Trends in substitution of commodities in the Indian economy

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Overview

As per a World Bank study titled 'The Role of Substitution in Commodity Demand', innovation and substitution between commodities have been key features of the commodity markets. Substitution among commodities is a complex process and can take place at short- and long-term horizons as well as within and across commodity groups. It can occur from a change in relative prices in the short-term (if alternative materials are readily available), with an extended lag (if the production of new materials entails significant costs), and in the longer term (from development of new technologies and innovation).

Substitution can also emerge from exogenous technological shocks. Apart from innovation, substitution among commodities can be caused by other factors such as domestic policies that often change the relative prices.

Trade policies (such as tariffs) and macroeconomic policies (such as exchange rate management) can alter the terms of trade and hence induce substitution. Changing consumer preferences too can also lead to substitution.

This study analyzes the role of substitution in commodity demand pertinent in the Indian economy particularly if present in the following sectors.

1. Oil and Gas
2. Power
3. Fertilizers
4. Non-Ferrous metals segment (Copper and Aluminium)

1. Oil and Gas Industry

Note: Two and three wheelers constitute about 80% and 4% of the Indian automobile sales while passenger vehicles (PVs) and commercial vehicles (CVs) have shares of around 13% and 4% of the sales respectively.

Petrol is used as a transportation fuel in vehicles such as passenger cars, two-wheelers and three-wheelers whereas diesel is mainly used in the road transport (70%), agriculture, industry and power generation sectors (diesel is used to fuel medium and high speed compression ignition engines (operating above 750 rpm) in CVs, stationary diesel engines, locomotives and pumps etc.).

Initially price of petrol and diesel were subsidised along with LPG and kerosene but petrol prices were deregulated in June 2010 and subsequently diesel prices too were decontrolled in October 2014.

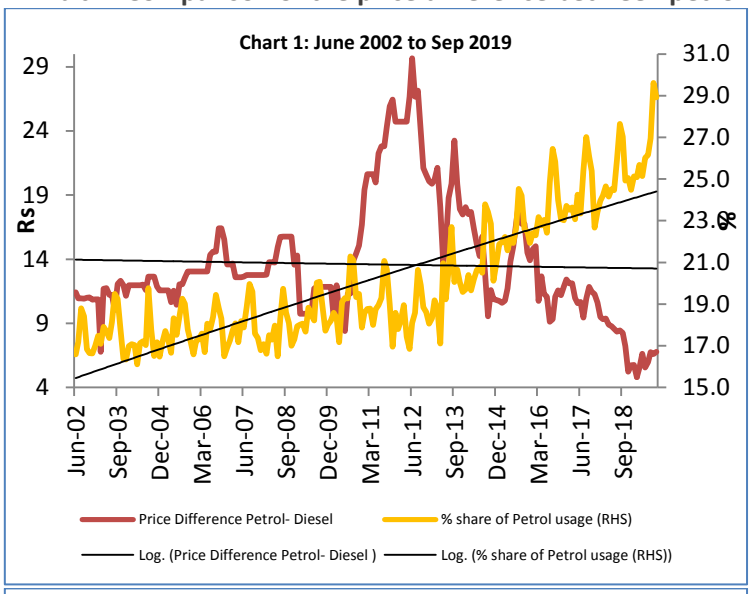
Petrol and diesel prices are now changed every day by fuel retailers at 6 am after taking into account several factors like international benchmark rates for fuel and the US-dollar exchange rate.

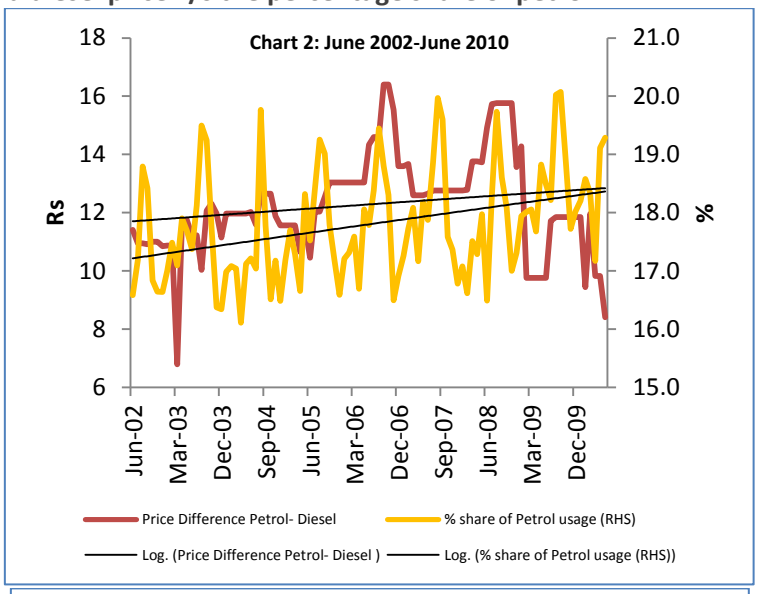
In order to see if there has been any substitution taking place between petrol and diesel, the study analyses the price and consumption differentials of both the auto fuels. In the charts below the price difference between petrol and diesel has been juxtaposed with the share of petrol in consumption of fuel (petrol plus diesel). It is implicitly assumed that the price variation is the single most important factor for substitution, which is not always the case as there are other factors such as market penetration of diesel vehicles, cost of the vehicles, policies in place, spread of CNG as a fuel etc. Therefore the exercise is carried out under ceteris paribus conditions and links change in share to only price differential.

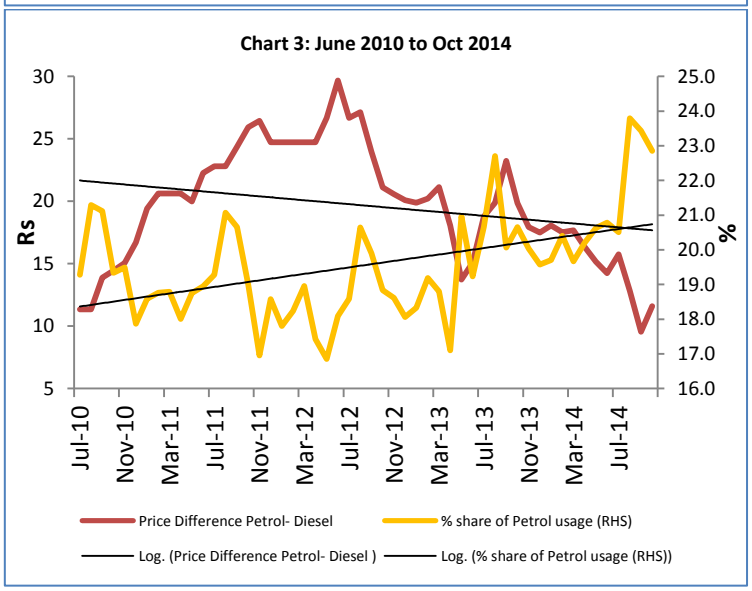
Time Frame	
June 2002-September 2019 (Chart 1)	Overall
June 2002-June 2010 (Chart 2)	Petrol price was regulated till June 2010
July 2010-October 2014 (Chart 3)	Diesel price was regulated till October 2014
November 2014- September 2019 (Chart 4)	Petrol and Diesel prices are market driven

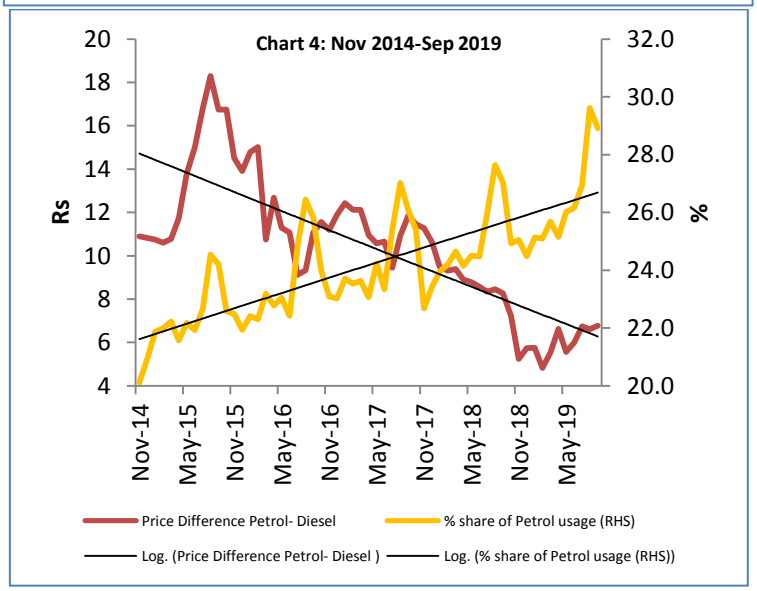
The charts below trace the relationship between these two variables over four time periods.

Exhibit 1: Comparison of the price difference between petrol and diesel price v/s the percentage share of petrol









Source: CARE Ratings

1. For the entire period starting 2002, the coefficient of correlation was -0.35 meaning thereby that the share of petrol went up over the period of 17 years as price differential reduced. Therefore over a period of time consumption of petrol appears to be positively related to lower price differential.
2. For the period June 2002 to June 2010 when petrol was deregulated, the coefficient of correlation was 0.02 meaning thereby that there was no relation between price differential and share of petrol. When price of petrol and diesel was regulated by the government the price difference between both the fuels used to range around Rs 12/ltr whilst the share of petrol was around 18%.
3. Between June 2010 and Oct 2014, petrol price was deregulated while diesel continued to be regulated. The share of petrol averaged 19% and ranged between 18-22%. The price differential however increased to an average of Rs 19/ltr and moved from the range of Rs 12 to Rs 28-29. The coefficient of correlation was -0.58.
4. Post October 2014 onwards (and till date), with the deregulation of diesel prices not only has the price difference between both the fuels narrowed to Rs 6 in the last 12 months, and averaged Rs 10-11 for the entire period but the percentage share of petrol consumption has increased from 18%-19% to 24% indicating the preference for petrol driven cars over diesel. The coefficient of correlation was -0.56.

Interestingly a regression analysis mapping share of petroleum to price differentials gave similar results where the pre-deregulation period had a coefficient that was not significant while that in other periods were significant.

Table 1: Percentage share of usage of petrol and diesel over the years

Time Frame	Petrol	Diesel
June 2002-May 2010	18%	82%
June 2010-September 2014	19%	81%
October 2014- September 2019	24%	76%

Source: CARE Ratings

Initially when the price gap between petrol and diesel was extremely wide, diesel powered cars were preferred despite petrol variants being priced cheaper and also because fuel efficiency of diesel models was relatively higher. Now with deregulation of both the fuels, the preference for petrol driven vehicles is increasing as the price gap between petrol and diesel has narrowed. Government mandated pollution control emission norms (currently India is following BS-IV norms but the country will be shifting to BS-VI April-2020 onwards) has also led to the gradual phasing out of diesel powered engines leading to the substitution of diesel with petrol.

As per SIAM, diesel powered cars accounted for 19% of total car sales in India during FY19 as compared with 47% of sales during FY13 (a year before diesel price was deregulated). The percentage of diesel driven passenger cars in total passenger vehicles has also dropped to 36% FY19 as compared with 58% during FY13. In the current financial year FY20, the share of diesel consumption has fallen due to a sluggish economy and structural changes like GST-induced road transport efficiency and trucks being allowed to carry a bigger load which has led to fewer CVs on the road.

Table 2: CNG sales (Unit: TMT)

	CNG Sales	Change (y-o-y)
2015-16	2,155	5.8%
2016-17	2,365	9.7%
2017-18	2,638	11.5%
2018-19 (P)	3,076	16.6%

Source: PPAC

Another factor to consider in the case of petrol and diesel substitution is the growing popularity of natural gas in the form of CNG as an auto fuel. With the government aiming to convert India into a gas based economy in-lieu with the effort of

controlling the pollution levels in the country as well, CNG is emerging as an alternative to petrol and diesel. CNG sales have increased at a CAGR of 10.9% during FY15-19. Most of the Indian states have mandated the use of CNG for public transport (taxis, auto-rickshaws and buses) and the government is expediting the infrastructure creation of CNG re-fuelling stations as well. The price of CNG is 60% cheaper than petrol and 45% cheaper than diesel and given the volatility in petrol-diesel prices more vehicle users are making a shift to CNG powered vehicles.

Pricing has been an important element for substitution to take place within petrol and diesel consumption. In the start diesel was preferred over petrol with respect to pricing and fuel efficiency but with the deregulation of diesel, petrol consumption has gained traction. The correlation of the entire times series shows a negative relation indicating substitution taking place as well. Going forward with the government propagating the manufacturing of EVs, the switchover to BS-VI fuel norms and the increase in usage of natural gas as an auto-fuel, there will be more substitution taking place in the oil and gas industry.

2. Power Industry

The aim here is to relate substitution of electricity generated by conventional sources (coal, gas and diesel) and its share in total electricity generation in India, by renewable power (solar-based power) and other such non-conventional energy sources over the years.

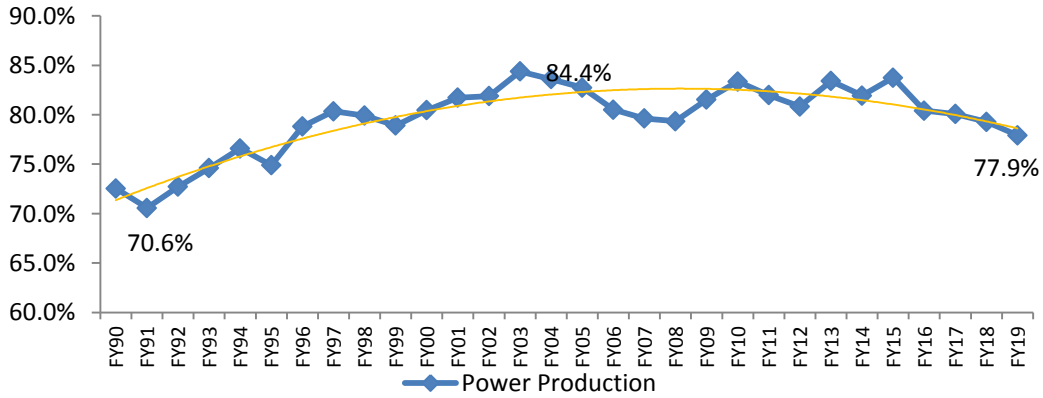
We have also tried to analyze the impact of price of coal vis-à-vis price of photovoltaic cells used for solar power installation. The analysis was unable to derive significant insights from statistical tools used to measure the change in share of thermal w.r.t. rising share of renewable power in India, due to limited data points.

Power Sector in India: Evolution and Substitution

Power sector in India continues to be highly regulated and state controlled. Its availability and distribution has wide socio-economic implications. India's power capacity expanded 4x times post-1997. Bulk of this growth in capacity addition took place during 2007-2017 as a result of investments made by private-sector power generators. Private sector generation capacity increased from 17 GW in 2007 to 143.6 GW in 2017. Thermal- majorly coal-based and some gas-based plants, contributed to the majority of this capacity addition followed by solar, wind and hydro energy. Post 2017, an additional 21 GW of power capacity has been added -primarily in renewable energy segment.

Power generation in India recorded CAGR growth of 6.1% during 1990-2019. Power generation by thermal power plants grew by 6.3% CAGR during the same period. Generation from renewable energy sources on the other hand has grown at a much sharper rate with an absolute growth of 355% and CAGR growth of 16.4% during the last decade.

Exhibit 2: Evolving Share of Thermal Power (1990-2019)



Source: Annual Reports- Ministry of Power

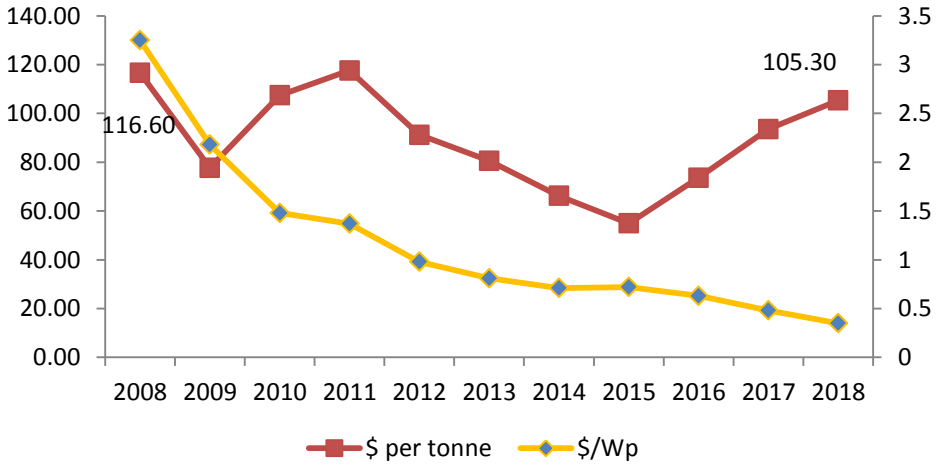
Share of thermal power was 72.5% in 1990 and it gradually peaked and remained over ~80% between 2000 and 2014. Thereafter, share of thermal power in the overall share has gradually decreased to ~78% in FY19. Growing share of renewable energy in total installed capacity can be linked to some of the government's policies in the past. In 2010, India introduced its first major policy to focus on developing renewable energy. The government set a target to install 100 GW of renewable energy capacity under the National Solar Mission (part of the National Action Plan on Climate Change) by 2022. The scheme included setting up 20GW of Solar Power Capacity and an additional 2 GW off-grid installations. This target was later revised in 2015 to 100 GW of Solar Capacity which consisted of 60 GW of grid-based capacity and the remaining 40 GW of rooftop solar.

Growth of renewable energy's share can be attributed to the following three major factors-

- Falling prices of installing renewable power capacity
- Lower cost of maintenance and operation of such capacity over its operational lifespan
- Positive and enabling government policies and intervention.

The above three factors have made renewable energy competitive against power generated by conventional sources. Tariff fall has been majorly due to advancement in technology in the renewable power segment and lower prices of manufacturing renewable equipment. Falling price of renewable energy installation has been a major factor for faster adoption and installation. Increase in demand for renewable energy is also bolstered by its ability to produce electricity without fuel, which provides the additional benefit of lower maintenance and operation costs. But initially when the prices of installation of renewable energy plants were high, government policy supported its adoption through incentives like Feed-in-Tariffs and Viability Gap Funding etc. Over the last decade, solar module prices have fallen by over ~80% on an average, making it a viable alternate over conventional sources. As the prices moderated over the last decade, the industry witnessed transformation from a policy and incentive backed installation model to its current form where developers participate in competitive bidding to set-up such plants.

Exhibit 3: Coal and Solar Cell (PV) Prices (2008-2018)



Source: Various sources like IEA, World Bank and Publicly available reports

But we have noticed a trend in which, despite rapid expansion in renewable energy, it has had a limited impact on power generation by thermal power plants- coal-based in particular.

Coal-based power has a vital role in forming base load for grid power as well as fulfilling the power requirement of industrial users. Even though the prices of coal remained volatile at an average low of $ 50 per tonne and recovered to its decadal high of over $120 per tonne during the last decade, its usage and volumes have grown at a steady rate. Coal

imports have grown by ~20% during the last decade. Production too has grown at a healthy rate in line with the growth in production of thermal power.

Thus the theory of substitution may not hold in entirety in the Indian context for power sector. Prices and costs require additional support of policy intervention for substitution of thermal power to a certain degree by renewable sources. At the same time, limitations like availability of supporting infrastructure and lack of viable storage for renewable power continues to hamper large-scale substitution of thermal energy by renewable energy.

3. Fertilizers Industry

The Indian fertilizer sector is very crucial to the economy in terms of assuring food security. Hence is it is highly regulated by the government. In India the most widely used fertilizer in the nitrogenous category is Urea, and DAP and MOP for phosphorus and potassic category respectively.

The government of India also monitors the cost of fertilizers in order to make it affordable for the farming community. The difference between the cost of production and the price at which the fertilizer is sold to the beneficiary is reimbursed in the form of subsidies.

The MRP of urea is fixed as it is controlled by the Central Government. This is not the case with decontrolled fertilizers where manufacturers can price the product freely. Decontrolled fertilizers are subsidized under the nutrient based subsidy (NBS) scheme which deals with 22 grades of fertilizers namely DAP, MAP, TSP, DAP Lite, MOP, SSP, Ammonium Sulphate and 15 grades of complex fertilizers. These fertilizers are provided to the farmers at the subsidized rates based on the nutrients (N, P, K & S) contained in these fertilizers.

According to the FY20 Budget Rs 79,996 crores is allocated for the fertilizer industry, to be given of as subsidies- Rs 53,629 crore earmarked as the urea subsidy and Rs 26,367 crore earmarked as the nutrient based subsidy.

Table 3: All India fertilizers consumption ratio over the years

	N	P	K	Factors which could have affected Consumption
1977-92	6.2	2.2	1	The Govt. decontrolled all P&K fertilizers namely which were under RPS since 1977 except urea which continued to remain under RPS.
1992-97	9.2	2.8	1	The Govt. announced a Concession Scheme for P&K fertilizers.
1997-10	6.3	2.5	1	The Department of Agriculture & Cooperation started indicating an all India uniform MRP for P&K fertilizers.
2010-11	4.7	2.3	1	Introduction of NBS.
2011-12	6.7	3.1	1	Price of urea was fixed at Rs. 5,360/tonne which is prevalent till date
2012-13	8.2	3.2	1	
2013-14	8.0	2.7	1	
2014-15	6.7	2.4	1	Soil Health card was launched.
2015-16	7.2	2.9	1	The Govt. mandated coating of urea by neem in order to avoid pilferages and arrest the nitrogen content in the soil.
2016-17	6.7	2.7	1	
2017-18	6.1	2.5	1	

P&K- Phosphatic and Potassic; RPS- Retention Price Scheme
Source: FAI, CARE Ratings

In India there has been an apparent indiscriminate use of urea since it is the most affordable and cheapest fertilizer which has led to its consumption being high. Post the decontrolling of P&K fertilizers (which happened on August 25, 1992) and once the price of urea was fixed at Rs 5,360/tonne (which happened on November 11, 2012) there has been a spike in N type fertilizer consumption.

The government time and again has introduced policies to tweak urea consumption in order to save on the subsidies and encourage the usage of decontrolled fertilizers. With the introduction of the NBS the consumption of P type fertilizer increased to 3.1 in the following year.

With the introduction of soil health cards and neem coating of urea the consumption of N type fertilizers has fallen from 7.2 to 6.7 to 6.1 between 2015-16 and 2017-18.

Hence, substitution is clearly visible whenever the government has intervened or introduced any scheme which has prompted skewed usage of fertilizers.

Note: Soil Health cards aim at promoting soil test based and balanced use of fertilisers to enable farmers to realise higher yields at lower cost also the main objective is to create awareness amongst growers about the appropriate amount of nutrients for the concerned crop depending on the quality of soil

Neem Coating of Urea: As per notification Vide Department of Fertilizers dated on May 25, 2015 all the urea producers in the country have to mandatorily produce 100% of their total production of subsidized urea as neem coated urea (NUC). Neem coating of urea is the most cost effective way to preserve the nitrogen component in the fertilizer. It is estimated that spraying of neem oil slows the release of nitrogen by 10-15%, thus, in effect, reducing the urea requirement to that extent. NUC was introduced so that it could save a substantial chunk of the fertilizer subsidy.

4. Non- Ferrous Metals (Copper and Aluminium)

(Note: This analysis is not considering scrap imports as a part of consumption. It is only restricted to primary metal usage.)

Copper is a malleable, ductile metallic element and is an excellent conductor of heat and electricity. It also has relatively high creep strength as compared to other commonly used materials. Demand for copper in the domestic market is largely dependent on the electrical and telecommunication industry (56%) followed by consumption led in the transportation (8%), consumer durables (7%), building & construction (7%), general engineering goods (6%) and other industries including Process Industries (16%).

Aluminium is 3 times lighter than iron but it is as strong as steel and extremely flexible. It has been continuously finding new applications due to rising price competence, superior weight to strength ratio, corrosion resistance, formability and dampness. Aluminium in the domestic markets is consumed mainly in the electrical sector (48%), followed by automobile and transport sector (15%), construction (13%), consumer durables (7%), machinery & equipment (7%), packaging (4%) and other miscellaneous sectors(6%).

Since both the metals are good conductors of electricity its usage is mainly found in the electrical wiring and cables industry.

Copper metal finds its usability mainly in the electrical industry where it is used in the form of cables and winding wires as it encounters much less resistance and is safe for electrical distribution system from high voltage transmission cables to micro-circuits. Copper is also used in power cables, either insulated or uninsulated, for high, medium and low voltage applications. Renewable energy sources such as solar, wind, geothermal, fuel cells and other technologies are all heavily reliant on copper due to its excellent conductivity.

Aluminium too is an excellent conductor of electricity and over the years it has been replacing copper in the wiring and cable sector even though copper offers a better electrical capacity per volume and conductivity. Aluminium is 2-3 times cheaper than copper and offers better capacity per weight than any metal.

Table 4: Copper: Aluminium consumption ratio v/s Copper price: Aluminium price ratio

	CU Consumption: Al Consumption	CU Price: Al Price
2003-04	0.43	1.45
2004-05	0.37	1.69
2005-06	0.38	2.02
2006-07	0.35	2.62
2007-08	0.42	2.89
2008-09	0.4	2.63
2009-10	0.33	3.27
2010-11	0.15	3.61
2011-12	0.28	3.66
2012-13	0.28	3.98
2013-14	0.29	4.01
2014-15	0.34	3.47
2015-16	0.36	3.28
2016-17	0.53	3.06
2017-18	0.81	3.15
2018-19	1.54	3.11

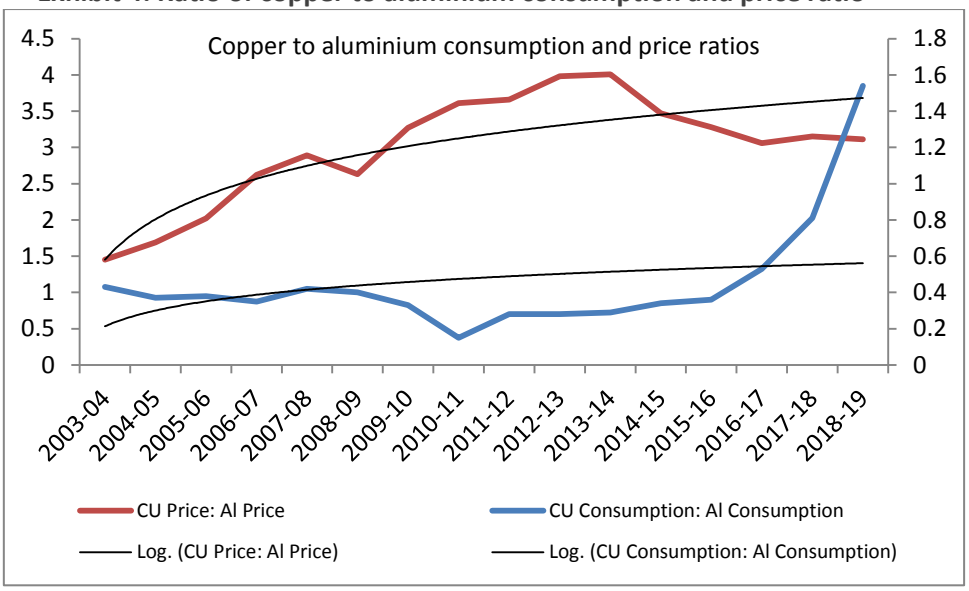
Note: Green highlight signifies that the increase in the copper-aluminium consumption and/or price ratio, whereas red highlight indicates the fall in the copper-aluminium consumption and/or price ratio.
Source: CMIE, CARE Ratings

In the beginning of the time series the direction indicates the replacement of copper by aluminium as the ratio of copper price to aluminium price has been widening and simultaneously the ratio of copper consumption to aluminium consumption has narrowed. This trend is clearly visible till FY11.

From FY12, the ratio of copper consumption to aluminium consumption has been increasing while the ratio of copper price to aluminium price has contracted and expanded. During FY15-17 the trend suggests copper replacing aluminium as the ratio of copper price to aluminium price has contracted and the ratio of copper consumption to aluminium consumption has increased; so as and when the price of copper has fallen manufacturers have switched/preferred the application of copper as it is a better conductor of electricity.

The study is also able to indicate the non-substitution of both the metals as there are certain applications in which copper cannot replace aluminium and vice-versa. When the copper-aluminium price ratio was at its all-time high (during FY14 4.01:1) the consumption ratio was still increasing.

Exhibit 4: Ratio of copper to aluminium consumption and price ratio



Source: CARE

The analysis does confirm the substitution of copper and aluminium taking place but it cannot side-line the fact that each of the metals has unique properties and application as well which has also been responsible in influencing the Copper to Aluminium consumption ratio. Both the metals are also finding new applications in use with newer technologies coming in play but again depending on the price volatility substitution may or may not take place.

Concluding thoughts

Given certain basic assumptions on the use of certain commodities, there does appear to be substitution taking place based on prices among other factors. Government policies (regulation in fuel and fertilizers) have also played a role in bringing about such substitution. This would hence be a continuous process that will impact these industries over the long run.

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