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## **Relationship between Money Supply, Price Level and Exchange Rate**

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**Abstract:**

*According to the quantity theory of money as the money supply increases price level in the country also increases in the same proportion. Since prices of all goods and services increase the price of foreign exchange also in terms of domestic currency also increase. In different word the domestic currency depreciates as the money supply increases. This paper studies the relation between money supply, price level and exchange rate in India during 2000-2010. This study finds that During the period of study Whole Sale Price Index (WPI) and M1 and M3 show the positive relation but WPI is more correlated with M1. In case of WPI and Nominal Exchange Rate (NER) though they should move in the same direction many a times due to global effects (US crisis of 2001, global crisis of 2008 and large capital inflows of January 2008) they did not move in the same direction. Thus negative correlation has been found between WPI and NER.*

**Keywords:** *Broad money, money supply, narrow money, nominal exchange rate, wholesale price index*

### **1. Hypotheses – As Money Supply in the Country Increases Price Level Also Increases in the Country and the Domestic Currency Depreciates Vis-À-Vis a Foreign Currency**

In this chapter the relationship between money supply, price level and the exchange rate has been studied for the period 2000-01 to 2009-10. In the case of money supply both M1 (narrow money) and M3 (broad money) have been studied. In this study M1 and M3 measures are considered as the money supply but more emphasize is given on M1. In case of price level India's Whole Sale Price Index (WPI) has been considered. The reason for considering WPI is WPI is published for All Commodities (AC) which is a good representation of the prices in Indian economy. On the other hand Consumer Price Index (CPI) which is published shows the different representations for Industrial Workers (IW), Urban Non Manual Employees (UNME), Agricultural Laborers (AL). In case of exchange rate Nominal Exchange Rate (NER) vis-à-vis US \$, is considered while comparing with India's price level with NER. As the theory suggests a stepwise increase in country's money stock ultimately leads to a proportional increase in its price level and a proportional fall in its currency's foreign exchange values that is depreciation of country's currency vis-a vis a foreign currency.

### **2. Money Supply and Price Level**

Although prices depend on many other factors in the real world, according to the monetary approach price and money supplies should move together in the long run. Many theories suggest that there is a positive relationship between money supply and the price level. In this study the absolute figures of money supply (both M1 and M3) are compared with the price level (WPI) and also the growth rate of money supply (M1 and M3) are compared with the price level. (WPI).

While finding out the results the figures of M1 and M3 and of WPI are taken on monthly basis for the period of April 2000 to March 2010. April 2000 is considered as the base year for M1, M3, and for WPI and changes are made subsequently for the rest of the period so the amount of money supply and the price level would be compared on the same platform.

The growth of M1 is shown by red curve in the following diagram while the growth of WPI is shown by the blue curve for the period of April 2000 to March 2010.

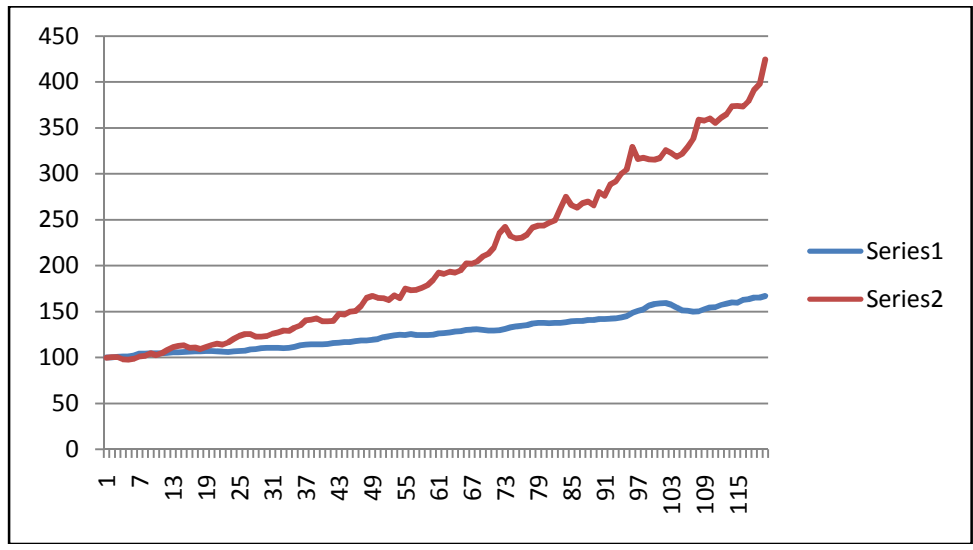


Figure 1

The growth of M3 is shown in the following diagram by red curve while the growth of WPI is shown by blue curve for the period of April 2000 to March 2010. Though M3 is increasing at higher rate WPI is increasing at a lower rate.

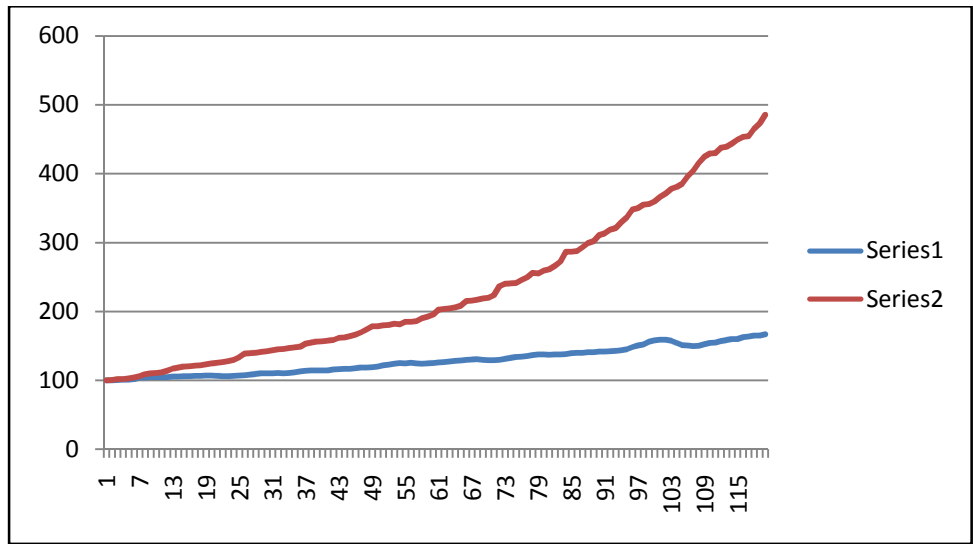


Figure 2

It is found that WPI shows more correlation to M1 than to M3 for the above mentioned period.

- Narrow Money (M1)
- Purpose- To study if there is any relationship between WPI and narrow money
- Null Hypotheses-H0: There is no relationship between WPI and narrow money (M1). ( $r=0$ ).
- Alternative Hypotheses H 1: There is a significant relationship between WPI and narrow money (M1). ( $r \neq 0$ ).
- Statistical test –Correlation
- Level of significance:  $\alpha = .05$

Correlations			
		WPI	Narrow Money
WPI	Pearson Correlation	1	.987**
	Sig. (2-tailed)		.000
	N	120	120
Narrow Money	Pearson Correlation	.987**	1
	Sig. (2-tailed)	.000	
	N	120	20

Table 1

\*\* Correlation is significant at the 0.01 level (2-tailed).

Observation:

$r = 0.987$ ,  $N = 120$ ,  $P = 0.000$ ,  $r^2 = 0.974$

- Interpretation- The above output shows that there is a strong relationship between WPI and narrow money. ( $r = 0.987$ ). Since the P value is less the level of significance, the null hypothesis is rejected and hence it is concluded that WPI and narrow money are strongly related.  $r^2$  of .974 suggests that WPI and narrow money share 97% of variance.

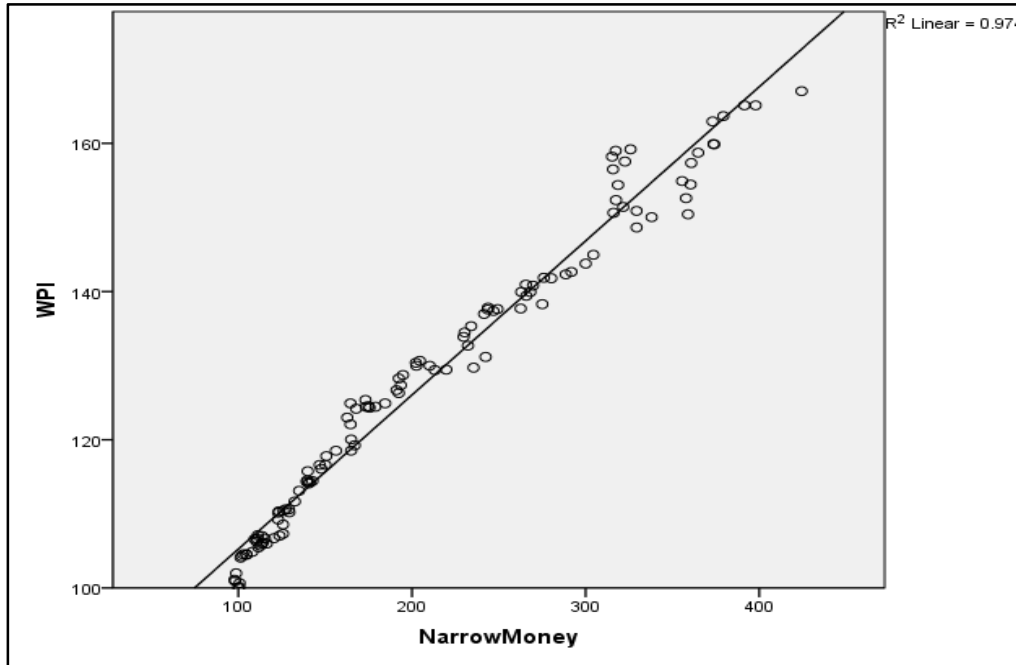


Figure 3

The above scatter plot shows a joint distribution for the two variables, WPI and narrow money. The coordinates in the scatter plot almost fits the straight line and follows an uphill suggesting a positive relationship between WPI and narrow money and hence it can be concluded that increase in narrow money leads to increase in WPI.

**3. Regression Analysis**

- Purpose- To study if narrow money can predict WPI.
- Variables and measurement- WPI, a dependent variable was measured using a ratio scale. Narrow money is an independent variable also measured using a ratio scale.
- Null Hypotheses- $H_0$ : Narrow money is not a predictor of WPI. ( $b = 0$ ).
- Alternative Hypotheses  $H_1$ : Narrow money is a significant predictor of WPI. ( $b \neq 0$ ).
- Statistical test – Simple regression
- Level of significance:  $\alpha = .05$

Model Summary					
Model		R	R Square	Adjusted R Square	Std. Error of the Estimate
dimension0	1	.987 <sup>a</sup>	.974	.974	3.083

a. Predictors: (Constant), Narrow Money

Table 2

Coefficients <sup>a</sup>						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	84.469	.708		119.322	.000
	Narrow Money	.208	.003	.987	66.988	.000

a. Dependent Variable: WPI

Table 3

Model summary shows  $r = 0.987$ ,  $r^2 = 0.974$ . This indicates that 97.4% of variance in WPI is explained by narrow money. Standard error of estimate + 3.083.

1	Regression	42665.893	1	42665.893	4487.382	.000 <sup>a</sup>
	Residual	1121.941	118	9.508		
	Total	43787.833	119			

b. Dependent Variable: WPI

Observation-  $f(1,118) = 4487.38$ ,  $P = 0.000$

ANOVA test is significant at 5% level of significance. This proves that the model is doing a good job of prediction.

Coefficients <sup>a</sup>						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	84.469	.708		119.322	.000
	Narrow Money	.208	.003	.987	66.988	.000

Table 4

a. Dependent Variable: WPI

Observation- Y- intercept = 84.46

$b = 0.208$

Beta = 0.987

$t = 66.988$ ,

$P = 0.000$

- Interpretation- t test for narrow money is significant. P-value is less than the level of significance. This proves that narrow money is a significant predictor of WPI. Based on the values of unstandardised coefficient the regression equation can be presented as follows –

$$WPI = 84.469 + 0.208 (\text{narrow money}).$$

This shows that if narrow money is increased by one unit WPI will go up by 0.208 units.

- Broad Money
- Purpose- To study if there is any relationship between WPI and broad money
- Null Hypotheses- $H_0$ : There is no relationship between WPI and broad money. (M3) ( $r=0$ ).
- Alternative Hypotheses  $H_1$ : There is a significant relationship between WPI and broad money (M1) ( $r \neq 0$ )
- Statistical test –Correlation

Correlations			
		WPI	BroadMoney
WPI	Pearson Correlation	1	.979**
	Sig. (2-tailed)		.000
	N	120	120
Broad Money	Pearson Correlation	.979**	1
	Sig. (2-tailed)	.000	
	N	120	120

\*\* . Correlation is significant at the 0.01 level (2-tailed).

Table 5

Level of significance: alpha Interpretation- The above output shows that there is a strong relationship between WPI and broad money. ( $r=0.989$ ). Since the P value is less the level of significance the null hypotheses is rejected and hence it is concluded that WPI and broad money has a strong relationship.  $r^2$  of 0.979 suggests that WPI and narrow money share 95% of variance.

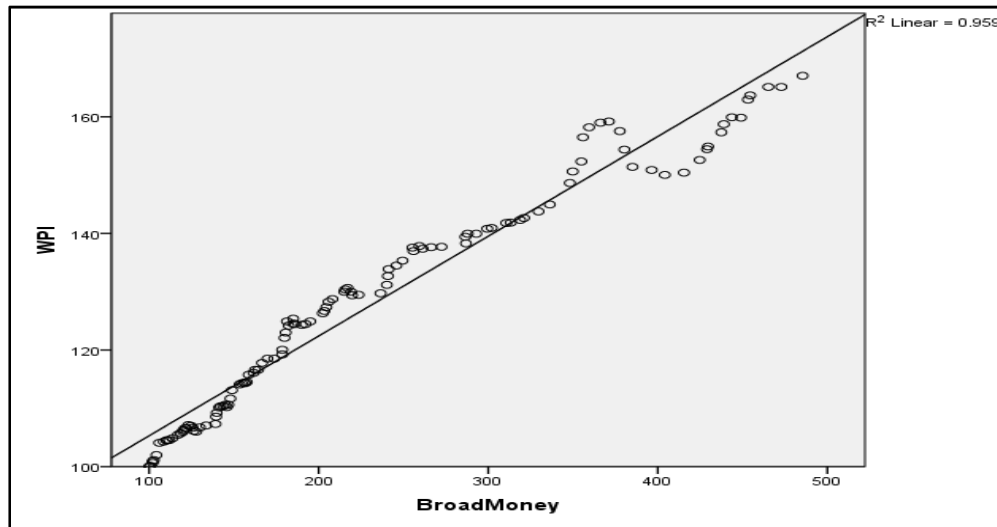


Figure 4

The above scatter plot shows a joint distribution for the two variables WPI and broad money. The coordinates in the scatter plot almost fits straight line and follows an uphill suggesting a positive relationship between WPI and broad money and hence it can be concluded that increase in broad money leads to increase in WPI.

**4. Regression Analysis**

- Purpose- To study if broad money can predict WPI.
- Variables and measurement- WPI is a dependent variable measured using a ratio scale. Broad money is an independent variable also measured using a ratio scale.
- Null Hypotheses-H<sub>0</sub>: Broad money is not a predictor of WPI. (b=0).
- Alternative Hypotheses H<sub>1</sub>: Broad money is a significant predictor of WPI. (b ≠ 0).
- Statistical test – Simple regression
- Level of significance: α = .05

Model Summary				
Model dimension	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.979 <sup>a</sup>	.959	.959	3.894

a. Predictors: (Constant), BroadMoney

Table 6

Model summary shows  $r = 0.979$ ,  $r^2 = 0.959$ . This indicates that 95% of variance in WPI is explained by broad money. Standard error of estimate + 3.894

ANOVA <sup>b</sup>						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	41998.210	1	41998.210	2769.180	.000 <sup>a</sup>
	Residual	1789.623	118	15.166		
	Total	43787.833	119			

. Predictors: (Constant), Broad Money

Table 7

b. Dependent Variable: WPI      Observation-  $f(1,118) = 2769.189$ ,  $P = 0.000$   
 ANOVA test is significant at 5% level of significance. This proves that the model is doing a good job of prediction.

Coefficients <sup>a</sup>						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	88.187	.836		105.539	.000
	Broad Money	.171	.003	.979	52.623	.000

a. Dependent Variable: WPI

Table 8

Observation- Y- intercept = 88.187

b = 0.171

Beta = 0.979

t = 52.623,

P = 0.000

- Interpretation- t test for broad money is significant. t value is less than the level of significance. This proves that broad money is a significant predictor of WPI. Based on the values of unstandardised coefficient the regression equation can be presented as follows –  $WPI = 88.187 + 0.171 (\text{broad money})$ .

This shows that if broad money is increased by one unit WPI will go up by 0.171 units.

#### 4.1. Relation between the Growth Rate of WPI and Growth Rate of M1 and M3

No relation has been found between growth rate of WPI and growth rate of M1 and M3

Correlations			
		growth rate of WPI	growth rate of M1
growth rate of WPI	Pearson Correlation	1	.057
	Sig. (2-tailed)		.541
	N	119	119
growth rate of M1	Pearson Correlation	.057	1
	Sig. (2-tailed)	.541	
	N	119	119

Table 9  
[Data Set 0]

Chi-Square Tests					
	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.321 <sup>a</sup>	1	.571		
Continuity Correction <sup>b</sup>	.079	1	.779		
Likelihood Ratio	.333	1	.564		
Fisher's Exact Test				.776	.401
Linear-by-Linear Association	.318	1	.573		
N of Valid Cases	119				

a. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 4.99.  
b. Computed only for a 2x2 table

Table 10

#### 4.2. Relation between WPI and Nominal Exchange Rate

In case of WPI and nominal exchange rate according to the theory there is a positive relationship between these two variables but it is found that nominal exchange rates and WPI are not moving together in this period. In fact it is found that during this period though WPI is increasing NER is appreciating which should have been depreciated since WPI is increasing, all prices including the price of the dollar in terms of Indian rupee should be increasing.

There are some reasons why Indian currency is not moving in the same direction of the movement of the WPI.

During this period the world economy experienced one of the worst shocks in the aftermath of September 11th, 2001 events in the U.S. Foreign exchange market in India also became volatile with the rupee showing the depreciation of 1.3% vis-a-vis U.S. \$ during the 10 day period between 10-20 September, 2001. It is found that exchange rate vis-a-vis U.S. \$ went (depreciation) to Rs. 49.01 in October 2001. During this period not much volatility was seen in WPI and in fact there was a fall in WPI. Indian rupee appreciated to Rs. 39.37 vis-a-vis U.S. \$ in January 2008 due to high capital inflows. In the same year WPI had increased by 5%. September 2008 witnessed the fall of Indian rupee (depreciation) vis-à-vis U.S.\$ by 5.8% and March 2009 witnessed the fall (depreciation) of Indian rupee vis-à-vis U.S.\$ by 3.9% reflected mainly supply-demand mismatch in the foreign exchange market as a fallout of global crisis. During the same period WPI fell down by 5.3%. During the period April 2007 to January 2008 Indian rupee vis-à-vis U.S.\$ kept on appreciating during the same period WPI kept on increasing.

Correlations			
		nominal exchange rate	WPI
nominal exchange rate	Pearson Correlation	1	-.244**
	Sig. (2-tailed)		.007
	N	120	120
WPI	Pearson Correlation	-.244**	1
	Sig. (2-tailed)	.007	
	N	120	120

Table 11

This above table shows negative correlation between WPI and nominal exchange rate.

## 5. Conclusion

During the period of study WPI and M1 and M3 show the positive relation but WPI is more correlated with M1. In case of WPI and NER though they should move in the same direction many a times due to global effects (US crisis of 2001, global crisis of 2008 and large capital inflows of January 2008) they did not move in the same direction. Thus negative correlation has been found between WPI and NER.

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