Exchange Rate Pass-Through to External and Internal Prices: A Developing Country Perspective

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We estimate the exchange rate pass-through to external and internal prices of a developing country, specifically, Bangladesh. The study also examines whether the tradition view that exchange rate pass-through should be 'full' for developing countries. We construct some variables which are not readily available in existing databases. A full sample estimation indicates that exchange rate pass-through to external prices is 'full', however, pass-through to internal prices is 'partial'. Rolling regressions indicate that the response of external prices to exchange rate movement has been constantly around unity until 2003, however, it has fallen rapidly in subsequent years. Response to internal prices has been found unstable and relatively small.

INTRODUCTION

Although there is a growing body of literature on exchange rate pass-through (ERPT), few studies have investigated this issue for developing countries. Nonetheless, testing ERPT to external and internal prices for developing countries are extremely useful for policy implications. It is worth clarifying here that external prices include both import and export prices and internal price means domestic price level, which is measured by either consumer price index (CPI) or producer price index (PPI).

Estimating ERPT to export price is necessary to apply an effective exchange rate policy in those economies which have been following an export-led growth strategy. Generally, the developing countries follow an export-led growth policy and they therefore frequently adjust the exchange rate to find competitiveness in export markets. However, if the exporting industries of those countries import their capital goods, then any increased demand for exports immediately increases the demand for capital goods, thereby increasing the expenditure on imports. So ERPT to import price of these economies also need to be investigated. These lead us to estimate ERPT to both import and export prices.

Secondly, Olivei (2002), Marazzi *et al.* (2005) and Mumtaz *et al.* (2006) indicate that import price is one of the main channels through which the exchange rate affects domestic prices. Subsequently, ERPT to domestic prices is worth estimating to test whether the 2nd stage pass-through[1] is significant for the country. This gives an opportunity to examine whether the exchange rate is one of the significant determinants of inflation. Besides, Mishkin (2008) and McCarthy (1999) suggest that the price level of an economy may be affected by import price pass-through. Moreover, inflation has become a great concern for Bangladesh economy in recent years. Subsequently, testing the 2nd stage pass-through may be useful for inflation-forecasting and monetary policy targeting (Taylor 2000, Marazzi *et al*. 2005) for the country.

IMF Annual Report (2008) indicates that Bangladesh has been following the *de facto* managed floating exchange rate regime. Hence, assuming the managed floating exchange rate regime in Bangladesh, we investigate ERPT to both external and internal prices for the country. It is worth noting that even if a country follows the free floating exchange rate regime, the exchange rate can be affected by the country's monetary policy (Mishkin, 2008), which in turn may influence external and internal prices.

Bangladesh has been pursuing an active exchange rate policy since its independence in 1971, which is reflected in its frequent exchange rate regime shifts and frequently announced exchange rate devaluations (Islam, 2003; Younus *et al.*, 2006; Aziz, 2012). The key objectives of these policies are to reduce the extra pressure of imports, accelerate exports and improve the balance of trade (Hossain and Alauddin, 2005; Financial Sector Review, 2006; Aziz, 2012). Subsequently, examining the effectiveness of the exchange rate is required to apply appropriate policy. However, Hoque and Razzaque (2004) and Chowdhury and Siddique (2006) are only studies which estimate ERPT to export price and domestic prices of Bangladesh, respectively. The earlier literature estimates ERPT to disaggregated export prices. Hoque and Razzaque (2004) find a partial evidence of significant pass-through to export prices, while ERPT to domestic prices is found to be an insignificant phenomenon in Chowdhury and Siddique (2006). To the best of our knowledge, none of the studies in the literature tests ERPT to import price of Bangladesh. This study attempts to fulfil that vacuum. We estimate ERPT to both external and internal prices at aggregate level.

THE LITERATURE

Yang (1997), Anderton (2003), Campa and Goldberg (2005), Campa and Minguez (2006), Mumtaz *et al.* (2006), Zorzi *et al.* (2007) find evidences of incomplete ERPT to import price in developed countries. Mallick and Marques (2006) and Zorzi *et al.* (2007) also indicate that there is an incomplete ERPT to import prices in developing countries and emerging markets, respectively.

Some studies, for instance, Dornbusch (1987), Olivei (2002), Marazzi et al. (2005), Mumtaz et al. (2006), Ihrig *et al.* (2006), Mallick and Marques (2006) suggests that there is a sustainable fall in ERPT to import prices over time.

Other studies including Froot and Klemperer (1989), Anderton (2003), Marazzi *et al.* (2005), Campa and Goldberg (2005), and Mishkin (2008) indicate that the size of pass-through coefficient depend on firms' price setting behaviour. That means, the magnitude of ERPT coefficient depends on whether exporting firms set their product prices in local/consumer currency (LCP) or they follow the producer currency pricing (PCP). Consequently, the success of exchange rate policy (currency devaluation) to increase exports depends on whether the export price is rigid in PCP or LCP. If the export price follows LCP, then devaluation cannot increase exports.

The evidence of ERPT to export price is mixed. Bussière (2007), Gagnon and Knetter (1995), Knetter (1993) and Ohno (1989) find a partial ERPT to export price in developed countries. Vigfusson *et al.* (2007) and Mallick and Marques (2006) also find a partial support of ERPT to export price in middle income countries and developing countries, respectively. On the contrary, Haque and Razzaque (2004) find an evidence of full-ERPT to export prices in Bangladesh.

Literature on ERPT to domestic prices has also found a mixed result. Using the VAR approach, McCarthy (1999) finds that ERPT to domestic prices is partial in industrial economies. Zorzi *et al.* (2007) also find a partial support of ERPT to domestic prices in emerging markets. Zorzi *et al.* (2007),

therefore, reject the hypothesis that – ERPT is always higher in emerging economies compared to their developed country counterpart. Leigh and Rossi (2002) find that ERPT is 'full' in Turkey. However, Chowdhury and Siddique (2006) find no significant evidences of ERPT to domestic prices in Bangladesh. We, in light of the existing research, estimate ERPT to external and internal prices and test whether the pass-through is 'partial' or 'full' in developing countries, particularly in Bangladesh. Secondly, we examine whether ERPT has been falling over time. Thirdly, we investigate whether there is any evidence of pricing-to-market (PTM). Finally, we test whether ERPT to consumer prices and producer prices are different from each other.

The organisation of the following sections is as follows. Section 3 discusses data and variables. Section 4 gives theoretical basis of empirical models and methodology of the study. Section 5 analyses the estimated results. Section 6 concludes the paper.

DATA AND VARIABLES

This study uses data from various local and international sources, namely, 'Monthly Statistical Bulletin' (MSB) and 'Foreign Trade Statistics' (FTS) of 'Bangladesh Bureau of Statistics' (BBS), International Financial Statistics (IFS) of the International Monetary Fund (IMF), and the World Development Indicators (WDI) of the World Bank.

We used 'unit price index' (UPI) for external prices. UPI of exports and UPI of imports are collected from various volumes (1972 - 2008) of FTS of BBS. The producer/wholesale price index (PPI/WPI) and consumer price index (CPI), which are proxies for domestic prices, have been collected from MSB of BBS. It is worth noting that BBS has developed the CPI by using data of the middle income group from Dhaka city. Exchange rate data are found in the IFS (2010) of the IMF, and the constant GDP and world WPI are found in the WDI (2010) of the WB.

Data for domestic prices are used from 1973-2007. However, data for external prices are used from 1978-2007. It is worth mentioning that the quarterly data for external prices are available up to 1991q4 only. We therefore have failed to use quarterly data in our study.

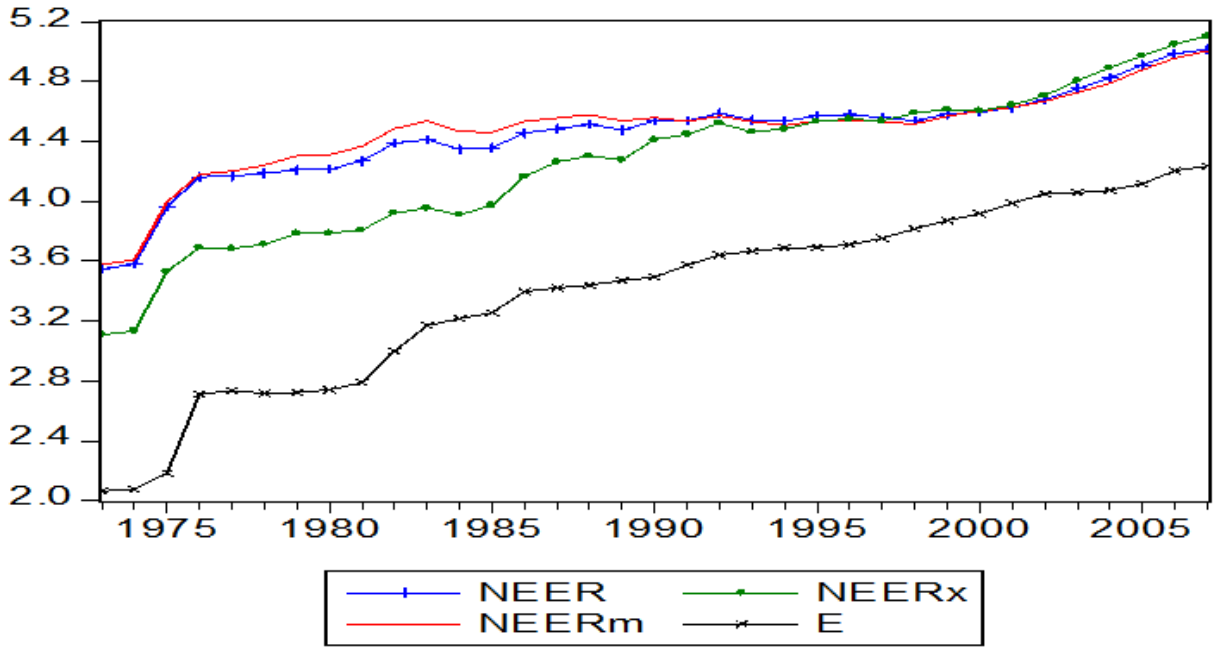
The Nominal Effective Exchange Rates of Import ($NEER_m$) and Export ($NEER_x$) for Bangladesh were constructed by using the following formula:

$$NEER_{it} = \sum_{i=1}^{k} w_{it} E_{it} ,$$

where, t is time and w_{it} is trade-weight of ith trade partners at time t (see Appendix IA and Appendix IB).

Figure 1 shows NEERm, NEERx, the nominal exchange rate (NEER) and the exchange rate with US-dollar (E). We have included data of all major trade partners to construct the exchange rate variable for Bangladesh. NEERx and NEERm explain 77.78% (19 countries) and 76.66% (24 countries) of total export and import share of the country, respectively. Bangladesh mainly imports from India and China, followed by Japan, Singapore and the USA. The USA is the largest importer from Bangladesh which is followed by Germany and the UK. We have not considered countries which have less than 0.5% individual trade share with Bangladesh, in this regard.

FIGURE 1
TIME-SERIES OF E, NEER, NEERM AND NEERX



MODEL AND METHODOLOGY

Three different models are estimated in this paper which are explained as follows.

Import Price

The study employs the benchmark model for import price which is suggested by Campa and Goldberg (2002, 2005) and Goldberg and Knetter (1997). However, we include one additional variable (the trade openness) with the existing model. The following model is estimated empirically.

$$\Delta \ln P_t^M = \alpha_0 + \alpha_1 \Delta \ln E_t + \alpha_2 \Delta \ln PC_t^X + \alpha_3 \Delta \ln Y_t + \alpha_4 OPEN + u_t, \quad (1)$$

where P_t^M is the import price at time *t*, E is NEERm in this model, PC^X is production cost by foreign firm; Y is home GDP (constant); and $OPEN$ is the ratio of trade to GDP. α_1 is the coefficient of interest, ERPT. First-difference of variables in the model possibly overcomes the non-stationarity problem for relatively small sample size.

Export Price

ERPT to export price is tested by adjusting the model presented in Knetter (1995) and Gagnon and Knetter (1995). Our benchmark model for export prices is derived as follows.

We know that the difference between revenue and cost determines firm's profit. Firm maximizes its profit, which is indicated in the following equation-

$$Max \prod = \sum_{i=1}^{n} P_j^X Q_i \left(\frac{P_j^X}{E} \right) - \sum_{i=1}^{n} Q_i \left(\frac{P_j^X}{E} \right) MC\left(w_j, E \times w_i \right),$$

where Q_i is demand for *j* from country *i*; $\left(\frac{P_j^X}{E}\right)$ is product price for consumer in their own currency (say, P_i^m); P_j^x is export price; *i* stands for importer, *j* for exporter, and *MC* is marginal cost of production. *MC* depends on w_j which is the domestic input cost, and w_i is cost of imported capital goods. We assume that export demand changes positively when *E* changes. Similarly, *MC* changes with *E* in the positive direction. Consequently, any change in input prices (imported capital goods) due to change in exchange rate is reflected in the production cost of firms.
The necessary condition for profit maximization gives us:

$$P_j = MC \times \left(\frac{\eta_i (P_j^X / E)}{\eta_i (P_j^X / E) - 1} \right),$$

where, η_i is elasticity of demand for export. Raising price is not an option for the exporter because if exporter does so, he/she may lose market share. However, depreciation may give that opportunity.
Logarithm in both side and the first order Taylor series approximation give,

$$d \ln P_j^X = d \ln MC + \frac{d \ln \eta_i}{d \ln\left(P_j^X / E\right)} \left(\frac{d \ln P_j^X - d \ln E}{\eta_i - 1} \right).$$

By re-organizing, we find the testable model for export prices which can be written as:

$$d \ln P_{jt}^x = \mu_i + (1 - \beta_j) d \ln MC_{jt} + \beta_j d \ln E_t,$$

where, $\beta_j = \frac{\partial \ln \eta_i}{\partial \ln\left(P_j^X / E\right)} \left[1 - \eta_i + \frac{\partial \ln \eta_i}{\partial \ln\left(P_j^X / E\right)} \right]^{-1}$, and μ_i is a constant. If the price of imported capital goods w_i is not affected by the movement of the exchange rate, then β_j gives the magnitude of ERPT to export prices. This is in line of the findings in Ohno (1989) and Mallick and Marques (2006). In fact, the effect of exchange rate movements is implied in *MC*. β would indicate whether there is *PTM* behaviour by exporter. If $1 > \beta_j > 0$, then ERPT is partial, which means that exporting firms adjust prices in local currency term. If, however, $\beta_j = 1$, it means that ERPT is 'full' and no adjustment is taken place in LCP. Hence, the testable model for ERPT to export prices is given as follows.

$$\Delta \ln P_t^X = \mu + \beta \Delta \ln E_t + \delta \Delta \ln PC_t + \lambda OPEN + \varepsilon_t \quad (2)$$

where P_t^X is price of exports at time t; E_t is $NEER_x$ for Model (2), and β captures the exchange rate pass-through; PC_t is production cost.

Domestic Prices

The theoretical setting of ERPT to consumer and producer prices emerged from the law of one price (LOP) and the purchasing power parity (PPP) concepts. Additionally, a constant term and an openness variable are included in the model. The model is as follows:

$$\Delta \ln P_t^d = \mu_0 + \beta' \Delta \ln E_t + \gamma \Delta \ln P_t^* + \lambda OPEN + \varepsilon_t, \quad (3)$$

where P_t^d is domestic price; E_t is NEER; and P_t^* is foreign prices. β' is the pass-through coefficient. It is worth mentioning that if the pass-through is complete, (i.e., $\beta' = 1$) and all other coefficients become zero then it will indicate that the PPP holds between Bangladesh and its trade partners.

This study estimates all empirical models (Model 1, Model 2 and Model 3) using OLS. We also employ the rolling regressions technique to capture any significant variation in ERPT over time.

ESTIMATED RESULTS

Estimated results are reported in Table 1. This table shows that ERPT to import price is +0.73, which is statistically significant. This indicates that a one percent devaluation increases the import price by 0.73 percent. Consequently, import falls. The R^2 is not large because we have used some proxy variables such as, world-WPI and 'domestic real GDP' in Model 1. These variables are not found statistically significant. Moreover, PPI of some major trade partners of Bangladesh such as Germany, China, UAE, France, Malaysia, Hong Kong, Italy, and Saudi Arabia are not available in existing datasets. It is worth mentioning here that we have used the weighted foreign price index (WFPI) as a proxy for foreign production cost. However, it cannot make any significant difference in estimated results. Besides, a large number of imported goods of Bangladesh are necessary goods and they are inelastic to income (Aziz, 2012). It can also be noted here that Vigfusson *et al.* (2007) and Marazzi *et al*. (2005) have also experienced small R^2 values in their ERPT model.

ERPT to export price is -0.91, which is found to be significant. The negative sign indicates that if there is a devaluation of currency, export price of Bangladeshi products significantly decreases. Consequently, the demand for export increases. Hence, devaluation is found to be an effective policy for export competitiveness of Bangladeshi products.

ERPT to domestic prices are +0.59 (CPI) and +0.62 (PPI), respectively. They are found to be positive and significant. These indicate that if there is a devaluation of currency, inflation increases. This pass-through is also called second-stage pass-through. Hence, the exchange rate is found to be a significant determinant of inflation in Bangladesh.

TABLE 1
EXCHANGE RATE PASS-THROUGH TO EXTERNAL AND INTERNAL PRICES

Variables	Coefficients (standard error in parenthesis)			
	Import Prices (1978 – 2007)	**Export Prices (1978 – 2007)**	**Consumer Prices (1974-2006)**	**Producer Prices (1974-2006)**
$\Delta \ln E_t$	0.73** (0.345)	-0.912*** (0.297)	0.59*** (0.094)	0.62*** (0.097)
$\Delta \ln Y_t$	-0.032 (1.328)	-	-	-
$\Delta \ln P_t$	-	1.35*** (0.39)	-	-
$\Delta \ln P_t^*$	0.33 (0.247)	-	0.47** (0.172)	0.47** (0.178)
OPEN	-0.01 (0.007)	0.010 (0.007)	-0.012*** (0.003)	-0.014*** (0.003)
Cons.	-0.007 (0.085)	0.017 (0.032)	0.018 (0.022)	0.01 (0.023)
R^2	0.25	0.46	0.70	0.70
$F-test$	1.91	6.70***	22.23***	22.66***
DW	2.42	1.97	1.72	1.56

*Note: ***, **, and * indicate significance at the 1%, 5% and 10% levels, respectively.* E_t *is NEERm for import, NEERx for export and NEER for domestic prices. The Breusch-Godfrey Serial Correlation LM Test confirms that there is no autocorrelation. The White Heteroskedasticity Test suggests that there is no heteroskedasticity. The CUSUM test indicates that there is no structural break in data. The Jarque-bera test affirms that the error is normally distributed.*

Complete or Partial Pass-Through

We test whether ERPT to import price is 'full' or 'partial' (i.e., the unit coefficient of the exchange rate). The test result (TABLE 2) indicates that ERPT to import price is 'full'. It indicates that there is no PTM behaviour in Bangladeshi imports. This may be because exporters are not much concerned about their market share in Bangladesh.

We also test whether ERPT to export price is 'full'. We could not reject the hypothesis. This implies that ERPT to export price is also 'full'. Hoque and Razzaque (2004) also find similar results at commodity specific ERPT to export prices.

Finally, we test whether ERPT to internal prices are 'full'. Unlike external prices pass-through, we find that ERPT to internal prices are only 'partial'. Hence, the conventional wisdom that ERPT should be complete in developing countries is found appropriate for external prices but not for internal prices. The rejection of full-ERPT to domestic prices also indicates that the PPP, between Bangladesh and its trade partners, does not hold.

TABLE 2
SUMMARY OF 'FULL' AND 'PARTIAL' EXCHANGE RATE PASS-THROUGH

Exchange Rate Pass-through to	Null Hypothesis	T-Statistic	Critical Values	
Import Prices	$H_0 : \alpha_1 = 1$	-0.791	2.467 2.048	(1%) (5%)
Export Prices	$H_0 : \beta = -1$	0.296	2.467 2.048	(1%) (5%)
Consumer Prices	$H_0 : \beta' = 1$	-4.36	2.457 2.042	(1%) (5%)
Producer Prices	$H_0 : \beta' = 1$	-3.96	2.467 2.048	(1%) (5%)

The Rolling Regressions

We then run 'rolling regressions' to examine whether there is any significant variation in ERPT over time. The study employs the baseline Model (2) for export and Model (3) for consumer prices. The study, however, has not employed the entire Model (1) for import price pass-through. This is because firstly, most of Bangladeshi imports are inelastic to income (Aziz, 2012). Secondly, although 'world-WPI is a proxy for cost of production (for foreign firm) in our model, the majority imports of Bangladesh come from a small set of trade partners. An eighteen-year window for each regression is used.

Figure 2 indicates that response of export price to exchange rate movement has been negative and significant until 2003. Pass-through is consistently around one till 2003 and it has fallen in later years. It can be noted that we use both 95 percent and 90 percent confidence intervals.

FIGURE 2A
ROLLING REGRESSIONS FOR ERPT TO EXPORT PRICES
(CI = CONFIDENCE INTERVAL)

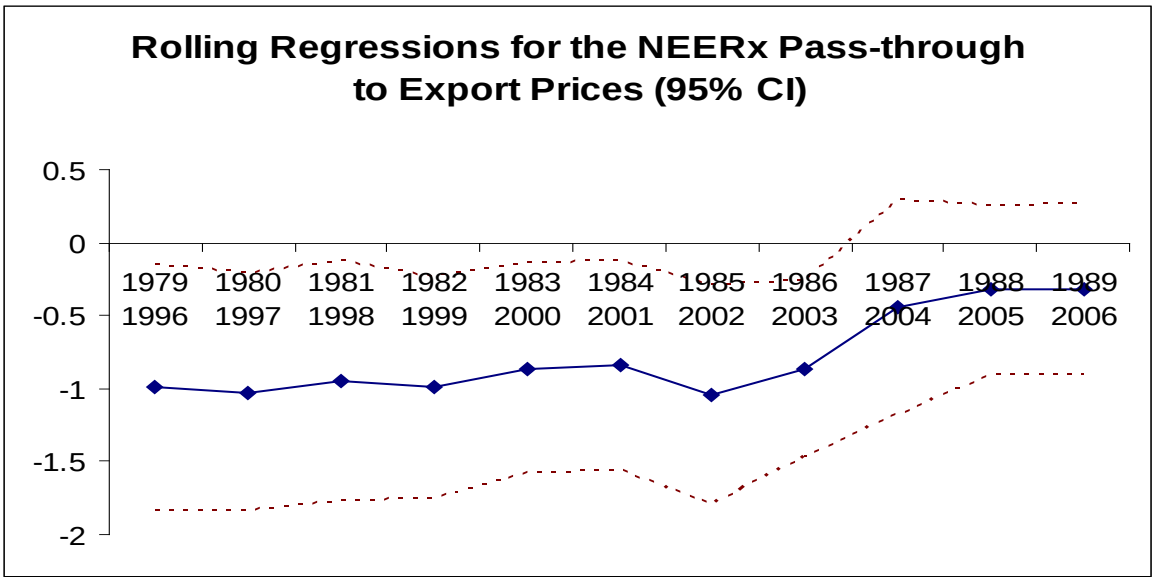


FIGURE 2B
ROLLING REGRESSIONS FOR ERPT TO EXPORT PRICES

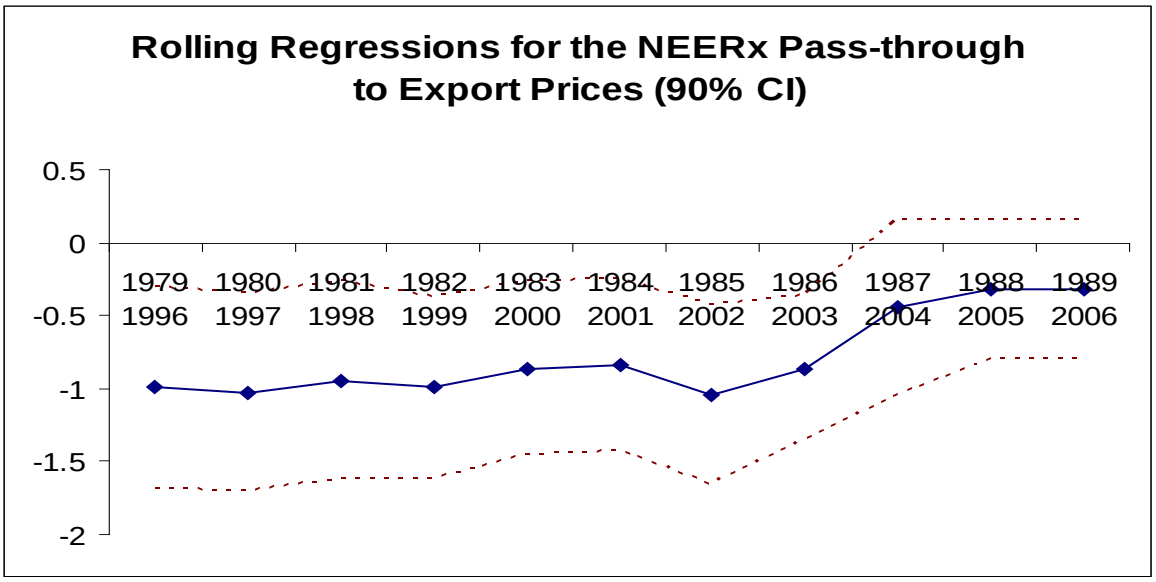


Figure 3 shows the rolling regressions for ERPT to import price which indicate that ERPT has been complete until 2001 and it has fallen gradually after 2001.

FIGURE 3A
ROLLING REGRESSIONS RESULTS FOR ERPT TO IMPORT PRICES

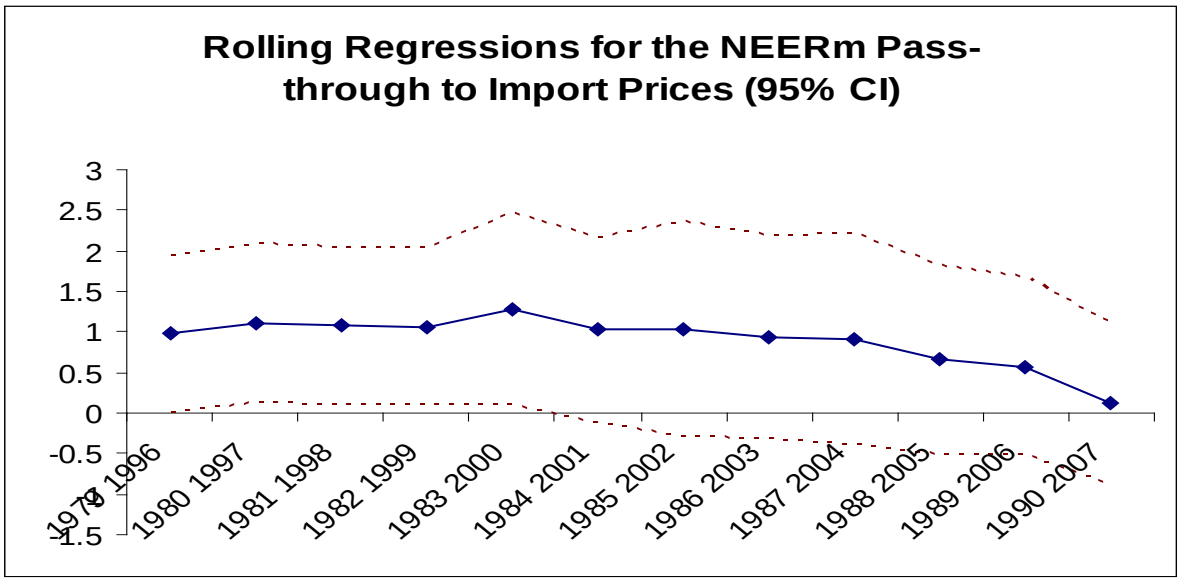
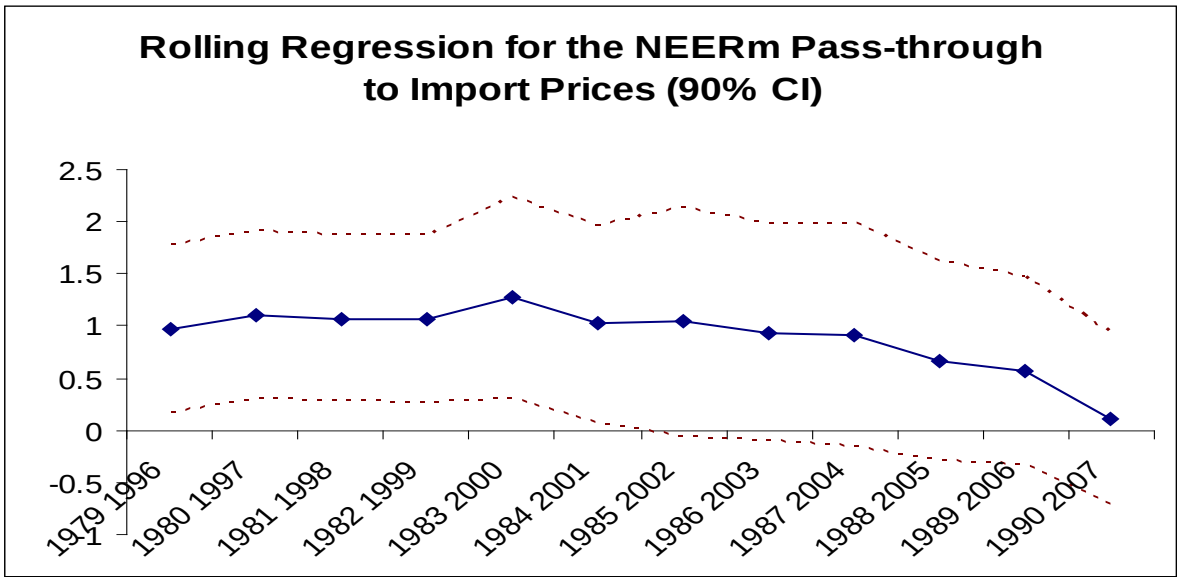


FIGURE 3B
ROLLING REGRESSIONS RESULTS FOR ERPT TO IMPORT PRICES



Unlike ERPT to external prices, ERPT to internal prices are found unstable over time. Figure 4 shows that ERPT is partial for internal prices which has been around 0.6 until 1993, and it has fallen to about 0.3 (Figure 4a, Figure 4b, Figure 4c and Figure 4d) after 1993. We also find that trade openness is a significant determinant of internal prices in Bangladesh.

FIGURE 4A
ROLLING REGRESSIONS FOR ERPT TO CONSUMER PRICES

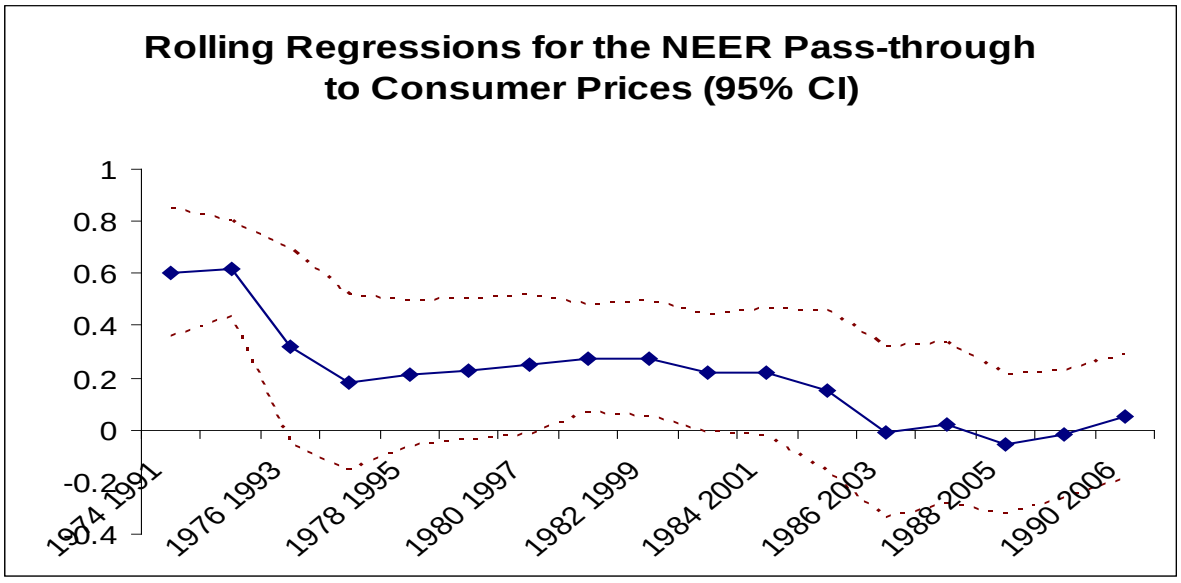


FIGURE 4B
ROLLING REGRESSIONS FOR ERPT TO CONSUMER PRICES

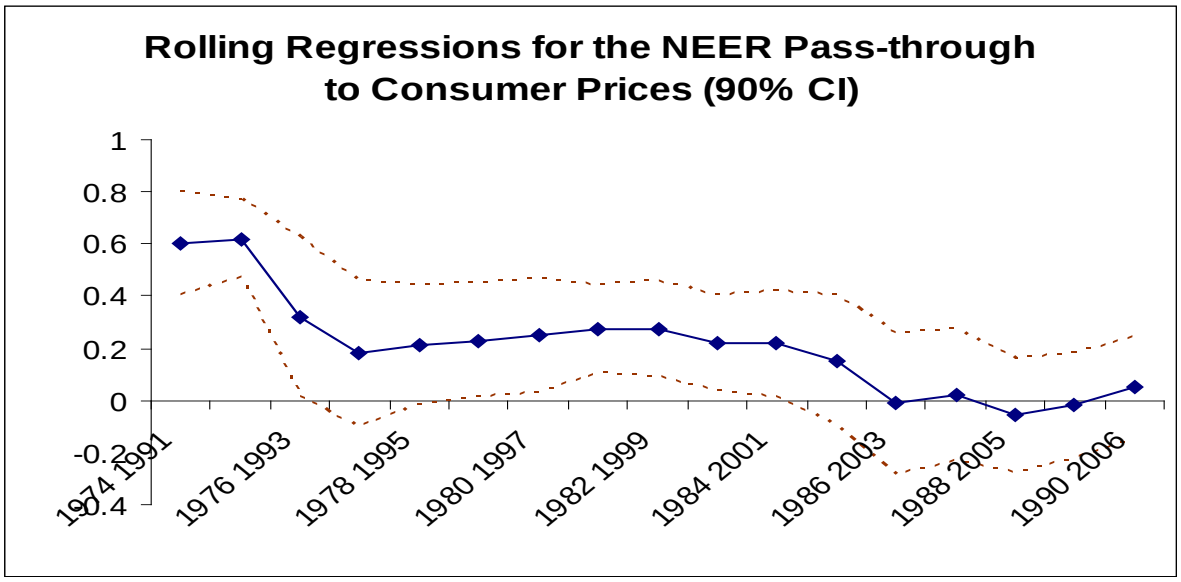


FIGURE 4C
ROLLING REGRESSIONS FOR ERPT TO PRODUCER PRICES

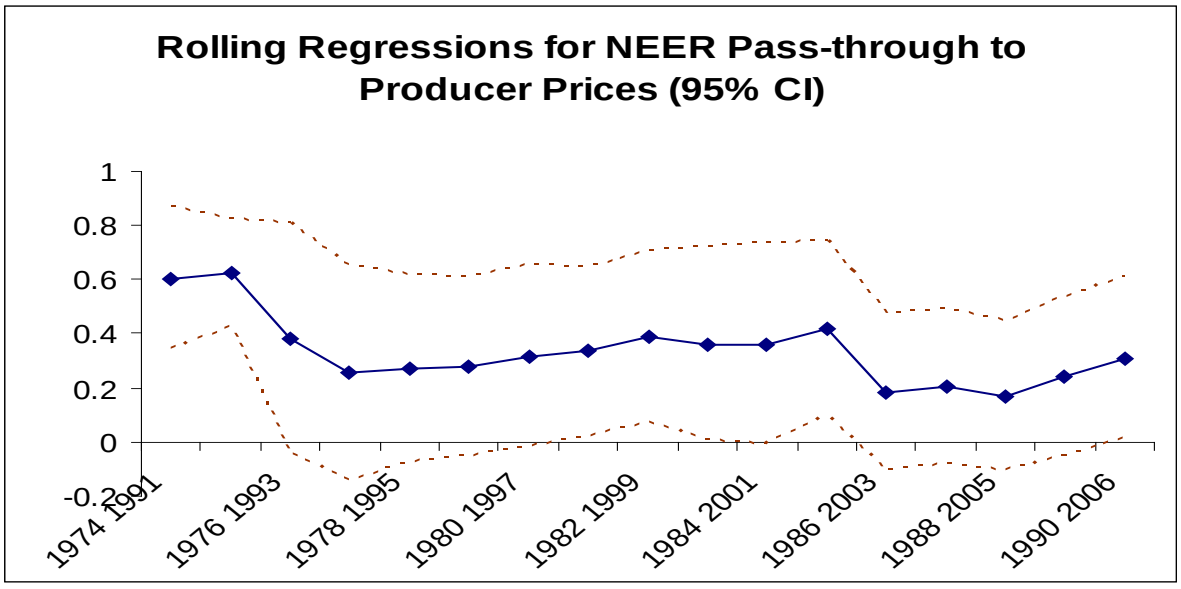
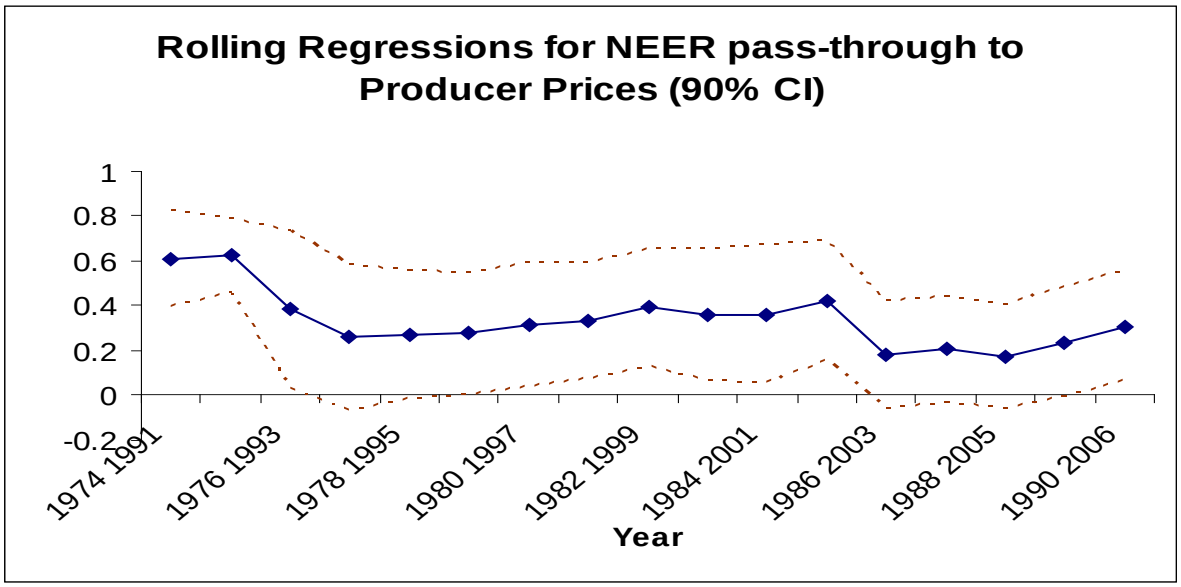


FIGURE 4D
ROLLING REGRESSIONS FOR ERPT TO PPI



CONCLUSION

This study estimates the exchange rate pass-through to external and internal prices of Bangladesh. Nominal effective exchange rate variables, which are not readily available in existing databases, are constructed for the estimation. We test the hypothesis that unlike developed countries, ERPT should be 'full' for developing countries. We also examine whether trade liberalization has a significant effect on external and internal prices. Finally, we estimate rolling regressions to depict the responses of external and internal prices to exchange rate movements over time.

Estimated results indicate that ERPT to external prices (i.e., import and export prices) are statistically significant and 'full'. However, ERPT to internal prices (i.e., consumer and producer prices) are found to be 'partial'. Trade liberalization is found to be a significant determinant of internal prices.

Rolling regressions demonstrate that responses of external prices to exchange rate movement have been significant and consistently one until 2003. However, this pass-through has fallen considerably in subsequent years. This finding is in accordance with the evidence reported by Marazzi *et al.* (2005) and Frankel *et al.* (2005). The responses of internal prices to exchange rate movement, however, are relatively small and unstable in Bangladesh.

We have not found any evidence of pricing-to-market behaviour in import and export of Bangladesh. There is no evidence of PPP between Bangladesh and its trade partners either. The theoretical prediction about the complete exchange rate pass-through in developing countries cannot be rejected when we take the external prices into consideration. However, we reject this theoretical prediction when we take the internal prices into account. No significant difference is found between exchange rate pass-through to consumer price and producer price.

ENDNOTE

1. Exchange rate pass-through to import price is considered as the first stage pass-through because the exchange rate directly affects the import prices. We know that CPI (basket) includes both domestic and

imported products. Hence, domestic price may be affected by the import prices. Exchange rate pass-through to domestic prices are therefore called the second stage pass-through.

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APPENDIX IA
TRADE-SHARE AND TRADE-WEIGHT (%) FOR IMPORT OF BANGLADESH

Countries	Weight (%) for each country	Bangladeshi import-share (%)
Australia	2.59	1.99
Canada	1.95	1.495
China	12.25	9.39
Denmark	0.87	0.66
France	1.22	0.935
Germany	3.21	2.46
Hong Kong	6.10	4.68
India	14.89	11.41
Indonesia	2.36	1.81
Italy	1.15	0.89
Japan	9.84	7.54
Korea	5.03	3.85
Kuwait	3.91	3.00
Malaysia	2.24	1.72
Netherlands	1.71	1.31
Pakistan	1.57	1.21
Saudi Arabia	3.19	2.45
Singapore	8.99	6.89
Sweden	1.08	0.83
Switzerland	1.52	1.16
Thailand	2.42	1.86
UAE	2.99	2.29
UK	3.50	2.69
USA	5.40	4.14
Total	**100**	**76.66**

APPENDIX IB
TRADE-SHARE AND TRADE-WEIGHT (%) FOR EXPORT OF BANGLADESH

Countries	Weights (%)for each country	Bangladeshi Export-share (%)
Australia	0.69	0.54
Belgium	3.18	2.47
Canada	3.06	2.38
China	0.91	0.71
Denmark	1.17	0.91
France	6.99	5.43
Germany	14.01	10.89
Hong Kong	1.99	1.55
India	1.50	1.17
Italy	5.89	4.58
Japan	2.35	1.83
Netherlands	4.52	3.52
Pakistan	1.34	1.045
Singapore	1.34	1.05
Spain	2.75	2.14
Sweden	1.64	1.28
Switzerland	0.67	0.52
UK	11.49	8.94
USA	34.49	26.82
Total	**100**	**77.78**