Accounting for City Real Exchange Rate Changes in India

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Abstract

We examine the role of nontraded goods in the city-to-city real exchange rate changes within India. Using Engel's Mean Squared Error (MSE) decomposition we find that nontraded goods explain about 30% of the variation in Indian city real exchange rate changes, rather than the small amount found in cross-country studies. To investigate we consider the role of the consumption elasticity of substitution – between traded and nontraded goods, extending Engel's methodology to the case of non-unit elasticity, as is approprviate to our application. We find that a realistic elasticity value yields results more in line with cross-country studies.

JEL Classification: F3, F4

Keywords: Real Exchange Rate, Nontraded goods, Consumption Elasticity of Substitution, Indian Cities

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1 Introduction

The role of nontraded goods in explaining the fluctuations in the real exchange rate (RER) has been widely apprecviated in the theoretical models, but in a seminal empirical paper Engel (1999) decomposed the RER for developed countries in terms of traded goods and nontraded goods and found that contrary to the expectations, the role of relative prices of nontraded goods in US real exchange rate fluctuations is insignificant. This decomposition of the real exchange rate fluctuations casts doubt on the merit of the theoretical models focusing on the presence of the nontraded goods in explaining the fluctuations of the RER (Obstfeld and Rogoff, 2000). The presence of highly volatile nominal exchange rates, observed between-country differences in institutions, and difference in data quality may bias the result of such an exercise. Consequently, researchers examined data for the fixed exchange rate/managed floating period and found that nontraded goods explain some portion of the RER movement (Mendoza, 2000).

To shed light on the contribution of nontraded goods to the RER changes under permanently fixed nominal exchange rates, Chen, Choi and Devereux (2006) decomposed the US regional real exchange rates following Engel's (1999) methodology, and found that the share of nontraded goods in accounting for real exchange rate fluctuations is much higher than that in Engel's between-country study. They argue that the share of nontraded expenditure in Engel's study is too low to fit U.S. regional data, and that a higher share of expenditure on nontraded goods yields a larger contribution of nontraded goods to the RER fluctuations. Chen et al. (2006) also examined U.S. city real exchange rates and found that the contribution of nontraded goods is around 40% to the city RER changes.

There exists virtually no study for the developing countries[3] that examines the role of traded and nontraded goods in the fluctuations of the RER. The main stumbling block is the lack of disaggregated data for different countries. The importance of information about the sources of the fluctuations in the RER can not be overemphasized as Rodrik (2008) shows that there exists a

[3]Parsley (2007) examined the role of nontraded good in the RER for middle-income countries of East Asia.

strong relationship between the RER and economic growth. In the extant literature, some authors examine city prices within a country to get some idea about the behavior of the RER[4]. In these studies each city is treated as a proxy for a country and thus the city RER is a proxy for the cross country RER but abstracted from the nominal exchange rate fluctuations and trade barriers.

The availability of disaggregated price indices for cities within India gives us a specvial opportunity to examine the role of nontraded goods in the RER changes, in the context of a developing country. The Bureau of Labour Statistics of India reports consumer price indices for industrial workers for about 70 cities all across India. It not only reports aggregated CPI but also reports disaggregated indices like food price indices and clothing, footwear, and bedding indices for all these locations. Since food, clothing, footwear, and bedding are the main traded items in the consumption bundle of the industrial workers, these data allow us to create traded and nontraded goods price indices for all these cities. Consequently, we can examine the contributions of nontraded goods to the city RER fluctuations in India. The results will shed some light on the sources of the cross-country RER fluctuations in developing countries. Applying the Engel (1999) methodology to India city data, we find a much larger role for nontraded goods in city real exchange movements than did Engel (1999) for developed country national exchange rates. So, the results seem contrary to Engel's findings.

One methodological aspect of Engel (1999) is the representation of the consumer price index as a geometric weighted average of traded and non-traded goods prices indexes. This is consistent with a representative consumer having Cobb-Douglas utility with unitary elasticity between traded and nontraded goods. As a matter of fact, by examining time series and cross-section data researchers suggest that the unitary elasticity of substitution is not the norm but the exception[5]. Stockman and Tesar (1995) found that the elasticity of substitution between traded and nontraded goods in consumption is only 0.44. Mendoza (1995) found the elasticity of substitution is 0.74

[4] Cecchetti et al. (2002), Chen and Devereux (2003) for U.S.cities, Sonora (2005) for Mexican cities, Morshed et al. (2006) for Indian cities, and Rangakakulnuwat and Ahn (2006) for Thai regions.

[5] A number of papers discuss the role of elasticity of substitution in production in real exchange rate dynamics and found that the elasticity of substitution in production is a crucvial varviable. See Morshed and Turnovsky (2006) for a recent contribution.

for OECD countries while Ostry and Reinhart (1992) found the same for the poor countries to be 1.3. For poor countries, an elasticity value different than 1, and instead 1.3, is consistent with the literature – Ostry and Reinhart (1992). We therefore derive and re-estimate the contribution of nontraded goods to RER movements, in the setting with non-unity elasticity. With a realistic elasticity value, the role of nontraded goods drops dramatically. Hence, Engel's view – that nontraded goods are not important for understanding RER movements, holds up substantvially once the methodology is suitably modified for developing countries.

2 Decomposition of Real Exchange Rate Movements

We show the decomposition of real exchange rate movements under different consumption aggregators in the following section.

2.1 Cobb-Douglas Utility Function

If the utility function underlying a price index at city i is a Cobb-Douglas aggregator such as

$$U_i = C_{iT}^{1-\alpha} C_{iN}^{\alpha} \tag{1}$$

where C_{iT} is the consumption of traded goods and C_{iN} is the consumption of nontraded goods and α is the share of nontraded goods in the consumption basket, then the price index can be written as

$$P_i = P_{iT}^{1-\alpha} P_{iN}^{\alpha} \tag{2}$$

where P_{iT} and P_{iN} are prices of traded goods and nontraded goods, respectively.

Similarly the utility function and price index for a different city j are

$$U_j = C_{jT}^{1-\delta} C_{jN}^{\delta} \tag{3}$$

and

$$P_j = P_{jT}^{1-\delta} P_{jN}^{\delta} \tag{4}$$

where C_{jT} and C_{jN} are consumptions of traded and nontraded goods, respectively and δ is the share of nontraded goods in the consumption basket in city j. The prices of traded and nontraded goods are P_{jT} and P_{jN} respectively.

The city real exchange rate (RER) is defined as

$$Q = \frac{P_j}{P_i} \tag{5}$$

where Q stands for the city RER. By definition this city RER is free from nominal exchange rate fluctuations and also it is invarviant to international trade barriers. Taking logs and rearranging the terms we obtain the following (lower case letters are in log form)

$$q = x + y \tag{6}$$

where

$$x = p_{jT} - p_{iT} \tag{7}$$

via a differential in traded goods prices across cities, and

$$y = \delta(p_{jN} - p_{jT}) - \alpha(p_{iN} - p_{iT}) \tag{8}$$

is a price contrast of nontraded goods relative to traded goods. Researchers including Chen et al. (2006) examined the contributions of x and y to the fluctuations of q and found that the fluctuation in q is mainly generated from fluctuations in x.

2.2 Constant Elasticity of Substitution Utility Function

If the utility function underlying a price index at city i is a constant elasticity aggregator such as

$$U(C_{iT}, C_{iN}) = \left(a_{i1} C_{iT}^{\rho} + a_{i2} C_{iN}^{\rho}\right)^{\frac{1}{\rho}} \tag{9}$$

where a_{i1} and a_{i2} are shares of traded and nontraded goods in total consumption, and $\frac{1}{1-\rho}$ is the consumption elasticity of substitution, then the price index can be written as

$$P_i = \left(a_{i1} \left(\frac{P_{iT}}{a_{i1}} \right)^r + a_{i2} \left(\frac{P_{iN}}{a_{i2}} \right)^r \right)^{\frac{1}{r}} \tag{10}$$

where $r = \frac{\rho}{\rho-1}$.

Similarly the utility function and price index for city j would be[6]

$$U(C_{jT}, C_{jN}) = \left(b_{j1} C_{jT}^{\epsilon} + b_{j2} C_{jN}^{\epsilon} \right)^{\frac{1}{\epsilon}} \tag{11}$$

$$P_j = \left(b_{j1} \left(\frac{P_{jT}}{b_{j1}} \right)^{\phi} + b_{j2} \left(\frac{P_{jN}}{b_{j2}} \right)^{\phi} \right)^{\frac{1}{\phi}} \tag{12}$$

where $\phi = \frac{\epsilon}{\epsilon-1}$.

The city real exchange rate is, as earlier,

$$Q = \frac{P_j}{P_i} \tag{13}$$

Taking logs and rearranging the terms we get the following:

$$q = \frac{1}{\phi} \ln \left(b_{j1} \left(\frac{P_{jT}}{b_{j1}} \right)^{\phi} \right) - \frac{1}{r} \ln \left(a_{i1} \left(\frac{P_{iT}}{a_{i1}} \right)^{r} \right) + \frac{1}{\phi} \ln \left(1 + \frac{b_{j2} \left(\frac{P_{jN}}{b_{j2}} \right)^{\phi}}{b_{j1} \left(\frac{P_{jT}}{b_{j1}} \right)^{\phi}} \right) - \frac{1}{r} \ln \left(1 + \frac{a_{i2} \left(\frac{P_{iN}}{a_{i2}} \right)^{r}}{a_{i1} \left(\frac{P_{iT}}{ai_{1}} \right)^{r}} \right) \tag{14}$$

In the Cobb-Douglas case presented in section 2.1 and studied by Chen et al. (2006), q can be written as a sum $x + y$ with x representing a traded goods price differential and y contrasting traded and nontraded goods prices, within cities. In the general CES setting we obtain the following relationship

$$q = x_{ces} + y_{ces} \tag{15}$$

[6] where b_{j1} and b_{j2} are shares of traded and nontraded goods in total consumption whereas $\frac{1}{1-\epsilon}$ is the elasticity of substitution.

where

$$x_{ces} = \frac{1}{\phi} \ln \left(b_{j1}^{1-\phi} P_{jT}^{\phi} \right) - \frac{1}{r} \ln \left(a_{i1}^{1-r} P_{iT}^{r} \right) \tag{16}$$

and

$$y_{ces} = \frac{1}{\phi} \ln \left(1 + \left(\frac{b_{j2}}{b_{j1}} \right)^{1-\phi} \left(\frac{P_{jN}}{P_{jT}} \right)^{\phi} \right) - \frac{1}{r} \ln \left(1 + \left(\frac{a_{i2}}{a_{i1}} \right)^{1-r} \left(\frac{P_{iN}}{P_{iT}} \right)^{r} \right) \tag{17}$$

Note that if unit elasticity holds for both cities then the CES result reduces to the Cobb-Douglas case, with $x_{ces} = x$ and $y_{ces} = y$.We examine the contributions of x_{ces} and y_{ces} to the fluctuations of q. The term x_{ces} related to the traded goods can be simplified as

$$x_{ces} = p_{jT} - p_{iT} + \frac{1}{\rho} \ln(a_{i1}) - \frac{1}{\epsilon} \ln(b_{j1})$$

Hence x_{ces} differs from the Cobb-Douglas value of x by a non-stochastic term $\frac{1}{\rho} \ln(a_{i1}) - \frac{1}{\epsilon} \ln(b_{j1})$. For our purposes, we will measure *changes* in x, y, and q over time, in which case the series x_t, $t = 1, 2, ..$ and $x_{ces,t}$, $t = 1, 2, ..$ will be indistinguishable.[7] On the other hand, y_{ces} will generally be different from y. Since we observe different elasticities of substitution in consumption in different countries, we choose different consumption elasticity of substitution parameters to define x_{ces} and y_{ces} and determine the role of nontraded goods in explaining fluctuations in the RER in Indian cities.

3 Inflation in Indian Cities

In order to examine the role of traded and nontraded goods in city real exchange rate fluctuations in India, we collected yearly price indices for industrial workers for 25 largest cities[8] in India for the period 1961-2000 with the base year 1982. We have the consumer price index, food price index, and clothing, bedding, and footware price index for all these cities. Since food counted for approximately 55% of the consumer expenditure for developing countries, and food along with

[7] Note also that, if the share of nontraded goods in both cities (b_{j1} and a_{i1}) are equal, and the consumption elasticity of substitution in both cities ($\frac{1}{1-\rho}$ and $\frac{1}{1-\epsilon}$) are equal, and if the law of one price holds, then the term x_{ces} equals zero and hence disappears from the q decomposition.

[8] The cities are Guntur, Hyderabad, Jamshedpur, Ahmedabad, Bhavnagar, Sri Nagar, Bangalore, Bhopal, Indore, Mumbai (Bombay), Nagpur, Sholapur, Amritsar, Ajmer, Jaipur, Coimbatore, Chennai (Madras), Madurai, Kanpur, Shaharanpur, Varanasi, Asansol, Kolkata (Calcutta), Howrah, and Delhi.

clothing, bedding, and footware would include almost the entire traded goods consumption by the industrial workers, we constructed the traded goods price index which is the weighted average of the food and clothing price indexes.

Using CPI and the traded goods price index for every city we compute the price index of nontraded goods in each city using both Cobb-Douglas aggregation and CES aggregation. The average share of traded goods in CPI for all cities is 65% while the share of nontraded goods is 35%. In Figure 1, we show the rate of CPI inflation of largest seven cities in India[9]. We observe that the inflation was fluctuating more in the 1960s and in the early 1970s – with average inflation around 6.5% – compared to that in 1980s and onwards, although the average rate of inflation is slightly higher in this latter period (8.5%). We compute the yearly coefficient of variation for inflation calculated from CPI, traded goods price indices, and nontraded goods price indices. We find that the coefficient of variation is very high not only for the CPI but for other price indices. The average coefficient of variation in 1960s and early 1970s were almost twice of that in the later part of the data span. This suggests that the rates of inflation in Indian cities were different in the 1960s and 1970s but they are largely similar in the 1980s onwards with an exception of 1989.

4 Indian City Real Exchange Rates

The city RERs are calculated using the formula $Q = \frac{P_j}{P_i}$, where P_j is the CPI of each city and P_i is the CPI of Delhi. Thus we obtain 24 city RERs. Figure 3 shows the RER for the seven largest cities in India[10] and it suggests that the city RERs follow different paths, and that prices in different cities adjust differently.

4.1 City Real Exchange Rate Decomposition

We decompose the city RER according to the decomposition technique discussed in section 2 in order to apprise the importance of traded and nontraded goods in the city RER fluctuations. We

[9] They are Ahmedabad, Bangalore, Chennai, Delhi, Hyderabad, Kolkata, and Mumbai.
[10] Since these RER are based on Delhi prices, we include Nagpur in this figure instead of Delhi.

compute x and y for Cobb-Douglas aggregation and x_{ces} and y_{ces} for the CES aggregation and have used the share of nontraded and traded goods for each city to calculate these measure. The share are given in Table 1. We then examine the contribution of these xs and ys to the fluctuations of qs. Following Engel (1999), we calculate mean sum of squares (MSE)[11] of xs, ys, and qs and then calculate two measures to determine the fraction of the MSE of $q_{t+k} - q_t$ accounted for by the MSE of $x_{t+k} - x_t$, the traded goods component[12]. These measures are

$$\frac{MSE\ (x_t - x_{t-n})}{MSE\ (x_t - x_{t-n}) + MSE\ (y_t - y_{t-n})} \tag{B1}$$

and

$$\frac{MSE\ (x_t - x_{t-n}) + mean(x_t - x_{t-n})\ mean(y_t - y_{t-n}) + cov(x_t - x_{t-n},\ y_t - y_{t-n})}{MSE\ (q_t - q_{t-n})} \tag{B2}$$

where MSE is defined as

$$MSE\ (x_t - x_{t-n}) = var\ (x_t - x_{t-n}) + [mean\ (x_t - x_{t-n})]^2$$

We compute the B1 and B2 measures for Cobb-Douglas aggregation and for CES aggregation with different consumption elasticity of substitutions.

To further interpret the RER historical data we conduct unit root tests and find that, generally, the India city RER changes are highly persistent, consistent with a nonstationary process. Also, we examine the correlation between x and y components and find that there is no consistent pattern in correlation, and on average these correlations are not significant. See Table 3 for details.

[11] Following Parsley (2007) we also computed

$$\text{The traded goods share of } n\text{-period variance} = \frac{var(x_t - x_{t-n})}{var(x_t - x_{t-n}) + var(y_t - y_{t-n})}.$$

The results are similar to that from the more comprehensive measure MSE. We do not report these results but they are available upon request.

[12] These section is largely drawn from Engel (1999).

4.2 Results

We select a maximum of 10 period (year) lag in computing the B1, as our dataset consists of only annual data and we have used city-specific weights for traded and nontraded goods in the consumption basket[13]. The average weight for nontraded goods in the consumption basket for all the cities is 0.35 but it varies between 0.3 to 0.4 for individual cities. For CES aggregation, following indications from Ostry and Reinhart (1992), we assume elasticity of substitution between traded and nontraded goods to be 1.3 for Indian cities. Also we compute B1 measures with elasticity of substitution 1.1 and 0.8 to examine the relationship between the elasticity of substitution and the importance of nontraded goods in the city RER changes. The average proportions of the city RER changes attributable to traded goods under both types of aggregations are shown in Figure 3[14].

We find that, in terms of the B1 measure, on an average about 80 percent of the RER changes for Indian cities can be attributed to traded goods when we take the Cobb-Douglas aggregation (the elasticity of substitution of traded and nontraded goods to be equal to 1) and this proportion remains the closer to this measure for the time horizon of 10 years. Thus, even with the Engel (1999) specification, nontraded goods can explain 20% of the changes in the city RER in India. We also observe that the share of nontraded goods in explaining the city RER change and the elasticity of substitution in consumption are negatively related. For example, if the elasticity of substitution is taken to be 1.3, the share of nontraded goods in the city RER changes declines to 11%. As Ostry and Reinhart (1992) suggested that elasticity of substitution in consumption to be 1.3 for developing countries, the contribution of nontraded goods for the Indian city RER changes seems to be small. Chen et al. (2006) argue that a low share of nontraded goods may bias downwards the contribution of nontraded goods. Our findings suggest that the contribution of nontraded goods in the city RER changes is not negligible even when the share of nontraded goods is very low (0.35).

[13] We also calculated B2 measures for all these variation and we do not report this here since the results are similar to what we can obtain from B1 measure.

[14] We have also computed the B1 measures with the same weight (average weight for all 25 cities) for traded and nontraded goods in consumption basket for all the cities and the results remain very similar to what we have found with city specific weights for traded and nontraded goods.

We also find that the elasticity of substitution of traded and nontraded goods play a significant role in the size of the contribution of nontraded goods in the city RER changes.

However, we observe significant differences in the contribution of nontraded goods across cities in India even with the same elasticity of substitution in consumption. We report the computed measures of B1 only for seven largest cities in Table 2 under both the Cobb-Douglas and CES aggregations for a horizon of five years. Note that we have obtained nontraded goods price indices by using traded goods price indices and also aggregate CPI using equation (2) for Cobb-Douglas utility function and equation (10) for CES utility function. Thus, for different consumption elasticity of substitution, we create different nontraded goods price indices for each city. Then we decompose the city RER using the traded and nontrade price indices as suggested by equations (7 and 8) and equations (16 and 17) for Cobb-Douglas utility function and CES utility function, respectively. It is clear from the table that cross-city variations in the contribution of nontraded goods is large. For example with elasticity of substitution 1(second block in Table 2), nontraded goods explains only 14% of the Nagpur RER changes while the same is 29% for Kolkata (Calcutta). The gaps narrow down as we take into account a higher elasticity of substitution. This is not due to very different shares of nontraded goods in CPIs of these two cities (share of nontraded goods in Nagpur is 36% while it is for Kolkata is 33%). This also does not depend on the distance from the base city as the calculated correlation between the share of nontraded goods under Cobb-Douglas aggregation and the distance in miles from Delhi, our base city, is only -0.05.

These results imply that the share of nontraded goods in the city RER in India is not insignificant, but much smaller when the elasticity of substitution is set to a realistic value, rather than unity. Also, the consumption elasticity of substitution between traded and nontraded goods turns out to be significant in apportioning the contribution of nontraded goods in the fluctuations of the city RERs.

5 Conclusions

The role of nontraded goods prices in explaining fluctuations in the real exchange rates has been recently questioned by the researchers who show that fluctuation in the RER is mainly emanating from the traded goods prices. Researchers have used developed country data (Engel, 1999; Mendoza, 2000) and also data from middle income countries (Parsley, 2007) to obtain these results. Other researchers examine regional data and city price data to apportion the role of nontraded goods in regional and city RER changes (Chen et al., 2006) and found that the share of nontraded goods is not minimal. To the best of our knowledge we find no previous research related to developing countries, and to shed some light on the contribution of nontraded goods in the RER fluctuations we examine the city real exchange rate changes of the 25 largest cities in India. Using the MSE decomposition we apportion the sources of fluctuation in terms of traded and nontraded goods. We find that nontraded goods are very important in explaining the city RER changes even when Engel's (1999) methodology is used.

The issue of consumption elasticity of substitution of traded and nontraded goods has received virtually no attention in the above cited decomposition exercises. Empirical researchers obtain different consumption elasticity of substitutions for different countries, with developed countries having consumption elasticity of substitution much lower than 1 while for the developing countries, it is greater than 1. We adopt a new decomposition technique where the consumption elasticity of substitution is explicitly stated, and from the Indian city RER we find that higher the consumption elasticity of substitution the lower is the share of nontraded goods in city RER changes. We believe that consumption elasticity of substitution should be carefully dealt with in the RER decomposition exercises.

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Table 1

Weights of Traded and Nontrade Goods in CPI for Industrial Workers in India

City	Traded Good	Nontraded Good
Guntur	0.67	0.33
Hyderabad	0.63	0.37
Jamshedpur	0.65	0.35
Ahmedabad	0.69	0.31
Bhavnagar	0.68	0.32
Srinagar	0.64	0.36
Bangalore	0.60	0.40
Bhopal	0.63	0.37
Indore	0.61	0.39
Mumbai (Bombay)	0.68	0.32
Nagpur	0.64	0.36
Sholapur	0.68	0.32
Amritsar	0.60	0.40
Ajmer	0.64	0.36
Jaipur	0.63	0.37
Coimbatore	0.65	0.35
Chennai (Madras)	0.65	0.35
Madurai	0.65	0.35
Kanpur	0.66	0.34
Sharanpur	0.63	0.37
Varanasi	0.66	0.34
Asansol	0.68	0.32
Kolkata (Calcutta)	0.67	0.33
Howrah	0.70	0.30
Delhi	0.63	0.37

Note: Traded good includes food, clothing, footwear, and bedding.

Table 2

Share of Traded Good in the City Real Exchange Changes in the Largest Seven Cities under Different Elasticity of Substitutions in Consumption

Horizon ->	1	2	3	4	5
Consumption Elasticity of Substitution 0.8					
Hyderabad	0.712	0.610	0.507	0.498	0.552
Ahmedabad	0.757	0.726	0.722	0.741	0.755
Bangalore	0.709	0.648	0.652	0.621	0.636
Mumbai	0.672	0.602	0.567	0.581	0.635
Nagpur	0.799	0.764	0.751	0.717	0.633
Chennai	0.771	0.709	0.678	0.672	0.679
Kolkata	0.616	0.501	0.502	0.538	0.596
Consumption Elasticity of Substitution 1					
Hyderabad	0.790	0.700	0.608	0.600	0.655
Ahmedabad	0.836	0.805	0.800	0.812	0.823
Bangalore	0.783	0.732	0.735	0.708	0.721
Mumbai	0.751	0.686	0.658	0.673	0.724
Nagpur	0.858	0.829	0.820	0.794	0.727
Chennai	0.840	0.790	0.765	0.762	0.768
Kolkata	0.709	0.598	0.599	0.633	0.689
Consumption Elasticity of Substitution 1.1					
Hyderabad	0.834	0.761	0.676	0.668	0.714
Ahmedabad	0.873	0.850	0.846	0.856	0.865
Bangalore	0.830	0.787	0.790	0.767	0.779
Mumbai	0.807	0.753	0.727	0.740	0.783
Nagpur	0.890	0.868	0.860	0.838	0.778
Chennai	0.875	0.834	0.813	0.810	0.815
Kolkata	0.769	0.673	0.674	0.705	0.753
Consumption Elasticity of Substitution 1.3					
Hyderabad	0.881	0.824	0.755	0.748	0.787
Ahmedabad	0.914	0.895	0.892	0.899	0.905
Bangalore	0.876	0.844	0.846	0.827	0.837
Mumbai	0.861	0.817	0.797	0.808	0.843
Nagpur	0.922	0.907	0.900	0.883	0.838
Chennai	0.913	0.883	0.867	0.864	0.868
Kolkata	0.832	0.752	0.753	0.779	0.819

Table 3
Some Statistics for q, x, and y (Real Exchange Rate and Its Components) for Indian Cities
(Trading Partner Delhi)

		RER (q)		x and y Component	
City	RER, 1st order autocorrelation Coefficient	Unit Root Test ADF Test	ADF Test p-value	Correlation Coefficient	p-value
Guntur	0.67	-1.18	0.67	-0.31	0.05
Hyderabad	0.84	-0.74	0.90	0.47	0.00
Jamshedpur	0.84	-0.38	0.90	-0.12	0.46
Ahmedabad	0.70	-2.14	0.23	-0.17	0.28
Bhavnagar	0.53	-2.77	0.07	-0.37	0.02
Srinagar	0.86	-1.84	0.35	-0.80	0.00
Bangalore	0.68	-1.74	0.40	-0.30	0.06
Bhopal	0.80	-1.58	0.48	0.00	1.00
Indore	0.64	-1.49	0.53	0.00	0.98
Mumbai (Bombay)	0.87	-1.78	0.39	-0.80	0.00
Nagpur	0.62	-2.78	0.09	-0.59	0.00
Sholapur	0.43	-3.78	0.01	-0.82	0.00
Amritsar	0.88	1.77	0.99	0.63	0.00
Ajmer	0.64	-1.66	0.45	-0.46	0.00
Jaipur	0.71	-0.42	0.90	0.03	0.86
Coimbatore	0.82	-1.64	0.45	-0.16	0.33
Chennai (Madras)	0.63	-2.98	0.05	-0.75	0.00
Madurai	0.64	-2.50	0.12	-0.82	0.00
Kanpur	0.80	0.02	0.95	-0.12	0.48
Sharanpur	0.82	-0.14	0.94	-0.32	0.04
Varanasi	0.48	-3.26	0.02	-0.51	0.00
Asansol	0.88	0.64	0.99	-0.04	0.80
Kolkata (Calcutta)	0.84	-0.58	0.86	0.15	0.36
Howrah	0.91	-1.22	0.66	0.15	0.35
AVERAGE	0.73	--	--	-0.25	0.25

Note: The RER decomposition of x and y here emanates from Cobb-Douglas utility function.

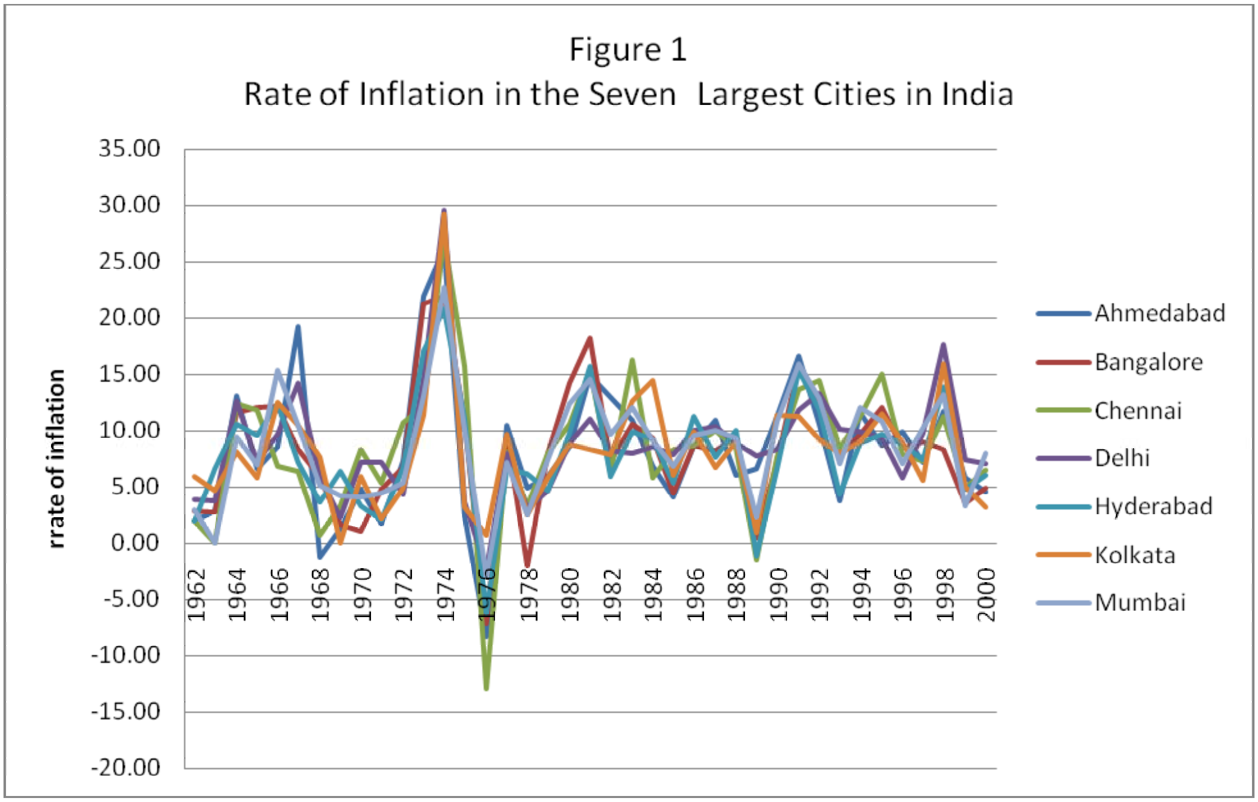
Figure 1
Rate of Inflation in the Seven Largest Cities in India
rrate of inflation
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
-5.00
-10.00
-15.00
-20.00
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
Ahmedabad
Bangalore
Chennai
Delhi
Hyderabad
Kolkata
Mumbai

Figure 2

City Real Exchange Rates of the Seven Largest Cities in India

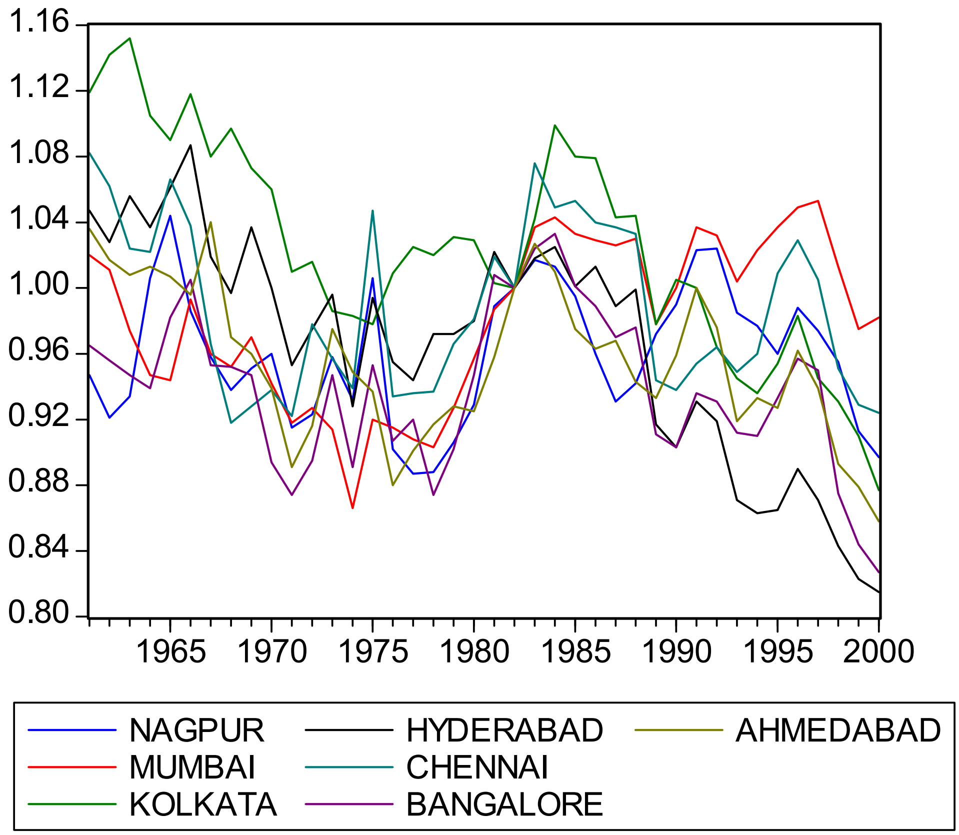

Figure 3

Share of Traded Good in the RER Changes under Different Elasticity of Substitutions