Exchange rate transmission at industry level: A tale of two policy regimes in India*

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Abstract:

In the 1990s, India initiated extensive policy reforms that included the adoption of a flexible exchange rate regime and an acceleration of trade liberalisation. This paper analyses the impact of the policy reforms on exchange rate pass-through into export prices using sectoral panel data (at the 2-digit SITC level) for the pre- (1980-90) and post-reform (1991-2001) periods. Chow and CUSUM tests revealed the existence of a structural break in pass-through into export prices around 1991. The panel results suggest that the number of industries exhibiting incomplete pass-through increased in the 1990s relative to the 1980s reflecting higher degree of pricing power by these firms, as rupee prices react to exchange rate changes in more sectors but to a lesser extent. These changes in pass-through behaviour may be partly attributable to the elimination of currency and trade controls, which increased competition among firms and fostered a concern with market share gains in the 1990s, over an attempt to make profits as a result of depreciation in the 1980s.

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1 Introduction

Following the balance of payments (BOP) crisis in 1991, India implemented a comprehensive package of economic reforms,[1] including a devaluation of the rupee vis-à-vis the USD of more than 30%, subsequently leading to a managed float regime. Between 1981-82 and 2001-02, the rupee depreciated at an average annual rate of about 8%. At the same time, trade was extensively liberalised, with tariffs being reduced and quantitative restrictions being eliminated. Import licensing was fully abolished by 1993 for capital goods and intermediates, but only by 2001 for final consumer goods. The export taxes and export promotion arrangements that prevented free competition among exporting firms have been largely removed. India's openness index, defined as the sum of exports and imports with respect to GDP, went up from 16% in 1985-86 to 37% in 2002-03 (Mattoo and Stern (2003)). The highest tariff rate was brought down from 150% in 1991-92 to 30.8% in 2002-03, whilst the average import-weighted tariff was reduced from 72.5% in 1991-92 to 29% in 2002-03 (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)).

These crucial elements of the new export promotion strategy have helped meet the fairly high import contents of many export products and allowed Indian exporters access to the global market place. Coupled with the devaluation of the rupee, the reforms taking place since 1991 have reduced the anti-export bias of Indian industry (Chopra *et al.* (1995)) and thus India has become an increasingly important player in world trade. The simultaneous trade liberalisation and change of exchange rate regime included in the 1991 reforms make India an interesting case study to investigate the extent of exchange

[1] For a detailed discussion of the 1990s trade policy reforms, see Ahluwalia (2002) and Panagariya (2004). Also see Joshi (2003), particularly for a discussion of the management of India's BOP in the 1990s. For the different quantitative impact of trade and exchange rate policy changes, see Table A1 in the Appendix.

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 and implement liberalising reforms.

There are numerous studies examining the pass-through effect. 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 have dealt with smaller countries: South Korea (Athukorala (1991), Yang and Hwang (1994), Lee (1997)), Australia (Menon (1992,(1996)), Switzerland (Gross and Schmitt (1996)), and Ireland (Doyle (2004)). Recently, Frankel et al (2005) have examined the pass-through into import prices of eight selected narrowly defined brand commodities in 76 developing countries, reporting a downward trend in the exchange rate pass-through. Nevertheless, there is limited evidence in the case of developing countries for a broad spectrum of products. In the context of India, Mallick and Marques (2005) being the only study at an aggregated 1-digit level, the present paper thus fills the gap in the literature examining the disaggregated cross-sectional exchange rate pass-through effect at a two-digit industry level for the case of a developing economy.

The phenomenon of incomplete pass-through of exchange rates to trade prices is largely seen in the context of high-income countries. With global integration and trade reforms, this can also be feasible in developing country markets. It is this issue which leads us to examine the extent of transmission of exchange rate changes to India's export prices and whether such pricing behaviour varies across industries. The exchange rate used is a trade-weighted average of nominal bilateral exchange rates against India's main

trading partners[2] that account for the bulk of transactions (NEER). The paper attempts to continue filling the existing gap regarding developing countries, at the same time extending the analysis in several directions. First, the paper provides a sectorally disaggregated analysis of pass-through to 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 using a panel of 2-digit SITC level products. Second, this paper attempts to draw some conclusions on the impact of the 1991 policy reforms, including the change in exchange rate regime, by analysing the pass-through behaviour of Indian exporters in the 1990s relative to the 1980s.

The main findings can be summarised as follows. Compared to the 1980s, in the 1990s the export prices, measured in rupee terms, respond in more sectors, although to a lesser extent, to the rupee's movements against a trade-weighted basket of currencies, after having controlled for the effect of product shares and marginal cost variations. In most sectors, Indian exporters fully pass-through the exchange rate changes, although in a few sectors, exporters appear to adjust their profit margins by changing rupee prices. In those sectors, the relative sensitivity of the foreign currency prices of Indian exports is translated into incomplete pass-through, and it suggests that Indian exporters can, to some extent, manipulate the foreign price of their exports, reflecting a change in pricing behaviour in a liberalised regime.

In this context, the 1990s policy reforms regarding exchange rate regime and faster trade liberalisation have produced fruits. Although it might be to the benefit of Indian exporters to refrain from fully passing through the exchange rate shock to the foreign currency 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, as opposed to the 1980s, when the pegged currency

[2] A total of 36-country bilateral weights of Indian rupee have been used in the index (index base:

regime made the exchange rate relatively sticky and caused substantial currency overvaluation. In addition, relatively higher inflation in the 1980s could explain the exporters' rupee prices rising relatively quickly, and thus leading to the changes in foreign currency export prices. Also, in the 1990s the free float and liberalisation climate increased competition among Indian exporters, who relied less on depreciation to increase their profits and tried instead to gain market share.

The remainder of the paper is organized as follows. Section 2 describes a simple model of exchange rate pass-through into export prices, from which an empirical specification is derived. Section 3 discusses the data and estimation results. A summary and discussion of implications of the findings are provided in Section 4.

2 Analytics of exchange rate pass-through

The study of exchange rate pass-through, defined as the elasticity of import prices to exchange rate changes, goes back to the 1970s (Goldberg and Knetter (1997)). This phenomenon is made possible by imperfect competition and the associated mark-up pricing:[3] when the exchange rate changes, exporters change the price in their own currency to stabilise their export prices in the importer's currency.

In theoretical terms, the phenomenon can be explained through a mark-up model (Knetter (1989,(1993), Gagnon and Knetter (1995)). This model is based on 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. Considering the model in Gagnon and Knetter (1995), we modify it for the case of a representative profit-maximizing exporting firm that

1985=100). For full details, see www.rbi.org.in.

[3] 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.

produces *n* goods for sale in foreign markets.[4] The firm's profits will equal the difference between its revenue and its cost:

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

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).

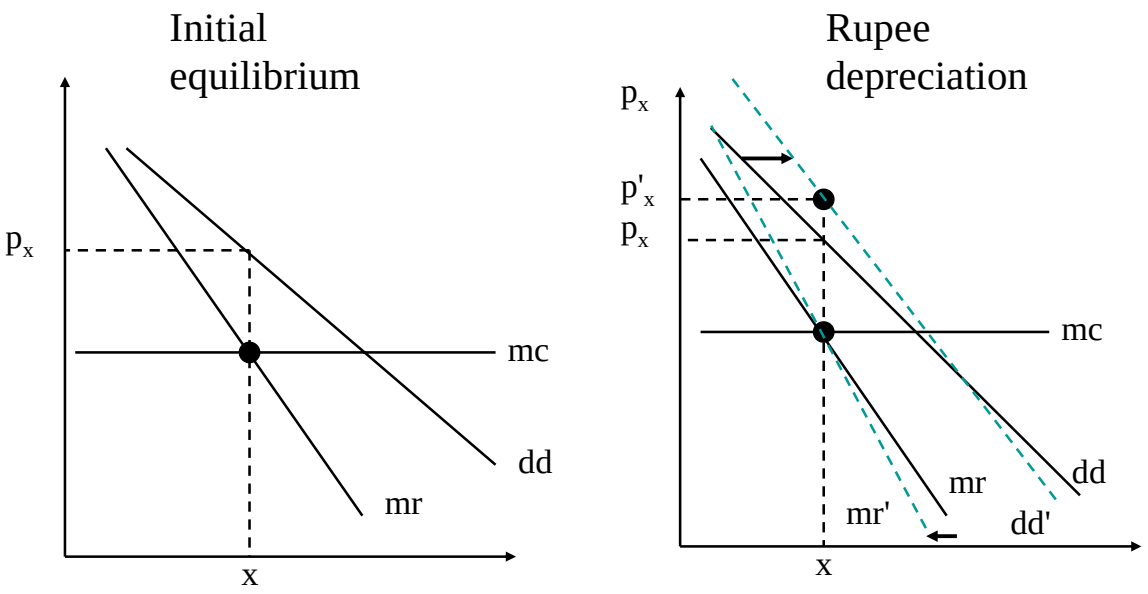
Assume that the firm's external demand changes as the exchange rate changes. To maintain competitiveness, the representative exporter may be constrained to keep the price of its products in its own currency stable despite exchange rate fluctuations. This means that the exporter would maximise its profit 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 (1) with respect to P^x, the following expression is obtained:

$$(2) \qquad P_i^x = MC \left[\frac{\eta_i \left(\frac{P_i^x}{e} \right)}{\eta_i \left(\frac{P_i^x}{e} \right) - 1} \right], i = 1, ..., n$$

where η is the absolute value of the price elasticity of demand in the foreign market. The diagrams in Figure 1, which are built using equation (2), explain the impact of rupee depreciation.

[4] 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 show 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 as in Goldberg and Knetter (1997), who found that pricing-to-market differed more across industries than across countries within the same industry. In this model, it is implicitly assumed that India faces an aggregate foreign price and foreign demand

Figure 1: Exchange rate pass through under imperfect competition



A typical exporting firm sets the price of a good as a constant markup over marginal costs. The linear demand curve 'dd' represents the demand for the exported good as function of its price. Profit maximization requires 'mr' to equal 'mc'. With rupee depreciation, external demand increases and thus price increases as shown in Fig.1 (right panel). As external demand increases, the exporting firm is likely to charge a higher mark-up over its marginal production cost, if products are differentiated under an imperfectly competitive market condition. This means if $\eta_i > 1$, p_x could go up to p_x'. The extent to which this local currency export price will increase is an empirical question and product-specific, as it depends on the respective firm's market share, determining the mark-up. The figure shows that the higher mark-up would result in a smaller decline in foreign currency price, indicating incomplete pass-through.

Using log-linear differentiation, equation (2) can be written as:

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elasticity per product, or that the variation across products is so high that it dwarfs the variation across countries.

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

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

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

where $\delta_i = \frac{\partial \ln \eta_i}{\partial \ln\left(\frac{P_i^x}{e}\right)}\left[1-\eta_i + \frac{\partial \ln \eta_i}{\partial \ln\left(\frac{P_i^x}{e}\right)}\right]^{-1}$ 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. The coefficient δ is a coefficient of pricing-to-market, which can be analysed as a coefficient of pass-through by assuming that exchange rates have no effect on the exporter's cost of production. 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.[5]

It should be noted that, from the exporter's point of view, pass-through is measured only indirectly (Krugman (1987), Giovannini (1988), Knetter (1989), Marston (1990), Kasa (1992), Knetter (1993), Gagnon and Knetter (1995), Goldberg (1995), Knetter (1995)). The dependent variable is the price in the exporter's currency and, assuming marginal costs are independent from the importing markets, it also represents

[5] It should be noted that constant elasticity of demand would imply δ=0. For intermediate values of δ to be possible, it is implicitly assumed that the demand schedule is less convex than a constant elasticity demand schedule. This condition applies to, for example, linear demand, but other functional forms would be possible. In any instance, as long as the demand function is assumed to be less convex than the constant elasticity demand function, the specification of a particular functional form would not have an impact on the empirical model.

the exporter's mark-up. In general, low-income countries are more inflation-prone than high-income countries. As higher inflation could be associated with a lower markup in the long run (see Banerjee and Russell (2001)) and higher inflation is likely to change the marginal production cost, it is important to control for this variable while examining the exchange rate pass-through effect.

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:

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

The coefficient of pass-through to foreign currency is then equal to the coefficient of pass-through to domestic currency minus one. Therefore, as long as mark-ups vary with exchange rates, pass-through will be incomplete.

The pass-through to export prices is a crucial estimate to gauge the pricing behaviour of exporters in different products. The extent of exchange rate pass-through depends on the level of mark-ups and product differentiation, which influence 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 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 selling price to remain competitive, but when a local currency depreciates, exporters may take advantage of this depreciation by

increasing their selling price marginally, still establishing the case of incomplete pass-through as is found in this paper.

3 Evidence for sectoral pass-through effects in India

The unit value indices[6] of exports for a number of sectoral groups are regressed against the rupee NEER so as to investigate the extent of exchange rate pass-through into the unit values of exports (see Appendix 1 for more detail on data sources and definitions). Two control variables are added: the sector's share in total exports[7] and the sector's wholesale price index (WPI) as an approximation for marginal costs.

On the basis of equation (4), the empirical measurement of exchange rate pass-through has been commonly carried out in a panel data framework (Knetter (1994), Gagnon and Knetter (1995), Feenstra *et al.* (1996), Madsen (1998), Goldberg and Knetter (1999)). Some 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. Frankel et al. (2005) find that emerging economies experience a rapid downward trend in the recent years in the degree of short-run pass-through, using a dataset for only 8 narrowly defined brand commodities exported by 76 countries.

This paper focuses solely on India, for a broad spectrum of products at a 2-digit level, looking at the pass-through effects in India's export prices. This paper also uses panel data to estimate the pass-through of exchange rate changes to changes in India's export prices in local currency assuming sector-specific slopes. Referring back to

[6] It is well known that unit values are an imperfect proxy for the true prices of goods and are subject to aggregation bias. Although the results must be interpreted with caution, unit values can be regarded as a first approximation to goods prices.

equation (4), export prices depend on both marginal costs and exchange rates, as well as sector shares in exports. Hence the empirical specification for India's exports of sector *i* in period *t* can be written as follows:

$$(6) \qquad d\ln P_{it}^{x} = \tau + \alpha d\ln S_i + \beta d\ln MC_i + \delta_i d\ln e_t + \varepsilon_{it}$$

where $d\ln P_{it}^{x}$ is the change in the log of export prices in domestic currency (rupees), $d\ln e_t$ is the variation in the log of the NEER exchange rate (an increase indicates depreciation), $d\ln MC_i$ is the change in the log of sectoral producer price indices, and $d\ln S_i$ is the change in the log of sectoral export shares. From equation (5), $\frac{d\ln P^{x*}}{d\ln e} = \delta_i - 1$ with P^{x*} the foreign currency export price.

The degree of pass-through to export prices will be analysed from India's point of view. In the export price equation (6), 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: $\delta=0$ and H_0: $\delta=1$ are rejected, then there is incomplete pass-through in export prices. If neither H_0: $\delta=0$ nor H_0: $\delta=1$ are rejected, no conclusion can be reached as the standard errors of the coefficients are simply too large.

[7] For a detailed explanation of the relationship between pass-through and market share see Feenstra *et al.* (1996). They study the market share of a number of exporters in a number of markets. In the present paper we look at the share of each product in India's total exports. Hence the perspectives differ.

3.1 Did the change in policy regime induce a structural break in pass-through?

The answer is provided by a Chow test for a structural break in the estimated export price equation at an aggregated level.[8] The null of no structural break in 1991 is rejected jointly for slopes and intercepts, although not for slopes only (Table 1). This may indicate that the 1991 reforms had an effect on changes in rupee prices by making the pass-through relationship shift downwards as represented in Figure 2. Given the structural break in 1991, as revealed from the CHOW test, we further carry out the stability test using recursive estimation to obtain the cumulative sum of the squared residuals, which also indicate a break point in the early 1990s (Figure 3). From Table 1, Indian exporters responded to changes in the rupee NEER in the 1990s, but not in the 1980s. Before 1991, foreign prices changed one-to-one with the exchange rate, but after 1991 exchange rate changes were partially compensated by small increases in the rupee price, so that foreign prices changed less than the exchange rate.

Table 1: Chow test (H0: no structural break in 1991)

	1980-1990	*1991-2001*
Exchrate	0.048 (0.297)	0.152** (0.070)
Cons	0.087*** (0.018)	0.021*** (0.007)
Adj R-sq	0.094	
F-test	20.13***	
N obs	735	
Chow test on slopes	0.12	
Chow test on slopes and intercepts	9.70***	

Note: * indicates significance at the 5% level. Standard errors are in parenthesis.

[8] We have run Chow tests for every year of the sample and find structural breaks for exports in the following years at 5% level of significance: 1989, 1990, 1991, 1992, and 1993. However we have chosen to break the sample in 1991 because it is both the median of the break period and because the devaluation of the rupee occurred in 1991.

Figure 2: Structural pass-through relationships before and after the reforms

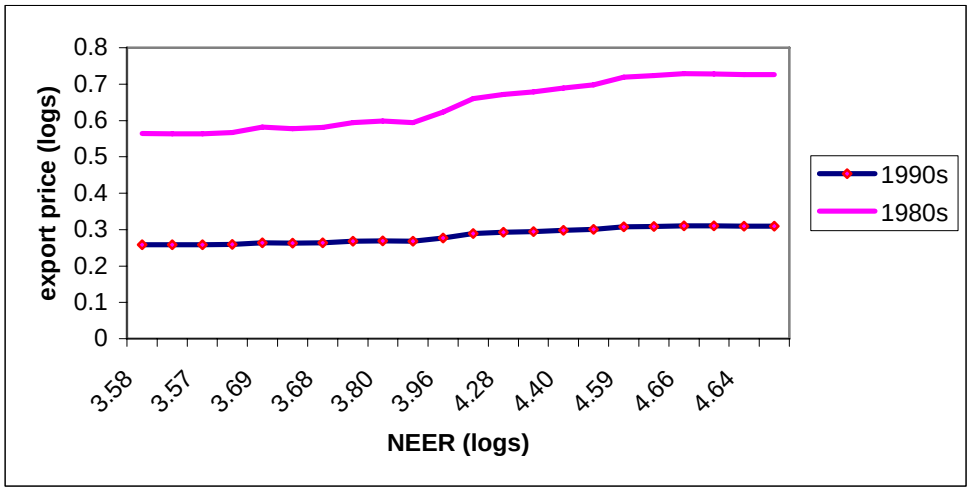
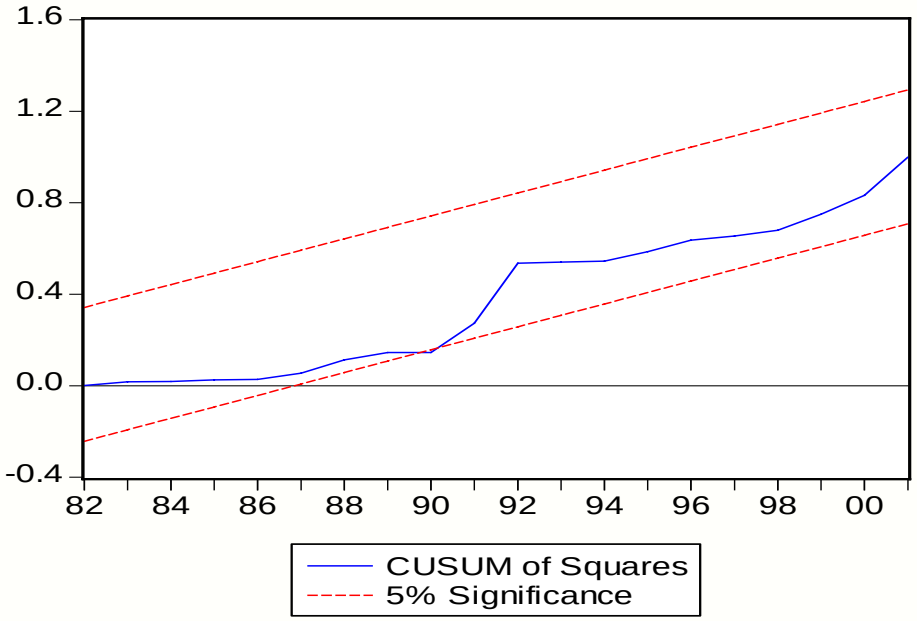


Figure 3: Cumulative sum of squared recursive residuals



3.2 Two-digit sectoral pass-through behaviour

The incomplete pass-through observed in the previous sub-section in the pooled data still holds in the 1990s when we use panel estimation with common sector coefficients (Table 2) and for some sectors when we consider sector-specific coefficients (Table 3). Table 2 shows the pre- and post-1991 regression results for the common pass-through coefficients into export prices for 34 two-digit sectors, including the coefficients

of the two control variables – sector share in total exports and sectoral wholesale price index. During the 1980s, the pass-through coefficient not being significantly different from zero, whether the control variables are used or not, suggests that on average there was full pass-through during the 1980s. In the 1990s, the pass-through coefficient is significantly different from either zero or one, suggesting incomplete pass-through even with the control variables. As these average coefficients present a clear contrast between the pre-reform and the post-reform periods, it is important to present the product-specific pass-through coefficients in order to reflect upon sectoral variations in pass-through.

Table 2: Panel regression results for export prices

	1980-1990	*1991-2001*	*1980-1990*	*1991-2001*
Sector share			0.058* (0.032)	0.033** (0.015)
Marginal cost			0.457** (0.223)	0.293*** (0.094)
Exchrate [1]	0.085††† (0.193)	0.276***††† (0.045)	0.039††† (0.193)	0.178***††† (0.054)
Cons	0.088*** (0.011)	0.016*** (0.004)	0.058*** (0.019)	0.001 (0.007)
N obs	735		714	
Log-likelihood	196.854		203.567	
Wald chi-sq	227.07***		248.38***	

Note: ***, **, * indicate a coefficient significantly different from zero at respectively the 1%, 5%, 10% level. In sectoral pass-through coefficients, †††, ††, † indicate a coefficient significantly different from one at respectively the 1%, 5%, 10% level. Standard errors are in parenthesis. A likelihood-ratio Chi-squared test for panel heteroskedasticity and the Wooldridge (2002) panel autocorrelation test were conducted on exports. 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). The value of the autocorrelation test is 2.651 for exports (p-value 0.1421). All estimates were produced using cross-sectional time-series FGLS with heteroskedastic panels and no autocorrelation.

The results reported in Table 3 show that the sectoral slope coefficients do not significantly differ in the overall time-series or cross-section dimensions. However, for three sectors – cotton articles, transport equipment, and textile yarn – there are significant differences between the 1980s and the 1990s. In all three cases, the rupee price decreased during the 1980s and increased during the 1990s. At the same time, sector shares and producer costs are significant and positive both in the 1980s and in the 1990s. However, although the statistical significance increases after the reforms, the magnitude of the

effect actually decreases. Hence, the reforms may have had mostly a stabilising effect on the export sector by reducing macroeconomic volatility. Within this point, it is also interesting to note the large reduction in standard errors in the 1990s compared to the 1980s.

In the 1980s, the pass-through coefficients of two sectors – cotton articles and transport equipment – are significantly different from zero, suggesting incomplete pass-through during the period. Moreover the hypothesis of no pass-through (unit coefficient) for these sectors is rejected at respectively 5% and 1%. Given that these two coefficients are actually negative, the rupee price was decreasing, in effect reinforcing the depreciation of the rupee. In the other sectors, statistical insignificance of the pass-through coefficients suggests full pass-through to foreign currency prices during this period. In addition, in many cases, the hypothesis of no pass-through (unit coefficient) is rejected. The main reason for the high or full pass-through during the 1980s could be the existence of currency controls and trade barriers that distort market forces and shelter the domestic producers from foreign competition to the extent that they do not tend to change their rupee prices in reaction to external factors, such as exchange rate changes.

A positive pass-through coefficient in Table 3 implies that as the NEER depreciates, the rupee price increases. If this increase is less than proportional to the depreciation, the price in foreign currency declines. Otherwise, the price in foreign currency increases despite the depreciation, which justifies a pricing behaviour that an exporting sector with less concern for market share could enjoy. A negative pass-through coefficient indicates that even with exchange rate depreciation, the rupee price declines, meaning a double source of decrease in foreign currency price.

Table 3: Panel regression results for sectoral export prices

	1980-90	*1991-01*	*Chi-sq (1)*		*1980-90*	*1991-01*	*Chi-sq (1)*
Carpets	0.192 (0.600)	-0.000††† (0.167)	0.10	***Clothes***	0.503 (0.419)	0.275***††† (0.115)	0.28
Cereal	-0.832† (1.139)	0.125††† (0.322)	0.66	***Cotton***	-3.322*†† (1.977)	0.890 (0.559)	4.20**
Coal	0.578 (1.009)	-0.147††† (0.284)	0.48	***Footwear***	0.556 (0.695)	0.398**††† (0.192)	0.05
Coffee	-0.213 (1.276)	-0.172††† (0.359)	0.00	***Ironore***	-0.162††† (0.461)	0.440***††† (0.128)	1.58
Elmach	-0.850 (1.546)	-0.150††† (0.432)	0.19	***Manmet***	-0.382††† (0.575)	0.389***††† (0.160)	1.67
Fish	0.117† (0.504)	0.137††† (0.145)	0.00	***Minerals***	0.736 (1.237)	-0.674**††† (0.347)	1.21
Fruit	0.375 (1.047)	-0.411††† (0.295)	0.52	***Spices***	-0.631† (0.901)	0.411*†† (0.254)	1.24
Ironsteel	0.357 (0.768)	-0.063††† (0.213)	0.28	***Tobacco***	-0.419††† (0.520)	0.425***††† (0.143)	2.45
Leather	0.680 (0.642)	-0.051††† (0.179)	1.20	***Transeq***	-1.708**††† (0.745)	0.362*††† (0.208)	7.16***
Livemat	0.107 (0.896)	0.305††† (0.251)	0.05	***Yarn***	-0.716††† (0.547)	0.258*††† (0.151)	2.94*
Meat	0.131† (0.520)	0.144††† (0.149)	0.00	***Sector share***	0.055* (0.032)	0.036*** (0.015)	
Metals	2.232 (2.617)	-0.371† (0.733)	0.92	***Marginal cost***	0.441** (0.210)	0.339*** (0.090)	
Mixmanuf	-0.550 (2.027)	-0.242†† (0.567)	0.02	***Constant***	-0.060*** (0.018)	0.002 (0.006)	
Nonelmach	1.412 (1.196)	0.253†† (0.334)	0.87	***Chi-sq (2)***	22.24	39.75	
Nonfermet	0.630 (1.932)	-0.017† (0.541)	0.10	***Chi-sq (3)***	62.99		
Nonmetmin	0.741 (0.828)	0.189††† (0.231)	0.41	***N obs***	714		
Oils	-0.288 (0.868)	0.059††† (0.245)	0.15	***Log-likelihood***	233.251		
Othfib	-0.323 (1.227)	0.051††† (0.344)	0.09	***Wald chi-sq***	346.60***		
Othtex	-0.121 (2.382)	-0.939††† (0.667)	0.11				
Sugar	0.167 (1.659)	0.212† (0.468)	0.00				
Tea	0.013 (0.725)	-0.118††† (0.206)	0.03				
Textart	-0.440†† (0.749)	0.192††† (0.208)	0.66				
Veg	0.421 (0.668)	0.063††† (0.190)	0.26				
Wovcot	0.799 (1.060)	0.050††† (0.296)	0.46				

Note: ***, **, * indicate a coefficient significantly different from zero at respectively the 1%, 5%, 10% level. In sectoral pass-through coefficients, †††, ††, † indicate a coefficient significantly different from one at respectively the 1%, 5%, 10% level. Standard errors are in parenthesis. All estimates were produced using cross-sectional time-series FGLS with heteroskedastic panels and no autocorrelation. A likelihood-ratio Chi-squared test for panel heteroskedasticity and the Wooldridge (2002) panel autocorrelation test were conducted on exports. 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). The value of the autocorrelation test is 2.651 for exports (p-value 0.1421). Chi-sq (1): Chi-sq test where H0: equal sector slopes between the two decades. Chi-sq (2): Chi-sq test where H0: equal sector slopes within each sub-period. Chi-sq (3): Chi-sq test where H0: equal sector slopes in the whole period.

In general, in the 1990s there is an increase in the number of sectors whose rupee price changes by less than 1%, implying a fall in foreign currency price. In fact, in the 1990s the pass-through coefficient is less than 1% in all sectors except cotton articles, whereas in the 1980s this happened for only 11 of the 34 sectors in Table 3. In the 1990s, the coefficients of nine sectors – clothes, footwear, iron ore, metal manufactures, minerals, spices, tobacco, transport equipment, and textile yarn – are significantly different from zero (up from only two sectors in the 1980s), implying that incomplete pass-through may be more common during the second sub-period relative to the 1980s. In all these sectors, the coefficients also significantly differ from one, implying that there is pass-through to some extent, although incomplete.

The share of adjustment borne by Indian exporters in these nine sectors in the 1990s is summarised in Table 4. Only in minerals the depreciation is reinforced by a drop in the rupee price. In the other eight sectors, the adjustment is shared, with most of it falling on the foreign currency price.

Table 4: Percentage changes in rupee and foreign currency denominations of export prices given a 10% exchange rate depreciation (1991-2001)

	Rupee	*Foreign price*
Clothes	2.75%	-7.25%
Footwear	3.98%	-6.02%
Iron ore	4.40%	-5.60%
Metallic manufactures	3.89%	-6.11%
Minerals	-6.74%	-16.74%
Spices	4.11%	-5.89%
Tobacco	4.25%	-5.75%
Transport equipment	3.62%	-6.38%
Textile yarn	2.58%	-7.42%

Note: own calculation from the Table 3 coefficients.

From an economic point of view, the post-reform changes in pricing behaviour can also 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, when 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. The finding that pass-through is incomplete for virtually all sectors in the 1990s, against only 11 in the 1980s, confirms that the reforms have influenced the way Indian producers react to exchange rate changes by increasing the extent of competition they face. They tend to react more actively to changes in the economic environment, but at the same time they react more strategically, taking care of maintaining price-competitiveness abroad.

4 Conclusions

This paper examines the responsiveness of Indian export prices 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 in 1991. Based on the panel data of 2-digit SITC sectors over the period from 1980 to 2001, the pass-through of changes in the NEER of the rupee into export prices is often found to be incomplete or imperfect in the 1990s. The results also indicate that there is incomplete pass-through into the foreign currency price of exports for more sectors 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.

Similar to most newly industrialised countries, India is generally held to be 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, in line with the findings for high-income countries in the literature.

Using industry level data enabled us to estimate the extent of pass-through more correctly since the exchange rate could be treated as exogenous to a single industry, which may not be the case at the aggregate macroeconomic level. The Chow and the CUSUM tests validate the prior of a structural break in 1991, reflecting the policy shift regarding the exchange rate and trade regimes that also gave rise to a downward shift in the pass-through relationship. The consequence was a rise in the number of sectors showing an incomplete pass-through in the 1990s.

Specifically, in the liberalised 1990s, Indian exporters pass-through some, but not all, exchange rate changes to foreign currency prices in all but one industry (cotton products), as opposed to 11 in the 1980s. This implies that after the liberalisation, Indian exporters have gained sufficient pricing power to change their rupee price so that they can to some extent manipulate the change in the foreign currency price of their exports when the exchange rate changes. However, in most sectors, Indian exporters still do not change their rupee price at all, as the exporters do not have the pricing power to manipulate the foreign currency price of their exports. This is the case in 32 sectors in the 1980s and in 25 sectors in the 1990s.

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, located in the sectors that represent a higher share of exports. The impact of policy choices on different types of sectors may be a lesson to other developing countries currently globalising their economies.

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Appendix 1

Table A1: Impact of Trade liberalisation in India (in %)

	1974-1979	1980-1989	1990-1995	1996-2001
Trade (% of GDP)	13.3	14.1	19.2	26.7
Import Duty (% of total imports)	29.9	45.8	38.3	24.8
Export Duty (% of total exports)	2.7	0.8	0.2	0.2
Exchange rate Depreciation	-0.5%	-6.8%	-10.4%	-5.7%
Import prices (% change)		6.9	7.7	5.9
Import volume (% change)		7.5	15.1	6.2
Export prices (% change)		11.1	10.1	4.3
Export Volume (% change)		5.4	14.3	7.9

Source: Calculated with Data from WDI, World Bank; and Datastream
Note: Trade as % of GDP for the last column includes data upto 2003

Data Sources and Definitions

The unit value indices of imports and exports for a number of sectoral groups, the rupee NEER (Nominal effective exchange rate), and the wholesale price indices (sectoral producer price index corresponds to different components of wholesale price index), 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. Financial year (annual average) data are used in this paper. Export value indices for the two-digit products are calculated by multiplying the quantity index with unit value index, and with base year values in local currency for the respective product, the sectoral value indices are converted to local currency units and the product shares are then derived.

The NEER is calculated as a weighted geometric average of the bilateral nominal exchange rates of the Indian rupee in terms of foreign currencies. Here it measures the appreciation/depreciation of rupee against the weighted basket of 36 currencies whose countries are the main trading partners or competitors of India. The formula is:

$$NEER = \prod_{i=1}^{36} \left(e_{i,INR}\right)^{w_i}$$

where e_i: exchange rate of the rupee against the currency of the trading partner 'i', i.e., rupee per currency i (in index form); w_i: 36-country bilateral trade weights attached to currency/country i in the index.

Data on exports, which include re-exports, relate to free on board (f.o.b.) values and imports relate to cost, insurance and freight (c.i.f.) values. All the data is annual. The codes and definition of the 2-digit SITC (Rev. 2) sectors are as follows:

Code	*Description*	*SITC Rev2 Code*
MEAT	FOOD & FOOD ARTICLES: MEAT & MEAT PREPARATIONS	01
FISH	FOOD & FOOD ARTICLES: FISH & FISH PREPARATIONS	03
CEREAL	FOOD & FOOD ARTICLES: CEREALS & CEREAL PREPARATIONS	04
VEG	FOOD & FOOD ARTICLES: VEGETABLES	054+056
FRUIT	FOOD & FOOD ARTICLES: FRUITS & NUTS	057
SUGAR	FOOD & FOOD ARTICLES: SUGAR	06
COFFEE	FOOD & FOOD ARTICLES: COFFEE	071
TEA	FOOD & FOOD ARTICLES: TEA	074
SPICES	FOOD & FOOD ARTICLES: SPICES	075
OILS	FOOD & FOOD ARTICLES: OILSEED CAKE	0813
TOBACCO	BEVERAGES & TOBACCO: TOBACCO & TOBACCO MANUFACTURES	12
COTTON	CRUDE MATERIALS, INEDIBLE, EXCEPT FUELS: RAW COTTON	263
OTH FIB	CRUDE MATERIALS, INEDIBLE, EXCEPT FUELS: TEXTILE FIBRES & WASTE EXCL. COTTON	26-263
MINERALS	CRUDE MATERIALS, INEDIBLE, EXCEPT FUELS: MINERALS (EXCL. COAL, PETROLEUM, CRUDE FERTILISERS, SULPHUR & PRECIOUS STONES)	27-272
IRONORE	CRUDE MATERIALS, INEDIBLE, EXCEPT FUEL: IRON ORE & CONCENTRATES	281
METALS	CRUDE MATERIALS, INEDIBLE, EXCEPT FUEL: ORES & CONCENTRATES OF BASE METALS N.E.S.	287
LIVEMAT	CRUDE MATERIALS, INEDIBLE, EXCEPT FUELS: CRUDE ANIMALS & VEGETABLES MATERIAL N.E.S.	29
COAL	MINERAL FUELS, LUBRICANTS, ETC.: COAL	32
LEATHER	MANUFACTURED GOODS CLASSIFIED CHIEFLY BY MATERIAL: LEATHER & LEATHER MANUFACTURES EXCL. FOOTWEAR	61
YARN	MANUFACTURED GOODS CLASSIFIED CHIEFLY BY MATERIAL: TEXTILE YARN	651
WOVCOT	MANUFACTURED GOODS CLASSIFIED CHIEFLY BY MATERIAL: COTTON FABRICS WOVEN	652
OTHTEX	MANUFACTURED GOODS CLASSIFIED CHIEFLY BY MATERIAL: TEXTILE FIBRES OTHER THEN COTTON	653+654+655 +656+657
TEXTART	MANUFACTURED GOODS CLASSIFIED CHIEFLY BY MATERIAL: MADE-UP ARTICLES OF TEXTILE MATERIALS	658
CARPETS	MANUFACTURED GOODS CLASSIFIED CHIEFLY BY MATERIAL: FLOOR COVERINGS	659
NONMETMIN	MANUFACTURED GOODS CLASSIFIED CHIEFLY BY MATERIAL: NON-METALIC MINERAL MANUFACTURES N.E.S.	66
IRONSTEEL	MANUFACTURED GOODS CLASSIFIED CHIEFLY BY MATERIAL: IRON & STEEL	67
NONFERMET	MANUFACTURED GOODS CLASSIFIED CHIEFLY BY MATERIAL: NON-FERROUS METALS	68
MANMET	MANUFACTURED GOODS CLASSIFIED CHIEFLY BY MATERIAL: MANUFACTURES OF METALS	69
NONELMACH	MACHINERY & TRANSPORT EQUIPMENT: NON-ELECTRICAL MACHINERY	711+712 +713+714
ELMACH	MACHINERY & TRANSPORT EQUIPMENT: ELECTRICAL MACHINERY	77
TRANSEQ	MACHINERY & TRANSPORT EQUIPMENT: TRANSPORT EQUIPMENT	79
CLOTHES	MISCELLANEOUS MANUFACTURED ARTICLES: ARTICLES OF APPAREL & CLOTHING ACCESSORIES	84
FOOTWEAR	MISCELLANEOUS MANUFACTURED ARTICLES: FOOTWEAR	85
MIXMANUF	MISCELLANEOUS MANUFACTURED ARTICLES: MISCELLANEOUS MANUFACTURED ARTICLES N.E.S.	89

A full description of the SITC codes can be found at http://www.census.gov/foreign-trade/reference/codes/sitc/sitc.txt.