Examining responsiveness of India's trade flows to exchange rate movements

Anirudh Shingal

27. December 2007

Examining Responsiveness of India's Trade Flows to Exchange Rate Movements

Anirudh Shingal[1]

March 18, 2010

Abstract

Determinants of trade flows have always attracted researchers. In this paper, we model monthly trade flows in India over January 2000 – December 2007 in a bid to gauge their responsiveness to exchange rate movements. Capital account and overall BOP surplus have led the Indian Rupee (INR) to appreciate and forex reserves to accumulate. In so far as the RBI intervenes to stem this forex accretion by the net purchase of USD, it puts further pressure on the INR to appreciate. It therefore becomes important to study the response of the current account to these changes in the exchange rate. We employ standard empirical estimations of India's export supply and import demand functions using data from the Reserve Bank of India. We also assess the short-term dynamics of these trade flows through error correction models. Finally, we estimate vector auto regression models to gauge the extent of contemporaneous interaction between trade flows and the explanatory variables in the system.

JEL classification: F10, F17, F40, F47

Key words: India, trade, imports, exports, exchange rate, VAR, Granger-causality

---

[1] Senior Research Fellow, WTI and Research Affiliate, CARIS. This paper was written during my consultancy with the Treasury Research Group of ICICI Bank Ltd. over July-December 2007. I would like to thank Samiran Chakraborty for both suggesting this topic for research and for his excellent inputs and comments. The usual disclaimer applies. Address for correspondence: World Trade Institute, Hallerstrasse 6, 3012 Bern, Switzerland; Email: anirudh.shingal@wti.org.

Table of Contents

1. Introduction 3
2. Model specification from literature 3
3. Data 7
4. Preliminary examination 8
5. Cointegration and Error Correction Models (ECM) 8
6. Results from multivariate analysis 9
7. Contemporaneous determination of trade flows 10
8. Conclusion 11

References 13

Table 1: Estimating the single-equation import demand function 15
Table 2: Estimating the single-equation the export supply function 15
Table 3: Contemporaneous determination of import demand 16
Table 4: Contemporaneous determination of export supply 16
Table 5: Estimating VAR for import demand 17
Table 6: Estimating VAR for export supply 17
Table 7: Joint determination of trade flows 18

Annex Table 1: Summary statistics 19
Annex Table 2: Results from ADF unit root tests 19
Annex Table 3: Correlation between import demand and explanatory variables 19
Annex Table 4: Correlation between export supply and explanatory variables 19
Annex Table 5: Results from the Johansen-Juselius test for cointegration 20

Bivariate charts for import demand 21
Bivariate charts for export supply 22

Series plots 23

1. Introduction

Determinants of trade flows have always attracted researchers. Such an interest basically stems from the close linkage between the current account and exchange rate performances in any given economy. In a similar vein, this study is an attempt to model monthly trade flows in India over January 2000 – December 2007 in a bid to gauge their responsiveness to exchange rate movements. In a sense, the idea is to study the effectiveness of Central Bank intervention on the current account especially in the wake of increasing capital flows that India has witnessed in recent years and its impact on the balance of payments (BOP). Capital account and overall BOP surplus has led the Indian Rupee (INR) to appreciate and foreign exchange (forex) reserves to accumulate. In so far as the Reserve Bank of India (RBI) intervenes to stem this forex accretion by the net purchase of USD, it puts further pressure on the INR to appreciate. It therefore becomes important to study the response of the current account to these changes in the exchange rate.

In what follows, we employ standard empirical estimations of India's export supply and import demand functions using data from the RBI. We also assess the short-term dynamics of these trade flows. Most studies in the literature, including those covering India over earlier time periods, look at annual trade flows and in that this study is a departure as it examines these flows on a monthly basis. *A priori* imports should be explained by the exchange rate, tariffs and national income while exports should most likely be determined by global purchasing power and domestic supply-side factors. Domestic and foreign prices should also play a part in determining these flows. Finally, we estimate vector auto regression models to gauge the extent of contemporaneous interaction between trade flows and the explanatory variables in the system.

The structure of the paper is as follows. Section 2 reviews the model specification from literature while Sections 3 and 4 look at the data and its preliminary examination. Section 5 discusses the concepts of cointegration and error correction models. Sections 6 and 7 discuss the results from multivariate single equation estimation and contemporaneous determination of trade flows, respectively. Section 8 concludes.

2. Model specification from literature

Investigations of determinants of trade flows are basically directed toward assessing the effects of currency depreciation on the current account. There are two major approaches to investigating the effects of a real devaluation on the trade balance of a country, namely the 'elasticities' and the 'trade balance' approaches. Here we shall use the former.

From an econometric point of view, the elasticities approach is based on estimating the import and export demand functions. In most studies, export (import) volumes are regressed on effective exchange rates, relative export (import) price, and world (domestic) real income. These elasticities are then used to assess the validity of famous theories such as the Marshall-Lerner-(Robinson) Condition[2]. This, of course, is a fairly static treatment of the behavior of trade flows and one can also estimate more dynamic models to make J-curve type of arguments[3].

Goldstein and Khan (1985) provide a survey of studies on income and price effects in foreign trade, with an excellent discussion of the specification and econometric issues in trade modeling, as well as a summary of various estimates of price and income elasticities and related policy issues. They maintain that trade relationships are either gradual or change suddenly. Gradual changes are due to the process of economic development or emanate from a change in government policies. Sudden changes, on the contrary, are due to fluctuations in the exchange rate or large increases in oil prices.

All major studies in the literature in this area base their analyses on the imperfect substitutes model[4] and regress import volumes on relative import prices and real domestic income; and export volumes on relative export prices and real world income. Theoretically, price and income elasticities are expected to have negative and positive signs, respectively. An important assumption is the perfect elasticities of import and export supplies that allows us to restrict our attention to only the demand side. Relaxing this assumption, on the other hand, therefore complicates the picture.

It is also important to note that all elasticities approach models focus on aggregate data for volume variables, such as import/export volumes and real incomes. Here two related questions can be posed as in Goldstein and Khan (1985) and Theil (1954). First, is it really necessary to estimate the disaggregated relationships and then to collect them together to get an aggregate estimate? Second, if our answer to this is in the affirmative, how should this task be carried out? The answer to the former was formulated in the Goldstein and Khan (1985) survey. They argued that when the effect of the determining variables is exactly the same in aggregate and disaggregated models, or if there is a stable relationship between the components and aggregate explanatory variables, then we can be indifferent between aggregate and disaggregated equations[5].

Most studies in the literature, except Bahmani-Oskooee (1986), use a static framework, which is consistent with the formulation of the Marshall-Lerner stability condition, which does not involve any dynamics. The satisfaction of the condition however is dependent on the type of formulation employed, variables involved, and sample period. Therefore, each econometric case of trade flows can be perceived as an island in itself.

---

[2] This says that 'a depreciation or devaluation of a country's currency will improve its current-account balance if the sum of the absolute values of the price elasticities of domestic and foreign demand for imports is greater than unity, provided that trade balance -which is assumed to be equal the current account balance- is zero initially.

[3] Goldstein and Khan (1985) and Junz and Rhomberg (1973) state that the response of imports and exports to changes in other variables is not instantaneous due to recognition, decision, delivery, replacement, and production lags. So a dynamic treatment is required. However, the formulation of the Marshall-Lerner Condition itself does not involve any dynamics.

[4] This model says that neither imports nor exports are perfect substitutes for the domestic goods of the country under consideration.

[5] For more detail, refer to Grunfeld and Griliches (1960) and Aigner and Goldfeld (1974).

Khan (1974), for instance, investigated annual date for a set of developing countries[6] over 1951-1969 estimating the following import demand function:

$log\ MD_{it} = a_0 + a_1 log\ (PM_i/PD_i)_t + a_2 logY_{it} + U_t$,

where MD_{it} is the quantity of imports of country i at time t, PM_i is the unit value of imports in country i, PD_i is the domestic price level of country i, Y_i is the real GNP of country i, and U_t is an error term associated with each observation.

Analogously, the export supply function, of the following specification was estimated:

$log\ XS_{it} = b_0 + b_1 log\ (PX_i/PW)_t + b_2 logYW_t + V_t$,

where XS_{it} is the quantity of exports of country i, PX_i is the unit value of exports of country i, PW is world price level, and W is the real world income (proxied by OECD real GNP).

Since each variable is defined in logarithmic terms, the estimated coefficients are the elasticities of imports and exports with respect to the corresponding variables. Having estimated these functions using OLS, Khan reported that prices did play an important role in determining developing countries' imports and exports and that the Marshall-Lerner Condition was satisfied.

Warner and Kreinin (1983) also employed a similar model[7], but their approach was different from Khan (1974) in two respects: Firstly, they used two distinct investigation periods[8], corresponding to fixed and flexible exchange rate regimes, to analyze the behavior of the model in the two periods. Secondly, they estimated the import demand functions as Khan (1974) did, but also repeated the estimation after excluding petroleum products.

Import demand function for the 1957:1-1970:4 period:
$lnM = c + a_1 lnY + a_2 ln(PM/PD)$
$lnM = c + b_1 lnY + b_2 ln\ PD + b_3 lnPM$

Import demand function for the 1972:1-1980:4 period:
$ln\ M = c + a_1 lnY + a_2 ln\ PM/PD$
$ln\ M = c + b_1 lnY + b_2 lnPD + b_3 lnPM$
$ln\ M = c + c_1 lnY + c_2 lnPD + c_3 lnPM^{FC} + c_4 lnE$

---

[6] Countries included Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Ghana, India, Morocco, Pakistan, Peru, the Philippines, Sri Lanka, Turkey, and Uruguay.

[7] Countries included the United States, Germany, France, Japan, the United Kingdom, Canada, Italy, Netherlands, Belgium, Sweden, Denmark, Switzerland, Norway, Finland, Austria, Spain, Ireland, Austria, and the New Zealand.

[8] Quarterly data for the periods 1957:1-1970:4 (fixed exchange rate period) and 1972:1-1980:4 (floating exchange rate period).

where, PM^{FC} is the import price in foreign currencies, M is the volume of imports on a per capita basis, Y is the real GNP on a per capita basis, PD is domestic prices, PM/PD denotes the relative prices, and E stands for the exchange rate. Exchange rate was included in the model only for the floating exchange rates period and it was calculated as an import-weighted effective exchange rate.

Their export supply equation was the following:

$$ln\ X_i = c + a_1 ln\ YW_i + a_2 lnPx^{LC}{}_i + a_3 lnE_i + a_4 ln\ E^P{}_i + a_5 lnP^{FC}comp$$

where X_i is the volume of the country's exports, YW_i is the weighted average GDP of 23 major importing countries facing country i, $Px^{LC}{}_i$ is the export unit value index of the country i (1974=100), E_i is the effective exchange rate index of country i's currency (1975=1), EP_i is the expected rate of change in the exchange rate, which is proxied by $E^P=[0.7(\log E_t - \log E_{t-1}) + 0.3(\log E_{t-1}-\log E_{t-2})]$, following Wilson and Takacs (1979). P^{FC}comp is the average export price of 64 competing countries expressed in foreign currencies, weighted by each competing country's exports into each of the markets.

Having estimated the demand for imports and exports using OLS, Warner and Kreinin reported that the introduction of floating exchange rates appeared to have affected the volume of imports in several major countries, but the direction of change varied between them. Thus, exchange rate and the export price of competing countries were found to be powerful determinants of a country's exports.

Bahmani-Oskooee (1986) used quarterly data over 1973-1980 and provided estimates of aggregate import and export demand functions for seven developing countries[9]. They also provided estimates of price and exchange rate response patterns by introducing a distributed lag structure on relative prices and effective exchange rate. Given their dynamic approach to the determination of trade flows, Bahmani-Oskooee (1986) presented a more realistic setup and their results supported Orcutt’s (1950) earlier conjecture about trade flows adjusting differently to different price stimuli. Specifically, Bahmani-Oskooee (1986) found trade flows to be more responsive to changes in relative prices than to changes in exchange rates in the long-run.

Two more recent studies in this area, Bahmani-Oskooee and Niroomand (1998) and Bahmani-Oskooee (1998), employed the Johansen (1988) and Johansen-Juselius (1990) cointegration analyses to match the long-run characteristics of the Marshall-Lerner Condition with cointegration analysis. These studies were the first to apply the Johansen-Juselius technique to estimate trade elasticities. Estimating the equations for 30 countries, the authors concluded that for almost all cases devaluations could improve the trade balance. Bahmani-Oskooee[10] (1998) used quarterly data for the period 1973-1990 with a

[9] Countries included Brazil, Greece, India, Israel, Korea, South Africa, and Thailand.

[10] Countries included Greece, Korea, Pakistan, the Philippines, Singapore, and South Africa.

slight modification of the import and export demand equations in Bahmani-Oskooee and Niroomand (1998) by including nominal effective exchange rate as an explanatory variable.

In this paper, we use the following specification for import demand:

$$\boldsymbol{ln(Mval/WUVx)_t = a_0 + a_1lnPD_t + a_2lnY_t + a_3lnTAR_t + a_4lnNEER_t + a_5STRm + \varepsilon_t}$$

where *Mval* is the value of imports, *WUVx* is the index of unit value for world export price, PD is the domestic price level, Y is the real GDP, TAR are the unweighted applied tariffs, NEER is the Nominal Effective Exchange Rate, STRm is a dummy variable representing structural breaks in the import data and ε is the error term. A priori, we expect a_1, a_2 and a_4 to be positive and a_3 to be negative.

Analogously, the export supply function has the following specification:

$$\boldsymbol{ln(Xval/WUVm)_t = b_0 + b_1lnPD_t + b_2lnWY_t + b_3lnIIP_t + b_4lnNEER_t + b_5STRx + v_t}$$

where *Xval* is the value of exports, *WUVm* is the index of unit value for world import price, WY is an indicator of global purchasing power, IIP is the domestic index of industrial production, STRx is a dummy variable representing structural breaks in the export data and v is the error term. A priori, we expect b_1 and b_4 to be negative and b_2 and b_3 to be positive.

3. Data

Essentially, trade data is available in value terms and needs to be deflated by unit export and import value figures for the world (obtained from the IMF's IFS) to get, respectively, the import and export volumes in the above specifications. Further, since real GDP data is quarterly for most countries, we decided to use data on the Index of Industrial production (IIP), which is available on a monthly basis, to proxy domestic income effect on import demand and global income effect on export supply. For the latter, we look at India's top export destinations and weigh their individual IIPs by the respective share of India's exports to these countries to get a composite proxy for global income for use in the export supply function. Domestic prices are measured by the index of wholesale prices (WPI). Tariff data is available only annually and has been culled out from the WTO's Trade Policy Reviews for India (various years). Given the log-linear specification of the model, the coefficients indicate the elasticities of import demand and export supply with respect to the included explanatory variables.

We look at monthly trade flows for India from 2000 to 2007 and exclude flows pertaining to trade in gems, jewelery and oil[11] from our analysis as trade in such flows is likely to be relatively price inelastic. India's top export markets include the US, UK, UAE, China, Japan, Hong Kong, Singapore, Italy, Germany, Belgium and the Netherlands. Exports to

---

[11] This amounts to excluding about 23% of all exports and 29% of all imports by value (USD mn).

these markets accounted for 58% of India's total exports in 2006-07. All base data is in USD mn, wherever applicable, and has been sourced from the RBI, the IMF and Ecowin. The summary statistics for the variables used are reported in Annex Table 1.

4. Preliminary examination

Since we are dealing with time series, we needed to check our data for stationarity using the Augmented Dickey-Fuller (ADF) unit-root tests. The results from these are reported in Annex Table 2. We found the log of all variables to be non-stationary, specifically to be I(1).

Results from bivariate analysis can be seen from the correlation tables for imports and exports, respectively (see Annex Tables 3 and 4). Domestic IIP, prices and tariffs have a high correlation with import demand, but the coefficient for NEER, though high, is counter-intuitive. Export supply seems to be influenced more by domestic prices and IIP but the result for prices is counter-intuitive. Global income effect and NEER also have a pronounced effect on export supply. The correlation tables also confirm the presence of significant multicollinearity in the data for both the import demand and export supply functions.

Finally, visual and analytical examination of the underlying import and export data using the Chow breakpoint-test revealed the presence of a structural break in trend in both imports and exports in July 2004. To account for this, we use dummy variables STRM and STRX that take a value of 0 before July 2004 and behave like trend dummies thereafter.

5. Cointegration and Error Correction Models (ECM)

As observed, the series in our model are non-stationary. Problem of spurious correlation in estimation arise if the series in any empirical model are non-stationary. One way to solve this problem is by differencing these series, which would render them stationary. However, differencing loses the long run relationship between variables, which is contained in the levels, not in the differences and this, therefore, is not the best approach.

Literature[12] tells us that it is possible that a linear combination of two or more series is integrated of a lower order i.e. the common stochastic trends cancel out yielding a stationary series. This is the concept of Cointegration and the concomitant equation is called the Cointegrating Equation, which expresses the long run relationship between the dependent and independent variables. In fact, the application of Ordinary Least Squares (OLS) to a cointegrating equation yields 'super-consistent' estimates[13].

[12] For e.g. see Engle and Granger (1987).
[13] These converge to their true values at a faster rate than if the series used were stationary.

If the residuals obtained from the cointegrating equation are stationary[14], then the next step is to form an ECM, which integrates short-run dynamics into the long-run adjustment process. In setting up an ECM, the first differences of the variables are regressed against each other together with the lagged residual from the cointegration term. The latter is the 'Error Correction Term' and measures the short run disequilibrium. The coefficient on the error correction term in the ECM is a measure of the speed of adjustment to long run equilibrium from a situation of short run disequilibrium.

6. Results from multivariate analysis

The Johansen-Juselius test for cointegration (results reported in Annex Table 5) indicated the presence of one cointegrating equation (CE) significant at 5% for both import demand and export supply. Results from the CEs, reported in Tables 1 and 2, suggest that monthly imports are largely determined by domestic demand proxied by IIP (elasticity of 0.69) and domestic prices (elasticity of 2.1). The impact of NEER, though insignificant, is in the "right" direction. Tariffs report insignificance, which most probably is due to the lack of monthly variation in tariff data given that the latter is available only annually. If we used a dummy variable to represent tariffs with the dummy taking value 1 for unweighted applied tariffs in excess of 28%, this variable still registered insignificance. However, NEER now reported a significant result with an elasticity of 0.9 significant at 1%. The elasticities of IIP and domestic price also rose to 0.78 and 2.4, respectively, in this case. Alternatively, if we used the INR-USD exchange rate, instead of the NEER, then the exchange rate turned up significant at 1% with an elasticity of -1, which also conformed to economic intuition.

<Insert Table 1 here>

Monthly exports, on the other hand, are primarily determined by domestic supply-side factors proxied by the IIP (elasticity of 1). The price effects are significant but counter-intuitive for both domestic prices and NEER. However, this counter-intuitive price effect may be explained if we account for a majority of the imports being used as intermediate inputs into production for exports[15]. The exchange rate becomes insignificant if we replace NEER by the INR-USD exchange rate but has a sign in the "right" direction.

If we only include the sample period from 2004 onwards to examine the period of increasing capital flows (results reported in columns III-IV of the export supply function Table 2), both the exchange rate (NEER or INR-USD) and domestic prices register insignificance as explanatory variables for exports and only supply-side factors and global purchasing power show significance.

<Insert Table 2 here>

---

[14] Unit root tests on these residuals need to be performed without a trend, drift and the intercept term. If the residuals turn out to be non-stationary, then the cointegrating equation is rendered invalid.

[15] At the turn of the century, for instance, imports of intermediate goods and raw materials comprised a fourth of all imports. Intermediate goods in turn accounted for roughly 15% of all manufacturing output. The share of manufacturing in exports was more than 75% (Virmani et. al., 2004).

The null of unit root is rejected by the residuals of both the long-term import demand and export supply functions, thereby indicating that an error correction model (ECM) can be formed in both cases. From the ECM, we find that exports converge marginally more rapidly to equilibrium from positions of short-run disequilibria at a rate of 81.4% per month as compared to imports (80%).

Thus, exchange rate movements do not seem to have much impact on exports, even at a time when India has witnessed a surge in capital flows and consequent INR appreciation[16].

7. Contemporaneous determination of trade flows

One shortcoming of the single equation models used above is the assumption of instantaneous response of trade flows to the variables in the system. Typically, however, imports and exports may respond to movements in the exchange rate, for instance, after considerable lags. We therefore checked for the optimal lag length in determining these flows using the Ljung Box Q-statistic and found the former to be 13 in the case of imports and 10 in the case of exports. Thus, exports for instance, respond "best" to the variables in our system after a lag of 10 months while for imports the "best response" is after 13 months.

Comparing the results (reported in Tables 3 and 4) from these with the instantaneous response models used above, we find that the price effect becomes more pronounced in the case of imports (but only with the INR-USD exchange rate) while the income effect loses all significance throughout these specifications. Tariffs continue to report insignificance. In the case of exports, for the complete sample period, the elasticity of domestic supply side factors falls now compared to the instantaneous response model, while that of domestic prices rises (though their impact remains counter-intuitive). NEER loses significance while the INR-USD exchange rate exhibits a significant but counter-intuitive impact. If we only look at the period since 2004 (results reported in columns III-IV of the export supply function table here), then the supply-side factors lose significance, while the impact of domestic prices becomes more pronounced (even as it continue to be in the "wrong" direction). The impact of the exchange rate, however, remains insignificant.

<Insert Tables 3 and 4 here>

It may be the case that the feedback among the variables is not one-way; rather each variable may affect the others at certain number of lags. To account for this, we estimate two-period vector auto regression specifications (VAR) for imports and exports using the unrestricted VAR model. The definitions of data employed in estimating the VAR are identical to those used in the single equation models. The standard practice while setting

[16] Interestingly, if we estimate a model in growth rates, instead of log levels, exchange rates report an impact in the "right" direction for both imports and exports but the result remains insignificant. Moreover, the model in growth rates lacks any explanatory power (R-squared value is around 0.05).

up a VAR is to follow the sequence ordering of variables from the most exogenous to the most endogenous.

The contemporaneous relationship among the variables in the import demand VAR (see Table 5) follows the sequence ordering from NEER to tariffs to domestic prices and demand, finally to imports. The results shows the importance of lagged NEER, domestic prices lagged by one period and lagged imports, with all these, with the exception of NEER lagged by two periods, suggesting impacts that conform to economic intuition. Thus, in contrast to the result of the single equation model, NEER lagged by one period has a significant impact on import demand (elasticity of 2), while lagged domestic demand does not report any significance. The analysis also points to the existence of a partial import demand adjustment function with lagged imports affecting import demand in the current period.

<Insert Table 5 here>

In the case of the export supply VAR (see Table 6), the contemporaneous relationship among the variables follows the sequence ordering from global purchasing power to NEER domestic prices and supply-side factors, finally to exports. The export supply VAR only shows the importance of supply-side factors lagged by two periods in determining export supply in the current period. While domestic prices and NEER showed significant, albeit counter-intuitive impacts in the single equation model, they do not report any significance in the VAR estimation.

<Insert Table 6 here>

Finally, we carry out a simultaneous determination of trade flows in a VAR model wherein trade flows are considered endogenous and the rest of the variables are treated as exogenous. This estimation points to the importance of domestic demand, prices and NEER in jointly determining trade flows (see Table 7). The impacts of domestic prices and NEER are however counter-intuitive in the case of exports. Interestingly, global purchasing power and tariffs do not report any significance, while it is exports (as also imports) lagged by a month that have a bearing on imports and not vice-versa. We find these results to be independent of the ordering sequence of the endogenous and/or exogenous variables in the VAR. Moreover, Granger-Causality tests reject the hypothesis of exports "granger-causing" imports up to three lags, while in the case of imports "granger-causing" exports the hypothesis is always upheld.

<Insert Table 7 here>

8. Conclusion

Appreciation of the INR has led to talk of its negative implications for Indian exporters. However, both our single equation and contemporaneous determination of monthly trade flows in India over January 2000 – December 2007 have shown exports to be determined largely by global purchasing power and domestic supply-side factors, instead of movements in the exchange rate. In view of the theoretical inverse relationship between an appreciation of the domestic currency and exports, how do we reconcile these results? It must be noted that our data is at an aggregate level and its constituent flows may therefore react differently to movements in the exchange rate. In that, it may be more interesting to undertake such a study at a commodity level. However, monthly data is not available at the commodity level, which renders analysis at the aggregate level more viable. It should also be noted that an appreciation of the INR affects imports favorably and a majority of the imports are in fact intermediate inputs into production (for exports). Having said that, the price effect of INR appreciation may be more inimical to the profitability of exporters than to export volumes alone and that is why movements in the exchange rate and their impact on the price component of export value may become more important than what an analysis based on volumes alone may suggest.

References

Aigner, D.J. and S.M. Goldfeld (1974). "Estimation and Prediction from Aggregate Data When Are Measured More Accurately Than Their Components", *Econometrica*, 42:113-134.

Bahmani-Oskooee, M. (1986). "Determinants of International Trade Flows: The Case of Developing Countries", *Journal of Development Economics*, 20:107-123.

Bahmani-Oskooee, M. (1998). "Cointegration Approach to Estimate the Long-run Trade Elasticities in LDCs", *International Economic Journal* 12:89-96.

Bahmani-Oskooee, M. and F. Niroomand (1998). "Long-run Price Elasticities and the Marshall-Lerner Condition Revisited", *Economics Letters*, 61(1):101-109.

Engle, R.F. and Granger, C.W.J. (1987). 'Cointegration and Error Correction: Representation, Estimation and Testing,' Econometrica, 55, pp. 251-76.

Goldstein, Morris & Khan, Mohin S. (1978). "The Supply and Demand for Exports: A Simultaneous Approach," The Review of Economics and Statistics, Vol. 60, No. 2 (Apr. 1978), pp 275-86.

Goldstein, M. and Khan M.S. (1985). "Income and Price Effects in Foreign Trade", in Handbook of International Economics, Vol II:1041-1105, eds. R.W. Jones and P.B. Kenen, Elsevier Science Publishers B.V.

Grunfeld, Y. and Z. Griliches (1960). "Is Aggregation Necessarily Bad?,"*The Review of Economics and Statistics*,42:1-13.

Johansen, S. and K. Juselius (1990). "Maximum Likelihood Estimation and Inference on Cointegration-with Application to the Demand for Money", *Oxford Bulletin of Economics and Statistics*, 52:169-210.

Johansen, S. (1988). "Statistical Analysis of Cointegration Vectors", *Journal of Economic Dynamics and Control*, 12:231-254.

Junz, H.B. and R.R. Rhomberg (1973). "Price Competitiveness in Export Trade Among Industrial Countries", *The American Economic Review*, 63:412-418.

Khan, M.S. (1974). "Import and Export Demand in Developing Countries", *IMF Staff Papers*, 21:678-693.

Orcutt, G. (1950). "Measurement of Price Elasticities in International Trade", *The Review of Economics and Statistictics*, 32:117-132.

Theil, H. (1954). Linear Aggregation of Economic Relations. (North-Holland, Amsterdam)

Virmani, Arvind, Bishwanath Goldar, Choorikkad Veeramani And Vipul Bhatt (2004). "Impact of Tariff Reforms on Indian Industry: Assessment Based on a Multi-Sector Econometric Model," Indian Council for Research on International Economic Relations, Working Paper No. 135.

Warner, D. and M.E. Kreinin. 1983. "Determinants of International Trade Flows", *The Review of Economics and Statistics*, 65:96-104.

Wilson and Takacs (1979). "Differential Responses to Price and Exchange Rate Influences in the Foreign Trade of Selected Industrial Countries", *The Review of Economics and Statistics*, 61:267-279.

World Trade Organization (various years). *Trade Policy Review for India.*

Table 1: Estimating the single-equation import demand function

Dependent variable: LNMddt				
Independent variables	**I#**	**II#**	**III#**	**IV#**
C	-11.9***	-16.8***	-5.6***	-6***
LNIIPt	0.69***	0.78***	0.53***	0.56***
LNPDt	2.1***	2.4***	2.1***	2.19***
LNNEERt	0.39	0.9***		
LNTARIFFt	-0.07		-0.08	
STRMt	0.098*	0.1**	0.065	0.073
TARDVt		0.036		-0.013
LNERt			-1.1***	-1.17***
Incd. Obs	87	90	87	90
R-squared	0.936	0.94	0.94	0.95
DW statistic	1.5	1.5	1.73	1.7
AIC	-1.76	-1.78	-1.85	-1.87
F-statistic	236***	277.36***	261.7***	307.3***
# Robust estimates				
Significance levels: * 10%, ** 5%, * 1%**				

Table 2: Estimating the single-equation the export supply function

Dependent variable: LNXsst				
Independent variables	**I**	**II**	**III**	**IV**
C	-11.3***	-7.4***	-8.67***	-6.3**
LNIIPt	1***	1.13***	1.27***	1.23***
LNPDt	1.1**	0.86**	-0.64	-0.57
LNNEERt	0.67***		0.57	
LNIIPWLDt	0.29	0.009	1.7**	1.78**
STRXt	-0.016	0.0127	0.034	0.036
LNERt		0.15		-0.089
Incd. Obs	91	91	43	43
R-squared	0.93	0.92	0.85	0.84
DW statistic	1.7	1.6	1.5	1.4
AIC	-2.2	-2.1	-2.26	-2.2
F-statistic	222.96***	207.9***	43***	40.3***
Significance levels: * 10%, ** 5%, * 1%**				

Table 3: Contemporaneous determination of import demand

Dependent variable: LNMddt				
Independent variables	**I#**	**II**	**III#**	**IV#**
C	-15.7***	-12.7***	-14.1***	-13.8***
LNIIP(t-13)	0.37	0.29	0.25	0.2
LNPD(t-13)	3.7***	3.5***	4.17***	4.15***
LNNEER(t-13)	-0.25	-0.65		
LNTARIFF(t-13)	-0.044		0.047	
STRM(t-13)	-0.11**	-0.116**	-0.164***	-0.18***
TARDV(t-13)		-0.088		-0.15
LNER(t-13)			-1.28***	-1.22***
Incd. Obs	77	77	77	77
R-squared	0.92	0.92	0.93	0.93
DW statistic	1.88	1.8	2.1	2.1
AIC	-1.54	-1.56	-1.67	-1.67
F-statistic	158.4***	162.35***	183.3***	182.87***
# Robust estimates				
Significance levels: * 10%, ** 5%, * 1%**				

Table 4: Contemporaneous determination of export supply

Dependent variable: LNXsst				
Independent variables	**I#**	**II#**	**III**	**IV#**
C	-9.5***	-7***	-13***	-9.5***
LNIIP(t-10)	0.5***	0.4**	0.215	0.14
LNPD(t-10)	2.3***	2.4***	4.78***	4.76**
LNNEER(t-10)	0.07		0.397	
LNIIPWLD(t-10)	-0.42	-0.38	-2.8**	-2.65**
STRX(t-10)	0.011	-0.013	-0.075	-0.08
LNER(t-10)		-0.6*		-0.53
Incd. Obs	81	81	43	43
R-squared	0.9	0.9	0.8	0.8
DW statistic	2.28	2.4	2.5	2.5
AIC	-1.96	-2	-1.99	-1.996
F-statistic	134.9***	141.8***	31.17***	31.37***
Significance levels: * 10%, ** 5%, * 1%**				

Table 5: Estimating VAR for import demand

	LNNEER	LNTARIFF	LNPD	LNIIP	LNM
LNNEER(-1)	1.17***	-0.26	-0.059	-0.36	2.0**
LNNEER(-2)	-0.38***	0.15	0.026	0.28	-2.03**
LNTARIFF(-1)	-0.019	0.78***	0.0017	0.12	0.05
LNTARIFF(-2)	-0.014	0.0314	-0.0085	-0.12*	-0.078
LNPD(-1)	-0.29	2.55*	1.25***	-1.7**	3.8*
LNPD(-2)	0.18	-2.2*	-0.33***	2.08***	-2.0
LNIIP(-1)	0.035	-0.23	0.032**	0.28**	-0.27
LNIIP(-2)	-0.026	0.087	-0.00092	0.39***	0.31
LNM(-1)	0.0132	-0.11	-0.00022	-0.066	0.2*
LNM(-2)	-0.026*	-0.097	0.00176	0.1**	0.26**
C	1.54***	0.84	0.42	0.057	-7.4
Incd. Observations	85				
R-squared	0.94	0.97	1.00	0.94	0.94
F-statistic	119.63	214.82	3139.06	125.61	116.33
Akaike AIC	-5.91	-2.74	-7.59	-3.56	-1.72
Significance levels: * 10%; ** 5%; * 1%**					

Table 6: Estimating VAR for export supply

	LNIIPWLD	LNNEER	LNPD	LNIIP	LNX
LNIIPWLD(-1)	0.59***	-0.032	0.0095	-0.19	-0.095
LNIIPWLD(-2)	0.21*	-0.12*	0.037	0.125	-0.26
LNNEER(-1)	-0.049	1.19***	-0.039	-0.43	-0.44
LNNEER(-2)	-0.038	-0.35***	0.052	0.4	0.66
LNPD(-1)	0.21	0.05	1.2***	-1.7**	-0.9
LNPD(-2)	-0.24	-0.077	-0.29***	2.34***	2.54
LNIIP(-1)	0.048	0.056	0.022	0.16	-0.38
LNIIP(-2)	-0.063	0.047	0.0075	0.55***	0.94***
LNX(-1)	-0.016	0.015	0.0058	-0.0076	0.15
LNX(-2)	0.085***	-0.033**	-0.0043	-0.057	-0.00047
C	1.12	0.93**	0.017	-1.2	-7.9***
Incd. Observations			89		
R-squared	0.95	0.94	1.00	0.95	0.91
F-statistic	138.55	121.92	3947.85	138.01	75.66
Akaike AIC	-4.87	-5.92	-7.68	-3.51	-1.87
Significance levels: * 10%; ** 5%; * 1%**					

Table 7: Joint determination of trade flows

Simultaneous VAR model		
Independent variables	**LnMddt**	**LnXsst**
LNM(t-1)	0.29***	-0.12
LNM(t-2)	0.15	-0.022
LNX(t-1)	-0.36***	-0.021
LNX(t-2)	-0.017	0.045
C	-17.5***	-10.99***
LNIIPt	0.59***	1.1***
LNPDt	2.1***	1.05**
LNNEERt	1.14***	0.69*
LNTARIFFt	0.0053	-0.099
LNIIPWLDt	0.56	0.32
Included observations	85	
R-squared	0.94	0.93
AIC	-1.82	-2.24
F-stat	141.4	109.4
Significance levels: * 10%; ** 5%; * 1%**		

Annex Table 1: Summary statistics

	M_VAL (USD mn)	M	X_VAL (Usd mn)	X	IIP	IWAHS	NEER	UNWID_APPD_TAR	WLD_UVM	WLD_UVX	WPI_INDEX	XWID_IIPWLD
Mean	6,009.90	49.76	4,774.99	40.93	198.53	7.74	72.36	25.66	110.62	111.35	180.73	44.66
Median	4,674.00	41.91	4,118.50	37.41	189.50	8.00	71.61	29.00	105.23	109.18	177.81	44.91
Maximum	13,546.57	98.05	9,341.52	69.08	289.10	8.57	79.83	32.00	140.04	137.99	215.53	51.64
Minimum	2,260.00	23.00	2,170.68	21.37	154.90	6.40	67.08	15.80	91.17	92.32	145.92	34.33
Std. Dev.	3,196.78	19.96	2,035.55	11.98	33.69	0.85	3.34	6.67	13.71	13.41	20.36	3.85
Skewness	0.74	0.65	0.73	0.61	0.61	-0.67	0.41	-0.73	0.40	0.29	0.18	-0.34
Kurtosis	2.39	2.27	2.24	2.19	2.31	1.88	1.96	1.66	1.85	1.74	1.75	2.25
Jarque-Bera	10.03	8.38	10.47	8.14	7.67	6.13	6.71	14.29	7.46	7.18	6.75	3.97
Probability	0.01	0.02	0.01	0.02	0.02	0.05	0.03	0.00	0.02	0.03	0.03	0.14
Observations	93	90	93	91	93	48	92	87	91	90	96	94

Annex Table 2: Results from ADF unit root tests

Variable	**Lagged differences**	**Intercept**	**Trend**	**I(1)**
lnm	4	0.038***	-	-6.23***
lnx	4	0.035***	-	-7***
lnpd	9	-	-	-3.2**
lniipwld	8	-	-	-1.64*
lnneer	0	-	-	-6.9***
lniip	8	Insig.	0.00047***	-9.1***
lntariff	0	-	-	-9.2***
McKinnon Critical Values: * 10%; ** 5%; * 1%**				

Annex Table 3: Correlation between import demand and explanatory variables

	LNM	LNIIP	LNNEER	LNTARIFF	LNPD
LNM	1.00				
LNIIP	**0.94**	1.00			
LNNEER	**-0.66**	**-0.68**	1.00		
LNTARIFF	**-0.89**	**-0.87**	**0.44**	1.00	
LNPD	**0.95**	**0.94**	**-0.75**	**-0.87**	1.00

Annex Table 4: Correlation between export supply and explanatory variables

	LNX	LNIIPWLD	LNNEER	LNIIP	LNPD
LNX	1.00				
LNIIPWLD	**0.88**	1.00			
LNNEER	**-0.55**	**-0.72**	1.00		
LNIIP	**0.96**	**0.90**	**-0.59**	1.00	
LNPD	**0.94**	**0.92**	**-0.65**	**0.95**	1.00

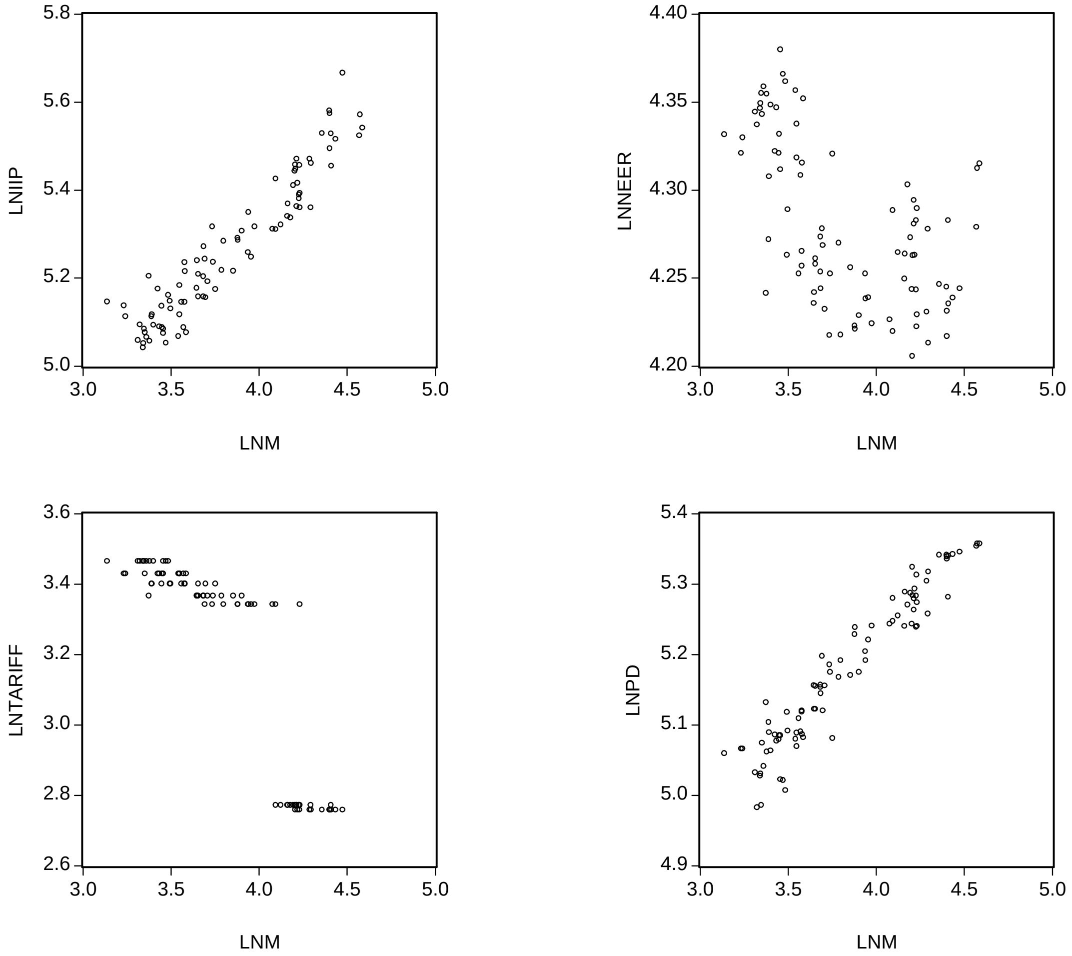
Annex Table 5: Results from the Johansen-Juselius test for cointegration

Series: LNM LNIIP LNNEER LNTARIFF LNPD				
Eigenvalue	LR	5%CV	1%CV	Hypd. No. of CE(s)
0.29	70.16	68.52	76.07	None *
0.25	41.65	47.21	54.46	At most 1
0.10	17.52	29.68	35.65	At most 2
0.09	8.71	15.41	20.04	At most 3
0.01	1.16	3.76	6.65	At most 4
n=84				

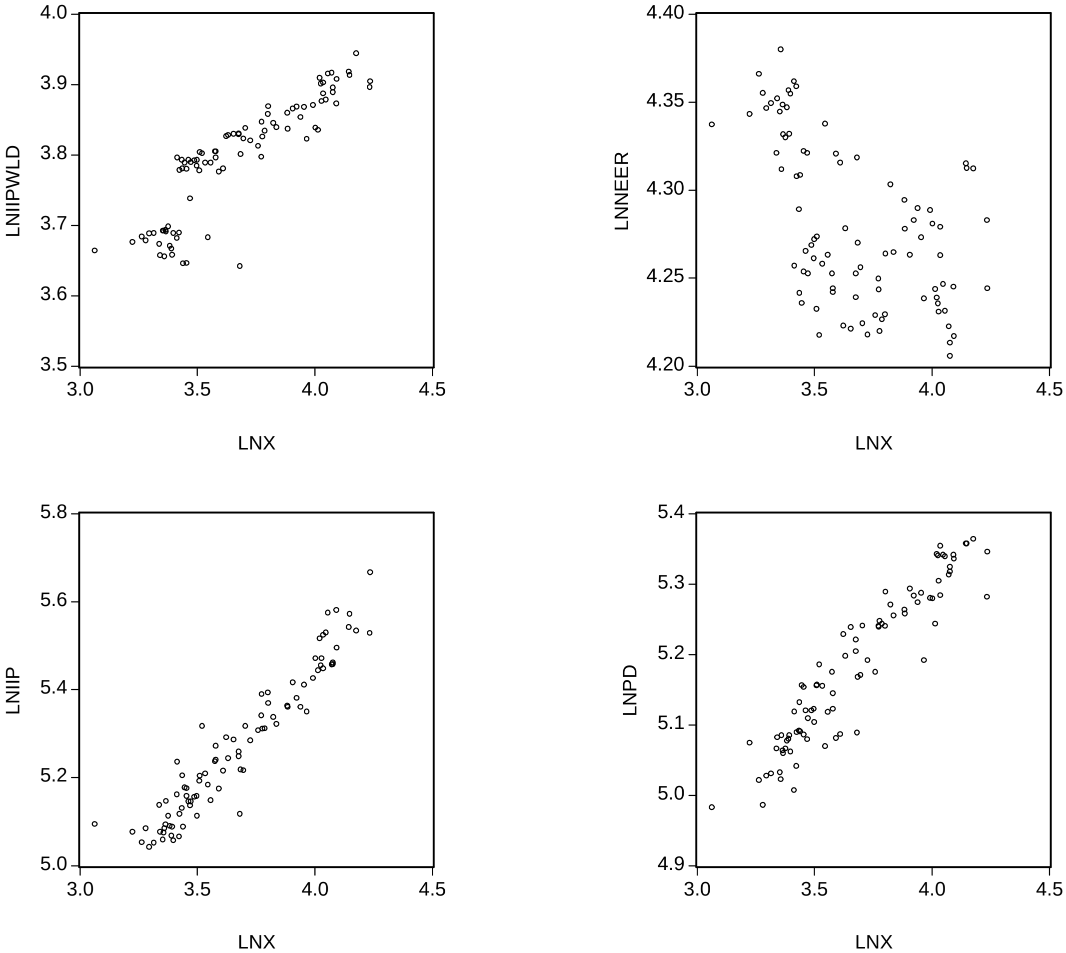
Series: LNX LNIIPWLD LNNEER LNIIP LNPD				
Eigenvalue	LR	5%CV	1%CV	Hypd. No. of CE(s)
0.29	74.40	68.52	76.07	None *
0.22	43.98	47.21	54.46	At most 1
0.14	22.52	29.68	35.65	At most 2
0.09	8.85	15.41	20.04	At most 3
0.00	0.24	3.76	6.65	At most 4
n=88				

"n" = Number of observations
Test assumption: Linear deterministic trend in the data
**(**) denotes rejection of the hypothesis at 5%(1%) significance level*
L.R. test indicates 1 cointegrating equation(s) at 5% significance level

Bivariate charts for import demand



Bivariate charts for export supply



Series plots