Queen Mary
University of London

Centre for Globalization Research
School of Business and Management

Pass-through of Exchange Rate and Tariffs into Import Prices of India: Currency Depreciation versus Import Liberalization

CGR Working Paper 3 (September 2007)

Sushanta Mallick and Helena Marques

Abstract

This paper examines the extent of pass-through of exchange rate and tariff changes into import prices using sectoral panel data (at the 2-digit SITC level) for the post-reform period in India (1990-2001). After having controlled for unobserved effects that might have an impact on the import prices by using sector dummies, we find that on average exchange rate pass-through (ERPT) is a dominant effect compared to tariff rate pass-through (TRPT) in explaining changes in India's import prices. The sectoral panel results suggest that the pass-through of exchange rates and tariff rates varies across products. ERPT into import prices is significant in 12 industries, whereas TRPT is significant only in 6 industries, with full pass-through. However, ERPT is incomplete only in 4 industries, but TRPT is incomplete in 36 industries, which means that firms exporting to India more frequently adopt strategies to maintain their market share against tariffs than against exchange rate changes. The sectoral differences in pass-through seem to be related to the sector's share in total imports and the sector's effective protection rate. Hence India's relatively high levels of protection have an impact on the behaviour of foreign exporters.

Keywords: import tariffs and exchange rate in India, sectoral imports, effective protection

JEL Classification: F14, F31

Contact details: Sushanta Mallick (Queen Mary, University of London) s.k.mallick@qmul.ac.uk; **Helena Marques** (Loughborough University) H.I.Marques@lboro.ac.uk

CGR Working Paper Series

Pass-through of exchange rate and tariffs into import prices of India: Currency depreciation versus import liberalisation*

Sushanta Mallick and Helena Marques

Introduction

In recent years, the growing global external imbalances have motivated renewed interest to investigate the link between changes in a country's exchange rate and the prices of traded goods – the so-called exchange rate pass-through (ERPT) relationship.[1] This becomes even more important in emerging market economies undergoing trade liberalisation and adopting floating exchange rate systems, which seem to have revitalised the potential impacts of exchange rate movements on traded goods prices. Given its implications for a country's terms of trade, the evidence on pass-through allows an understanding of trade imbalances between developed and emerging market economies. Besides, the degree of ERPT is also critical for the assessment of monetary rules (Devereux *et al.* (2006)), as changes in exchange rate can lead to a rise in import prices and thus spur overall inflation. Furthermore, the response of local-currency prices

* We have benefited from comments and suggestions by participants at Eastern Economic Association Annual meetings (New York, February 2007), the European Economics and Finance Society Annual Conference (Crete, Greece, May 2006), International Conference on Macroeconomic Analysis and International Finance (University of Crete, May 2006), International Atlantic Economic Conference (New York, October 2005), European Economic Association Annual Congress (Amsterdam, August 2005), Royal Economic Society Annual Conference (University of Nottingham, April 2005). Also thanks are due to seminar participants at the Leverhulme Centre for Research on Globalisation and Economic Policy (University of Nottingham), Joint Development Economics seminar at IDPM and Economics Department (University of Manchester), Loughborough and Keele Universities, Institute of Economic Growth (Delhi), University of Hyderabad, Institute for Social and Economic Change and ICFAI Business School (Bangalore), and Academic Staff College (Jawaharlal Nehru University, New Delhi). We are grateful for the useful comments of Robin Bladen-Howell, Huw Edwards, Ben Ferrett, Subrata Ghatak, David Greenaway, Jong-Hee Hahn, Chris Milner, Theo Panagiotidis, Eric Pentecost, Daniel Seidmann, and Kunal Sen. The usual caveat applies.

[1] ERPT is the percentage change in local currency import prices resulting from a one percent change in the exchange rate between the exporting and importing countries.

of imported products to changes in exchange rate may not be one-for-one, as has been debated in the case of many advanced markets.

India's move to a flexible exchange rate allowed gradual exchange rate depreciation to offset the effects of import liberalisation and tariff reduction (Ahluwalia (2006)). This suggests that significant currency depreciation was needed to reduce import demand following import liberalisation.[2] A relatively weak linkage between exchange rate and import prices seems to be indicating a low level of pass-through, which requires a closer investigation of the pricing behaviour of foreign exporters. Also, more flexible exchange rate regimes may neutralize the impact of any terms of trade shocks on the current account (see Broda (2004)). Although India liberalized its imports by means of lower tariff barriers and elimination of quantitative restrictions, there are still sizeable restrictions, including other non-tariff barriers (NTBs) to imports[3], which may diminish the ability of the flexible exchange rate regime to neutralize the terms of trade shocks. The simultaneous trade liberalisation and change of exchange rate regime included in the 1990s reforms thus makes India an interesting case study to investigate the relative contribution of exchange rate depreciation and reduction of trade barriers to the determination of import prices. Besides, India may serve as an example to other developing countries that are trying to internationalise their economies and implement liberalising reforms.

In this paper we are particularly interested in assessing the relative importance of

[2] Between 1990-91 and 2001-02, the rupee depreciated at an average annual rate of over 8%, whereas the local currency import prices increased at an annual average rate of 6.8% during the same period.

[3] 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)).

ERPT and tariff rate pass-through (TRPT) into sectoral import prices following the balance of payments (BOP) crisis in 1991 and the consequent trade liberalisation and introduction of a flexible exchange rate regime in India.[4] We further investigate whether ERPT and TRPT are more pronounced in some sectors, after having controlled for a range of unobserved factors captured through sector-specific dummies.[5]

Existing empirical evidence shows that the deviations from the law of one price[6] are large and persistent, and the phenomenon of ERPT is country- and even product-specific (Athukorala and Menon (1994), Bleaney (1997), Feenstra (1989), Froot and Klemperer (1989), Gagnon and Knetter (1995), Goldberg (1995), Hooper and Mann (1989), Kim (1990), Knetter (1989, (1994), Koch and Rosensweig (1992), Parsley (1993), Tange (1997), Yang (1997, (1998)). However, most of the existing studies have looked at the behaviour of firms in larger high-income countries, either US importers, or Japanese and German exporters practicing pricing-to-market. Overall, these studies 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. A second generation of studies has dealt with smaller countries: South Korea (Athukorala (1991), Lee (1997), Yang and Hwang (1994)), Australia (Menon (1992, (1996)), Switzerland (Gross and Schmitt (1996)), and Ireland (Doyle (2004)). With global integration and trade reforms, incomplete pass-through can also be feasible

[4] These reforms included devaluation of the rupee vis-à-vis the USD subsequently leading to a free float regime. For a detailed discussion of the 1990s trade policy reforms, see Ahluwalia (2002) and Panagariya (2005). Also see Joshi (2003), particularly for a discussion of the management of India's BOP in the 1990s.

[5] Similarly to ERPT, TRPT is the percentage change in local currency import prices resulting from a one percent change in the tariff rate between the exporting and importing countries.

[6] See Taylor (2003) for a review on purchasing power parity with reference to the literature of the last two decades.

in emerging markets.[7] Recently, Frankel *et al.* (2005) have examined the pass-through into import prices of eight selected narrowly defined brand commodities exported by 76 developing countries, reporting a downward trend in ERPT. Nevertheless, there is limited evidence in the case of developing countries for a broad spectrum of products. Besides, there are only two studies in the literature that discuss both TRPT and ERPT (Feenstra (1989), Menon (1996)).

The present paper thus fills a gap in the literature: first, by examining the disaggregated sectoral ERPT effect using a panel of 2-digit SITC level products for India as an emerging market economy during 1990-2001; second, comparing the relative impact of TRPT and ERPT, which becomes crucial to reflect the variation in pricing behaviour across industries and whether such variation would be indicative of any form of non-tariff barriers still in place. The main findings can be summarised as follows. In the traditional framework of the law of one price and perfect competition, foreign exporters would fully pass-through the exchange rate changes. In the case of India as a developing country, we show that there is a significant degree of pass-through of the rupee's movements against a trade-weighted basket of currencies to the local currency prices of the Indian importers. The exchange rate used is a trade-weighted average of nominal bilateral exchange rates against India's main trading partners[8] that account for the bulk of transactions (NEER). Compared to ERPT, TRPT is significant less often (5 against 12 sectors), but incomplete more often (35 against 4 sectors). These results hold after having controlled for unobserved effects using industry-specific dummies. In 34

[7] See Mallick and Marques (2006), which is the only previous study on Indian ERPT at the sectoral level (SITC 1-digit). This study compares ERPT in India's export and import prices before and after the introduction of the 1991 reform package.

[8] A total of 36-country bilateral weights of Indian rupee have been used in the index (index base: 1985=100). For full details, see www.rbi.org.in.

sectors foreign exporters completely pass-through the exchange rate changes, but in 36 sectors exporters absorb tariff changes to varying degrees. Although it might be to the benefit of foreign exporters to refrain from fully passing through exchange rate shocks to the local currency price of Indian imports, their reaction is sector-specific. The results suggest that foreign exporters can, to some extent, manipulate the foreign price of their exports, but they react more to tariffs than to exchange rates. In other words, foreign exporters appear to adjust their profit margins to tariff rates by changing prices in their own currency, and the relative sensitivity of the foreign currency prices is translated into incomplete pass-through.

The remainder of the paper is organized as follows. Section 2 describes a simple model of ERPT into import prices in the presence of tariffs, from which an empirical specification is derived. Section 3 discusses the data and model specification. The estimation results are presented in Section 4, with alternative explanations for the sectoral pass-through variation in Section 5. A summary and discussion of implications of the findings are provided in Section 6.

A conceptual framework of exchange rate pass-through with tariffs

The study of ERPT, defined as the elasticity of import prices induced by a change in the exchange rate, goes back to the 1970s (see, for example, the survey in Goldberg and Knetter (1997)). Empirical studies have provided substantial evidence of incomplete ERPT (see Menon (1995), for an earlier survey). This phenomenon is made possible by imperfect competition and the associated mark-up pricing: when the exchange rate changes, exporters change the price in their own currency to stabilise their export prices in the importer's currency. This exporter pricing behaviour framework is our starting point in order to examine ERPT into import prices. In theoretical terms, the phenomenon

can be explained through a mark-up model (Campa and Goldberg (2005), Gagnon and Knetter (1995)). This model is based on the definition of the price of exports in foreign currency as the product of marginal cost and a mark-up. The firm's profits will equal the difference between its revenue and its cost:

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

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 (price in exporter's currency) relative to the price level in the destination market, e is the exchange rate defined as the domestic currency (e.g., rupee) price of foreign currency (e.g., USD). T is the unit tariff rate.

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:

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

where η is the absolute value of the price elasticity of demand in the foreign market. A typical exporting firm sets the price of a good as a constant mark-up over marginal costs. 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 $0 < \eta_i < 1$, the foreign currency export price

could go up or remain stable via mark-up adjustment. The extent to which the local currency import price will increase is an empirical question and product-specific. Lowering mark-up, as a function of exchange rate, would result in little increase in local currency import price, indicating incomplete pass-through. Using log-linear differentiation, equation (2) can be written as:

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

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

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

where $\delta_i = \frac{\partial \ln \eta_i}{\partial \ln\left(e(1+T)P_i^x\right)}\left[\eta_i - 1 + \frac{\partial \ln \eta_i}{\partial \ln\left(e(1+T)P_i^x\right)}\right]^{-1}$ is a function of both the level and the elasticity of η_i. The coefficient δ is a coefficient of pricing-to-market and influences both ERPT and TRPT. When the exchange rate or tariff rate elasticity of the export price (δ) is zero, there is complete pass-through with both the demand elasticity for exports and the marginal costs constant. If neither the export demand elasticity nor the marginal cost of production is constant, the elasticity of the export price will range between 0 and 1. If δ=1, exporters fully absorb exchange rate changes and no pass-through to importing currency prices will take place, in which case the demand elasticity of exports is unitary (η=1).

The dependent variable is the price in the exporter's currency and, assuming marginal costs are independent from the importing markets, it represents the exporter's mark-up. The relationship between foreign currency export prices (P^x) and domestic currency import prices (P^m) can be written as: $P^m = eP^x$. This means the import prices

for any country are a transformation of the export prices of that country's trading partners using the exchange rate. Taking logs and differentiating:

(5) $d \ln P^m = d \ln e + d \ln P^x$.

Substituting (4) in (5), the equation to be estimated can be written as follows:

(6) $d \ln P_{it}^m = \tau_i + (1-\delta_i) d \ln e_t + \beta_i d \ln T_{it}$.

where $\tau_i = (1-\delta_i) d \ln MC_i$ is a sector-specific term[9], $1-\delta_i$ is the ERPT coefficient and $\beta_i = -\delta_i \frac{T}{1+T}$ is the TRPT coefficient.

Equation (6) suggests that a depreciation of the rupee (increase in *e*) must result in a rise in India's import prices, of the same magnitude, unless there is a decline in the foreign producer prices via reduction in mark-up (δ). So the ERPT coefficient is going to depend on the mark-up parameter (δ), and as long as mark-ups vary with exchange rates, pass-through will be incomplete. If δ=0, producer currency pricing (full pass-through) takes place; if δ=1, local currency-pricing occurs and the exporters absorb the exchange rate changes in their own mark-ups (see Campa and Goldberg (2005) for a similar interpretation). Between the two extremes, there is the possibility of incomplete pass-through. On the other hand, with tariff reduction in the context of trade liberalisation, import prices will decrease by the same percentage if the foreign producers do not adjust their mark-ups. Note that the TRPT coefficient (β) will be zero with either free trade (zero tariffs) or full ERPT (δ=0).[10] In India's context, tariffs tend to be very high and so

[9] The term τ_i becomes a sector-specific term, as it is assumed that marginal costs are constant over time.

[10] On the other hand, one would expect import liberalization (tariff cuts in a large number of sectors) to substantially raise the import demand causing depreciation of Indian currency. Therefore a part of ERPT may be due to tariff cuts. In other words, instead of passing on the advantage of lower tariffs to the Indian

β will be close to one independent of the degree of ERPT. If foreign exporters were to react to tariff reductions, they would have the opportunity of increasing their mark-ups, thus partially offsetting the tariff reduction. They might however have an interest in keeping their prices constant to maintain competitiveness. What we may find in the case of India is an empirical question. [11]

The pass-through coefficients are crucial estimates to gauge the pricing behaviour of exporters in different products. The extent of ERPT and TRPT 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. Exchange rates and tariffs influence mark-ups and thus export prices. In turn, industry-specific characteristics, namely production differentiation, market shares, and economies of scale are important determinants of the degree of ERPT and TRPT into import prices of the exporters' destination market.[12]

---

consumers the foreign exporters absorb a part of the increase in the import cost caused by currency depreciation that results from trade liberalization.

[11] From equation (4), when η is larger (or smaller) than unity and $\delta_i > 1$, the sign of the numerator of the δ function is positive (or negative). If η is smaller (or larger) than unity and $0 < \delta_i < 1$, the sign of the numerator of the δ function is negative (or positive). Thus the exact sign of exchange rate coefficient is indeed an empirical question.

[12] It is also possible that the ERPT could depend on forward contracts. But due to the fact that India did not have a well-developed forward FX market until the late 1990s, it is hard to investigate the influence of forward rates for the time span used in this paper (1990-2001).

Data and Empirical Framework

The unit value indices of imports for a number of sectoral groups are regressed against the rupee NEER and the tariff rates so as to investigate the relative contribution of exchange rate depreciation and tariff reduction into changes in the unit values of imports. If foreign firms exporting to India price to market when the exchange rate or tariffs change, such pricing behaviour will be reflected in the import prices measured in rupees as partial or incomplete pass-through. To test this, we use a sample of 38 2-digit level SITC (standard international trade classification) products in the period 1990-2001. The detailed definitions and sources of variables are listed in the Appendix.

It should be noted that, in spite of the extensive reforms undertaken by India during the 1990s, the country remains very protectionist in terms of international standards. The simple average of tariff rates within each of the 38 2-digit sectors used in this paper had declined from 213% in 1990 to 127% in 2001. Although this represents substantial liberalisation, the average tariff level is still very high in India. On the other hand, in 2001 there was substantial variation across sectors, with tariff rates ranging from a maximum of 210% in Beverages and Organic Chemicals to a minimum of 0% in Cereals, Crude Fertilisers, Pharmaceuticals, Metalworking and Electrical Machinery, Scientific and Photographic Instruments.

The role of each sector's share in total imports is important in the context of India, as the composition of India's import structure has been changing since the start of the reforms (Table 1). One of the main characteristics of a developing country is its dependency on intermediate goods. However, during the reform period there was a shift from Petrol into Crude, indicating that India has developed refining capacity. The decrease in importance of Iron & Steel in total imports also highlights the industrialisation effort associated with the reforms.

[Table 1 here]

The empirical measurement of ERPT has been commonly carried out in a panel data framework (Feenstra *et al.* (1996), Gagnon and Knetter (1995), Goldberg and Knetter (1999), Knetter (1994), Madsen (1998)). Referring back to equation (6), import prices depend on tariffs and exchange rates, as well as on sector-specific factors. Hence the empirical specification for India's imports of sector *i* in period *t* can be written as follows:

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

where $d \ln P_{it}^{m}$ is the change in the log of import prices in domestic currency (rupees), $d \ln e_t$ is the variation in the log of the NEER exchange rate (an increase indicates depreciation), $d \ln T_i$ is the change in the log of the tariff rate, τ is the industry-specific dummy variable, and the error term, ε, is assumed to be independently and identically distributed. The degree of pass-through to import prices will be analysed from India's point of view. In the import price equation (7), if β=0 or μ=0 (β=1 or μ=1), there is no (complete) pass-through into India's import prices as the rupee price of *imports* does not change (changes one-to-one) with the tariff rate or the exchange rate. If both β and δ are strictly between 0 and 1, then there is incomplete pass-through to import prices.

In order to validate the first differences theoretical specification in equation (6) for our sample, we test the integration order of each variable in the panel. For this purpose, we use the tests provided by Levin *et al.* (2002) and Im *et al.* (2003). All the variables are non-stationary in levels in Model 2 (see Table 2), as the null hypothesis of a unit root is not rejected, and thus the variables are used in first differences, with which we obtain a stationary panel.

[Table 2 here]

Evidence for sectoral pass-through effects in India

Tables 3 and 4 show the regression results for 1990-2001 using panel estimation with common sector coefficients (Table 3) and considering sector-specific coefficients (Table 4). The dependent variable in both cases is the annual change in import prices for 38 two-digit sectors. The TRPT coefficient is not significantly different from zero, which suggests that on average there was no TRPT into import prices. That is, although tariffs were reduced, this liberalisation was matched by foreign exporters increasing prices in their own currency, and consequently rupee import prices did not benefit from the liberalisation. The ERPT coefficient is significantly different from zero, but we cannot reject that rupee prices changed one-to-one with the exchange rate, so that foreign exporter prices may have been kept constant, suggesting complete ERPT. This means that Indian import prices responded to changes in the rupee NEER, but not to changes in the tariff rates, because foreign exporters were more responsive to liberalisation than to depreciation.

We also test for symmetry and homogeneity of the exchange rate and tariff rate coefficients. The nulls of these tests are respectively, the two coefficients being equal, and the sum of the two coefficients being one. The symmetry test confirms that on average import prices react differently to exchange rates and tariff rates. However, the null of the homogeneity test cannot be rejected, so that on average there could be full joint pass-through of exchange rates and tariffs into import prices. This is due to ERPT being very close to one and TRPT being very close to zero.

[Table 3 here]

We now want to look at sectoral differences in ERPT and TRPT. As expected, a positive pass-through coefficient in Table 4 implies that the rupee price of imports increases with exchange-rate depreciation and decreases with tariff reduction. If the

positive pass-through coefficient is lower than one, the rupee price change is less than proportional to the exchange-rate depreciation or to the tariff reduction, so the price in foreign currency must have changed reflecting foreign firms 'pricing to market' adjusting their mark-up according to the destination market conditions. Also incomplete pass-through may depend on the local market conditions, contingent on the extent of competition an importing firm faces in the local market, its market share, and the extent to which the product is differentiated from similar products. For example, a foreign firm that is attempting to increase its share of the Indian market may pass-through much of the change in the exchange rate when the rupee is appreciating, but the same firm will resist when the rupee is depreciating in an effort to maintain its market share. In a developing country where the exchange rate depreciates more often than it appreciates, one would expect a constant or declining foreign currency price that might explain why in some leading import sectors there is incomplete pass-through. If there are import restrictions or high tariffs, then the mark-up adjustment due to change in exchange rate may not help in this regard. Thus it is important to look at ERPT and TRPT simultaneously.

The ERPT coefficient is significantly positive in 12 sectors, out of which only in Specialised Machinery the coefficient is significantly different from one (1.42%). Hence in this sector foreign exporters increase their prices by 42% of the exchange rate depreciation, forcing an increase in the rupee price that is 42% above the exchange rate depreciation. This result can be understood in light of India's dependence on machinery to bolster rapid growth in the 1990s. As a result, foreign exporters have a high degree of market power. In the other 11 sectors showing significant ERPT, we cannot reject full pass-through, that is, rupee import prices change one-to-one with the exchange rate. Along the lines of Dixit (1989), this result suggests that there is active entry and exit of foreign firms in the 11 sectors where we cannot reject full pass-through, whereas foreign

firms neither enter nor exit in the remaining sectors where we cannot reject no pass-through.

The TRPT coefficient is significant in 6 sectors, out of which only in Metalworking Machinery it is not significantly different from one, meaning that in this sector there is full pass-through of tariff reductions, with the import prices being reduced proportionately. In three other sectors - Nickel, Fruits and Nonferrous Metals – rupee import prices decrease by respectively 12%, 18% and 40% of the tariff cut. Hence the rupee price of imports has partly reacted to trade liberalisation in these sectors, meaning that foreign exporters increased their foreign currency price by respectively 88%, 82% and 60% of the tariff cut. The consequence is that the impact on the price paid by consumers is not as large as otherwise it could be and trade liberalisation benefits the exporters by allowing them to increase their prices, still benefiting from some reduction in the rupee price. In this case, the foreign exporters benefit relatively more than Indian consumers. There are also two sectors – Beverages and Other Fibers – with negative and significant TRPT. In these sectors, rupee import prices actually increase by respectively 5% and 20% of the tariff cut. This is because foreign exporters increase their foreign currency prices by the same proportion of the tariff cut, which could be due to an inelastic demand in these two sectors helping the foreign exporters to exploit the tariff cuts to increase their prices. Non-tariff barriers may contribute to the incomplete ERPT.[13]

[Table 4 here]

The results reported in Table 4 show that the sectoral slope coefficients significantly differ for TRPT but not for ERPT. We also repeat the symmetry and

[13] If foreign exporters are able to extract rents as a result of a quota, a depreciation of the importer's currency should only have the effect of reducing the rent component of the good's price and not increase the price itself, so long as the quota remains binding (Steel and King (2004)).

homogeneity tests for each sector in Table 4. The symmetry test fails in 12 sectors which have significant ERPT, but no TRPT.[14] Only four sectors fail the homogeneity test: Beverages, Petrol, Electrical and Specialised Machinery. These are the four sectors for which we could reject full ERPT and full TRPT. The homogeneity condition is satisfied when at least one of the coefficients is statistically equal to one and the condition fails only when both coefficients are statistically different from one.

The regression results in Tables 3 and 4 implicitly assume that India's imports are invoiced in a variety of currencies. However, it seems reasonable to presume that a large proportion of imports is invoiced in USD. In the absence of detailed customs data on invoice currencies, we can take the extreme assumption that all of India's imports are invoiced in USD. In order to check the robustness of the NEER regression results to the use of the USD as the only invoice currency, we replicated the regressions of Tables 3 and 4 replacing the NEER with the bilateral rupee/USD exchange rate.[15] The only qualitative change occurring in Table 3 is that we reject that the ERPT coefficient for the USD is equal to one, whilst we could not reject that hypothesis for the NEER. With respect to Table 4, only 11 sectors out of 38 are affected by either gaining or losing significance (9 with respect to ERPT and 2 with respect to TRPT).[16] We then replicated

[14] Except Other Fibers, this has a significantly positive ERPT but a significantly negative tariff pass-through. These two coefficients do significantly differ.

[15] The full results are available from the authors upon request.

[16] In detail, the ERPT coefficient in Iron & steel, Organic chemicals and Pharmaceuticals is no longer significantly different from zero, whilst it becomes significantly different from zero in Cereal and Metalworking machinery; it is no longer significantly different from one in Specialised machinery, whilst it becomes significantly different from one in Scientific instruments and Tin. In turn, the TRPT coefficient in Fruit is no longer significantly different from zero, whilst it becomes significantly different from zero in Petrol.

the regressions of Table 3 removing those 11 sectors from the sample and verified that the previous results for the USD remain qualitatively the same, possibly because the sectoral changes cancel out one another. As a consequence, we can conclude that in general, the higher the proportion of India's imports invoiced in USD, the more likely it is that ERPT is incomplete. However, as not all transactions are invoiced in USD, the NEER results stand as being more general than the USD results.

Searching for explanations in the sectoral pass-through variation

The literature has documented that the degree of ERPT is in general low (see Engel (2002)). This observation is in line with our Table 4 results, where rupee import prices react to exchange rate and tariff changes in respectively 12 and 6 sectors out of 38, and remain unchanged in the rest of the sectors. However there is still disagreement in the literature regarding the causes of low pass-through. Some authors argue that the explanation is microeconomic, based on structural features of international trade, such as pricing-to-market by imperfectly competitive firms (Corsetti and Dedola (2005)), domestic content in the distribution of traded goods (Burstein *et al.* (2003)), the importance of non-traded goods in consumption, or the role of substitution between goods in response to exchange rate changes (Burstein *et al.* (2005)). It has also been shown that the degree of pass-through increases with the exporter's share in the destination market (Feenstra *et al.* (1996)) and with the extent of entry and exit of foreign firms in an industry (Dixit (1989)). Other authors argue that the failure of pass-through is mostly a macroeconomic phenomenon related to the slow adjustment of goods prices at the consumer level (Engel (2002)) or motivated by macroeconomic policy reforms, for example, monetary policy (Taylor (2000)). Campa and Goldberg (2002) provide evidence for OECD countries that both macro and microeconomic factors are important

in the evolution of ERPT estimates over time, but in the end favour a microeconomic explanation based on the changing composition of import goods.

In this section, we compare the importance of a number of factors in explaining the sectoral differences found in Table 4. The factors considered are: (i) each sector's share in total imports; (ii) the effective rate of protection; (iii) the importance of non-tariff barriers; (iv) the import penetration rate. The first measure was directly calculated from the TRAINS database (see Appendix), whilst the other three are taken from Das (2003). Here we follow Das (2003) in distinguishing two phases in India's trade liberalisation: the first (1991-95) starts with the 1990-91 reforms; the second (1996-2001) includes the EXIM policies that aim at simplifying procedures and rationalising tariff rates. In general, the second phase slowed down the tariff reduction, especially in the most sensitive sectors.

[Table 5 here]

Table 5 shows the results of a cross-sectional regression of the exchange rate and tariff pass-through coefficients on the four measures indicated above for 1990-95 and 1996-2001. In the linear model (1), the degree of ERPT increases with the effective protection rate in 1996-2001, that is, import prices react more to exchange rate changes in sectors with higher effective protection rates. The degree of TRPT decreases with the sector's share in total imports, that is, import prices react less to changes in tariff rates in sectors with higher share in total imports. The significance of the sector's share in total imports confirms the important role of import shares in determining TRPT. The import penetration ratio has no effect on the degree of pass-through, which could be interpreted as a consequence of the analysis in Dixit (1989), according to which a sufficiently small

increase in import penetration[17] does not have any effect on entry and exit of firms, consequently having no effect on pass-through. However, as Dixit (1989) pointed out, non-linearities may be important in this context. To investigate this possibility, Table 5 also presents the results of a quadratic specification (2). Indeed, the impact of import penetration appears as a second-order effect in the case of ERPT in 1996-2001. Moreover, in the case of TRPT the Ramsey RESET test shows that second-order effects are required for a correct specification. The lack of significance in other cases may be due to data limitations or to small sample problems.

Conclusions

This paper makes a contribution to the literature by empirically testing the degree of pass-through of exchange rates and tariffs in the context of an emerging market economy undergoing deep structural change. India started extensive reforms in the beginning of the 1990s, comprising both exchange rate depreciation and tariff reduction. The paper examines the responsiveness of Indian import prices to exchange rate changes and tariff variations in the post-reform period, modelling TRPT alongside ERPT, both theoretically and empirically.

Using data for a panel of 38 2-digit SITC sectors over the period from 1990 to 2001, the pass-through of changes in both the NEER of the rupee and the tariff rates into import prices is often found to be incomplete or imperfect in the reform period. This finding suggests that the pricing behaviour of foreign exporters varies across industries, with ERPT being complete in 32% (12 out of 38) of sectors, and zero or incomplete in the remaining 68%. The results also indicate that the foreign exporters absorb at least part

[17] In our sample the unweighted average import penetration ratio across the 38 2-digit sectors increases from 0.216 in 1991-95 to 0.249 in 1996-2001.

of the exchange rate and tariff changes in respectively 4 and 35 industries. The share of each sector in total imports and the effective protection rate are found to contribute to sectoral differences in the degree of pass-through, although in a non-linear way.

In India's context, tariffs are still high despite more than a decade of liberalisation. However, the paper's results show that TRPT is not complete, although zero pass-through cannot be ruled out. Hence, tariff rates are not high enough to verify empirically the theoretical presumption that, under high tariff rates, TRPT will be close to one independent of the degree of ERPT. Our results hint that, at least in some sectors, tariff liberalisation has benefited less the Indian consumers and more the foreign exporters, who react to tariff reductions by increasing their mark-ups, thus partially or even totally offsetting the tariff reduction. On the contrary, exchange rate depreciation has not benefited foreign exporters, since either the rupee import price changes one-to-one with the exchange rate, or does not react to the depreciation, implying that foreign exporters totally absorbed the price increase. It is thus interesting that, in India's import markets, trade liberalisation leads to an increase in foreign exporter's mark-ups and the benefit is not passed on to the consumers, but exchange rate depreciation causes a decrease in foreign exporter's mark-ups because the foreign producer seems to absorb a part of the increase in the cost of imports.

References

Ahluwalia, M. S. (2002), Economic Reforms in India since 1991: Has Gradualism Worked?, *Journal of Economic Perspectives,* 16, 67-88.

Ahluwalia, M. S. (2006), India's Experience with Globalisation, *Australian Economic Review,* 39, 1-13.

Athukorala, P. (1991), Exchange Rate Pass-Through: The Case of Korean Exports of Manufactures, *Economics Letters,* 35, 79-84.

Athukorala, P. and Menon, J. (1994), Pricing-to-Market Behaviour and Exchange Rate Pass-through in Japanese Exports, *Economic Journal,* 104, 271-81.

Bleaney, M. F. (1997), Invoicing-Currency Effects in the Pricing of Japanese Exports of Manufactures, *Canadian Journal of Economics,* 30, 968-74.

Broda, C. (2004), Terms of Trade and Exchange Rate Regimes in Developing Countries, *Journal of International Economics,* 63, 31-58.

Burstein, A., Eichenbaum, M. and Rebelo, S. (2005), Large Devaluations and the Real Exchange Rate, *Journal of Political Economy,* 113, 742-84.

Burstein, A. T., Neves, J. C. and Rebelo, S. (2003), Distribution Costs and Real Exchange Rate Dynamics, *Journal of Monetary Economics,* 50, 1189-214.

Campa, J. M. and Goldberg, L. S. (2002), Exchange Rate Pass-through into Import Prices: A Macro or Micro Phenomenon?, *NBER Working Paper 8934.*

Campa, J. M. and Goldberg, L. S. (2005), Exchange Rate Pass-through into Import Prices, *Review of Economics and Statistics,* 87, 679-90.

Corsetti, G. and Dedola, L. (2005), A Macroeconomic Model of International Price Discrimination, *Journal of International Economics,* 67, 129-55.

Das, D. K. (2003), Quantifying Trade Barriers: Has Protection Declined Substantially in Indian Manufacturing?, *ICRIER Working Paper 105, ICRIER: New Delhi.*

Devereux, M. B., Lane, P. R. and Xu, J. (2006), Exchange Rates and Monetary Policy in Emerging Market Economies, *Economic Journal,* 116, 478-506.

Dixit, A. (1989), Hysteresis, Import Penetration, and Exchange Rate Pass-Through, *The Quarterly Journal of Economics,* 104, 205-28.

Doyle, E. (2004), Exchange Rate Pass-through in a Small Open Economy: The Anglo-Irish Case, *Applied Economics,* 36, 443-55.

Engel, C. (2002), The Responsiveness of Consumer Prices to Exchange Rates: A Synthesis of Some New Open Economy Macro Models, *The Manchester School,* 70 (Suppl.), 1-15.

Feenstra, R. (1989), Symmetric Pass-through of Tariffs and Exchange Rates under Imperfect Competition: An Empirical Test, *Journal of International Economics,* 27, 25-45.

Feenstra, R., Gagnon, J. and Knetter, M. (1996), Market Share and Exchange Rate Pass-through in World Automobile Trade, *Journal of International Economics,* 40, 187-207.

Frankel, J., Parsley, D. and Wei, S. (2005), Slow Pass-through around the World: A New Import for Developing Countries?, *NBER Working Paper,* 11199.

Froot, K. and Klemperer, P. (1989), Exchange Rate Pass-through When Market Share Matters, *American Economic Review,* 79, 637-54.

Gagnon, J. and Knetter, M. (1995), Markup Adjustment and Exchange Rate Fluctuations: Evidence from Panel Data on Automobile Exports, *Journal of International Money and Finance,* 14, 289-310.

Goldberg, P. (1995), Product Differentiation and Oligopoly in International Markets: The Case of the US Automobile Industry, *Econometrica,* 63, 891-951.

Goldberg, P. and Knetter, M. (1997), Goods Prices and Exchange Rates: What Have We Learned?, *Journal of Economic Literature,* 35, 1243-72.

Goldberg, P. and Knetter, M. (1999), Measuring the Intensity of Competition in Export Markets, *Journal of International Economics,* 47, 27-60.

Gross, D. and Schmitt, N. (1996), Exchange Rate Pass-through and Rivalry in the Swiss Automobile Market, *Weltwirtschaftliches Archiv,* 123, 278-303.

Hooper, P. and Mann, C. (1989), Exchange Rate Pass-through in the 1980s: The Case of US Imports of Manufactures, *Brookings Papers on Economic Activity,* 1, 297-329.

Im, K. S., Pesaran, M. H. and Shin, Y. (2003), Testing for Unit Roots in Heterogeneous Panels, *Journal of Econometrics,* 115, 53-74.

Joshi, V. (2003), India and the Impossible Trinity, *World Economy,* 26, 555-83.

Kim, Y. (1990), Exchange Rates and Import Prices in the US: A Varying-Parameter Estimation of Exchange Rate Pass-Through, *Journal of Business and Economic Statistics,* 8, 305-15.

Knetter, M. (1989), Price Discrimination by US and German Exporters, *American Economic Review,* 79, 198-210.

Knetter, M. (1994), Is Export Price Adjustment Asymmetric?: Evaluating the Market Share and Marketing Bottlenecks Hypotheses, *Journal of International Money and Finance,* 13, 55-70.

Koch, P. and Rosensweig, J. (1992), The Dollar and the US Terms of Trade, *Journal of Macroeconomics,* 14, 467-86.

Lee, J. (1997), The Response of Exchange Rate Pass-through to Market Concentration in a Small Economy: The Evidence from Korea, *Review of Economics and Statistics,* 79, 142-45.

Levin, A., Lin, C.-F. and Chu, C.-S. J. (2002), Unit Root Tests in Panel Data: Asymptotic and Finite Sample Properties, *Journal of Econometrics,* 108.

Madsen, J. (1998), Errors-in-Variables, Supply Side Effects, and Price Elasticities in Foreign Trade, *Weltwirtschaftliches Archiv,* 134.

Mallick, S. K. and Marques, H. (2006), Sectoral Exchange Rate Pass-Through: Testing the Impact of Policy Reforms in India, *Scottish Journal of Political Economy,* 53, 280-303.

Mattoo, A. and Stern, R. (2003), *India and the WTO,* Oxford University Press, Oxford.

Menon, J. (1992), Exchange Rates and Prices of Australian Manufactured Exports, *Weltwirtschaftliches Archiv*, 695-710.

Menon, J. (1995), Exchange Rate Pass-Through, *Journal of Economic Surveys,* 9, 197-231.

Menon, J. (1996), The Degree and Determinants of Exchange Rate Pass-Through: Market Structure, Non-Tariff Barriers and Multinational Corporations, *Economic Journal,* 106, 434-44.

Panagariya, A. (2005), India's Trade Reform, In *The India Policy Forum 2004*, Vol. 1 (Ed, Panagariya, A.) Brookings and NCAER, India.

Parsley, D. (1993), Exchange Rate Pass-Through: Evidence from Aggregate Japanese Exports, *Southern Economic Journal,* 60, 454-62.

Steel, D. and King, A. (2004), Exchange Rate Pass-Through: The Role of Regime Changes, *International Review of Applied Economics,* 18, 301-22.

Tange, T. (1997), Exchange Rates and Export Prices of Japanese Manufacturing, *Journal of Policy Modelling,* 19, 195-206.

Taylor, J. B. (2000), Low Inflation, Pass-through, and the Pricing Power of Firms, *European Economic Review,* 44, 1389-408.

Taylor, M. P. (2003), Purchasing Power Parity, *Review of International Economics,* 11, 436-52.

Wooldridge, J. (2002), *Econometric Analysis of Cross Section and Panel Data,* MIT Press, Cambridge (MA).

Yang, J. (1997), Exchange Rate Pass-through in US Manufacturing Industries, *Review of Economics and Statistics,* 79, 95-105.

Yang, J. (1998), Pricing-to-Market in US Imports and Exports: A Time Series and Cross-Sectional Study, *Quarterly Review of Economics and Finance,* 38, 843-61.

Yang, Y. and Hwang, M. (1994), Price Behaviour in Korean Manufacturing, *Review of Economics and Statistics,* 76, 461-70.

Tables

Table 1: Sectoral share (%) of main import categories in India's total imports (1990-2001)

Product Name	***1990***	***1992***	***1997***	***1999***	***2001***
Crude	14.97	17.77	10.74	19.34	25.42
Petrol	11.62	11.08	9.91	6.64	2.26
Nonmetallic Minerals	9.75	12.34	8.82	11.54	9.80
Iron & Steel	5.22	3.80	3.59	1.96	1.65
Oorganic Chemicals	3.56	3.14	4.44	3.16	3.17
General Industrial Machinery	3.53	3.02	3.60	2.68	2.61
Electrical Machinery	3.37	3.15	2.96	2.79	3.34
Specialised Machinery	3.23	2.98	3.77	1.72	1.97
Inorganic Chemicals	2.09	3.80	3.02	2.73	2.35
Transport Equipment	2.83	1.28	1.60	1.44	1.67
SUM (1)	60	62	52	54	54
SUM (2)	81	83	71	69	69

Note: SUM (1) represents the import share of all the 10 sectors in the table;
SUM (2) represents the import share of all the 38 sectors used in the regressions.
Own calculations using data from TRAINS as described in Appendix

Table 2: Panel unit root tests (1990-2001)						
H0: I(1) H1: I(0)	**Levin, Lin & Chu (2002)**			**Im, Pesaran & Shin (2003)**		
	(1)	**(2)**	**(3)**	**(1)**	**(2)**	**(3)**
Levels						
Ln (imprice)	-0.078*	-0.499*	-0.969*	-2.538*	-0.807	0.770
Ln (neer)	N/A	N/A	N/A	-4.398*	N/A	N/A
Ln (tariff)	-0.086*	-0.087	-0.567*	1.072	6.532	0.951
First differences						
ΔLn (imprice)	-1.489*	-1.667*	-1.988*	-10.750*	-6.849*	-5.327*
ΔLn (neer)	N/A	N/A	N/A	-28.662*	N/A	N/A
ΔLn (tariff)	-0.743*	-0.917*	-1.637	-6.068*	-2.764*	0.526

*Note: These tests were performed using the STATA commands levinlin and ipshin, written by Fabian Bornhorst and Chris Baum and fully described in http://ideas.repec.org. The command levinlin allows 3 choices of deterministics: (1) none; (2) constant;(3) constant & trend. The command ipshin allows another 3 choices of deterministics: (1) constant; (2) constant with cross-sectionally demeaned variable; (3) constant & trend with cross-sectionally demeaned variable. Nonstationarity is the null. The values given are the coefficient for levinlin and the W[t-bar] statistic for ipshin. * represent significance at the 1% level.*

Table 3: Panel regression results for import prices (common sector slopes), 1990-2001	
Exchange rate	0.927*** (0.094)
Tariff rate	0.001††† (0.013)
Cons	0.026 (0.033)
Sector dummies	YES
Chi-sq test (H0: sector dummies jointly equal to zero)	19.09
Symmetry test	95.11***
Homogeneity test	0.56
Ramsey RESET test	1.31
N obs	418
N sectors	38
Log-likelihood	43.14
Wald chi-sq	116.19***

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 imports showing both heteroskedasticity and autocorrelation. These tests are fully described in http://www.stata.com/support/faqs/stat/panel.html. All estimates were produced using cross-sectional time-series FGLS with heteroskedastic panels and first-order autocorrelation. *Symmetry test: Chi-sq test where H0: each sector's slope equal for exchange rates and tariffs. Homogeneity test: Chi-sq test where H0: the sum of each sector's exchange rate and tariff coefficients is significantly equal to one.*

Table 4: Panel regression results for sectoral import prices (sector-specific slopes), 1990-2001

	Exchange rate	*Tariff rate*	*Symmetry test*	*Homogeneity test*		*Exchange rate*	*Tariff rate*	*Symmetry test*	*Homogeneity test*
Manufactures of metals	1.488 (1.494)	-0.027† (0.566)	0.84	0.09	***Pharmaceuticals***	1.827* (1.082)	-0.035††† (0.231)	2.95*	0.49
Fruit	1.244 (0.958)	0.180*††† (0.097)	1.32	0.18	***Specialised machinery***	1.422***†† (0.219)	0.057††† (0.116)	23.84***	5.17**
Manmade fertilizers	1.211 (0.812)	-0.314††† (0.300)	2.68	0.02	***Rubber***	1.380*** (0.331)	-0.009††† (0.016)	17.64***	1.25
Metalworking machinery	1.014 (0.783)	0.972*** (0.231)	0.00	1.71	***Minerals***	1.346*** (0.497)	0.057††† (0.081)	6.34***	0.66
Power machinery	0.976 (0.693)	0.057††† (0.082)	1.74	0.00	***Other fibers***	1.156*** (0.242)	-0.199**††† (0.079)	32.28***	0.02
Pulp	0.930 (1.545)	0.294†† (0.374)	0.15	0.02	***Photographic instruments***	1.106** (0.526)	0.117††† (0.210)	3.20*	0.11
Cereal	0.871 (0.581)	-0.285††† (0.406)	1.98	0.52	***Aluminium***	1.062** (0.446)	-0.371††† (0.246)	8.79***	0.34
Paper	0.836 (0.601)	0.135††† (0.123)	1.20	0.00	***Organic chemicals***	1.039** (0.425)	0.096††† (0.114)	4.21**	0.10
Nonferrous metals	0.755 (0.484)	0.404**††† (0.161)	0.42	0.11	***Transport equipment***	1.037*** (0.392)	0.021††† (0.159)	4.95**	0.02
General industrial machinery	0.671 (0.821)	-0.371††† (0.383)	1.37	0.58	***Spices***	0.974*** (0.372)	-0.067††† (0.137)	7.17***	0.05
Plastic	0.670 (0.741)	0.047††† (0.263)	0.66	0.12	***Crude***	0.969*** (0.338)	0.147††† (0.141)	5.03**	0.10
Copper	0.621 (0.574)	0.163††† (0.121)	0.57	0.14	***Iron&steel***	0.949** (0.383)	0.057††† (0.243)	4.72**	0.00
Dairy	0.556 (0.462)	0.060††† (0.126)	0.94	0.75	***Constant***	0.051 (0.044)			
Inorganic chemicals	0.539 (0.816)	-0.052††† (0.344)	0.43	0.35	***Sector dummies***	YES			
Dyes	0.444 (0.685)	-0.144††† (0.190)	0.66	1.01	***Chi-sq (1)***	40.78			
Lead	0.335 (1.053)	0.393 (0.395)	0.00	0.06	***Chi-sq (2)***	33.29			
Scientific instruments	0.294 (0.534)	0.006††† (0.047)	0.28	1.76	***Chi-sq (3)***	60.40***			
Tin	0.285 (0.523)	-0.016††† (0.223)	0.23	2.13	***N obs***	418			
Beverages	-0.244† (0.671)	-0.049*††† (0.027)	0.09	3.63**	***N sectors***	38			
Nickel	-0.323 (0.919)	0.124**††† (0.061)	0.24	1.66	***Log-likelihood***	82.11			
Yarn	-0.404 (1.668)	-0.197††† (0.127)	0.02	0.85	***Wald chi-sq***	277.27***			
Crude fertilizers	-0.409 (1.196)	0.111†† (0.453)	0.15	1.11	***Ramsey RESET***	0.76			
Metals	-0.507 (1.860)	-0.061† (0.600)	0.05	0.67					
Nonmetallic minerals	-0.558 (1.219)	-0.001††† (0.394)	0.17	1.62					
Petrol	-0.610†† (0.704)	-0.092††† (0.064)	0.60	5.21**					
Electrical machinery	-1.250†† (1.042)	0.312† (0.385)	2.05	2.94*					

*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 imports showing both heteroskedasticity and autocorrelation. These tests are fully described in http://www.stata.com/support/faqs/stat/panel.html. All estimates were produced using cross-sectional time-series FGLS with heteroskedastic panels and first-order autocorrelation. Symmetry test: Chi-sq test where H0: each sector's slope equal for exchange rates and tariffs. Homogeneity test: Chi-sq test where H0: the sum of each sector's exchange rate and tariff coefficients is significantly equal to one. Chi-sq (1): Chi-sq test where H0: sector dummies jointly equal to zero. Chi-sq (2): Chi-sq test where H0: equal sector slopes for exchange-rates. Chi-sq (3): Chi-sq test where H0: equal sector slopes for tariffs.*

Table 5: Cross-sectional regression results for pass-through coefficients, 1990-2001								
	Exchange rate coefficients				*Tariff rate coefficients*			
	1990-95		*1996-00*		*1990-95*		*1996-00*	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Sector share in total imports	-0.048 (0.055)	0.099 (0.207)	-0.037 (0.071)	0.177 (0.203)	-0.025* (0.014)	-0.046 (0.062)	-0.040* (0.024)	-0.052 (0.078)
Sector share in total imports (squared)		-0.016 (0.017)		-0.033 (0.028)		0.001 (0.005)		-0.000 (0.010)
Effective protection rate	0.005 (0.008)	0.034 (0.052)	0.032* (0.018)	0.187 (0.231)	-0.003 (0.003)	-0.030 (0.022)	-0.009 (0.007)	-0.115 (0.089)
Effective protection rate (squared)		-0.000 (0.000)		-0.002 (0.003)		0.000 (0.000)		0.001 (0.001)
Non-tariff barriers	-0.005 (0.006)	-0.009 (0.019)	-0.010 (0.007)	0.022 (0.022)	-0.001 (0.002)	0.003 (0.005)	-0.002 (0.002)	-0.000 (0.009)
Non-tariff barriers (squared)		0.000 (0.000)		-0.001 (0.000)		-0.000 (0.000)		-0.000 (0.000)
Import penetration ratio	-1.154 (1.263)	2.599 (6.597)	-0.469 (0.981)	-5.589 (3.474)	0.409 (0.360)	1.165 (1.783)	0.349 (0.243)	1.038 (0.919)
Import penetration ratio (squared)		-7.029 (11.266)		10.559* (5.551)		-0.935 (3.021)		-1.277 (1.794)
Cons	0.668 (0.897)	-0.965 (2.331)	-0.223 (0.873)	-3.040 (4.793)	0.246 (0.353)	1.175 (0.896)	0.366 (0.307)	2.302 (1.739)
N obs	29	29	29	29	29	29	29	29
R-sq	0.134	0.223	0.217	0.396	0.232	0.344	0.218	0.342
Ramsey RESET test	1.26	1.81	0.83	1.45	2.12*	1.09	4.52***	1.82
F-test (H0: coefficients jointly equal to zero)	1.41	9.91***	2.97**	12.94***	2.16*	2.54**	1.15	1.30

Note: ***, **, * indicate a coefficient significantly different from zero at respectively the 1%, 5%, 10% level. OLS robust standard errors are in parenthesis. (1) is a linear model. (2) is a quadratic model. For more details on how the explanatory variables are calculated and their values see Das (2003).

Appendix

Data Sources and Definitions

The unit value indices of imports for a number of sectoral groups, and the rupee NEER (Nominal effective exchange rate) were compiled from the Handbook of Statistics on the Indian Economy 2002-03, Reserve Bank of India, over the period 1990-91 to 2001-02. Financial year (annual average) data are used in this paper. Import 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 imports relate to cost, insurance and freight (c.i.f.) values. All the data is annual. Data on tariffs were taken from the TRAINS database at http://wits.worldbank.org. The rate used is the weighted average of all the tariff lines within each 2-digit category, as provided by TRAINS.

The codes and definition of the 2-digit SITC (Rev. 2) sectors are as follows:

Code	*Description*	*SITC Rev2 Code*
DAIRY	FOOD & FOOD ARTICLES: DAIRY PRODUCTS	02
CEREAL	FOOD & FOOD ARTICLES: CEREALS & CEREAL PREPARATIONS	04
FRUIT	FOOD & FOOD ARTICLES: FRUITS & NUTS	057
SPICES	FOOD & FOOD ARTICLES: SPICES	075
BEV	BEVERAGES & TOBACCO: BEVERAGES	11
RUBBER	CRUDE MATERIALS, INEDIBLE, EXCEPT FUELS: CRUDE RUBBER INCL.SYNTHETIC & RECLAIMED	23
PAPER	CRUDE MATERIALS, INEDIBLE, EXCEPT FUELS: PULP & WASTE PAPER	25
OTH FIB	CRUDE MATERIALS, INEDIBLE, EXCEPT FUELS: TEXTILE FIBRES & WASTE EXCL. COTTON	26-263
CRUFERT	CRUDE MATERIALS, INEDIBLE, EXCEPT FUELS: CRUDE FERTILIZERS	272
MINERALS	CRUDE MATERIALS, INEDIBLE, EXCEPT FUELS: MINERALS (EXCL. COAL, PETROLEUM, CRUDE FERTILISERS, SULPHUR & PRECIOUS STONES)	27-272
METALS	CRUDE MATERIALS, INEDIBLE, EXCEPT FUEL: ORES & CONCENTRATES OF BASE METALS N.E.S.	287
NF METALS	CRUDE MATERIALS, INEDIBLE, EXCEPT FUELS: NON-FERROUS BASE METALS, WASTE & SCRAP	288
CRUDE	MINERAL FUELS, LUBRICANTS, ETC.: PETROLEUM CRUDE	33
PETROL	MINERAL FUELS, LUBRICANTS, ETC.: PETROLEUM PRODUCTS	33
ORGCHEM	CHEMICALS & RELATED PRODUCTS:ORGANIC CHEMICALS	51
INORGCHEM	CHEMICALS & RELATED PRODUCTS:INORGANIC CHEMICALS	52
DYES	CHEMICALS & RELATED PRODUCTS: DYEING, TANNING & COLOURING MATERIALS	53
PHARM	CHEMICALS & RELATED PRODUCTS: MEDICINAL & PHARMACEUTICAL PRODUCTS	54
MANFERT	CHEMICALS & RELATED PRODUCTS: FERTILIZERS, MANUFACTURED	56
PLASTIC	CHEMICALS & RELATED PRODUCTS: ARTIFICIAL RESIN & PLASTIC MATERIAL & CELLULOSE ESTER	57
PAPER	MANUFACTURED GOODS CLASSIFIEDCHIEFLY BY MATERIAL: PAPER, PAPERBOARD & ARTICLES THEREOF	64
YARN	MANUFACTURED GOODS CLASSIFIED CHIEFLY BY MATERIAL: TEXTILE YARN	651
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
COPPER	MANUFACTURED GOODS CLASSIFIED CHIEFLY BY MATERIAL: COPPER	682
NICKEL	MANUFACTURED GOODS CLASSIFIED CHIEFLY BY MATERIAL: NICKEL	683
ALUM	MANUFACTURED GOODS CLASSIFIED CHIEFLY BY MATERIAL: ALUMINIUM	684
LEAD	MANUFACTURED GOODS CLASSIFIED CHIEFLY BY MATERIAL: LEAD	685
TIN	MANUFACTURED GOODS CLASSIFIED CHIEFLY BY MATERIAL: TIN	687
MANMET	MANUFACTURED GOODS CLASSIFIED CHIEFLY BY MATERIAL: MANUFACTURES OF METALS	69
POWERMACH	MACHINERY & TRANSPORT EQUIPMENT: POWER GENERATING MACHINERY & EQUIPMENT	71
SPECMACH	MACHINERY & TRANSPORT EQUIPMENT: MACHINERY SPECIALISED FOR PARTICULAR INDUSTRIES	72
METWORKMACH	MACHINERY & TRANSPORT EQUIPMENT: METAL WORKING MACHINERY	73
GENINDMACH	MACHINERY & TRANSPORT EQUIPMENT: GENERAL INDUSTRIAL MACHINERY & EQUIPMENT	74
ELMACH	MACHINERY & TRANSPORT EQUIPMENT: ELECTRICAL MACHINERY	77
TRANSEQ	MACHINERY & TRANSPORT EQUIPMENT: TRANSPORT EQUIPMENT	79
SCINSTR	MISCELLANEOUS MANUFACTURED ARTICLES: PROFESSIONAL, SCIENTIFIC & CONTROLLING INSTRUMENTS & APPARATUS N.E.S.	87
PHOTOINSTR	MISCELLANEOUS MANUFACTURED ARTICLES: PHOTOGRAPHIC APPARATUS ETC.	88

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