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.

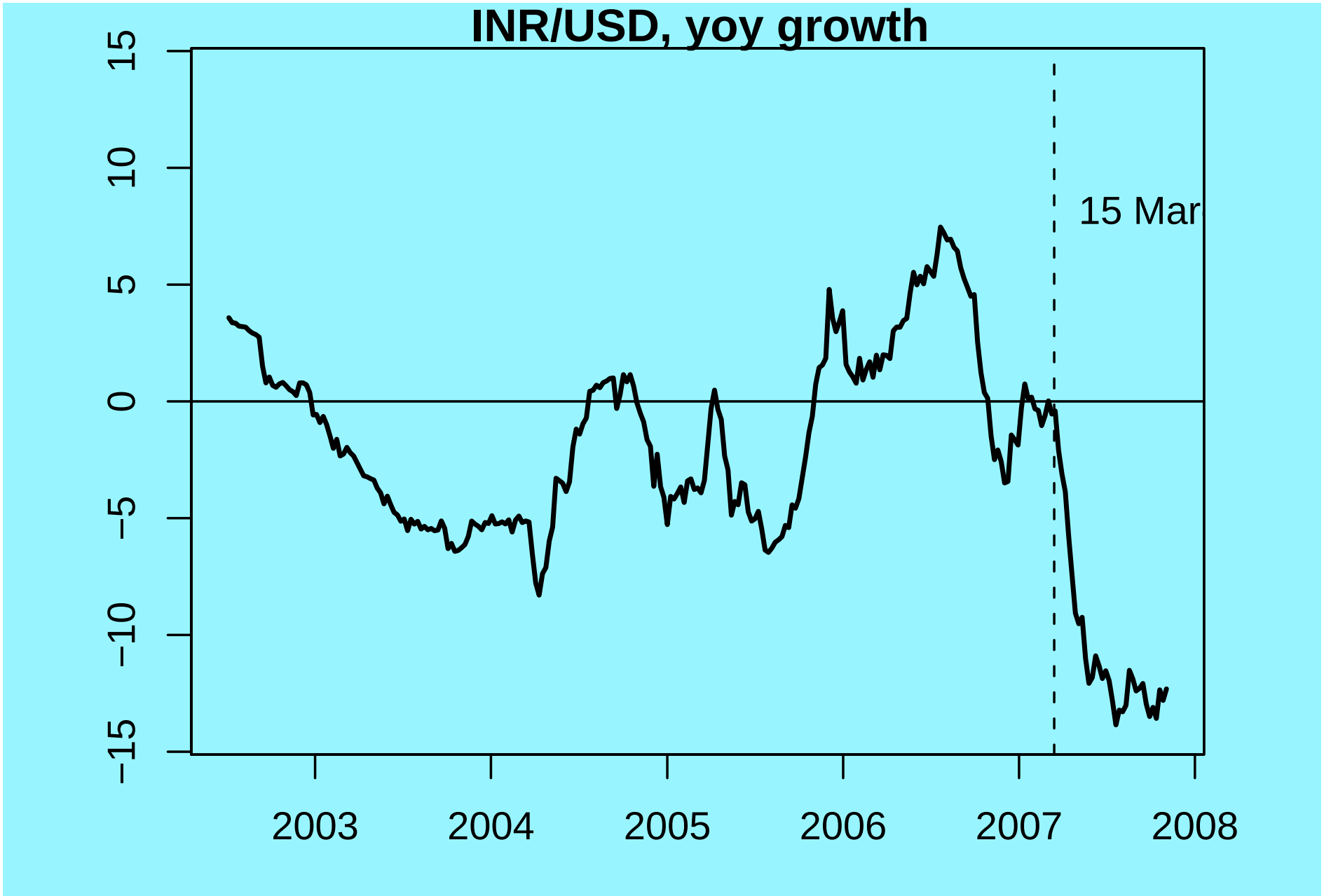

Figure: Recent Indian exchange rate Movements

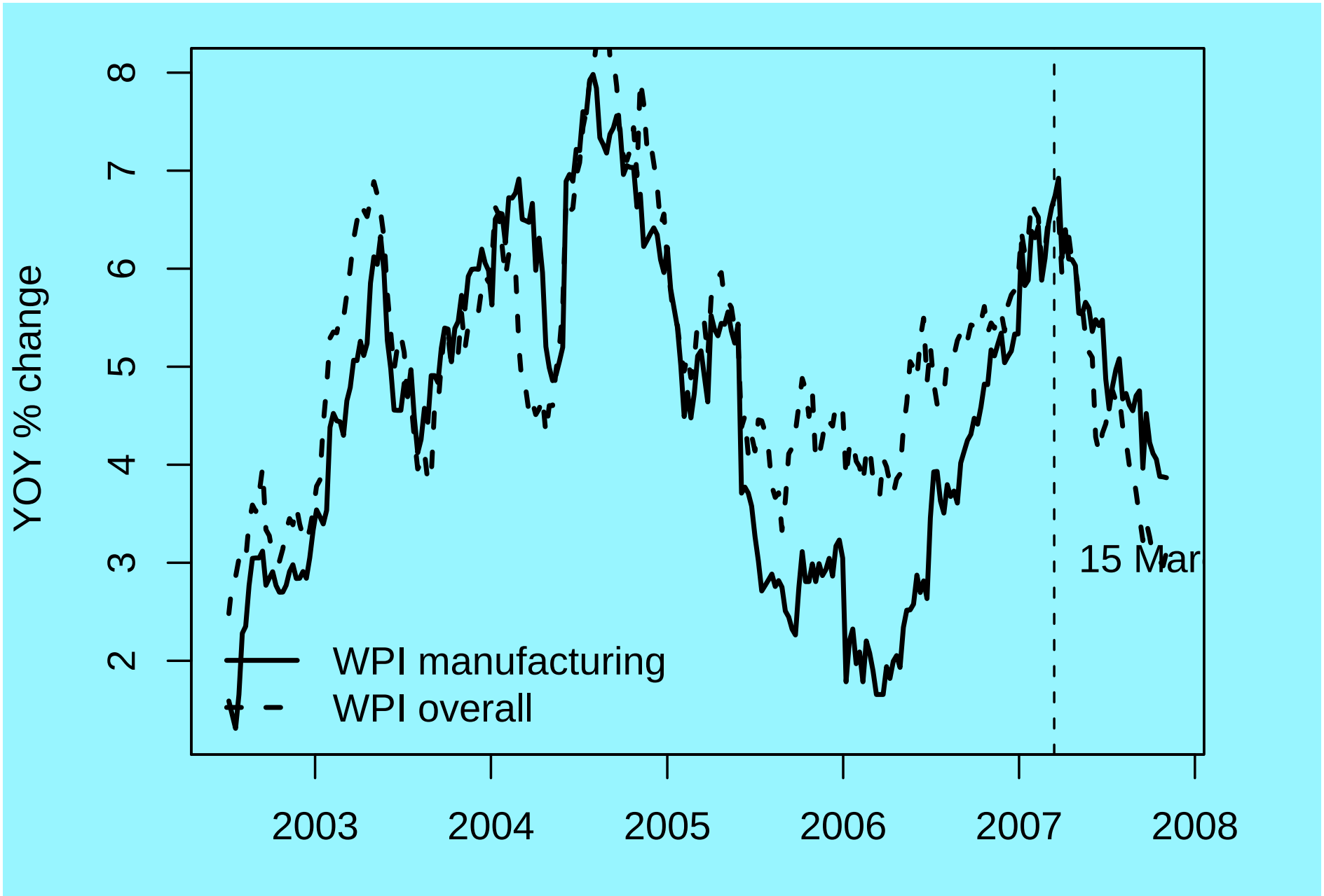

Figure: Recent Indian WPI Changes

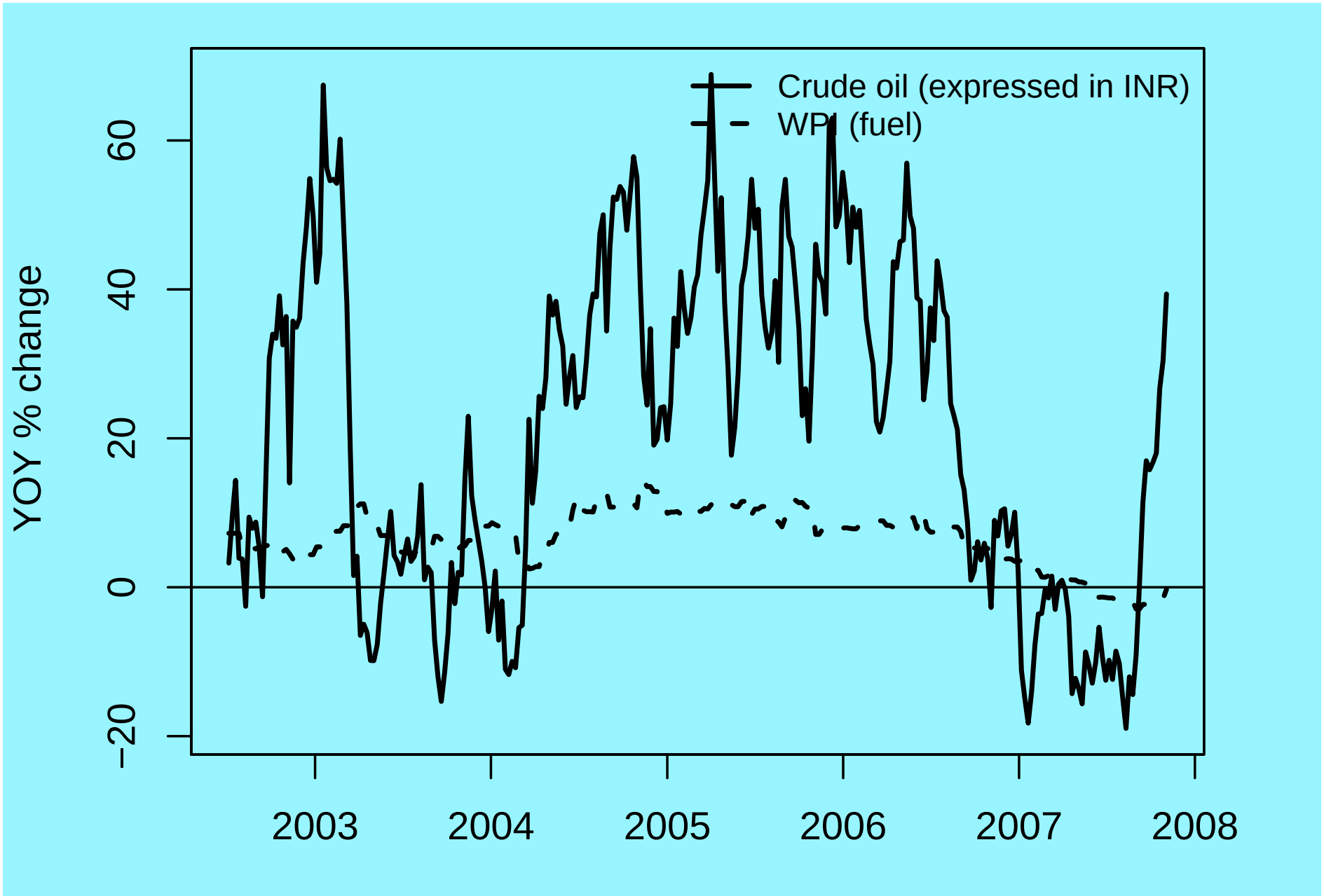

Figure: Oil Price Movements

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?

Estimation of ERPT in India: Single equation model

- Khundrakpam, 2007.
- Problem: Estimates can be affected by potential endogeneity of domestic prices and exchange rate (Osbat and Wagner, 2006).
- Solution: Bivariate analysis where both domestic prices and exchange rate are endogenous to the system.

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Estimation of ERPT in India: Bivariate error correction mechanism

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Our Approach

- 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

$$\pi_t^{\text{oil}} = \alpha_1 \pi_{t-1}^{\text{oil}} + \ldots + \alpha_p \pi_{t-p}^{\text{oil}} + \epsilon_t^{\text{oil}} \quad (1)$$

$$Y_t = \beta_1 \Delta Y_{t-1} + \ldots + \beta_p \Delta Y_{t-p} + \beta_3 \epsilon_t^{\text{oil}} + \beta_4 \epsilon_t^{Y} \quad (2)$$

$$\Delta e_t = \gamma_1 \Delta e_{t-1} + \ldots + \gamma_p \Delta e_{t-p} + \gamma_3 \epsilon_t^{\text{oil}} + \gamma_4 \epsilon_t^{Y} + \gamma_5 \epsilon_t^{e} \quad (3)$$

$$\pi_t^{\text{i}} = \delta_1 \pi_{t-1}^{\text{i}} + \ldots + \delta_p \pi_{t-p}^{\text{i}} + \delta_3 \epsilon_t^{\text{oil}} + \delta_4 \epsilon_t^{Y} + \delta_5 \epsilon_t^{e} + \epsilon_t^{i} \quad (4)$$

π: 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.

VECM

The general Framework of the Model:

$$\Delta y_t = \mu + \alpha\beta' y_{t-1} + A_1 \Delta y_{t-1} + ... + A_{p-1} \Delta y_{t-p+1} + \epsilon_t$$

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.

VECM

- We estimate the model using Johansen (1988) MLE technique.
- Estimates of β gives us long-run elasticities of domestic prices with respect to exchange rate and oil or commodity prices.
- Estimates of α 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

Variables	Model 2		Model 3		Model 4	
	Lcpi		Lcpi		Lwpi	
	Long-run Relation	Short-run ERPT	Long-run Relation	Short-run ERPT	Long-run Relation	Short-run ERPT
$Ln(e)$	0.037	0.101*	0.173	0.113*	0.286	0.136***
$Ln(P^O)$					0.187	
$Ln(P^W)$	0.262		0.247			
$Ln(Y)$	- 2.805		-3.707			
$Ln(interest)$					- 0.067	
$Ln(m3real)$			0.023			
Constant	3.718		3.049		3.51	
p-value	0.000	0.047	0.000	0.027	0.000	0.000

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.

Dynamic Behavior of prices

- 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.

Dynamic Behavior of prices

- 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%

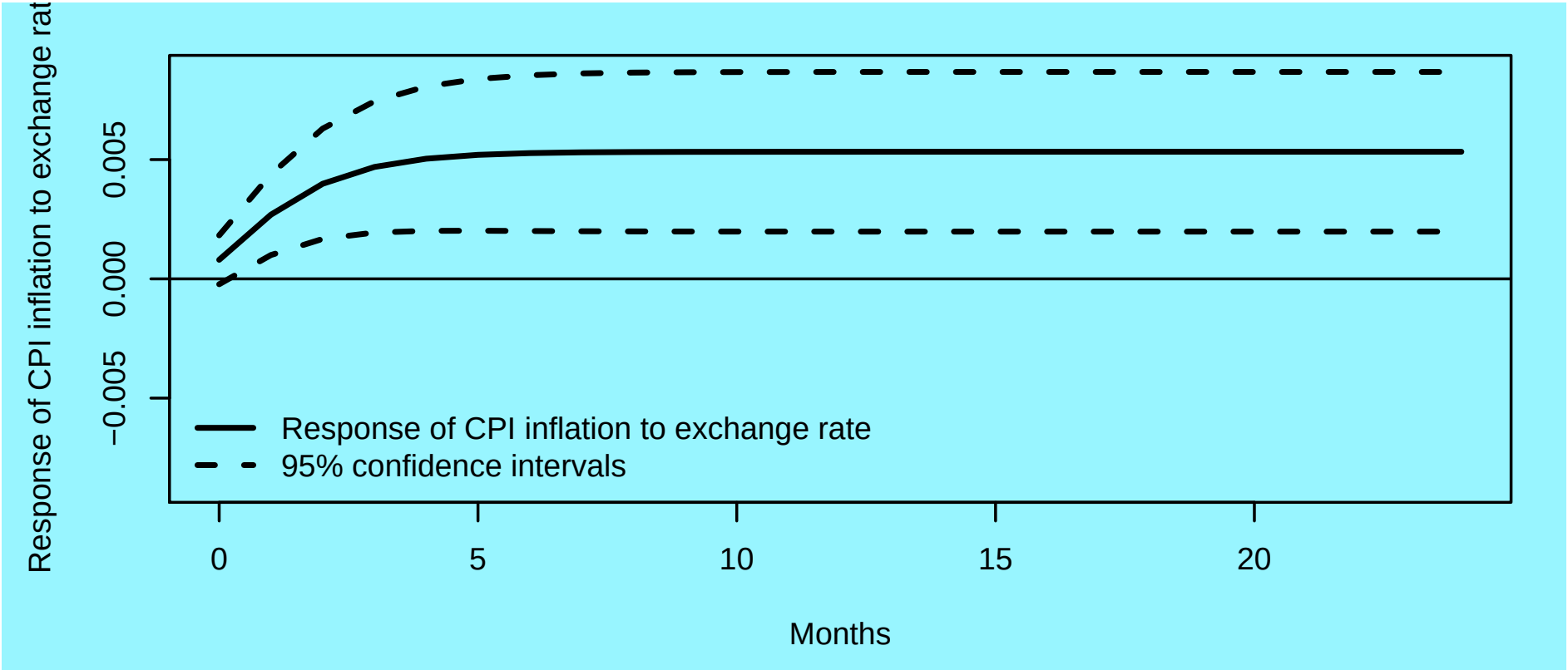

Figure: Cumulative Impulse Response of CPI Inflation to a Unit Shock to Exchange Rate and Fuel Price Inflation

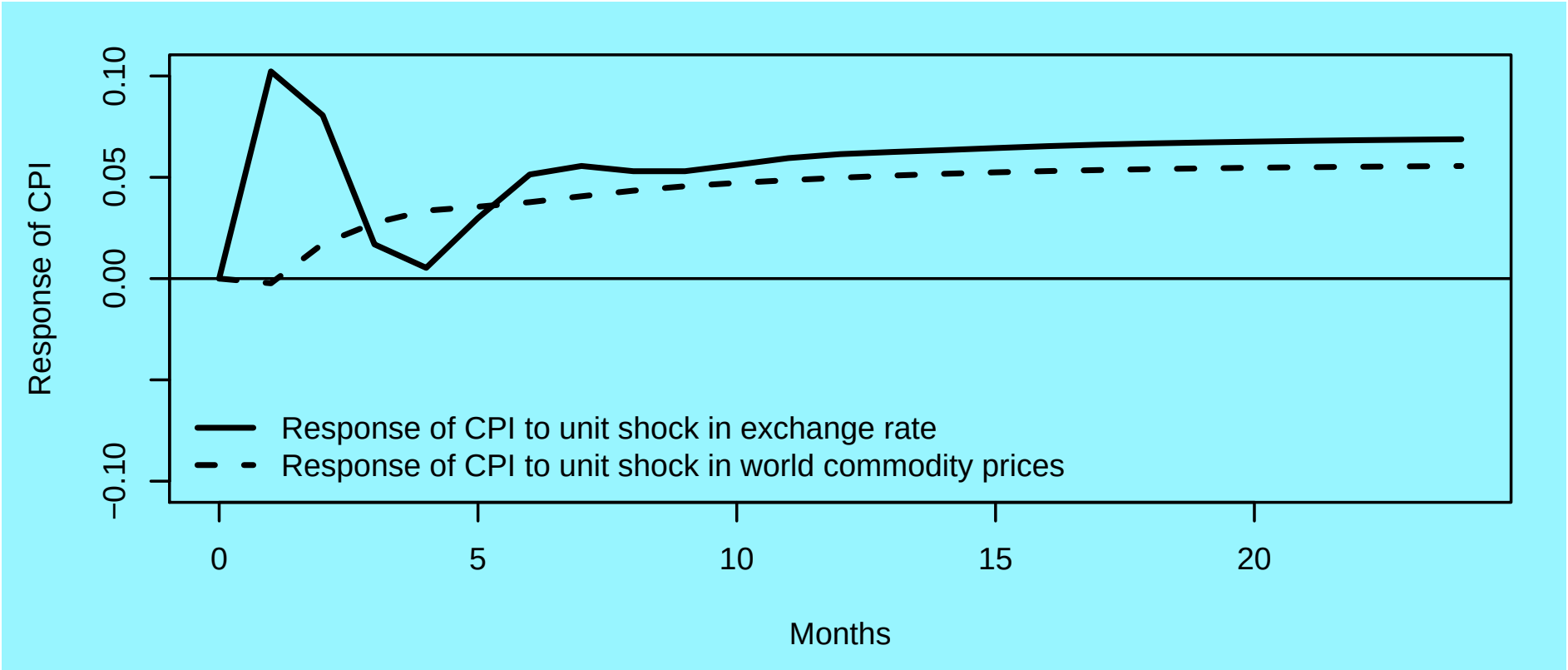

Figure: Impulse Response of CPI to 1 Percent Shock to Exchange Rate and World Commodity Price

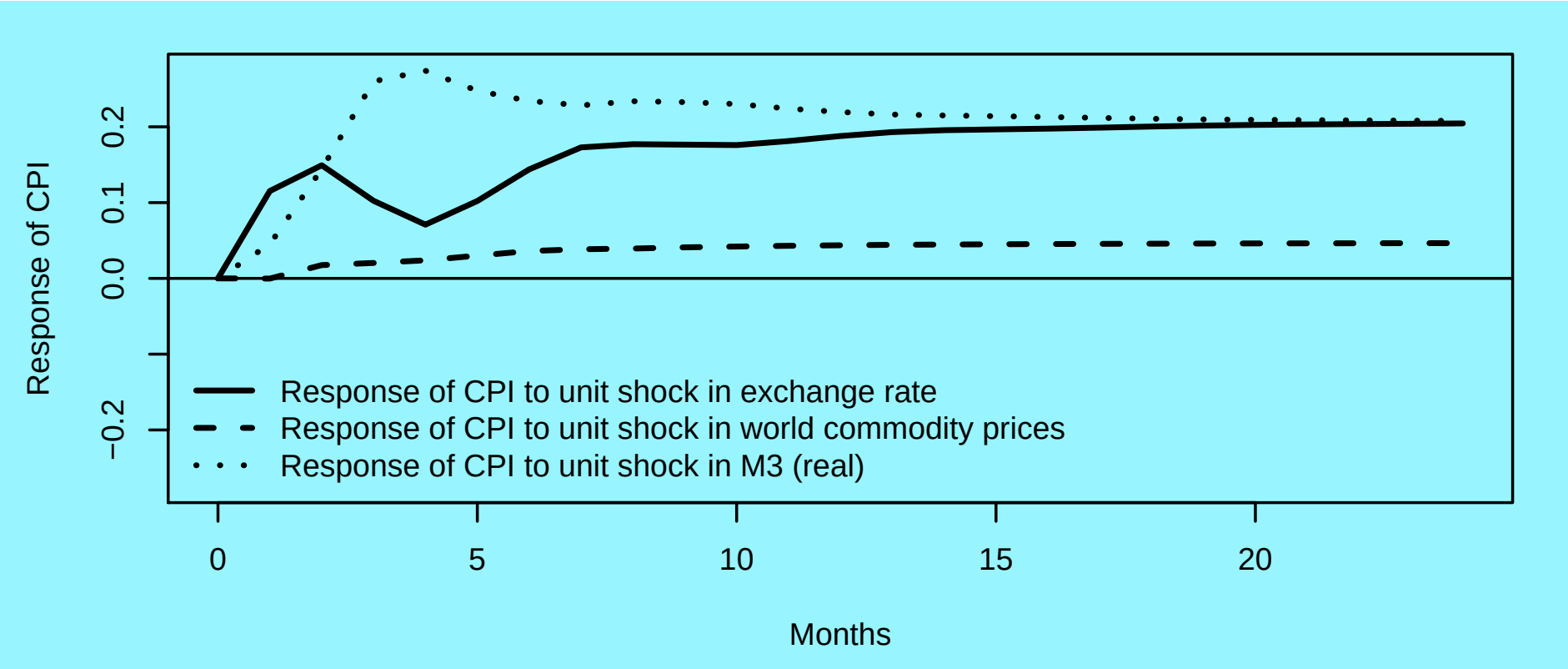

Figure: Impulse Response of CPI to 1 Percent Shock to Exchange Rate, World Commodity Price and Money Supply

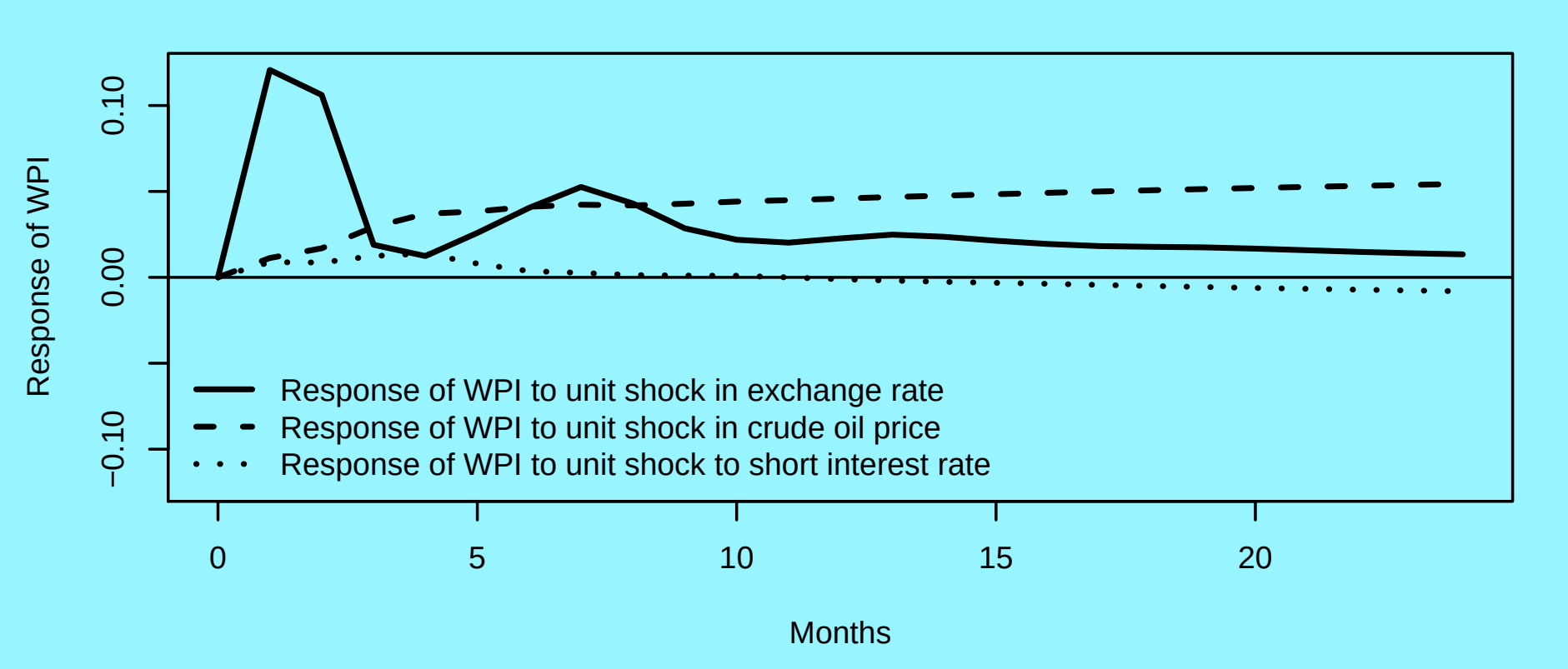

Figure: Impulse Response of WPI to 1 Percent Shock to Exchange Rate, Crude Oil Price and Interest Rate

Summary

- 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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