Exchange Rate Pass-Through In India

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- Presentation based on:
- 1) Ghosh, A. and R.S. Rajan (2007). "How High is Exchange Rate Pass-through in India: Has it Changed Over Time," *The Journal of International Trade & Economic Development*, 16 (3), 373-382.
- 2) Ghosh, A. and R.S. Rajan (2007). "Macroeconomic Determinants of Exchange Rate Pass-through in India," mimeo (August).
- 3) Ghosh, A. and R.S. Rajan (2007). "A Survey of Exchange Rate Pass-through in Asia," *Asia Pacific Economic Literature*, 21 (2), 13-28.

1. Format of Presentation

- 1) Understanding Exchange Rate Pass-Through (ERPT).
- 2) Simple framework to understand EPRT.
- 3) Extent of ERPT in India (1980-2006).
- 4) Macroeconomic determinants of ERPT in India.
- 5) Summary and Conclusion.

1. Defining ERPT

Definition of ERPT:

"Percentage change in local currency import prices due to one-percent change in the exchange rate between the exporting and importing nations."

• At the macro level one could examine ERPT into a nation's CPI and aggregate import prices.

• At a micro level one could examine ERPT into import prices of specific goods.

• Low ERPT creates less inflationary pressure and keeps a country insulated from changes in the foreign exchange market -- less reason for "fear of floating".

 Conversely, low ERPT could render the use of any exchange rate based adjustments to improve the trade balance less effective. -- Extreme case of "Local Currency Pricing" in NOEM literature. Industrial country studies have found incomplete and declining rates of ERPT in the case of CPI.

- Problems of using CPI:
 - ▶ Nontradables and "flight to quality".
 - Monetary policy response.
 - Local distribution costs.

 Studies using import prices (first stage EPRT) showed higher pass-through but still incomplete and declining.

2. Simple Framework to understand EPRT

 Consider two countries trading a single good with A being the importing nation and B the exporting one.

 E_B^A = bilateral exchange rate defined as the number of units of A's currency per unit of B's currency.

 P_A^M = price of imports (M) in local currency of A. p_B^X = price of exports (X) in the currency of B.

All mariables in loss

Assuming law of one price (LOP) holds in relative terms:

$$\frac{\Delta p_A^M}{\Delta E_B^A} = \frac{\Delta p_B^X}{\Delta E_B^A} + 1 \tag{1}$$

Import ERPT into A's currency is given by l.h.s. of eq. 1.

Pricing-to-market (PTM) for B (in its own currency) is given by the first term on the r.h.s. of eq. (1).

$\frac{\Delta p_B^X}{\Delta E_B^A} = 0$ implies no PTM by exporters in country B and consequently full ERPT to country A's imports.

 $\frac{\Delta p_B^X}{\Delta E_B^A} = -1 \text{ implies complete PTM and consequently} \\ 0 \quad \text{ERPT} \quad \text{into} \quad \text{country} \quad \text{A's} \quad \text{imports.} \end{cases}$

Assuming imperfect competition we can w_{I}^{X} te more generall y_{B}^{X} as $mc^{X} + mkp^{X}(E)$ (2)

where mc= marginal costs and mkp= exporters mark-up, both in logs.

The literature generally assumes *mc* is invariant to the exchange rate while *mkp* varies inversely with the exchange rate.

Specifically
$$-1 < \frac{\Delta m k p}{\Delta E_B^A} < 0.$$

The greater the PTM by exporters in country B the more willing they are to lower mark-ups in response to own country's currency appreciation.

In other words
$$\frac{\Delta m k p}{\Delta E_B^A} \rightarrow -1$$
 implies $\frac{\Delta p_B^X}{\Delta E_B^A} \rightarrow -1$

and therefore

$$\frac{\Delta p_A^M}{\Delta E_B^A} \to 0.$$

3. Examining ERPT in India

- To operationalize Eq. (1) we need to augment it by control variables.
- The primary control variables are the cost conditions in the exporting nation's market and demand conditions in the importing nation's market.

• We consider ERPT using both the bilateral-US dollar exchange rate as well as the nominal effective exchange rates (NEER).

$$\ln(CPI)^{India} = \alpha_0 + \alpha_1 \ln(E_{US}^{India}) + \alpha_2 \ln(PPIorCPI)^{US} + \alpha_3 \ln(IP)^{India} + \varepsilon_t \quad (3)$$
$$\ln(CPI)^{India} = \delta_0 + \delta_1 \ln(NEER)^{India} + \delta_2 \ln(CPI)^{World} + \delta_3 \ln(IP)^{India} + \varepsilon_t \quad (4)$$

• We control for shifts in aggregate demand in India by using the overall industrial production index of India (quarterly GDP data for India was not available).

- For cost conditions in the exporting nation we use two alternate measures:
 - ≻ US PPI and the CPI (Eq. 3).
 - ≻ Aggregate CPI of the world (Eq. 4).

• Data on India's CPI, bilateral dollar exchange rate, US CPI, US PPI, and India's index of industrial production are all sourced from the *IFS*. Data on India's NEER is taken from the *RB I*.

• The data for India spans the period 1980Q1-2006Q4.

• Variables are found to be non-stationary in their level form but stationary in their first-differenced form and there is evidence that of a co-integration vector among the variables.

 We estimate regressions in levels using both OLS and DOLS.

OLS Regression Results for India

	Spec.1	Spec.2	Spec.3
С	-0.149	-0.661	-0.069
	0.555	0.536	0.258
LEXRT	0.432***	0.410***	
	0.030	0.052	
LNEER			0.064
			0.047
LPPIUSA	-0.036		
	0.167		
LCPIUSA		0.149	
		0.202	
LCPIW			0.313***
			0.04
LIP	0.712***	0.656***	0.634***
	0.059	0.066	0.076
Adj. R ²	0.998	0.998	0.998

Terms below co-efficients denote standard errors. ***, **, * indicate statistical significance at 1%, 5%, and 10%, respectively.

Dynamic OLS Regression Results for India

	Spec. 1	Spec. 2	Spec. 3
С	0.228	0.929	0.468*
	0.446	0.612	0.269
LEXRT	0.446***	0.485***	
	0.026	0.040	
LNEER			0.033
			0.037
LPPIUSA	-0.139		
	0.145		
LCPIUSA		-0.427*	
		0.231	
LCPIWORLD			0.352***
			0.038
LIPINDIA	0.721***	0.830***	0.516***
	0.062	0.075	0.075
$\Delta LEXRT_{(t-1)}$	-0.274***	-0.261***	0.013
	0.084	0.077	0.026
$\Delta LEXRT_{(t+1)}$	0.155**	0.226***	0.071**
	0.072	0.071	0.034
Δ LPPIUSA _(t-1)	0.014	-0.779	-1.465***
	0.228	0.643	0.356
Δ LPPIUSA _(t+1)	-0.234	-2.501***	-0.395
	0.213	0.777	0.384
$\Delta LIP_{(t-1)}$	-0.055	-0.072	-0.226*
(* 1)	0.124	0.113	0.130
$\Delta LIP_{(t+1)}$	0.381***	0.438***	0.176
	0.081	0.072	0.107
Adi. R^2	0.998	0.998	0.997

Terms below co-efficients denote standard errors. ***, **, * indicate statistical significance at 1%, 5%, and 10%, respectively.

• We find ERPT elasticity into India's CPI for the entire sample period (1980-2006) to be about 40-50%.

• We also estimated ERPT elasticity from India's NEER into the CPI but found it to be a statistically insignificant for the NEER, implying lack of any evidence of ERPT.

• We also examined short-run ERPT into India's CPI by using the error correction (ECM) forms of eqs. (3) and (4).

$$\Delta \ln(CPI)_{t}^{Inalia} = \beta_{0} + \beta_{1}(ECM)_{t-1} + \beta_{2}\Delta \ln(E_{US}^{Inalia})_{t} + \beta_{3}\Delta \ln(PPI/CPI)_{t}^{OS} + \beta_{4}\Delta \ln(IP)_{t}^{Inalia} + \beta_{5}\Delta \ln(CPI)_{t-1}^{Inalia} + \varepsilon_{t}$$
(5)

India

 $\Delta \ln(CPI)_{t}^{India} = \gamma_{0} + \beta_{1}(ECM)_{t-1} + \gamma_{2}\Delta \ln(E_{US}^{India})_{t} + \gamma_{3}\Delta \ln(PPI/CPI)_{t}^{US} + \gamma_{4}\Delta \ln(IP)_{t}^{India}$

+
$$\gamma_5 \Delta \ln(CPI)_{t-1}^{India}$$
 + ε_t (6)

Error-Correction Model Results for India

	Spec. 1	Spec. 2	Spec. 3	
С	0.009***	0.008***	0.008***	
	0.003	0.003	0.002	
$ECM_{(t-1)}$	-0.128***	-0.118***	-0.067***	
	0.044	0.039	0.023	
ΔLEXRT	0.102***	0.096***		
	0.025	0.027		
ΔLNEER			-0.009	
			0.013	
ΔLPPIUSA	-0.048			
	0.104			
ΔLCPIUSA		0.149		
		0.169		
ΔLCPIW			0.164**	
			0.067	
ΔLIP	0.082	0.076	0.029	
	0.055	0.055	0.056	
$\Delta LCPI_{(t-1)}$	0.362***	0.360***	0.281***	
	0.090	0.074	0.077	
Adj. R^2	0.245	0.247	0.235	

Terms below co-efficients denote standard errors. ***, **, * indicate statistical significance at 1%, 5%, and 10%, respectively.

• The ECM term suggests that any deviation from the long-run equilibrium relationship is adjusted by about 13 to 12 percent in the short-run for bilateral USD changes.

 The short-run ERPT elasticity is found to be about 10 percent respectively for the two specifications over the entire sample period.

• For the NEER we once again do not find any significant ERPT.

• Since the Indian economy undertook a set of market-oriented reforms following the balance of payments crisis in 1991 we re-estimated ERPT for two sub-periods, viz. 1980Q1-1990Q4 and 1992Q1-2006Q4.

Level Regression Results for India

		1980Q1 -			1992Q1 -	
		1990Q4			2005Q3	
	Spec. 1	Spec. 2	Spec. 3	Spec.1	Spec.2	Spec.3
C	-1.242	-3.032***	0.634	1.012	0.098	0.518***
	1.031	0.579	1.136	0.715	1.263	0.309
LEXRT	0.368***	0.019		0.381***	0.497***	
	0.136	0.107		0.065	0.067	
LNEER			0.154			-0.103
			0.138			0.070
LPPIUSA	0.296			-0.393		
	0.268			0.205		
LCPIUSA		1.115***			-0.167	
		0.236			0.452	
			0.518**			0 460444
LCPIW			*			0.468^^^
			0.087			0.158
LIP	0.658***	0.477***	0.176	0.860***	0.738***	0.519***
	0.134	0.086	0.215	0.089	0.162	0.162
Adj. R ²	0.985	0.993	0.992	0.993	0.992	0.983

Terms below co-efficients denote standard errors. ***, **, * indicate statistical significance at 1%, 5%, and 10%, respectively.

• Using bilateral USD rate, for the pre-liberalization period we find an ERPT elasticity of 37 percent when we use US PPI, while we do not find any significant ERPT when we use the US CPI as a control.

• For the post-liberalization period, the ERPT elasticities for specifications using the US PPI and CPI are 38 and 50 percent, respectively.

 For India's NEER, once again we do not find any significant ERPT in either period. • These results indicate that at the macro level there is some evidence of stable-to-somewhat higher ERPT for the post-liberalization era which may be consistent with greater openness of the country to external influences.

• The ECM results reveal no evidence of short-run ERPT for the bilateral USD-rupee rate for either of the two sub-samples compared to about 10 percent for the entire period using the bilateral USD-rupee rate.

The liberalization program in India has not been a
 0 or 1 situation -- reform program itself is an
 ongoing one characterized by gradualism.

 Accordingly it may be more insightful to consider dynamic changes in ERPT over time.

• To this end we perform dynamic estimates of ERPT by using the Kalman-Filter and recursive OLS methodologies.

• For ERPT of the bilateral nominal dollar-rupee rate into India's CPI we do not find any evidence of changing rates of ERPT over time.

Recursive OLS: ERPT (USD) estimates of India's CPI



Recursive OLS: ERPT (NEER) estimates of India's CPI



4. Macroeconomic Determinants of ERPT

 ERPT may be endogenous to a nation's monetary policy and inflation outcomes.

➤ The more stable is a country's monetary policy and the lower its inflation the lower will be the extent of ERPT (Taylor, 2000.

Impact of exchange rate volatility is ambiguous (Devereux and Engel, 2001 vs. Froot and Klemperer, 1989).

Effect of Macro variables on Recursive ERPT elasticities of US dollar: When US PPI is used as Foreign Exporters' Costs

С	0.427***	0.422***	0.483***	0.418***	0.470***	0.467***	0.457***
	0.037	0.041	0.058	0.035	0.045	0.047	0.038
Money growth	0.002			0.001	0.004		0.003
	0.008			0.008	0.008		0.008
Inflation rate _(t-1)		0.006		0.006		0.010	0.010
× /		0.013		0.012		0.013	0.013
USD volatility			-1.746**		-1.796**	-1.867**	-1.901**
			0.688		0.727	0.795	0.823
Adj. R ²	-0.010	-0.009	0.006	-0.019	-0.003	-0.001	-0.011

Effect of Macro variables on Recursive ERPT elasticities of US dollar: When US CPI is used as Foreign Exporters' Costs

				U	_		
С	0.296***	0.312***	0.335***	0.315***	0.336***	0.349***	0.348***
	0.028	0.029	0.033	0.030	0.033	0.032	0.032
Moneygrowth	-0.002			-0.001	0.000		0.001
	0.003			0.003	0.003		0.003
Inflationrate _(t-1)		-0.012		-0.012		-0.009	-0.009
		0.008		0.008		0.007	0.008
USDvolatility			-1.667***		-1.665***	-1.562***	-1.568***
2			0.553		0.556	0.565	0.564
Adj.R ²	-0.008	0.018	0.087	0.009	0.078	0.092	0.083

Ferms below co-efficients denote standard errors. ***,**,* indicate statistical significance at 1%, 5%, and 10%, respectively

• On trying various combinations of the three macro variables, we fail to find any statistically significant impact of money growth or lagged inflation rate on ERPT.

 However, exchange rate volatility is consistently found to have a negative impact on ERPT; this finding is robust to when we used various lagged structures of the independent variables. • A reason often cited for the "fear of floating" is that emerging economies are relatively more susceptible to ERPT effects into domestic prices.

 However, our results suggest that exchange rate pass through may be endogenous to the degree of flexibility of the exchange rate regime itself.

• Low ERPT implies that small and open economies may be less concerned about the potential inflationary consequences of exchange rate fluctuations, suggesting there is less reason to fear floating.

5. Summary and Conclusion

• We have estimated ERPT into India's CPI for the period 1980Q1 to 2006Q4.

• We find the ERPT elasticity of the bilateral exchange rate of the Indian rupee with the USD to be about 40 percent for the entire period in the long run, while it is inevitably smaller in the short run (10 percent).

• For India's NEER we do not find any evidence of significant ERPT even in the long-run.

• This suggests that as far as "importing inflation from abroad" is concerned, gyrations in the bilateral rupee-dollar rate have been more important then fluctuations in India's NEER.

• We also estimated ERPT both before and after the introduction of economic reforms in India in 1991.

• Our results suggest some evidence of a slightly higher ERPT for the post-liberalization era, which is consistent with greater openness of the country to external influences.

• We also investigated some macro determinants of ERPT and found exchange rate volatility reduced ERPT.

• Other factors that may play a role:

➢ Magnitude of currency change - the greater the size of exchange rate change, the more is EPRT (Krugman, 1987 and Marazzi et al., 2005). – *Though not always, e.g.*. *Contractionary devaluations*.

➢ Asymmetry -- Currency appreciation may lead to more ERPT than depreciation of equal amount (Coughlin & Pollard, 2003 and Madhavi, 2002). Low ERPT in aggregate prices may be due to changing product composition (Campa and Goldberg, 2005, Otani et al., 2003 and Marazzi et al., 2005).

 Future research should focus on estimating it for both aggregate import prices as well as for disaggregate import prices at the industry level subject to the availability of data.

Thank you!

INR/US\$ Rate, 2002-2007



Source: Pacific Exchange Rate Services

Monetary and Inflation Growth India (y-o-y % growth), 2001-2007



SourceIMFInternationalinanceStatisticsatabase.