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India's oil demand: On the verge of "take-off"?

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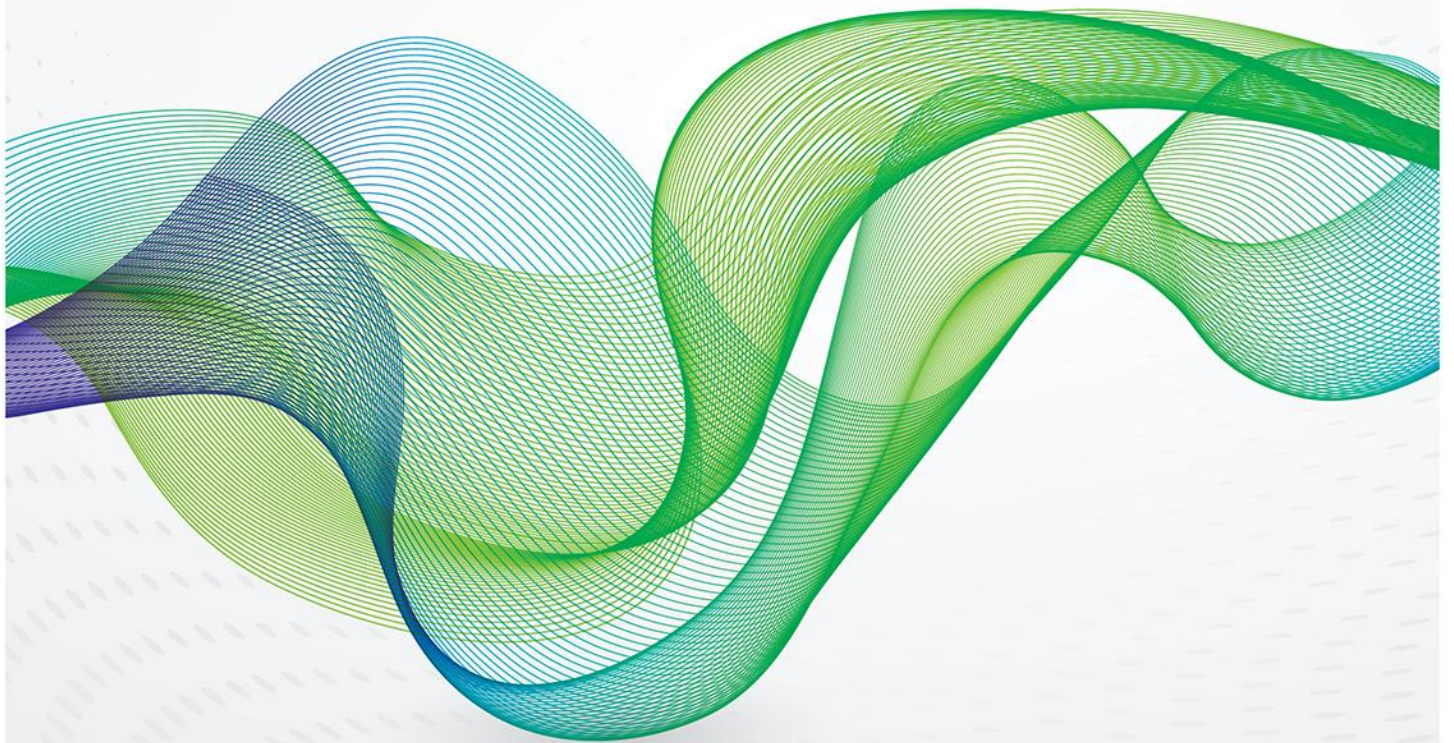
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India's Oil Demand: On the Verge of 'Take-Off'?





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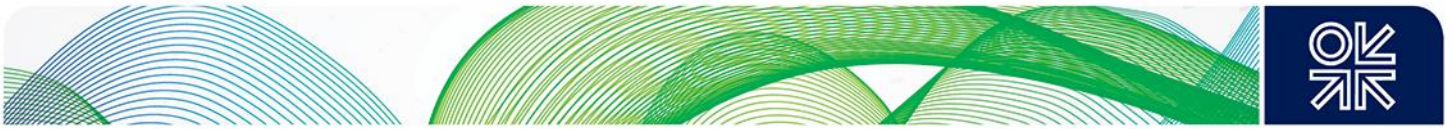
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Abstract

Over the last decade, non-OECD oil demand growth, and by extension global oil demand growth, was driven mainly by China, which accounted for half to two-thirds of this growth. However, since the Chinese government embarked on a deliberate policy of rebalancing, the country's annual demand growth has slowed to under 0.3 mb/d, compared to an average demand growth of over 0.5 mb/d in the 10 years prior to 2013. In this new era of slower Chinese growth, a new contender has emerged: India, which in 2015 was the main driver of non-OECD oil demand growth. In this paper we argue that in addition to the boost from low oil prices, structural and policy-driven changes are underway which could result in India's oil demand 'taking off' in a similar way to China's during the late 1990s, when Chinese oil demand was at levels roughly equivalent to current Indian oil demand. These changes include: a rise in per capita oil consumption (reflected in rising motorization of the Indian economy), a massive programme of road construction (amounting to 30 km per day), and a push towards increasing the share of manufacturing in GDP by 2022 (which could increase oil consumption by at least a third based on a conservative linear estimate). This paper also examines the implications of a take-off in domestic demand for India's recently acquired status as a net petroleum product exporter.

Keywords: India, oil, demand, manufacturing, transportation, construction



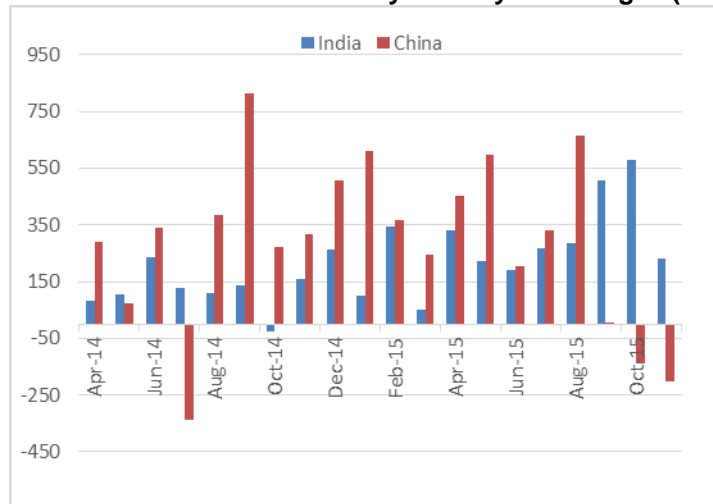
1. Introduction

In 2015, India emerged as the main driver of non-OECD oil demand growth, with world demand growth at its strongest since 2010, at 1.8 million barrels per day (mb/d). However, in contrast with 2010, when demand growth was largely stimulus-led following the global financial downturn, demand growth in 2015 was independent of stimulus, although the 50 per cent fall in oil prices provided a significant boost to consumer demand. Although part of the demand growth has come from OECD economies, where a slow global economic recovery is underway, an interesting dynamic pertaining to shifts in non-OECD demand growth has emerged over the course of the last year.

Over the last decade, non-OECD demand growth, and by extension global oil demand growth, was driven mainly by China, which accounted for half to two-thirds of this growth. However, since the Chinese government embarked on a deliberate policy of rebalancing economic growth away from export-oriented heavy industry, the country's annual demand growth has slowed to under 0.3 mb/d, compared to an average figure of just over 0.5 mb/d in the decade prior to 2013. Despite a sharp drop in oil prices, this slowing trend continued in 2015, with Chinese demand growth ranging around 0.3 mb/d from January to November.¹

In this new era of slower Chinese growth, a new contender has emerged: India. Touted by many as the worthy successor to China, Indian oil demand growth had previously failed to parallel that of China, partly due to the proportionately dominant share of its services sector relative to manufacturing in GDP, and partly because a situation of 'political paralysis' over the last few years was unattractive for industrial investment. India's burgeoning budget deficit prior to the oil price drop, worsened by oil prices above US\$100 per barrel, added to the lacklustre investment climate, and oil demand growth languished at around 0.13 mb/d for the past decade. However, 2015 saw a 'new India' emerge, with oil demand growth year-on-year (y/y) jumping to 0.3 mb/d, a record high (see Figure 1).

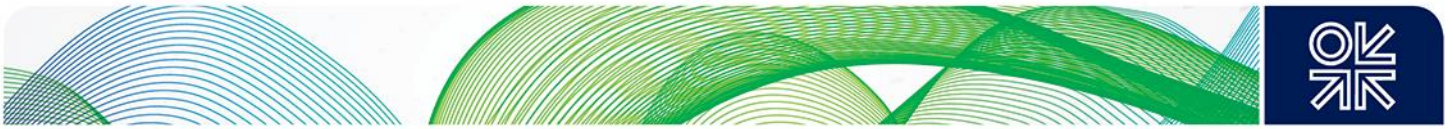
Figure 1: Oil Demand Growth in China and India: year-on-year changes (kb/d)



Source: Energy Aspects.

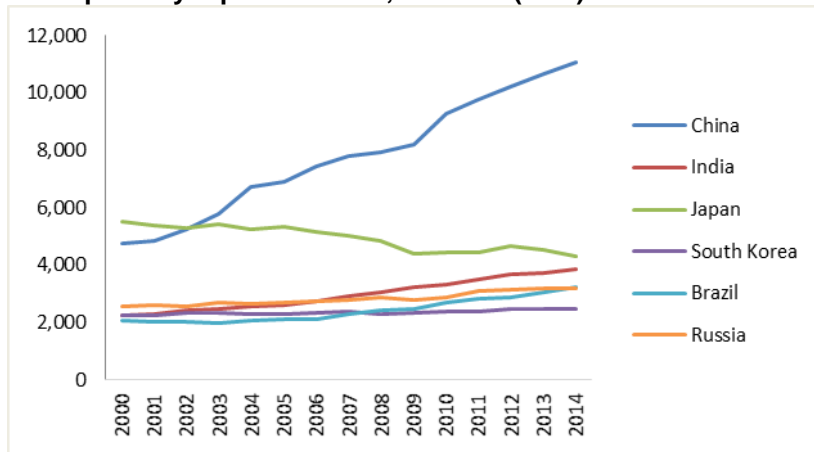
India is soon likely to overtake Japan as the second-largest oil consuming economy in Asia (see Figure 2). Part of this demand growth has come from the effects of a low oil price. The global price downturn, which began in June 2014, halved the oil import bills of the largest oil importing economies, bringing substantial fiscal improvements (World Bank, 2015a; 2015b). This implies potential longer-term effects for economic growth: for instance, a 10 per cent decrease in oil prices is estimated to

¹ December data was not available at the time of writing.



raise growth in oil-importing countries by 0.1 to 0.5 per cent, depending on the share of oil imports in GDP (World Bank, 2015a; 2015b; Rasmussen and Roitman, 2011). Furthermore, the shift in income from oil exporting economies with high average savings rates, to net importers with a higher propensity to spend, is said to result in stronger global demand over the medium term (World Bank, 2015a; 2015b).

Figure 2: Oil Consumption by top consumers, 2000–14 (kb/d)

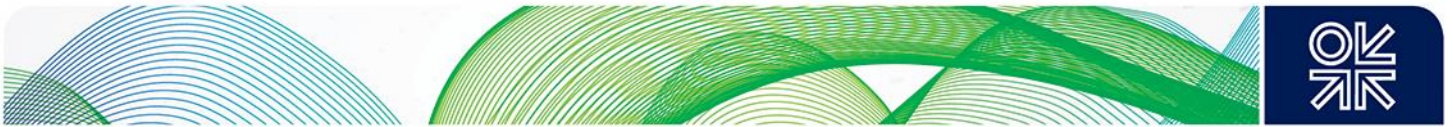


Source: BP (2015)
 Note: Excludes USA.

Apart from the effects of the oil price decline, India’s GDP growth is estimated to have overtaken China’s in 2015 (7.2 per cent growth for India, as opposed to 6.9 per cent for China) and is forecast to remain relatively high in 2016, with China’s economy readjusting to a ‘new normal’ of lower growth (IMF, 2016). Improvements in macroeconomic and fiscal indicators (for instance, a historically low current account deficit at around 1.6 per cent of GDP as of late 2015) suggest that India’s GDP growth could continue on a relatively high path, subject to its ability to carry out structural reform. This has significant long-term implications for the country’s oil demand. The oil ministry, for instance, estimates that India will consume 3.56 mb/d of refined products in the current financial year (which began 1 April 2015); this figure is 7 per cent higher y/y, much larger than a previous estimate of 3.3 per cent.

In this paper we argue that in addition to the boost from low oil prices, structural and policy-driven changes are underway which could result in India’s oil demand ‘taking off’ in a similar way to China’s during the late 1990s, when Chinese oil demand was at levels roughly equivalent to current Indian oil demand. India’s per capita oil consumption has increased as a result of the increased affordability of oil in various uses (on the back of the drop in the oil price) for a large section of its population who could not previously afford it; this is becoming visible in the motorization of the Indian economy. Furthermore, the Indian government’s target of increasing the manufacturing sector’s share of GDP to 25 per cent by the beginning of the next decade (from roughly 15 per cent at present) could lead to higher oil consumption in manufacturing. Finally, the programme of infrastructure construction (roads and national highways) that is being partly funded through revenues from the higher taxation of oil and oil products is also likely to support oil demand growth.

The paper begins in Section 2, by looking at the rising trend in oil consumption, and breaks this down into growth in product demand (diesel, gasoline, and LPG) to identify which sector has had the most significant effect on oil demand. Section 3 briefly discusses the theory of ‘take-off’ in economic growth, specifically in relation to energy (and oil) use, highlighting the role of the transport sector and the significance of a key metric – the trend in motorization. Section 4 focuses on per capita oil consumption through the lens of the transport (specifically automobile) sector, where the prices of the main oil products have been liberalized; these prices have responded relatively quickly to movements in international crude prices, and have in turn affected consumption. This section also looks at

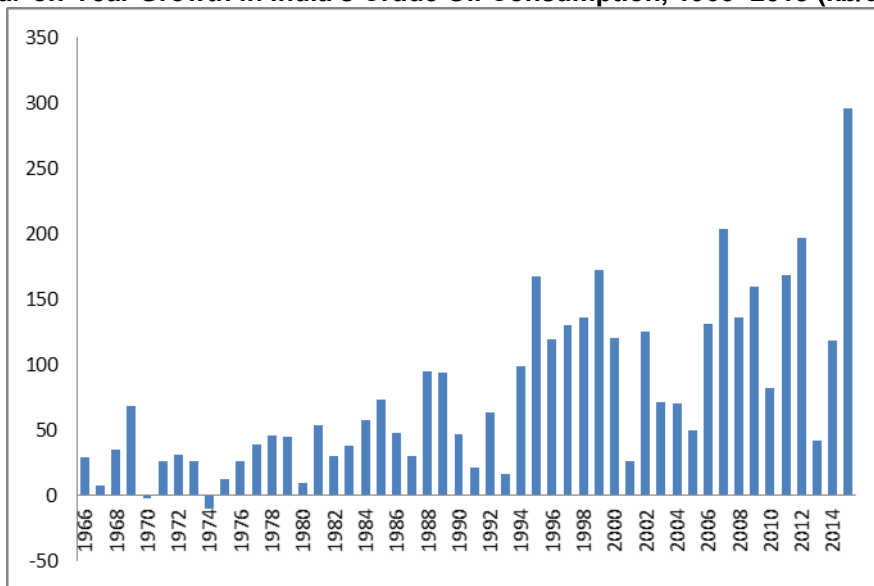


environmental constraints on transportation, whilst also considering the government’s road construction programmes in relation to oil use. Section 5 examines India’s recent push towards manufacturing, and the potential impact of this on oil consumption. Section 6 discusses the implications of all the above issues for product trade flows, in light of India’s recent status as a net petroleum product exporter. Section 7 concludes.

2. Historical and Current Oil Demand

Historical data for India shows that crude oil consumption has been rising at a steady rate (Figure 3). Over the past decade or so (2004–15), the average oil demand growth has been roughly 0.15 mb/d annually. This steady rise is consistent with the literature on oil consumption in countries at relatively early stages of income and development,² which concludes that income effects tend to ‘swamp’ price effects in these stages, implying a low price elasticity of demand. Fattouh et al. (2013) for instance, show an income elasticity of demand for gasoline and diesel of around 1 for India between 2005 and 2012. These figures are consistent with a large number of studies that find similar income elasticity values for developing countries (IMF, 2011; Dahl 1993). The IMF in 2011, for instance, predicted that between 2015 and 2018 the Indian economy would grow at around 6 per cent on average. An income elasticity of around unity implies that diesel and gasoline consumption would grow at a similar rate (Fattouh et al., 2013).

Figure 3: Year-on-Year Growth in India’s Crude Oil Consumption, 1965–2015 (kb/d)



Source: BP (2015); Energy Aspects.

In addition to this expected long-term trend, however, there was an upsurge in oil demand in India during 2014 and 2015. Although some of the upsurge can be attributed to lower prices (and the increased affordability of oil to consumers), it has occurred despite the removal of oil product subsidies and the imposition of excise duties on oil consumers, implying that the full extent of the price fall has not even been passed on to consumers.³ Retail selling prices of diesel and gasoline did not fall commensurately with the drop in the crude oil price in late 2014; notably, the Indian government carried out four excise duty increases from November 2014 to January 2015, which

² Relative to OECD economies.

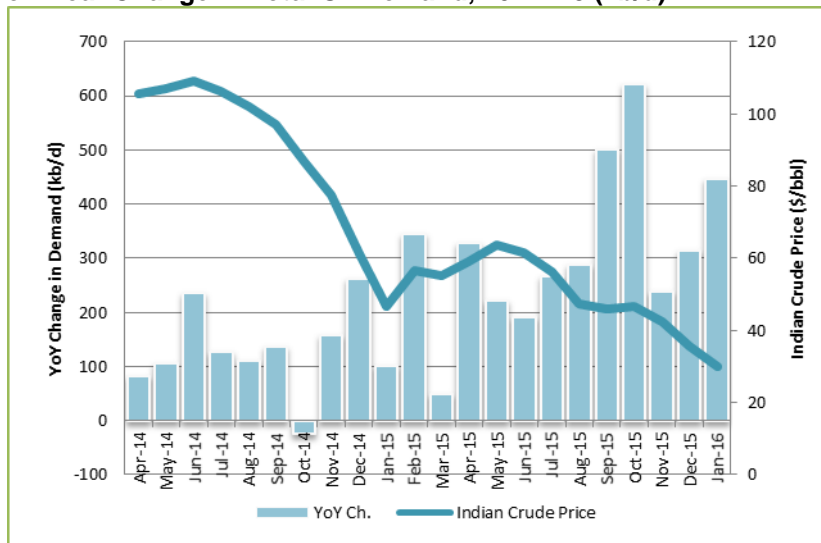
³ The Indian government had reduced excise duties to zero during the period of US\$100 oil prices (between 2010-mid 2014) in an attempt to mitigate the impact on finances of the National Oil Companies and state-owned oil marketing companies, as their revenues were used to finance the oil subsidy and import bills.



supported retail prices.⁴ Retail prices actually stabilized at levels equivalent to a crude price of around 70 US\$/bbl.

This demand pattern can be better understood by a further examination of data from 2014 and 2015 (Figure 4), as oil demand remained largely depressed during 2013 due to an economic downturn in India. It picked up in June 2014 with the strongest demand growth since January 2013, but remained relatively muted through 2014 and registered its first fall since August 2014 in October 2014. Demand rebounded from November 2014 onwards, showing a then record increase of 9.4 per cent in February 2015 (or 0.34 mb/d, totalling 3.91 mb/d – the second highest growth on record at the time).

Figure 4: Year-on-Year Change in Total Oil Demand, 2014–15 (kb/d)



Source: Energy Aspects.

Note: Indian crude oil price excludes taxes.

Demand growth remained robust through 2015, albeit with occasional dips due to a weakening rural sector.⁵ In September 2015 y/y demand growth reached 0.5 mb/d (similar to levels seen in China in the 2000s; totalling 3.82 mb/d) and a record 0.62 mb/d in October⁶ – the latter was led by diesel, rising (y/y) by 0.22 mb/d (16.3 per cent), following a mammoth 0.25 mb/d of diesel demand growth in September. Growth rates were, however, inflated by a very low 2014 base, during which floods impacted irrigation and construction activity, weighing on diesel in particular.⁷ Gasoline demand increased y/y by 14.5 per cent to 0.53 mb/d, supported by rising vehicle miles driven and stronger car sales. In October, domestic passenger car sales rose at their fastest pace for four and half years, with y/y growth at 21.8 per cent. Two-wheeler sales, the key driver of gasoline demand, hit a record high of over 5.25 million units, up y/y by nearly 37 per cent.

⁴ India's gasoline and diesel prices are adjusted fortnightly, in line with international crude oil prices. Gasoline prices were liberalized at the retail level in 2010, whereas diesel prices were liberalized in September 2014 following an 18 month process of the gradual elimination of the diesel subsidy. See Fattouh et al. (2013) for further analysis. The four excise duty hikes totalled Rs7.75/litre for gasoline and Rs6.50/litre for diesel.

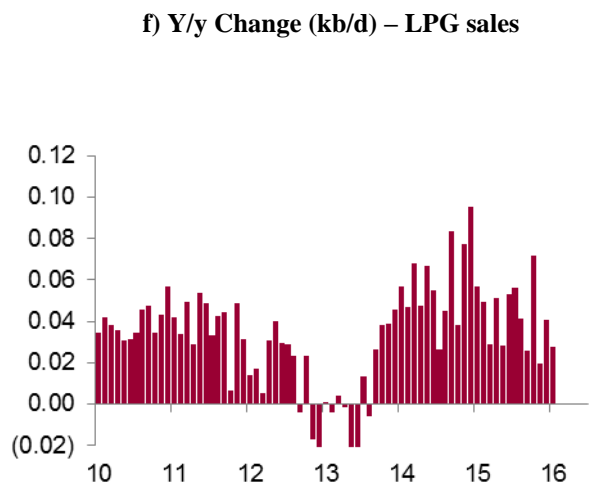
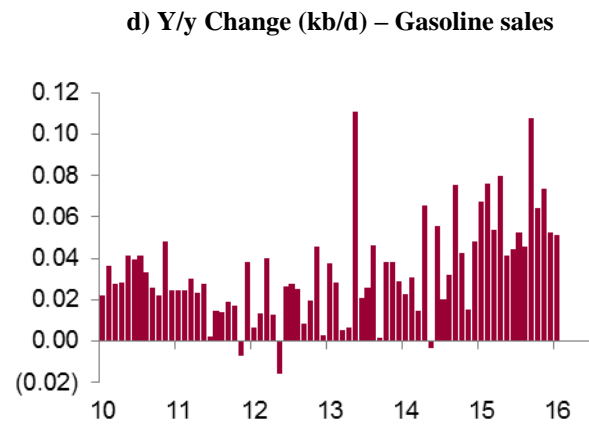
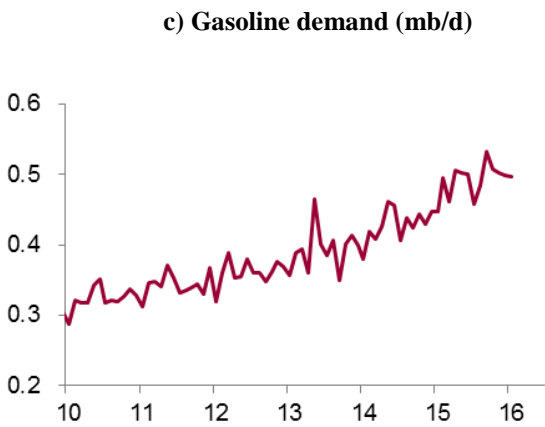
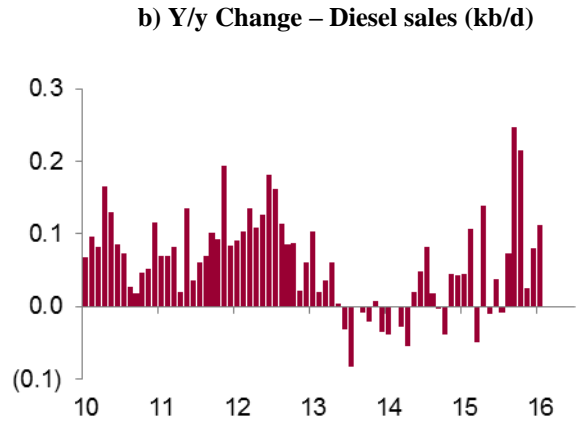
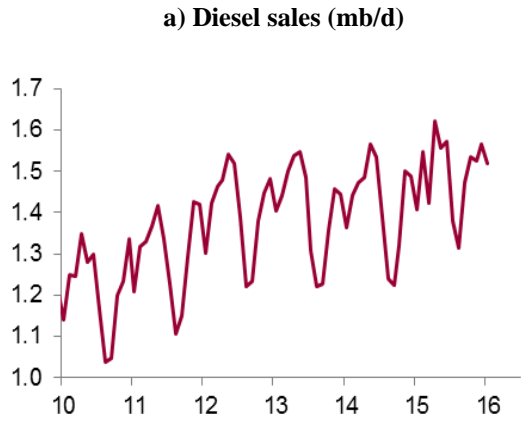
⁵ Demand growth slowed in March, May, and July, owing to factors such as erratic rainfall and poor crop realization.

⁶ This coincided with the festive season in India.

⁷ See 'India and Pakistan Floods', BBC News, 9 September 2014. Available at www.bbc.com/news/world-asia-india-29121941.



Figure 5: India Oil Product Demand, 2009–15



Source: Energy Aspects



While November 2015 demand growth eased back to a more realistic 6.4 per cent (0.24 mb/d), December 2015 demand growth picked back up to 0.31 mb/d. Average oil demand growth from April 2014 to December 2015 was around 0.22 mb/d, while average growth from January to December 2015 was 0.29 mb/d, both figures being considerably higher than the historical average demand growth of roughly 0.1–0.15 mb/d between 2000 and 2015. Demand stayed near record highs at 3.95 mb/d in January, higher y/y by 0.45 mb/d, continuing with the momentum seen in 2015.

A clearer picture of the growth of oil demand in various uses can be obtained by a closer look at a breakdown of product demand – particularly diesel, gasoline, and LPG (Figure 5, a–f). Although influenced by various seasonal factors (for instance, by monsoon rainfall), it is possible to discern some trends from April 2014 to January 2016.

Diesel growth has been somewhat inconsistent over the period under observation due to the cyclicity of demand (reflected in Figure 5a). Diesel is mostly used in goods transportation and agricultural (tractor) operations; notably, both agricultural and power generation demand tend to be seasonal. But the inconsistency of diesel demand is also due to the effect of the gradual removal of diesel subsidies and the substitution effect with gasoline – this is reflected in the Indian auto industry, in which product demand has arguably swung towards gasoline.⁸ Average monthly growth rates (based on y/y changes) in diesel demand over the period were around 4 per cent, with demand contracting in six out of 21 months.⁹ Overall, diesel demand growth over 2015 has been strong – a record figure of 20.2 per cent (totalling 1.47 mb/d) being seen in September. By November, growth had slowed dramatically to 1.6 per cent as floods in southern India curtailed economic activity, but it picked up in December to achieve a total of 1.57 mb/d. Diesel demand in January 2016 picked up to 1.52 mb/d, with y/y growth rising to 0.11 mb/d (7.9 per cent).

Average growth in gasoline demand (based on y/y changes) has been consistently high, at around 12 per cent between April 2014 and December 2015. February and April 2015 were notable months as demand growth in both touched 20 per cent (y/y). A record 25.5 per cent (y/y) (0.53 mb/d) was reached in September; this was followed by a marginally lower y/y growth in October (totalling 0.52 mb/d), before a rise to 17.2 per cent in November, and to 0.50 mb/d (total) in December, growing further by 51 thousand b/d (y/y) in January 2016. The majority of this growth has been driven by the Indian automobile sector, particularly two-wheeler sales in addition to passenger cars.

LPG demand has consistently posted positive y/y growth since April 2014, with average monthly growth rates (based on y/y changes) at around 8.2 per cent between April 2014 and December 2015. The highest y/y growth during the period was in December 2014, at 17.7 per cent (0.96 mb/d), but growth from January to December 2015 averaged around 0.57 mb/d. Some of this has come off the back of the provision of LPG subsidies, but it has also been due to the gradual move towards urbanization and a shift in household fuel use away from non-commercial sources and kerosene. LPG demand reached a record high of 0.68 mb/d in December 2015, before easing to 0.64 mb/d in January 2016.

The data indicate a ‘jump’ in oil demand over the past several months. The growth in product demand – particularly gasoline – is reminiscent of the growth rates in China about a decade ago, at the beginning of the country’s industrialization ‘boom’, when Chinese gasoline demand went on to average around 1 mb/d. Moreover, India’s growth in demand has occurred despite the removal of subsidies and the imposition of excise duties.

⁸ This is a partial reversal of a previous trend – when gasoline prices were liberalized in 2010, the Indian auto industry (which at the time was 70 per cent gasoline), had turned into an 80 per cent diesel market by 2012, and auto companies were either diverting gasoline vehicles to export markets or using heavy promotions and discounts to market them domestically.

⁹ Including April and October 2014, and March, May, and July 2015.



3. The Concept of 'Take-off' in Economic Growth and Energy Use

The concept of 'stages' of economic growth in a country's economic trajectory is distinctive in the literature on growth theory. It can be traced back to a paper, published by W.W. Rostow in 1956, which describes the process of economic growth as centring on a relatively brief time interval of two or three decades when an economy, and the society of which it is a part, transform themselves in such ways that economic growth is subsequently more or less automatic. The sequence of growth is taken to consist of three periods: a long period (amounting to several decades) when the preconditions for take-off are established,¹⁰ the take-off itself, defined within two or three decades, and a long period when growth becomes normal and relatively automatic¹¹ (Rostow, 1956). These three stages do not preclude the possibility of growth giving way to secular stagnation and decline. The 'take-off' is further defined as requiring three related conditions (Rostow, 1956):

- (a) A rise in the rate of productive investment from 5 per cent or less to over 10 per cent of national income or net national product;
- (b) The development of one or more substantial manufacturing sectors, with a high rate of growth; and,
- (c) The existence or emergence of a political, social, and institutional framework which supports sustained economic growth.

Rostow's theory of a stage-based growth trajectory has not been empirically proven, and as such, is considered by many to be redundant. For instance, while the presumption of stage-based growth is a sequential progression from agricultural to industrial growth, developing economies such as India have followed a non-linear path, with the tertiary (or services) sector forming the largest proportion of GDP, whilst the take-off in manufacturing has thus far failed to occur. However, Rostow acknowledges that a growing society need not replicate the structural sequence of developed economies such as Britain or the USA (on which the theory is largely based) but stipulates that four basic factors must be present (Rostow, 1956):

- i) There must be an enlarged effective demand for the product or products of sectors which have the potential to generate a rapid rate of growth in output. Historically this has been brought about by the transfer of income from consumption to productive investment, by capital imports, by a sharp increase in the productivity of current investment inputs yielding an increase in the consumers' real income expended on domestic manufactures, or by a combination of the above.
- ii) There must be an introduction into these sectors of new production functions as well as an expansion of capacity.
- iii) The society must be capable of generating the capital initially required to catalyse the take-off in these key sectors, and there must be a high rate of plough-back by the state or private entrepreneurs controlling capacity and technique in these sectors, and in supplementary growth sectors.
- iv) The leading sector(s) must be such that their expansion and technical transformation induce a chain of Leontief input-output requirements for increased capacity and the potential for new production functions in other sectors, to which the society progressively responds.

It can be argued that although empirically unproven, the fundamental concept of the economic 'take-off' is a normative ideal to which most developing country governments aspire and one which they consequently attempt to catalyse through specific policies. One of the reasons for a lack of consensus around the empirical evidence on 'stage-based' theories of economic growth is that it has been

¹⁰ Also termed the 'traditional society' and 'transition' stages.

¹¹ Also known as the 'drive to maturity' and the 'stage of high mass consumption'.



extremely difficult to pinpoint a ‘watershed’ growth period for any economy based on historical data. Furthermore, some of the stipulated conditions for take-off – such as a rise in the rate of productive investment to over 10 per cent of national income or net national product – are arguably redundant, as many economies (for instance, India) have attained levels of 20–30 per cent without clearly demonstrating a watershed period. Nevertheless, some broad patterns are discernible in the data for developing countries; for example, the push towards manufacturing as a catalyst for the economic take-off stage (similar to the course taken by China).

Some studies of ‘take-off’ have taken a microeconomic approach, focusing specifically on an economic sector and looking for stage-based advancements. In energy use, Bruce (2005) suggests an ‘energy ladder’ for analysing fuel use patterns in lighting and cooking for poor households; it argues that a move up the energy ladder from traditional fuels (firewood, for instance) to more commercial and efficient, yet costlier, fuels (such as LPG and electricity) coincides with increased income and progress in economic development. The energy ladder hypothesis is based on the assumption that as households move up the income ladder, they not only consume more of the same fuel, but also start using better quality fuels. El Katiri and Fattouh analyse the energy ladder hypothesis in detail, using recent evidence which suggests that as incomes rise, households tend to increase the number of fuels used (fuel stacking) but do not completely switch from the consumption of traditional fuels to modern ones (El-Katiri and Fattouh, 2011). Furthermore, the causality under the energy ladder approach to stage-based economic development is unclear: improved access to energy can contribute to improvements in household incomes through enabling factors such as education and productivity (El-Katiri and Fattouh, 2011).

A more recent approach to the study of stage-based economic growth has been to focus on per capita oil consumption in transport, which is estimated to account for over half of oil consumption worldwide. The underlying argument is that as economies and incomes grow, larger proportions of their populations become vehicle owners, contributing to the ‘motorization’ of the economy. The relationship between the growth of vehicle ownership and per capita income is highly non-linear (Dargay et al., 2007). Various empirical studies have postulated that vehicle ownership grows relatively slowly at the lowest levels of per capita income, then about twice as fast as income at middle income levels (4,000–10,000 US\$ per capita), and about as fast as income at high income levels, before reaching ‘saturation’ at the very highest levels of income (~US\$30,000) (Dargay et al., 2007). Previous studies have empirically modelled this effect as an ‘S’ shaped curve, estimated through a Gompertz function (Dargay et al., 2007; Dargay and Gately, 1999).¹² Dargay et al. (2007) utilize historical data and projections on passenger vehicle ownership and per capita income for OECD and non-OECD countries (including India), using an ‘S’ shaped function. Based on their data, they estimate that the vehicle ownership level at which the maximum income elasticity occurs is around 90 vehicles per 1000 people.

In the remaining sections of this paper, we use evidence from India to explore the argument that Indian oil demand is poised for a ‘take-off’, reflecting a wider economic shift. It is beyond the scope of this paper to pinpoint whether this falls within any of the defined stages of economic growth in a wider sense, but it is analytically useful to have this discussion of stage-based growth theory as the context, both to our main arguments and to India’s recent ‘policy push’.

4. Per Capita Oil Consumption

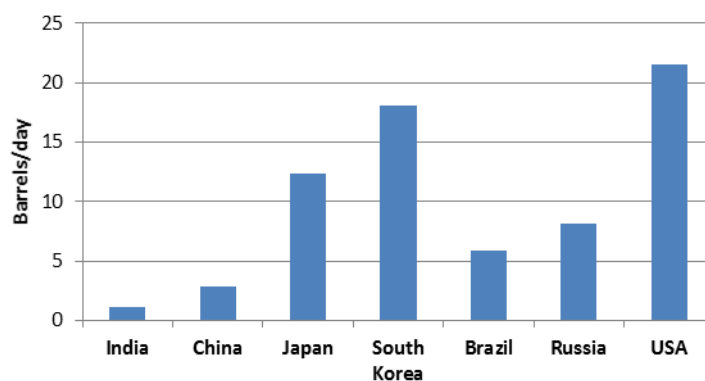
India’s per capita oil consumption remains relatively low in comparison to both the world’s largest consuming economies and to other non-OECD countries (Figure 6). The wealthiest 10 per cent of its

¹² The Gompertz function, used to model the relationship between per capita income and vehicle ownership, is similar to a logistic function, but allows different curvatures at low and high income levels.



population accounts for a quarter of household energy expenditure. Furthermore, household expenditure on energy is two and a half times higher in urban areas than in rural areas, with the most affluent sectors of the urban population spending around eight times as much as the poorest, whereas in rural areas the most affluent only spend four and a half times as much as the poorest (IEA, 2015). The drop in oil prices (the price of the Indian crude oil basket has fallen from 109 US\$/barrel in June 2014 to 25 US\$/barrel in January 2016)¹³ has been sufficient to increase affordability for a whole new segment of the growing middle class population. The effect of prices is reflected in both higher consumption of fuels as well as a switch away from bioenergy and kerosene towards commercial fuels such as LPG.

Figure 6: Per capita oil consumption, 2014 (b/d)



Source: BP (2015).

4.1 Vehicle ownership

Following Dargay and Gately (2007), the effect on per capita oil consumption is best observed in the transportation sector, which accounts for roughly 40 per cent of India’s oil consumption (most of which is diesel).¹⁴ The bars (scale on the left axis) in Figure 7 show figures for car ownership in India, while the line illustrates the number of cars per 1000 people in the country (scale on the right axis). In 2014, this latter measure stood at 20 per 1000 people;¹⁵ this is well below the maximum elasticity level of 90 per 1000 postulated by Dargay et al. (2007). It is also far below levels seen in other economies which have arguably begun to approach maximum income elasticity, followed by a plateau. For instance, Figure 8 shows car ownership and penetration for China, and the data thus displayed imply that China reached the estimated ‘maximum elasticity’ level of 90 cars per 1000 people sometime between 2013 and 2014. In contrast, India appears to be somewhere around the level that China was at in the mid-2000s (2006–7) in terms of both car ownership and penetration.

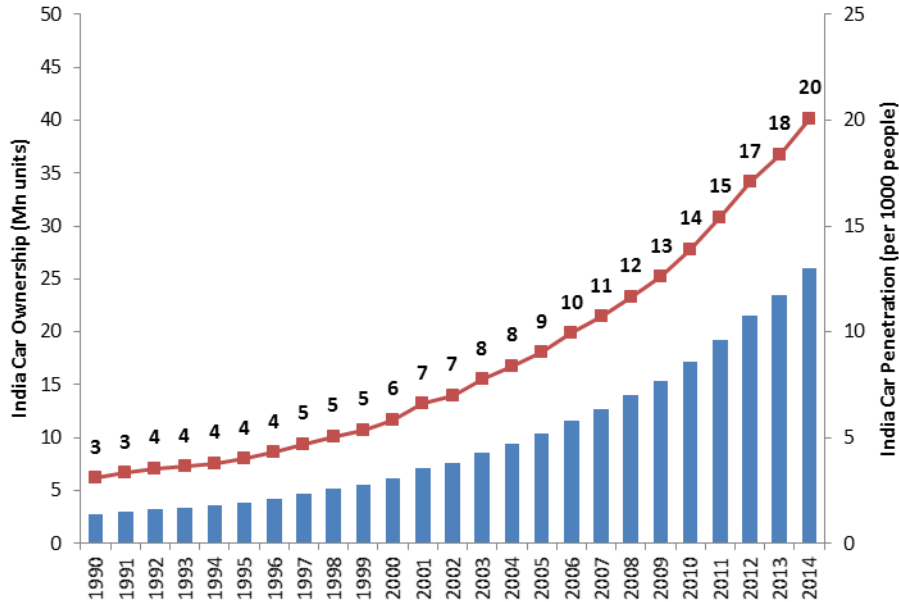
¹³ ‘Global crude oil price of Indian basket was US\$24.96 per bbl on 18.01.2016’, Press Information Bureau, Ministry of Petroleum and Natural Gas, Government of India. Available at <http://pib.nic.in/newsite/PrintRelease.aspx?relid=134583>.

¹⁴ 70 per cent of oil consumption in transport in India is accounted for by diesel (IEA, 2014).

¹⁵ Authors’ analysis. This estimate is corroborated by the estimate of passenger vehicle ownership in IEA (2015).

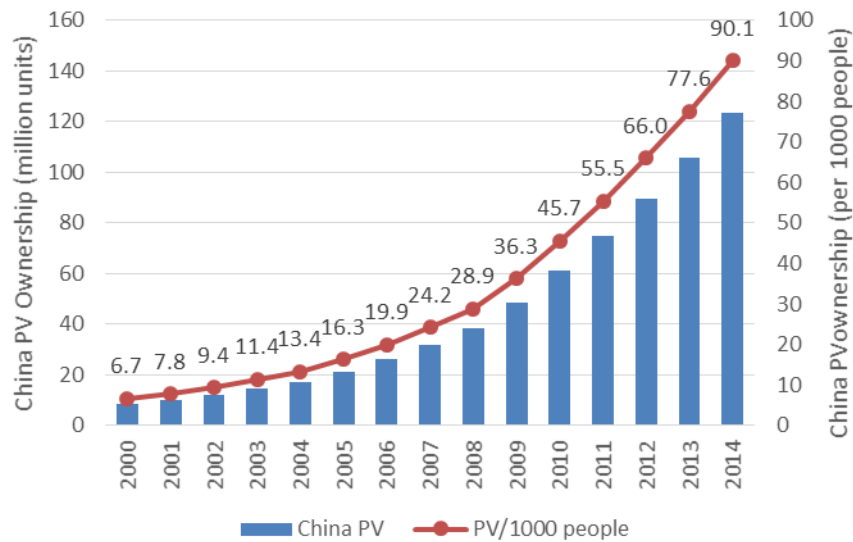


Figure 7: India – Car ownership and penetration



Source: Authors' analysis; Ministry of Road Transport and Highways, India.¹⁶

Figure 8: China – Car ownership and penetration

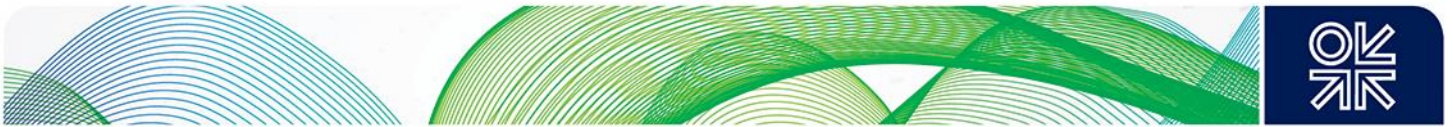


Source: Authors' analysis; National Bureau of Statistics of China.¹⁷

Car ownership and penetration, although commonly used in OECD studies as an indicator of economic take-off, is not an entirely accurate representation of patterns in India. Car sales are indicative of the effect of rising incomes and the move towards higher-end private transportation;

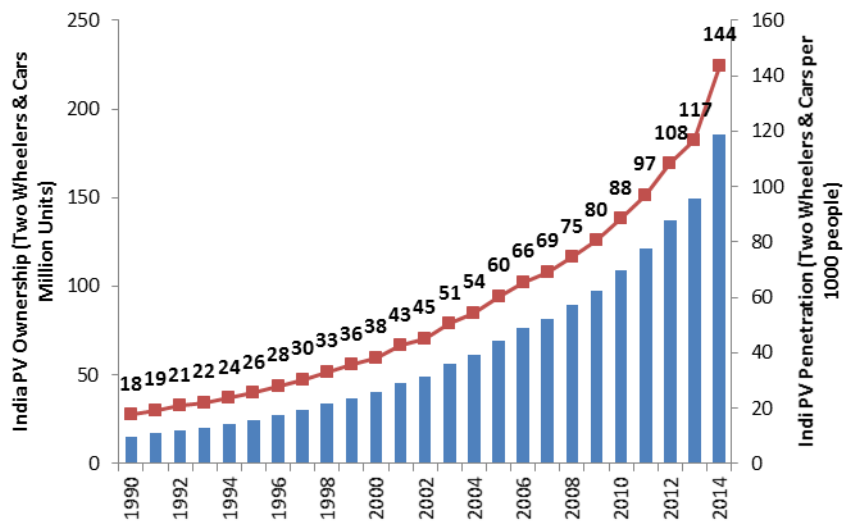
¹⁶ See <http://morth.nic.in/>.

¹⁷ Data available at <http://data.stats.gov.cn/english/easyquery.htm?cn=C01>. We use data for Chinese civil passenger vehicles, in line with the literature estimating Gompertz curves for China. See Huo et al. (2007).



however, two-wheeler sales are much more reflective of the number of new consumers entering the market for personal transportation, on the back of the increased affordability of oil. The purchasing of two-wheelers is therefore a closer reflection of a step up on the energy ladder towards motorization. Figure 9 depicts the ownership and penetration of cars and two-wheelers combined for India, and shows the much higher figure of 144 per 1000 people. It can be expected that much of the two-wheeler fleet will be replaced by cars, as consumers continue to climb the energy ladder on the back of rising economic growth and per capita income.

Figure 9: India – Vehicle ownership and penetration (cars plus two-wheelers)



Source: Authors' analysis; Ministry of Road Transport and Highways, India.

Figures 7 and 9 illustrate the fact that India's vehicle ownership pattern mimics the rising trend of the Gompertz curve. Furthermore, while India's per capita income in FY 2015 was estimated at Rs88,533,¹⁸ when this figure was converted on a purchasing power parity metric (US\$1 = Rs17),¹⁹ it stood at US\$5,208, falling just above the lower bound of the middle-income range of 'peaking' income elasticity of demand as postulated by Dargay et al. (2007). 'Saturation' levels for OECD countries such as the USA are estimated to be around 850 vehicles per 1000 people; India's low-income curvature (estimated by Dargay et al. 2007 at 200 vehicles per 1000 people) is estimated to be reached at a per capita income level of US\$6,500, while its saturation level is predicted to be roughly 683 per 1000 people (Dargay et al., 2007). Figures 7 and 9 also depict a 'jump' in vehicle ownership and penetration having taken place around 2014. Figure 10 shows additions to India's total vehicle fleet disaggregated by cars, two-wheelers, and all other vehicles; this shows that the 'take-off' has been driven mainly by additions of two-wheelers to the total vehicle fleet, further reinforcing the point that a combination of rising per capita income levels and the drop in the oil price have facilitated the affordability of oil to a wide range of lower and middle income consumers.

India is now the world's sixth largest car market, with 26 million units sold in 2014. From 2010 to 2015, car sales have been increasing by around 2 million units annually. Percentage growth rates are misleading here. Even if the market slows down, the crucial factor for oil markets is that the vast majority of new car sales in India go to fleet expansion. That is to say, unlike developed markets (where the majority of new cars are replacing ageing vehicles that are being scrapped and overall fleet growth tends to track population growth) India, like other developing markets, is experiencing a rapid increase in the size of its vehicle fleet.

¹⁸ See 'Per capita income rises to Rs88,533 in FY15', Hindu Business Line, 26 February. Available at www.thehindubusinessline.com/economy/per-capita-income-rises-to-rs-88533-in-fy15/article6937042.ece

¹⁹ Based on PPP conversion factor, GDP; from World Bank World Development Indicators 2014.

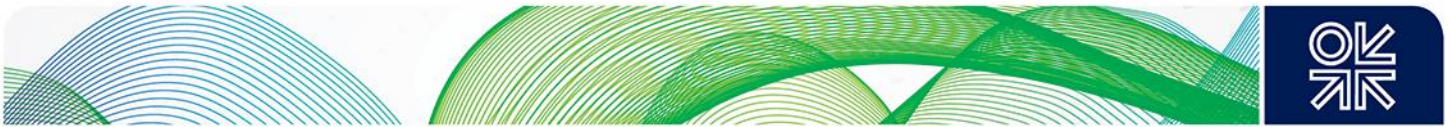
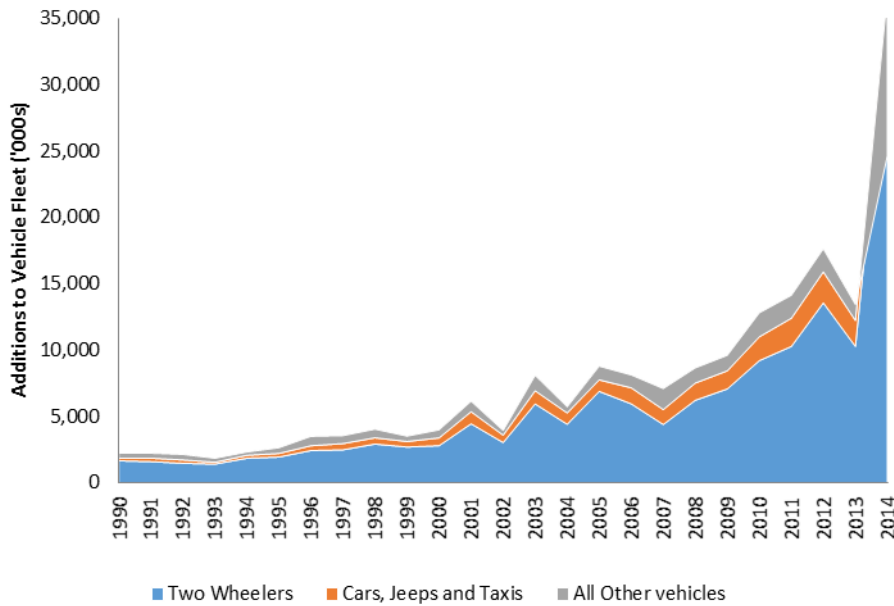


Figure 10: Additions to India's total vehicle fleet



Source: Ministry of Road Transport and Highways, India.

Between 2007 and 2014 the size of India's vehicle fleet nearly doubled, rising from around 96 million vehicles to just under 200 million vehicles. And while the used car market is growing, it remains a fraction of new car sales. The average Indian car is just five years old, so relatively few cars are old enough to be worth scrapping. Not surprisingly, this implies that new car sales and fleet growth are closely correlated. Furthermore, the major proportion of the increase in vehicle sales is accounted for by two-wheelers (Figure 10), reflecting the entry of new consumers into the passenger vehicle transportation market.

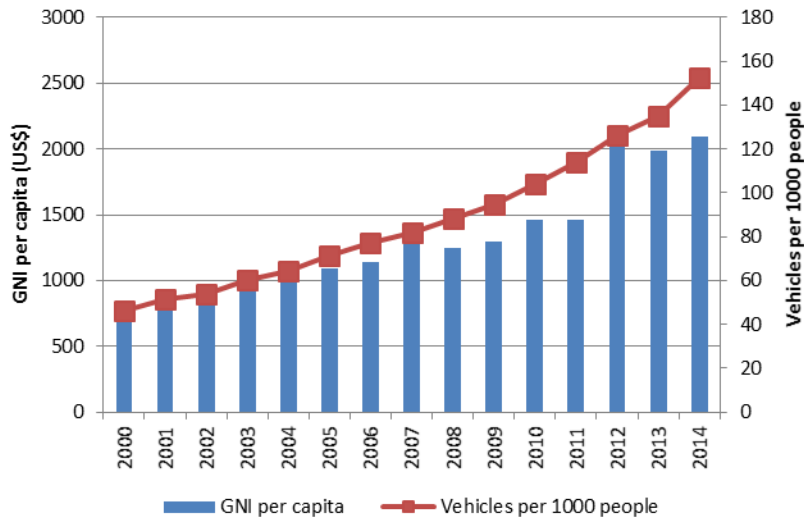
Collectively, this evidence implies that India's vehicle ownership pattern is indicative of the motorization stage, with consequent implications for oil consumption. For instance, when China underwent a similar take-off in oil consumption, vehicle ownership was estimated to be growing 2.2 times as fast as per capita income (Dargay et al., 2007).

4.2 Infrastructure and Road Building

One aspect that is not separately accounted for in the literature related to economic 'take-off' is the development of infrastructure. In the studies discussed above, per capita income is taken to be the primary determinant of vehicle ownership growth and saturation levels (Figure 11). The development of infrastructure, particularly roads in developing countries, is assumed to follow the trajectory seen in developed countries.

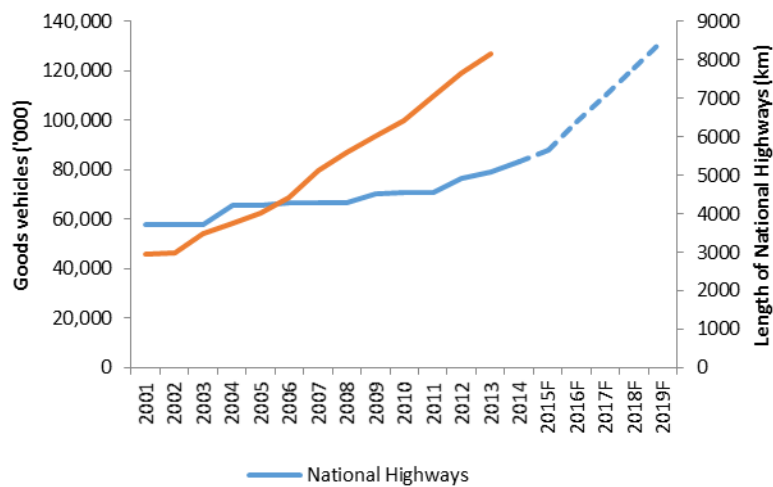


Figure 11: Per capita income²⁰ and vehicles per 1000 people in India



Source: Economic Survey (2014); Ministry of Road Transport and Highways, India.

Figure 12: Construction of National Highways in India



Source: Ministry of Road Transport and Highways, India; authors' estimates.

India's government has embarked upon a massive programme of infrastructure creation, aiming to construct 30 km of highway roads per day. The blue line in Figure 12 depicts past and projected trends in national highway construction (scale on the right axis). Highway construction has been extremely erratic during the past decade, with substantial additions seen in some years (for instance, a 13 per cent growth in length of national highways in 2004 and 2012) and no progress in others (for instance, negligible or zero growth in 2002, 2003, 2005, 2008, 2010, and 2011). Given that personal transportation (namely, the car fleet) is likely to grow in line with per capita income levels, this expansion in national highways holds significant implications, primarily for road transportation, particularly for diesel consumption. These implications are evident in the expansion of the goods vehicle fleet, given by the orange line in Figure 12 (scale on the left axis). This depicts a steep curve,

²⁰ Market exchange rates.



indicating that the size of the goods vehicle fleet has been rising despite flat growth in national highway construction in previous years. The broad conclusion from this is that the 'boom' in road construction, if successfully achieved, will further lift the expansion of the goods vehicle fleet and concomitantly increase diesel consumption. In a recently released 'Global Construction 2030' report,²¹ the Indian construction market is highlighted as the key driver of growth – being set to overtake Japan as the third-largest construction market within the next five years.

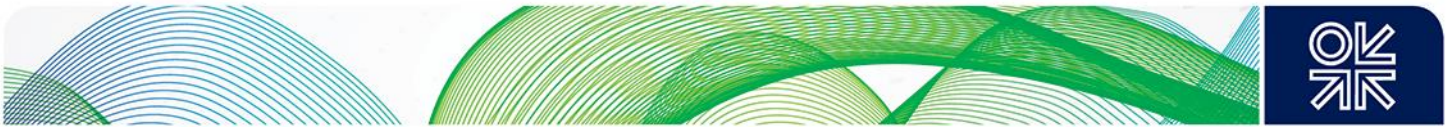
4.3 Environmental Factors

A factor that is largely unaccounted for in the literature on growth-based motorization is that of environmental constraints, imposed through policy measures on pollution, aimed at curbing particulate matter emissions from vehicles. While this constraint is unlikely to alter the trend in motorization, it will alter the demand for oil products used in enabling motorization. In India, this is likely to affect diesel demand, as diesel-powered vehicles account for over 90 per cent of SUVs, 34 per cent of small cars, and 70 per cent of large/medium cars. In December 2015, India's Supreme Court placed restrictions on the use of high-end diesel passenger vehicles (including SUVs with an engine size of 2000 cc and above) in India's National Capital Region (which includes Delhi, ranked amongst the most polluted cities in the world); these restrictions ban such high-end vehicles from new registrations until 31 March 2016. The Court has also banned diesel goods vehicles registered prior to 2005 from entering Delhi. Furthermore, all taxis in the capital must mandatorily switch to Compressed Natural Gas (CNG); this is estimated to impact around 30,000 vehicles. The impact of the ban on overall diesel demand in January 2016 was relatively small (around 10-20 thousand b/d), more than offset by higher demand from manufacturing.

Delhi's state administration has also imposed a 'green cess' on light and heavy commercial vehicles which will push up the cost of maintaining diesel vehicles. Should policy measures aimed at controlling air pollution be replicated in other large metropolitan areas, India's transport sector could see a massive shift towards gasoline (in passenger vehicles) and CNG (in public transportation). However, this is unlikely to fundamentally alter the rising trend of the Gompertz curve, as diesel will be substituted by gasoline and CNG in the growth of the vehicle fleet. CNG use in India is currently constrained by infrastructure – the existing number of CNG filling stations is unable to cater to even existing demand, let alone allow for a potential increase. There is therefore likely to be a lag between the substitution of diesel with CNG, and the shortfall could be made up by gasoline.

That said, much like the position in other emerging markets, Indian policymakers are increasingly concerned about rising urban air pollution levels. In January 2016, Delhi's government carried out a 15 day pilot programme when private cars were allowed to operate on public roads only on alternate days, depending on whether their licence plates ended in an even or an odd number. As the middle class population grows and more cars are purchased, such measures are likely to be more widely adopted. However, certain exemptions apply: for instance – and importantly for gasoline – two-wheelers have thus far been excluded from such initiatives. Nevertheless, over the longer run, the pace of gasoline demand growth is likely to be tempered from the double digit figures seen in 2015 to around 8–9 per cent over the next decade.

²¹'A global forecast for the construction industry to 2030', Global Construction Perspectives and Oxford Economics, 10 September 2015. Available at <https://www.pwc.com/gx/en/engineering-construction/pdf/global-construction-summit-2030-enr.pdf>.



5. The Push towards Manufacturing

While the bulk of the growth in Indian oil demand so far has been in the transportation and power sectors, an important aspect for oil products demand going forward could be the potential change to industrial fuel demand.

5.1 The 'Make in India' policy initiative

In September 2014, India's government announced a major policy initiative entitled 'Make in India'; this was aimed at expanding the share of manufacturing from 15 per cent of GDP (around which figure it has languished for a long time, see Figure 13), to 25 per cent by the year 2022. The primary driver behind the adoption of this policy has been a growing concern over the creation of jobs for India's growing working-age demographic²² – it has been estimated that 220 million additional jobs will be required by 2025 (Gol, 2011). India's manufacturing sector currently comprises roughly 11 per cent of total employment, in contrast with the position in other emerging markets where the share of manufacturing employment ranges from 15 to 30 per cent (Gol, 2013), and the 'Make in India' policy aims to generate 100 million additional manufacturing jobs by 2022. In order to do so, it has been estimated that India's manufacturing sector as a whole will need to grow at a rate that is 2 to 4 percentage points higher than the growth rate of its GDP, a pattern that is visible in most other emerging market economies, where manufacturing sector growth has equalled or exceeded GDP growth (Gol, 2011; 2013). In contrast, India's manufacturing sector has generally grown at a rate below that of its GDP.²³

Figure 13: Sectoral Shares of GDP (%)

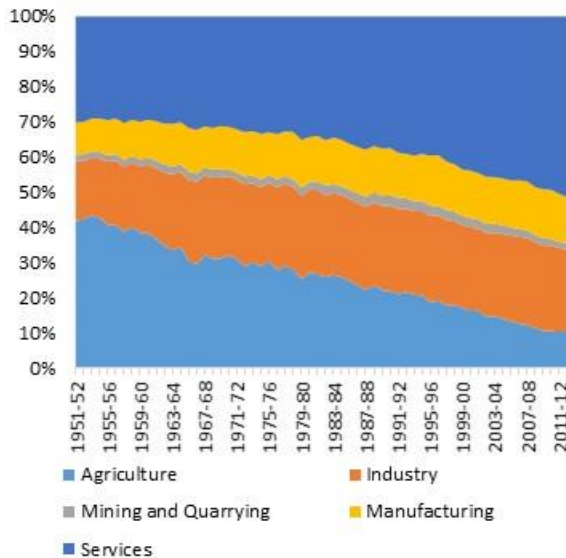


Figure 14: Growth in Sectors (%)

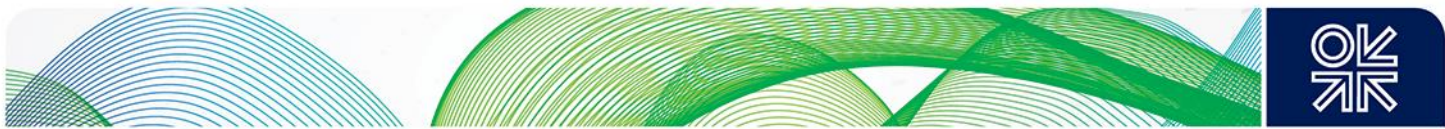


Source: India Open Government Data Platform, 2015.²⁴

²² Around 60 per cent of India's population is aged between 15 and 59 years of age.

²³ The annual average growth of manufacturing from 1999 to 2009 was 6.8 per cent, compared with GDP growth of 7 per cent for the same period. In contrast, China's manufacturing sector grew at 10.3 per cent during 1999–2009, whereas its GDP grew at 9.9 per cent for the same period.

²⁴ Manufacturing is usually a subset of industry but has been represented separately for analytical purposes. Refer to India's National Industrial Classification for details. Available at http://mospi.nic.in/Mospi_New/site/inner.aspx?status=2&menu_id=129



As seen in Figure 14, manufacturing growth over the last decade has been inconsistent (relative to services, which have achieved 5–10 per cent growth) with frequent spikes and troughs, and it slowed down to 2 per cent in 2012. The push towards manufacturing through ‘Make in India’ aims at raising the manufacturing growth rate to 12–14 per cent by 2025 (Gol, 2013). It appears to be targeted at replicating China’s success: China’s manufacturing sector currently comprises 30 per cent of GDP, and its manufacturing output as a percentage of world output has risen from below 5 per cent in 1970 to roughly 19 per cent in 2010 (Gol, 2013). Export-oriented manufacturing has formed an important part of China’s economic boom; its merchandise exports rose from a figure of 2 per cent of world merchandise exports in 1990, to 12 per cent in 2014. In contrast, India’s share of world merchandise exports rose from less than 1 per cent to under 2 per cent during the same period.²⁵

The push towards manufacturing through ‘Make in India’ is targeted towards specific segments of manufacturing industry: employment-intensive industries, capital goods industries, strategically important industries (the development of ‘national capabilities’), industries where India is seen as already having a competitive advantage (through existing indigenous expertise and cost effective manufacturing), Small and Medium Enterprises (SMEs),²⁶ and public sector enterprises. These are summarized in Table 1 below.²⁷

Table 1: Sectors Targeted through ‘Make in India’

| | |
|--|--|
| Employment-intensive industries | Textiles and garments, leather and footwear, gems and jewellery, food processing. |
| Capital goods | Machine tools, heavy electrical equipment, heavy transport, earth moving and mining equipment. |
| Strategic industries | Aerospace, shipping, IT hardware and electronics, telecommunications equipment, defence equipment, solar energy. |
| Competitive advantage | Automobiles, pharmaceuticals, medical equipment. |
| Small and Medium Enterprises (SMEs) | Miscellaneous. |
| Public Sector Enterprises | Miscellaneous. |

Source: Gol (2011).

Table 2 further details the estimated growth rates deemed necessary within specific sub-sectors of manufacturing in order to achieve these manufacturing targets (Gol, 2013). This is based on several assumptions, which include the target annual average growth rate of 12 per cent for the manufacturing sector as a whole during the Twelfth Five-Year Plan (2012–17) and until 2025.

²⁵ In 2010, manufacturing represented 61.5 per cent of India’s total merchandise exports.

²⁶ SMEs contribute significantly to manufacturing output, employment, and exports.

²⁷ ‘Make in India’ separates the target sectors into automobiles, auto components, aviation, biotechnology, chemicals, construction, defence, manufacturing, electrical machinery, electronic system design and manufacturing, food processing, leather, mining, oil and gas, pharmaceuticals, ports, railways, roads and highways, renewable energy, ‘space’, textiles, and thermal power.

Table 2: Targeted Growth in Manufacturing Sectors

| | <i>% of Manufacturing GDP</i> | <i>Existing CAGR²⁸</i> | <i>Target CAGR²⁹</i> | |
|----|---|---------------------------------------|-------------------------------------|------|
| 1 | Food products & beverages | 8.7 | 7.3 | 8.8 |
| 2 | Tobacco products | 1.7 | 4.7 | 4.7 |
| 3 | Textiles | 9.2 | 3.8 | 11.5 |
| 4 | Wearing apparel | 3.9 | 7.3 | 11.5 |
| 5 | Leather products and others | 1.3 | 4.6 | 24.0 |
| 6 | Wood and others | 2.2 | 12.0 | 12.0 |
| 7 | Paper, publishing, and others | 2.7 | 5.8 | 8.7 |
| 8 | Coke, petroleum products, nuclear fuel, rubber, and plastics | 10.6 | 7.5 | 10.7 |
| 9 | Chemicals and chemical products | 12.2 | 9.0 | 12.0 |
| 10 | Other non-metallic mineral products | 6.8 | 13.6 | 13.6 |
| 11 | Basic metals | 9.7 | 1.9 | 10.3 |
| 12 | Machinery and equipment | 11.1 | 8.1 | 16.8 |
| 13 | Electrical machinery and apparatus, telecoms, and others | 6.0 | 12.8 | 12.8 |
| 14 | Motor vehicles and other transport equipment | 7.7 | 6.0 | 13.0 |
| 15 | Furniture and other manufacturing | 6.3 | 6.3 | 6.3 |

Source: Gol (2013).

5.2 The effect on oil consumption

India's push to expand its share of manufacturing in GDP implies a concomitant increase in oil consumption, subject to improvements in the energy efficiency of GDP. Manufacturing GDP in India in 2014 was estimated at US\$153 billion, or roughly 15 per cent of total GDP, which is estimated at around US\$1 trillion (Planning Commission Databook, 2014). In Figure 15, we build an estimate of India's manufacturing GDP to 2022 (the series of blue bars with the scale on the left axis) and of concomitant oil consumption in manufacturing (the line with the scale on the right axis).³⁰ We begin by using historical data from 2007 to 2015 for total GDP, manufacturing GDP, and oil consumption in manufacturing. We use the IMF World Economic Outlook estimates for GDP growth to build projections of India's total GDP (in US\$ bn) to 2022.³¹ We then obtain the estimate for manufacturing GDP as a proportion of total GDP (in US\$ bn) for the year 2022 by using the 25 per cent target set by the government. Working back from this target, we assume that the expansion required in manufacturing GDP from 2016 to 2022 will follow a linear trend to 2022. The historical figures and projected estimates for manufacturing GDP are plotted as the series of blue bars whose values are given by the scale on the left axis of Figure 15. Similarly, we utilize our historical data on oil consumption in manufacturing to obtain the amount of oil consumed per unit of manufacturing GDP, averaged over 2007–14.³² We then utilize this average, along with our projected estimates of manufacturing GDP, to compute a broad estimate of projected oil consumption in manufacturing for each year from 2016 to 2022. These projections are plotted as the line whose values are given by the scale on the right axis in Figure 15.

²⁸ Compound Annual Growth Rate during Eleventh Five-Year Plan (2007–12).

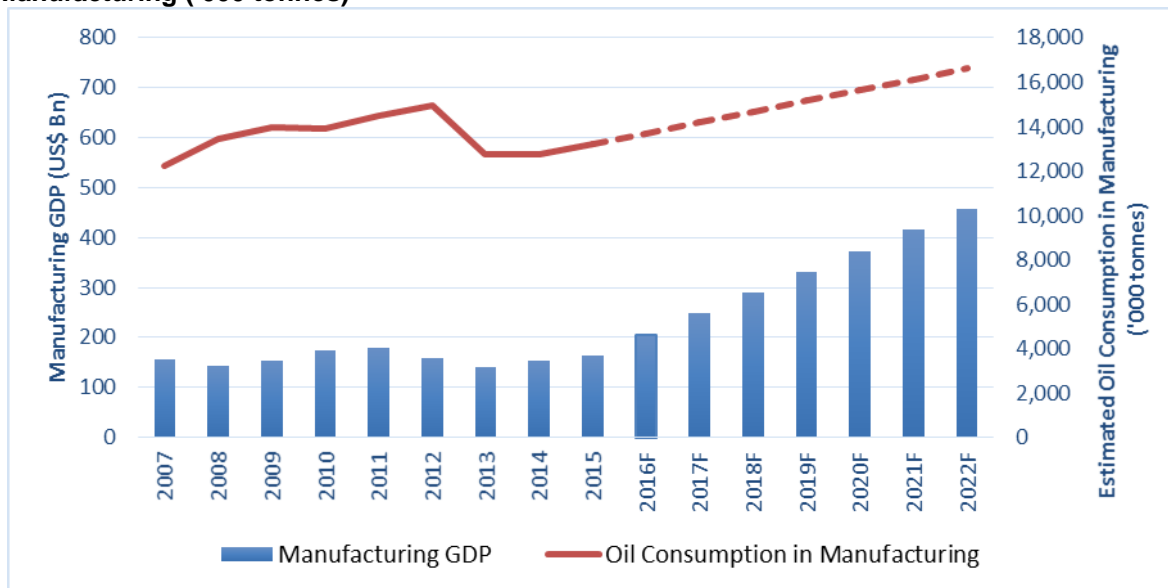
²⁹ Compound Annual Growth Rate to 2025.

³⁰ At current prices.

³¹ See Appendix 1 for IMF projections of GDP and for details of the assumptions used to build our estimates.

³² We use an eight year average, as this is the entire time series for which we were able to obtain data on oil consumption in manufacturing.

Figure 15: Manufacturing GDP (US\$) and Estimated/Projected Oil Consumption in Manufacturing ('000 tonnes)



Source: Authors' estimates.

The projections show a clear upward trend from 2016 onwards, with oil consumption in manufacturing in 2022 estimated at around a third higher than the figure for 2014. However, it must be stressed that this is a broad and somewhat conservative estimate, based on a set of assumptions. The actual trend could well be non-linear, and is contingent upon the effectiveness of government policy in catalysing the required ramp-up in manufacturing GDP. Furthermore, improvements in energy efficiency could temper oil consumption growth in manufacturing. However, one firm conclusion that can be drawn is that the push towards manufacturing will support the upward trend in oil consumption, through to 2022.

5.3 Naphtha and Petrochemicals

Diesel will not be the sole beneficiary of the push toward manufacturing, as naphtha and bitumen consumption are also likely to increase. Indeed, naphtha demand has grown considerably since March 2015, reaching a double-digit growth figure in July 2015. Between July and November 2015, naphtha demand growth averaged 29 per cent, with November growth a massive 40 per cent. This was driven by the demand for naphtha as a gasoline blend stock, and more importantly by demand from the growing petrochemical (particularly plastics and polymers) and fertilizer sectors. As manufacturing demand grows, so will the demand for plastics (petrochemical industry), and naphtha is best placed to benefit from this, particularly given the focus of the 'Make in India' campaign.

The Indian petrochemical industry has grown rapidly in the last 10 years; capacity expansions have led to much greater self-sufficiency for major petrochemical building blocks such as ethylene, propylene, butadiene, and aromatics, amongst others. These building blocks all had surplus capacity of at least 0.5 million tons per annum (Mtpa)³³ as of 2013. The olefinic base chemical capacity is expected to increase from ~ 4.5 Mtpa to 8–10 Mtpa, while the aromatic base chemical capacity is expected to increase from 3.2 Mtpa to 5–6 Mtpa over the next five to six years. Robust expansions in the refining sector, together with surplus availability of naphtha as feedstock for petrochemical plants, have supported this growth. Over the next five years, the capacity expansion projects announced by

³³ Department of Chemicals and Petrochemicals.



all major Indian petrochemical companies will lead to a reversal of balances, with excess naphtha supplies falling sharply.

For instance, Mangalore Refinery and Petrochemicals Limited (MRPL) recently launched its long-delayed aromatics plant (OMPL), which will use naphtha. Brahmaputra Cracker & Polymer Ltd. (BCPL) has begun commissioning activities for the first phase of its long-awaited integrated petrochemical complex in Assam. Reliance Industries' Jamnagar complex, although delayed, is also expected to begin operations in the next few years. The long-delayed 1.1 Mtpa OPAL naphtha cracker in Gujarat is inching toward completion and is likely to process some naphtha in 2016. Indian Oil Corporation (IOCL) will expand capacity at its Panipat naphtha cracker to 1.2 Mtpa by 2019, from 0.85 Mtpa at present. A recent McKinsey report³⁴ concludes that India will consume an additional 20–25 Mtpa of petrochemical intermediates by 2025 as industrial demand rises. The Indian Ministry of Petroleum and Natural Gas, which had earlier forecast that naphtha and fuel oil sales would contract year-on-year in 2016, now foresees substantial growth for both fuels, with naphtha demand set to rise in 2016 by 16.6 per cent. Thus, the petrochemical sector has contributed substantially to double-digit growth rates in sales of naphtha.

6. Implications for Trade Flows

Our analysis suggests that oil consumption in India is at a potential inflection point, mimicking the stage of economic 'take-off'. It can be argued that the relationships between infrastructure creation, the push towards manufacturing, and oil consumption, generally hold true for emerging markets, and can be illustrated by looking at export data for China and India.³⁵ Figure 16 shows that oil consumption and exports (plotted here as a percentage of GDP to enable relative comparisons) have tended to move together – a simple correlation of India's merchandise exports with its oil consumption yields a strong positive coefficient of 0.92.³⁶

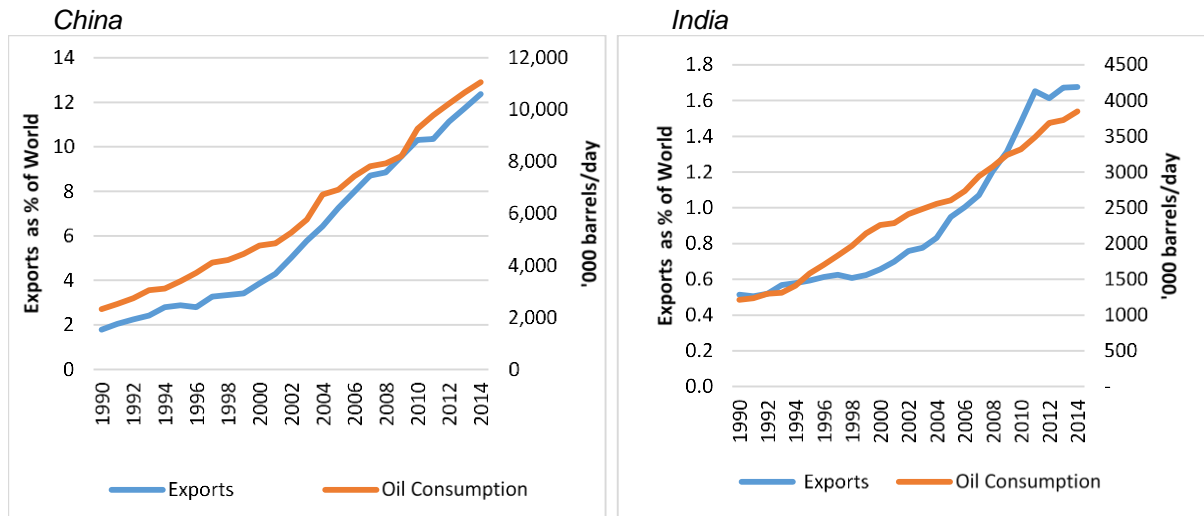
³⁴ 'Building a self-sufficient petrochemical intermediates industry in India by 2025', *Chemicals Practice*, McKinsey & Company, March 2015.

³⁵ We consider 'exports' as a uniform measure; this enables comparison between India and China, since 'manufacturing' may constitute different definitions (and calculations) in either country's national accounts data. Furthermore, it can be argued that the bulk of manufacturing is injected into exports.

³⁶ Authors' estimate.



Figure 16: Exports and Oil Consumption



Source: BP (2015); World Trade Organization (2015).

However, the take-off in oil consumption also holds implications for trade flows, both with specific regard to India's trade balance and its recent status as an oil products exporter, as well as for international oil trade flows. Already, oil product exports have fallen y/y for eight of the first eleven months of 2015, with average product exports over the same period lower by over 0.1 mb/d compared to the same period in 2014. Product imports, which are still less than half the levels of total product exports, rose y/y by over 0.1 mb/d.

Gasoline imports have been on the rise. IOCL and Hindustan Petroleum Corporation Ltd. (HPCL) – traditional exporters of gasoline – turned into net importers of gasoline in 2015. Indian gasoline imports may remain strong in the first few months of 2016, as the start-up of IOCL's 0.3 mb/d Paradip refinery was delayed until March 2016. Moreover, Paradip will initially run at 60 thousand b/d and only ramp up to full capacity at the end of Q1 2017 – only then will it help ease IOCL's import burden. However, given the pace of domestic demand growth, we estimate that Paradip will provide a respite for one to two years at best, before Indian state-owned refiners potentially turn into net importers of gasoline. This is despite Paradip maximizing its gasoline output (at 81 thousand b/d) at the expense of naphtha (the refinery will not have any surplus naphtha).

The area where the change in trade flows has been the most apparent has been in naphtha. Indian naphtha exports have fallen y/y by around 21 thousand b/d between January and November 2015, with the decline extending to 44 thousand b/d between September and November, as the country consumes more of its own output due to the rapid growth in demand discussed above. India has long been a key short-haul naphtha supplier for the Asian market, so the decline in exports has been felt very rapidly. Moreover, these shipments are unlikely to return. India exported just over 0.1 mb/d of naphtha in October 2015; this is the smallest amount it has shipped overseas since February 2009, due to turnarounds and domestic demand (which was up by 73 thousand b/d y/y, to more than 0.3 mb/d). In November 2015, Indian naphtha exports remained lower y/y by 52 thousand b/d. With gasoline demand set to continue to grow at a phenomenal rate, Indian refiners are struggling to keep pace, which will keep up the pressure on naphtha supplies.

Diesel exports have also fallen, by an average of 39 thousand b/d in 2015. While part of this is tied to heavy refinery maintenance, growing demand also played a part in a trend that is likely to continue. The absorption of India's surplus diesel by domestic demand growth is a positive development for the oversupplied East of Suez markets and, if sustained, has the potential to be felt in global prices in the summer months if there were to be significant refinery disruptions in the Middle East or Asian



markets. A 'take-off' in domestic oil demand could therefore reverse India's recently achieved status as a net oil products exporter, with significant implications for international trade flows.

7. Conclusion

India's oil demand has soared over the last year, reaching an average figure for oil demand growth y/y of 0.30 mb/d in 2015, compared with 0.1–0.15 mb/d over the previous decade. This jump in demand reflects a number of underlying dynamics at play, which indicate that India's oil demand may be on the verge of 'taking off'. The magnitude of this 'take-off' can be gauged by the fact that Indian oil demand is demonstrating trends that were visible in China around a decade or a decade and a half ago, during the country's industrialization 'boom': for instance, the level of growth in oil product demand, particularly gasoline, is rapidly approaching levels seen in China prior to its 'boom'. Furthermore, an analysis of motorization, widely regarded as an acceptable metric in gauging oil consumption patterns and economic 'take-off', shows that car ownership trends in India (per thousand population) are at around the levels which China reached a decade ago. India's per capita income on a purchasing power parity basis is also estimated to have breached the threshold beyond which motorization rapidly ensues.

While the drop in oil prices since June 2014 has aided the expansion in oil demand (the increased affordability of oil to a very large section of the population is reflected, for instance, in massive additions of two-wheelers to the total vehicle fleet over 2015) this paper has also shown that recent policy initiatives are likely to further lift oil demand, a process which is already apparent in the data. Specifically, this paper has estimated the impact on oil demand, and specifically on oil products such as diesel and naphtha, of the push to increase manufacturing's share within GDP from 15 per cent at present to 25 per cent by 2022. Such an increase could add at least a third to India's current demand levels, based on a broad and conservative linear estimate. A concomitant programme of road infrastructure creation targeting the addition of 30 km a day will add to this, although this paper has argued that growing environmental and air pollution concerns could constrain growth in oil demand in the transportation sector. In terms of the bigger picture: while China's oil demand growth has slowed to around 0.30 mb/d since 2013 from levels of 0.50 mb/d in the previous decade, India appears to not have long to go in terms of achieving the same levels of oil demand growth. This rise in demand also has implications for India's recently acquired status as a net exporter of oil products, which, as discussed, could well be reversed. Finally, the question of whether India will manage to soar to a higher plane of development and consumption is contingent to a great extent upon its ability to carry out and sustain structural reforms to support economic growth.



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Appendix 1: Estimates of oil consumption in manufacturing

IMF-WEO projections for India's GDP growth

| Year | % GDP growth |
|-------|--------------|
| 2014 | 7.3 |
| 2015 | 7.3 |
| 2016 | 7.5 |
| 2017 | 7.5 |
| 2018 | 7.6 |
| 2019 | 7.7 |
| 2020 | 7.7 |
| 2021* | 7.7 |
| 2022* | 7.7 |

*Assumed by authors

Assumptions for estimates of oil consumption in manufacturing

| Year | Total GDP (US\$ bn) | Manufacturing GDP (US\$ bn) | Share of Manufacturing GDP in Total GDP (%) | Oil Consumption in Manufacturing ('000 tonnes) |
|------|---------------------|-----------------------------|---|--|
| 2007 | 968 | 156 | 16.14 | 12229 |
| 2008 | 906 | 143 | 15.78 | 13430 |
| 2009 | 952 | 154 | 16.17 | 13959 |
| 2010 | 1079 | 174 | 16.17 | 13929 |
| 2011 | 1095 | 178 | 16.28 | 14515 |
| 2012 | 1008 | 159 | 15.76 | 14954 |
| 2013 | 949 | 142 | 14.94 | 12775 |
| 2014 | 1018 | 153 | 15.00 | 12726 |
| 2015 | 1093 | 164 | 15.00 | 13213 |
| 2016 | 1175 | 206 | 17.52 | 13700 |
| 2017 | 1263 | 248 | 19.61 | 14186 |
| 2018 | 1359 | 290 | 21.31 | 14673 |
| 2019 | 1463 | 331 | 22.65 | 15160 |
| 2020 | 1576 | 373 | 23.68 | 15646 |
| 2021 | 1697 | 415 | 24.46 | 16133 |
| 2022 | 1828 | 457 | 25.00 | 16620 |

Note: Data on oil consumption in manufacturing covered LPG, Naphtha, High Speed Diesel Oil, Light Diesel Oil, Furnace Oil, and Low Sulphur Heavy Stock/High Sulphur Heavy Stock. Data on oil consumption was gathered from the Indian Petroleum and Natural Gas Statistics of the Ministry of Petroleum and Natural Gas. GDP data was obtained from the (erstwhile) Planning Commission and National Accounts.