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Sectoral Impact of Exchange Rate Pass-through on Import Prices in India

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Abstract

The study investigates into the degree of exchange rate pass-through to prices of non-oil imports in India during reforms. Exchange rate pass-through (ERPT) is the responsiveness of trade prices (expressed in local currency) to unit change in exchange rate. ERPT is complete if there is a proportional change in prices on account of a unit change in exchange rate and is incomplete if the change in price is less than proportional. Theoretically, depreciation of home currency leads to an increase in import prices in terms of home currency. Currency depreciation thus reduces the domestic demand for imports and results in lowering of exporters' market share. In order to maintain the existing market shares, especially in the short run, exporters adjust their mark-ups. This explains why exchange rate movements often do not bring about proportional change in import prices and pass-through is incomplete. Existing empirical literature on the subject provides evidence on incomplete pass-through to import prices. Even though most of these studies have sound theoretical basis, their empirical estimates are necessarily weak based on single equation models. In this study, in sharp contrast, a simultaneous equation model incorporating both demand and supply sides is set up for estimation. Food and food products, crude materials, chemical and chemical products, manufacture of metals, machineries and some miscellaneous product groups are studied. The empirical results, which are robust, show incomplete exchange rate pass-through to import prices in India. The degree of pass-through is found to vary across commodity groups, the coefficient is found to be insignificant in case of most import sub-sectors with the only exception of chemicals.

Keywords: Exchange Rate Pass-Through (ERPT), Import, Prices, Currency, Depreciation .

JEL Classification No. C32, E31, F14, F31, F41

1. Introduction

This study investigates into the degree of exchange rate pass-through to prices of aggregate as well as disaggregated imports in India during reforms. Exchange rate pass-through (ERPT) is the responsiveness of trade prices (expressed in local currency) to unit change in exchange rate. Accordingly, a pass-through coefficient measures the degree of responsiveness. ERPT is complete if there is a proportional change in

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prices on account of a unit change in exchange rate and is incomplete if the change in price is less than proportional. The responsiveness of prices of internationally traded goods and services to exchange rate movements has, of late, assumed importance in open economy macroeconomic analysis of developing countries.

Theoretically, devaluation of home currency leads to an increase in import prices in terms of home currency. Following home country currency depreciation, price of imports in home country currency rises which in turn reduces the domestic demand for imports and results in lowering of exporters' market share. In order to maintain the existing market shares, especially in the short run, exporters generally adjust their mark-ups. The higher the price elasticity of demand of a country lower will be the mark-up over production cost. This explains why exchange rate movements often do not bring about proportional change in import prices and pass-through is incomplete. Market segmentation is one of the possible reasons for incomplete pass-through, which allows imperfectly competitive firms to charge different prices for the same product in different export market (pricing-to-market). Pricing-to-market, thus, depends on the market power of the respective firm in the export market to a large extent. For instance, as Halpern and Koren (2007), find import prices are higher for products of firms with greater market power. However, in the long run permanent change in nominal exchange rate may lead to complete adjustment in import prices, with pass-through being complete in the long run.

In the context of trade and exchange rate reforms and movements in exchange rate in India, this study analyses on the degree of exchange rate pass-through to import prices in some selected sectors. As the Indian rupee depreciated or moved otherwise since reforms in 1991, the study of its pass-through to import prices becomes necessary. A review of existing literature will identify the issues that are important in determining the extent of exchange rate pass-through.

2. Review of Literature

Earlier studies on pass-through find out that exchange rate pass through are generally incomplete. Incomplete pass-through is generally explained in the existing literature by the existence of trade barriers, transaction and transportation costs, market power and imperfect substitutability between domestic substitute and foreign products. Krugman (1986) shows that PTM is a real phenomenon, but not universal; in particular, evidence on German export prices suggest stickiness being confined to machinery and transport equipment prices. The aggregate estimates in this paper suggest that 35 to 40 percent of the real appreciation of the dollar since 1980 has been absorbed by foreign exporters in a rise in their prices to the US compared with prices in other markets. To find out why exchange rate pass-through is incomplete, Dornbusch (1987) explains the adjustment of relative prices to exchange rate movements in an industrial organization approach by using various models. The approach is to draw on models of industrial organization to explain price adjustment in terms of market concentration, product homogeneity and substitutability, and relative market shares of domestic and foreign firms and market structure. All the models in this analysis predict that appreciation leads to a decline in the price of imports. In the case of homogenous goods, domestic firms fully match the decline in price. If products are differentiated, relative price of the imported brands declines in response to an appreciation. The extent of the decline depends on competition and on the relative number of home and foreign firms. Feenstra, Gagnon and Knetter (1993) find that pass-through tends to be highest for high market shares. When market share is very high, the firms face less competition that has not experienced a similar change in costs, and thus will fully pass-through an exchange rate change for a given market demand schedule. However, Krugman (1986) stresses that dynamic models of imperfect competition are the best to explain exchange rate pass-through. The study explains the phenomenon in terms of supply dynamics

resulting from the costs of rapidly adjusting the marketing and distribution infrastructure, and the demand dynamics resulting from the need of firms to invest in reputation.

The choice of currency in invoicing impacts exchange rate pass-through. Firms set prices based on price fluctuations in both home and destination currencies. If export prices are less volatile in the firm's own currency, they opt for producer currency pricing (PCP), whereas local currency stability (LCS) is preferred when prices are more stable in the destination market's currency. Bacchetta and van Wincoop (2002) argue that setting prices in the exporter's currency results in complete pass-through, while using the importer's currency eliminates the impact of exchange rate fluctuations on prices. Goldberg and Knetter (1997) and Engel (2005) also support these findings, emphasizing that firms prefer to invoice in the importer's currency when it results in price stability.

Inflation plays a crucial role in pass-through, as shown by Taylor (2000), Choudhuri and Hakura (2001), and Zorzi et al. (2007), who find a positive relationship between inflation and pass-through. Exchange rate regimes and trade openness further influence the degree of pass-through. Since the 1990s, the pass-through has decreased, particularly in the UK, Sweden, and Brazil, linked to lower inflation volatility (Taylor, 2000). Choudhuri and Hakura (2001) confirm that low inflation leads to lower pass-through, while Edwards (2006) finds that inflation targeting (IT) countries experience reduced pass-through. However, there's no evidence of a shift in the exchange rate's role as a shock absorber.

The pass-through degree varies across sectors and economies. Zorzi et al. (2007) challenge the belief that emerging markets exhibit higher pass-through than developed economies, finding a positive relationship between pass-through and inflation. Campa, Goldberg, and Minguez (2005) show that short-term pass-through in the Euro area is high but incomplete, with a long-term approach approaching complete pass-through. Campa and Goldberg (2002) report that, across OECD countries, import prices reflect 60% of exchange rate fluctuations in the short run and 80% in the long run.

3. India's Trade Reforms, Exchange Rate Impact, Trade Trends: Some Facts

A prelude on India's trade and exchange rate reforms will provide the necessary framework for the analysis of India's exchange rate pass-through. Trade reforms, though in a piecemeal way, were initiated during the 1980s¹, whereas exchange rate reforms towards a market-determined exchange rate of the rupee started in the early 1990s. This is, however, not to say that there was no exchange rate reforms prior to the 1990s.

Trade policy reforms in India, on the whole, aimed at reducing distortions in relative prices, removing anti-export bias, improving competition thereby enhancing international competitiveness. The formation of WTO in 1995 acted as a catalyst in this process of trade liberalization in India. The major trade policy changes in the post-1991 period included removal of quantitative restrictions and replacement of such restrictions by tariffs, substantial reduction in the tariff rates as also their dispersion and simplification of procedures relating to trade. With trade liberalisation, the level of protection to Indian industry declined significantly. Table 1 shows the decline in weighted average import tariff across various sectors during 1991-92 to 2004-05. At the aggregated level, weighted average customs tariff fell from 81.4 per cent to 17.7 per cent between 1991-92 and 2004-05. The average rate of import duty for the agricultural products declined from 47 per cent in 1991-92 to 28.7 per cent in 2004-05. The decline was the highest for capital goods from 94.8 per cent in 1991-92 to 17.8 per cent in 2004-05. The coefficient of variation for total duty rates increased for the period from 1991-92 to 1996-97 followed by a decline from 1997-98 to 2001-02. Since then, it starts to increase again.

¹ See Panagariya (2005) and Sinha Roy (2005) for the purpose

There has been a spurt in the growth of trade in the post reforms period. From the mid 1980s, India's exports grew at an increasing rate up to 1990.¹ There was quantum rise in imports of POL from 16.5 million tonnes to 23.4 million tonnes over the same period². The annual average growth rate of exports during 1990s is about 12.9 per cent, while imports experienced a higher average growth rate of 16.7 per cent during 1991 to 1996. The growth rate of Indian imports reached 36.35 per cent in the year 1995-96. Subsequently, in the remainder of the 1990s, the average growth of imports more than halved to 8.0 per cent on account of a relative slowdown in economic activity³. After 2000, as evident from Figure 1, exports grew at a faster average rate of about 20 per cent per annum and import growth was even higher. During 2004-05, the growth rate of merchandise imports peaked at 39.53 per cent (see Table 2 as well).

Table 1: Average Import Duty Rates in India, 1991-92 to 2004-05

Commodity Group	1991 - 92	1992 - 93	1993 - 94	1994 - 95	1995 - 96	1996 - 97	1997 - 98	1998 - 99	1999 - 00	2000 -01	2001 - 02	2002 - 03	2003 - 04	2004 - 05
Weighted average														
Agriculture	47.0	22.7	19.6	16.7	16.7	24.0	22.3	17.7	20.5	25.4	21.6	27.8	27.2	28.7
Consumer goods	97.8	72.4	60.5	47.8	36.1	38.6	28.9	30.1	30.5	58.2	45.1	42.9	43.5	49.6
Intermediate goods	69.5	54.9	39.8	30.6	34.8	33.0	30.0	22.8	26.4	31.0	31.0	27.7	24.1	19.3
Capital goods	94.8	75.0	50.2	37.4	29.1	27.3	21.9	20.9	24.0	23.6	23.1	20.9	20.9	17.8
All Commodities	81.4	54.1	40.7	37.1	32.9	30.4	26.7	22.6	24.9	26.1	25.9	22.4	21.3	17.7
Coefficient of Variation														
Agriculture	43.5	102.0	100.0	87.5	87.7	76.6	74.4	78.5	65.1	48.0	49.3	63.0	63.6	64.1
Consumer goods	25.5	42.7	47.4	56.9	58.9	62.0	58.5	56.0	50.8	45.1	45.1	48.1	62.3	64.7
Intermediate goods	31.8	22.3	28.6	31.6	27.9	33.9	33.0	34.1	27.1	25.7	25.9	26.5	27.3	33.3
Capital goods	31.4	29.8	41.4	44.2	37.3	36.2	34.1	37.1	28.6	25.4	42.8	42.4	43.8	55.5
All Commodities	32.0	36.2	42.3	47.2	46.5	49.9	48.2	47.8	40.5	37.0	39.6	41.5	44.1	55.4

Source: Mathur and Sachdeva (2005).

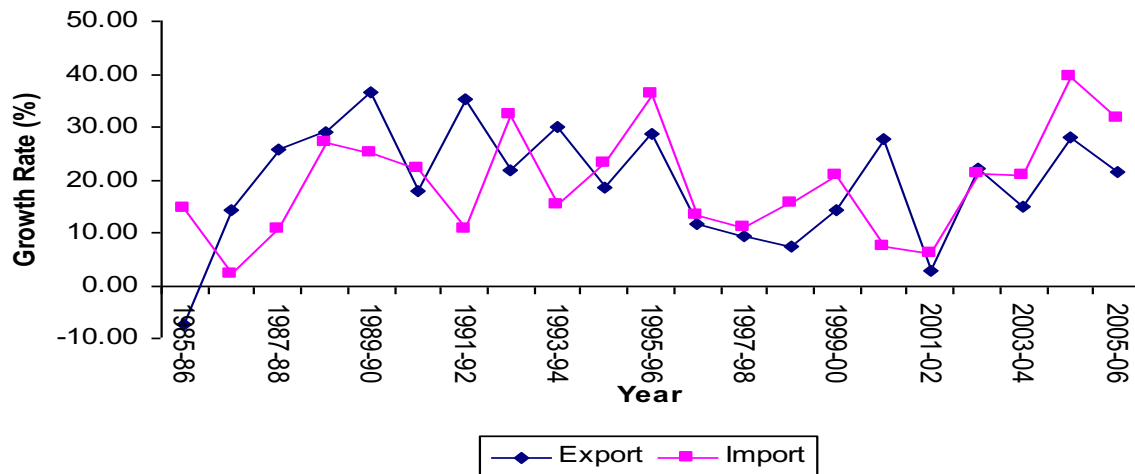
¹ Sinha Roy (2005) provides similar evidence. However, the study does not attribute growth in post reforms exports to trade liberalization alone.

² Economic Survey, 1990-91.

³ RBI, Report on Currency and Finance, 2001-02

With high growth in exports and imports since the mid 1980's, India's share in world trade also increased to more than double. The share of India's imports increased from 0.90 per cent in 1984-85 to 1.45 per cent in 2005-06. The pattern of India's foreign trade, both merchandise exports and imports, has undergone substantial changes during trade reforms in terms of growth and diversification of markets and products.

Figure 1: Post-reforms Growth of India's Exports and Imports



Accompanying high growth, India's merchandise imports have undergone directional and compositional changes. During the reforms period, India's imports are being sourced from a wider range of countries. Data from RBI sources show that the shares of India's traditional trading partners like Germany, Japan, UK and Australia have declined along with the emergence of new import partners from East Asia including China. In recent years, Belgium, from where India imports raw gems, has emerged as one of the principal sources of imports. The share of India's imports from the OPEC region increased significantly from 16.3 percent in 1990-91 to 25.9 percent in 1999-2000¹¹. India's share of imports from developing country increased during the 1990s. Another interesting feature has been the fall in the share of the Commonwealth of Independent States (CIS) countries as sources of India's imports (RBI, 2002-03).

4. Exchange Rate: Policy Changes and Movements

In 1991, following India's balance of payment crisis, a series of currency reform measures was undertaken in addition to other structural reform measures. A transition to a market determined exchange rate regime was felt necessary to deal effectively with different sectors to initial reform measures. Reserve Bank of India (RBI) undertook a sharp downward adjustment of the exchange rate of about 18 per cent in two stages on July 1 and July 3, 1991. This set the stage for more fundamental changes in the exchange rate regime as recommended by the High-Level Committee on Balance of Payments (GOI, 1991). This adjustment was followed by the introduction of the Liberalized Exchange Rate Management System (LERMS) in March 1992 and hence the adoption of, for the first time, a dual exchange rate system in India under which one leg of the exchange rate, applicable to 40 per cent of all current receipts, essential imports and debt service payments, was determined by the RBI and the other leg, which applied to all other transactions, was determined by the market. This dual exchange rate system implied a depreciation of about 11 percent for transactions routed through market. However, the dual exchange rate imposed an implicit tax on export proceeds and remittances, which hindered supplies of foreign exchange in the foreign exchange market. Consequently, downward pressures had been building up and a regime change was overdue. Subsequently, in March

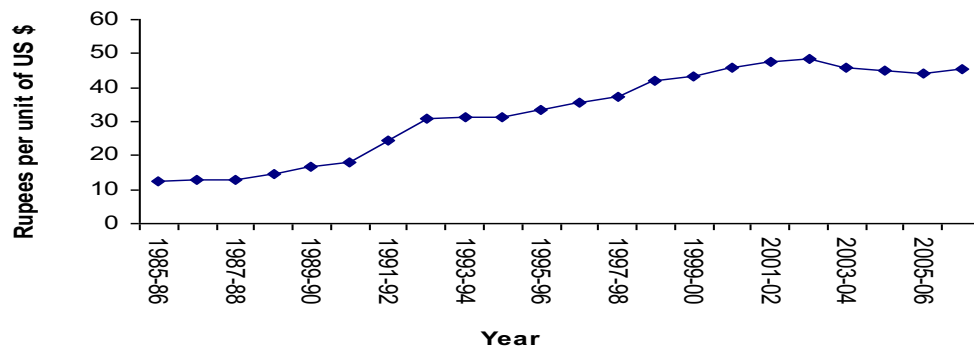
¹¹ RBI, *Report on Currency and Finance*, 2001-02

1993, the dual exchange rate system gave way to a unified exchange rate system, which along with removal of exchange restriction on imports through the abolition of foreign exchange budgeting are the first step towards current account convertibility. The final step towards current account convertibility was taken in August 1994 by further liberalization of invisible transactions and exchange control regulations upto a specified limit.

Table 2: India's Foreign Trade Performance, 1984-85 – 2005-06

Year	Export Value (Rs. Crore)	Export Growth Rate (%)	Import Value (Rs. Crore)	Import Growth Rate (%)	TOI (%)	IOR	Export Share in World (%)	Import Share in World (%)
1984-85	11743.7	----	17134.2	----	12.68	0.075	0.53	0.90
1985-86	10894.6	-7.23	19657.7	14.73	12.01	0.077	0.53	0.81
1986-87	12452.0	14.30	20095.8	02.23	11.47	0.071	0.56	0.75
1987-88	15673.7	25.87	22243.7	10.69	11.79	0.069	0.56	0.74
1988-89	20231.5	29.08	28235.2	26.94	12.63	0.074	0.61	0.74
1989-90	27658.4	36.71	35328.4	25.12	14.25	0.080	0.56	0.72
1990-91	32557.6	17.71	43192.9	22.26	14.71	0.084	0.55	0.58
1991-92	44041.8	35.27	47850.8	10.78	15.47	0.081	0.58	0.66
1992-93	53688.3	21.90	63374.5	32.44	17.18	0.093	0.63	0.64
1993-94	69751.4	29.92	73101.0	15.35	18.03	0.092	0.65	0.69
1994-95	82674.1	18.53	89970.7	23.08	18.66	0.097	0.66	0.74
1995-96	106353.3	28.64	122678.1	36.35	21.14	0.113	0.65	0.74
1996-97	118817.1	11.72	138919.7	13.24	20.44	0.110	0.65	0.71
1997-98	130100.6	09.50	154176.3	10.98	20.28	0.110	0.63	0.71
1998-99	139753.1	07.42	178331.9	15.67	19.68	0.110	0.67	0.81
1999-00	159561.4	14.17	215236.5	20.69	20.98	0.120	0.73	0.74
2000-01	203571.0	27.58	230872.8	07.26	22.56	0.120	0.74	0.77
2001-02	209018.0	02.68	245199.7	06.21	21.63	0.117	0.84	0.90
2002-03	255137.3	22.06	297205.9	21.21	24.38	0.131	0.87	0.95
2003-04	293366.8	14.98	359107.7	20.83	25.59	0.141	0.91	1.08
2004-05	375339.5	27.94	501064.5	39.53	30.69	0.175	1.03	1.34
2005-06	456417.9	21.60	660408.9	31.80	34.35	0.203	1.10	1.45
Average	19.54	19.40	0.69	0.83				

Figure 2: Movements in Rs. -US \$ Annual Exchange Rate



The Nominal Effective Exchange Rate (NEER) of rupee is the weighted geometric average of bilateral nominal exchange rates of rupee in terms of foreign currencies. The Real Effective Exchange Rate (REER) is the weighted average of NEER adjusted by the ratio of domestic currency to foreign currency. A rise (fall) in NEER or in REER shows appreciation (depreciation) of Indian rupee¹².

Table 3 shows that both nominal and real effective exchange rates depreciated from mid-1980s to early 1990s. The rate of depreciation was very high during the early 1990s due to the devaluation of rupee. However, the nominal effective exchange rate appreciated during 1993-94 and thereafter again in 1997-98¹³. Between 2000-01 and 2002-03, the NEER appreciated in most years. The large devaluation of Indian rupee during 1991 is also reflected in the behaviour of REER. The depreciation of REER continued till 1992-93. The real rupee however appreciated at 7.9 per cent and 7.2 per cent in 1993-94 and 1994-95 respectively. While NEER depreciated during 1994-95, both NEER and REER depreciated in 1995-96. Similar movements are observed in 1998-99 and 1999-00. After that REER continued its appreciation up till 2005-06. On an average, NEER and REER depreciated during the entire period, with a higher depreciation rate for NEER than REER. The observed movements in NEER and REER resulted in widening the gap between NEER and REER levels over the period of time 1985-2005.

Table 3: Annual Percentage Change in India's NEER and REER

Year	Growth in NEER	Growth in REER
1985-86	-2.93	-2.57
1986-87	-12.84	-8.17
1987-88	-5.46	-5.41
1988-89	-6.89	-5.80
1989-90	-4.51	-2.45
1990-91	-6.87	-3.65
1991-92	-21.86	-15.06
1992-93	-17.23	-11.09
1993-94	2.83	7.90
1994-95	-2.95	7.23
1995-96	-8.39	-3.66
1996-97	-1.91	0.30
1997-98	2.67	5.03
1998-99	-9.17	-5.34
1999-00	-2.42	-0.24
2000-01	0.17	5.12
2001-02	0.65	2.86
2002-03	3.64	6.33
2003-04	-2.16	1.90
2004-05	0.20	0.53
2005-06	2.90	2.26
Average	-4.41	-1.14

¹² See RBI Bulletin, December 2005

¹³ Sinha Roy (2005) also arrives at similar findings.

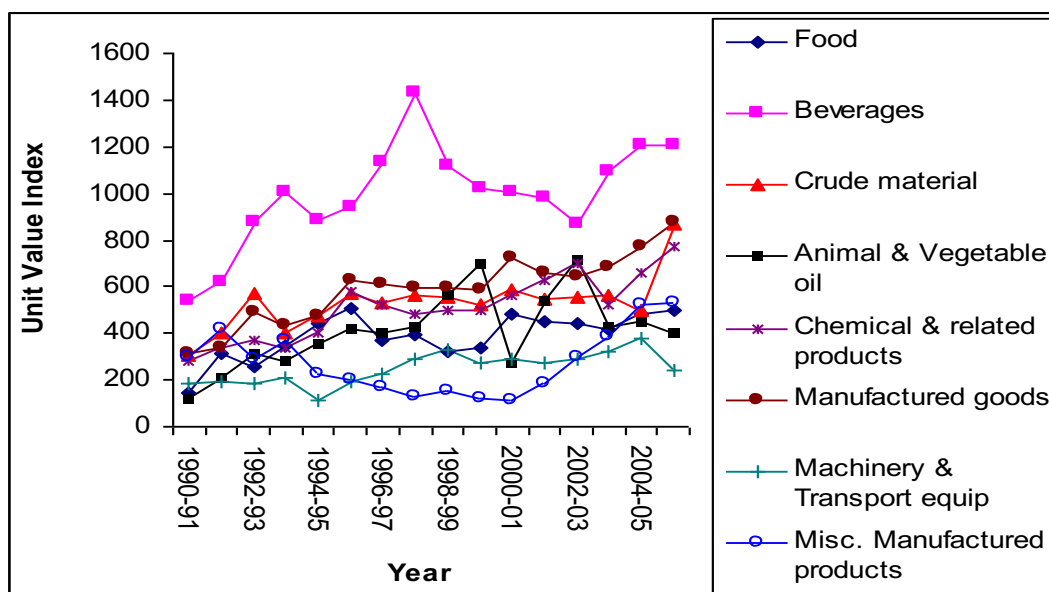
Source: RBI, *Handbook of Statistics on Indian Economy*, various years.

5. Movements in India's Import Prices

In general, the 1990s decade is described as the era of price stability all over the world. However, the phased opening up of Indian economy during 1990s increased uncertainties on account of fluctuations in the global economy. As part of the macroeconomic stabilisation programme and structural reforms undertaken in the aftermath of the crisis, exchange rate depreciated substantially. Between 1990-91 and 1991-92, the Indian rupee depreciated by nearly 37 per cent. Such high order of depreciation added to pressures on prices to rise.

During the reforms period the movements import prices for almost all product groups shows upward tendencies (see Figure 3). The unit value index for the product group 'Beverages and Tobacco' was higher among all the non-oil imports. It has grown up till 1997-98, followed by a sharp fall till 2002-03 and increased thereafter. For all other non-oil imports, unit value index shows an upward trend, through within a narrow band. There are however some fluctuations are there during the nineties.

Figure 3: Movements of unit values of Indian imports



Growth rates for import prices across sectors are shown in Table 4. Prices of major imports fell during 1996-97. The only exception is beverages and machinery imports. Otherwise during the 1990s, growth rates of import prices for most products are positive.

Table 4: Growth of Import Prices across Sectors for India

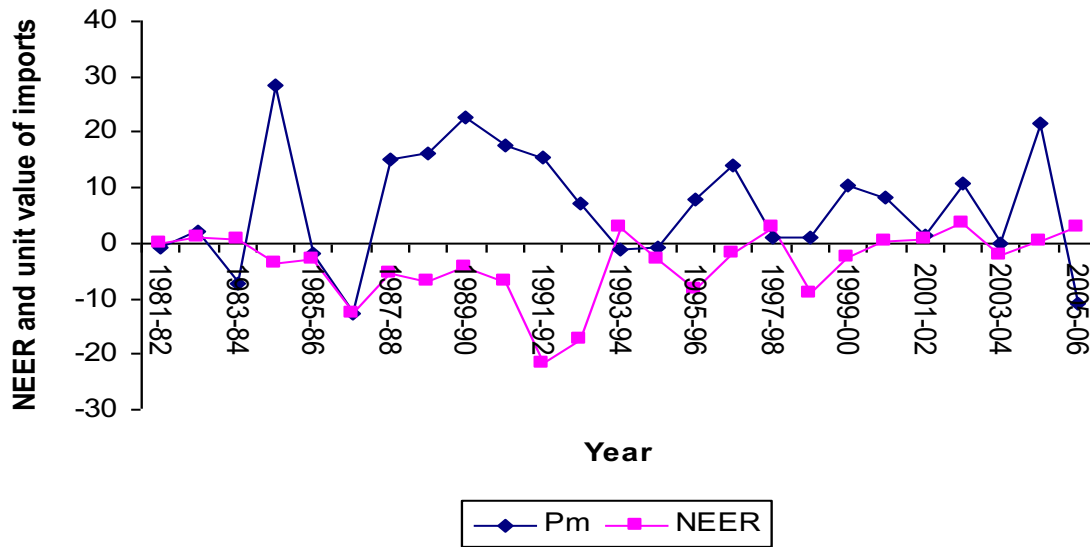
Year	Food and Food Products	Food & Tobacco	Beverages Material	Crude Material	Animals & Veg. oil	Chemical Good	Manufactured Manufacture	Machinery	Misc.
1991-92	119.86	15.67	31.49	76.03	21.79	8.36	3.19	42.86	
1992-93	-15.81	14.61	40.99	47.89	8.21	45.10	-6.70	-30.48	
1993-94	31.42	14.12	-29.60	-9.84	-8.67	-11.66	17.68	26.03	
1994-95	30.03	-11.68	18.91	23.94	20.47	9.26	-46.95	-39.13	
1995-96	13.23	6.10	19.25	18.18	42.61	32.63	69.03	-10.27	
1996-97	-26.53	20.45	-6.67	-3.61	-9.84	-2.24	18.32	-15.42	
1997-98	5.39	26.70	5.26	5.99	-7.28	-2.78	29.65	-25.29	
1998-99	-18.41	-21.77	-1.43	32.24	2.89	0.17	13.65	19.69	
1999-00	5.96	-8.56	-5.43	24.38	0.60	-1.34	-17.12	-18.42	
2000-01	42.90	-1.76	12.64	-60.52	11.78	23.64	4.71	-10.48	
2001-02	-6.21	-2.98	-6.80	94.20	12.14	-9.22	-5.88	64.86	
2002-03	-2.65	-11.36	0.55	33.40	11.94	-2.42	5.88	61.75	
2003-04	-4.31	26.44	1.81	-40.42	-25.89	5.90	10.76	31.42	
2004-05	13.74	10.05	-11.41	5.63	26.87	13.64	18.50	33.42	
2005-06	4.58	0.17	75.05	-10.22	16.34	12.90	-35.98	2.12	
Average	12.88	6.88	9.64	15.82	8.26	8.13	5.25	8.84	

Note: Values are from RBI, *Handbook of Statistics on Indian Economy*, various years.

During 2001-02, import prices for major sectors excepting animal and vegetable oils and fats, chemicals, and some miscellaneous manufactures show a downturn, which revealed in the growth rate. For the year 2005-06, almost all products show high positive growth of import prices. Average growth rate of import prices is highest for animal and vegetable oils at 15.82 per cent followed by that of food and food products at 12.88 per cent after the reforms period. The average growth rates are moderate for crude materials, chemical & chemical products and manufactured goods. The average growth rate is the lowest for machinery at 5.25 per cent.

Having shown the movements in exchange rate and import price behavior during reforms, it is pertinent to show whether the two variables have moved synchronously. The movements in NEER reveal the depreciation of Indian rupee at the beginning of 1990s which influences the general unit value index for imports. As a result of this depreciation, import prices show an upward movement. Figure 4, shows that in most years the two series have moved in opposite directions. This evidence indicates that when the rupee currency depreciated, there is an increase in the price of imports. On the other hand, an appreciation in exchange rate and a decline in import price are simultaneous. This observation would tend to show synchronous movements in NEER and import prices, which call for a detailed econometric analysis.

Figure 4: Growth of import price and NEER



6. 3.1. Methodology

In this study the econometric model is based on a simultaneous equation imperfect substitutes model as in Goldstein and Khan (1985). In the model, the quantity of import demand depends on the price of imports in domestic currency and price of domestic substitute commodities. The domestic demand for imports can also be an important factor influencing import demand. Another influencing factor is the trade openness of the economy. Therefore the import demand function can be specified as:

$$M^d = f(EP_m^*, P_s, GDP, TOI) \quad (2)$$

where M^d is the quantity demanded for imports, E is the exchange rate of foreign currency in terms of domestic currency, P_m^* is the price of imports in foreign currency, P_s is the price of domestic substitute commodities in terms of domestic currency, GDP is the real gross domestic product of the economy, and TOI is the trade openness index of the economy.

Equation (2) can also be written in log linear form, as suggested by Khan and Ross (1977) and Salas (1982), in the following way:

$$\ln M^d = \alpha_0 + \alpha_1 \ln E + \alpha_2 \ln P_m^* + \alpha_3 \ln P_s + \alpha_4 \ln GDP + \alpha_5 \ln TOI + \varepsilon_1 \quad (3)$$

with $\alpha_1, \alpha_2 < 0$ and $\alpha_3, \alpha_4, \alpha_5 > 0$.

On the other hand, even if Indian imports account for a very small share of the world trade, the supply side of the imports cannot be assumed away based on infinite elastic assumption. Assuming law of one price not to hold, supply of imports depends on the price of imported commodities in exporters' currency as well as exporters' domestic price. The import supply equation can be specified as:

$$M^s = g(P_m^*, P^*) \quad (4)$$

where P^* is exporters' domestic price, P_m^* is the price of the importable in source country currency. It is thus obvious that producers' currency pricing is assumed here. This is not necessary due to stability in producers' currency, but it may be optimal to do so. Moreover, India is not a major importer of most of these products. In log linear form the equation can be written as:

$$\ln M^s = \beta_0 + \beta_1 \ln P_m^* + \beta_2 \ln P^* + \varepsilon_2 \quad (5)$$

with $\beta_1 > 0$ and $\beta_2 < 0$.

In equilibrium, demand for and supply of imports are equal. From the equilibrium condition:

$$M^d = M^s = M \text{ (say)} \quad (6)$$

the following equation can be derived.

$$\ln P_m^* = \delta_0 + \delta_1 \ln E + \delta_2 \ln P^* + \delta_3 \ln P_s + \delta_4 \ln GDP + \delta_5 \ln TOI + \nu \quad (7)$$

where

$$\delta_0 = \left(\frac{\beta_0 - \alpha_0}{\alpha_2 - \beta_1} \right), \quad \delta_1 = -\left(\frac{\alpha_1}{\alpha_2 - \beta_1} \right), \quad \delta_2 = \left(\frac{\beta_2}{\alpha_2 - \beta_1} \right), \quad \delta_3 = -\left(\frac{\alpha_3}{\alpha_2 - \beta_1} \right),$$

$$\delta_4 = -\left(\frac{\alpha_4}{\alpha_2 - \beta_1} \right), \quad \delta_5 = -\left(\frac{\alpha_5}{\alpha_2 - \beta_1} \right) \text{ and } \nu = (\varepsilon_2 - \varepsilon_1).$$

The coefficient δ_1 provides us the degree of pass-through to import prices expressed in foreign currency. The sign of this coefficient is expected to be negative. This can also be referred to as the elasticity of import prices in terms of foreign currency with respect to exchange rate.

Now for estimation purpose equation (7) can be rewritten for i^{th} sector in t^{th} time period as follows:

$$\ln P_{mit}^* = \delta_0 + \delta_1 \ln E_t + \delta_2 \ln P_{it}^* + \delta_3 \ln P_{sit} + \delta_4 \ln GDP_{it} + \delta_5 \ln TOI_{it} + \nu_{it} \quad (8)$$

with $\delta_1 < 0$, $\delta_2 < 0$, $\delta_3 > 0$, $\delta_4 > 0$, and $\delta_5 > 0$. The parameter of interest is δ_1 .

Now if P_m is expressed as the price of imports in terms of domestic currency then the relationship between exchange rate, import prices in foreign currency and domestic currency can be written as:

$$P_m^* = \left[\frac{P_m}{E} \right] \quad (9)$$

where P_m^* = import prices in terms of foreign currency

P_m = import prices in terms of domestic currency

E = Exchange rate in terms of domestic currency

Taking logarithm on both sides of the equation (9), we get

$$\ln P_m^* = \ln P_m - \ln E \quad (10)$$

Now differentiating both sides with respect to E , we get

$$\frac{1}{P_m} \left(\frac{dP_m^*}{dE} \right) = \frac{1}{P_m} \left(\frac{dP_m}{dE} \right) - \frac{1}{E}$$

Multiplying both sides by E ,

$$\left(\frac{dP_m^*}{P_m^*} \right) \left(\frac{E}{dE} \right) = \left(\frac{dP_m}{P_m} \right) \left(\frac{E}{dE} \right) - 1 \quad (11)$$

$$\left(\frac{dP_m}{P_m} \right) \left(\frac{E}{dE} \right) = \left(\frac{dP_m^*}{P_m^*} \right) \left(\frac{E}{dE} \right) + 1 \quad (12)$$

The elasticity of the domestic currency import prices with respect to the exchange rate is thus equal to that of foreign currency prices plus one. The degree of pass-through to import prices in domestic currency be measured as $(\delta_1 + 1)$.

7. Data

The unit value index used in the estimation is formulated on the basis of the rupee prices for the products under study. Data for that is taken from the '*Handbook of Statistics on Indian Economy*' published by Reserve Bank of India. The base year of the unit value index is changed from 1978-79 = 100 to 1993-94=100. In the final equation we have the explanatory variable as unit value for the products in terms of foreign currency. For that purpose, the unit value index is converted to foreign currency unit value by multiplying with the ratio of exchange rate for the year concerned and exchange rate for the base period. The exchange rate data used in the study is the nominal effective exchange rate (NEER) based on 36-country bilateral weights. The base year is 1993-94. As NEER is used for estimation, and its increase implies appreciation, its increase will have a negative influence on the import prices in home currency terms.

Therefore, the expected sign of the term $(\delta_1 + 1)$ becomes negative. The source countries export prices are the producer price index. To be very restrictive here we use the producer price index for US economy. Since there is paucity of data for substitute commodities price, general price index, i.e. the wholesale price index, the consumer price index, the GDP deflator etc. can be used¹. Here the wholesale price index is used as a proxy variable for the price of import substitute commodities in the domestic economy.

Gross Domestic Product (GDP) of the economy is generally used to specify demand for imports. As the study is at a disaggregated level, we use value of output for these products instead of GDP. The value of output for these products is collected from the Annual Survey of Industries (ASI) database of the Central Statistical Organisation, Government of India. ASI database provides data according to the National Industrial Classification (NIC). As there is a revision of NIC of 1998, the concordance becomes different for the post 1998 period. As the study is on import side, in place of trade openness index (TOI) import orientation ratio (IOR) can serve as a measure of trade openness. IOR is calculated as the ratio between import volumes for respective products and its corresponding value addition for the year concerned.

¹ See Dutta & Ahmed (2006)

8. Estimation Results

Panel data estimation of the equation (8) is carried out to estimate the degree of exchange rate pass-through to import prices across sectors by applying sector-specific dummy. As data for all arguments for all the years are not available it becomes an unbalanced panel. Estimation of equation (8) using panel data techniques gives robust results. Results on all the sectors as a whole for both fixed effects and random effects are shown in the following Table 5.a:

Table 5.a: Estimation of Degree of ERPT to Import Prices: *Fixed Effect*

lnuv_fc	coeff	Std. Err	t	P>t	[95% Conf. Interval]	
lne	-1.654931	0.4265085	-3.88	0.000	-2.494236	-0.815626
lnppi	-0.197542	0.2990276	-0.66	0.509	-0.785983	0.390899
lnwpi	0.598179	0.1447741	4.13	0.000	0.313286	0.883074
lngdp	0.056904	0.0476042	1.20	0.233	-0.036774	0.150582
lntoi	0.018213	0.0342318	-0.53	0.595	-0.085575	0.049150
cons	9.709485	2.8121090	3.45	0.001	4.175676	15.243290

Table 5.b: Estimation of Degree of ERPT to Import Prices: *Random Effect*

lnuv_fc	coeff	Std. Err	z	P>z	[95% Conf. Interval]	
lne	-1.315027	0.3927092	-3.35	0.001	-2.084723	-0.545331
lnppi	-0.154646	0.2809479	-0.55	0.582	-0.705294	0.396001
lnwpi	0.592910	0.1340689	4.42	0.000	0.330139	0.855680
lngdp	0.109345	0.0365705	2.99	0.003	0.037668	0.181022
lntoi	0.012720	0.0287473	0.44	0.658	-0.043624	0.069064
cons	7.265090	2.5603260	2.84	0.005	2.246945	12.283240

The result on the all sectors as a whole show that all the sign of the coefficients of variables are same as expected. The coefficients of exchange rate in both the models are significant indicating significant pass-through. The fixed effect shows that exchange rate pass-through to import prices is about 65 per cent and random effect shows the same at about 31 per cent. These findings match with the finding of incomplete exchange rate pass-through to import prices in the earlier studies. Now to find out whether fixed effect or random effect model provide with better result, Hausman test has been carried out. Hausman test, as shown in Table 5.c, show the inability to reject the null hypothesis indicating that fixed effect model is better.

Table: 5.c. Hausman Test for all Sectors

Coefficients				
(b)	(B)	(b - B)sqrt (diag(V_b - V_B))		
Fixed	Random	Difference	SE	
lne	-1.654931	-1.315027	-3.3399043	0.1664000
lnppi	-0.197542	-0.154646	0.0428957	0.1024001
lnwpi	0.598180	0.592910	0.0527030	0.0546357

lngdp	0.569044	0.109350	-0.0524408	0.0304755
lntoi	-0.018213	0.012720	-0.0309327	0.0185852

b = consistent under Ho and Ha; obtained from fixed effect estimation

B = inconsistent under Ha, efficient under Ho; obtained from random effect estimation

Test: Ho: difference in coefficients not systematic

$$\chi^2(5) = (b-B)'[(V_b - V_B)^{-1}](b-B) = 4.36$$

$$\text{Prob} > \chi^2 = 0.4983$$

Sector wise results are provided below. For food and food products, the signs are as expected and the level of pass-through is very small as well as insignificant (see Tables 6.a, and 6.b). In this case also, as the Hausman test indicates, fixed effect model gives results (see Table 6.c). As exchange rate pass-through to import prices of food products is small and insignificant, these import prices are determined by determined by other factors including domestic prices.

Table 6.a: Estimation of Degree of ERPT to Import Prices of Food Products: *Fixed Effect*

lnuv_fc	coeff	Std. Err	t	P>t	[95% Conf. Interval]	
lne	-1.274173	0.8050360	-0.96	0.337	-2.358364	0.810018
lnppi	-0.157681	0.3064170	-0.51	0.607	-0.760664	0.445302
lnwpi	0.781908	0.1424167	5.49	0.000	0.501653	1.062162
lngdp	0.152216	0.0414567	3.67	0.000	0.070635	0.233796
lntoi	0.246895	0.0338371	0.73	0.466	-0.041897	0.091276
cons	9.709485	2.8121090	3.45	0.001	4.175676	15.243300

Table 6.b: Estimation of Degree of ERPT to Import Prices of Food Products: *Random Effect*

lnuv_fc	coeff	Std. Err	z	P>z	[95% Conf. Interval]	
lne	0.008616	0.0421838	0.20	0.838	-0.0740624	0.091295
lnppi	-0.123712	0.2853251	-0.43	0.665	-0.6829391	0.435515
lnwpi	0.784925	0.1242337	6.32	0.000	0.5414318	0.233957
lngdp	0.167258	0.0337956	4.95	0.000	0.1010195	0.233496
lntoi	0.041273	0.0286918	1.44	0.150	-0.0149616	0.097508
cons	-0.557848	1.0745710	-0.52	0.604	-2.6639680	1.548272

Table 6.c: Hausman Test: Food Products Import Price

Coefficients				
(b)	(B)	(b - B)sqrt (diag(V_b - V_B))		
Fixed	Random	Difference	SE	
lne	-1.274173	0.008616	-0.7827892	-1.282789

lnppi	-0.157681	-0.123712	-0.0339687	0.111719
lnwpi	0.781908	0.784925	0.0030179	0.069631
lngdp	0.152216	0.167258	-0.0150420	0.024011
lntoi	0.024690	0.041273	-0.0165838	0.017937

b = consistent under H_0 and H_a ; obtained from fixed effect estimation

B = inconsistent under H_a , efficient under H_0 ; obtained from random effect estimation

Test: H_0 : difference in coefficients not systematic

$$\chi^2(5) = (b-B)'[(V_b - V_B)^{-1}](b-B) = 3.18$$

$$\text{Prob} > \chi^2 = 0.6716$$

9. Conclusion and Policy Implications

This paper has investigated into the degree of exchange rate pass-through to prices of aggregate as well as disaggregated imports in India during reforms. To recapitulate, exchange rate pass-through (ERPT) is the responsiveness of trade prices (expressed in local currency) to unit change in exchange rate. Accordingly, a pass-through coefficient measures the degree of responsiveness. ERPT is complete if there is a proportional change in prices on account of a unit change in exchange rate and is incomplete if the change in price is less than proportional. For the purpose of analysis, only non-oil imports into India are taken into account, which account for about 70 per cent of the country's total imports. The present study, thus, analyses ERPT for imports of disaggregated product group including chemicals, machinery, transport equipments, metal manufactures and food processing.

The study has provided evidence that movements of import prices and nominal effective exchange rate are synchronous, apart from econometric estimation of pass-through coefficient across sectors. The non-econometric data analysis shows high growth in merchandise trade during reforms. This has necessarily resulted in rising trade orientation of the economy. During reforms, it is also observed, that India's exchange rate has either depreciated or appreciated over time. It is further observed that import prices have synchronous movements with exchange rate, which is indicative of the possibility of exchange rate pass-through to import prices.

In the econometric analysis, an econometric model based on simultaneous equation imperfect substitutes model is made use of, which is distinctly different from econometric models being used for estimation purposes in the literature. Panel data regression techniques are used as the econometric method on a dataset carefully compiled from different sources. The data appendix will provide an indication of the care with which comparable data was compiled for the purpose. The regression exercise was, thus, carried out using a fully specified econometric model, best possible econometric method and a time-comparable dataset. The model has suited the data well and the results are thus robust.

The above results show that even though some import sectors have responded to exchange rate movements, this is no way extensive as is expected during reforms. The impact of exchange rate on import prices is limited. This conforms to the fact that of phenomenal increase in imports during reforms despite depreciation in exchange rate over the years. On the other hand, import prices across sectors, are more dependent on factors other than exchange rate. Even trade reforms do not play an important role in this regard. This analysis indicates that factors like domestic prices play a significant role in determining import prices in certain sectors. This would necessarily show that domestic market power plays an important role in import price determination, if domestic manufacturing prices are assumed to be cost plus. In a way this shows the ineffectiveness of reforms in bringing about competition in the economy. On the whole, the reforms have not been able to bring about significant changes with regards to imports, both prices and quantity. This result in a way contrasts the findings of an earlier study by Mallick and Marques (2006), which show that exogenous factor like reforms, have played a significant role in exchange rate pass-through. The study thus has immense implications for external sector policy choices in developing countries like India.

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