Sectoral exchange rate pass-through: A tale of two policy regimes in India*

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Abstract:
This paper uses panel data to analyse the extent to which the prices of India's imports and exports in nine product groups react to exchange rate changes before (1980-90) and after (1991-2001) a change in policy that included the adoption of a flexible exchange rate regime and an acceleration of trade liberalisation. It finds that for all the nine groups of Indian industries the null hypothesis of complete pass-through from exchange rate changes into import prices cannot be rejected. On the contrary, the results suggest that Indian exporters appear to have to some degree passed through exchange rate changes into foreign currency export prices in three industry groups in the 1980s and in six groups of industries in the 1990s. The increase in the number of sectors exhibiting some degree of pass-through in the 1990s, relative to the 1980s, may be partly attributable to the elimination of currency and trade controls. Whilst the pass-through into import prices does not exhibit a structural break around 1991, a Chow test revealed the existence of such structural break in pass-through into export prices. The pass-through to import prices seems to be exogenous (determined by external factors), but the pass-through to export prices appears to be endogenous (driven by internal factors, mostly trade and exchange rate policies).

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1 Introduction

India has become an increasingly important player in world trade since it started relaxing its trade controls nearly two decades ago. India's trade (sum of exports and imports of goods and services) as percent of GDP has gone up from 16% in 1985-86 to 37% in 2002-03. The knocking-down of tariffs has been particularly fast during the 1990s, going from an average import-weighted tariff of 87% in 1990 to 35.7% in 2000 (Ahluwalia (2002)). However this average hides important sectoral differences, with imports such as textiles and footwear still subject to tariffs higher than 40% (Mattoo and Stern (2003)). At the same time, India allowed the rupee exchange rate to be market-determined following the 1991 devaluation. Between 1981-82 and 2001-02, the rupee depreciated

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at an average annual rate of about 8%. The simultaneous trade liberalisation and change of exchange rate regime make India an interesting case study to investigate the exchange rate pass-through to traded goods prices. Moreover, India may also serve as an example to other developing countries that are trying to internationalise their economies.

The prices of traded goods and exchange rates have been linked by three main concepts: the law of one price, exchange rate pass-through and pricing-to-market (Goldberg and Knetter (1997)). The study of exchange rate pass-through, defined as the elasticity of import prices to exchange rate changes, goes back to the 1970s. The pass-through is said to be incomplete, or less than one, when an exchange rate change is not completely transmitted to the prices denominated in the importer's currency. This phenomenon is made possible by the corresponding variation in the exporters' mark-ups: when the exchange rate changes, exporters change the price in their own currency to stabilise their export prices in the importer's currency. This sort of behaviour is generally associated with imperfect competition, where firms are able to generate profits, at least in the short run.[1] From the exporter's point of view, the manipulation of profit margins may originate what Krugman (1987) has called pricing-to-market: prices in the exporter's currency vary across markets, hence the same product may have different prices in different markets importing from the same exporter.[2]

This paper examines the extent of transmission of rupee/USD exchange rate changes to India's import and export prices and whether such pricing behaviour varies across industries. The rupee/USD exchange rate gives a fair indication of traded goods pricing, as the USD is the billing currency for India's trading partner countries. As India's export and import prices are

[1] In this paper, the definition of imperfect competition relies on the existence of mark-ups fostered by product differentiation. The differentiation present mostly in the manufacturing sector gives each firm a degree of monopoly power that allows the firm to use mark-up pricing. As product differentiation is lower in the agricultural sector, firms in this sector have fewer possibilities for mark-up pricing behaviour.
[2] Alternatively, pricing-to-market may designate the discrimination of the domestic and the foreign market. A discussion is provided in Yang and Hwang (1994).

disaggregated by product and not by country, the analysis of export prices will be made based on the pass-through into USD-denominated prices using the mirror image of rupee-denominated prices. Thus, what will be discussed in the paper is the pass-through phenomenon, albeit for both imports and exports. If anything, while doing sectoral analysis, this paper would introduce a new concept called pricing-to-product indicating how the pass-through effect to a single market can vary for different product categories.

There are numerous studies examining the pass-through mechanism. Most of the existing studies have looked at the behaviour of firms in larger countries, either US importers, or Japanese and German exporters practicing pricing-to-market (Feenstra (1989), Froot and Klemperer (1989), Hooper and Mann (1989), Knetter (1989), Kim (1990), Koch and Rosensweig (1992), Parsley (1993), Athukorala and Menon (1994), Knetter (1994), Gagnon and Knetter (1995), Goldberg (1995), Bleaney (1997), Tange (1997), Yang (1997,(1998)). A second generation of studies has dealt with smaller countries: South Korea (Athukorala (1991), Yang and Hwang (1994), Lee (1997)), Australia (Menon (1992,(1996)), Switzerland (Gross and Schmitt (1996)), Ireland (Doyle (2004)). However, in the context of emerging market economies such as India, there is little evidence examining the exchange rate pass-through effect.

This paper attempts to fill the existing gap regarding developing countries, at the same time extending the analysis in several directions. First, while most studies in the literature have dealt with either exports or imports, thus developing specific models of either exchange rate pass-through or pricing-to-market, this paper links exchange rate changes to both export and import prices. This is done by stressing how changes in import prices can feed through to export prices when the imported component of exports is substantial, as it is frequent in developing countries. Second, the paper provides a sectorally disaggregated analysis for both import and export prices. In the context of India as a developing country, it is worth exploring whether there is evidence for cross-sectional differences in exchange rate pass-through. Finally, this paper attempts to draw some conclusions on the impact of the change in exchange rate regime by analysing the existence

of a structural break in 1991 and studying how Indian import and export prices respond to exchange rate changes in the 1990s relative to the 1980s.

The main findings can be summarised as follows. Both import and export prices of India, measured in rupee terms, are very responsive to the rupee's movements in the 1990s. On the whole, exchange rate changes are mostly absorbed by Indian importers and exporters. Exporters appear to adjust their profit margins by changing rupee prices, as they prefer to avoid large fluctuations in the USD price of traded goods. The relative insensitivity of the US dollar prices of Indian exports and imports is translated into incomplete pass-through, and it suggests that India is still a price-taker in the global market place. This is due to the fact that the firms' behaviour depends on the elasticity of external demand, and on the importance of the imported content embodied in exports. The dependence on imported components precludes a structural break in import prices pass-through.

However, in the 1990s the policy change regarding exchange rate regime and faster trade liberalisation has produced its fruits. Although it might be to the benefit of Indian exporters to refrain from fully passing through the exchange rate shock to the USD price of exports, their reaction has changed over time and is sector-specific. The pass-through effect in exports has been extended to a greater number of sectors in the liberalised 1990s, with currency changes being transmitted for six industry groups, relative to three industry groups in the 1980s. This behaviour partly reflects the 1980s pegged currency regime, which made the exchange rate relatively sticky, and caused substantial currency overvaluation. In addition, as a result of high inflation, the exporters' rupee prices were rising relatively quickly. Consequently, domestic inflation was more responsible than exchange rate changes for the changes in USD export prices. On the contrary, in the 1990s the free float effectively gave more pricing power to Indian exporters, who no longer needed to compress their profit margins and could make the export prices denominated in foreign currency react to exchange rate changes.

The remainder of the paper is organized as follows. Section 2 describes a simple model of exchange rate pass-through into export and import prices, from which an empirical specification is derived. Section 3 gives further details about the data and empirical findings. A summary and discussions of implications of the findings are provided in the final section (Section 4).

2 Pass-through and pricing-to-market effects

Goldberg and Knetter (1997) have considered three generations of models that try to explain the relationship between traded goods prices and exchange rates. The first generation of models relating the exchange rate and traded goods prices tried to test the law of one price – the prices of the same good in different countries should be the same when converted to the same currency. The second generation of models[3] measured directly the exchange rate pass-through using equations where the price in the importer's currency was the dependent variable. If the exchange rate coefficient were significant, then there would be pass-through, albeit incomplete if the coefficient would be less than one. Following this approach, exchange rate pass-through (EPT) can be described in the import price (P^m) equation as follows:

(1) $$d \ln P_{it}^m = \alpha_i + \beta_i d \ln e_t + \varepsilon_{it}$$

where e_t is the rupee/USD exchange rate and β_i is the EPT coefficient of import prices and indicates the percentage of exchange rate change that is transmitted to the import price given in domestic currency.

The third generation of models[4] measures pass-through only indirectly. The dependent variable is the price in the exporter's currency and, assuming marginal costs are independent from the importing markets, it also represents the exporter's mark-up. If the exchange rate coefficient were

[3] See, among others, Mann (1986), Dornbusch (1987), Feenstra (1989), Froot and Klemperer (1989), Hooper and Mann (1989), Ohno (1989), Yang (1995).
[4] See, among others, Krugman (1987), Giovannini (1988), Knetter (1989), Marston (1990), Kasa (1992), Knetter (1993), Gagnon and Knetter (1995), Goldberg (1995), Knetter (1995).

significant, the exporter's mark-up would vary with the exchange rate of each market's currency, and there would be pricing-to-market. The third-generation model stresses the existence of pricing-to-market (PTM) that leads to permanent deviations from the law of one price. The relationship between foreign currency export prices (P^{x*}) and domestic currency export prices (P^{x}) can be written as $P^{x*} = \frac{P^{x}}{e}$. Taking logs and differentiating:

$$\frac{d \ln P^{x*}}{d \ln e} = \frac{d \ln P^{x}}{d \ln e} - 1 \qquad (2)$$

The coefficient of pass-through to foreign currency is then equal to the coefficient of pricing-to-market in domestic currency minus one. Therefore, as long as mark-ups vary with exchange rates, pass-through will be incomplete. Aside from the extent of direct pass-through into import prices, the pass through to export prices is a crucial estimate to gauge the pricing behaviour of exporters in different product groups. The extent of exchange rate pass-through depends on the level of mark-ups and product differentiation, which in turn determine the degree of imperfect competition. In other words, product differentiation gives the firm a degree of monopoly, and it is this monopoly power that allows the firm to use the mark-up approach to price determination. The manufacturing sector could conform to an imperfectly competitive market, as opposed to the agricultural and small business sectors, which appear to have less market power and thus could be price takers. The importance of studying this imperfect competition behaviour, both from the perspective of the importer (pass-through) and of the exporter (pricing-to-market), is justified by both theory and policy reasons. Exchange rates influence mark-ups and thus export prices. When a local currency appreciates, exporters reduce their mark-ups to remain competitive, but when a local currency depreciates, exporters may take advantage of this depreciation by increasing their mark-ups marginally, as is found in this paper.

The general mark-up model developed by, among others, Knetter (1989,(1993), Gagnon and Knetter (1995), and common to most pricing-to-market studies, is built from the definition of the

price of exports in domestic currency as the product of marginal cost and a mark-up coefficient. In a panel structure, these elements can be distinguished as respectively time-varying and product-specific. As an illustration, consider the model in Gagnon and Knetter (1995), modified for the case of a representative profit-maximizing exporting firm that produces *n* goods for sale in foreign markets.[5] The firm's profits will equal the difference between its revenue and its cost:

$$(3) \qquad \Pi = \sum_{i=1}^{n} P_i^x q_i \left(\frac{P_i^x}{e} \right) - C\left(\sum_{i=1}^{n} q_i \left(\frac{P_i^x}{e} \right), w \right)$$

where *w* is an index of input prices, including the imported raw materials, *q* is the quantity demanded of exports, which can be assumed as a function of the export price relative to the price level in the destination market, *e* is the exchange rate defined as the price of foreign currency (e.g., USD) in terms of domestic currency (e.g., rupee). Assume that the firm's external demand changes as the exchange rate changes. To maintain competitiveness, the representative exporter may be constrained to keep the USD price of its products stable despite exchange rate fluctuations. This means that the exporter would maximise its profit function by setting its export price as a mark-up over the production cost, where the exchange rate is assumed to determine the profit mark-up at a given price elasticity of external demand. Taking the first order derivative of equation (3) with respect to P^x, the following expression is obtained:

$$(4) \qquad P_i^x = MC \left[\frac{\eta_i \left(\frac{P_i^x}{e} \right)}{\eta_i \left(\frac{P_i^x}{e} \right) - 1} \right], i = 1, ..., n$$

where η is the absolute value of the price elasticity of demand in the foreign market. Using log-linear differentiation, equation (4) can be written as:

$$(5) \qquad d \ln P_i^x = d \ln MC + \frac{d \ln \eta_i}{d \ln \left(\frac{P_i^x}{e} \right)} \left(\frac{d \ln P_i^x - d \ln e}{\eta_i - 1} \right).$$

[5] The original model refers to the case of a representative profit-maximising exporting firm that produces a good for sale in *n* foreign markets. This set-up originates the pricing-to-market commonly referred to in the literature, as the firm's mark-up varies by market. However, the data used in this paper shows India's exports of several goods to the rest of the world. Hence, we modify the original model to allow for mark-ups to vary by product. This could be called pricing-to-product.

Collecting terms for $d \ln P_i^x$ on the left hand side yields the following testable equation:

(6) $$d \ln P_{it}^x = \tau_i + (1-\delta_i) d \ln MC_i + \delta_i d \ln e_t$$

where $\delta_i = \dfrac{\partial \ln \eta_i}{\partial \ln\left(\dfrac{P_i^x}{e}\right)}\left[1-\eta_i - \dfrac{\partial \ln \eta_i}{\partial \ln\left(\dfrac{P_i^x}{e}\right)}\right]^{-1}$ is a function of both the level and the elasticity of η_i and τ_i is a sector-specific intercept that captures the constant terms. If δ=0, the export price in domestic currency is determined only by internal factors and there is full pass-through in foreign currency terms. If δ=1, the export price in domestic currency is determined solely by external factors and exporters fully absorb exchange rate changes, that is, there is no pass-through to foreign currency prices.

On the basis of equation (1) for imports and equation (6) for exports, the empirical measurement of exchange rate pass-through has been commonly carried out in a panel data framework.[6] The panel structure presents several advantages, namely the possibility of sectoral disaggregation of the data and the incorporation of time and cross-sectional effects. In this case, time effects measure changes in marginal costs and other supply factors, whilst cross-sectional effects control for variations specific to each importing market, such as exchange rate changes and other demand factors. The issue is usually whether exchange rate changes also make prices in the importing market vary or are reflected on the exporters' margins. Existing studies (e.g., Mann (1986), Knetter (1989), Marston (1990), Knetter (1993)) conclude that Japanese and German exporters tend to accommodate exchange rate changes, whereas US exporters keep margins constant and pass-through any exchange rate changes. These studies however look at this effect for OECD countries, but there is little evidence in the context of emerging economies providing this link at a sectoral level, which could be due in part to lack of sectoral data. The fact that India has such

[6] See, among others, Knetter (1994), Gagnon and Knetter (1995), Feenstra *et al.* (1996), Madsen (1998), Goldberg and Knetter (1999).

disaggregated data allows this paper to look at the sectoral pass-through effects in India's exports and imports.

3 Testing sectoral pass-through effects in India

The unit value indices of imports and exports for a number of sectoral groups are regressed against the rupee/US dollar exchange rate so as to investigate the extent of exchange rate pass-through into the unit values of imports and exports (see Appendix 1 for more detail on data sources and definitions). As it is well known that unit values are an imperfect proxy for the true prices of goods and are subject to aggregation bias, the results must be interpreted with caution. However, in the absence of micro data for emerging markets, unit values can be regarded as a first approximation to allow the analysis of an important issue.

Figure 1: Changes in aggregate export and import prices and exchange rate

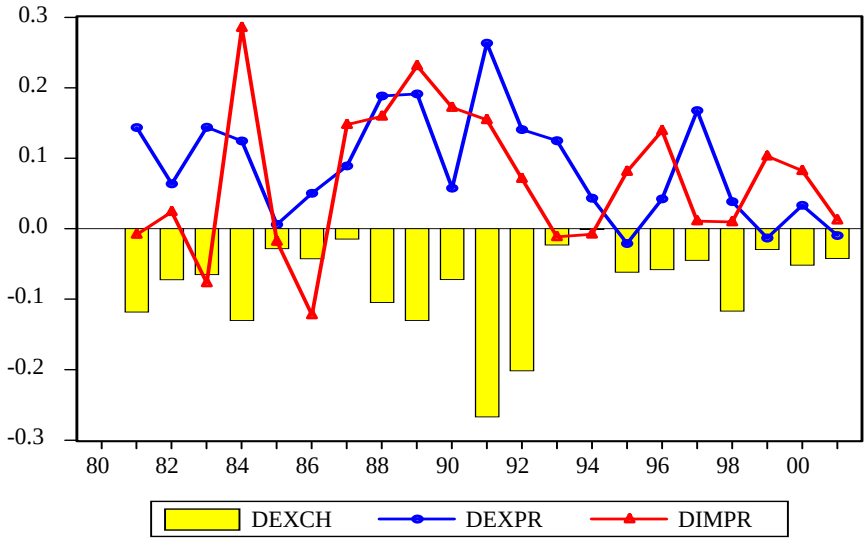


Figure 1 plots the changes in export and import prices along with the exchange rate changes in the sample period (1980-2001). It appears that the export prices in domestic currency track import prices with a lag, mainly because the export-oriented industries embody a large imported component in their products. Kara and Nelson (2003) have used UK data to study inflation behaviour in an open economy and argue that, when imports are modelled as intermediate

commodities, the inflation dynamics shows a better match with the data than when imports are considered as final consumer goods. This argument is also relevant in the context of developing economies, which import more intermediate products than final goods. Burstein et al. (2004) also observe that the rate of exchange rate pass-through is the highest for imported equipment. Higher import prices can therefore spur domestic inflation[7] and in turn increase export prices. To what extent exchange rate changes have influenced the foreign currency price of exports in the context of a developing economy, namely India, requires some investigation.

With reference to the changes in sectorally disaggregated export and import prices, there appears to be higher volatility in import prices due in part to exchange rate changes, compared to export prices (see Appendix 2). Although the changes in aggregate export and import prices show volatility within a narrow range, the sectoral prices display fluctuations within a wider band. For example, the fuel group shows a range of wide volatility and such high volatility in fuel import prices could be reflecting refining costs, fuel duties and mark-ups. Since India imports close to 75% of the country's requirements of crude oil and petroleum products, high international oil prices could spur the fluctuations in import prices.

This paper uses panel techniques to estimate the pass-through of exchange rate changes to changes in India's import and export prices in local currency assuming a common slope across sectors, and a SUR estimation assuming sector-specific slopes. Referring back to equations (1) and (6), the empirical specifications for respectively India's imports and exports of sector *i* in period *t* can be written as follows:

(7) $$d \ln P_{it}^{m} = \alpha_i + \beta_i d \ln e_t + \varepsilon_{it}$$

(8) $$d \ln P_{it}^{x} = \gamma_i + \delta_i d \ln e_t + \varepsilon_{it}^{'}$$

[7] In a more general model of price formation in traded and non-traded goods sectors, incorporating the effect of exchange rate variations, the dynamic homogeneity in aggregate prices has been demonstrated empirically in Mallick (2004) – a small macroeconometric model for India.

where $d \ln P_{it}^{m}$ and $d \ln P_{it}^{x}$ are respectively the change in the log of import and export prices in domestic currency (rupees), $d \ln e_t$ is the variation in the log of the rupee/USD exchange rate (defined as rupees per USD) and, from equation (6), $\gamma_i = \tau_i + (1-\delta_i) d \ln MC_i$. From equation (2), $\frac{d \ln P^{x*}}{d \ln e} = \delta_i - 1$ with P^{x*} the foreign currency export price.

The degree of pass-through to import and export prices will be analysed from India's point of view. In the import price equation (7), if H_0: $\beta=0$ ($\beta=1$) is accepted, there is no (full) pass-through into India's import prices as the rupee price of *imports* does not change (changes one-to-one) with the exchange rate. In the export price equation (8), if H_0: $\delta=0$ ($\delta=1$) is accepted, there is complete (no) pass-through into India's export prices as the rupee price of *exports* does not change (changes one-to-one) with the exchange rate. If both H_0: $\beta=0$ ($\delta=0$) and H_0: $\beta=1$ ($\delta=1$) are rejected, then there is incomplete pass-through in import (export) prices. If neither H_0: $\beta=0$ ($\delta=0$) nor H_0: $\beta=1$ ($\delta=1$) are rejected, no conclusion can be reached as the standard errors of the coefficients are simply too large.

3.1 Pass-through in imports

India is generally held to be a small open economy with a high proportion of imports and persistent trade imbalances. Given the heavy currency devaluation and the introduction of a relatively flexible exchange rate regime since 1991, it is important to test for a structural break in the export and import price equations to be estimated. The null of no structural break cannot be rejected in the case of import prices, and hence the behaviour of import prices will be analysed for the whole 1980-2001 period (Table 1). Note however that evidence of pass-through can only be found after 1991.

Table 1: Chow test on imprice (H0: no structural break in 1991)	
Exchrate 80-90	0.994 (0.585)
Exchrate 91-01	0.368* (0.132)
Cons 80-90	-0.003 (0.054)
Cons 91-01	-0.002 (0.017)
Adj R-sq	0.109
F-test	6.76*
N obs	189
Chow test on slopes	1.09
Chow test on slopes and intercepts	2.13
Note: * indicates significance at the 5% level.	

Table 2 shows the estimated pass-through coefficient in import prices for a range of panel techniques, comprising several models that place different assumptions on the variances-covariances matrix.[8] The short-run pass-through coefficient amounts to 0.80% on average across all models, and is always significantly different from zero. However, except for FGLS, we cannot reject the hypothesis of full pass-through of exchange rate changes into import prices in rupees. It is commonly argued that incomplete pass-through may be a short-run phenomenon due to price rigidities, but it would vanish in the long-run when all prices can be fully adjusted. The dynamic models 5 and 6 do not show conclusive evidence of stickiness in import prices as the lagged dependent variable is significant in the Arellano-Bond but not in the Anderson-Hsiao specification. Nevertheless, these models allow the computation of the long-run pass-through coefficient as shown in Table 2. The average long-run pass-through is thus 0.82%, which does not differ much from the short-run estimate.

[8] A likelihood-ratio Chi-squared test for panel heteroskedasticity and the Wooldridge (2002) panel autocorrelation test were conducted on exports and imports. These tests are fully described in http://www.stata.com/support/faqs/stat/panel.html. The results show that our sample is heteroskedastic but does not show evidence of autocorrelation. The value of the heteroskedasticity test is 46.98 for exports (p-value 0.0000) and 32.92 for imports (p-value 0.0001). The value of the autocorrelation test is 2.651 for exports (p-value 0.1421) and 3.634 for imports (p-value 0.0931). After having corrected for the heteroskedastic nature of the sample, both random and fixed effects models are presented. An F-test cannot reject that the fixed effects are zero. For the whole sample period, the Breusch-Pagan test rejects that the variance of the random effects is zero, but this hypothesis cannot be rejected for the sub-periods exports. Both models are reported and in any case the pass-through coefficient is the same.

Table 2: Sectoral panel regression results for import prices (1980-2001)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Exchrate [1]	0.773* (0.244)	0.773* (0.239)	0.814* (0.197)	0.773* (0.246)	0.910* (0.239)	0.853* (0.336)
Cons	0.004 (0.027)	0.004 (0.027)	0.005 (0.022)	0.004 (0.028)	-0.003 (0.003)	0.004 (0.031)
Imprice(-1) [2]					-0.286* (0.073)	0.090 (0.167)
Long-run pass-through ([1]/1-[2])					0.708	0.937
N obs	189	189	189	189	171	162
R-sq	0.053	0.053		0.053		0.028
Log-likelihood			20.387			
Wald chi-sq		10.43*	17.01*	9.85*	26.46*	
Breusch-Pagan (H0:Var(u[sector])=0)		3.33*				
F-test	10.06*					3.32*
F-test (u_i=0)	0.17					
F-test (exchrate = 1)	0.87	0.91	4.50*	2.25		
Sargan test of over-identifying restrictions					153.36	
Arellano-Bond (H0:AR(1)=0)					-8.23*	
Arellano-Bond (H0:AR(2)=0)					-1.9*	

Note: * indicates significance at the 5% level. Model 1 Fixed-effects (within) ; Model 2: Random-effects GLS; Model 3: Cross-sectional time-series FGLS (heteroskedastic panels, no autocorrelation); Model 4: PCSEs OLS (correlated panels, no autocorrelation); Model 5:Arellano-Bond dynamic panel; Model 6: Anderson-Hsiao First-Differenced IV dynamic panel

Table 3: Sectoral SUR on imprice (1980-2001)

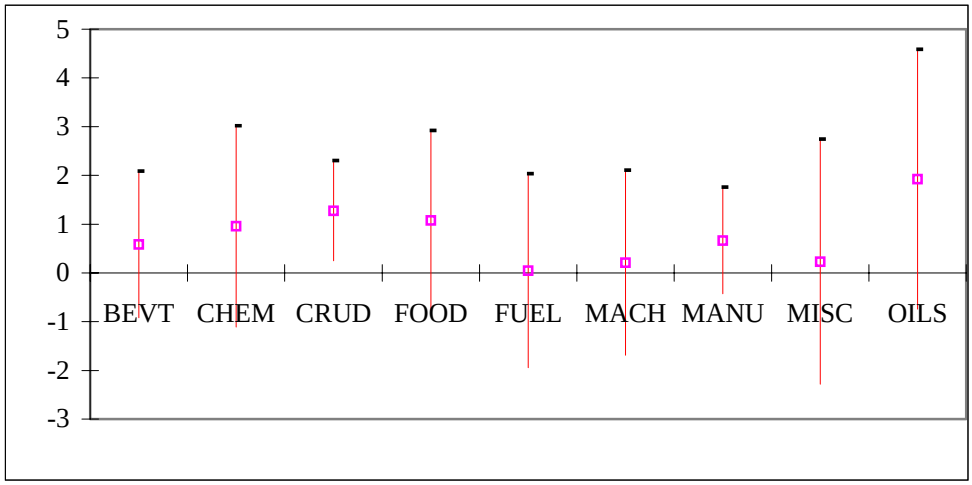
	bevt	chem	crud	food	fuel	mach	manu	misc	Oils
Exchrate	0.584 (0.577)	0.954 (0.792)	1.273* (0.394)	1.075 (0.709)	0.044 (0.764)	0.210 (0.728)	0.663 (0.420)	0.228 (0.964)	1.924 (1.023)
Cons	0.048 (0.065)	-0.012 (0.089)	-0.042 (0.044)	-0.027 (0.079)	0.061 (0.086)	0.032 (0.082)	0.038 (0.047)	0.011 (0.108)	-0.075 (0.115)
RMSE	0.191	0.263	0.131	0.235	0.253	0.241	0.139	0.320	0.339
R-sq	0.051	0.071	0.354	0.108	0.000	0.004	0.116	0.003	0.157
F-test	1.027	1.451	10.416*	2.301	0.003	0.084	2.496	0.056	3.538
N obs	21	21	21	21	21	21	21	21	21
F-test (H0: slope equals 1)	0.52	0.00	0.48	0.01	1.57	1.18	0.64	0.64	0.82
F-test (H0:equal sector slopes)					0.84				
Breusch-Pagan (H0: independence of residuals)					39.643				

*Note: * indicates significance at the 5% level.*

When we distinguish sectoral slopes through SUR estimation (Table 3), we find pass-through only in the Crude sector, and we cannot reject that it is complete. However, we cannot reject either independence of residuals across sectors or equality of slope coefficients, thus not validating the SUR regression. Figure 2 exhibits the interval estimates of sectoral coefficients of

the pass-through to import prices and provides an explanation as to why in Table 3 both the hypotheses that the average coefficient can be zero or one are not rejected. This happens because of the high standard errors in the pass-through coefficient that make the confidence intervals relatively wide. However, Figure 2 also shows that the average point estimates differ across sectors, ranging from a low 0.044 in Fuel to a high 1.924 in Oils.

Figure 2: Sectoral coefficient estimates of import prices (within 95% confidence interval)



3.2 Pass-through in exports

Whilst the Chow test on the imports regression could not reject the null of no structural break, the Chow test on the exports regression indicated the existence of a structural break in 1991, when India devalued its currency and subsequently switched to a floating exchange rate leading to substantial currency depreciation over the decade. The null of no structural break is rejected (Table 4) and thus exports prices are analysed for both the whole 1980-2001 time period and for the two sub-samples, 1980-1990 and 1991-2001. Note however that, whilst Indian exporters responded to exchange rate changes in both periods, that response was lower after 1991 (see Tables 6 and 7).

Table 4: Chow test on exprice (H0: no structural break in 1991)	
Exchrate80-90	1.210* (0.353)
Exchrate91-01	0.346* (0.080)
cons80-90	-0.020 (0.033)
cons91-01	0.007 (0.010)
Adj R-sq	0.300
F-test	21.23*
N obs	189
Chow test on slopes	5.70*
Chow test on slopes and intercepts	6.31*
Note: * indicates significance at the 5% level.	

Table 5: Sectoral panel regression results for export prices (1980-2001)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Exchrate [1]	0.776* (0.148)	0.776* (0.145)	0.749* (0.118)	0.776* (0.149)	0.777* (0.155)	0.851* (0.231)
Cons	0.011 (0.017)	0.011 (0.016)	0.011 (0.013)	0.011 (0.017)	-0.002 (0.002)	-0.009 (0.021)
Exprice(-1) [2]					-0.137* (0.074)	0.322 (0.193)
Long-run pass-through ([1]/1-[2])					0.683	1.255
N obs	189	189	189	189	171	162
R-sq	0.133	0.133		0.133		0.059
Log-likelihood			122.394			
Wald chi-sq		28.74*	40.06*	27.2*	27.45*	
Breusch-Pagan (H0:Var(u[sector])=0)		3.83*				
F-test	27.64*					7.06*
F-test (u_i=0)	0.11					
F-test (exchrate = 1)	2.29	2.41	0.89	0.85		
Sargan test of over-identifying restrictions					149.62	
Arellano-Bond (H0:AR(1)=0)					-7.59*	
Arellano-Bond (H0:AR(2)=0)					-3.12*	

Note: * indicates significance at the 5% level. Model 1 Fixed-effects (within) ; Model 2: Random-effects GLS; Model 3: Cross-sectional time-series FGLS (heteroskedastic panels, no autocorrelation); Model 4: PCSEs OLS (correlated panels, no autocorrelation); Model 5:Arellano-Bond dynamic panel; Model 6: Anderson-Hsiao First-Differenced IV dynamic panel

The results for export prices when a common slope coefficient is assumed suggest an average pass-through coefficient of 0.78% for the whole sample across all models (Table 5), meaning that the export price in US dollar terms is reduced by 0.22% for 1% rupee depreciation. For the two pre- and post-floating sub-samples, we find a different picture as during the 1980s the coefficients add up to 1.2% on average across different models (Table 6), which means a 0.2% increase in

dollar-denominated export prices despite currency depreciation. This reflects the case of an overvalued fixed exchange rate regime in the 1980s. In contrast, in the 1990s, the average coefficient of 0.29% across models (Table 7) suggests that for 1% rupee depreciation, the export price in US dollars has declined by 0.71% – a case of incomplete pass-through.

Table 6: Sectoral panel regression results for export prices (1980-1990)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Exchrate [1]	1.210* (0.338)	1.210* (0.329)	0.895* (0.193)	1.210* (0.391)	1.541* (0.373)	1.280* (0.362)
Cons	-0.020 (0.031)	-0.020 (0.030)	0.013 (0.018)	-0.020 (0.036)	0.004 (0.006)	-0.005 (0.024)
Exprice(-1) [2]					-0.382* (0.120)	-0.594 (0.332)
Long-run pass-through ([1]/1-[2])					1.115	0.803
N obs	90	90	90	90	72	63
R-sq	0.133	0.133		0.133		0.190
Log-likelihood			85.643			
Wald chi-sq		13.53*	21.40*	9.58*	21.97*	
Breusch-Pagan (H0:Var(u[sector])=0)		1.72				
F-test	12.83*					6.29*
F-test (u_i=0)	0.43					
F-test (exchrate = 1)	0.39	0.42	0.29	0.29		
Sargan test of over-identifying restrictions					54.3	
Arellano-Bond (H0:AR(1)=0)					-4.04*	
Arellano-Bond (H0:AR(2)=0)					0.33	

Note: * indicates significance at the 5% level. Model 1 Fixed-effects (within) ; Model 2: Random-effects GLS; Model 3: Cross-sectional time-series FGLS (heteroskedastic panels, no autocorrelation); Model 4: PCSEs OLS (correlated panels, no autocorrelation); Model 5:Arellano-Bond dynamic panel; Model 6: Anderson-Hsiao First-Differenced IV dynamic panel

Similarly to imports, the dynamic models 5 and 6 do not show conclusive evidence of persistence in export prices, as the lagged dependent variable is significant in the Arellano-Bond but not in the Anderson-Hsiao specification, and in the 1990s it is never significant. The average long-run change in the rupee export price for the whole sample period is 0.97% (Table 5), of which 0.96% in the 1980s (Table 6) and 0.18% in the 1990s (Table 7). These values show that the long-run pass-through behaviour differs substantially before and after 1991. Indian exporters absorbed 96% of the exchange rate changes in the 1980s, but only 18% in the 1990s. In all cases (Tables 5-7), the pass-through into USD export prices is higher in the long-run than the short-run.

Table 7: Sectoral panel regression results for import prices (1991-2001)						
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Exchrate [1]	0.346* (0.087)	0.346* (0.084)	0.370* (0.073)	0.346* (0.068)	0.290* (0.130)	0.062 (0.302)
Cons	0.014 (0.022)	0.014 (0.021)	0.006 (0.019)	0.014 (0.017)	-0.014 (0.006)	-0.005 (0.031)
Exprice(-1) [2]					-0.182 (0.098)	0.424 (0.310)
Long-run pass-through ([1]/1-[2])					0.245	0.108
N obs	90	90	90	90	81	63
R-sq	0.149	0.149		0.149		0.007
Log-likelihood			53.921			
Wald chi-sq		16.91*	25.59*	26.27*	7.40*	
Breusch-Pagan (H0:Var(u[sector])=0)		3.42				
F-test	15.76*					0.99
F-test (u_i=0)	0.17					
F-test (exchrate = 1)	56.27*	61.64*	73.99*	93.78*		
Sargan test of over-identifying restrictions					64.21*	
Arellano-Bond (H0:AR(1)=0)					-3.34*	
Arellano-Bond (H0:AR(2)=0)					-2.58*	

Note: * indicates significance at the 5% level. Model 1 Fixed-effects (within) ; Model 2: Random-effects GLS; Model 3: Cross-sectional time-series FGLS (heteroskedastic panels, no autocorrelation); Model 4: PCSEs OLS (correlated panels, no autocorrelation); Model 5:Arellano-Bond dynamic panel; Model 6: Anderson-Hsiao First-Differenced IV dynamic panel

In both sub-samples, the rupee exchange rate against the USD has depreciated annually about 8% on average in each of the decades – one regime with an adjusted peg system and the other with a managed floating system. This broad scenario leads us to examine the pass-through effects at the sectoral level using the SUR methodology. For the whole period (Table 8), we find a coefficient significantly different from zero for four sectors – BEVT, CHEM, CRUD, MACH. The null of the coefficients of these four sectors being equal to one cannot be rejected, thus establishing the possibility of no pass-through. This suggests that firms in these four product groups are price takers, in line with the "small-country" assumption. On the contrary, we cannot reject full pass-through in the case of the remaining five sectors – FOOD, FUEL, MANU, MISC, OILS.

The Breusch-Pagan test shows that the residuals of each sectoral equation in SUR are not independent and thus it makes sense to use the SUR technique. Although the point estimates differ, the F-test for equality of the sectoral coefficients for the whole sample (Table 8) is by no means conclusive, due to the fact that the confidence intervals overlap. As exchange rates and

prices are volatile, it makes more sense to talk about confidence intervals rather than point estimates. The confidence intervals originated by the SUR method for the whole sample are represented in Figure 3. While the fuel group shows the widest interval, partly because of the large fluctuations in global fuel prices, all other product groups show a relatively narrow band. Unlike the case of imports, the small variability in the export price coefficient allows the acceptance of the absence of exchange rate pass-through at the sectoral level.

Figure 3: Sectoral coefficient estimates for export prices (within 95% confidence interval)

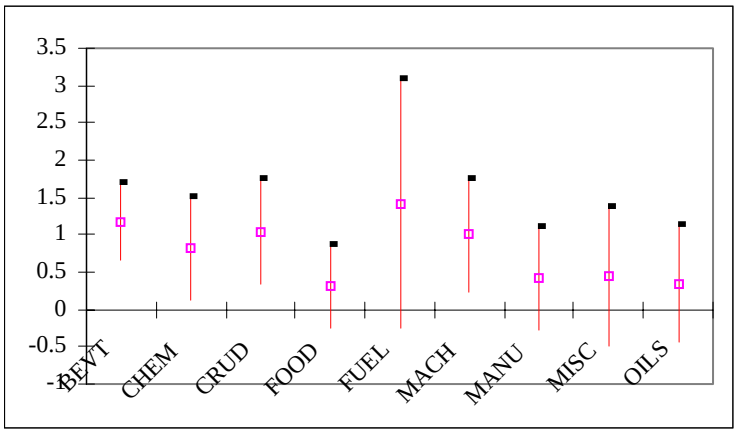


Table 8: Sectoral SUR on exprice (1980-2001)

	bevt	chem	crud	food	fuel	mach	manu	misc	oils
exchrate	1.181* (0.261)	0.820* (0.353)	1.047* (0.365)	0.321 (0.283)	1.423 (0.843)	1.005* (0.387)	0.414 (0.354)	0.435 (0.476)	0.341 (0.401)
cons	-0.031 (0.029)	-0.002 (0.040)	-0.004 (0.041)	0.046 (0.032)	-0.044 (0.094)	-0.014 (0.043)	0.047 (0.040)	0.062 (0.053)	0.037 (0.045)
RMSE	0.087	0.117	0.121	0.094	0.279	0.128	0.117	0.158	0.133
R-sq	0.519	0.222	0.302	0.063	0.131	0.262	0.067	0.042	0.037
F-test	20.460*	5.406*	8.231*	1.282	2.853	6.737*	1.371	0.838	0.723
N obs	21	21	21	21	21	21	21	21	21
F-test (H0: slope equals 1)	0.48	0.26	0.02	5.74*	0.25	0.00	2.74	1.41	2.70
F-test (H0:equal sector slopes)					1.28				
Breusch-Pagan (H0: independence of residuals)					55.143*				

Note: * indicates significance at the 5% level.

In the sub-periods, however, the sectoral slope coefficients are not equal (see Tables 9 and 10). In the 1980s, the pass-through coefficients of three sectors – CHEM, FUEL, OILS – are not significant (Table 9), suggesting full pass-through during the period. However the hypothesis of no pass-through cannot be rejected either due to the high standard errors of the coefficients. The

main reason for the low or inexistent pass-through in the other six sectors during the 1980s could be the existence of currency controls and trade barriers that distort market forces. These sectors are the ones in which India is a price-taker in the international market. In the 1990s, the coefficients of six sectors – FOOD, FUEL, MACH, MANU, MISC, OILS – are not significant (Table 10), implying that full pass-through may be more common during the second sub-period relative to the 1980s. However, once again the hypothesis of no pass-through cannot be rejected either for the same reason – high standard errors. Overall, India seems to be more of a price-maker in the 1990s, although in BEVT, CHEM, and CRUD India appears to be still a price-taker.

Table 9: Sectoral SUR on exprice (1980-1990)

	bevt	chem	crud	food	fuel	mach	manu	misc	oils
exchrate	1.419*	0.230	1.291*	0.683*	0.888	1.347*	0.441*	0.516*	0.541
	(0.221)	(0.494)	(0.499)	(0.200)	(1.279)	(0.359)	(0.220)	(0.210)	(0.512)
cons	-0.041	0.048	-0.016	0.025	-0.062	-0.042	0.078*	0.083*	0.011
	(0.028)	(0.063)	(0.064)	(0.026)	(0.165)	(0.046)	(0.028)	(0.027)	(0.066)
RMSE	0.057	0.127	0.128	0.051	0.329	0.092	0.056	0.054	0.132
R-sq	0.821	0.024	0.426	0.564	0.051	0.610	0.310	0.402	0.110
F-test	41.171*	0.218	6.686*	11.661*	0.482	14.067*	4.044*	6.054*	1.117
N obs	11	11	11	11	11	11	11	11	11
F-test (H0: slope equals 1)	3.58	2.43	0.34	2.51	0.01	0.93	6.47*	5.34*	0.80
F-test (H0:equal sector slopes)					5.62*				
Breusch-Pagan (H0: independence of residuals)					54.591*				

Note: * indicates significance at the 5% level.

Table 10: Sectoral SUR on exprice (1991-2001)

	bevt	chem	crud	food	fuel	mach	manu	misc	oils
exchrate	1.212*	0.946*	1.032*	0.301	1.015	0.938	0.378	0.430	-0.024
	(0.375)	(0.361)	(0.397)	(0.420)	(0.814)	(0.534)	(0.504)	(0.725)	(0.460)
cons	-0.040	-0.014	-0.009	0.042	0.032	-0.007	0.017	0.037	0.066
	(0.048)	(0.046)	(0.051)	(0.053)	(0.104)	(0.068)	(0.064)	(0.092)	(0.059)
RMSE	0.113	0.109	0.120	0.127	0.246	0.161	0.152	0.219	0.139
R-sq	0.537	0.433	0.429	0.054	0.147	0.255	0.059	0.038	0.0003
F-test	10.425*	6.876*	6.755*	0.515	1.556	3.082	0.563	0.352	0.003
N obs	11	11	11	11	11	11	11	11	11
F-test (H0: slope equals 1)	0.32	0.02	0.01	2.77	0.00	0.01	1.52	0.62	4.95*
F-test (H0:equal sector slopes)					3.07*				
Breusch-Pagan (H0: independence of residuals)					48.382				

Note: * indicates significance at the 5% level.

From an economic point of view, the acceptance of the null hypothesis of β being both equal to zero and one suggests that the exporting firms can either pass through the exchange rate changes fully or can keep the dollar price constant. This scenario is evident in five sectors in the liberalised 1990s as opposed to three sectors in the 1980s, which can be linked to the extent of export orientation of the sectors. The share of manufactured goods in total exports has gone up to 76% in 2001-02 from 68% in 1987-88, while the share of primary products has come down to 16% of total exports from 26% during the same period. Because manufactured goods are subject to a higher degree of differentiation, whilst agricultural goods are more homogeneous, the structural shift to manufactures has established a pattern of imperfect competition and increased the potential for the existence of mark-ups. Therefore, in an environment where the exchange rate is depreciating more often than appreciating, the exporters have a choice between allowing exchange rate variations to improve competitiveness or to keep the foreign currency price unchanged to increase export profitability.

4 Conclusions

This paper provides a comparative analysis of how Indian import and export prices have reacted to exchange rate changes, particularly the degree of export price pass-through after the acceleration of trade openness and the introduction of a flexible exchange rate regime. Based on panel data analysis of nine industry groups over the period from 1980 to 2001, the full pass-through of changes in the bilateral rupee/US dollar exchange rate into import prices is not rejected, whilst for export prices the pass-through is often found to be incomplete or imperfect. The results also indicate that there is pass-through into the dollar price of exports for more industry groups in the 1990s than in the 1980s, suggesting that the pricing behaviour of the Indian exporters varies across industries, with the variations being linked to industry-specific features, as well as exchange rate and trade policies.

India is generally held to be a small country in the sense that it is a price-taker in international markets. This assumption would mean zero pass-through of exchange rate changes to foreign currency prices. The panel results in this paper show that the small country assumption does not fully fit India and suggest an incomplete pass-through instead. For the whole sample period (1980-2001), around 80% of the impact of currency depreciation is borne by domestic firms, but foreign firms bear 20% of the impact. Put differently, there is a 0.2% dollar price reduction and a 0.8% rupee price increase for 1% currency depreciation and this result holds for both exports and imports. However, whilst in the long-run this result holds for imports, exporters absorb on average 97% of the exchange rate changes in the long-run.

The export story is made more interesting by a structural break in 1991, which makes the extent of pass-through differ in the two sub-periods. In the 1980s, the rupee price amplified exchange rate changes by 20% and this excess was transmitted to the dollar export prices, while in the 1990s the rupee price compensated exchange rate changes by increasing only 29% and allowing the dollar export prices to decline by 71%. Hence, for a 1% depreciation of the rupee, the dollar prices of exports increased by 0.2% in the 1980s, but declined by 0.71% in the 1990s. This means that the exporters were taking more advantage of the exchange rate changes in the pegged currency regime of the 1980s by inflating the export prices in foreign currency terms. The main reason for the low pass-through in the 1980s appears to be the existence of currency controls and trade barriers that place a barrier on market forces. The Chow test for a structural break in 1991 does reflect the policy shift regarding the exchange rate regime that reflected upon a higher pass-through in the 1990s. The difference is particularly extreme in the long-run, as while in the 1980s only 4% of a change in the exchange rate was reflected upon USD prices, in the 1990s that figure goes up to 82%.

From a sectoral standpoint, in the liberalised 1990s, Indian exporters do pass through most of the exchange rate changes to dollar prices in six industry groups, as opposed to three in the 1980s. This implies that India is more of a price-maker after the liberalisation, as exporters in the food

sector, machinery, transport equipment and manufactured goods in general have gained sufficient pricing power to make the dollar price of their exports change when the exchange rate changes. However, in the beverages & tobacco, chemical products, and crude materials sectors, India is still a price-taker in the international market, as the exporters do not have the pricing power to change the dollar price of their exports. It could be the case that, because product differentiation is more a characteristic of the manufacturing sectors than of the agricultural and resource-based sectors, imperfect competition is more common in the former than in the latter. As a consequence, as manufactures gain export share over agriculture and natural resources, exporting firms have more leverage to adjust their profit margins when facing exchange rate changes. Other sectoral characteristics that may generate a different behaviour are the degree of durability of the goods or the sectoral degree of non-tariff barriers such as import licences. More flexible exchange rate regimes may neutralize the impact of any terms of trade shocks, emanating from these non-tariff barriers, on the current account (see Broda (2004)).

In policy terms, the liberalisation that took place in the 1990s has empowered India's exporters to exhibit a pricing behaviour that is less that of a price-taker and more that of a price-maker. It should be noted however that the policy impact seems to have been sectoral, possibly located in the more modern sectors, giving these an edge over the more traditional exports. At the same time, whilst a more flexible exchange rate regime and more trade liberalisation have benefited exporters, there is no evidence of policy effects on importers. The main reason for this lack of impact is that India's importing sector, unlike its exporting sector, is more dependent on external factors – international market conditions – than on internal factors – exchange rate and trade policies. The impact of policy choices on modern and traditional sectors, as well as on the exporters and importers, may be a lesson to other developing countries currently internationalising their economies.

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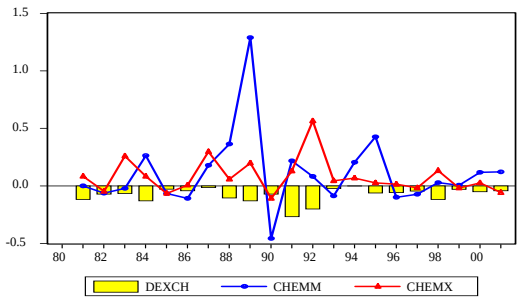
Appendix 1
Data Sources and Definitions

The unit value indices of imports and exports for a number of sectoral groups, and the rupee exchange rate against US dollar, were compiled from the Handbook of Statistics on the Indian Economy 2002-03, Reserve Bank of India, over the period 1980-81 to 2001-02. The definition of the sectoral groups is as follows:

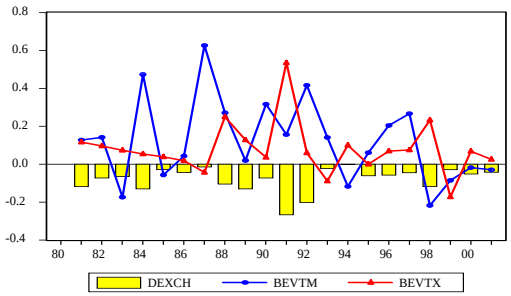
BEVT – Beverages & Tobacco
CHEM – Chemicals & Related Products
CRUD – Crude Materials, Inedible, Except Fuels
FOOD – Food & Food Articles
FUEL – Mineral Fuels, Lubricants, Etc
MACH – Machinery & Transport Equipment
MANU – Manufactured Goods Classified Chiefly By Material
MISC – Miscellaneous Manufactured Articles
OILS – Animal & Vegetable Oil, Fats & Waxes

Appendix 2
Changes in sectoral export and import prices and exchange rate

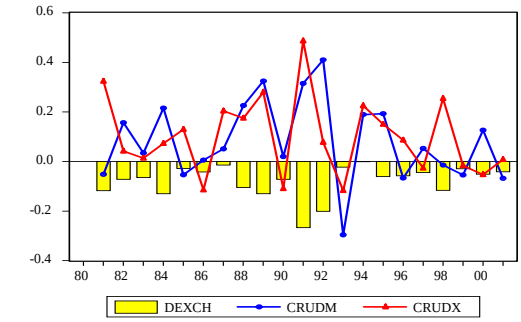
A. Chemical and related products



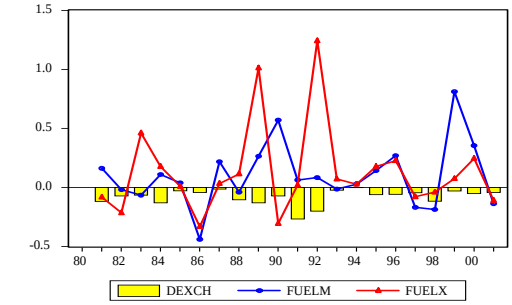
B. Beverages and tobacco



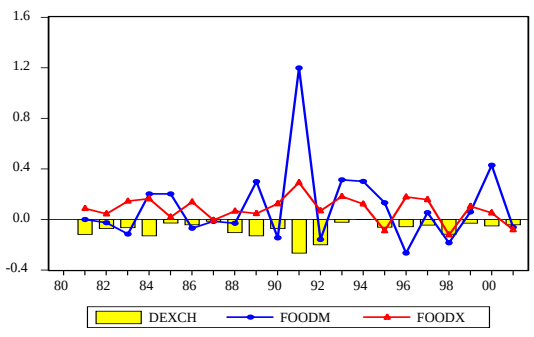
C. Crude materials



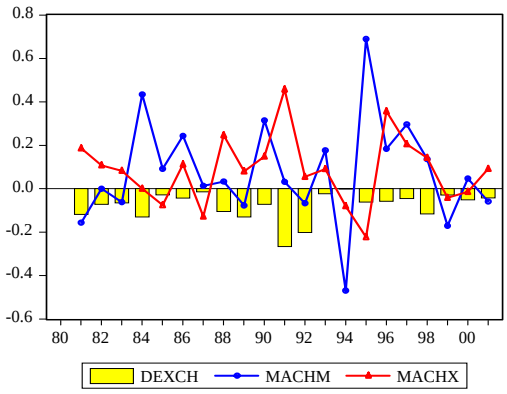
D. Mineral fuels, lubricants etc.



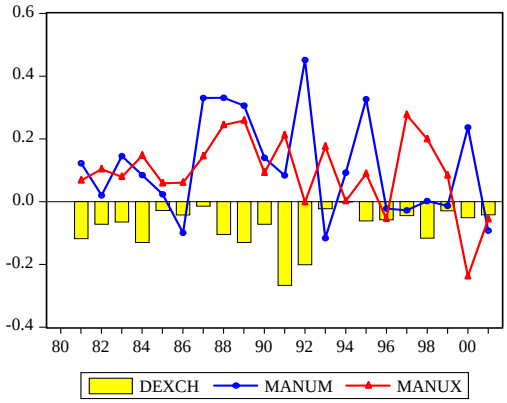
E. Food and food articles



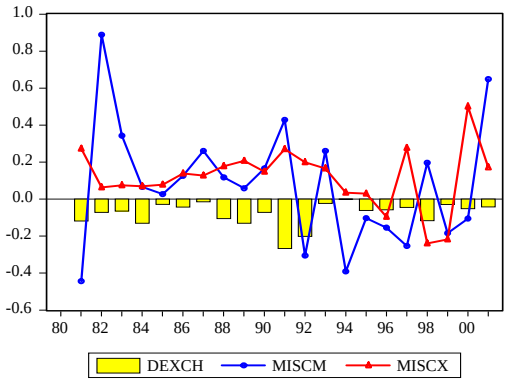
F. Machinery and transport equipment



G. Manufactured goods



H. Miscellaneous manufactured articles



I. Animal & vegetable oil, fats & waxes