Exchange Rate Pass-through in India

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What is Exchange Rate Pass-through (ERPT)?

- Definition: percentage change in domestic prices, resulting from one-percent change in the exchange rate.
- ’Domestic Prices’ includes consumer prices, producer prices, import prices and sometimes the prices set by domestic exporters.
- If one percent change in exchange rate leads to one percent change in prices then pass-through is ’complete.’
- Less than one-to-one response of prices to exchange rate is referred to as ’incomplete’ exchange rate pass through.
How does exchange rate movements pass into domestic prices?

- The transmission mechanism of pass-through works in two stages.
- In the first stage, a depreciation increases prices of imported consumption and intermediate goods.
- In the second stage, it affects prices of domestically produced goods through supply and demand channels.
- By affecting the price of intermediate goods, it affects the cost of production and hence prices of domestically produced goods.
- Because of rise in import prices, demand shifts to domestically produced goods, leading to further increase in domestic prices.
Why understanding pass-through is important?

- Degree and timing of pass-through is important for forecasting inflation.
- Setting of effective monetary policy in response to inflation shocks require knowledge about ERPT.
- While there are several empirical studies on ERPT in the developed countries and some of the emerging markets like South-East Asia, Latin America and East-European Nations, literature on India is limited.
Stylised facts

- The Indian rupee has appreciated with respect to the US dollar since 2001.
- After a period of slow appreciation, in 2007 there has been a sharp change in the exchange rate.
- During the same time, both overall WPI and the WPI for manufacturing show sharp decline.
- Crude oil price also dropped sharply during this period followed by a sharp rise afterwards.
- WPI of fuel remains stable given the fact that this price is administered in India.
Figure: Recent Indian exchange rate Movements

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Figure: Oil Price Movements

Crude oil (expressed in INR)
WPI (fuel)

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Questions

- Do changes in the exchange rate have a significant effect on inflation?
- How large is the exchange rate pass-through?
- How much time does it take for a change in the exchange rate to impact the inflation rate?
- How long does the impact of a shock to exchange rates last?
- How do changes in oil prices impact inflation in India?
- How do changes in world commodity prices impact inflation in India?
- Does ERPT vary when monetary policy variables are brought into the picture?

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Solution: Bivariate analysis where both domestic prices and exchange rate are endogenous to the system.

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- Solution: Multivariate Analysis.
We adopt the alternative approach of multivariate analysis in line of McCarthy (1999) and others.

All the relevant variables are endogenous and the whole system is represented by a VAR model accounting for correlations among the variables.

Problem: Potential long run relation among variable not captured by VAR-based models.

Solution: Vector Error Correction Mechanism to capture long run relation among domestic prices, exchange rate and world prices.

We incorporate monetary policy variables in the analysis.
VAR-based Approach

The general Framework of the Model

\[ \pi_{oil}^t = \alpha_1 \pi_{oil}^{t-1} + \ldots + \alpha_p \pi_{oil}^{t-p} + \epsilon_{oil}^t \]  
\[ Y_t = \beta_1 \Delta Y_{t-1} + \ldots + \beta_p \Delta Y_{t-p} + \beta_3 \epsilon_{oil}^t + \beta_4 \epsilon_t^Y \]  
\[ \Delta e_t = \gamma_1 \Delta e_{t-1} + \ldots + \gamma_p \Delta e_{t-p} + \gamma_3 \epsilon_{oil}^t + \gamma_4 \epsilon_t^Y + \gamma_5 \epsilon_t^e \]  
\[ \pi_i^t = \delta_1 \pi_{i-1}^t + \ldots + \delta_p \pi_{i-p}^t + \delta_3 \epsilon_{oil}^t + \delta_4 \epsilon_t^Y + \delta_5 \epsilon_t^e + \epsilon_i^t \]  

\( \pi \): inflation measured by a particular index CPI/WPI/Oil.  
\( Y \): IIP gap.  
\( e \): exchange rate.
VAR-based Approach

Ordering of the variables implies an oil price shock contemporaneously affects output gap but not vice versa.

This recursive effect follows through other variables ending with consumer prices, on which all shocks are expected to have an impact.

This Cholesky decomposition of the shock structure allows us to identify the effects of structural shocks on inflation.

We conduct impulse response and variance decomposition analysis.
The general Framework of the Model:

\[ \Delta y_t = \mu + \alpha \beta' y_{t-1} + A_1 \Delta y_{t-1} + \ldots + A_{p-1} \Delta y_{t-p+1} + \epsilon_t \]

where

\[ y_t = \begin{bmatrix} P_{t}^{W/O} \\ Y_t \\ e_t \\ m_t \\ P_t^i \end{bmatrix} \]

\( P_{t}^{W/O} \): world commodity prices or crude oil prices.
\( m_t \): real money supply or interest rate.
\( P_t^i \): CPI or WPI index.
We estimate the model using Johansen (1988) MLE technique. Estimates of $\beta$ gives us long-run elasticities of domestic prices with respect to exchange rate and oil or commodity prices. Estimates of $\alpha$ give us how different variables behave in response to a deviation from long-run equilibrium. Estimates of $A$ give short run effects. We conduct impulse response analysis and variance decomposition analysis for the VECM model.
Variables and Data

- We use monthly data from September, 1997 to October, 2007.
- Nominal rupee dollar (INR-USD) exchange rate.
- World commodity price index are sourced from IFS.
- IIP gap: proxy for monthly GDP.
- CPI and WPI.
- The measure of real money supply is M3 adjusted for IIP.
- All variables, except for exchange rate are seasonally adjusted using ARIMA X(11).
- The output gap is deviation of seasonally adjusted IIP from its Hodrick-Prescott filtered trend.
Stationarity and Co-integration

- All variables except for output gap are I(1). Output gap is I(1) for certain lags.
- Johansen co-integration test shows existence of co-integration relation among variables.
Summary of our estimation approach

Model 1: Recursive VAR: Impact fuel Price and exchange rate movements on CPI inflation.

Model 2: VECM: Impact of commodity prices and exchange rate on CPI level.

Model 3: VECM: Does the results of model 2 vary if we incorporate money supply?

Model 4: VECM: Impact of crude oil price, exchange rate and interest rate on WPI level assuming stationarity of IIP gap.
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Results: Long and short run elasticities of CPI level with respect to exchange rate

- 10% shock to exchange rate.
  - CPI changes by 1-1.1% in short run.
  - CPI changes by 0.37-1.7% in the long run.
  - WPI changes by 1.36% in the short run.
  - WPI changes by 2.86% in the long run.
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## Results

<table>
<thead>
<tr>
<th>Variables</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Lcpi</td>
<td>Lcpi</td>
<td>Lwpi</td>
</tr>
<tr>
<td></td>
<td>Long-run Relation</td>
<td>Short-run ERPT</td>
<td>Long-run Relation</td>
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<tr>
<td>$Ln(e)$</td>
<td>0.037</td>
<td>0.101*</td>
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<tr>
<td>$Ln(P^O)$</td>
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<td>$Ln(P^W)$</td>
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<tr>
<td>$Ln(Y)$</td>
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<tr>
<td>$Ln(interest)$</td>
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<tr>
<td>$Ln(m3real)$</td>
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</tr>
<tr>
<td>Constant</td>
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<tr>
<td>p-value</td>
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<td>0.047</td>
<td>0.000</td>
</tr>
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</table>

**Table:** Long-run and Short-run pass-through
Results

- CPI adjusts by 1.6-4.1% as a response to any deviation from the long run relation.
- WPI adjusts by 2% as a response to any deviation from the long run relation.
- Crude-oil price, world commodity prices for the model 3 and interest rate do not respond to the long-run equilibrium relation. Hence these variables are weekly exogenous to the system.
10% increase in exchange rate leads to 1.02-1.15% increase in CPI in the next period.

If effect of money supply is not considered after two years, the effect is 0.68%.

If money supply effects are considered, after two years the effect is 2%.

10% increase in exchange rate leads to 1.2% rise in WPI in the next period, while after two years, the effect is 0.13%.

10% increase in depreciation has a cumulative effect of 0.25% after two years on the CPI inflation.
10% shock to commodity prices changes CPI by 0.47-0.56% in the long run.

10% shock to crude oil prices has an immediate effect on WPI of 0.1% which rises to 0.5% in two years.

10% shock to real money supply changes CPI by 0.45% immediately and in two years the effect is 2%.

10% shock to interest rate has an immediate positive effect on WPI, but in two years the effect is -0.08%
Figure: Cumulative Impulse Response of CPI Inflation to a Unit Shock to Exchange Rate and Fuel Price Inflation
Figure: Impulse Response of CPI to 1 Percent Shock to Exchange Rate and World Commodity Price
Figure: Impulse Response of CPI to 1 Percent Shock to Exchange Rate, World Commodity Price and Money Supply
Figure: Impulse Response of WPI to 1 Percent Shock to Exchange Rate, Crude Oil Price and Interest Rate
10% shock to exchange rate

- CPI changes by 1.02-1.15%.
- If money supply is not accounted for, effect drops to 0.68% in two years.
- If effect of money supply is considered effect rises to 2% in two years.
- WPI rises by 1.2% in the next period, while after two years, the effect drops to 0.13%.
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Summary

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- CPI changes by 1.02-1.15%.
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