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Does Inflation Targeting decrease Exchange Rate Pass-through in Emerging Countries?*

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Abstract:

In this paper, we empirically examine the effect of inflation targeting on the exchange rate pass-through to prices in emerging countries. We use a panel VAR that allows us to use a large dataset on twenty-seven emerging countries (fifteen inflation targeters and twelve inflation nontargeters). Our evidence suggests that inflation targeting in emerging countries contributed to a reduction in the pass-through to various price indexes (import prices, producer prices and consumer prices) from a higher level to a new level that is significantly different from zero. The variance decomposition shows that the contribution of exchange rate shocks to price fluctuations is more important in emerging targeters compared to nontargeters, and the contribution of exchange rate shocks to price fluctuations in emerging targeters declines after adopting inflation targeting.
JEL Classification: E31, E52, F41.

Keywords: Inflation Targeting, Exchange Rate Pass-Through, panel VAR.

Résumé :

Dans ce papier, nous examinons empiriquement l'impact de l'adoption du ciblage d'inflation sur l'incidence ("pass-through") du taux de change dans les pays émergents. Nous utilisons une approche en panel VAR qui nous permet d'utiliser un grand échantillon sur vingt-sept pays émergents (quinze cibleurs d'inflation et douze non-cibleurs d'inflation). Nos résultats montrent que l'adoption du ciblage d'inflation dans les pays émergents a permis de réduire l'incidence du taux de change sur divers indices de prix (prix des imports, prix des producteurs et prix de la consommation) d'un niveau très élevé à un nouveau niveau qui est significativement différent de zéro. L'analyse de la décomposition de la variance montre que la contribution des chocs de taux de change dans la fluctuation des prix est élevée dans les pays cibleurs que dans les pays non-cibleurs, et la contribution des chocs de taux de change dans la fluctuation des prix dans les pays cibleurs a baissé après l'adoption du ciblage d'inflation.
Classification JEL: E31, E52, F41.

Mots-clés: Ciblage d'inflation, Pass-through, incidence du taux de change, panel VAR.

1 Introduction

After New Zealand initiated inflation targeting in 1990, a large number of industrial and emerging countries have explicitly adopted an inflation target as their nominal anchor. In the last two decades, ten industrial economies and twenty emerging economies[1] have adopted the full-fledged inflation targeting system for managing monetary policy. Many other emerging countries intend to adopt this monetary framework in the near future. Given the vulnerability of emerging countries to exchange rate shocks, a key element for the success of this strategy depends on its ability to reduce the exchange rate pass-through. Various studies have shown a decrease in exchange rate pass-through in the last two decades: is it related to inflation targeting?

Many studies have provided some evidence that adoption of inflation targeting is associated with an improvement in overall economic performance (Bernanke and Mishkin (1997); Svensson (1997); Bernanke et al.(1999) among others). Ball and Sheridan (2005), one of the few empirical papers critical of inflation targeting, argue that the implementation of inflation targeting appears to have been irrelevant in industrial countries. Based on OLS cross-section estimation, their results indicate that the reduction in the level and the volatility of inflation in inflation targeting countries simply reflects regression toward the mean, i.e., inflation will fall faster in countries that start with high inflation than in countries with an initial low inflation. Since countries having implemented inflation targeting had generally an initial high level of inflation, the bigger drop in inflation for those countries simply reflects a tendency for this variable to revert to its mean. But their study focused solely on industrial countries and therefore cannot address this issue for emerging countries targeting inflation. Gonçalves and Salles (2008) extended Ball and Sheridan's analysis for a subset of 36 emerging economies and found that, for those countries, results are different. Specifically, emerging countries which have adopted inflation targeting have experienced greater reductions in inflation and in growth volatility, even after controlling for mean reversion.

The present paper contributes to this literature on inflation targeting by analyzing the effect of inflation targeting on exchange rate pass-through in emerging countries. It is based on the hypothesis in Taylor (2000) that argues that exchange rate pass-though is lower in low-inflation environment. More

[1] The ten industrial countries targeters are Australia, Canada, Finland, New Zealand, Norway, Spain, Sweden, Switzerland and United Kingdom. Finland and Spain are now in euro area. The twenty emerging countries targeters are Brazil, Chile, Colombia, Czech republic, Ghana, Guatemala, Hungary, Indonesia, Israel, Korea, Mexico, Peru, Philippines, Poland, Romania, Serbia, Slovakia, South Africa, Thailand and Turkey. Slovakia ceased inflation targeting in January 2009 with its ERM II entry

precisely Taylor's argument is that in low-inflation environment firms expect a deviation of inflation to be less persistent and would therefore pass on less of an exchange rate-induced increase in the price of imported inputs to its selling prices. This hypothesis has been supported by empirical evidence based on the consumer price index (CPI), both for industrialized and emerging countries (see for example Gagnon and Ihrig, 2001, or Choudhri and Hakura, 2006). Since Gonçalves and Salles (2008) show that inflation targeting has helped to reduce inflation in emerging countries, it is interesting to analyze whether the adoption of inflation targeting has lead to a decrease in exchange rate pass-through. [2]

This paper tackle this issue using a subset of twenty-seven emerging economies (fifteen targeters and twelve nontargeters).[3] After a first VAR analysis by including the consumer prices (CPI) as the only price, we conduct a second VAR analysis by including two other prices: import prices (IMP) and producer prices (PPI). The use of these two prices in the VAR allows us to directly answer to the Taylor's hypothesis. A decrease in pass-through effect to import prices means that after the adoption of inflation targeting a retailing firm that imports goods from abroad absorbs a larger fraction of an exchange rate shock through a smaller variation in its selling prices. A decrease in pass-through effect to producer prices means that after the adoption of inflation targeting, a firm that imports its inputs from abroad absorbs a larger fraction of an exchange rate shock through a smaller variation in the prices of its final products.

Even though impulse responses give information about the size of exchange rate pass-through to domestic prices, they do not show how important exchange rate shocks are in explaining domestic price fluctuations. Since implementation of inflation targeting requires flexible exchange rate regime,

[2]This idea was explored by Mishkin and Schmidt-Hebbel (2007). Mishkin and Schmidt-Hebbel (2007) empirically study the link between inflation targeting and some measures of economic performance including exchange rate pass-through to consumer prices. Using data on twenty-one industrial and emerging inflation-targeting countries (targeters) and thirteen industrial countries without inflation targeting (nontargeters) they employ panel VAR techniques. To test for differences, they adopt the before-and-after approach by comparing impulse response functions in different country samples, depending on whether a country has inflation targeting in place. The results of this analysis show that pass-through effect to consumer prices has been close to zero in industrial inflation targeters before and after inflation targeting and in nontargeters. In emerging inflation targeters, the exchange rate pass-through to consumer prices fell after the countries achieved a stationary target, but remained significantly different from zero. However, these results in Mishkin and Schmidt-Hebbel (2007) suffer from selection bias as there are no emerging inflation nontargeters in the control group.

[3]In the sequel, "targeters" refers to emerging countries targeting inflation, and "non targeters" to emerging countries not targeting inflation.

inflation targeting can lead to a great volatility in exchange rate. Thus, even if inflation targeting leads to a decline in exchange pass through to domestic prices, it can lead to mitigate effect on the the contribution of exchange rate shocks to domestic prices fluctuations. Hence, to assess the contribution of exchange rate shocks to domestic prices fluctuations, we also perform a variance decomposition of domestic prices.

The main results of this paper are the following. The adoption of inflation targeting in emerging countries has helped to reduce the pass-through to consumer prices from a initial higher level to a new level that, however, remains significantly different from zero. For emerging nontargeters however, the pass-through to consumer prices has not been significantly different from zero before 1999 and has significantly become positive after 1999. By comparing emerging inflation targeters after adopting inflation targeting to emerging nontargeters after 1999, the pass-through effects to consumer prices are not significantly different among the two groups of emerging targeters and nontargeters. The decline in pass-through to consumer prices in emerging inflation targeters is attributable to the decline in pass-through effect along the prices chain. Pass-through effects to both import and producer prices fell significantly in emerging inflation targeters after adopting inflation targeting framework. These results are corroborated by the variance decomposition analysis. The variance decomposition analysis shows that exchange rate shocks explain an important part of prices fluctuations in targeters countries, while the contribution of exchange rate shocks to the fluctuations in prices in nontargeters countries is insignificant. The variance decomposition analysis also shows that the contribution of exchange rate shocks to prices fluctuations in targeting countries declines after the adoption of inflation targeting.

The remainder of the paper is organized as follows. Section 2 presents methodology and data. Section 3 presents the empirical results and theirs interpretations. Section 4 concludes the study.

2 Methodology and Data

Our quarterly dataset consists of twenty-seven emerging economies (fifteen targeters and twelve nontargeters), covering the 1989Q1-2009Q1 period. Using the panel VAR before-and-after strategy already employed by Mishkin and Schmidt-Hebbel (2007), we investigate whether inflation targeting has helped to reduce the exchange rate pass-through to domestic prices in emerging countries.

We use panel VAR techniques to estimate the impulse response functions.

The use of panel VAR techniques has two main advantages. First, the VAR approach addresses the endogeneity problem by allowing endogenous interactions between the variables in the system. Second, the asymptotic results are easier to derive for panel data.

The econometric model takes the following reduced form:

$$Y_{it} = \Gamma(L)Y_{it} + u_i + \epsilon_{it} \tag{1}$$

where Y_{it} is a vector of stationary variables, $\Gamma(L)$ is a matrix polynomial in the lag operator with $\Gamma(L) = \Gamma_1 L^1 + \Gamma_2 L^2 + \ldots + \Gamma_p L^p$, u_i is a vector of country specific effects and ϵ_{it} is a vector of idiosyncratic errors.

An issue in estimating this model concerns the presence of fixed effects. As fixed effects are correlated with the regressors, due to lags of the dependent variable, we use forward mean differencing (the Helmert procedure), following Love and Zicchino (2006). In this procedure, to remove the fixed effects, all variables in the model are transformed in deviations from forward means. Let $\bar{y}_{it}^m = \sum_{s=t+1}^{T_i} y_{is}^m/(T_i - t)$ denote the means obtained from the future values of y_{it}^m, a variable in the vector $Y_{it} = (y_{it}^1, y_{it}^2, \ldots, y_{it}^M)'$, where T_i denotes the last period of data available for a given country series . Let $\bar{\epsilon}_{it}^m$ denote the same transformation of ϵ_{it}^m, where $\epsilon_{it} = (\epsilon_{it}^1, \epsilon_{it}^2, \ldots, \epsilon_{it}^M)'$. Hence we get:

$$\tilde{y}_{it}^m = \delta_{it}(y_{it}^m - \bar{y}_{it}) \tag{2}$$

and

$$\tilde{\epsilon}_{it}^m = \delta_{it}(\epsilon_{it}^m - \bar{\epsilon}_{it}^m) \tag{3}$$

where $\delta_{it} = \sqrt{(T_i - t)/(T_i - t + 1)}$. For the last year of data this transformation cannot be calculated, since there are no future value for the construction of the forward means. The final transformed model is thus given by:

$$\tilde{Y}_{it} = \Gamma(L)\tilde{Y}_{it} + \tilde{\epsilon}_{it} \tag{4}$$

where $\tilde{Y}_{it} = (\tilde{y}_{it}^1, \tilde{y}_{it}^2, \ldots, \tilde{y}_{it}^M)'$ and $\tilde{\epsilon}_{it} = (\tilde{\epsilon}_{it}^1, \tilde{\epsilon}_{it}^2, \ldots, \tilde{\epsilon}_{it}^M)'$

This transformation is an orthogonal deviation, in which each observation is expressed as a deviation from average future observations. Each observation is weighed so as to standardize the variance. If the original errors are not autocorrelated and are characterized by a constant variance, the transformed

errors should exhibit similar properties. Thus, this transformation preserves homoscedasticity and does not induce serial correlation (Arelano and Bover, 1995). Additionally, this technique allows to use the lagged values of regressors as instruments and estimate the coefficients by the generalized method of moment (GMM).
Once all coefficients of the panel VAR are estimated, we compute the impulse response functions (IRFs).[4] In order to compute the IRFs we use Cholesky decomposition. The assumption behind Cholesky decomposition is that series listed earlier in the VAR order impact the others variables contemporaneously, while series listed later in the VAR order impact those listed earlier only with lag. Consequently, variables listed earlier in the VAR order are considered to be more exogenous. We apply bootstrap methods to construct the confidence intervals of the IRFs. Since we cannot assume independence among the various samples, we also employ bootstrap methods to construct confidence intervals for differences in IRFs rather than simply taking their differences.[5]

Following Ito and Sato (2007, 2008)[6], we begin by setting up a 5-variable VAR model, $Y_{it} = (\Delta oil_{it}, gap_{it}, \Delta m_{it}, \Delta ner_{it}, \Delta cpi_{it})'$, where *oil* denotes the natural log of world oil prices; *gap* the output gap; m the natural log of money supply; *ner* that of the nominal exchange rate; *cpi* that of the consumer price index (CPI); and Δ represents the first difference operator. The change in oil prices is included to identify the supply shock. We include the output gap to capture the demand side. The money supply is included in the VAR to allow for the effect of monetary policy in response to a large fluctuation in exchange rate or devaluation.

To answer directly the Taylor conjecture, we also conduct an additional estimation with 7-variable VAR model by including two other price indexes: the producer price index (PPI) and the import price index (IMP). As mentioned above, a decrease in the pass-through effect on import prices will mean that retail firms that import their commodities pass through a lower fraction of an exchange rate shock into their selling prices; and, a decrease in the pass-through effect on producer prices will mean that firms that import their inputs pass though a lower fraction on such a shock into the final goods prices. According to Burstein, Eichenbaum and Rebelo (2002, 2005), the

[4]The panel VAR is estimated by using the package provided by Inessa Love. This package is a Stata programs for Love (2001) and it is used in Love and Zicchino (2006).

[5]If we assume sample independence, the confidence intervals for differences in IRFs would be narrower.

[6]Ito and Sato (2007) used VAR technique to compare the exchange rate pass-through effects of East Asia and Latin American Countries, while Ito and Sato (2008) applied VAR analysis to exchange rate pass-through in East Asian countries .

extent of CPI inflation after a large changes in exchange rate depends on the relative importance of imported inputs being used for domestic production and the presence of distribution costs. The production or distribution channels can dampen the effect of exchange rate changes and account for a low pass-through to consumer prices. Then, the 7-variable VAR model allows us to examine the exchange rate pass-through along the pricing chain. In other words, it allows us to examine whether inflation targeting could have negatively impacted on the pass-through to consumer prices by lowering pass-through to imported and/or producer prices.

As discussed above, the order of endogenous variables is central to the identification of structural shocks. The change in oil prices included to identify the supply shock is ordered first in the VAR. The output gap is placed second. The demand and supply shocks that affect the output gap are assumed to be predetermined. The money supply is ordered third and before the nominal exchange rate and the price variables. Then, for the 5-variable VAR the ordering is: $\Delta oil, gap, \Delta m, \Delta ner, \Delta cpi$. In 7-variable VAR it seems appropriated to place import prices ahead of producer and consumer prices and to place consumer prices last in the ordering. Thus, for the 7-variable VAR the ordering is: $\Delta oil, gap, \Delta m, \Delta ner, \Delta imp, \Delta ppi, \Delta cpi$.

3 Empirical Results

This section presents the results of the impulse response function analysis. The details of the data for empirical estimation are presented in the appendix. Before conducting the VAR estimation, we tested for stationarity. Since the oil price is a variable that does not depend on countries, the stationarity test on this variable is conducted by using the standard Augmented Dickey-Fuller unit root test. For the other variables, we use Maddala and Wu (1999) panel unit root test. The tests results (see Table 1) show that the oil price, three types of domestic prices, the money supply and the nominal exchange rate are non-stationary in level but stationary in first-differences for all countries. The output gap is found to be stationary in level. Previous studies (for example Ito and Sato 2007, 2008, Mishkin and Schmidt-Hebbel, 2007) suggest to include in a VAR the output gap in level together with other variables in first-difference. We follow this methodology in our VAR analysis. The model yields similar IRFs when we include more than three lags for targeters sample. For nontargeters sample, more than three lags are not accepted for estimating IRFs owing to a nearly singular matrix determinants. Hence, we selected a lag order of three for reasons of parsimony.

We start by discussing the impulse responses of CPI to an exchange rate shock in the 5-variable VAR model for targeters and nontargeters. We also discuss the impulse responses of all prices (CPI, PPI and IMP) to an exchange rate shock in the 7-variable VAR model for targeters.

Table 1: Unit Root test

Variables	Test Statistic
oil	-2.225
Δoil	-4.532***
g	238.9443***
m	63.4918
Δm	203.5607***
ner	38.3284
Δner	199.9251***
cpi	42.3842
Δcpi	104.0440***
imp	52.8330
Δimp	160.7035***
ppi	58.7423
Δppi	93.6602***

Note: The unit root test for oil and Δoil is Dickey-Fuller Generalized Least Square (DFGLS) test since these variables do not depend on countries. The null hypothesis of the DFGLS test is that the variable is non-stationary. For other variables, the unit root test is the panel unit root test developed by Maddala and Wu (1999) with the the null hypothesis that all series are non-stationary against the alternative that at least one series in the panel is stationary. No lag is used for g. The lag length used in the panel tests is the maximum lag length of individual tests that are chosen based on Schwarz information criterion. 1 (3) lags are used for oil (Δoil) . 10 (5), 10 (6) , 10 (11), 7 (8), and 10 (10) lags are used for m (Δm), ner, (Δner), cpi, (Δcpi), imp (Δimp) and ppi (Δppi), respectively. Using a lag length higher, the results were still found to be the same. For the level of variables (expected g), constant and time trend are included. For the first-difference of variables, only constant is included. ***, **, * denote the significance at 1, 5, 10 %, respectively.

3.1 Exchange pass-through to domestic prices in emerging targeters: before and after inflation targeting

In this subsection we discuss the impulse responses of domestic prices to an exchange rate shock using data on fifteen emerging inflation targeters. The impulse responses for the different samples are reported in Figures 1 and 2. Each figure reports before-and-after comparisons: before and after adopting inflation targeting. In these figures the third cell reports the difference between the two preceding responses (the response in the second cell minus the response in the first cell).

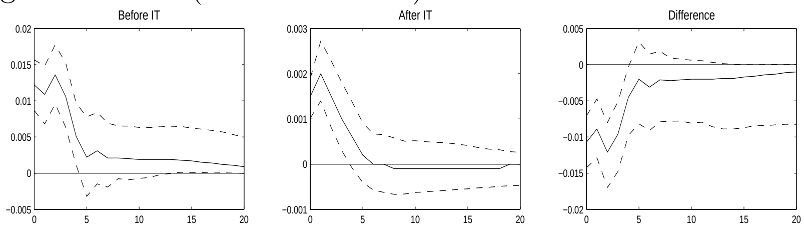
Figure 1 reports the dynamic response of CPI inflation to an exchange rate shock using the 5-variable VAR. Figure 1 shows a positive significant exchange rate pass-through to consumer prices in inflation targeting countries that decreases after they adopted inflation targeting. As reflected by the confidence intervals in third cell, the decrease in exchange rate pass-through to consumer prices is statistically different from zero. This evidence suggest that the adoption of inflation targeting in emerging countries has helped to reduce the pass-through from a higher level, and the pass-through effect remains significantly different from zero.

As discussed above, the response of consumer prices to changes in exchange rate depends on the extent of imported inputs being used for domestic production and the presence of distribution costs. The production or distribution channels can dampen the effect of exchange rate changes on consumer prices and account for a low exchange rate pass-through to consumer prices. In order to take into account the production and distribution channels we estimate a 7-variable VAR that includes two other price indexes: the producer price index (PPI) and the import price index (IMP). This estimation helps us to directly check the hypothesis made by Taylor who argues that in a low-inflation environment firms expect a deviation of inflation to be less persistent and would therefore less adjust its selling prices in response to an exchange rate-induced increase in the price of imported inputs. Figure 2 reports the dynamic response of the three prices index (CPI, IMP, PPI) inflation to an exchange rate shock using the 7-variable VAR. Figure 2 shows that the decline in pass-through to consumer prices in emerging inflation targeters is attributable to the decline in pass-through effect along the price chain. The pass-through effects to all the three prices significantly falls in emerging inflation targeters after adopting inflation targeting to levels that are significantly different from zero.

By comparing the exchange rate pass-through along the price chain, the results show that the response is the largest in import prices, then in producer prices, and the least in consumer prices. This finding is consistent with those of previous results such as McCarthy (2000), Hahn (2003), Faruque (2006) and Ito and Sato (2007, 2008).

In summary, we have obtained evidence that the adoption of inflation targeting has helped to reduce the pass-through to all three price indexes from a higher level to a new level that remains significantly different from zero. Our evidence confirms the view that when initial credibility of emerging markets' central banks is low, practicing inflation targeting makes their mon-

Figure 1: Response of CPI inflation in inflation targeters countries to an exchange rate shock (5-variable VAR)



Note: "IT" denotes inflation targeting. The solid line shows the impulse response to an exchange rate shock. The dashed lines indicate five standard error confidence band around the estimate. Error are generated by Monte-Carlo with 500 repetitions.

etary policy more credible, and thus leads to a lower inflation environment. More specifically, in accordance with the argument made by Taylor, inflation targeting by implementing low inflation environment in emerging countries induces input-importing firms as well as retailing firms to pass through less of the exchange rate depreciation in the form of higher prices (producer prices and import prices). Hence exchange rate fluctuations lead to smaller exchange rate pass-through to domestic producer and import prices.

3.2 Comparison between inflation targeters and inflation nontargeters

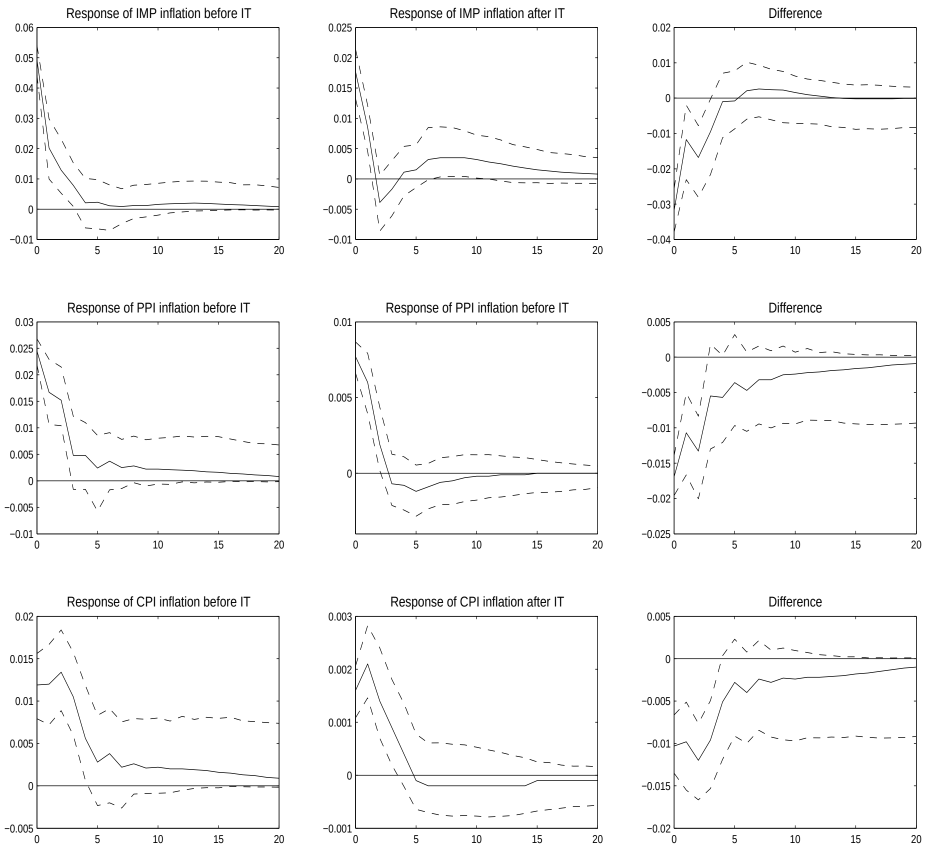
In the previous subsection, we have obtained evidence that inflation targeting has helped to decrease the exchange rate pass-through to all the three price indexes (CPI, IMP, PPI). A comparison with emerging nontargeters ove the same period conveys interesting additional information. Data for twelve nontargeters are used to conduct this comparative analysis. To perform before-and-after comparison for nontargeters, the demarcation period for nontargeters is set at year 1999, that is around the average of the adoption date of inflation targeting in emerging countries.[7]

Figure 3 and 4 report before-and-after comparisons for inflation nontargeters before and after 1999. Figures 3 displays the response of the CPI inflation to an exchange rate shock using the 5-variable VAR, while Figure 4 displays the response of the three indexes to an exchange rate shock using the 7-variable VAR [8].

[7] We also ran estimations using, 1998, and 2000 as the demarcation periods. These changes did not substantially affect our results.

[8] China and Uruguay are not included in the 7-variable VAR as no data on import and producer prices are available for these countries.

Figure 2: Response of prices in inflation targeters countries to an exchange rate shock (7-variable VAR)

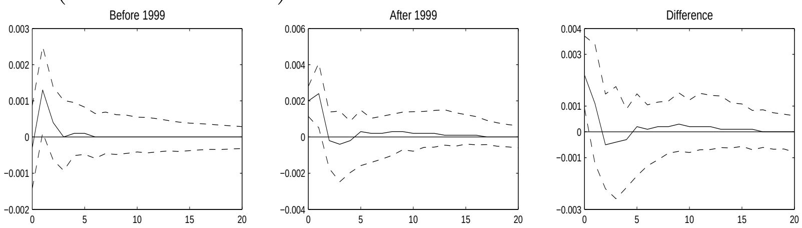


Note: “IT” denotes inflation targeting. The solid line shows the impulse response to an exchange rate shock. The dashed lines indicate five standard error confidence band around the estimate. Error are generated by Monte-Carlo with 500 repetitions.

Figure 3 shows that for nontargeters the exchange rate pass-through to CPI has not been significantly different from zero before 1999 and has become significantly positive after 1999. Figure 4 shows that, before 1999, pass-through effects to the three indexes in nontargeters are not significantly different from zero, while after 1999 these effects are significantly positive.

To compare targeters to nontargeters, Figure 5 and 6 reports comparisons across the two samples of countries: inflation targeters after adopting inflation targeting are compared to nontargeters after 1999. Figures 5 com-

Figure 3: Response of CPI inflation in inflation nontargeters to an exchange rate shock (5-variable VAR)



Note: The solid line shows the impulse response to an exchange rate shock. The dashed lines indicate five standard error confidence band around the estimate. Error are generated by Monte-Carlo with 500 repetitions.

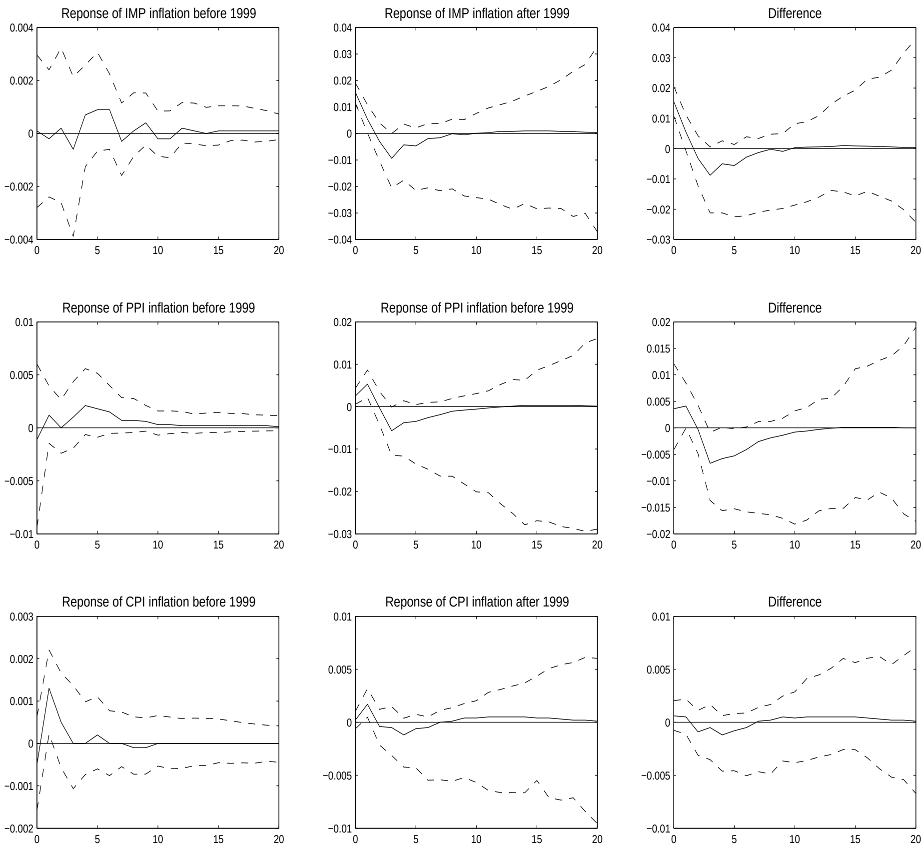
pares the response of the CPI inflation to an exchange rate shock using the 5-variable VAR, while Figure 6 compares the response of the three indexes to an exchange rate shock using the 7-variable VAR. Figure 5 shows that the exchange pass-through to consumer prices is the same for targeters after inflation targeting and nontargeters after 1999. However Figure 6 qualifies this result. The impulse response functions in Figure 6 indicate that the exchange pass-through to consumer and import prices in inflation targeting countries after adopting inflation targeting is slightly higher than that in nontargeters after 1999, while the exchange pass-through to producer prices in targeters after inflation targeting is not significantly different than that in nontargeters after 1999.

We can infer two claims from these comparisons. First, for emerging nontargeters, the pass-through has not been significantly different from zero before 1999 and becomes significantly positive after 1999. Second, by comparing inflation targeters after adopting inflation targeting to nontargeters after 1999, the pass-through effects are rather close among the two groups of targeters and nontargeters. This evidence suggests that countries experiencing high exchange rate pass-through are more prone to adopt inflation targeting in order to gain credibility, than countries with low pass-through.

3.3 Variance decomposition

Even though impulse responses give information about the size of exchange rate pass-through to domestic prices, they do not show how important exchange rate shocks are in explaining domestic price fluctuations. To assess the importance of exchange rate shocks for domestic prices fluctuations, we perform a variance decomposition for domestic price indexes. We begin by examining the importance of exchange rate shocks for consumer prices by

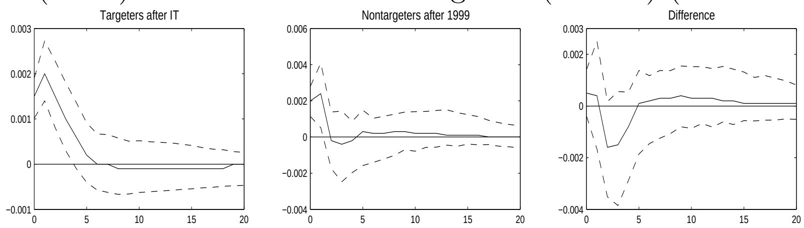
Figure 4: Response of prices in inflation nontargeters countries to an exchange rate shock (7-variable VAR)



Note: The solid line shows the impulse response to an exchange rate shock. The dashed lines indicate five standard error confidence band around the estimate. Error are generated by Monte-Carlo with 500 repetitions.

using the 5-variable VAR (Table 2). Table 2 indicates that exchange rate shocks are more important in explaining CPI fluctuations in targeters countries. The results contained in Table 2 also show that the contribution of exchange rate shocks to consumer price fluctuation decreases in targeting countries after they adopted inflation targeting, while it increases in nontargeting countries after 1999. Exchange rate shocks explain (after 20 quarters) 19.21% of consumer price forecast variance for targeting countries before they adopted inflation targeting. This percentage declines to 11.82% after

Figure 5: Response of CPI inflation to an exchange rate shock: Inflation targeters (ITers) versus Inflation nontargeters (NITers) (5-variable VAR)



Note: The solid line shows the impulse response to an exchange rate shock. The dashed lines indicate five standard error confidence band around the estimate. Error are generated by Monte-Carlo with 500 repetitions.

the adoption of inflation targeting. In nontargeting countries, exchange rate shocks explain (after 20 quarters) 0.92% of consumer prices variability before 1999, and, this percentage is 3.72% after 1999.

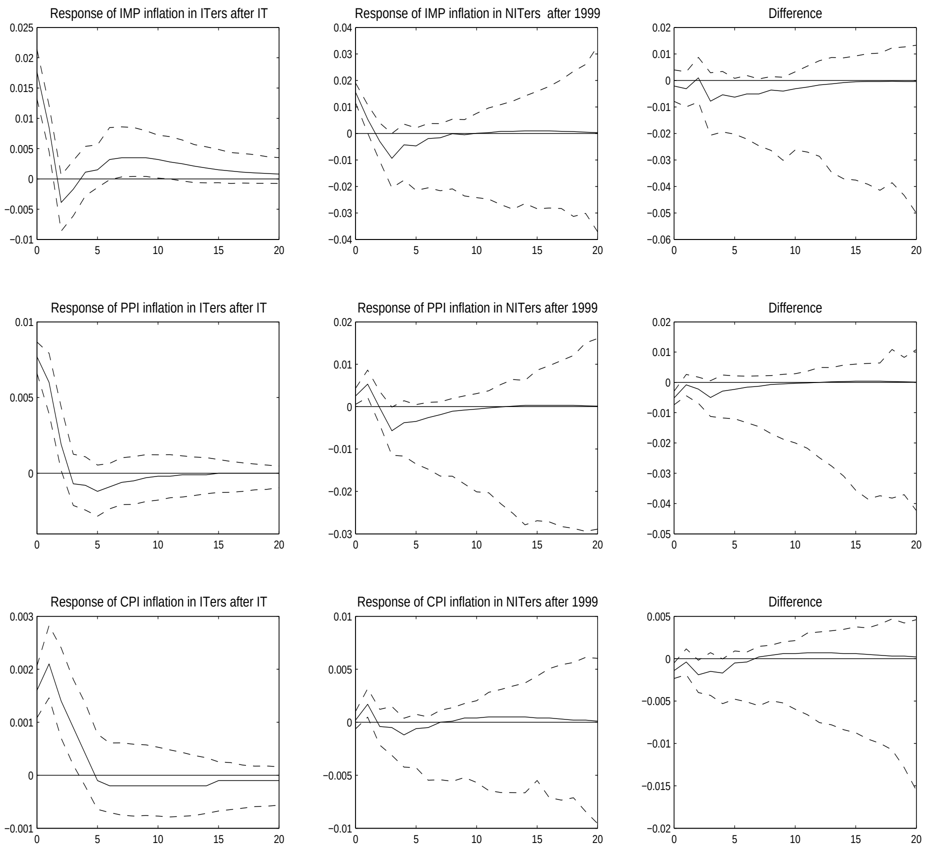
Table 2: Percentage of CPI inflation forecast variance attributed to exchange rate shocks (5-variable VAR)

	Inflation targerters		Inflation nontargerters	
Horizon	Before IT	After IT	Before 1999	After 1999
1	9.05	5.62	0.07	3.72
2	14.69	11.19	1.20	5.46
4	22.58	12.91	1.03	4.25
8	20.19	12.06	0.86	3.76
12	19.28	11.86	0.81	3.61
20	19.21	11.82	0.78	3.61

Note: “IT” denotes inflation targeting.

Table 3 displays the contribution of exchange rate shocks in explaining the fluctuations of all three price indexes using the 7-variable VAR. The results in Table 3 indicate that exchange rate shocks are more important to explain the fluctuations of all three indexes in targeters countries, while the contribution of exchange rate shock to the fluctuations in price indexes in nontargeters countries is insignificant. The percentage of price forecast variance attributed to exchange rate shocks declines in targeting countries after they adopted inflation targeting, while it slightly increases in nontargeters after 1999. In targeters before they adopted inflation targeting exchange shocks explain (after 20 quarters) 43.47%, 43.70% and 19.76% of the variance of import prices, producer prices and consumer prices, respectively . After the adoption of inflation targeting, these percentages fall to 12.54%,

Figure 6: Response of prices to an exchange rate shock: Inflation targeters (ITers) versus Inflation nontargeters (NITers) (7-variable VAR)



Note: The solid line shows the impulse response to an exchange rate shock. The dashed lines indicate five standard error confidence band around the estimate. Error are generated by Monte-Carlo with 500 repetitions.

23.30 % and 13.89%, respectively. In nontargeters before 1999, exchange rate shocks explain (after 20 quarters)0.31%, 0.35% and 1.32% of the variance of import prices, producer prices and consumer prices, respectively. After 1999, these contributions are 5.31%, 3.56% and 1.73%, respectively.

In summary, the variance decomposition analysis indicates that exchange rate shocks explain an important part of price fluctuations in emerging countries targeting inflation, while the contribution of exchange rate shocks to the fluctuations in prices in nontargeters countries is insignificant. The variance

Table 3: Percentage of prices forecast variance attributed to exchange rate shocks in inflation targerters (7-variable VAR)

	Inflation targerters		Inflation nontargerters	
Horizon	Before IT	After IT	Before 1999	After 1999
	Import prices		Import prices	
1	52.09	11.38	0.00	7.11
2	53.25	12.24	0.00	5.17
4	50.83	11.51	0.05	5.62
8	45.30	11.43	0.28	5.68
12	43.76	12.20	0.31	5.46
20	43.47	12.54	0.31	5.31
	Producer prices		Producer prices	
1	52.09	22.59	0.03	1.05
2	60.34	28.02	0.06	2.14
4	56.44	25.27	0.09	2.84
8	47.48	23.68	0.32	3.66
12	44.60	23.33	0.34	3.65
20	43.70	23.30	0.35	3.56
	Consumer prices		Consumer prices	
1	8.80	6.31	0.28	0.05
2	15.38	12.48	1.87	1.63
4	22.95	14.21	1.66	1.32
8	20.70	13.69	1.46	1.73
12	19.83	13.74	1.38	1.59
20	19.76	13.89	1.32	1.73

Note: "IT" denotes inflation targeting.

decomposition analysis also shows that the contribution of exchange rate shocks to price fluctuations in targeting countries declines after the adoption of inflation targeting. Hence the variance decomposition analysis corroborates the decline in exchange rate pass-through in targeting countries after adopting inflation targeting.

4 Conclusion

In this paper, we have empirically examined the effect of the adoption of an inflation targeting strategy on the exchange rate pass-through to prices in emerging countries. To conduct this empirical study, we used panel VAR techniques using data on twenty-seven emerging countries (fifteen inflation targeters and twelve inflation nontargeters). We have adopted the before-and-after approach by comparing impulse response functions in different country subsamples, depending on the adoption of inflation targeting.

The adoption of inflation targeting modifies the pricing decisions in emerging countries in a way which is consistent with the credibility view. The adoption of inflation targeting has helped to reduce the pass-through to all three price indexes that we considered (import prices, producer prices and consumer prices) in targeting countries from a higher level to a new level that remains significantly different from zero. For nontargeting countries exchange pass-through to all three price indexes is not significantly different zero before 1999, while after 1999 exchange rate pass-through to all the three prices is significantly different from zero. By comparing targeters after inflation targeting to nontargeters after 1999, our evidence suggests that exchange rate pass-through to prices in targeters after inflation targeting is close to that in nontargeters after 1999. The variance decomposition corroborates these results. The variance decomposition analysis indicates that the contribution of exchange rate shocks to price fluctuations in targeting countries is important, while the contribution of exchange rate shocks to prices fluctuations in nontargeters countries is insignificant. The variance decomposition analysis also shows that the contribution of exchange rate shocks to price fluctuations in targeting countries declines after the adoption of inflation targeting.

Finally, our evidence suggests that countries experiencing high exchange rate pass-through were more prone to adopt inflation targeting in order to gain credibility, than countries with low pass-through.

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Appendix

Countries in the sample

Emerging inflation targeters and adoption date of inflation targeting : Brazil (1999:Q2), Chile (1991:Q1), Colombia (1999:Q4), Czech Republic (1997:Q4), Hungary (2001:Q2, Indonesia (2005:Q3), Israel (1991:Q4), Mexico (1998:Q4), Peru (1999:Q3), Philippines (1999:Q3), Poland (1998:Q3), South Africa (2001:Q1), South Korea (1997:Q4), Thailand (2000:Q2), Turkey (2006:Q1).

Emerging inflation nontargeters: Argentina, Bulgaria, China, Estonia, India, Latvia, Lithuania, Malaysia, Singapore, Taiwan, Uruguay, Venezuela.

Variable and their sources

World oil price: The US dollar-basis oil price index that is an average of the three spot price index of Texas, U.K. Brent and Dubai. The world oil price is seasonally adjusted using the Census X12 method. Data source: IMF, International Financial Statistics (henceforth, IFS).

Output gap: The output gap is generated by applying the Hodrick-Prescott (HP) filter to eliminate a strong trend in the seasonally adjusted real gross domestic product (GDP). If the original GDP series is not adjusted, series is seasonally adjusted using the Census X-12 method. The quarterly data are collected using Datastream. The data sources depending on the countries are the following:
Argentina: GDP volume index (2000=100), IMF's International Financial Statistics (IFS)
Brazil: GDP volume index (1995=100) (seasonally adjusted), Instituto Brasileiro de Geografia e Estatistica (IBGE) (Brazil).
Bulgaria: GDP volume index, IFS.
Chile: GDP at 2003 prices (seasonally adjusted) Banco Central de Chile
China: GDP at current price (from IFS) divided by CPI.
Colombia: GDP at 2000 prices (seasonally adjusted), National Administrative Department of Statistics (Colombia).
Czech Republic: GDP at 2000 prices, (seasonally adjusted), Organization of Economic Co-operation and Development (OECD).
Estonia: GDP at 2000 prices, Estonia Statistics (Estonia).

Hungary: GDP volume index (2000=100)(seasonally adjusted),OECD.
India: GDP Volume index (2005=100) (seasonally adjusted), OECD.
Indonesia: GDP at 2000 prices (seasonally adjusted), OECD.
Israel: GDP at 2005 prices (adjusted series), Central Bureau of Statistics (Israel).
Latvia: GDP at 2000 prices, Central Statistics Bureau of Latvia (Latvia).
Lithuania: GDP at 2000 prices (seasonally adjusted), Statistics Lithuania (Lithuania).
Malaysia:GDP volume index (2000=100), IFS.
Mexico: GDP volume index (2000=100), IFS.
Peru: GDP volume index (2000=100), IFS.
Philippines: GDP at 1985 prices (seasonally adjusted), National Statistical Coordination Board (NSCB) (Philippines).
Poland: GDP at 2000 prices (seasonally adjusted),OECD.
Singapore: GDP volume index (2000=100), IFS.
South Africa: GDP at 2000 prices, (seasonally adjusted),IFS.
South Korea: GDP at 2000 prices (seasonally adjusted),OECD, (Quarterly National Accounts).
Taiwan: GDP at 2001 prices, Directorate General of Budget, Accounting and Statistics (DGBAS).
Thailand: GDP at 1988 prices (seasonally adjusted), Office of National Economic and Social Development Board (Thailand).
Turkey: GDP at 1995 prices, Eurostat.
Uruguay: GDP volume index (2005=100) (seasonally adjusted), Banco Central de Uruguay (Uruguay).
Venezuela: GDP at 1997 prices (seasonally adjusted), Banco Central de Venezuela (Venezuela).

Money supply: The data is collected using Datastream. For some countries, base money is used. For others, M1 is used. If the original series is not adjusted, series is seasonally adjusted using the Census X-12 method. The data sources depending on countries are the following:
Argentina: Base money,IFS.
Brazil: Base money, (seasonally adjusted), IFS.
Bulgaria: Money M1 (Banking Survey), IFS.
Chile: Money M1, IFS.
China: Money Supply, People Bank of China.
Colombia: Money M1 (Banking Survey), IFS.
Czech Republic: Money M1 (Banking Survey), IFS.
Estonia: Money M1 (Banking Survey),(seasonally adjusted), IFS.

Hungary: Monetary Base, IFS.
India: Money M1 (Banking Survey), IFS.
Indonesia: Money M1 (Banking Survey) (seasonally adjusted), IFS.
Israel: Money M1 (seasonally adjusted), IFS.
Latvia: Money M1 (Banking Survey) (seasonally adjusted), IFS.
Lithuania: Money M1 (Banking Survey) (seasonally adjusted), IFS.
Malaysia:Money M1, (seasonally adjusted), IFS.
Mexico: Money M1 (Banking Survey) (seasonally adjusted), IFS.
Peru: Money supply, IFS.
Philippines: Money M1 (Banking Survey) (seasonally adjusted), IFS.
Poland: Money M1, IMF, International Financial Statistics (IFS).
Romania: Money M1 (Banking Survey) (seasonally adjusted), IFS.
Singapore: Money M1 (Banking Survey) (seasonally adjusted), IFS.
South Africa: Money M1, IFS.
South Korea: Money M1 (seasonally adjusted), IFS.
Taiwan: Money supply, Bank Central of China.
Thailand: Money M1 (Banking Survey), IFS.
Turkey: Money M1 (Banking Survey) (seasonally adjusted), IFS.
Uruguay: Money M1 (Banking Survey)(seasonally adjusted), IFS.
Venezuela: Money M1 (Banking Survey)(seasonally adjusted), IFS.

Exchange rate: The data is collected using Datastream. The period average bilateral nominal exchange rate vis-à-vis the US dollar are used. For all countries, expected Taiwan, the data is taken from IMF's IFS. For Taiwan the data is taken from IFO World Economic Survey (WES).

Consumer Price Index: The data is collected using Datastream. For all countries expected China the consumer price index (2000=100) is taken from IMF, International Financial Statistics (IFS). For china, the monthly CPI taken from EOCD is used to construct the quarterly CPI. All series are seasonally adjusted using the Census X-12 method.

Import Price Index: The data is collected using Datastream. The import prices index are expressed in home currency. All series are seasonally adjusted using the Census X-12 method. The data sources depending on countries are the following:

Argentina: The import price index is the import unit value in US dollar (2000=100) taken from IFS multiplied by the exchange rate.
Brazil: The import price index is the import unit value in US dollar (2000=100) taken from IFS multiplied by the exchange rate.
Bulgaria: The quarterly series of import price index is constructed by dividing the total import value by the total import volume (1995 prices). The import value and the import volume are taken from National Statistics Institute (Bulgaria) and Eurostat, respectively.
Chile: Import Price Index (2003=100), Banco Central de Chile (Chile).
Colombia: The import price index is the import unit value in US dollar (2000=100) taken from IFS multiplied by the exchange rate. Czech Republic: Import Price Index (2005=100), Czech Statistical of Office.
Estonia: The quarterly series of import price index is constructed by dividing the total import value by the total import volume (2000 prices) Statistics Estonia. The data are taken from Statistics Estonia (Estonia).
Hungary: The import price index is the import unit value in US dollar (2000=100) taken from IFS multiplied by the exchange rate.
India: The quarterly series of import price index is constructed by dividing the total import value by the total import volume (1990 prices). Data are taken from OECD.
Indonesia: The quarterly series of import price index is constructed by dividing the total import value by the total import volume (2000 prices). Data are taken from EOCD.
Israel: The import price index is the import unit value in US dollar (2000=100) taken from IFS multiplied by the exchange rate.
Latvia: The import price index is the import unit value in US dollar (2000=100) taken from IFS multiplied by the exchange rate.
Lithuania: The quarterly series of import price index is constructed by dividing the total import value by the total import volume (2000 prices). The data are taken from Statistics Lithuania.
Malaysia: The quarterly series of import price index is constructed by dividing the total import value by the total import volume (2000 prices). The data are from Department of Statistics (Malaysia).
Mexico: The quarterly import price index is constructed by the monthly import price index (1980=100) taken from Banco de Mexico (Mexico).
Peru: The quarterly import price index is constructed by the average monthly import price index (1994=100) taken from Banco Central Reserva (Peru).
Philippines: The import price index is the import unit value in USdollar (2000=100) taken from IFS multiplied by the exchange rate.

Poland: The import price index is the import unit value in US dollar (2000=100) taken from IFS multiplied by the exchange rate.
Singapore: The import price index is the import unit value in US dollar (2000=100) taken from IFS multiplied by the exchange rate.
South Africa:The import price index is the import prices index in US dollar (2000=100) taken from IFS multiplied by the exchange rate.
South Korea: The import price index is the import unit value in US dollar (2000=100) taken from IFS multiplied by the exchange rate.
Taiwan: The quarterly import price index is constructed by the average monthly import price index (manufactruing goods) (2001=100) taken from Directorate General of Budget, Accounting and Statistics (DGBAS).
Thailand:The import price index is the import unit value in US dollar (2000=100) taken from IFS multiplied by the exchange rate.
Turkey:The import price index is the import unit value in US dollar (2000=100) taken from IFS multiplied by the exchange rate.
Venezuela: The import price index is the import unit value in US dollar (2000=100) taken from IFS multiplied by the exchange rate.

Producer Price Index: The data is collected using Datastream. For all countries expected Taiwan and Turkey, the producer prices index are taken form IFS. For Taiwan the quarterly producer prices index are the average monthly output prices index (2006=100) taken from Taiwans Directorate General of Budget, Accounting and Statistics. For Turkey the quarterly data are taken from Turkeys National Institute of Statistics.

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