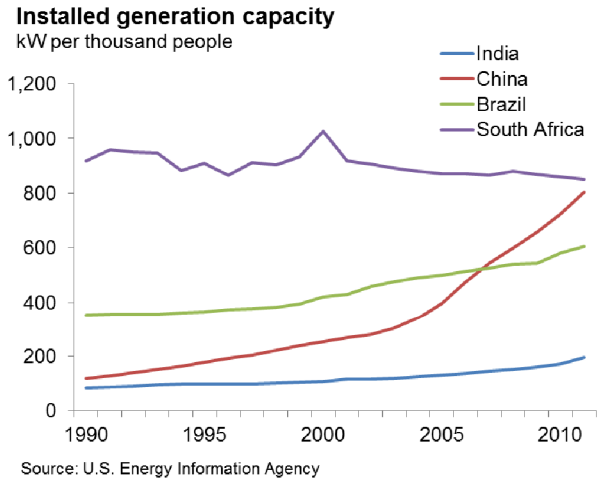
Interrupted power supplies mean Indian manufacturers need to maintain back-up power options to keep factories working. This adds to production costs, which are passed on to the consumer and hurt international competitiveness. Some companies accept regular days with no power, which disrupts production. This prevents supply from keeping up with rising demand and therefore exerts upward pressure on prices.

The problems in the sector are many. Power generation is predominantly coal-based, but despite having the fifth largest coal reserves in the world India is the worldôs third largest coal importer. Imported coal costs roughly five times as much as domestically extracted coal, imposing significant costs on power generators and discouraging imports. State monopoly supplier Coal India has been unable to increase its output to match demand, and inadequate transport infrastructure hampers delivery. The company blames bureaucratic delays in land acquisition and environment and forest clearances, but it is also suffers from mismanagement.

Generating capacity has also failed to keep pace with output: China, with output roughly 2.6 times that of India on a PPP basis has nearly five times its installed generating capacity.[7]

[7] Though some of this is attributable to Chinaôs relatively larger industrial sector, it is nevertheless indicative of how far behind India lags its international peers in generation capacity.

Figure 2.1: Installed electric generation capacity by country, 1990-2011



The World Bank estimates that capacity lags demand by 10% of energy and 12% of peak load. Meanwhile, though the connection of the southern energy grid to the national grid was a significant achievementð it created one of the largest operating synchronous grids in the worldð its current capacity is not enough to support the countryõs growing needs.

In the distribution segment, theft of power is rampant; by some estimates nearly 20% of supplied power is not paid for.[8] On top of revenue lost to theft, energy subsidies to the agriculture sector and tariffs that have not kept pace with costs have left state-owned distribution companies (discoms) insolvent. In fact, the sector has had to be bailed out twice, most recently in 2011 at a cost of 1% of GDP, and future bailouts seem all but assured as the schemes have failed to address the underlying structural issues that have driven their financial struggles.[9] The financial troubles of the discoms have dissuaded investment in the power sector at a time when it is desperately needed to upgrade the transmission grid and add generating capacity.

The government has outlined some sensible policies to tackle these problems. It proposes auctioning coal blocks for development only after bureaucratic hurdles like environment and forest clearances, land acquisition and water supplies have been resolved. If implemented efficiently, this could increase coal production significantly, helping to boost power generation without adding new capacity. It wants to open the sector to private firms to introduce competition,[10] but trade

[8] According to the World Bank, distribution losses have dropped from 32 percent in 2003 to around 21 percent on average in 2011.

[9] A recent report on the financial restructuring plan (FRP) finalized in September 2012 showed that most of the eight states that participated in the scheme failed to meet performance targets stipulated by the program.

[10] Some private firms do mine coal in India, but coal mined from these ñcaptiveò allocations may not be sold to third parties.

unions are vehemently opposed to private sector involvement and have scuttled similar efforts in the past. Moreover, the Supreme Court decision to cancel nearly all coal block allocations issued since 1993 has cast a huge shadow of uncertainty and may discourage future private sector investment in the sector. The most recent five year plan also proposed implementing a system of price pooling to limit disincentives to expand coal imports, and acknowledged the need for debt restructuring for power distributors.

The FY2015 budget also included some steps that would be positive for the sector: these include a two year extension of the tax holiday for power projects; the rationalisation of coal linkages to reduce transportation costs; and an allocation of INR10 billion for setting up solar plants in a few states.

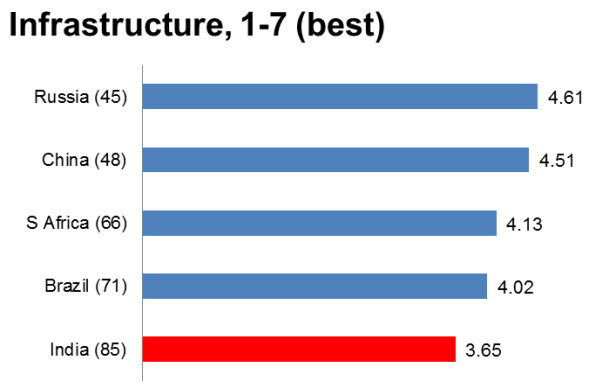
More will need to be done, however, to attract investment to the sector. Power theft needs to be combatted and severely curtailed; tariffs need to be rationalized to reflect current costs[11] and subsidies curbed; and utilities need to be insulated from pressure from politicians to supply below-cost power to their constituents. Such reforms will be politically difficult, especially so because the power sector comes under the jurisdiction of both the state and the central government. Lack of cooperation between the two is often the cause for delays in key reforms; the implementation of the Goods and Services Tax, for instance, has been held back for the past two years because of the lack of approval from state governments.

Infrastructure

According to the WEF rankings, Indiaôs infrastructure ranked 85th out of 148 countries trailing well behind emerging market peers such as Russia (45th), China (48th), South Africa (66th), and Brazil (71st). The quality of Indiaôs transport, telecommunications, and energy infrastructure is poor (see above), and inadequate infrastructure is cited by Indian firms surveyed by the WEF as the greatest hindrance to doing business ahead of corruption and inefficient government bureaucracy.

[11] According to a World Bank report, projections for the 12th Plan period show that even if tariffs rise by six percent a year to keep pace with rising supply costs, annual losses in 2017 could still reach INR 1,253 billion (US$27 billion).

Figure 2.2: Assessment of infrastructure by domestic residents



Source: World Economic Forum

As noted above, poor infrastructure is playing a key role in Indiaôs short-term dynamics, driving high food price inflation and hindering export growth. This in turn makes necessary reforms more difficult. The 12th plan indicated a strong desire to pursue public-private partnerships to fund infrastructure projects, acknowledging the scarcity of its own resources and the scale of the overhaul needed in several areas. However, the high interest rates needed to combat inflationð in part driven by subpar infrastructureð discourage private investment. This compounds already-existing hindrances to financing infrastructure projects, including the lack of a municipal bond market, poor performance of past PPP infrastructure investment projects, and high existing exposure of Indian banks to infrastructure investments.

Moreover, despite purportedly aiming to increase infrastructure investment to 9% of GDP by 2017, in the first two years of the five year plan the government cut capital spending to meet its fiscal deficit targets. Though cutting the deficit must continue to be a priority, doing so in a more sustainable fashion would allow the government to meet its fiscal targets without undermining long-term growth. Reducing current expenditure by cutting food and fuel subsidies is one solution. So far, there has been little sign of action from the government to this end. Railway passenger fares were hiked by 14.2% at the end of June 2014, but amid much opposition from the electorate, the government had to postpone the increase in natural gas prices by three months.

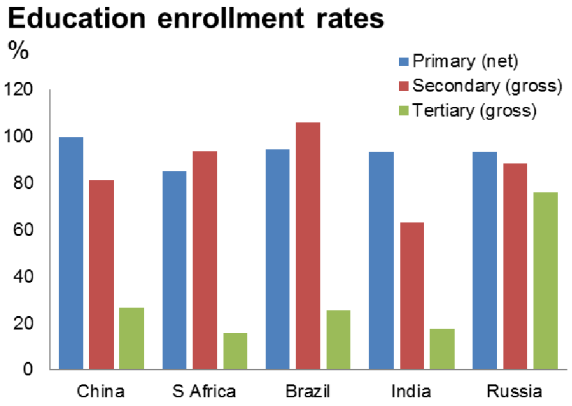
Another solution would be to revamp the taxation system by broadening the tax base and preventing tax evasion. The introduction of the Goods and Services Tax ï a comprehensive levy on the manufacture, sale and consumption of goods and services at a national level set to go into effect in 2016 ï will help to simplify the existing tax structure and make tax compliance more effective.

In addition, liberalization of restrictions on foreign direct investment in railways, airports, and telecommunications should be implemented to allow foreign capital to finance upgrades in these sectors.

Human capital

Though great efforts have been made to improve public health and access to education, Indiaôs poor overall public health and education levels remains a major cause of its low labour productivity.

Figure 2.3: Education enrolment rates by country[12]



Source: World Economic Forum

Though enrolment in primary education is in-line with that of emerging market peers,[13] the drop off from primary to secondary enrolment is substantial. Moreover, the quality of education at the primary level is poor.[14] In addition, although Indian universities are well-regarded,[15] enrolment in tertiary education is low even by emerging country standards.[16]

Health outcomes are similarly poor, as India ranked near the bottom of the WEFôs rankings on virtually all health indicators (111th on life expectancy, 120th on infant mortality, 114th and 116th on incidence of malaria and tuberculosis, respectively).

The Twelfth Plan set several ambitious targets to raise overall educational achievement levels in India, including raising the mean years of schooling to seven years, creating two million additional seats for each cohort in Indian universities, and eliminating gender and social gaps in school enrolment. In

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[12] China, 2011; Brazil, 2005; Russia, 2009; India, 2010; S Africa, 2009

[13] As of 2011, Indiaôs primary education enrollment rate of 93.3 as in line with Russia (93.4) and Brazil (94.4) but lagged China (99.8) whose enrollment rate as of 2011 was among the highest in the world.

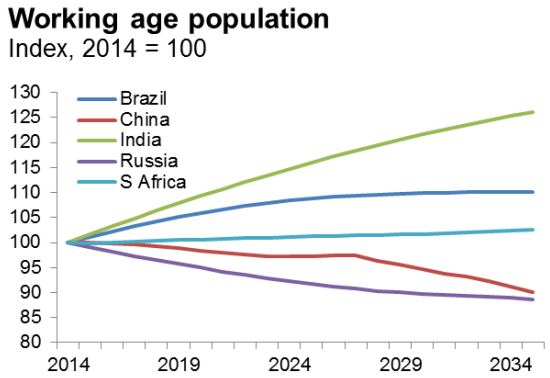
[14] In the WEF rankings, the quality of primary education in India ranked 84 out of 148 countries

[15] The quality of higher education in India was ranked 33rd in the WEF rankings (the U.S. and U.K. were ranked 25th and 26th, respectively).

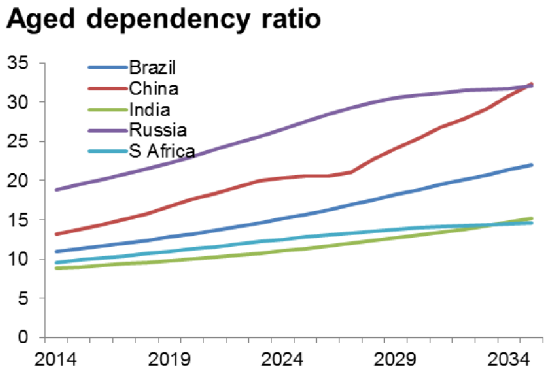
[16] India ranked 98th of 148 countries with less than 18% of university-aged Indians enrolled in tertiary education.

addition, the plan aims to improve public health by expanding the capacity of the public healthcare system and improving water and sanitation. The same fiscal reforms designed to free up budget capacity for infrastructure would also help create funding to meet these goals. This could go a long way to raising long-run growth potential; India is fortunate to have more favourable demographics than many of its peers, and reforms that raise the productivity of its workforce would allow it to take full advantage of its demographic dividend. Policies aimed at increasing the participation of women in the labour forceð Indiaôs female labour force participation rate is currently the lowest of any country outside the Arab world[17]ð could be particularly effective in this regard.

Figure 2.4: India's demographics are favourable compared to EM peers



Source: U.S. Census Bureau



Source: U.S. Census Bureau

Moreover, such investments would help facilitate a reduction in poverty rates, which the TFYP indicates India aims to reduce by 10 percentage points by 2017. An IMF analysis indicates that boosting spending on health and education by 1 percent of GDP is associated with a 0.5 percentage point decline in the poverty rate.

Institutions

After infrastructure, inefficient government bureaucracy and corruption were the two most widely cited hindrances to doing business in India according to the WEF survey. Public trust in politicians is low, and bribery is entrenched.

Though the costs of corruption are difficult to estimate, a World Bank study estimated that corruption costs India 0.5% of its GDP each year.[18] A 2013 survey by Ernst & Young[19] found that the vast majority of respondents believed that high-profile corruption scandals in India had negatively impacted foreign

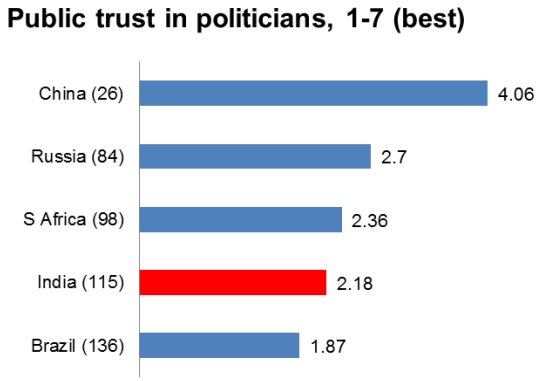
[17] Its 0.36 female to male worker ratio is 137th out of 148 countries according to the WEF GCR.

[18] Cited in *Bribery and corruption: ground reality in India,* Ernst & Young, 2013

[19] *ibid*

investment flows and led to lower valuation of Indian companies as investors account for the higher cost of doing business due to corruption. Notably, the survey found that among the sectors most vulnerable to graft were infrastructure, power, and utilities.[20] Corruption may be one of the factors that has driven the poor returns on past public-private investment projects, which could make attracting private investment for current priorities more difficult and more costly.

Figure 2.5: In your country, how would you rate ethical standards of politicians?



Source: World Economic Forum

To be able to achieve the governmentôs target growth rate of around 8%, India needs an institutional overhaul aimed at reducing crony capitalism that favours politically connected corporations and prevents smaller businesses from flourishing. Not only does this have a net negative impact on the economy, it also likely contributes to the acute inequality that currently prevails in India. Prime Minister Modi has close ties to many of Indiaôs corporate giants, and while this may aid him in improving the countryôs infrastructure, there is scant evidence that his BJP is less prone to political favouritism than the recently ousted Congress party.

[20] A UN study found similarly that Indiaôs roads and power sectors were most prone to graft.

3 Baseline forecast[21]

3.1 Key assumptions

Though much of our forecast for India is driven by variables that are endogenous to the Oxford Economics Global Economic Model,[22] there are several key exogenous factors in both the short and long run that ultimately shape our baseline projections for growth.

As discussed in Chapter 1, short-run growth is largely demand driven, as the structural determinants of output (labour, capital, and technology) are fixed in the near-term. As such, our short-run forecast for India relies on assumptions about exogenous factors that influence aggregate demand: monetary policy, fiscal policy, energy prices, and external demand.

Because economies trend towards their potential output in the long-run, our long-run forecast for India is driven by assumptions about the structural determinants of the economyôs productive capacity. Of particular importance to India are those related to energy and the power sector, including projections about electric generation capacity, coal production, and energy subsidies. In addition, weôve made key assumptions about infrastructure investment, population growth, labour force participation, education, and institutional quality.

3.1.1 Short-run factors

Monetary policy

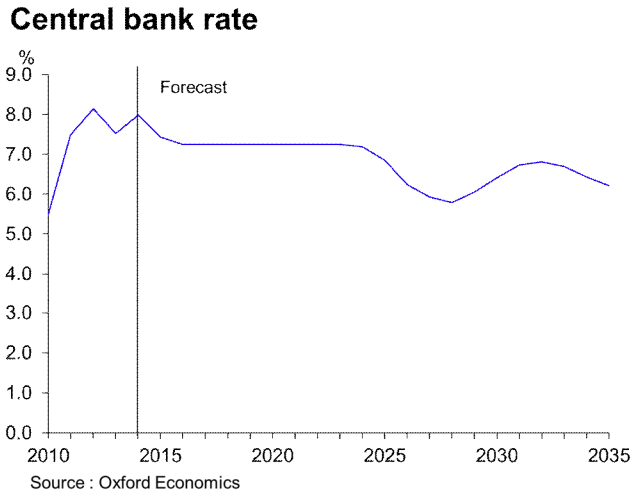
In the short-run, policy statements from the Reserve Bank of India provide guidance on the path of policy rates. The RBI is targeting retail inflation of 6% by January 2016 and 4% in the long run. While falling energy prices have helped bring down inflation and paved the way for some monetary easing, the recent rebound in inflation likely rules out additional easing in the near-term.

In the long-run the policy rate is forecast based on a Taylor rule reaction function in which the central bank adjusts the policy rate in response to changes in CPI inflation.

[21] Please note that the figures presented here represent our baseline projection for India as of autumn 2014.

[22] For a detailed description of the Oxford Economics Global Economic model, see the Appendix.

Figure 3.1: Policy rate forecast

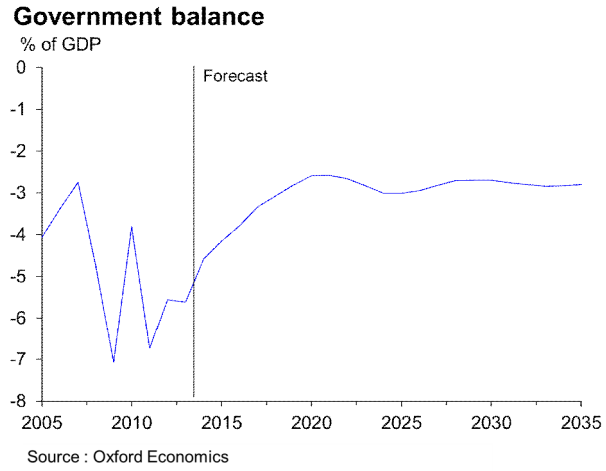


Fiscal policy

The FY15 budget, released in July 2014, projects central government spending of INR 18 trillion or roughly 15% of GDP, and maintained the previous governmentôs deficit target of 4.1% of GDP. In addition, the government put forward deficit targets of 3.6% and 3.0% of FY16 and FY17, respectively. These targets are perhaps ambitiousð our own forecast projects the deficit to be 4.5%, 4.1%, and 3.7% of GDP, respectively, in FY15, FY16, and FY17ð but overall we do expect the government to maintain its focus on cutting the deficit, and our forecast for fiscal policy going forward is built around this key assumption.

In the long run, we estimate the structural deficit--that is, resulting from the long-run imbalance between government receipts and expenditures--in India to be 2.9% of GDP, a level at which, given estimated GDP growth, gross government debt will stabilize at roughly 37% of GDP.

Figure 3.2: Budget balance forecast

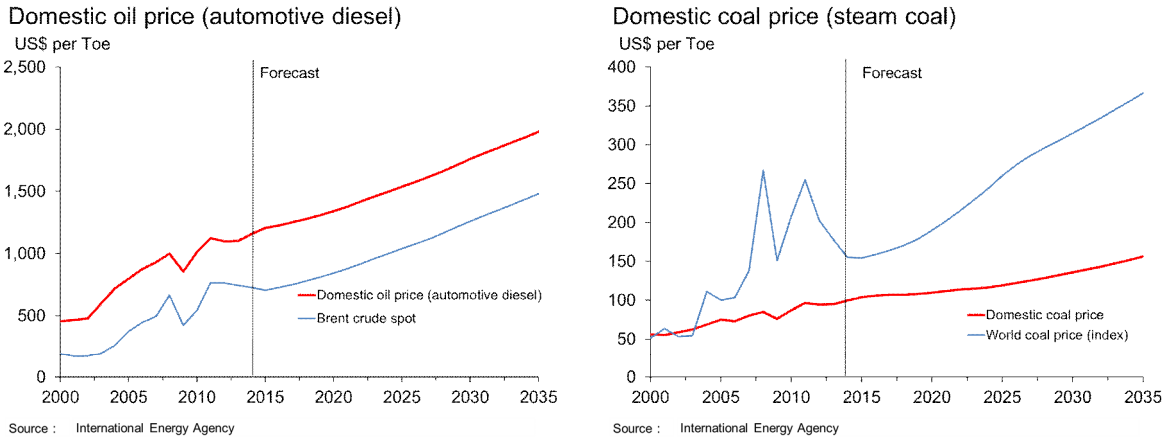


Energy prices

Our forecast for energy prices as of autumn 2014 for India is driven by our forecast for world prices. The price of diesel is projected to grow in line with Brent crude prices, with the wedge between their per barrel costs falling slightly in 2015 (due to the removal of the diesel subsidy) but remaining roughly unchanged thereafter.

Our forecast projects domestic coal prices to grow much more slowly than world prices, owing to both the lower overall quality of coal produced in India as well as price regulations which we expect to remain in place.

Figure 3.3: Fuel price forecast

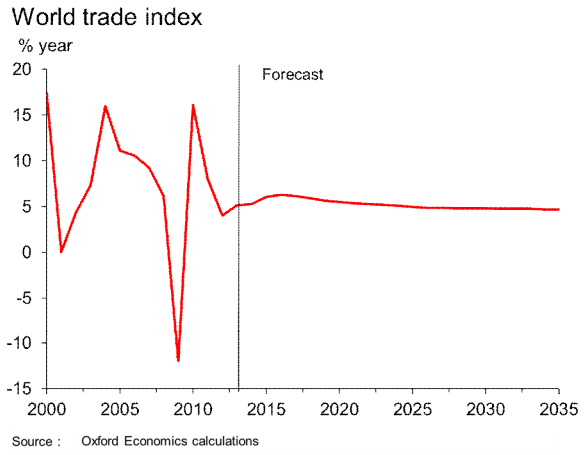


World Trade

Though endogenous to the model, our forecast for world trade (and global economic conditions more broadly) represents an important exogenous factor in our forecast for India. The World Trade Index for India is a weighted average index of our imports forecasts for each of Indiaôs trading partners, weighted by each partnerôs share of Indiaôs exports. It is an indicator of demand for Indian exports based on the import demand of its trading partners.

Based on current projections for Indiaôs trading partners, we project external demand to grow 5.2% annually on average to 2035.

Figure 3.4: World trade forecast



3.1.2 Long-run factors

In the long-run, economies trend towards their potential output. As such our long-run forecast for India is driven by assumptions about the growth of the labour supply, infrastructure, technology, and productivity that will drive Indiaôs future productive capacity.

Of particular importance to India are those pertaining to energy and the power sector. As enumerated above, the issues facing the power sector in India are substantial and play a key role in the relatively modest growth outlook contained in our baseline forecast. Within this sector we have made key assumptions regarding the expansion of generation capacity, the outlook for domestic coal production, and the future of Indiaôs energy subsidies.

Coal production

Our forecast for domestic coal production is based on IEA projections. The IEA projects coal production to rise 1% per annum to 273 mtoe by 2020, and then grow an average of 3.1% annually through 2035. We are somewhat less optimistic, as we expect the wrangling around permits and lack of credible government reforms to continue into the medium term.

Increases in production require investment in coal exploration years in advance to establish mineable reserves. However, according to the World Bank, planned exploration in the 11th Five-Year Plan was actually less than what was accomplished in the 10th Five-Year Plan, and only 70 percent of the target was achieved.[23] Moreover, the Supreme Courtôs decision on coal block allocations gives us reason to question the extent to which private sector investment in the coal sector will increase. We therefore assume a more moderate 2.5% annual growth rate in coal production after 2020, with production reaching 396 mtoe by 2035 (vs 435 in the IEA New Policies Scenario).

Our projection for domestic coal production impacts the forecast in several ways. While coal production is expected to grow an average of 2.1% annually over the next two decades, and oil production is projected to decline, fossil fuel demand is expected to rise 3.5% annually. As a result, coal imports are expected to triple from 2015 to 2035 and oil imports double. These imports are a major driver of persistent trade deficits in the forecast, contributing to a depreciating rupee and keeping inflation and policy rates higher than they otherwise would be. Higher interest rates, in turn, lower investment by raising the return required to make investment profitable, thus reducing the pool of profitable projects.[24] Reduced investment further hampers growth in potential output. Higher rates also raise the return on savings, thereby discouraging consumption

Greater coal imports also raise electricity costs for households and producers by forcing power plants to rely on expensive imported coal. This crowds out other consumption and investment and hurts the competitiveness of Indian firms. In sectors where electricity costs are subsidised, higher generation costs raise the overall cost of those subsidies.

Finally, the lack of adequate coal supply is a key contributor to Indiaôs unreliable power supply. India has experienced periodic coal shortages in recent years in which power plants have drawn coal stocks down to just days of supply, forcing them to run far below capacity and leading to blackouts. This, along with the lack of adequate generation capacity, has contributed to the need for producers to maintain backup power facilities, raising production costs and discouraging both domestic and foreign investment. This has an important follow-on impact on inflation through its impact on food prices: the cost of cold storage in India is high because of the need for backup generation, and this additional cost has

[23] Sheoli Pargal and Sudeshna Ghosh Banerjee. *More Power to India: The Challenge of Electricity Distribution*. The World Bank. July 2014.

[24] Higher rates can also be thought of as raising the cost of credit needed to finance investment, but even firms financing investment exclusively through their own retained profits will invest less at higher interest rates. Firms invest up to the point at which the discounted return on that investment is equal to its cost, the discount rate being the risk free rate plus a risk premium. Higher policy rates raise the discount rate (by raising the risk free rate), thereby raising the return required for projects to be profitable.

discouraged the expansion of cold storage capacity,[25] contributing to India's high food spoilage rates. By some estimates, 18% of fruits and vegetables produced in India go to waste because of a lack of cold storage, and spoilage may account for half the cost of milk.[26]

Power sector

Our baseline forecast for the power sector is based on assumptions about the growth of installed generation capacity, the growth and mix of electricity production, improvement in transmission and distribution losses, and the expansion of electricity access.

Electric Generation Capacity: Our baseline forecast for electric generation capacity is based on the New Policies Scenario[27] detailed in the IEA World Energy Outlook report for 2013. As in the IEA scenario, we assume that installed capacity rises from 250 GW in 2013 to 886 GW by 2035, implying that capacity will grow an average of 29 gigawatts annually (6% pa) over the next two decades. This projection implies an increase in investment in expanding both generation and transmission capacity, as installed generation capacity has risen an average of just 11 gigawatts per year (6% pa) since 2000. Capacity did, however, rise 30 gigawatts in 2011, suggesting that this level of annual growth is achievable.

Electricity production: We further assume that electricity production rises from 1,345 TWh in 2014[28] to 3,371 TWh in 2035, as projected in the IEA scenario. Production from coal-fired plants falls from nearly 70% today to 56% by the end of the forecast, while non-hydropower renewables (bioenergy, wind, and solar) rise from 5% of generation today to 14%.

Transmission and distribution losses: Aggregate technical and commercial (AT&C) losses, which include losses due to both technical inefficiencies in the transmission grid and those due to theft, inefficient metering, and inaccurate billing, were estimated by India's Central Electricity Authority to have been nearly 39% of total production in 2000-01 when it launched the launched the

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[25] *The Food Wastage & Cold Storage Infrastructure Relationship in India*. Emerson Climate Technologies.

[26] *ibid*

[27] This scenario is the central scenario of the IEA outlook, and incorporates both policies and measures already undertaken as of mid-2013, as well as relevant announced commitments (even if precise implementation measures remain undefined). For instance, the scenario assumes that India meets the targets of its Solar Mission initiative (22 GW of capacity by 2022).

[28] The Indian Ministry of Power's Load Generation Balance Report 2014-15 estimates 995 TWh of electricity available for consumption in the year. Assuming loss rates of 26% consistent with those reported by the Central Electricity Authority, this implies total generation of 1,345 TWh.

Accelerated Power Development Reform Program (APDRP) with the aim of reducing losses to 15% by the end of 2007. Though the program failed to meet this target, through 2008-09 AT&C losses fell an average of 1.2 percentage points per year, reaching 27.7%. However, improvement has stalled since despite a restructuring of the APDRP, and losses in 2011-12 were estimated to be 27%.

In the baseline we assume losses of 26% of production in 2014, and assume loss rates decline 0.8 percentage points annually, roughly the average decline from 2007-08 to 2011-12. Loss rates fall to 15% by 2028, nearly a decade later than the year targeted by the restructured APDRP.

Electricity access: It is estimated that one-quarter of Indiaôs population currently lacks access to electricity. The IEAôs New Policies Scenario assumes that the number of people without access to electricity falls to 10% of the total population by 2030, but this seems optimistic in our view. India has consistently under-invested in transmissionð as evidenced by its high technical loss ratesð and substantial ñcatch-upòinvestment will be required to modernize the transmission grid[29] in order to reduce losses and bring financial viability to the sector, a prerequisite to any large-scale expansion in electric capacity and production. We think it is unlikely that India can both meaningfully reduce transmission losses and aggressively expand access. Our baseline forecast instead projects access to reach 85.5% of the population by 2030 (about 70% of the reduction envisioned in the IEA scenario) and 88% by the end of the forecast window.

In sum, these assumptions imply that annual per capita consumption more than doubles, rising from 784 kWh today to 2,005 kWh in 2035.[30] While this represents substantial growth, at these levels electricity consumption will still be inadequate, falling below that of Indiaôs emerging market peers today.

This impacts the forecast in several ways. As with the inadequate supply of coal, a lack of adequate electricity supply contributes to the need for producers to maintain backup power supplies to avoid production delays, as the lack of spare capacity will continue to limit power plantsôability to accommodate peak demand or temporary declines in online capacity resulting from routine maintenance. This reduces the efficiency of the capital stock in two ways: firms that invest in backup generation facilities would otherwise use that capital to increase their productive efficiency; firms that do not invest in backup generation are yielding less output per unit of capital because of production delays.

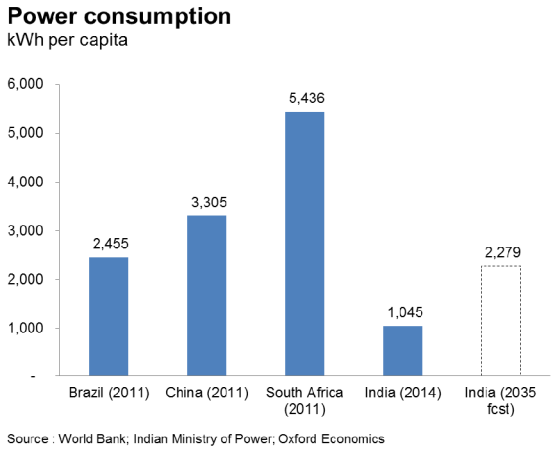
In addition, the lack of electricity access lowers human productivity by, for instance, hindering the ability of children to study after dark, and forcing women

[29] A report from the Federation of Indian Chambers of Commerce and Industry (FICCI) and Booz & Co estimated that India has invested only $0.30 in transmission for every $1 spent on expanding generation, compared to the $0.50 typically considered best practice.

[30] Consumption per capita for those with access rises from 1,045 kWh today to 2,279 kWh in 2035.

to devote more time to manual household chores rather than participating in more productive, income-generating activities.

Figure 3.4: Power consumption forecast



Source : World Bank; Indian Ministry of Power; Oxford Economics

*Figure depicts per capita power consumption for individuals with access to electricity. 2035 forecast for India based on 88% access from 75% today.

Energy subsidies

The prices of both electricity and some fuels in India are regulated. The central government regulates the retail prices of diesel, kerosene, and LPG, forcing oil marketing companies (OMCs) to sell these products at below-market prices. The government provides a direct fiscal subsidy for kerosene and LPG to make up some of the difference. Additional cash subsidies above the direct fiscal subsidy cover some of the remaining shortfall. The remaining difference between the cost and retail price of these products is borne in part by the National Oil Companies and in part by the OMCs. In FY14 total subsidies, including food, fertilizer, and petroleum were INR 2.55 trillion or 16% of total expenditure; petroleum subsidies were one-third of this total (0.8% of GDP). The FY15 budget allocates INR 2.60 trillion (15% of expenditure) for subsidies, of which petroleum accounts for nearly one quarter.[31]

Electricity prices are regulated at the state level. State electricity regulatory commissions set prices based on development objectives for different consumer categories (e.g. residential, agriculture, commercial, industry, railways). State governments provide subsidies that cover some of the shortfall between revenues and costs, while also providing capital subsidies to fund the maintenance of power infrastructure. However, the subsidies provided to the distribution companies have not been sufficient to cover the gap between

[31] Food subsidies are 28%, fertilizer subsidies 44%, and petroleum subsidies 24%. A similarly optimistic projection for petroleum subsidies in the FY14 budget was later revised up more than 30%, but this may be achievable given the phase out of the diesel subsidy.

revenues and costs, leaving the discoms in dire financial straits. From 2008-2010, subsidies paid by state government to electric utilities were 0.3-0.4% of GDP.

The Indian government began a phased deregulation of diesel prices in January 2013, and domestic prices have recently reached parity with world prices. As a next step it will formally move to eliminate all price controls on diesel, though controls will remain in place for kerosene and LPG. At the same time the government will also propose that under-recoveries resulting from the price controls on kerosene and LPG be split evenly between the government and the national oil producers in order to lower the subsidy burden and raise investment in the oil sector.[32]

Our baseline forecast assumes that the diesel subsidy is eliminated but that the others remain in place. As we expect the government to continue to focus on reducing the deficit, the primary impact of the subsidies is that they crowd out other spending, particularly investment. This is especially damaging to long-run growth given the woeful state of Indiaôs infrastructure. By distorting relative prices the subsidies may also lead to less efficient consumption and investment decisions by consumers and firms.

Infrastructure investment

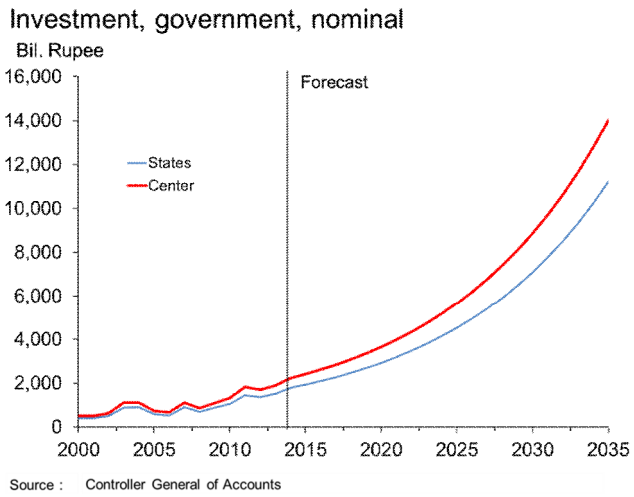
In addition to key assumptions relating to the energy and power sectors, our long-run forecast for India also relies on assumptions about other structural factors. The 12th plan projects public infrastructure investment of INR 29 trillion over the full plan period, with central government spending accounting for roughly 55% of the total and state spending the remaining 45%. However in recent years capital spending has been repeatedly slashed in order to meet fiscal deficit targets: in 2013-14 non-defence capital outlays were 79% of budgeted amounts.

Given our base assumption that the government will maintain its focus on reducing the deficit, as well as our assumption that non-diesel energy subsidies will remain in place,[33] our baseline assumes that India will continue to fall short of investment targets by a similar margin. The result is slower growth in the capital stock, which lowers potential output growth.

[32] The split will effectively be even more favourable to the oil firms as it will take into account an excise tax the firms currently pay on crude oil production.

[33] We assume similarly that food and fertilizer subsidies will remain in place.

Figure 3.5: Government investment forecast



Population growth

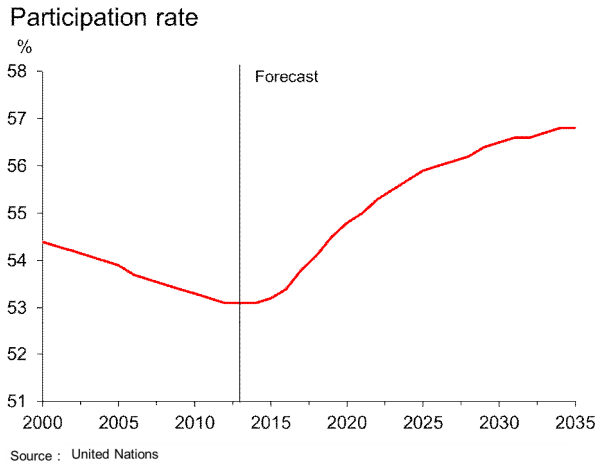
Our forecast for population growth is based on estimates from the United Nations. These estimates show that India stands to reap a substantial demographic dividend as the working age population is projected to grow to 910 million by 2020 and 1.04 billion by 2035, rising 2.4 percentage points as a share of the population overall. This steady growth in the labour supply contributes to rising potential output growth, though the impact of these favourable demographics would be greater if coupled with an increase in education levels, which would raise labour force productivity (output per worker), and female labour force participation, which would lead to even greater labour force growth (see next section).

Labour force participation

Labour force participation in India is expected to rise modestly over the next two decades but continue to lag that of its emerging market peers. This is due to the exceedingly low female participation rate which, even by 2035, is expected to remain well below 35%. By 2035 we project the overall participation rate will be 57%, compared to 79.8% in Brazil and 87.2% in China.

Though the labour force is still projected to grow more than 33% over the next twenty years, an increase in participation, particularly among women, would increase the impact of Indiaôs favourable demographics on growth potential. For instance, raising female labour force participation to 45%--a level on par with that seen in Mexico and South Africa today, but still well below that of China and Brazilð would increase the size of the labour force by 13%, or 79 million people, above our baseline projection.

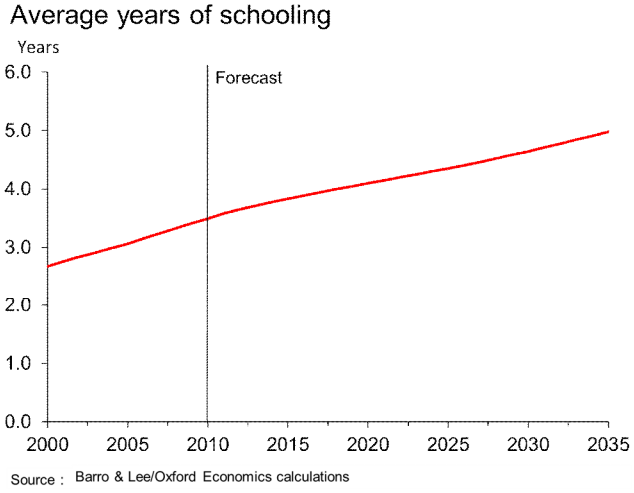
Figure 3.6: Participation rate forecast



Education

Using estimates from Barro and Lee,[34] education levels are forecast to rise over time as younger, more educated workers replace less educated older workers. Overall average years of schooling in our baseline forecast are projected to rise from 3.8 years to 5.0 years by 2035. However, even at this level education levels in India would lag those in peer countries like Brazil (5.4 years) and China (6.5 years) today. Low education levels lead potential output growth to be lower than it otherwise would be as less educated workers tend to be less productive members of the labour force.

Figure 3.7: Schooling forecast



[34] Robert Barro and J.W. Lee. *Educational Attainment for Total Population, 1950-2010, v. 1.3*. April 2013.

Institutional quality

Institutional quality forms a key pillar of economic growth. For firms and individuals to invest and innovate, they must feel confident that the legal system will protect their private property rights and that they will not be subject to institutional corruption or have their assets seized by the government. They must also feel confident that they will not be unduly burdened by excessive or unsound regulation, and if they find regulations unreasonable, that they have the ability to participate fairly in the political process to elect new leadership. Entrepreneurs must be able to navigate government bureaucracy easily and efficiently in order for new firms to be established and prosper.

Institutional quality can be thought of as a factor in determining the costs and risks of investment. If a firm considering an investment anticipates it will need to bribe government officials in order to secure necessary approvals, this raises the costs of that investment. The firm must also consider the risk of government expropriation, which would lower their expected returns. Even if the risk of government malfeasance is low, excessive regulatory compliance costs (licensing, permits, building codes, etc.) discourage investment in new and existing businesses.

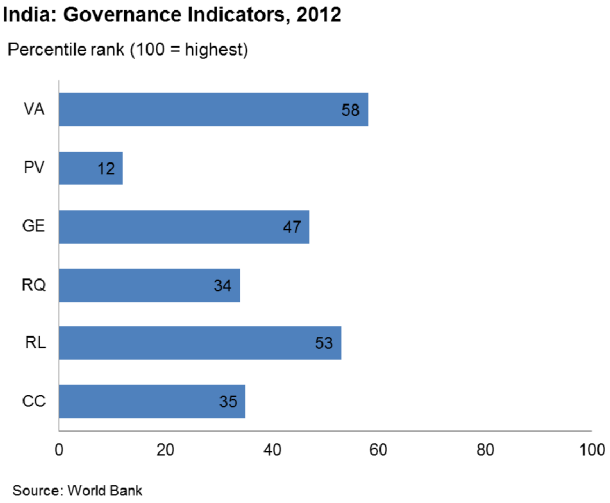
Since institutional quality factors heavily into decisions by firms and individuals to invest and partake in innovation, the GEM captures these factors in an index of institutional quality that feeds into our projection for trend TFP growth. The index is based on the World Bankôs Governance Indicators, which rate countries along six dimensions of governance on a scale from -2.5 (weak) to 2.5 (strong):

1. Voice and Accountability (VA) ï capturing perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media.
2. Political Stability and Absence of Violence/Terrorism (PV) ï capturing perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically-motivated violence and terrorism.
3. Government Effectiveness (GE) ï capturing perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.
4. Regulatory Quality (RQ) ï capturing perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.
5. Rule of Law (RL) ï capturing perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.

6. Control of Corruption (CC) ï capturing perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.

India ranks poorly on most dimensions, particularly political stability, regulatory quality, and control of corruption, and has made little progress to date in addressing these institutional shortcomings. Our baseline assumes no change in these institutional factors going forward, which limits trend productivity growth and, ultimately, output potential.

Figure 3.8: Governance indicators, 2012



3.2 Forecast overview[35]

Table 3.1: India baseline forecast key indicators

Key indicators Period average	GDP growth (%)	Inflation (%)	Exchange rate (rupee/US$)	Current account (% of GDP)	Gov't balance (% of GDP)
2015-2020	6.7	6.4	66	-1.8	-3.4
2020-2035	5.2	4.1	85	-2.8	-2.8
2015-2035	5.6	4.7	81	-2.5	-3.0

The assumptions enumerated in the previous section yield a forecast that falls far short of the governmentôs 8% growth target. Growth is expected to average 5.6% annually over the next two decades, with slightly higher near term growth

[35] Please note that the figures presented here represent our baseline projection for India as of autumn 2014.

falling towards a slower long-run trend. Though inflation is expected to decline steadily from recent high levels to a long-run average of 4%, a steady depreciation of the rupeeð driven in part by persistent trade deficits from rising fossil fuel importsð will keep inflation higher than it otherwise would be. We further expect improvement in the governmentôs fiscal position, with the deficit expected to decline to a level that will stabilise gross government debt at 38% of GDP.

3.2.1 Potential output

Based on the projected growth of the size and education level of the labour supply, capital stock, and the estimated path of productivity, we estimate potential output growth in India to be 5.5% per annum over the next two decades.

Potential output growth in our forecast is constrained in large part by chronic underinvestment, which will limit growth of the capital stock to average 6.6% pa to 2035, far below the 8.3% annual rate seen since 2000. This points to marginal improvement in the infrastructure deficiencies that constrain growth today. As noted above, for example, our projections for future coal production and generation capacity suggest that the electricity supply will continue to fall short of the needs of Indiaôs growing population.

The labour force is projected to grow 1.4% annually to 2035, marginally slower than the previous 15 year period but far below potential given our expectations for only minimal gains in labour force participation. Moreover, our profile for the education level of the Indian labour force yields labour productivity growth of 4% annually comparted to 5.2% annually from 2000 to 2015.

Finally, we project total factor productivity to contribute less to potential output growth than in the past, with TFP growth slowing to an average of 2.3% from 3.0% in the previous 15 years. This is in part due to the limited expected improvement in institutional quality, which acts as a drag on investment in research and development, and discourages the foreign investment that would provide opportunities for the absorption of innovative technologies and management structures developed abroad.

Table 3.2: India potential output drivers

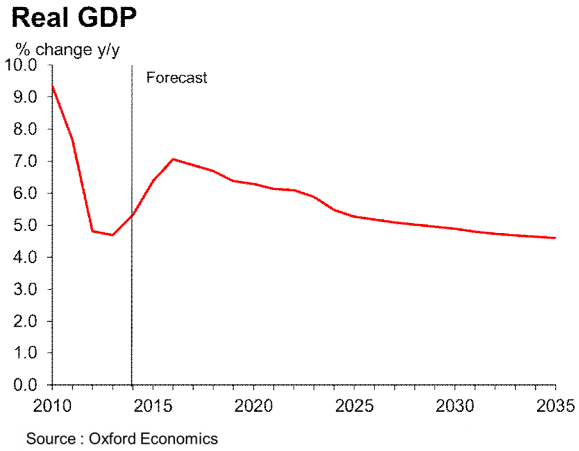
Potential GDP and its Components Average Percentage Growth		
	2000-2015	2015-2035
Potential GDP*	7.1	5.5
Employment at NAIRU	1.8	1.4
Capital stock	8.3	6.6
Total Factor Productivity	3.0	2.3

*Ln(Potential GDP) = 0.65*Ln(Employment at NAIRU) + 0.35*Ln(Capital Stock) + Ln(Total Factor Productivity)

3.2.2 Real GDP

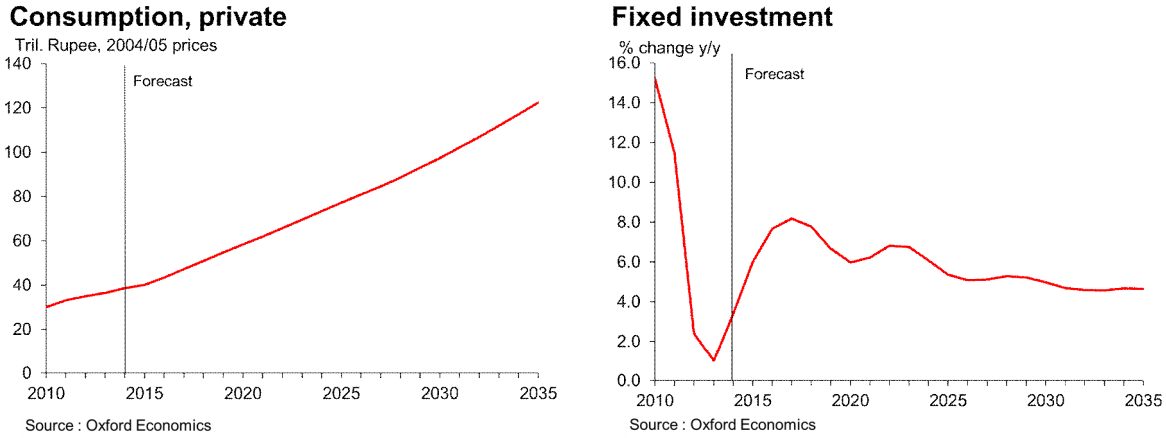
Our baseline forecast projects average annual growth in India of 6.7% from 2015 to 2020, and 5.2% from 2020 through 2035.

Figure 3.9: GDP forecast



In the near term, growth is constrained by above- target inflation and relatively tight monetary conditions despite recent easing. However, we expect inflation to gradually decline, and easing price pressures should allow for the RBI to ease policy. As monetary policy is loosened, consumption and investment should accelerate, and GDP growth will temporarily rise above our estimate of potential.

Figure 3.10: Aggregate spending forecast



We anticipate that growth in external demand will accelerate modestly in the near term, leading to a small increase in export growth. Fossil fuel imports, however, will drive a more substantial increase in imports, and as a result net trade will subtract about 1 percentage point from GDP growth on average through 2020. Meanwhile, we anticipate fiscal policy to remain tight as the government maintains its focus on reducing the budget deficit.

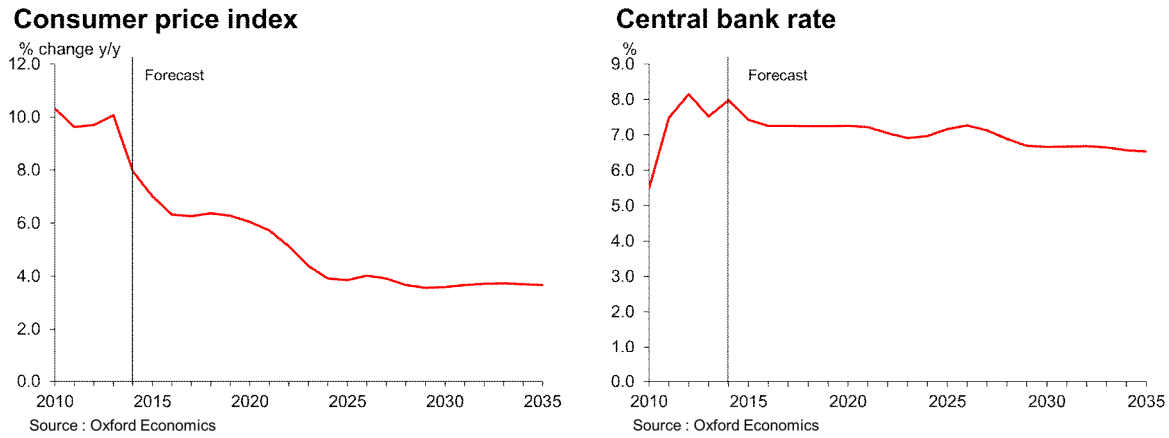
Short-term above-potential growth, however, is necessarily temporary, as supply-side constrains are ultimately binding. Faster growth in the medium-term will maintain upward pressure on inflation and force the RBI to maintain a tighter

monetary stance than it otherwise would. This will drive a gradual decline in consumption and investment growth, easing the economy towards its long-run potential growth rate, which is determined by the factors outlined in the previous section.

3.2.3 Inflation and monetary policy

We project inflation to slowly decline in the coming years, allowing an easing of policy rates, particularly after 2020.

Figure 3.11: Inflation and policy rate forecast

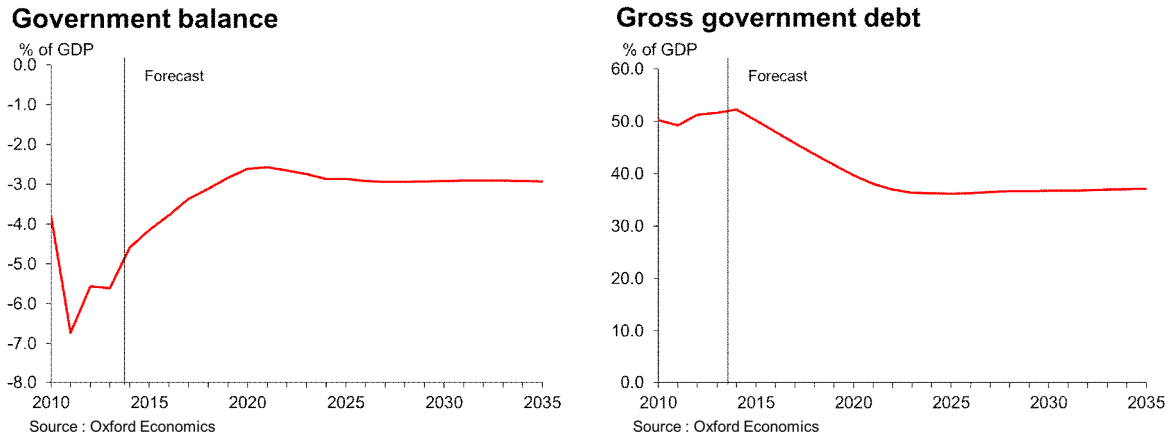


Longer-term we project inflation to average 4.0%, in line with the RBI target. While this represents a substantial improvement from current inflation trends, it should be noted that several factors will keep upward pressure on inflation in the long-run, suggesting that monetary policy in the long-run will have to be tighter than it might be otherwise. These include the price impacts of ongoing infrastructure issues resulting from a lack of adequate investment; a steady depreciation of the rupee resulting in part from rising fossil fuel imports; higher energy costs; and the impact of the continuing inadequacy of electric power production on food prices and production costs more broadly.

3.2.4 Fiscal policy

We expect the government to maintain its focus on cutting the budget deficit, and project the government balance to decline as a share of GDP to 2.6% by 2020. As a result, fiscal policy will remain tight, and government consumption will contribute only marginally to growth. In the long-run we estimate the structural deficit to be 2.8% of GDP, a level at which, given estimated GDP growth, gross government debt will stabilize at roughly 37% of GDP. However, because we expect little change over time to the structure and cost of subsidies (with the exception of diesel subsidies), deficit reduction will continue to come at the expense of capital investment, undermining long-run growth.

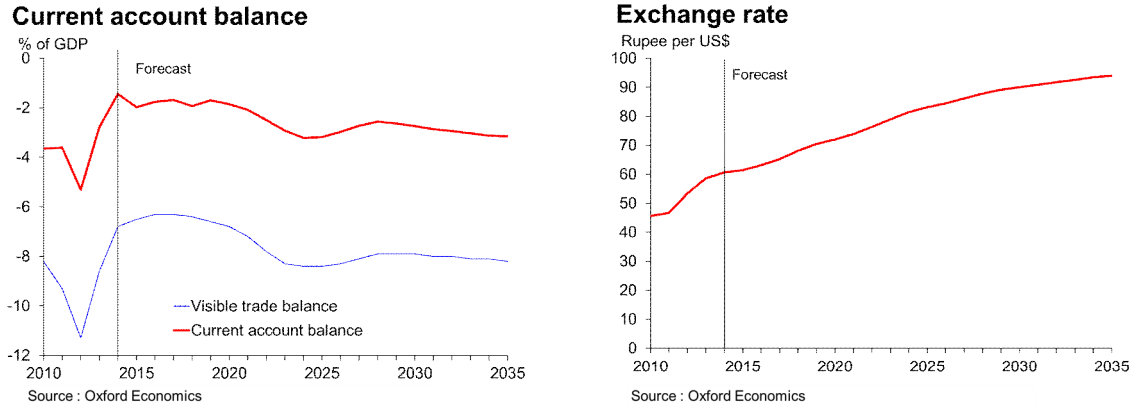
Figure 3.12: Government position



3.2.5 External sector

A steady rise in fossil fuel imports will contribute to persistent trade deficits throughout the forecast horizon, acting as a drag on growth. The visible trade deficit is projected to average nearly 8% of GDP over the forecast horizon, though this is offset in part by the surplus on trade in services, which is projected to decline from 4% of GDP in 2013 to an average of 2.6% from 2020 to 2035. As noted above, though we forecast a decline in inflation over time, trade deficits will contribute to a steady depreciation of the rupee[36], maintaining upward pressure on inflation and policy rates and acting as a drag on investment in the long-run.

Figure 3.13: External position



[36] Indiaôs need to pay for the goods it imports in foreign currency means it has to buy foreign exchange with rupees, whilst foreign countries importing Indian goods must buy rupees. Running a net trade deficit means that the supply of rupees to the market is ever-increasing relative to demand, which results in the currency depreciating over time.

4 Quantifying the impact of growth constraints

The previous sections of this report identified several key constraints on growth, and identified how each of these impacted our baseline forecast for India. In order to quantify the impact of each of these constraints, we construct scenarios in which each is lifted and measure the impact of releasing each constraint on short and long-run growth, inflation, government finances, and India's current account position. A final scenario measures the combined effects of releasing all of the outlined constraints, providing an estimate of the potential impact of the successful implementation of an aggressive reform agenda.

4.1 Power sector

4.1.1 Assumptions

Electric Generation Capacity and Production

Relaxing constraints imposed by the power sector begins with several key changes to the baseline power sector assumptions. Chief among them is a substantial increase in the growth of capacity and electricity production. In the relaxed constraint scenario, electricity production grows 6.6% annually compared to 4.5% in the baseline. This rate of growth falls below that achieved by China in the twenty years to 2011, but in line with that of other East Asian emerging countries in that span (Indonesia, Korea, Malaysia).[37] By 2035, electric generation reaches 6,617 TWh, more than four times its current level.

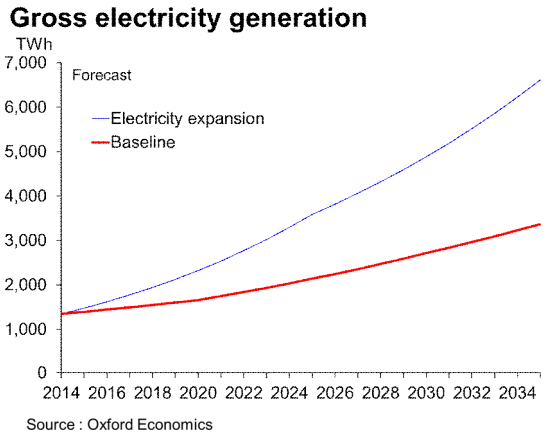
Table 4.1: Electricity production growth by country

	Total (TWh)		CAGR (%)	
	1991	2011	1991-2001	1991-97
China	678	4,716	10.2	9.0
Indonesia	37	182	8.3	12.5
Korea	113	520	8.0	11.3
Malaysia	27	130	8.4	14.1
Thailand	50	156	5.9	11.3
Brazil	234	532	4.2	
Mexico	129	296	4.3	
Scenario, 2014-35	**1,344**	**6,617**	**7.9%**	

Source: World Bank

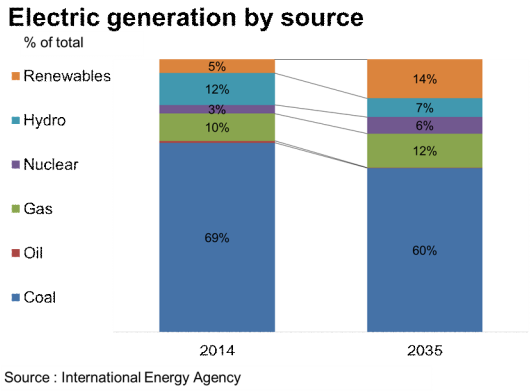
[37] Note that from 1991 through 1997, electricity production in Indonesia, Korea, Malaysia, and Thailand grew an average of 12.3% per year.

Figure 4.1: Electricity generation



As in the baseline we base our assumptions about the fuel composition of electricity production on the IEA New Policies Scenario, with coal based generation falling as a share of total production from 69% today to 60% in 2035, replaced by an increase in non-hydro renewables and nuclear generation.[38]

Figure 4.2: Electricity generation by source



The more rapid rise in electricity production coupled with the assumptions about the production mix implies that generation capacity will need to rise 9.4% annually over the forecast horizon, reaching 1,708 GW by 2035.[39]

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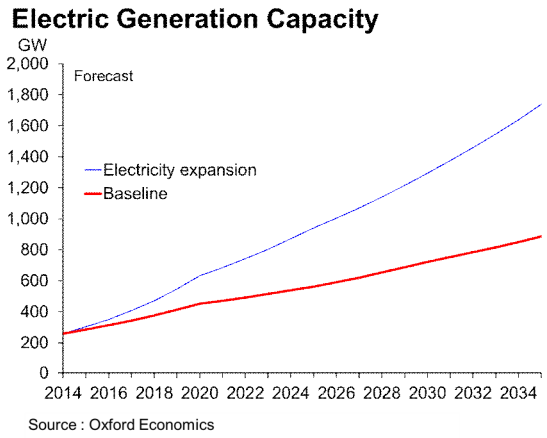
[38] The IEAôs assumptions regarding the fuel mix are based on a substantially lower level of total generation than envisioned in the scenario, so weôve adjusted the IEA assumptions slightly to account for the natural limits of hydroelectric capacity in India, which the Central Electricity Authority estimates to be 150 GW (see http://www.indiaenergy.gov.in/docs/Hydro%20Power_Documentation.pdf). As a result, coal-based generation accounts for a slightly higher share of total generation in the scenario than in the IEA scenario, and hydroelectric generation a slightly smaller share.

[39] Part of this capacity is back-up capacity to support renewables. Renewable sources of energy such as wind and solar power, which canôt be guaranteed to

Figure 4.3: Electricity generation capacity



Transmission and distribution losses

AT&C losses as a share of gross production decline faster than in the baseline, falling to 7.7% by 2035 (vs 9.2% in the baseline), slightly above the 6% loss rates seen in other large countries like the U.S., China, and Australia.

Table 4.2: Transmission losses by country

Rank (n/165)	Country	T&D losses, 2011 (IEA est)
165	Haiti	54.6
164	Congo, Rep.	46.0
163	Iraq	34.8
é		
151	Kyrgyz Republic	21.8
150	Myanmar	21.2
149	**India**	**21.1**[40]
é		
34	European Union	6.2
30	United States	6.0
26	China	5.7
18	Australia	5.3

Source: World Bank

produce electricity at all times, must be accompanied by back-up generation capacity.

[40] Official estimates from the Indian Central Electricity Authority put 2011-12 aggregate technical and commercial losses at 27.0%.

Though this is an improvement from the baseline, this target is still less ambitious than the Restructured Accelerated Power Development Reforms Program; the R-APDRP targets transmission losses of 15% on average across India by 2019; the scenario achieves this goal in 2027.

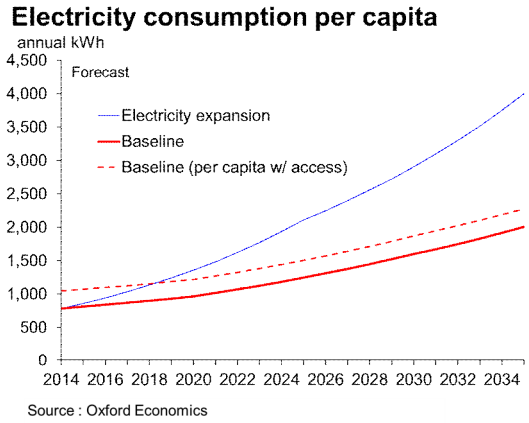
Electricity access

The scenario envisions growth of the electrified population at nearly twice the rate in the baseline (3.7% pa vs 2.0% pa) over the first ten years of the forecast, so that India achieves universal electricity access by 2025.

Electricity consumption

Based on the assumptions outlined above, per capita electricity consumption grows 8.1% annually, reaching 4,000 kWh annually by 2035.

Figure 4.4: Electricity generation per capita



This is consistent with consumption levels in South Africa today, and would be below levels projected for China in 2035.

Table 4.3: Electricity consumption per capita by country

	Consumption (kWh)	
	2011	2035 fcst[41]
U.S.	13,246	13,312
Russia	6,486	10,520
E.U.	6,115	6,583
S. Africa	4,604	n.a.
China	3,298	6,493
Brazil	2,438	4,019
Mexico	2,092	n.a.
Scenario	**684**	**4,000**

Source: World Bank, IEA, Oxford Economics calculations

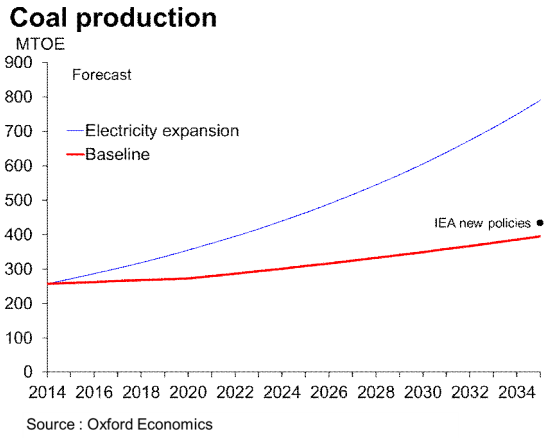
[41] Calculated using IEA New Policies Scenario projections for electricity generation, current T&D loss rates, and projected population growth

Coal production

Despite a marked decline in the share of electricity derived from coal-fired plants, the growth in production envisioned in the scenario significantly increases the power sectorôs demand for coal. By 2035, power sector coal demand rises to 951 mtoe, more than double the level projected in the baseline. Demand growth of this magnitude cannot feasibly be met entirely through incremental imports; at baseline coal production levels, imports, already a driver of Indiaôs trade deficit, would rise eight-fold by 2035 and would reach levels more than triple our baseline forecast.

We therefore assume that the rapid growth of the power sector is supported by reforms of and investment in the coal sector that substantially boost production growth. The IEA New Policies Scenario projects Chinese coal production of 1,976 mtoe by 2035. Indiaôs coal reserves are estimated by the IEA to be roughly 40% of Chinaôs, so in the scenario we assume 2035 production in India of 790 mtoe in rough proportion to the ratio of reserves between the two countries. This assumption implies production growth to 5.5% annually, compared to 2.1% in the baseline, with total coal production tripling from current levels.

Figure 4.5: Coal production



Investment requirements

To estimate the investment required to expand electric production, we first calculate the cost of expanding generation capacity using data from the U.S. Energy Information Agency on the per kW cost of constructing power plants in the United States. Costs estimates are provided by plant type, though weôve based our estimates on averages across plant types for a given fuel source.[42]

[42] For example, estimates are provided for seven different types of coal-fired plant (single unit advanced PC, dual unit advanced PC, single unit IGCC, etc.). Our estimates are based on an average of per kW costs across all coal plant types.

Construction costs in India are estimated to be 30-40% of those in the U.S.,[43] so for India we assume per kW costs are one-third of those estimated by the U.S. EIA. Based on these cost estimates, the scenario implies incremental investment of 1.4% of baseline GDP annually to expand generation capacity to 1,708 GW.

In addition to the investment in generation capacity, substantial investment in the transmission grid would be required to both reduce technical losses and expand electricity access. A report from the Federation of Indian Chambers of Commerce and Industry (FICCI) and Booz & Co. estimates that for every dollar invested in generation capacity $0.50 should be invested in transmission. In India, this ratio is 30%.[44] Thus, in the scenario we assume investment in transmission matches investment in generation dollar for dollar for the first five years to account for years of neglected maintenance and technology upgrades to the transmission grid. After 2019 transmission investments are assumed to total half the annual investment in generation in line with this estimated best practice. Investment in the transmission grid is estimated to average 1.0% of baseline GDP from 2015 to 2035.

Investment requirements to expand coal production appear to be relatively small. The IEA estimates that non-OECD countries will invest $645 billion from 2013-35 in this area, with non-OECD coal production rising 0.9% annually over that span. This implies investment costs of $60 million per incremental mtoe of coal production on average, which, based on our profile for coal production, implies total investment costs of just 0.6% baseline GDP over the full forecast horizon. In addition to direct investment in the coal sector, we assume an additional 0.5% annual investment in related infrastructure, including rail, roads, storage, and ports.

In total, we estimate an incremental investment requirement of 2.9% of baseline GDP annually. This investment is assumed to be funded by a mix of public and private sources. Specifically, we assume that half of the required investment in generation capacity and transmission and distribution, as well as investment in the coal supply chain, is funded through private domestic investment; foreign investment is assumed to fund the remaining investment in generation capacity, while the remaining investment in transmission and distribution, as well as assumed additional infrastructure investment, is funded through budget-neutral government investment.[45] We assume that the subsidies on kerosene and LPG

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[43] See *A brighter outlook: International construction cost survey 2013*. Turner & Townsend, plc. November 2013.

[44] *Power Transmission: The Real Bottleneck*. September 2013.

[45] The assumption of budget neutrality is in-line with our base assumption that the government will maintain its commitment to reigning in fiscal deficits. As such, incremental government investment in the scenario is assumed to crowd out other public spending.

are eliminated[46] which reduces the extent to which current spending must be lowered to finance increased public investment, but that electricity subsidies to the poor remain in place.

Energy prices

The elimination of subsidies would, however, cause energy prices to rise. Moreover, though we assume that electricity price subsidies for the poor remain in place, we assume that in order to attract private investment into the power sector, the distribution companies raise prices to stem their current financial losses. We assume that price rises are inversely proportional to the AT&C loss rate. As such, while electricity price increases are high in the short-term (24% in 2015), the impact declines as investment in the distribution sector improves distribution efficiency and reduces losses. By 2035, electricity prices are just 2% above baseline.

Energy prices overall are roughly 8% above baseline in 2015 due to the removal of subsidies, but are just 5% above baseline by 2025 and 2% above baseline by the end of the forecast horizon.

Trend productivity

According to an estimate from Allcott, et al (2014),[47] power shortages lower Indian manufacturersôoutput by 5% on average. We assume, therefore, that improving the reliability of the power supply would boost manufacturing productivity by 5% by 2025.

4.1.2 Economic impact

Real GDP growth in the scenario averages 6.0% from 2015 to 2035 - 0.4 percentage points above baseline - and by 2035 GDP is 8.1% above baseline.

In the short-run, increased investment stimulates demand through multiplier effects on consumption. As investment spending filters through the economy, employment and income rise, stimulating increased consumer spending. Rising demand and the improving reliability of the power supply prompt further investment gains as firms invest to expand production. Growth from 2015-19 rises to 7.5% annually, 0.8 percentage points above our baseline forecast.

In the long-run, the investment in the power sector raises growth potential by increasing the growth and efficiency of the capital stock, and raising productivity. Growth from 2020-35 averages 5.5% annually in the scenario, 0.3 points above baseline.

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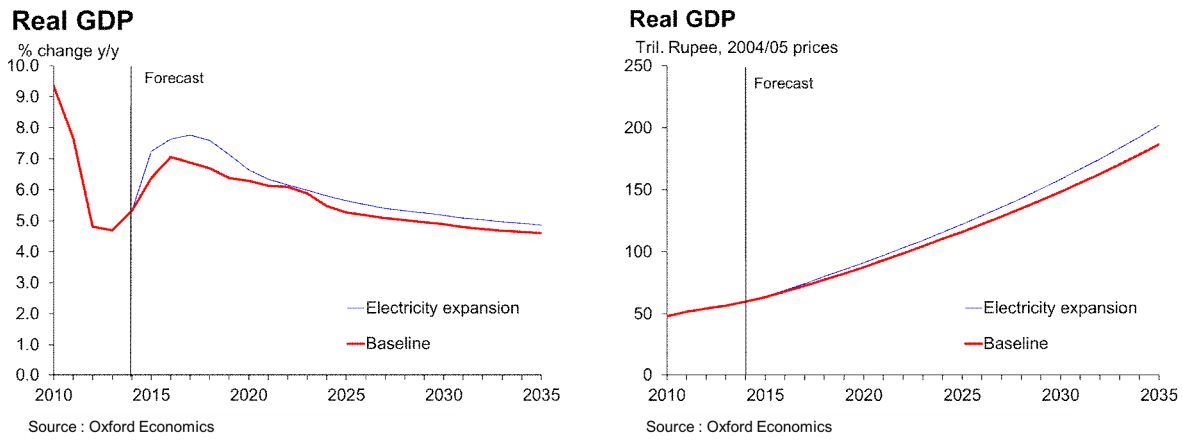
[46] The removal of subsidies will cause fuel prices to rise, and this assumption is also built into the scenario.

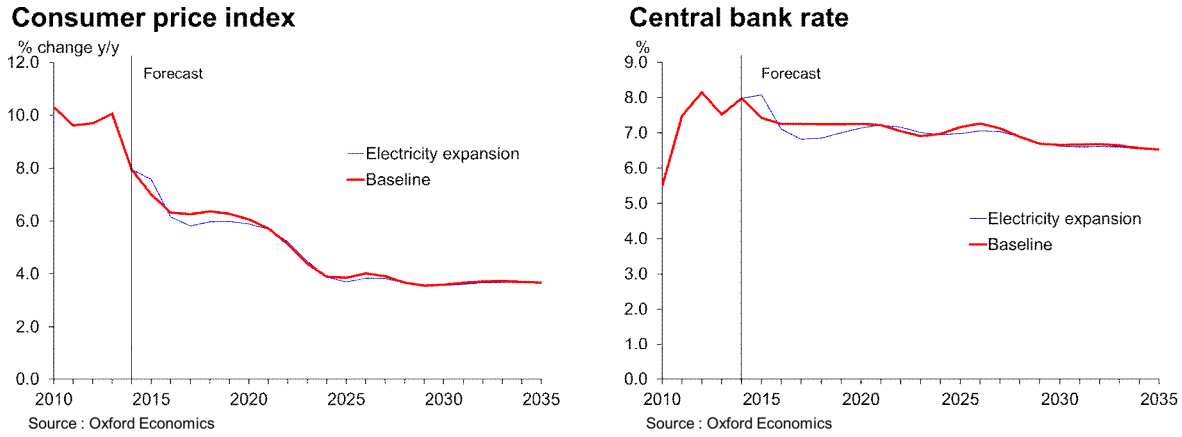
[47] Hunt Allcott, Allan Collard-Wexler, and Stephen D. O'Connell. *How Do Electricity Shortages Affect Productivity? Evidence From India.* NBER Working Paper 19977. March 2014.

Figure 4.6: Impact on GDP



While energy price increases initially cause a small increase in inflation, those pressures subside as growth in potential output rises, easing supply constraints. As a result, inflation is slightly below baseline for most of the forecast horizon, though overall the impact is small. Consumer price inflation averages 4.6% annually in the scenario, compared to 4.7% in the baseline.

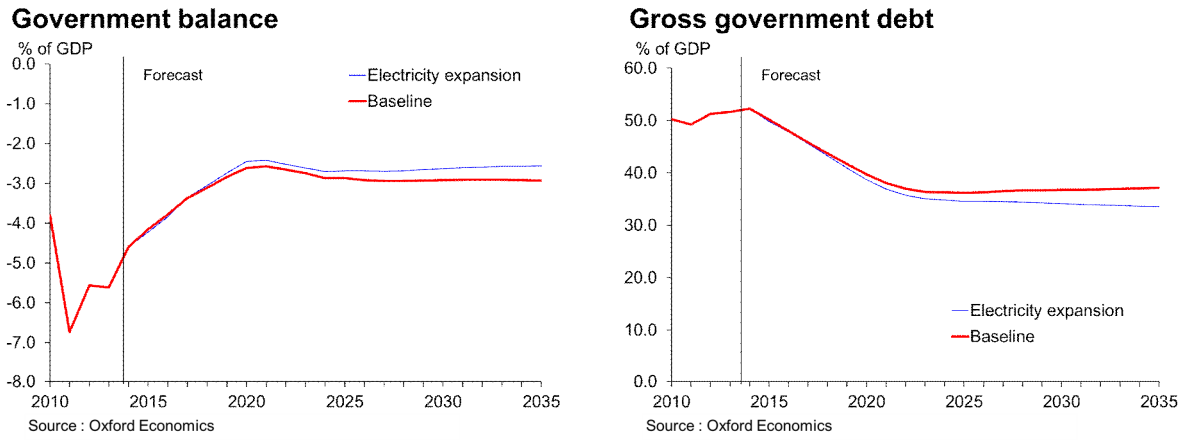
Figure 4.7: Impact on inflation and policy rates



With inflation below baseline monetary policy rates are also marginally below baseline in the scenario; the central bank rate averages 6.8% over the forecast compared to 7.0% in the baseline.

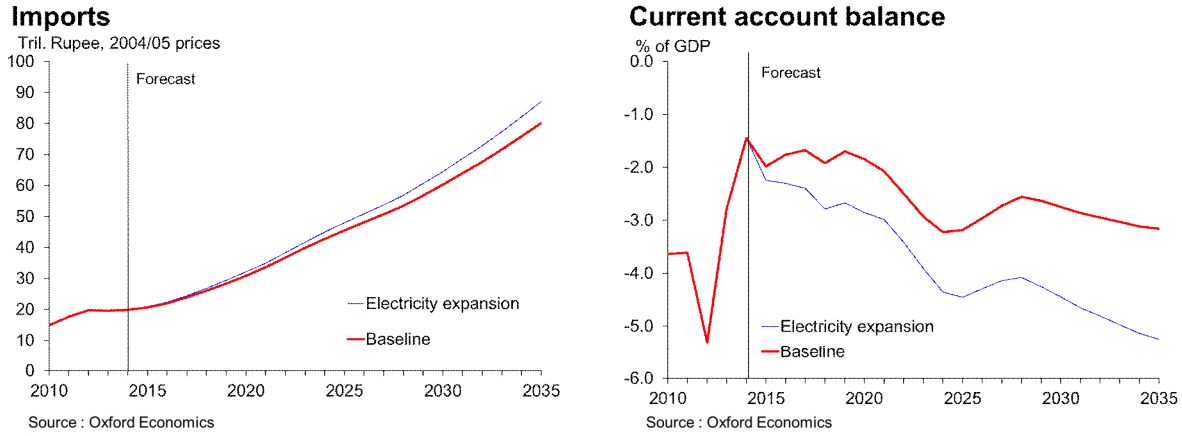
Government finances in the short-term are little impacted as, by assumption, the increase in government investment is budget-neutral. However in the medium and long-term government finances do benefit from the increase in growth, which grows employment and therefore raises greater tax revenues. By 2035, the budget deficit is 2.8% of GDP or 0.2 percentage points below baseline, and gross government debt is 34% of GDP compared to 37% in the baseline.

Figure 4.8: Impact on government position



The increase in investment spending fuels an increase in import growth both directly, via rising capital goods imports, and indirectly through its effect on consumption. In addition, the expansion in electricity generation is largely coal-based, and though the scenario assumes a rise in domestic coal production it is not sufficient to cover the increase in demand. As a result, coal imports rise. This widens Indiaôs current account deficit, although this is mitigated somewhat by a strengthening of the rupee relative to baseline, which improves Indiaôs terms of trade. By 2035 the current account deficit is 5.2% of GDP, compared to 3.1% in the baseline.

Figure 4.9: Impact on external position



4.2 Increased infrastructure investment

4.2.1 Assumptions

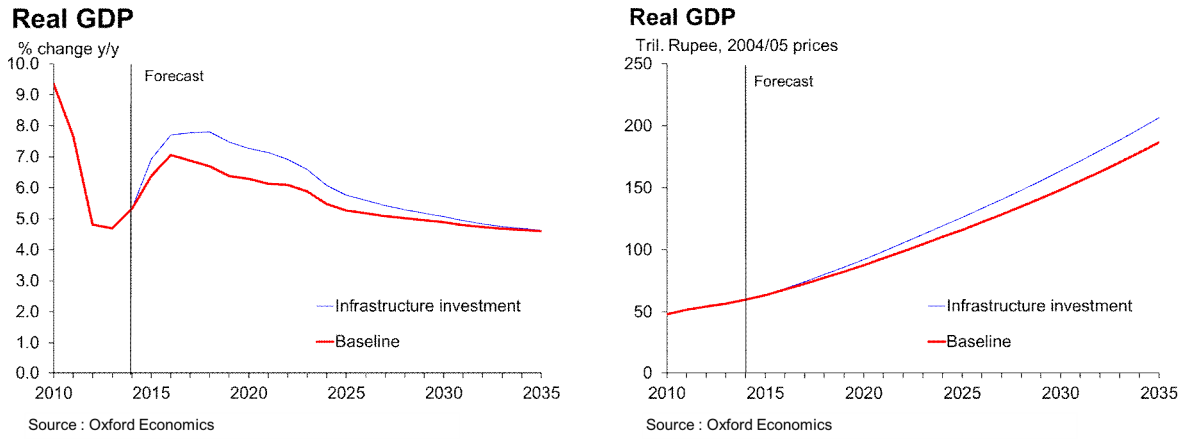
The baseline forecast assumes infrastructure investment averaging 4.6% of GDP annually, well below the level targeted in the Twelfth Plan. Chronic underinvestment in infrastructure contributes to high inflation and limits firmsô ability to bring their goods to market, discouraging investment.

In this scenario we assume that infrastructure investment[48] rises to the Twelfth Plan target of 10% of GDP. The incremental investment required (an average of 5.4% of baseline GDP annually) is financed entirely from domestic sources and is assumed to be budget neutral, in line with our expectation that the government will maintain its commitment to reigning in fiscal deficits.

4.2.2 Economic impact

The results of the scenario are broadly similar to the power sector reform scenario, though average growth is slightly higher as the investment shock is larger. Real GDP growth in the scenario averages 6.1% from 2015 to 2035 and by 2035 GDP is 11% above baseline.

Figure 4.10: Impact on GDP



In the short-run, increased investment stimulates demand through multiplier effects on consumption. As investment spending filters through the economy, employment and income rise, stimulating increased consumer spending. Rising demand and improving infrastructure prompt further investment gains as firms invest to expand production. Growth from 2015-19 rises to 7.5% annually, 0.9 percentage points above our baseline forecast.

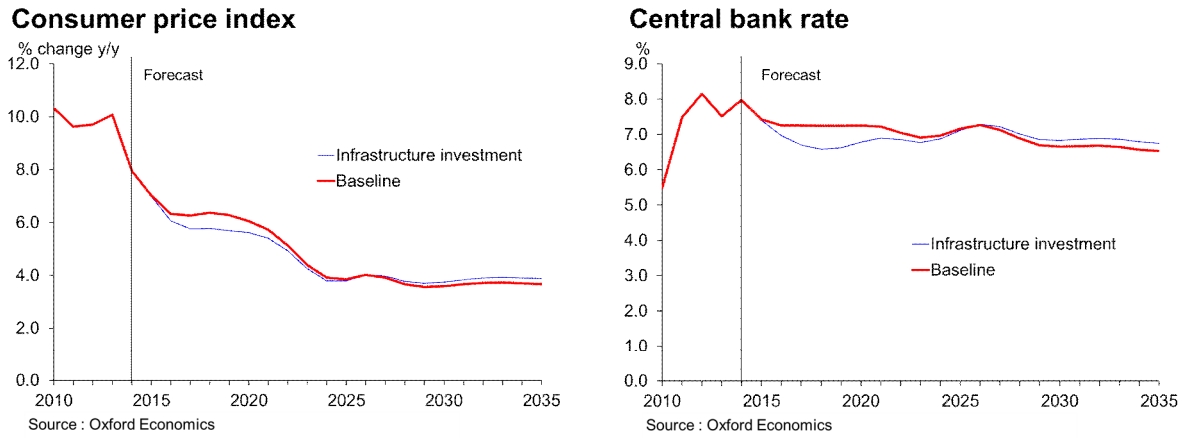
[48] Though no specific assumption is made about the composition of this investment, this would encompass investment in roads, railways, ports, and other critical infrastructure.

In the long-run, infrastructure investment raises growth potential by increasing the growth and efficiency of the capital stock; growth from 2020-35 averages 5.6% annually, 0.4 points above baseline.

Though the rise in investment drives an increase in short run demand, capacity grows more quickly and by 2016 inflation in the scenario is running below baseline. However, because the increase in supply-side potential output is relatively small, by 2025 rising demand has caught up and inflation is then marginally above baseline. Over the full forecast average inflation is unchanged.

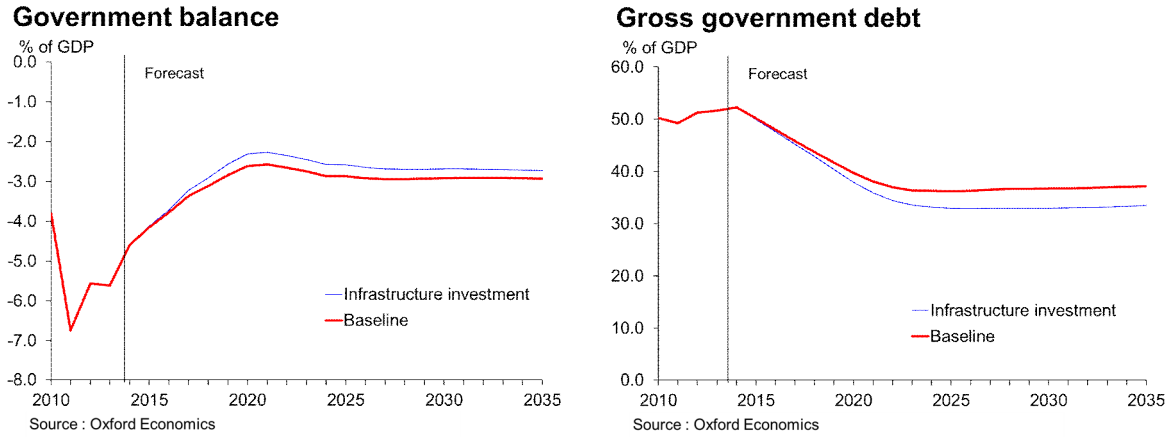
Following this inflation profile, policy rates begin to trend below baseline after 2016, but as demand catches up and inflation returns to its baseline path, the policy rate also returns to its baseline projection.

Figure 4.11: Impact on inflation



As in the power sector reform case, government finances benefit from both faster growth, which boosts revenues, and lower rates, which reduces interest expenditures.

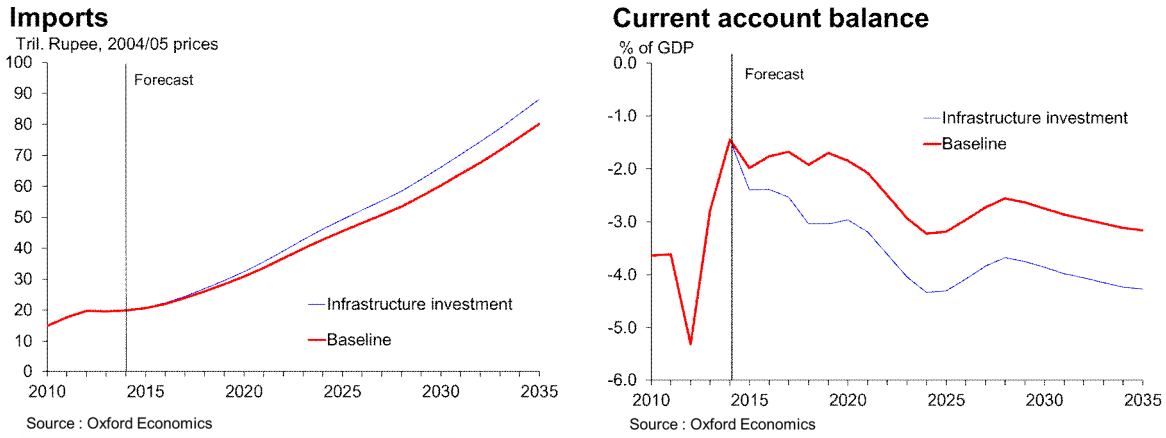
Figure 4.12: Impact on government



The increase in investment spending fuels an increase in import growth both directly, via rising capital goods imports, and indirectly through its effect on

consumption. Exports rise as well, though to a lesser extent, as improving infrastructure boosts productivity and competitiveness; as a result the current account balance widens to a greater extent in the scenario than in the baseline.

Figure 4.13: Impact on external position



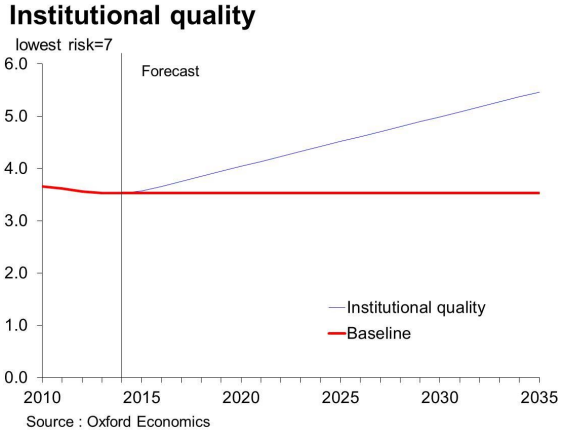
4.3 Improved institutional quality

4.3.1 Assumptions

Indiaôs public institutions tend to score badly in international comparisons, reflecting an economic environment that is not particularly conducive to investment and growth. More specifically, poorly functioning institutions raise the costs and risks of investment and discourage entrepreneurship and innovation, leading to slower productivity growth.

In this scenario, we estimate the impact of an improvement in institutional quality in India to U.S. levels by 2035.

Figure 4.14: Institutional quality assumption



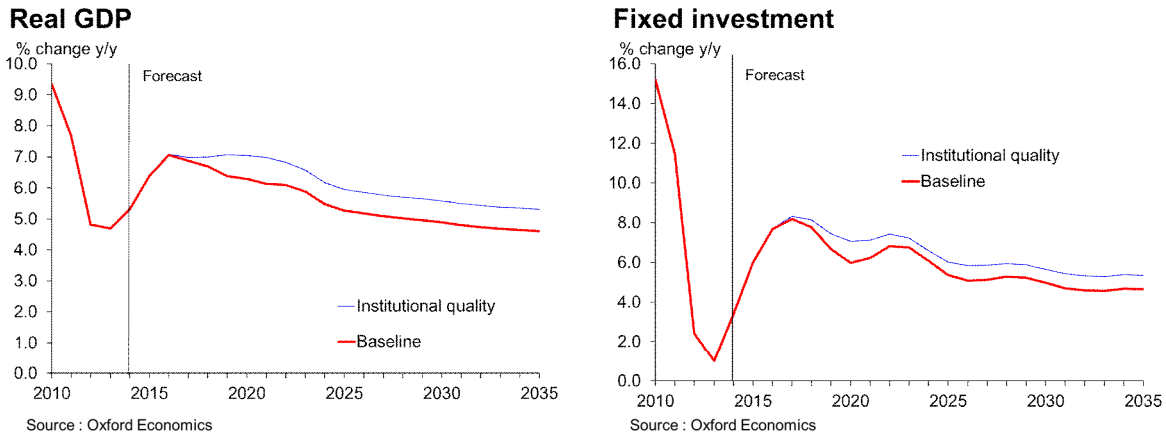
As this may be an optimistic target, the growth impacts reported should be considered an upper bound estimate.

4.3.2 Economic impact

The improvement in institutions induces an increase in investment, which by 2035 is 13% above baseline. This stimulates rising employment and consumer spending. The short-run impact is smaller than in the previous cases, reflecting the necessarily gradual improvement in institutions as reforms are implemented. Average growth from 2015-19 is just 0.2 points above baseline.

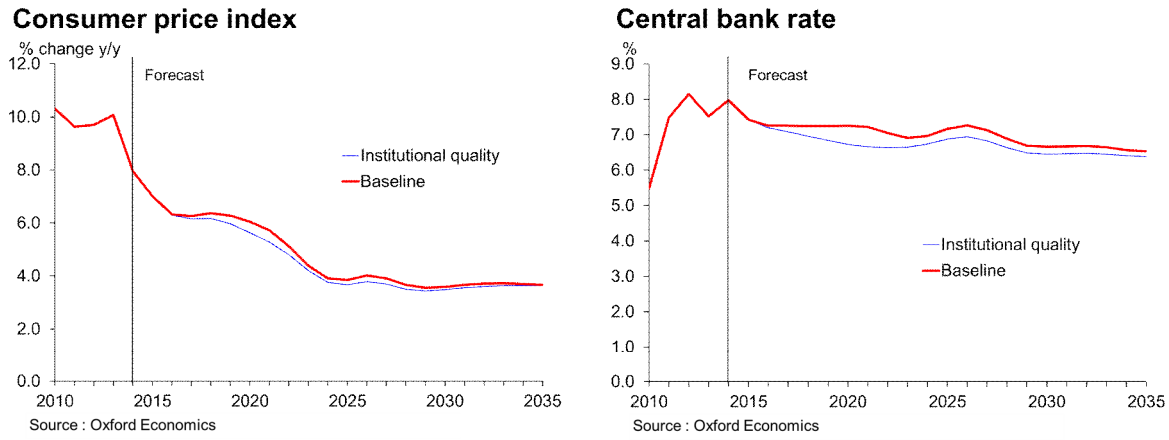
Over time, institutional improvements increase the economyôs productive capacity as firms and individuals, more assured of the protection of their property rights and the efficiency of government more broadly, invest and innovate. This investment raises trend productivity growth while also increasing the growth of the capital stock. In our scenario, institutional improvements raise growth to 5.9% on average from 2020-35.

Figure 4.15: Impact on GDP and investment



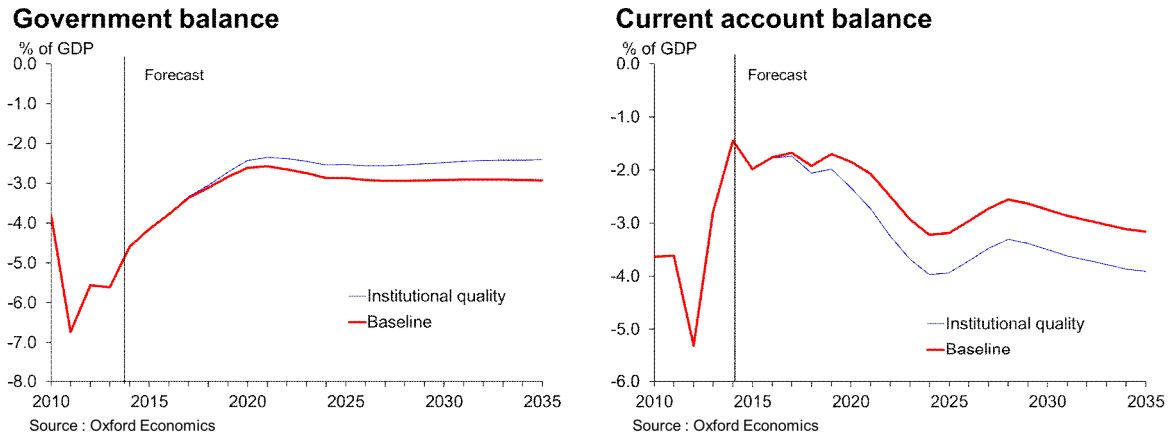
The increased investment helps ease supply side constraints, and as a result inflation runs slightly below baseline throughout the forecast. Policy rates, consequently, are on average 0.3 percentage points below baseline, which contributes to rising consumption and lowers investment financing costs.

Figure 4.16: Impact on inflation and policy rate



Lower interest rates, as in the previous two scenarios, help ease the burden of financing the deficit, leading to an improvement in government finances. Meanwhile, increased investment and consumption stimulate imports, leading to a widening of the current account deficit.

Figure 4.17: Impact on government position



4.4 Increased female labour force participation

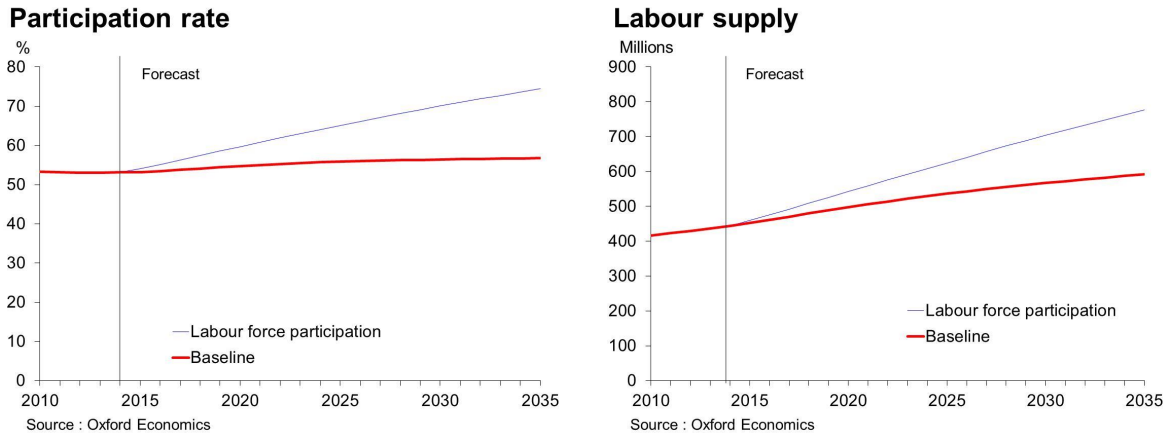
4.4.1 Assumptions

Less than 30% of working age Indian women participate in the labour force, among the lowest rates of participation in the world. Though Indiaôs labour force is expected to grow by more than one third over the next two decades, an increase in labour force participation by women would further boost the effect of Indiaôs favourable demographics.

This scenario assumes that female labour force participation rises to 65% by 2035, a level in line with Brazil today, but below China. This drives overall

participation to 75% compared to 57% in the baseline. As a result, labour supply growth is nearly double that in the baseline and by 2035 the number of people in the labour force exceeds the baseline by 185 million. It should be noted that this would represent a dramatic increase in female participation rates and, as with our assumptions regarding improvements in institutions, should be considered an upper bound estimate.

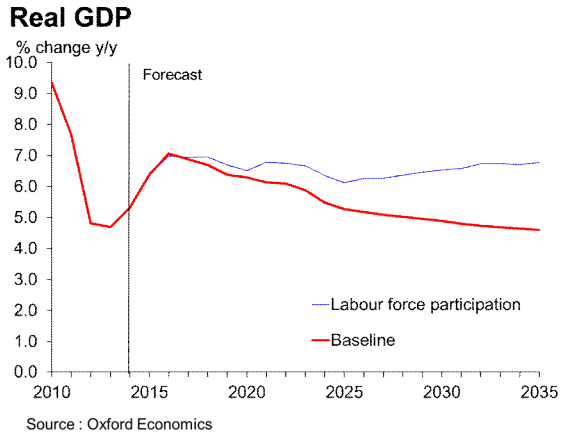
Figure 4.18: Labour market assumptions



4.4.2 Economic impact

Faster growth of the labour force dampens wage pressures, as there are initially more workers competing for jobs. This allows firms to reduce their wage bill and invest in improving efficiency and expanding capacity. This investment in turn stimulates hiring which leads to rising consumption. As in the previous case, the impact of this shift takes time to play out. As a result, in the first five years of the forecast the impact of slower wage growth and rising investment are roughly offsetting, and growth from 2015-19 is only marginally above baseline on average.

Figure 4.19: Impact on GDP

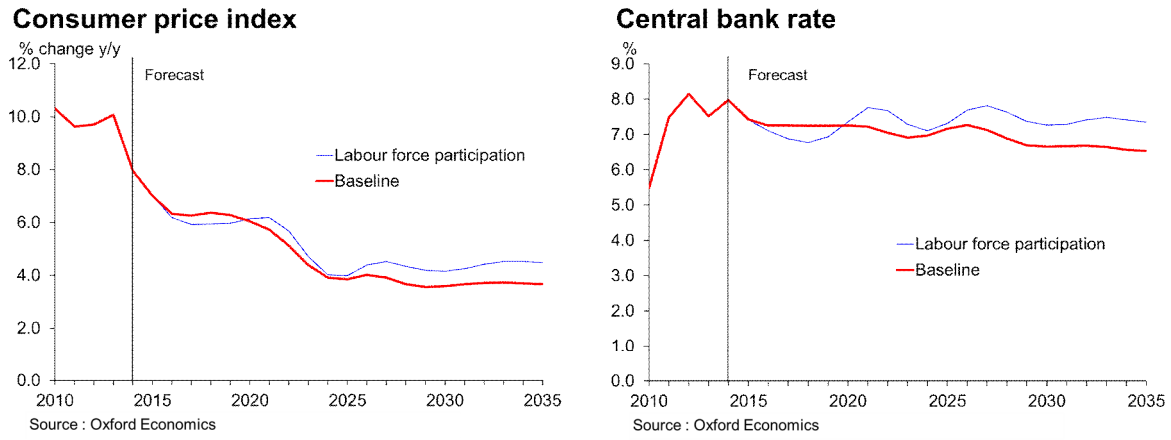


In the longer-term, higher investment and a growing labour force raise potential output, stimulating a virtuous cycle in which investment in capacity feeds growing demand, which prompts additional investment. In our scenario, growth from 2020-35 rises to 6.5% annually, 1.3 percentage points above baseline

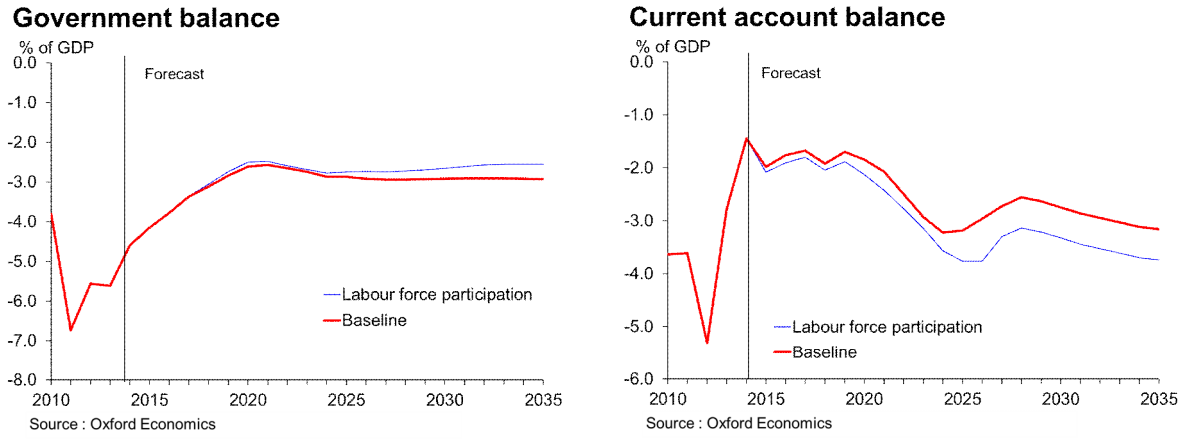
Inflation in the short-run is marginally below baseline as wage growth eases in the near term. This shift is gradually unwound as the economy adjusts to its new equilibrium, and eventually leads to inflation that is slightly above our baseline forecast in the long run; CPI inflation averages 4.7% per annum from 2020-35 compared to 4.2% in the baseline.

Policy rates, which are below baseline in the near-term and then above baseline in the long-run, mirror this inflation profile.

Figure 4.20: Impact on inflation and policy rate



As in the previous cases, rising growth in employment benefits the government accounts through increased revenues. However, growth in consumption, which is higher than the other relaxed constraint cases, drives a substantial increase in imports, which by 2035 are 20% above baseline. This is offset in part by exports, which rise as the growing labour force keep wage growth down and boosts competitiveness. On balance, however, the current account deficit widens.



4.5 Elimination of fuel subsidies

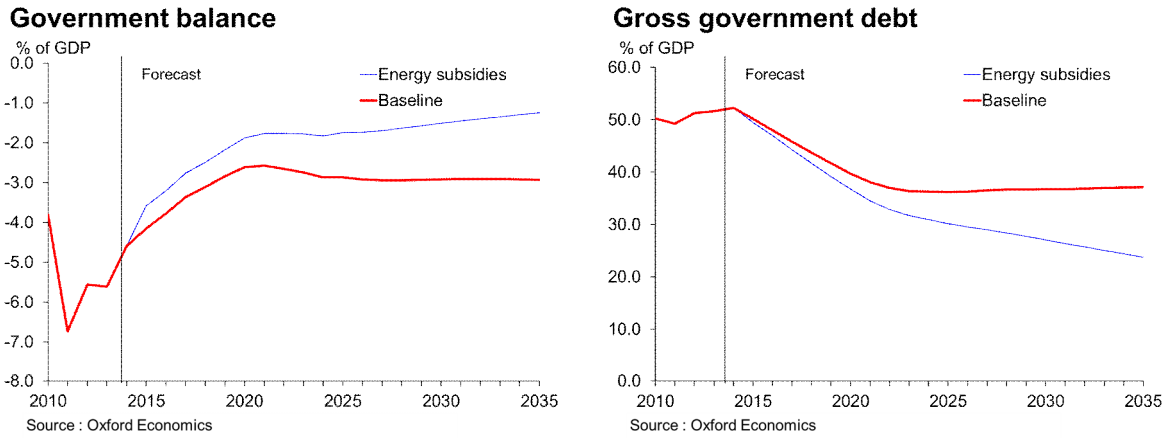
4.5.3 Assumptions

We assume that subsidies for electricity, LPG, and kerosene are eliminated, and the savings directed towards meeting fiscal deficit targets.[49] Together, these average 0.7% of GDP annually in the baseline.

4.5.1 Economic impact

The primary impact is an improvement in the government's fiscal position, which improves dramatically through the direct effect of lower subsidy spending along with an improvement in interest rates which lowers interest expenditures. By 2035, the deficit is just 1.2% of GDP, and government debt is 23.7% of GDP and falling.

Figure 4.21: Impact on government position

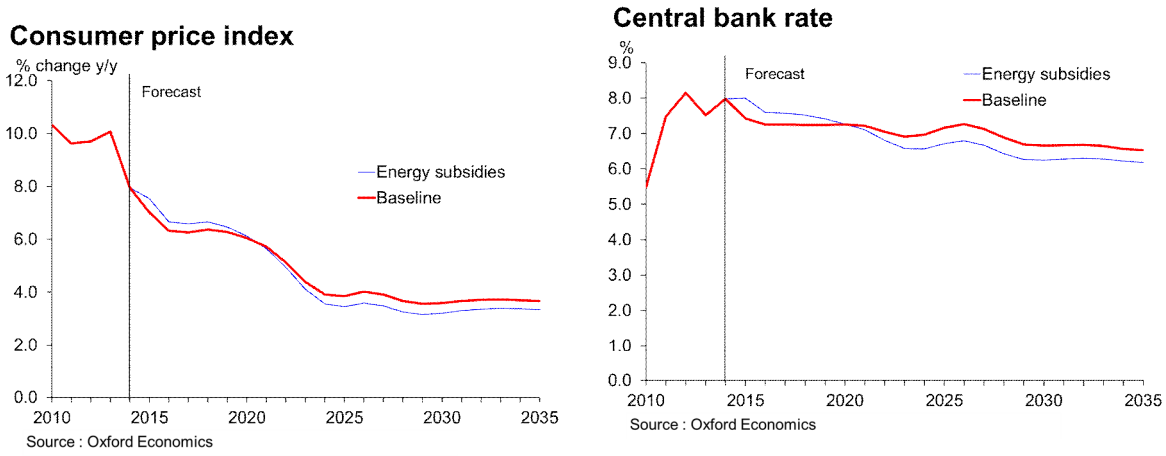


The elimination of subsidies initially puts upward pressure on inflation due to the rise in fuel prices, prompting the central bank to raise rates. This leads to slightly slower growth in the short term.

These effects dissipate by 2020, and for the remainder of the forecast inflation trends marginally below baseline, facilitating a decline in interest rates, which run an average of 0.2 points below baseline from 2020-35.

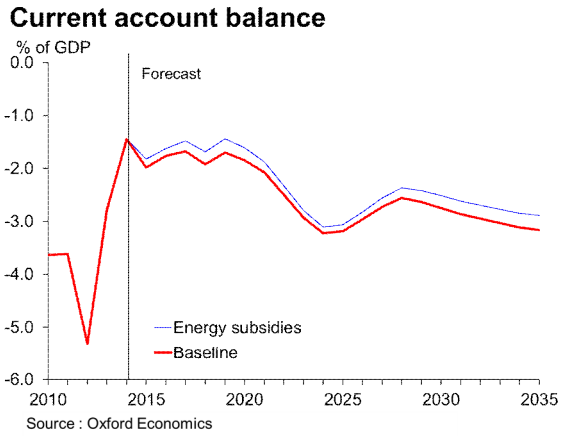
[49] Though electricity subsidies are financed at the state-level, the savings in the scenario are assumed to accrue to the central government through a decline in transfers to states, and the elimination of future financial bailouts of the state electricity distribution companies.

Figure 4.22: Impact on inflation and policy rate



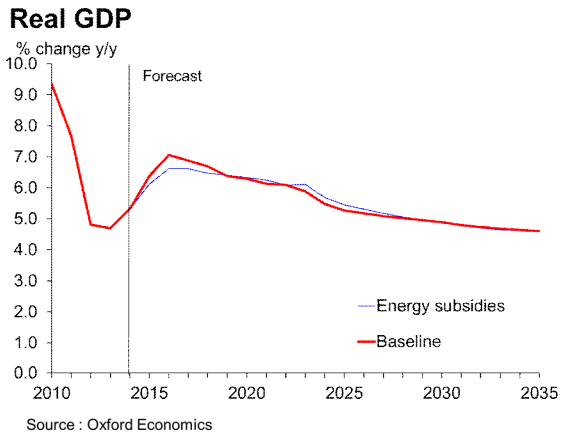
Lower rates drive a slightly larger depreciation of the rupee, which helps competitiveness and leads to a small improvement in Indiaôs external balance. By 2035 the current account deficit is 2.9% of GDP compared to 3.2% in the baseline.

Figure 4.23: Impact on current account



Though the elimination of subsidies has little direct impact on growth over the forecast, the improvement in the long run fiscal outlook could be used, along with other reforms, to attract both foreign and domestic private investment.

Figure 4.24: Impact on GDP



4.6 All constraints relaxed

The analysis suggests that even with optimistic assumptions there is no single reform that will propel the Indian economy to sustained annual growth of 8%. Still, the results suggest that India could reap substantial benefits from pursuing an aggressive reform agenda targeting its key supply-side constraints. We estimate that if India were able to successfully achieve all of the targets used in the constraints analysis, growth in the long-run could reach an average of 7.6% annually. Though this falls short of the 8% growth goal, GDP two decades from now would nevertheless be nearly 47% above our baseline projection.

Table 4.4: Constraints analysis, summary of key results

Key Indicators Period average unless otherwise noted	RDGP growth (%)			CPI inflation (%)	Government balance (% of GDP)	Government Debt in 2035 (% of GDP)	Current account balance (% of GDP)	Carbon emissions in 2035 (mtCO2))
	2015-19	2020-35	2015-35					
Baseline	6.7	5.2	5.6	4.7	-3.0	37.2	-2.5	4,066
Electricity expansion	7.1	5.6	6.0	4.5	-2.8	33.7	-3.3	5,634
Infrastructure investment	7.5	5.6	6.1	4.6	-2.8	33.5	-3.6	4,363
Institutional quality	6.9	5.9	6.2	4.5	-2.7	31.4	-3.1	4,373
Labour force participation	6.8	6.5	6.6	5.0	-2.8	29.5	-3.0	4,584
Energy subsidies	6.4	5.3	5.6	4.5	-1.9	23.7	-2.3	4,067
All constraints relaxed	7.4	7.6	7.5	4.6	-1.8	21.1	-3.0	6,857

5 Low carbon development paths

The constraints analysis suggests that a well-targeted, aggressive, and successfully implemented reform agenda has the potential to raise Indiaôs growth potential. Such growth, if achieved, is not without cost. In each case, though India is able to achieve higher growth to meet its development goals, CO_2 emissions are also significantly above the baseline projection--at odds with Indiaôs desire to reduce its emissions intensity. Based on IEA projections India could at baseline emissions levels account for 35% of the increase in global emissions over the next two decades;[50] the faster growth envisioned in the relaxed constraint cases would only exacerbate this problem.

In this section we consider two alternative energy futures for India that could allow India to meet its development goals while at the same time lowering its emissions intensity. The scenarios focus largely on the power sector as this represents both a key growth constraint as well as the largest source of Indiaôs CO2 emissions, both today and in the future.

The first scenario envisions growth in the supply and reliability of the electricity supply in line with that assumed in the power sector relaxed constraint scenario discussed in the Section 4.1. Using this as a starting point ensures that the scenario is fully consistent with Indiaôs growth objectives. However, whereas generation in the relaxed constraint case continues to be fuelled primarily by coal, in our first alternative scenario we assume a shift into renewables-based generation.

The second scenario builds on the first, adding incremental investment in demand-side energy efficiency that lowers the power requirement and further reduces consumption of fossil fuels.

5.1 Alternative scenario 1: Green energy

5.1.1 Scenario assumptions

Electricity consumption and access

As in the relaxed constraint scenario, we assume growth in capacity and production sufficient to increase per capita consumption to 4,000 kWh annually by 2035. In addition, access is assumed to expand at the same rate as in the relaxed constraint case; universal electricity access is achieved by 2025.

Transmission and distribution losses

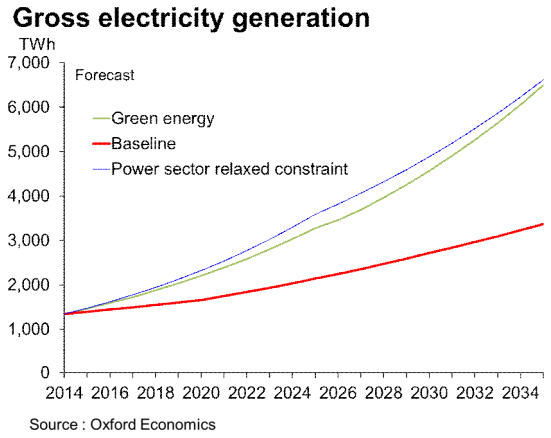
The scenario assumes that AT&C losses as a share of gross production decline twice as fast as in the baseline, such that losses fall to 6%--in line with loss rates in the U.S., China, and Australiað by 2027.

Electric Generation Capacity and Production

[50] Based on the IEA New Policies scenario.

Based on the assumed levels of per capita consumption and distribution loss, total electricity production grows 7.7% annually to 2035, rising to 6,496 TWh, just slightly below that in the relaxed constraint case.[51]

Figure 5.1: Electricity generation assumption



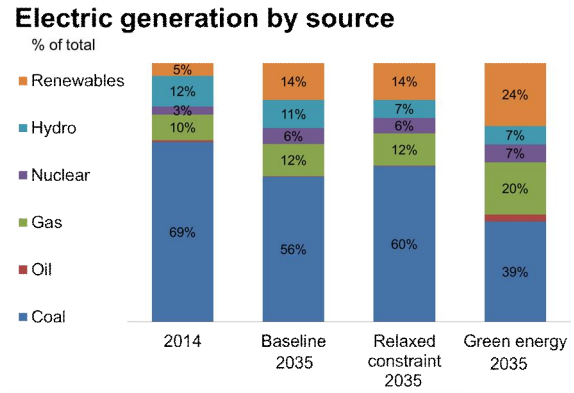
Our assumptions for the generation fuel mix are based on the IEA 450 scenario (as detailed in the 2013 World Energy Outlook)[52] adjusted to account for the feasible limits of both hydroelectric and nuclear capacity expansion in India.[53] Coal-based generation in the scenario falls to 39% of the total from nearly 70% today, bringing fossil-fuel based generation to 44% of the total from 80% today. Renewables (solar, wind, and biofuels) rise to 24% of generation from 5% today. Generation from hydroelectric and nuclear facilities also rises.

[51] The difference is the result of the assumed improvement in transmission efficiency relative to the relaxed constraint case. Total end user consumption is equal in the two cases.

[52] The IEA 450 scenario is designed to simulate a course for global energy consumption that is compatible with a 50% chance of liming the long-term increase in the average global temperature to 2°C. This requires a substantial greening of the power sector, among other changes, in India and the rest of the world. It is important to note, however, that the scenario described here is not a 450 scenario; the generation targets used here are substantially above those used in the IEA scenario.

[53] As in the power sector relaxed constraint scenario, because the IEA scenario is based on a much lower level of electric generation we've adjusted the fuel mix assumptions to account for the technical limits on hydroelectric capacity. Similarly, though there are no natural limits to nuclear capacity potential, the scenario assumptions have been adjusted to acknowledge the potential political opposition a large expansion of nuclear generation might face.

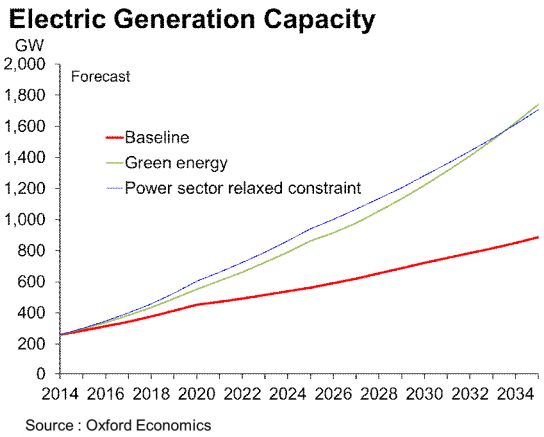
Figure 5.2: Generation by source



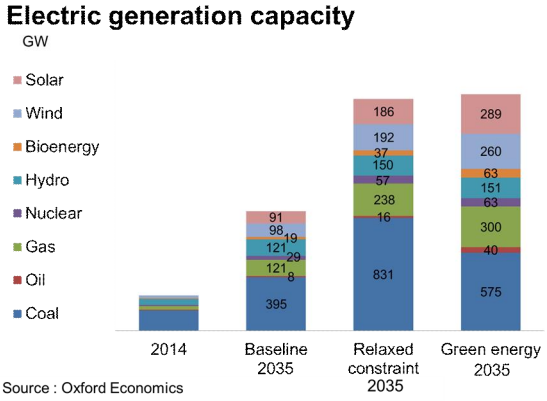
Source : International Energy Agency; Oxford Economics

Total installed capacity rises to 1,741 GW, slightly above the relaxed constraints case due to the need to maintain additional dispatchable capacity to account for the intermittent production profile of renewables based generation. While coal capacity rises in the scenario (from 150 GW today to 575 GW in 2035), as a share of the total coal capacity falls from 58% today to 33% in 2035. We assume further that 15% of added coal capacity from 2017 is in ultra-supercritical plants, and 85% in supercritical plants.[54]

Figure 5.3: Electricity production capacity



Source : Oxford Economics



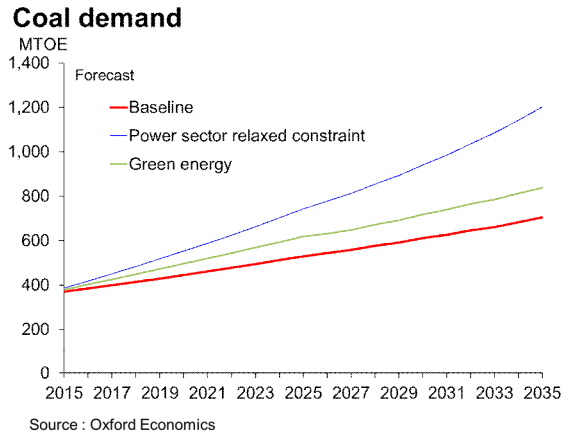
Source : Oxford Economics

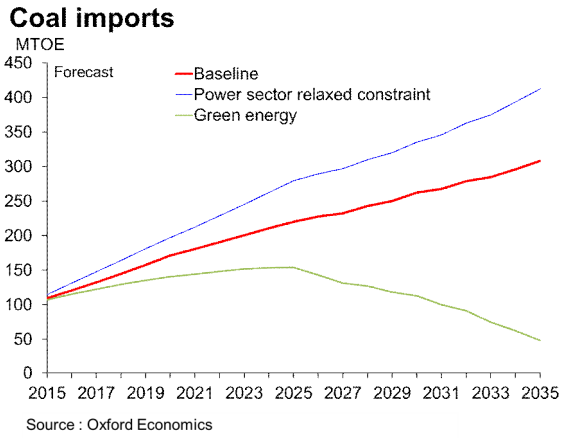
Coal production

Though total electricity consumption rises to the same level as the relaxed constraint scenario, coal demand from the power sector rises less due to the shift in the sectorôs fuel mix. Investment in the coal sector in the green scenario is assumed to be sufficient to raise domestic production to the same level as the power sector relaxed constraint case; as a result, coal imports trend steadily

[54] Our baseline assumes no ultra-supercritical coal capacity.

downward, providing a positive impact to the trade balance. This is, however, offset by an increase in oil and natural gas imports, which rise to meet growing demand from oil and gas-fired power plants. (Due to Indiaôs limited oil and natural gas reserves, thereôs little reason to expect that domestic production can rise to meet the increase in demand envisioned in the scenario.)





Investment requirements

Though total generation rises to the same level as the relaxed constraint scenario, installed capacity is slightly higher in the green energy scenario, reflecting the lower capacity factors of renewables-based generation (i.e. solar and wind power can only be produced when weather conditions allow). As such, incremental investment in traditional sources will be required on top of the expansion in renewables-based generation. Based on per-kW construction cost estimates from the U.S. EIA,[55] we estimate the incremental investment cost of capacity expansion to be 1.6% of baseline GDP annually.

Investment in transmission is estimated to average 1.1% of baseline GDP annually, slightly higher than in the relaxed constraint case which reflects the costs of the incremental improvements in transmission efficiency.

Investment required to expand coal production is marginal, though we assume additional related infrastructure investment (rail, roads, storage) of 0.5% of GDP annually.

In total, we estimate an incremental investment requirement of 3.2% of baseline GDP annually. As in the power sector relaxed constraint scenario (section 4.1) we assume investment is funded by a mix of public, private, and foreign sources.[56] We again assume the removal of remaining subsidies on kerosene

[55] To calculate the investment required to expand electric production, including both expanding generation capacity and improving transmission, we utilize the same methodology described in section 3.1.1.

[56] As in the relaxed constraint case we assume that half of the required investment in generation capacity and transmission and distribution, as well as

and LPG, as well as some electricity subsidies (though not those provided to the poor). This reduces the extent to which current spending must be lowered to finance this investment.

Energy prices

Renewable electricity sources face similar per MW capital costs to traditional sources, but those costs must be recovered over fewer MWh of production due to their lower capacity utilization. Similarly, because of the intermittent production profile of renewables additional baseload capacity must be maintained to meet demand. As a result, an increase in renewables-based generation will necessarily lower the capacity utilization of dispatchable sources as well, raising their per MWh costs.

This is offset somewhat by the fact that variable production costs (i.e. fuel costs) are zero for renewable sources. However, on net an increase in renewables-based generation will increase costs.

Further, we assume that incremental private investment in both generation capacity and transmission required in the scenario is amortized and passed along to customers through higher prices for electricity. The total impact of the higher per MWh cost of renewables-based generation, as well as the costs of financing the investment required, are projected to raise electricity prices 20% above baseline in the near term, and 25% above baseline by 2035.

This increase is in addition to the assumed rise in energy costs resulting from the removal of subsidies, and the electricity price increases designed to eliminate financial losses in the power sector, which raise electricity prices substantially in the near term (though less in the long-run as investment in the sector improves efficiency and lowers technical and commercial losses, see section 4.1.1).

Trend productivity

As in the relaxed constraint case we assume that improving the reliability of the power supply would boost manufacturing productivity by 5% by 2025.

5.1.2 Scenario results

Overall the results of the scenario are broadly similar to the power sector relaxed constraint case. The substantial increase in investment in the power sector raises demand in the short-term, stimulating gains in employment, income, and consumption. In the long-run, this investment also raises potential output by

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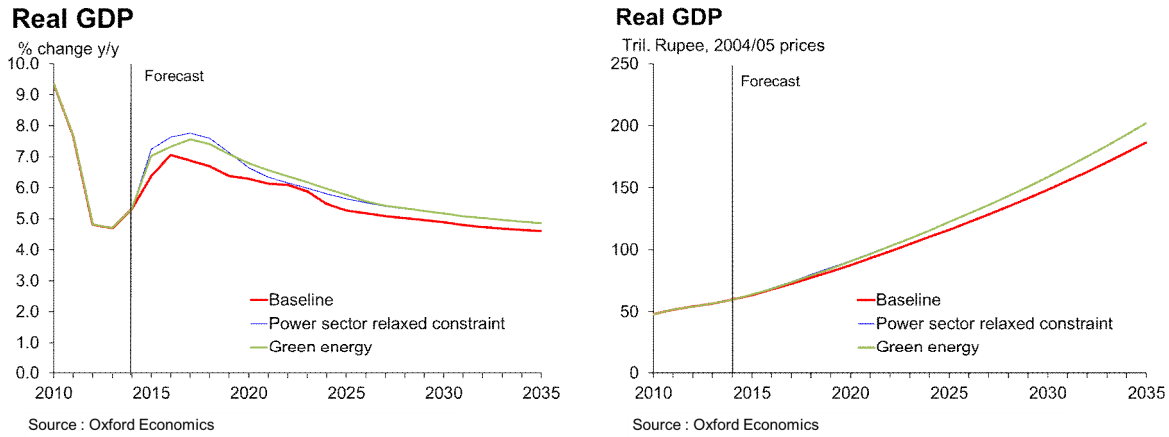
investment in the coal supply chain, is funded through private domestic investment; foreign investment is assumed to fund the remaining investment in generation capacity, while the remaining investment in transmission and distribution, as well as assumed additional infrastructure investment, is funded through budget-neutral government investment

increasing the size and productivity of the capital stock. Moreover, wider and more reliable access to electricity improves productivity growth overall, providing a further boost to growth potential.

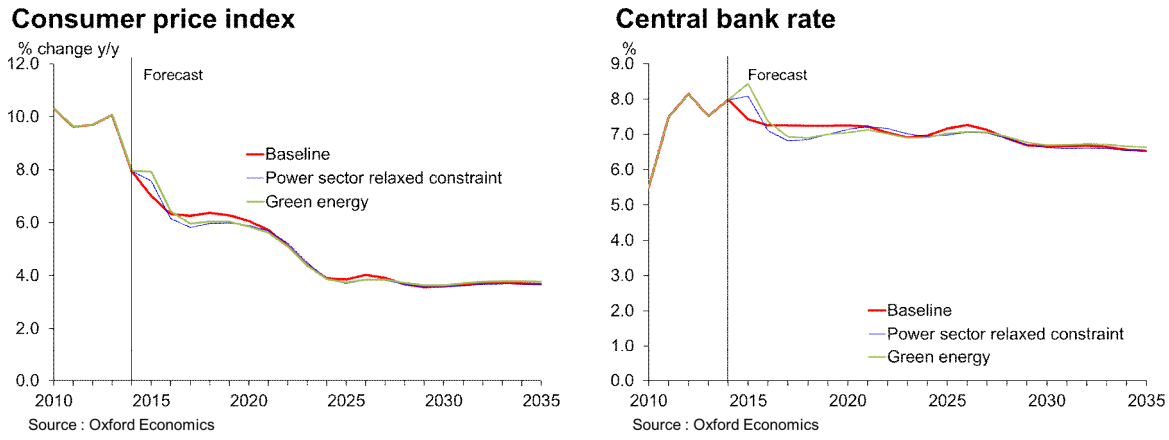
Overall, the level of output in the long run is 8.4% above baseline, compared to 8.2% in the relaxed constraint scenario. Growth in the near term averages 7.3%; over the full forecast horizon growth is 6.0%, compared to 5.6% in the baseline and equal to that in the relaxed constraint scenario.

Figure 5.4: Impact on GDP



As in the relaxed constraint case, energy price increases initially cause a small increase in inflation. However, those pressures ease as an increasingly reliable power supply helps ease capacity constraints. As a result, in the long run inflation is roughly at the baseline level despite higher electricity prices.[57]

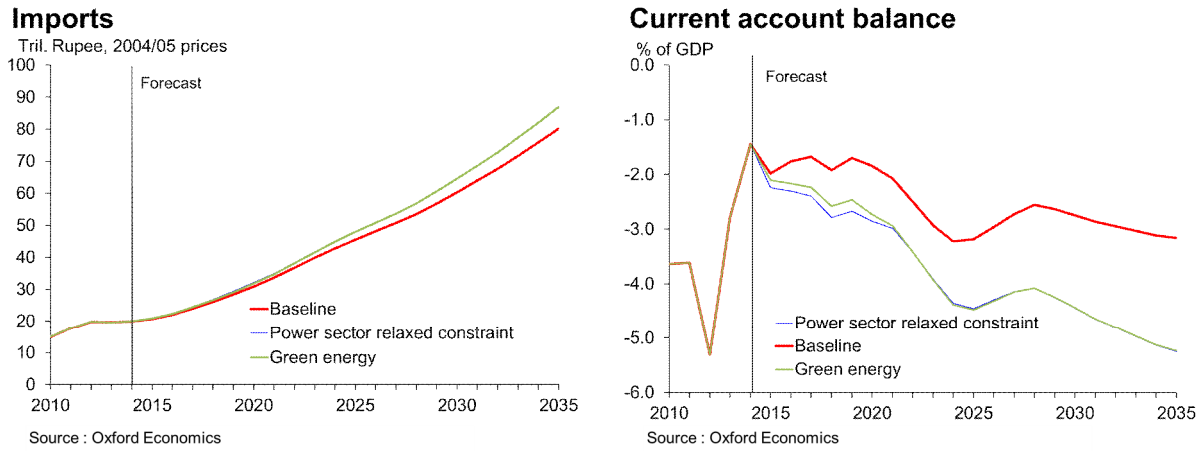
Figure 5.5: Impact on inflation and the policy rate



[57] Electricity accounts for just 3.5% of the consumer price index in India

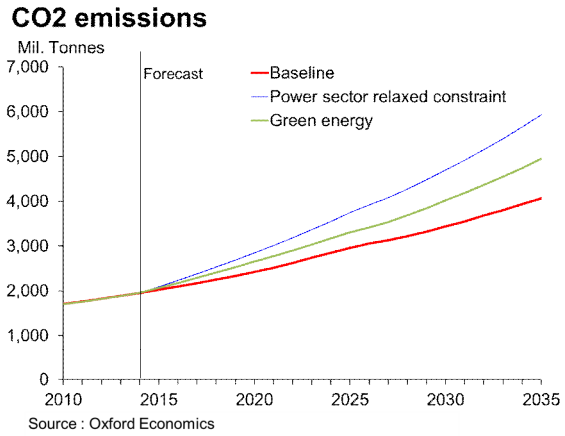
The current account deficit rises as the increase in investment spending stimulates increased imports. In addition, though in the long run coal imports fall substantially, oil and gas imports rise leading to further deterioration of the external balance. By 2035 imports are 8.5% above their baseline level, and the current account deficit widens to 5.2% of GDP.

Figure 5.6: Impact on external position



Total CO_2 emissions in the scenario are slightly elevated across the forecast horizon relative to baseline due to the substantial increase in electricity consumption. However, emissions are 17% below those in the power sector relaxed constraint scenario, which envisioned similar electricity consumption but with a heavier reliance on coal-based generation.

Figure 5.7: Impact on emissions



5.2 Alternative scenario 2: Green power and energy efficiency

5.2.1 Scenario assumptions

The second alternative scenario builds on the first; we continue to assume that the power sector shifts significantly towards a low-carbon fuel mix. In addition, we assume further that a mix of regulatory reforms prompts investment in energy efficiency across the key energy consuming sectors of the economy.

Energy efficiency

The assumptions used in the scenario are drawn from McKinsey & Company's work on emissions abatement in India.[58] Specifically, we assume:

- A 30% reduction in electricity consumption in commercial and residential buildings by 2035 (relative to the relaxed constraint/green power consumption level) through deployment of passive design techniques, high efficiency appliances, and LED bulbs;
- A 20% reduction in electricity and diesel consumption (relative to the relaxed constraint/green power consumption level) through use of more efficient irrigation techniques;
- A 40% reduction in oil demand in transportation through both improvements in the efficiency of traditional gasoline and diesel powered cars and through the introduction of hybrid and electric vehicles;
- A 25% decrease in coal demand from the cement and steel industries through the use of more efficient production techniques.

Though we make no specific assumptions about these measures, these could include setting higher fuel efficiency requirements for cars, buses, and trucks; requiring real estate developers to meet efficiency requirements to obtain a building permit; and setting emissions restrictions for the industrial sector. Such measures would require cooperation across all levels of government, the creation of new regulatory structures and the improvement of existing ones. While this presents a not insignificant challenge, we assume in the scenario that effective regulatory structures are put in place so as to facilitate these changes.

Investment requirements

The assumed electricity savings in buildings and agriculture lower total electricity generation 15% from the Green energy scenario. Coupling this with the same level of renewables generation (612 GW of capacity), non-renewables generation and capacity in the scenario are 19% and 20%, respectively, below the Green energy scenario. Total generation capacity in 2035 is 12% below the Green energy scenario.

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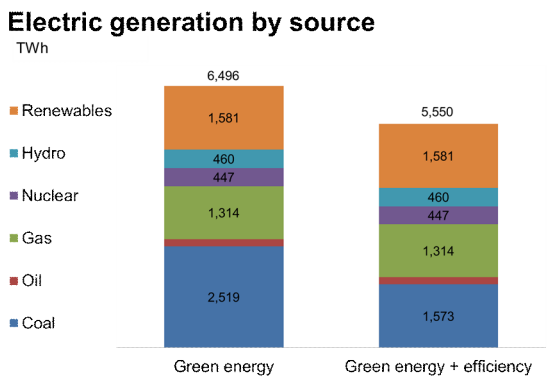
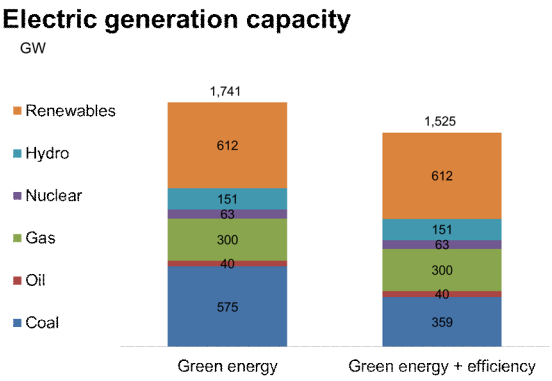
[58] *Environmental and Energy Sustainability: An Approach for India*. McKinsey & Company. August 2009

Figure 5.8: Electricity generation



Source : Oxford Economics



Source : Oxford Economics

Given the slightly lower generation and capacity targets, annual investment in the power sector, at 2.9% of baseline GDP, is below that in the Green energy scenario.

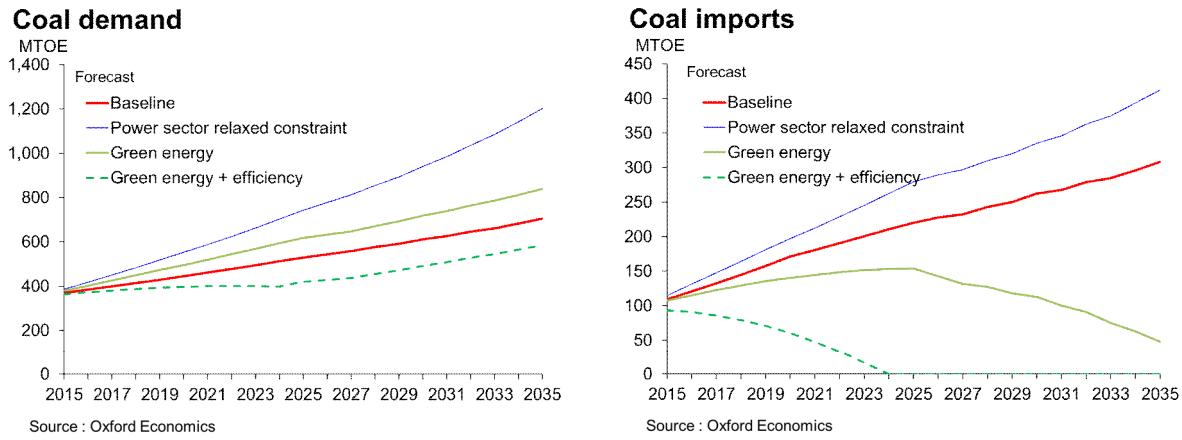
Based on the figures from McKinsey, the energy efficiency investments outside of the power sector are assumed to cost an additional 2.3% of GDP annually. The costs of reducing electricity consumption are scaled to reflect the higher level of consumption assumed in the scenario such that the cost per TWh saved is approximately equal to that implied by the McKinsey assumptions.

Table 5.1: Investment cost of implementing energy efficiency

Sector	Investment cost (% of GDP)
Transport	0.3%
Industry	0.4%
Buildings	1.1%
Agriculture	0.4%
Total	**2.3%**

Coal demand rises slowly over time and is below baseline in the scenario, both due to the assumed improvements in demand from the steel and cement sectors, and from the reduction in coal-based power generation. We assume investment in the coal sector is sufficient to raise domestic production such that imports of coal fall to zero by 2025.

Figure 5.9: Coal demand and imports



In total, annual investment costs in the scenario are 5.2% of baseline GDP.

As in the previous scenario, investments are financed through a mix of private domestic and foreign investment, and budget-neutral government investment, and that that power sector investment from private sources are amortized and passed along to electricity consumers in the form of higher prices. We again assume that electricity prices are raised in order to stem financial losses in the power sector and attract private investments, but that electricity price subsidies to the poor remain in place.[59]

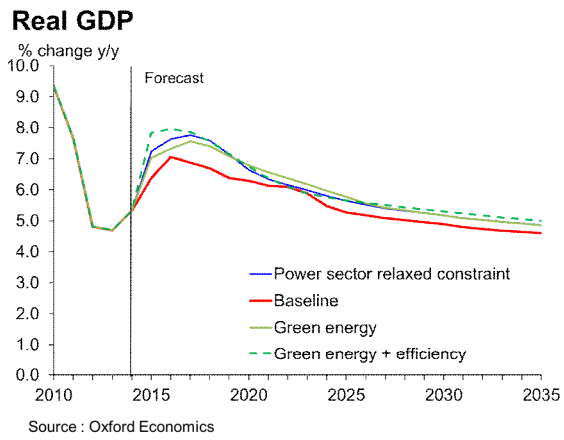
Similarly, investments in efficiency are funded by the private sector with the amortized costs passed along to consumers as higher prices.

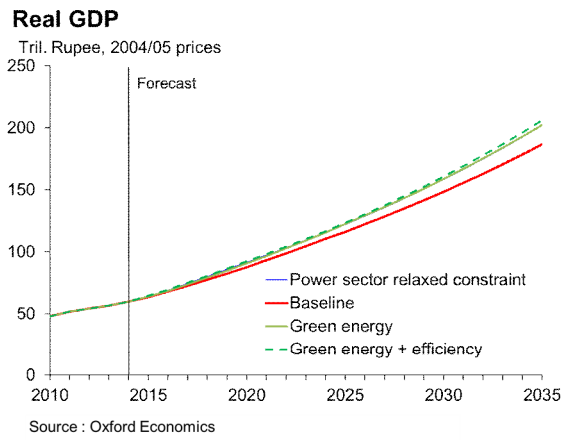
5.2.2 Scenario results

The substantial increase in investment pushes real GDP growth to an average of 7.7% annually in the near term. In the long-run, the increased availability of power, along with the improvement in the size and efficiency of the capital stock, boosts long-run growth potential. Growth averages 5.6% annually from 2020-35, in-line with the Green energy scenario and 0.3 percentage points above the baseline.

[59] Given that some electricity subsidies are directed at the agriculture sector, it seems likely that at least some reform of those subsidies will be required in order to incentivize investments in energy efficiency in the sector.

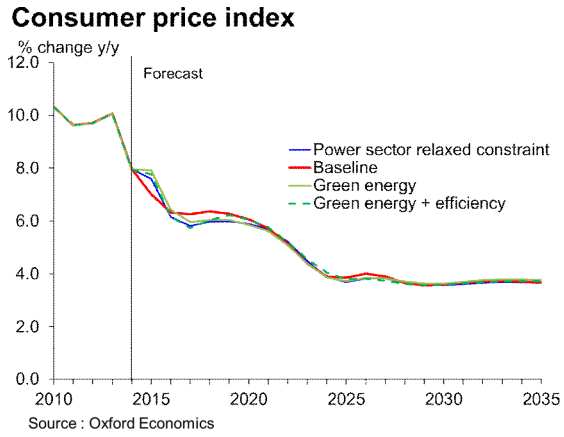
Figure 5.10: Impact on GDP





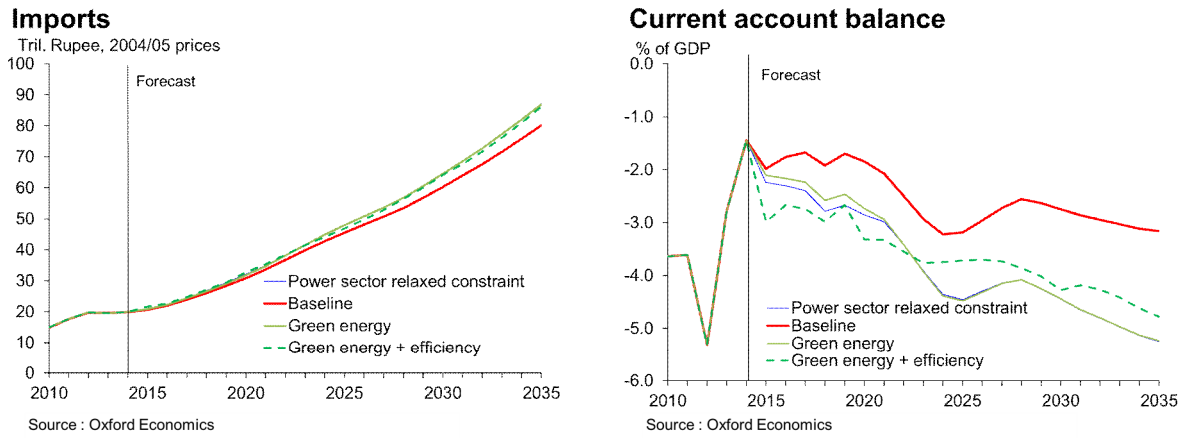
Inflation in the scenario is similar to that in the Green energy scenario; inflation rises slightly above baseline in the near term due to the higher cost of energy, but in the medium term as expanding capacity eases supply constraints and the amortized costs of demand side energy efficiency measures are offset by savings yielded by declines in energy consumption.

Figure 5.11: Impact on inflation



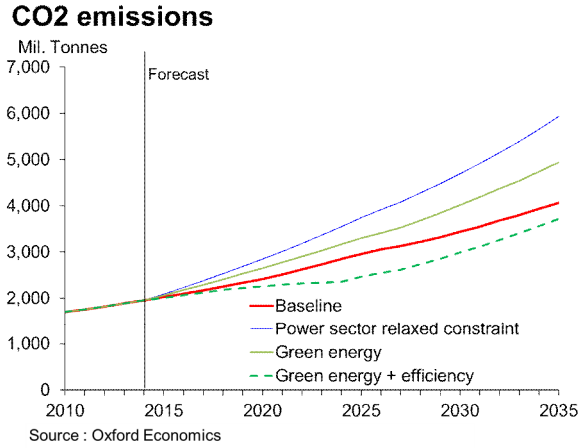
Import growth picks up in the near term primarily as a result of capital goods imports and additional domestic consumption. In the long run while coal demand falls to zero and oil demand falls below baseline, demand for natural gas rises due to increasing demand from gas-fired power plants. Overall, while imports are below the Green energy and Power sector relaxed constraint cases, they are above baseline levels. As a result, the current account balance is more negative than in the baseline, though less so than in the two cases where electric generation rises to a comparable level.

Figure 5.12: Impact on external position



CO_2 emissions fall below baseline levels as consumption of fossil fuels declines, with emissions by 2035 dropping to 3.7 billion tons. While this is still well above today's levels (we forecast emissions of 2 billion tons in 2015), emissions in the scenario are 8.5% below the baseline projection for 2035 despite output that is nearly 10% higher than currently forecast.

Figure 5.13: Impact on emissions



6 Co-benefits of reducing emissions

It is generally recognized that in addition to mitigating the severity of the effects from climate change, reducing GHG emissions can also have secondary benefits (and costs) that affect the overall net cost of emissions abatement on society. The improvement in air and water quality from reduced fossil fuel consumption, for example, should lead to improved human health, lower mortality, and higher labour productivity. Even if co-benefits are relatively small in magnitude, they effectively lower the net cost of GHG abatement. Moreover, they are a potentially effective way to build political support for such measures because they are tangible and often experienced in the near-term while the direct benefits of climate mitigation policies, by contrast, will be experienced over a longer time horizon and may be difficult to discern in daily life.

Co-benefits can be broadly categorized into environmental and economic co-benefits. Environmental co-benefits are those that result from improvements in air and water quality and their effects on human well-being, mortality, and agricultural productivity. Economic co-benefits stem from the potential growth of ñgreen jobsò and increased energy security from reductions in fossil fuel import dependency. India may particularly benefit from the former; according to WHO statistics,[60] 13 of the 20 most polluted cities in the world are in India.[61] Dehli ranks as the worldôs most polluted city, with particulate matter concentrations that are nearly three times those of Beijing. The costs to India are significant:

- A report by the Indian Institute of Tropical Meteorology estimated that ground-level ozone pollution--driven by the burning of fossil fuels-- damaged 6 million metric tons Indiaôs wheat, rice, soybean and cotton crops in 2005; the loss of wheat and rice was enough to feed 94 million Indians;
- The WHOôs report on the Global Burden of disease estimates that ambient air pollution caused 627,000 deaths in India in 2010 and was the fifth largest cause of death in India overall; indoor air pollution from the burning of solid fuels caused 1 million deaths;
- In an assessment of the national costs of environmental degradation in India,[62] the World Bank estimated that outdoor air pollution cost India 1.7% of GDP annually. The same study estimated that indoor air pollution cost India an additional 1.3% of GDP annually. ñThe higher costs for outdoor/indoor air pollution are primarily driven by an elevated exposure of the young and productive urban population to particulate matter pollution that results in a substantial cardiopulmonary and Chronic Obstructive Pulmonary Disease

[60] Ambient (outdoor) air pollution in cities database 2014 (see http://www.who.int/phe/health_topics/outdoorair/databases/cities/en/)

[61] Base on PM2.5 concentration levels

[62] *India - Diagnostic assessment of select environmental challenges : An analysis of physical and monetary losses of environmental health and natural resources.* World Bank. June 2013.

mortality load among adults.òOther studies have estimated the costs of air pollution could be significantly higher: according to estimates from the New Climate Economy,[63] the value of lives lost to air pollution in India were equivalent to 6.5% of GDP in 2010.

Pursuing õgreen growthòmeasures, such as those envisioned in our second alternative energy pathway scenario, could, then, yield substantial benefits beyond the increase in GDP estimated in our analysis. Reduced consumption of fossil fuels in power, transport, and industry would reduce outdoor air pollution, while the expansion of electricity access could reduce indoor air pollution by reducing the use of kerosene lamps. The NCE estimates that the health benefits of GHG abatement in India were worth $55/ton of CO2 abated in 2010.

[63] *India: Pathways To Sustaining Rapid Development In A New Climate Economy*. New Climate Economy. 2014.

7 Conclusion

Lifting growth potential and alleviating poverty rightly remains the focus of Indiaôs development agenda. The analysis presented in this paper suggests that India possesses substantial potential that could be unlocked with the right policy agenda, and the current government has already launched several policy initiatives aimed at tackling some of Indiaôs biggest growth obstacles.

While historically rapid economic growth has often come hand-in-hand with increasing energy intensity and rising carbon emissions, advancements in ñgreenò technologies in recent years suggest that India could be well positioned to buck the historical trend of developing dirty. Indiaôs Prime Minister has taken steps to move India on to a clean development path, setting ambitious targets for the development of renewable energy.

Although sustained growth of 8+% per annum may not be possible, the analysis suggests that India can marry rapid economic development, with GDP growth of over 6% pa for the next twenty years, with a substantial greening of the economy. This will not only improve living standards, but it will increase Indiaôs resilience to the impact of climate change and decrease its reliance on external fossil fuel supplies. Moreover, though not quantified in our analysis, a ñgreen growthò strategy could yield a number of co-benefits that the literature suggests could be particularly substantial for India.

Key Indicators
Period average
unless otherwise noted

	RDGP growth (%)							
	2015-19	2020-35	2015-35	CPI inflation (%)	Government balance (% of GDP)	Government Debt in 2035 (% of GDP)	Current account balance (% of GDP)	Carbon emissions in 2035 (mtCO2))
Baseline	6.7	5.2	5.6	4.7	-3.0	37.2	-2.5	4,066
Power sector relaxed constra	7.5	5.5	6.0	4.6	-2.8	33.6	-3.8	5,935
Green energy	7.3	5.6	6.0	4.7	-2.9	34.9	-3.8	4,944
Green energy + efficiency	7.7	5.6	6.1	4.7	-3.0	35.8	-3.7	3,719

Appendix A - The Oxford Economics Global Economic Model

The Oxford Economics Global Economic Model (GEM) is a fully integrated, global macroeconometric model for forecasting and scenario analysis. The GEM covers 46 countries, including the US, Canada, EU, and major emerging markets including China and India. The model provides a rigorous and consistent structure for analysis and forecasting, and allows the implications of alternative global scenarios and policy developments to be analysed at both the macro and sector level.

At the country level, the model's structure is Keynesian in the short run, with output driven by shifts in demand, but in the long run the model is neoclassical, and GDP determined by the economy's supply side potential (i.e. the level of output is determined by an economy's labour supply, capital stock and productive potential). For example, increased demand will lead to higher output and employment initially. But eventually that feeds through into higher wages and prices. Given an inflation target, interest rates have to rise, reducing demand again (ócrowding outô). As a result, output returns to its potential level over the long run.

Overview of the Global Economic Model

- **Consumption** - function of real income, wealth and interest rates
- **Investment** - ôjôformulation with accelerator terms
- **Exports** - depend on world demand and relative unit labour costs
- **Imports** - depend on total final expenditure and competitiveness
- **Real wages** depend on productivity and unemployment relative to NAIRU
- **Prices** are a mark-up on unit costs, with profits margins a function of the output gap
- **Monetary policy** endogenised. Options include Taylor rule, fixed money and exchange rate targeting
- **Exchange rate** determined by UIP
- **Expectations adaptive**

At the global level, countries are linked through trade (e.g. if demand in a major trading partner increases, a country's exports will rise), financial variables (e.g. if the Federal Reserve raise interest rates, the US$ appreciates against other currencies) and commodity prices (e.g. if oil prices rise as a result of tensions in the MENA region, domestic oil prices in oil-importing countries will rise).

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