Testing empirically the impact of inflating diesel prices in 
WPI and CCI

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Abstract: Diesel is a price determinant among various other commodities, because it is being used extensively in the construction projects, and rise or fall in its price will directly have an impact on the price of various commodities and overall cost of a construction project. In the Indian construction industry, in most of the contracts barring few, the variation in the project cost due to inflating diesel price is being calculated using WPI. CIDC has taken an initiative to develop construction-specific cost indices (CCI) but it is not being commonly used by the industry. Empirically, it has been observed that the cost of escalation, in the price of diesel, obtained from the present method is too low then the actual cost escalation incurred in the construction projects. For this reason, the focus of this study is on WPI and CCI with un-predictable inflation in the price of Diesel in India.

Keywords: Diesel Price, WPI, CCI, Inflation, Construction Project.

1. INTRODUCTION

A construction project sometimes referred to as a ‘project’, is the organized process of constructing, renovating, refurbishing, etc. a building, structure or infrastructure. Construction of the project is performed according to pre-confirmed amount, pre-fixed timeframe, and terms & conditions specified in the contract agreement. Depending upon the type of construction project, its completion usually takes several months to several years. Therefore, there is a probability that during the life of the project the cost of various resources (i.e. labour, raw materials, manufactured materials, and machinery) may rise and/or fall periodically, to a greater or lesser extent. Whereas, at the time of bidding, contractors quote their prices based on projected estimates and many times, during the execution of the project, due to frequent change in price the quoted prices become redundant and lead to cost overruns. Increase in prices of construction material, as well as the cost of labour, has become extremely unpredictable hence estimation of the escalation in cost with reasonable accuracy is very important, but difficult.

All the products/materials being used in construction projects are transported by trucks and trains with diesel engines, and most construction equipment, plant and vehicles are also powered by diesel engines. Diesel engines are used in other equipment also at construction sites such as generators (for generating electricity) and compressors. Therefore, any uncertainty about the pricing of diesel and/or supply of diesel can affect the functioning of the projects. Therefore, to cope with the sudden changes in the price, provisions for fair reimbursement of escalation in cost of diesel to the contractor should be made systemically in the contract.
WPI (Wholesale Price Index) is a price index representing the price of a basket of goods at a wholesale stage i.e. goods that are sold in bulk and traded between organizations instead of consumers. It captures price changes at the factory/wholesale level and is used as a measure of inflation in India. WPI series is compiled and released by the Office of the Economic Adviser (OEA), Department of Industrial Policy and Promotion, Ministry of Commerce and Industry, Government of India. The base year of WPI is revised from time to time to sync it up with the other indicators in the economy. WPI with the base year 2004-05 was launched in September 2010. The current series with the base year 2011-12 was introduced in May 2017 which synchronized it with the base year of other important indicators such as Gross Domestic Product (GDP) and Index of Industrial Production (IIP). In the calculation of present series (2011-12) about 697 distinct items are considered. According to OEA, almost all the important items being transacted in the economy have been included in the revised basket and the weights for items under different groups have been assigned based on their total wholesale transactions in the economy. Diesel is also considered one of the commodities and its weightage in the present series is given as 3.09548%.

In India, Construction Industry Development Council (CIDC) has been publishing the CCI (Construction Cost Indices) since 1998. CCI is an indicator of the average cost movement over time of a fixed basket of representative goods and services related to Construction Industry. Constitution of the basket of goods and services is done so that their cost variations best represent the inflationary/deflationary changes of a specific sector of Construction Industry or cumulatively for the entire Industry. The data is collected across the nation and it pertains to construction materials, oil, fuel and lubricants, wages and salaries. Weights used in the CCI are value weights not quantity weights and are allotted as per the sound engineering practices/standards.

The study will try to empirically test/reveal various facts pertaining to the impact of Inflating Diesel Prices in WPI and CCI considering construction activities in India.

2. LITERATURE REVIEW

Smith [1] studied the relationship between the price of gold and stock price indices for the United States over the period beginning in January 1991 and ending in October 2001 and concluded that there is no cointegration involving a gold price and US stock price index.

Arshad, Shah & Najma [2] checked the co-movement of WPI inflation and CPI (Consumer Price Index) inflation by conducting Granger causality test and concluded that the WPI inflation is influenced by the CPI inflation.

While analyzing that how much escalation is enough Butts [3] stated that predicting the exact annual escalation expected is admittedly difficult, if not impossible and found mean escalation as 2.5% for the 20 years between 1983 to 2003.

Singh [4] while assessing inflation modelling of India concluded that there is a discrepancy in inflation as reflected in the WPI and CPI. Here commended replacing WPI with PPI (Producers Prices Index), which captures prices of both goods and services and is more representative for supply-side management.

Dr. Chaphalkar & Sandhbhor [5] studied WPI and its effect on the price escalation of materials for the Indian construction industry and found that the WPI which is considered for calculation of escalation amount for Indian construction industry contains approximately 91% of the materials those are not directly related to the construction field. They concluded that the escalation calculated using WPI may not reflect the correct increase and recommended to develop an index which is exclusively useful to the construction sector.
While determining the impact of selected variables on inflation in India, Dr. Saxena & Singh [6] concluded that the selected independent variables have a significant impact on CPI.

Dev, Pandey & Rehman [7] studied the food inflation in India and found that in February 2014, the food inflation in India was 6% based on WPI and was 10% based on CPI.

While studying the relationship between international crude oil price and the inflation rate (CPI) in India using data from January 2011 to September 2014, Rafee & Hidhayathulla [8] concluded that hike in crude oil price does influence the domestic inflation rate.

While capturing the inflation that people experience Vlasenko & Cunningham [9] made the comparison of the Everyday Price Index (EPI) and the CPI, and concluded that since the trends of both the indexes began to diverge starting in the early 2000s, therefore, the EPI may be better than the CPI at reflecting the concept of “prices in general” held by the public.

Dr. Soundarapandiyan & Dr. Ganesh [10] studied the impact of crude oil price on the Indian economy by considering the relevant inputs like GDP, CPI and Crude Oil Price (COP) for the period of 15 years (2001 - 2015) and concluded that there is an inter-correlation between CPI and COP and vice versa. There is a clear indication that whenever the CPI increases there is a decrease in COP and vice versa. It was also found by them that there was a significant difference between COP and GDP and no significant difference between CPI and GDP.

Mukherjee & Coondoo [11] while studying Indian inflation from 2006 to 2016 found that the weights of food and fuel in WPI are different from that of CPI. This implies that adapting CPI or WPI as the target rate will have different implications for the economy. They also found that the WPI and CPI recorded different patterns varying from a cyclical one to highly increasing even when GDP was falling.

Ahmed, Vveinhardt, Streimikiene, Ghauri & Ahmad [12] conducted research to “evaluate the long-run relationship among commonly used inflation proxies induces such as WPI, CPI, and COP with Karachi Stock Exchange 100 Index (KSE) returns”. They used monthly data for the time period from July 1995 to June 2016 and their results indicated that CPI and COP significantly affect KSE returns that elaborate the COP and CPI both together are strong variables to estimate or forecast the KSE returns. On the contrary, the results of WPI and COP do not have any long-run relationship with the KSE in case of Pakistani economy.

Munde & Waghmare [13] while studying the measures for cost escalation in the bridge project found that to calculate the cost escalation WPI for materials and CPI for labour are being used in the Indian construction sector. But the WPI and CPI do not truly reflect the price variation of any specific industry including construction, as the main function of WPI and CPI is to calculate the inflation and not escalation. That for reason the value of escalation obtained from the present method is found to be much lower than the actual escalation amount incurred in the projects. They also found that CCI is computed more precisely as compared to WPI, as because WPI considers 676 items of all general sectors and categories, whereas, CCI are computed by considering only the materials that pertain to construction. They concluded that either the use of actual purchase rates of the materials or the adoption of CCI to calculate the escalation amount found to be significantly better than the existing method.

To found new approaches for estimation of cost escalation Bhosale & Khatri [14] concluded that for the Indian construction industry the value of escalation obtained from existing methods by using WPI and CPI do not yield a realistic value of escalation amount than the actual cost variation incurred
during the project which is leading to loss to the contractor. They inferred that the Market Rate Method (MRM) yielded better results than the results obtained from existing WPI method.

Goel [15] found that in India, inflation is measured using various price indices and the indices that are primarily chosen for any analysis are WPI and CPI. They concluded that both WPI and CPI inflation have significantly diverged from each other during different time periods. This divergence is attributed both to different weightage of major groups (like food articles, metals, fuel and power etc.) in both the indices.

3. RESEARCH OBJECTIVES AND METHODOLOGY

This study aims to test empirically whether WPI and CCI could significantly capture the inflation in Diesel price, and to estimate the magnitude of that effect if any. As because in calculating WPI and CCI, the Diesel is being considered as one of the commodities, therefore, the study considers the rate of inflation in ‘Average Monthly Diesel Prices in Delhi, India’ as dependent variable; and rate of inflation in ‘WPI for All Commodities’ and in ‘CCI for Building Projects of Delhi’ as independent variables.

3.1. Sample Size

The paper is analytical and based on the objective the time series data of the last 11 years for the study from January 2009 to December 2019 are retrieved from reliable secondary sources and used for the variables.

3.2. Data Source

- Average monthly Diesel Prices in INR (including taxes) in Delhi, India for the period from Jan’2009 to Dec’2018 and from Jan’2019 to Dec’2019 are calculated from [16],[17] respectively.
- Month-wise WPI for ‘All Commodities’ from base 2004-05 and 2011-12 series are retrieved from [18],[19] respectively.
- Month-wise CCI for Building Projects of Delhi from base Oct’2007 are retrieved from [20].
- To maintain the continuity in the time series data on WPI, a Linking Factor for the conversion of WPI (Base 2011-12) to WPI (Base 2004-05) series for use from April 2017 onwards are retrieved from [21](p.5). Accordingly, a Linking Factor of 1.561 is applied on "All Commodities" from April 2017 onwards.

3.3. Statement of Hypothesis

The Null Hypothesis for this study has been stated below:

- H₀₁: There is no significant impact of inflating Diesel Prices on WPI.
- H₀₂: There is no significant impact of inflating Diesel Prices on CCI.

3.4. Tools Used

Trendline, Scatter plots, Correlation analysis and Regression analysis were used to find out the relationship of diesel price inflation with inflation captured in WPI and CCI. The tools are applied using MS Excel, EViews (Vs.7) and SPSS (Vs.20).

4. RESULTS & ANALYSIS

4.1. Through Trendline

Figure 1 presents and compares the trends of Diesel Price, WPI and CCI from January 2009 through December 2019. It can be observed from the figures that none of the variables has moved together throughout the studied period.
Since the focus of this study is to test empirically whether WPI and CCI could significantly capture the inflation in Diesel price. Therefore, the average yearly data as well as the annual inflation rate in Diesel Price, WPI and CCI, from January’2009 to December’2019, are presented in Table 1. The actual average rate of annual inflation, during the period through January 2009 to December 2019, in Diesel Price was around 8.01% whereas the average annual inflation captured in WPI and CCI was 4.06% and 2.99% respectively.

| Period     | Diesel Price | WPI   | CCI   | Diesel Price | WPI   | CCI   |
|------------|--------------|-------|-------|--------------|-------|-------|
| Jan-Dec 2009 | 31.87        | 127.86| 111.91| 18.86%       | 9.56% | 3.95% |
| Jan-Dec 2010 | 37.88        | 140.08| 116.33| 3.05%        | 9.47% | 4.29% |
| Jan-Dec 2011 | 39.03        | 153.35| 121.32| 13.23%       | 7.55% | 9.28% |
| Jan-Dec 2012 | 44.19        | 164.93| 132.58| 14.29%       | 6.32% | 9.71% |
| Jan-Dec 2013 | 50.51        | 175.35| 145.45| 10.48%       | 3.80% | 1.04% |
| Jan-Dec 2014 | 55.80        | 182.01| 146.97| -14.56%      | -2.74%| 0.59% |
| Jan-Dec 2015 | 47.67        | 177.03| 147.84| -2.94%       | -2.74%| 0.59% |
| Jan-Dec 2016 | 51.31        | 180.57| 148.52| 7.63%        | 2.00% | 0.46% |
| Jan-Dec 2017 | 56.95        | 180.37| 149.21| 11.00%       | -0.11%| 0.46% |
| Jan-Dec 2018 | 67.46        | 185.67| 149.35| 18.45%       | 2.94% | 0.09% |
| Jan-Dec 2019 | 65.87        | 189.10| 149.42| -2.35%       | 1.85% | 0.05% |
| Average     | **49.87**    | **168.75** | **138.08** | **8.01%** | **4.06%** | **2.99%** |

Source: Author’s own calculations using the Online Database [16],[17], [18], [19],[20]

As because in the construction industry the variation in cost for the purpose of price adjustment is calculated from the base date i.e. the date 28 days prior to submission of the bid. Therefore, to check the actual inflation the impact is calculated w.r.t. base date. The graph in Figure 2 shows the average impact of inflation in all three variables by end of each year (from2009 to 2019)w.r.t. the value on Jan’2009of each variable, The table, adjacent to the graph shows the average inflation in Diesel Price, WPI and CCI by the end of the year 2019 w.r.t. the value of each variable on January month of different base years from 2009 to 2019.For e.g., if the bid of a project is submitted during Jan’2009, then the average actual inflation by the end of the year 2019 in Diesel is 113.46%, whereas, the inflation captured in WPI and CCI is 52.01% and 35.82% respectively.
Inflation by the end of 2019 w.r.t. Jan

| Year | Diesel | WPI   | CCI  | w.r.t. |
|------|--------|-------|------|--------|
| 2019 | 2.49%  | 1.63% | 0.03%| Jan    |
| 2018 | 6.43%  | 4.43% | 0.07%|        |
| 2017 | 12.76% | 2.16% | 0.21%|        |
| 2016 | 47.56% | 7.81% | 0.91%|        |
| 2015 | 36.50% | 6.66% | 1.23%|        |
| 2014 | 21.22% | 5.64% | 2.08%|        |
| 2013 | 38.97% | 11.04%| 3.83%|        |
| 2012 | 59.54% | 19.16%| 20.44%|       |
| 2011 | 74.50% | 27.77%| 25.48%|       |
| 2010 | 100.40%| 39.87%| 30.73%|       |
| 2009 | 113.46%| 52.01%| 35.82%|       |

**Figure 2.** Inflation in Diesel Price, WPI and CCI by end of 2019 w.r.t. different Base Years

**Source:** Author’s own calculations using the Online Database [16],[17], [18], [19][20]

For a better understanding the trends of inflation are plotted in graph. Figure 3 compares Y-O-Y rates of inflation in Diesel Price (ADP-YIR), WPI (WPI-YIR) and CCI (CCI-YIR). Year on year (Y-O-Y) inflation rates defines the yearly percentage change in the series. For e.g., January 2010 inflation rate will be the %age change in the series from January 2009.

**Figure 3.** Trends of Y-O-Y Rates of Inflation from Jan’2009 to Dec’2019

**Source:** Author’s own calculations (in MS Excel) using the Online Database [16],[17], [18], [19][20]

Figure 4 compares M-O-M rates of inflation in Diesel Price (ADP-MIR), WPI (WPI-MIR) and CCI (CCI-MIR). Month on month (M-O-M) inflation rates defines the monthly percentage change in the series. For e.g. January 2010 inflation rate will be the %age change in the series from December 2009.
Figure 4. Trends of M-O-M Rates of Inflation from Jan’2009 to Dec’2019

Source: Author’s own calculations (in MS Excel) using the Online Database [16],[17], [18], [19], [20]

The difference between the M-O-M and Y-O-Y measure for inflation is visible by eyeballing the plots. The M-O-M inflation captures the short-run inflation dynamics and has high forecast ability. The Y-O-Y rates capture the long-run dynamics of inflation and have low forecast ability.

Table 1 as well as Figures 1 to 4, all suggests that the inflation in Diesel Price is not in unison with the inflation captured in WPI and CCI both.

Since in the Construction Industry, the monthly data of Indices are considered to calculate the Price Adjustment (for an increase or decrease in rates and price), therefore, M-O-M inflation rates data are used for further study.

4.2. Through Scatter Plots and Correlation Analysis

To check further that up to what extent the WPI and CCI both had captured the Diesel Price inflation, the M-O-M rates of inflation of all the three variables have been correlated [by using EViews]. Figure 5 presents the visual examination of the relationship of all the three variables. The degree of closeness of scatter points and their overall direction depicts that between ADP-MIR and WPI-MIR a low but positive linear relationship (correlation coefficients=.376) is present [Figure 5(a) and Table 2]. But the correlation between ADP-MIR and CCI-MIR is nowhere near perfect (correlation coefficients=.189) and it reveals a very weak negative linear relationship[Figure 5(b) and Table 2].

Figure 5. Scatter Plot. (a) ADP-MIR vs. WPI-MIR; (b) ADP-MIR vs. CCI-MIR

Source: Author’s own calculations (in EViews) using the Online Database [16],[17], [18], [19], [20]
Table 2. Matrix of Pearson Correlation Coefficients

|            | ADP-MIR | WPI-MIR | CCI-MIR |
|------------|---------|---------|---------|
| ADP-MIR    | 1       | .376    | -.189   |
| WPI-MIR    | .376    | 1       | .131    |
| CCI-MIR    | -.189   | .131    | 1       |

Source: Correlation calculated using EViews

From Figure 5(a) and Table 2 it looks like that possibility of a bi-directional causal relation between ADP-MRI and WPI-MRI is plausible.

4.3. Through Regression Analysis

The regression analysis, using SPSS (Vs.20), is applied on ADP-MRI as dependent variable and WPI-MRI and CCI-MRI as the independent variable.

Table 3. Model Summary

| Model | R       | R Square | Adjusted R Square | Std. Error of the Estimate | Change Statistics | Durbin-Watson |
|-------|---------|----------|-------------------|----------------------------|-------------------|---------------|
|       |         |          |                   |                            |                   |               |
| 1     | .451a   | .203     | .191              | 3.4891                     | .203              | 16.337        | .000          | 2.116 |

a. Predictors (Constant): CCI-MIR, WPI-MIR
b. Dependent Variable: ADP-MIR

4.3.1. Determining how well the model fits. To determine how well a regression model fits the data, results from Table 3 are analyzed. R-value .451 shows a moderate relationship in the model and indicates a good level of prediction between ADP-MRI, WPI-MRI and CCI-MRI. The R square value for this model is.203. It shows that the independent variables (CCI-MIR and WPI-MIR) explain 20.3% of the variability of the dependent variable (ADP-MIR). And 79.7% (100%-20.3%) of the variation in Diesel Price is not considered in the predictors included in this model. The low R-squared value in this combination indicates that the independent variables are correlated with the dependent variable, but they do not explain much of the variability in the dependent variable.

Durbin-Watson value of 2.116, which is close to 2, indicates that there is no autocorrelation detected in the sample.

Table 4. ANOVA

| Model     | Sum of Squares | Df | Mean Square | F      | Sig.   |
|-----------|----------------|----|-------------|--------|--------|
| Regression| 397.773        | 2  | 198.886     | 16.337 | .000b  |
| 1         | 1558.237       | 128| 12.174      |        |        |
| Total     | 1956.009       | 130|              |        |        |

a. Dependent Variable: ADP-MIR
b. Predictors (Constant): CCI-MIR, WPI-MIR

4.3.2. Statistical significance of the model. Results of ANOVA tests from Table 4 are analyzed to check whether the overall regression model is a good fit for the data. Since the p-value (Sig.) = 0.000 < 0.05 = α, we can conclude that the regression model is a significantly good fit.

Using an α of 0.05, F_{0.05;2,128}=2.99 (from F distribution table). Since the test statistic (16.337) is much
larger than the critical value (2.99), the null hypothesis is rejected and we can conclude that there is a (statistically) significant impact among the variables and the regression model is a good fit of the data.

In overall, based on the ANOVA results model is significantly reliable and the regression output is not at random.

| Model | Unstandardized Coefficients | Standardized Coefficients | t | Sig. | Collinearity Statistics |
|-------|----------------------------|---------------------------|---|-----|-------------------------|
|       | B | Std. Error | Beta |     | Tolerance | VIF |
| (Constant) | .373 | .344 | 1.086 | .279 | .983 | 1.018 |
| 1 WPI-MIR | 1.953 | .378 | .411 | 5.161 | .000 | .983 | 1.018 |
| CCI-MIR | -1.571 | .504 | -.248 | -3.114 | .002 | .983 | 1.018 |

a. Dependent Variable: ADP-MIR

### 4.3.3. Statistical significance of the independent variables

The tests of significance are carried-out [Table 5] to investigate if each explanatory variable needs to be in the model, given that the others are already there. The p-values (Sig.) for all the coefficients are lesser than 0.05. This indicates that we can reject the null hypothesis. In other words, the model is meaningful because changes in the predictor's value (WPI-MIR and CCI-MIR) are related to changes in the response variable (ADP-MIR).

Ordinary Least Squares (OLS) Equation Model is:

\[
ADP-MIR = .373 + 1.953 \text{ (WIP-MIR)} - 1.571 \text{ (CCI-MIR)}
\]

If all independent variables are converted into Z scores, then the standardized OLS equation will be:

\[
Z (ADP-MIR) = .411 \text{ (WIP-MIR)} - 0.248 \text{ (CCI-MIR)}
\]

As the tolerance value is great than .2 for both WPI-MIR and CCI-MIR, we conclude that there exists multicollinearity between WPI-MRI and CCI-MIR.

Result for the VIF shows that both the predictor variables had values below 5. This indicates that all the prediction equations had no problem of collinearity.

### 5. CONCLUSION

The study concludes that there is a low positive inter-correlation between inflating Diesel Price and inflation considered in WPI (for All Commodities). Even though, it indicates that whenever Diesel Prices increases there is an increase in WPI (for All Commodities), but its impact on WPI is very low.

The study also concludes that there is a weak negative inter-correlation between inflating Diesel Price and CCI. There is a clear indication that whenever the Diesel Prices increases there is a decrease in CCI, but its impact on CCI is very low.

Since Diesel is extensively being used in construction projects, therefore, its dependability is excessive and unpredictable increase in its price affects the project cost on timely basis. The existing method of calculating the price adjustments amount by using the formulae which in linked to WPI is not effective and do not cover the actual cost variation incurred during the project on account of change in diesel price, thereby, cannot provide the financial relief to the contractor.
5.1. Suggestions
To manage or measure the price adjustments in the construction projects, it is important to find out transparent and simple methods that could determine the actual cost variation considering the current fluctuating market.

The WPI covers prices of products/commodities only pertaining to four sectors comprising agriculture, mining, manufacturing and electricity. The share of these four sectors in GDP at current prices in 2011-12 was 41.4%. The weighting diagram of WPI is not drawn on the basis of gross value added which is a concept in GDP. The WPI weights are derived on the basis of turnover or value of output adjusted for net imports. The ratio of gross value added to value of output differs significantly in the sectors covered under WPI.

Even the Government of India had recognized the problem associated with WPI, therefore, on 27th June 2019 they had formed an 18-member working group to revise the current series of WPI (base 2011-12) and devise a new Producer Price Index (PPI). The group will review the commodity basket of WPI, suggest changes in commodities in the light of structural changes in the economy witnessed since 2011-12, to decide on the computational methodology and weighting diagram to be adopted.

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