

**HOW HIGH IS EXCHANGE RATE PASS-THROUGH IN INDIA?  
HAS IT CHANGED OVER TIME?**

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### Abstract

Concerns about relatively high degrees of exchange rate pass-through in a number of emerging economies has contributed to a fear of floating. Despite the obvious policy relevance of this issue there is hardly any existing literature that has examined aggregate CPI pass-through into for India which has been liberalizing its economy since 1991. This paper estimates exchange rate pass-through (ERPT) at the aggregate level into India's CPI for the period 1980Q1-2005Q3. We also analyze whether exchange rate pass-through in India has changed over time, particular since 1991 which was beginning of the country's economic liberalization program.

*Keywords: exchange rate pass-through, Fear of floating, India, Inflation, NEER.*

*JEL classification: E31, F31, F41, O53.*

## 1. Introduction

One of the perennial concerns for liberalizing economies such as India is the extent of pass-through of currency changes into domestic inflation. Concerns about relatively high degrees of exchange rate pass-through in a number of emerging economies has contributed to a fear of floating (Goldfajn and Olivares, 2001). Despite the obvious policy relevance of this issue there is hardly any existing literature examining aggregate CPI pass-through for India which has been liberalizing its economy since 1991. This paper fills this void in the literature by estimating pass-through for India from 1980 to 2005. We also analyze whether exchange rate pass-through in India has changed over time, particularly since 1991 which was beginning of the country's economic liberalization program.

The paper is organized as follows. Section 2 presents the empirical framework and estimation equation to be used. Section 3 presents the data and the results for the estimates of exchange rate pass-through for India. Section 4 concludes the paper.

## 2. Empirical Framework

We consider the law of one price in absolute terms. A commodity Y that is exported by country B to country A.

$$P_Y^A = E_B^A P_Y^B \tag{1}$$

where  $E_B^A$  is the exchange rate between the two nations defined as A's currency over B's currency, while  $P_Y^A$ ,  $P_Y^B$  are prices of the exportable Y in each nation's domestic currency respectively. Taking total differentials of eq. (1) we have,

$$dP_Y^A = dE_B^A + dP_Y^B \quad (2)$$

If  $dP_Y^B = 0$  then the change in exchange rate is fully transmitted into A's import prices and there is full exchange rate pass-through. However, if  $dP_Y^B \neq 0$  then the change in the exchange rate is not fully transmitted into A's currency price of good Y and we have a case of incomplete pass-through.

In order to operationalize eq. (2) it needs to be augmented by proper control variables. The primary control variables are the cost conditions in the destination market and demand conditions in the importing nation's market. We consider exchange rate pass-through using both the bilateral-US dollar rate as well as the nominal effective exchange rates (NEER). Specifically, exchange rate pass-through into India's aggregate CPI is estimated by using the following estimating equations for the bilateral USD rates and the NEER.

$$\ln(CPI)^{India} = \alpha_0 + \alpha_1 \ln(E_{US}^{India}) + \alpha_2 \ln(PPI / CPI)^{US} + \alpha_3 \ln(IP)^{India} + \varepsilon_t \quad (3)$$

$$\ln(CPI)^{India} = \delta_0 + \delta_1 \ln(NEER)^{India} + \delta_2 \ln(CPI)^{World} + \delta_3 \ln(IP)^{India} + \varepsilon_t \quad (4)$$

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, viz. the US PPI and the CPI in eq. (3), while for estimation of the NEER pass-through (eq. 4) we use the aggregate CPI of the world to proxy for cost conditions of the exporters. The exchange rate pass-through elasticity is given by the co-efficient  $\alpha_1$ . If  $\alpha_1=1$  then we have complete exchange rate pass-through, while if  $\alpha_1 < 1$  we have less than full pass-through.

### **3. Empirics**

#### **3.1 Data**

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 *International Financial Statistics*. Data on India's NEER is taken from the *Reserve Bank of India*. All variables are seasonally adjusted by using the Census X-12 methodology. The data for India spans from 1980Q1-2005Q3.

#### **3.2 Exchange rate pass-through: Entire Sample**

We start by testing for the presence of unit root in the variables. We use both the augmented Dickey-Fuller and Phillip-Perron tests to detect for stationarity in the variables. The unit root test results are shown in Table 1(a). The variables are found to be non-stationary in their level form, but were found to be stationary in their first-differenced form i.e. they were  $I(1)$ . Next we tested for co-integration among the variables in eq. (3) using the Johansen and Juselius (1990) methodology. Co-integration

among the variables enables us to run the regression in level form. The co-integration results are presented in Table 1(b). We test for co-integration for the entire sample period as well as for two sub-samples: 1980Q1-1990Q4 and 1992Q1-2005Q3. As Table 1b shows there is evidence of the presence of a co-integration vector among the variables in the estimation equation for India. This confirms the presence of a long-run stable linear relationship among the variables. As such we run the regression in their level form. The results are shown in Table 2.

We find exchange rate pass-through elasticity into India's CPI for the entire sample period (1980-2005) to be 43 percent when we use the US PPI as a measure of foreign costs, while the elasticity is 41 percent when we use the US CPI. This implies a 1 percentage change in the rupee-dollar rate will lead to around 0.4 percentage increase in the CPI of India. We also estimated pass-through elasticity from India's NEER into the CPI. Here we find a statistically insignificant co-efficient for the NEER, implying lack of any evidence of pass-through.

We also examined short-run pass-through of exchange rate changes into India's CPI by using the error correction (ECM) forms of eqs (3) and (4).

$$\begin{aligned} \Delta \ln(CPI)_t^{India} = & \beta_0 + \beta_1 (ECM)_{t-1} + \beta_2 \Delta \ln(E_{US}^{India})_t + \beta_3 \Delta \ln(PPI / CPI)_t^{US} + \beta_4 \Delta \ln(IP)_t^{India} \\ & + \beta_5 \Delta \ln(CPI)_{t-1}^{India} + \varepsilon_t \end{aligned} \quad (5)$$

$$\begin{aligned} \Delta \ln(CPI)_t^{India} = & \gamma_0 + \beta_1 (ECM)_{t-1} + \gamma_2 \Delta \ln(E_{US}^{India})_t + \gamma_3 \Delta \ln(PPI / CPI)_t^{US} + \gamma_4 \Delta \ln(IP)_t^{India} \\ & + \gamma_5 \Delta \ln(CPI)_{t-1}^{India} + \varepsilon_t \end{aligned} \quad (6)$$

The ECM results are shown in Table 3. The error-correction term suggests that any deviation from the long-run equilibrium relationship is adjusted by about 13 to 12 percent in the short-run. The short-run exchange rate pass-through elasticity is found to be 10 and 9 percent, respectively, for the two specifications over the entire sample period. For the NEER we once again do not find any significant pass-through.

### **3.3 Exchange Rate Pass-through Pre and Post Liberalization**

Since the Indian economy undertook a set of market-oriented reforms following the balance of payments crisis in 1991, we have re-estimated pass-through for two sub-periods, viz. 1980Q1-1990Q4 and 1992Q1-2005Q3.<sup>1</sup> For the pre-liberalization period we find an exchange rate pass-through elasticity of 37 percent when we use US PPI, while we do not find any significant pass-through when we use the US CPI as a control. For India's NEER, once again we do not find any significant pass-through. For the post-liberalization period, the pass-through elasticities for specifications using the US PPI and CPI are 38 and 50 percent, respectively, while for NEER there is no evidence of pass-through. These results indicate that, at the macro level, there is evidence of a slightly higher exchange rate pass-through for the post-liberalization era, which is consistent with greater openness of the country to external influences. In addition, the ECM results reveal no evidence of short-run pass-through for either the bilateral USD-rupee rate or the NEER for either of the two sub-samples. For the entire period as a whole, the short-run exchange rate pass-through is about 10 percent using the bilateral USD-rupee rate.

### **3.4 Exchange Rate Pass-through over Time**

It might well be argued that the liberalization program in India have not been a 0 or 1 situation. In other words, while Indian reforms were initiated in 1991, the reform program itself is an ongoing one characterized by gradualism (for instance, see Ahluwalia, 2002 and Rajan and Sen, 2002). Accordingly it may be more insightful to consider dynamic changes in exchange rate pass-through over time<sup>2</sup>.

We perform dynamic estimates of exchange rate pass-through by using the Kalman-Filter methodology. This is a recursive methodology which essentially estimates eqs. (3) or (4) in a state space and then updates the chosen state variable (i.e. the exchange rate term here) in a dynamic model. In the second stage the exchange rate pass-through co-efficient is specified as a random walk, called the state equation and is estimated dynamically over time. The Kalman-filter exchange rate pass-through elasticities are shown in figures 1 and 2. For pass-through of the bilateral nominal dollar-rupee rate into India's CPI we do not find any evidence of declining pass-through over time. Using NEER, we find a slightly declining exchange rate pass-through in the 1990s, although insignificant as found earlier.

## **4. Conclusion**

This paper has estimated exchange rate pass-through into India's CPI for over the last quarter century – from 1980Q1 to 2005Q3. We find the exchange rate pass-through 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, however, we do not find any evidence of significant

pass-through even in the long-run. This suggests that as far as “importing inflation from abroad” is concerned, gyrations in bilateral rupee-dollar rate have been more important than fluctuations in India’s NEER. This may rationalize the seeming greater emphasis by the Reserve Bank of India (RBI) on ensuring stability of the Indian rupee vis-à-vis the US dollar in recent times (see Cavoli and Rajan, 2006 and references cited within). We also estimated exchange rate pass-through both before and after the introduction of economic reforms in India in 1991. Our results suggest some evidence of a slightly higher pass-through for the post-liberalization era, which is consistent with greater openness of the country to external influences.

Future research in estimating exchange rate pass-through in India should focus on estimating it for both aggregate import (export) prices as well as for disaggregate import (export) prices at the industry level subject to the availability of data.

**Notes:**

1. We excluded 1991 as it was the crisis period. However, we tried various cutoff dates but results were largely unchanged.
2. Recent literature on pass-through has focused on declining pass-through across the world. For details see Campa and Goldberg (2005), Frankel et al.(2005), Taylor (2000) and review by Ghosh and Rajan (2006).

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**Table 1(a): Unit Root Test Results\***

ADF	5%	ADF stat.	5%	P-P stat.	5%	P-P stat.	5%
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	stat.	critical value		critical value		critical value		critical value
	Levels		1st difference		Levels		1st difference	
Lcpi	0.245	-3.455	-7.514	-3.455	0.572	-3.455	-7.584	-3.455
Lexrt	-0.441	-3.455	-6.915	-3.455	0.324	-3.454	-6.740	-3.455
Lneer	-2.109	-3.454	-10.497	-3.455	-2.259	-3.454	-10.495	-3.455
Lppiusa	-2.766	-3.455	-5.876	-3.455	-2.963	-3.454	-5.876	-3.455
Lcpiusa	-3.005	-3.455	-6.618	-3.455	-4.146	-3.454	-6.618	-3.455
Lipindia	-2.297	-3.455	-14.145	-3.455	-3.186	-3.454	-13.895	-3.455
Lcpiw	-0.190	-3.457	-2.428	-3.457	1.051	-3.454	-2.752	-3.455

\*tests are conducted using the trend and intercept.

Lcpi = consumer price index of India, lexrt = bilateral nominal rupee-dollar exchange rate, lneer = nominal effective exchange rate of India, lppiusa= producer price index of the US, lcpi = consumer price index of the US, lipindia= industrial production index of India. Lcpiw = aggregate consumer price index of the world.

**Table 1(b): Co-integration results for India**

		Trace test			
		Hypothesized		Trace	0.05
		No. of CE(s)	Eigenvalue	Statistic	Critical Value
Full-Sample	Spec.1	None	0.191	42.165	47.210
Full-Sample	Spec.2	None *	0.265	56.630	47.856
Full-Sample	Spec.3	None*	0.211	49.024	47.210
1980Q1-1990Q4	Spec.1	None	0.413	33.746	47.210
1980Q1-1990Q4	Spec.2	None	0.413	22.364	27.070
1980Q1-1990Q4	Spec.3	None*	0.451	49.407	47.210
1992Q1-2005Q3	Spec.1	None	0.294	43.513	47.210
1992Q1-2005Q3	Spec.2	None	0.291	40.056	47.210
1992Q1-2005Q3	Spec.3	None *	0.489	62.516	47.210
		Eigenvalue test		Eigenvalue	
		No. of CE(s)	Eigenvalue	Statistic	Critical Value
Full-Sample	Spec.1	None	0.191	21.399	27.070
Full-Sample	Spec.2	None *	0.265	31.052	27.584
Full-Sample	Spec.3	None	0.211	23.957	27.070
1980Q1-1990Q4	Spec.1	None	0.387	45.631	47.210
1980Q1-1990Q4	Spec.2	None	0.387	20.546	27.070
1980Q1-1990Q4	Spec.3	None	0.451	25.207	27.070
1992Q1-2005Q3	Spec.1	None	0.294	19.165	27.070
1992Q1-2005Q3	Spec.2	None	0.291	18.912	27.070
1992Q1-2005Q3	Spec.3	None *	0.489	36.879	27.070

\* denotes rejection of the hypothesis at the .05 level.

**Table 2: Level Regression Results for India**

	Full-Sample			1980Q1-1990Q4			1992Q1-2005Q3		
	Spec.1	Spec.2	Spec.3	Spec.4	Spec.5	Spec.6	Spec.7	Spec.8	Spec.9
C	-0.149	-0.661	-0.069	-1.242	<b>-3.032***</b>	0.634	1.012	0.098	<b>0.518***</b>
	0.555	0.536	0.258	1.031	0.579	1.136	0.715	1.263	0.309
LEXRT	<b>0.432***</b>	<b>0.410***</b>		<b>0.368***</b>	0.019		<b>0.381***</b>	<b>0.497***</b>	
	0.030	0.052		0.136	0.107		0.065	0.067	
LNEER			0.064			0.154			-0.103
			0.047			0.138			0.070
LPPIUSA	-0.036			0.296			-0.393		
	0.167			0.268			0.205		
LCPIUSA		0.149			<b>1.115***</b>			-0.167	
		0.202			0.236			0.452	
LCPIW			<b>0.313***</b>			<b>0.518**</b>			<b>0.468***</b>
			0.04			*			
LIP	<b>0.712***</b>	<b>0.656***</b>	<b>0.634***</b>	<b>0.658***</b>	<b>0.477***</b>	0.176	<b>0.860***</b>	<b>0.738***</b>	<b>0.519***</b>
	0.059	0.066	0.076	0.134	0.086	0.215	0.089	0.162	0.162
Adj. R <sup>2</sup>	0.998	0.998	0.998	0.985	0.993	0.992	0.993	0.992	0.983
N	103	103	103	44	44	44	55	55	55

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

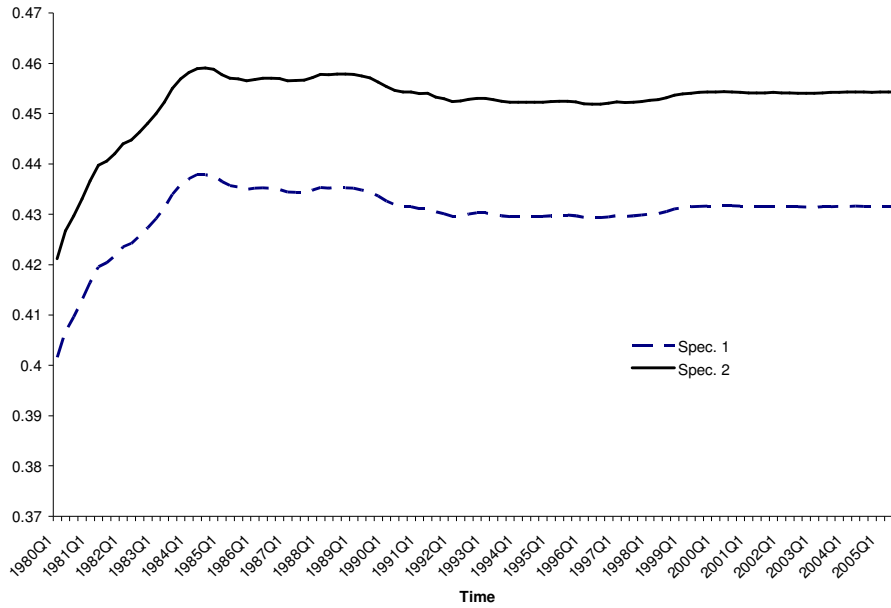
**Table 3: Error Correction Model Results for India**

	Full Sample			1980Q1-1990Q4			1992Q1-2005Q3		
C	<b>0.009***</b>	<b>0.008***</b>	<b>0.008***</b>	<b>0.010***</b>	<b>0.008***</b>	<b>0.011**</b>	<b>0.011***</b>	<b>0.013**</b>	<b>0.009***</b>
	0.003	0.003	0.002	0.003	0.003	0.005	0.004	0.006	0.002
ECM <sub>(t-1)</sub>	<b>-0.128***</b>	<b>-0.118***</b>	<b>-0.067***</b>	<b>-0.072*</b>	<b>-0.151**</b>	<b>-0.173***</b>	<b>-0.219**</b>	<b>-0.201***</b>	<b>-0.113***</b>
	0.044	0.039	0.023	0.035	0.061	0.044	0.088	0.066	0.031
ΔLEXRT	<b>0.102***</b>	<b>0.096***</b>		0.037	0.034		0.099	0.114	
	0.025	0.027		0.033	0.041		0.062	0.070	
ΔLNEER			-0.009			-0.012			-0.012
			0.013			0.066			0.008
ΔLPPIUSA	-0.048			0.069			-0.243		
	0.104			0.119			0.189		
ΔLCPIUSA						0.149			-0.587
		0.169			0.165			0.618	
ΔLCPIW			<b>0.164**</b>			0.027			<b>0.274***</b>
			0.067			0.074			0.068
ΔLIP	0.082	0.076	0.029	0.037	0.071	0.027	0.041	0.014	-0.068
	0.055	0.055	0.056	0.067	0.060	0.043	0.091	0.084	0.089
ΔLCPI <sub>(t-1)</sub>	<b>0.362***</b>	<b>0.360***</b>	<b>0.281***</b>	<b>0.463***</b>	<b>0.481***</b>	<b>0.436***</b>	<b>0.275**</b>	<b>0.312**</b>	0.168
	0.090	0.074	0.077	0.108	0.111	0.143	0.103	0.087	0.105
Adj. R <sup>2</sup>	0.245	0.247	0.235	0.139	0.213	0.297	0.156	0.146	0.195
D-W	2.029	2.05	2.059	2.052	1.999	2.194	1.953	2.018	1.873
F-stat	<b>7.486***</b>	<b>7.547***</b>	<b>7.129***</b>	<b>2.319*</b>	<b>3.217**</b>	<b>4.463***</b>	<b>2.961**</b>	<b>2.809**</b>	<b>3.570***</b>

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

Δ denotes first-differenced operator.

**Figure 1: Kalman-Filter Exchange rate Pass-through estimates of India's CPI**



**Figure 2: Kalman-Filter Exchange rate pass-through estimates into India's CPI**

