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Rupee Exchange Rate Dynamics from 1993 to 2011: Study of Factors Driving the Exchange Rate

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Abstract:*This paper attempts to study the factors driving the Rupee exchange rate and reasons for its sustained depreciation over the period since 1993. A statistical analysis is carried out to identify significant factors and regression models are developed to validate the assumptions. Solutions that can mitigate the depreciation of the Rupee are presented.*

Keywords: *Macroeconomics, Rupee Exchange Rate, Real Effective Exchange Rate, Trade Balance, Energy Imports, Solar Power, Wind Power, Value Add, International Trade*

I. Introduction

Significant effort has been made in developing forecasting models for the Rupee exchange rate using different empirical techniques.[1] These empirical techniques do not give intuition and key long term factors driving the Rupee lower are not highlighted very clearly in these models. As per [2], many of the empirical exchange rate modelling techniques of the seventies do not fare better than a random walk based model in predicting exchange rates. Some of the empirical techniques developed in nineties[3] outperform a random walk based model.

In this paper the Rupee exchange rate dynamics from 1993 to 2011are explored and various factors driving the exchange rate are examined with an aim to derive intuition on key factors driving the Rupee lower. Post liberalization by Dr. Manmohan Singh in 1990, the Rupee exchange rate became a function of the trade balance of the country. Widening trade deficits would devalue the Rupee and provide a short term boost to the exports which would restore the Rupee to a stronger level. Increasing exports would strengthen the Rupee and lower the cost of energy imports in the country. The chart below shows the Real Effective Exchange Rate (REER 6 currency index) and trade balance from 1993 to 2011. Stronger Rupee would lead to a lower value of the REER.

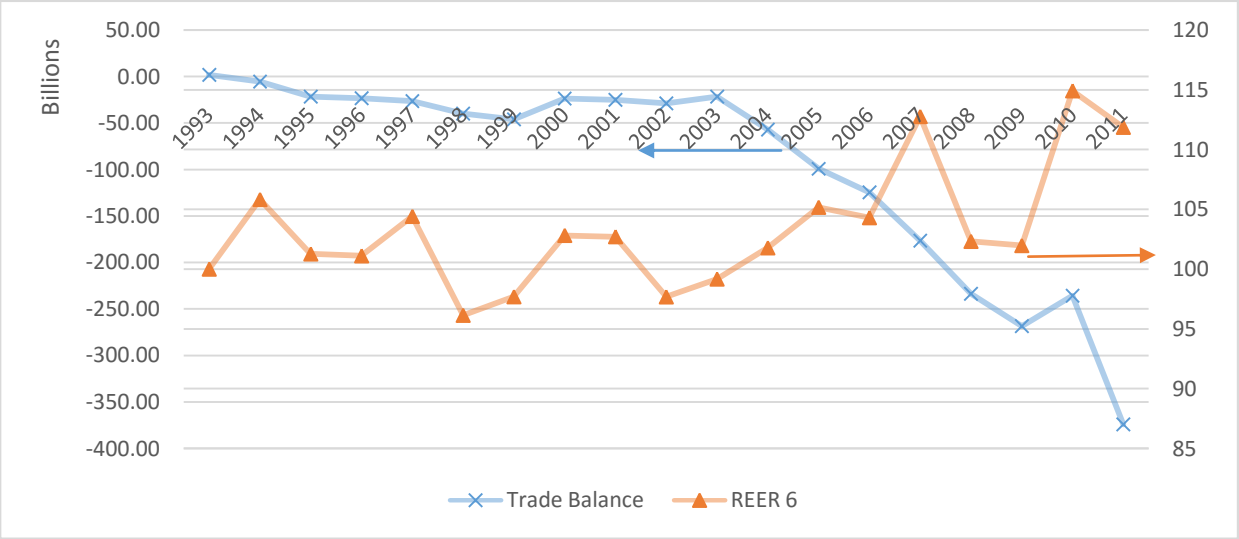

Figure 1: Trade balance and Rupee Real Effective Exchange Rate (REER 6 currency index) from 1993 to 2011

There is a correlation of about of -62.7% between the trade balance (exports – imports) and the REER 6 currency index between 1993 and 2011, validating the assumption that larger deficits lead to a weaker Rupee.

The above model would work as long as a country is primarily trading in manufactured goods and services. However, if a country imports large amounts of energy, the exchange rate cannot be stabilized by a corresponding increase in exports. Conversion of energy to manufactured goods and services would always have an efficiency of less than 1 and even with significant value addition, part of what is produced would be consumed domestically.Thus having exports valued at more than the imports would be a daunting challenge.

The figure below shows the energy balance measured as the energy produced domestically less the energy imports. The correlation between the energy balance and the trade balance, measured between 1993 and 2011 is 41.8%. The percentage of energy imported in India during this period was close to 20% of the total energy consumed.

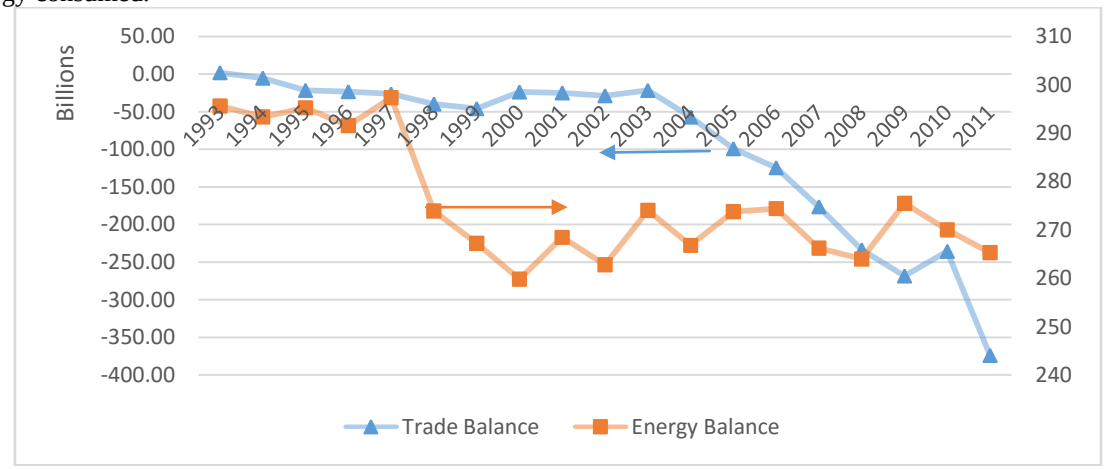

Figure 2: Energy balance and trade balance in India from 2001 to 2011. There is a 41.8% correlation here.

As can be seen from the above figure, energy balance has a very significant influence on the trade balance and thus on the exchange rate of the Rupee. The more we export goods, the more we import energy, and this import nullifies any gain we could have received from the increased exports to strengthen the exchange rate. Reducing the energy imports could boost the exchange rate when exports are higher.

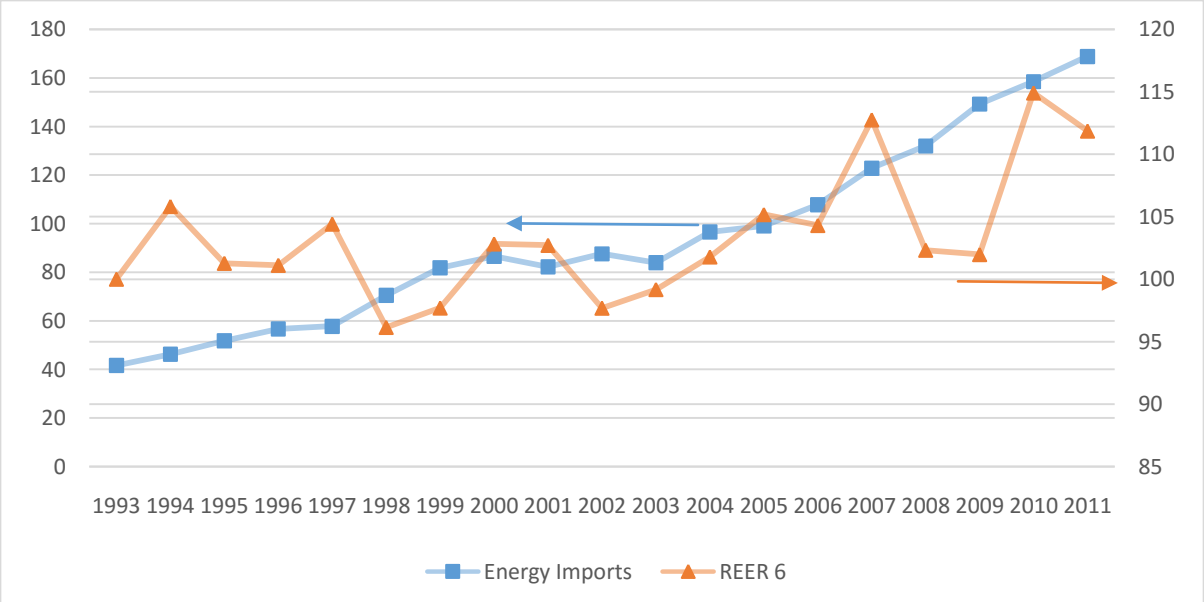

Figure 3: Energy imports and REER have a correlation of about 59.7% indicating that energy imports have a significant impact on REER. (Unit for energy imports: Kg of oil equivalent per capita)

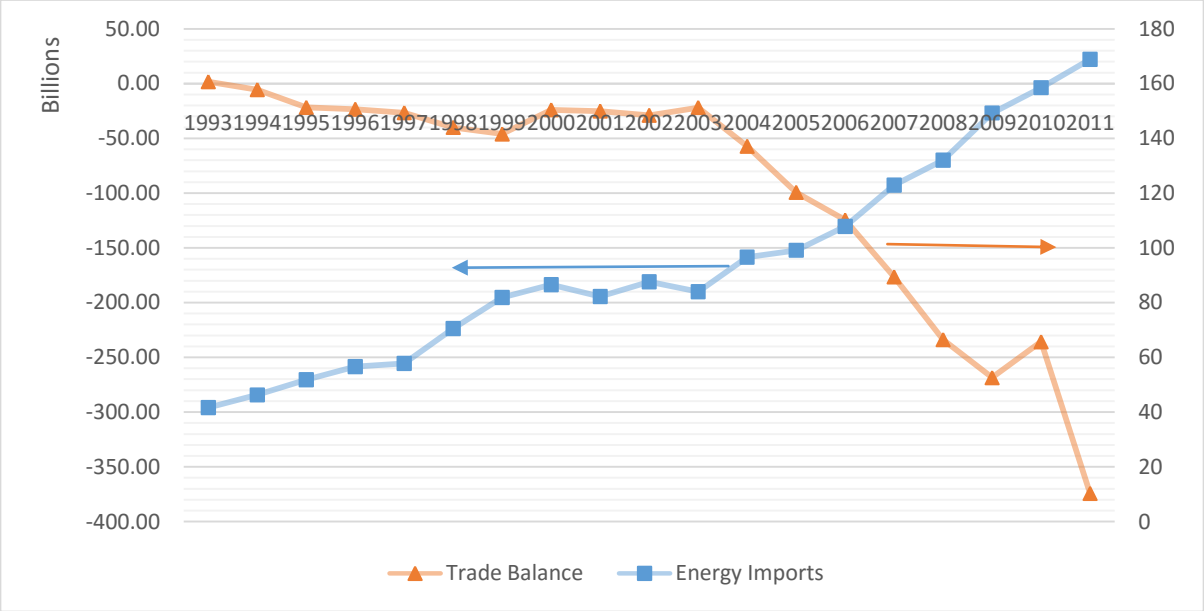

Figure 4:Trade balance and energy importshave a correlation of about 93.5% indicating energyimports have a significant impact on trade balance.

Value Add

Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. Services correspond to ISIC divisions 50-99. They include value added in wholesale and retail trade (including hotels and restaurants), transport, and government, financial, professional, and personal services such as education, health care, and real estate services. Also included are imputed bank service charges, import duties, and any statistical discrepancies noted by national compilers as well as discrepancies arising from rescaling.

Industry corresponds to ISIC divisions 10-45 and includes manufacturing (ISIC divisions 15-37). It comprises value added in mining, manufacturing (also reported as a separate subgroup), construction, electricity, water, and gas.

Agriculture corresponds to ISIC divisions 1-5 and includes forestry, hunting, and fishing, as well as cultivation of crops and livestock production [4].

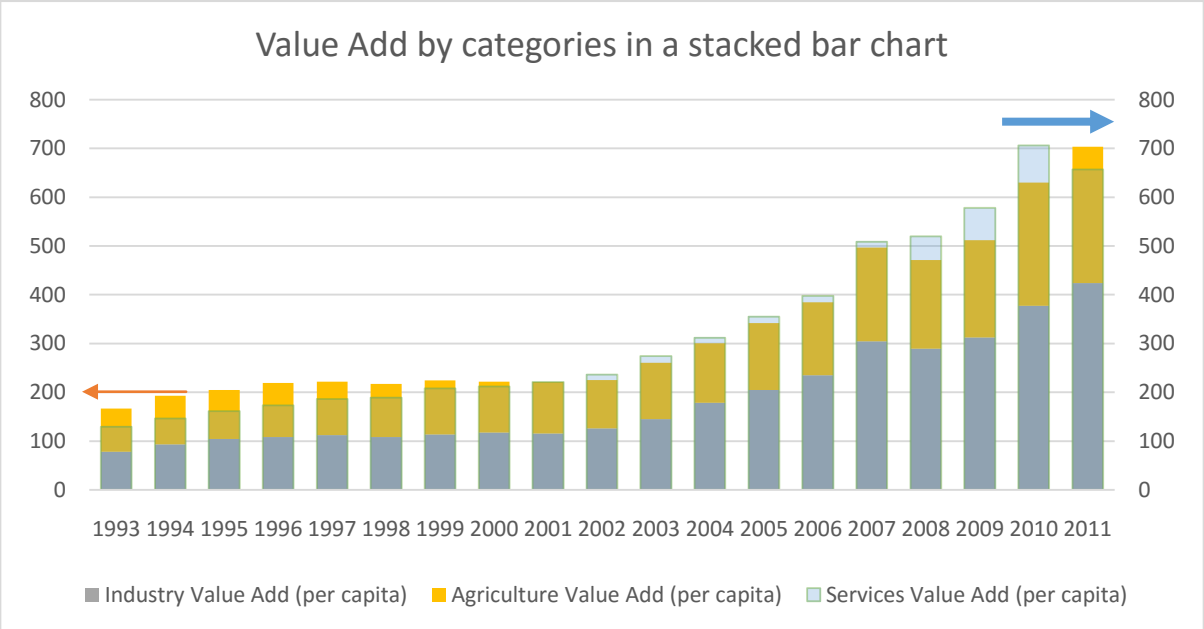

Figure 5: Value Add by categories: Data from data.worldbank.org

When we model the Rupee exchange rate (REER) as a function of the energy imports, there is the question of whether value add from the economic activity in the country could compensate for the increased energy imports. There is a 98.31% correlation between the exports and total value add per capita in India between 1993 and 2011. There is also a 96.6% correlation between energy imports and total value add per capita in India over the same time period.

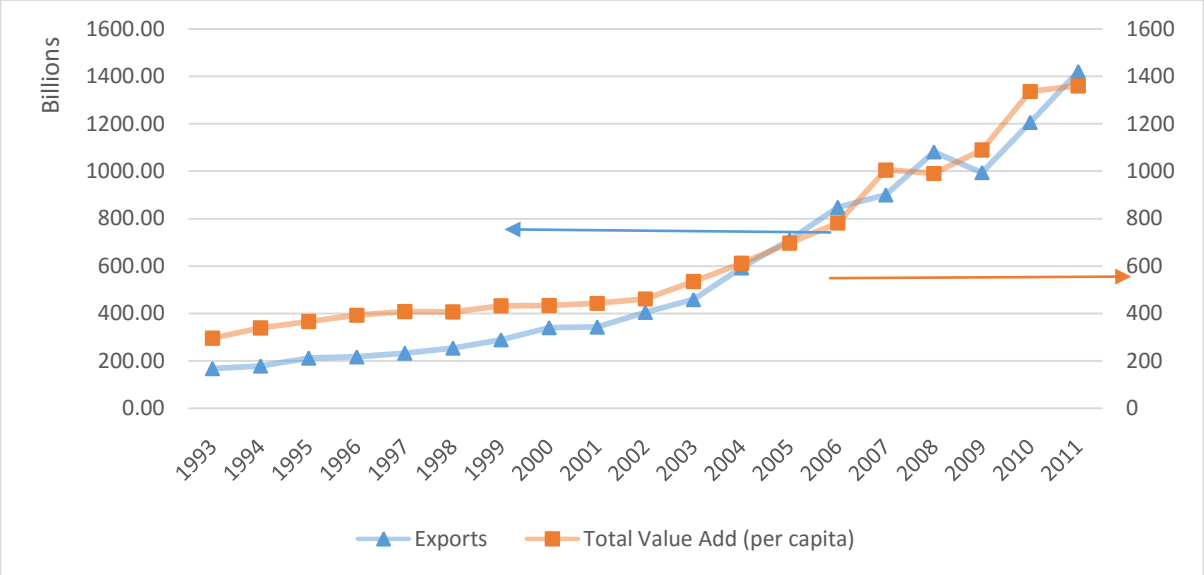

Figure 6: There is a 98.31% correlation between exports and total value per capita measured in USD.

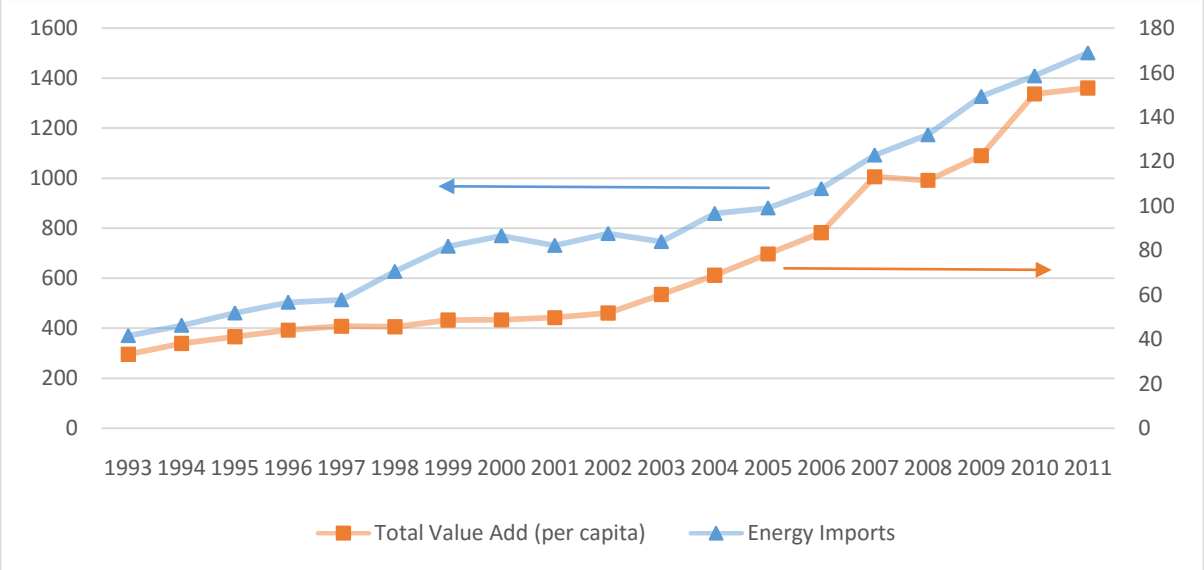

Figure 7: There is a 96.6% correlation between energy imports and total value add per capita in USD from 1993 to 2011

These correlations indicate that higher exports result from higher value addper capita but the energy imports increase as well. Thus there would not be any gains to the Rupee exchange rate from the higher exports. In an environment where the Rupee is appreciating, we would see the energy imports as a percent of total energy consumption decrease over a period of time. The slope of depreciating Rupee over time would be proportional to the percent of energy we import. In this case, a straight line fit for REER from 1993 to 2011 would have a slope proportional to the percent of energy we import. The amount of energy imported in India between 1993 and 2011 was constant at about 20% of the total and we should see an almost linear trend in the depreciating Rupee over this time period.

Regression Modelling for the Rupee Exchange Rate (REER)

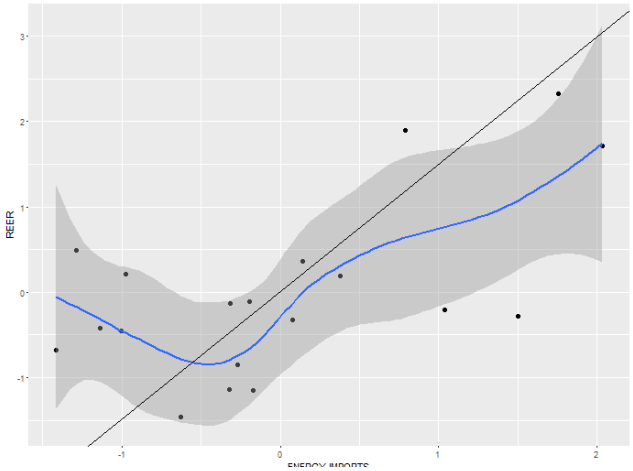

Figure8: Linear regression of REER on Energy Imports has a p-value of 0.006868

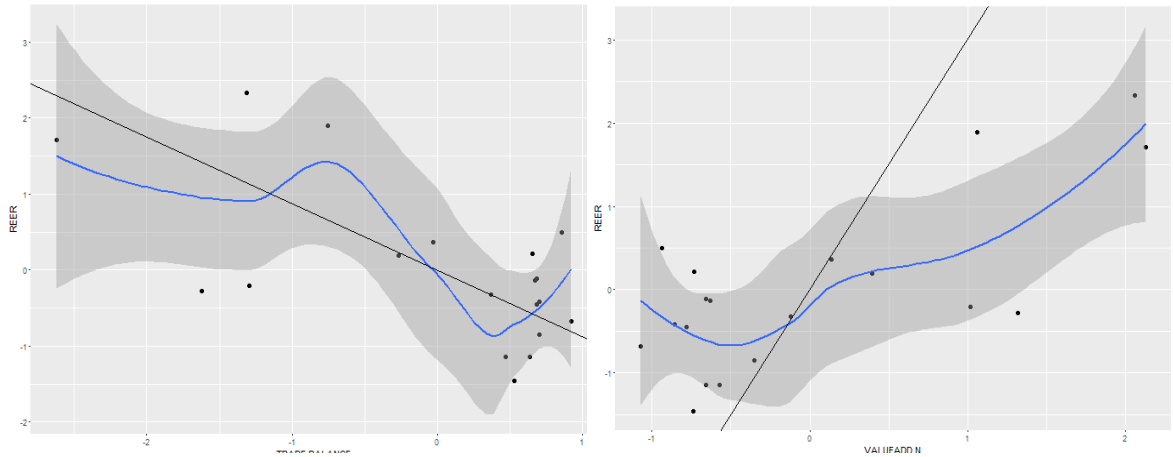

Figure 9: Linear regression model of REER on Trade Balance has a p-value of 0.004039Figure 10: Linear regression model of REER on Total Value Add has a p-value of 0.0004322

A multi-variate regression model of REER on energy imports, trade balance and value add is statistically significant with a p-value less than 0.01. The parameters for this model are as follows:

	ESTIMATE	STD. ERROR	T-VALUE	Pr(>|t|)
INTERCEPT	1.182e-10	1.304e-01	0.000	1.000000
TRADE	8.754e-01	4.828e-01	1.813	0.089830
ENERGYIMPORTS	-1.495e+00	5.071e-01	-2.949	0.009950
VALUEADD	3.014e+00	6.638e-01	4.540	0.000391
RESIDUAL ERROR	0.5684			
Multiple R Squared	0.745			
Adjusted R-squared	0.694			
p-value	0.0001011			

Table 1: Parameters for a multi-variable regression model of REER on normalized trade balance, energy imports and value add has a p-value of 0.0001011 which is significant at a level of 0.01.

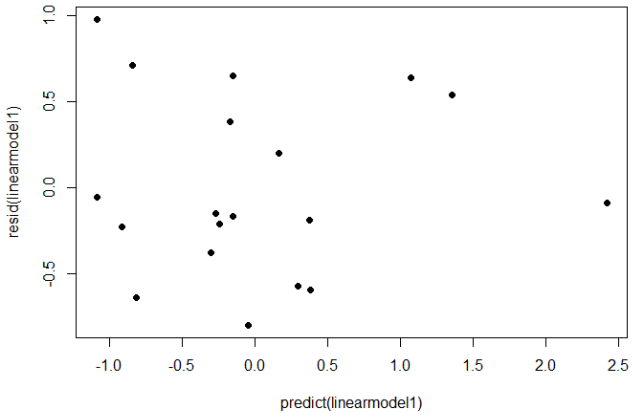

Figure 11: A plot of residues vs predicted values on the final regression model indicates the error is random in nature so the model is a good fit.

Alternative Forms of Energy

The energy imports discussed above mainly include coal, oil and natural gas. With the development of alternative forms of energy such as wind and solar power, the attractiveness of coal has reduced as a source of power. The cost of wind power has reached parity with thermal power today and solar is a little away from parity. Thermal power plants have to factor in a constant operating cost which increases with inflation over a period of time. Solar and wind power have close to 0 operating costs and minor maintenance costs. As a result, solar and wind become very viable long term investments as compared to thermal power from coal.

	FY2018	FY2020	FY2025	FY2030
Tariff (Rs per kWh)				
Supplied using Carmichael Coal	5.73	5.99	6.85	8.31
Supplied using Alpha Coal	5.41	5.62	6.37	7.68
Wind power - 2015 commissioning	4.60	4.60	4.60	4.60
Solar power - 2015 commissioning *	5.50	5.50	5.50	5.50
Solar power - 2018 commissioning *	4.00	4.00	4.00	4.00
Tariff inflation (yoy)				
Supplied using Carmichael Coal	6.0%	2.3%	3.1%	4.9%
Supplied using Alpha Coal	6.0%	2.0%	2.9%	4.8%
Solar power - assumed deflation pa	**10.0%**			
Relative cost of Renewables vs Imported Coal				
Wind vs imported coal - 2015 commissioning	80%	77%	67%	55%
Solar vs imported coal - 2015 commissioning	96%	92%	80%	66%
Solar vs imported coal - 2018 commissioning	70%	67%	58%	48%

** Assumes continuation of the upfront 30% investment credit from Solar Energy Corp India.*

Figure 12: Comparative cost of wholesale electricity from imported coal vs solar and wind power in India factoring in inflation and no technology improvements (Reference: IEEFA Briefing Note on India Power Priceshttp://www.ieefa.org/wp-content/uploads/2014/05/IEEFA-Briefing-Note_IndianElectricityCoalPricing_4-May-2014.pdf)

II. Conclusion

An effort was made to understand the dynamics of Rupee Exchange Rate (REER) as a function of trade balance, energy imports and value add.The impact of value add on the Rupee exchange rate suggests it is a net positive influence on the exchange rate and energy imports are a net negative influence. A regression model for REER on energy imports, trade balance and value add is statistically significant with p-value less than 0.01. Alternative sources of energy such as wind and solar are becoming more attractive than coal over the long term due to the low operating costs and persistent high inflation in the country.

Data Sources:

1. Services Value Add: http://data.worldbank.org/indicator/NV.SRV.TETC.CD
2. Manufacturing Value Add: http://data.worldbank.org/indicator/NV.IND.MANF.ZS?page=1
3. Industry Value Add: http://data.worldbank.org/indicator/NV.IND.TOTL.ZS
4. Agriculture Value Add: http://data.worldbank.org/indicator/NV.AGR.TOTL.ZS

5. GDP per capita: http://data.worldbank.org/indicator/NY.GDP.PCAP.CD
6. Population: http://data.worldbank.org/indicator/SP.POP.TOTL
7. Imports: http://data.worldbank.org/indicator/NE.IMP.GNFS.ZS?display=default
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9. REER: https://data.gov.in/keywords/real-effective-exchange-rates-rupee
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