Shifts in exchange rate regime and inflation persistence in Vietnam, 1992-2010

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Shifts in exchange rate regime and inflation persistence in Vietnam, 1992-2010

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ABSTRACT

A number of studies have found that more flexible exchange rate regimes (ERRs) tend to be associated with greater inflation persistence. In this paper we investigate whether that proposition applied in the case of Vietnam over the period 1992-2010. Following an approach similar to that of Alogoskoufis and Smith (1991) and Huang and Gu (2007), we found no evidence that inflation persistence in Vietnam was systematically higher under more flexible ERRs than under more rigid ERRs. Indeed, rolling regressions suggested that inflation persistence reached its highest level in the sub-period 2004 to 2007, which can be characterized as a hard-peg regime.

JEL classifications: E31, E58, F41, F47.

Keywords: Exchange rate regime, inflation persistence, hard peg, soft peg, Vietnam.

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1 Introduction

Are flexible exchange rates (ERs) bad for inflation control? In particular, is it true that flexible exchange rate regimes (ERRs) are more conducive to inflation persistence than pegged ERRs? Economic theory and intuition appear to be on the affirmative side of this question. It is generally accepted that inflation will be more persistent if monetary policy is more accommodative in responding to price shocks (Dornbusch, 1982). Therefore, a “credible lack of accommodation” to inflation shocks is often seen as a key requirement for low inflation persistence (Alogoskoufis and Smith, 1991). It is possible that a commitment to a pegged ERR may result in a lower degree of monetary accommodation, so that ‘exchange rate pegs act as a disciplining device, allowing policy makers in countries with a high inflation propensity to import credibility and, hence, lower inflation from abroad' (Husain, Mody, and Rogoff, 2005: 45).

Yet the above chain of reasoning depends critically on the assumption that in practice pegged ERRs result in lower monetary accommodation. It turns out that empirical evidence has been mixed regarding this assumption and, more generally, regarding the overall connection between ERRs and inflation persistence (see, e.g., Alogoskoufis and Smith, 1991; Anderton, 1997; Bleaney, 2000; Bleaney and Francisco, 2005). Contributing to the difficulties in obtaining clear, definitive conclusions about this connection has been the fact that the choice faced by policy makers is typically not between a perfect float and an immovable peg, but rather among various forms of a managed float, or between “softer” and “harder” versions of an ER peg.
The uncertainty over the effects of the choice between ERRs on inflation is of particular relevance to Vietnam. Since the latter part of the 1980s, when it began to transition in earnest toward the market system, the country has undergone a number of ERR shifts. Its inflation experiences have also been highly variable, ranging from hyper-inflation in the earlier years of the reform process, through moderate inflation in most years including deflation or minimal inflation in a couple of years, to a return in recent years to rates of inflation that are sufficiently high to cause widespread concern among the public.

If it is true that inflation persistence tends to decrease under a less flexible ERR, this might justify the authorities’ apparent preference for a stable VND/USD exchange rate over the past two decades or so (Nguyen-Tran-Phuc and Nguyen-Duc-Tho, 2009). By contrast, if there is no clear association between shifts in the ERR and inflation persistence, that fact would weaken one of the arguments underlying official resistance to calls for greater ER flexibility (e.g., IMF 2005, 2007; Nguyen-Thi-Thu-Hang, et al., 2010).

In this paper, we investigate possible linkages between ERR shifts and inflation persistence in Vietnam during the period 1992-2010. In so doing, we follow an approach adopted previously by Alogoskoufis and Smith (1991), Alogoskoufis (1992), Anderton (1997), Huang and Gu (2007), and others. The findings may potentially be of interest to not only Vietnam but also other developing countries faced with similar policy choices.

The rest of the paper is organized as follows. Section 2 provides some background information and a brief review of previous findings in this area. Section 3 describes the methods of analysis and data to be used, while Section 4 reports the
main findings. Finally, Section 5 presents a summary of the analysis and a brief discussion of its wider implications.

2 Background and previous findings

2.1 Vietnam’s inflation experiences and exchange rate regimes

Vietnam went through several years of hyperinflation during the mid-1980s; at its peak (which was reached in 1986) inflation was as high as 454% per annum (IMF, 2008). By 1993, however, inflation had been sharply reduced to single-digit levels, as shown in Figure 1. The figure also shows that inflation was kept largely under control during the period 1996 to 2003. Indeed, during 2000 and 2001, there was even some slight deflation, which was seen by some as part of the lagged effects of the Asian financial crisis of 1997-1998 (Le-Quoc-Ly, 2005). Since 2004, inflation has again risen, reaching 23% (on a year-on-year basis) in 2008 before subsiding but remaining relatively high by international standards.

[Insert Figure 1 about here]

The bilateral VND/USD exchange rate is the main focus of Vietnam’s ER policy and of transactions in the country’s foreign exchange market, notwithstanding increases during recent years in the market share of transactions involving other bilateral rates. As Figure 2 shows, the VND/USD has followed a general upward trend (indicating depreciations of the VND) over the past two decades, but was relatively flat during lengthy periods of time, such as the 1992-1996, 1999-2000 and 2004-2007 sub-periods.

[Insert Figure 2 about here]
The ERR has undergone major changes, evolving from a system of multiple ERs (which had been in existence for a number of years prior to the country’s reunification in 1975) to a single (but adjustable) pegged rate in 1989. Since then, the system has comprised an announced official ER and a band of allowable variations around this rate; market participants are supposed to trade within this band only. The official ER has been announced on a daily basis since around 1992. As shown in Figure 3, the allowable trading band was quite narrow (less than +/-1 % from the announced rate) for most of the study period, with the notable exceptions of the sub-periods corresponding to the Asian financial crisis and the recent global financial crisis.

[Insert Figure 3 about here]

2.2 Previous findings in the international literature

Alogoskoufis and Smith (1991) analyze annual data for the USA and UK and find that inflation persistence was significantly lower under gold-based, fixed-exchange-rate regimes (during the period 1948-1967) than under managed-exchange-rate regimes (during the period 1968-1987). In a separate study, Alogoskoufis (1992) compares the periods 1953-1971 and 1972-1987 for 21 OECD countries, and finds that a similar conclusion applies for 20 of these countries. Similarly, Obstfeld (1995) compares the periods 1953-1972 and 1973-1994 for 12 OECD countries, and finds that inflation persistence was higher under floating regimes (during the later period) for all of the countries studied except the USA.¹ More recently, Huang and Gu (2007) follow the approach used by Alogoskoufis and Smith (1991) and Alogoskoufis (1992) to analyse data for China during the 1991-2006 period, and report that they find evidence
suggesting that shifts to a more flexible ERR there would induce a rise in inflation persistence.

The main thrust of the above findings has been challenged by a number of authors. For example, using a model similar to that of Alogoskoufis and Smith (1991), Anderton (1997) examines inflation dynamics in a number of countries which were members of the European Exchange Rate Mechanism (ERM) and compares their experiences with those of selected non-ERM countries during the period 1970Q1-1992Q3. Anderton concludes that the adoption of less accommodative policies played a crucial role in reducing inflation persistence, but “membership of the ERM is not necessary or sufficient for achieving this objective” (Anderton, 1997: 33).

Bleaney (2000) argues that allowance should be made for possible shifts over time in the mean inflation rate which can have a substantial impact on the estimates of persistence. Upon making such an allowance, he finds no evidence of higher inflation persistence during the 1984-1999 period among eight developed countries with floating rates compared with seven countries which either were members of the European Monetary System (EMS) or pegged their currencies. He also reports that he finds no evidence that monetary policy in OECD countries became more accommodative under floating ERRs.

Burdekin and Siklos (1999) suggest that it may be an overstatement of the impact of changes in ERR to attribute to them, as did Alogoskoufis and Smith (1991), the post-1967 shift in inflation persistence. Burdekin and Siklos point out that other factors -- such as wars, oil price shocks, and central bank reforms -- could also account for changes in inflation persistence.
3 Methods and Data

Following Alogoskoufis and Smith (1991), Alogoskoufis (1992), Anderton (1997) and Huang and Gu (2007), we assume that the process of inflation in Vietnam during the study period can be represented by the following equation:

$$\pi_t = \alpha + \sum_{k=1}^{p} \beta_k \pi_{t-k} + \epsilon_t$$

where $\pi_t$ is the CPI inflation rate, $\alpha$ denotes an intercept term, and $\epsilon_t$ indicates serially uncorrelated shocks. Following standard practice (e.g., Marques, 2004; O'Reilly and Whelan, 2005; Zhang and Clovis, 2009), inflation persistence is measured as the sum of the autoregressive coefficients:

$$\rho = \sum_{k=1}^{p} \beta_k$$

Equation (1) can be rewritten to incorporate the measure of inflation persistence as:

$$\pi_t = \alpha + \rho \pi_{t-1} + \sum_{k=1}^{p-1} \phi_k \Delta \pi_{t-k} + \epsilon_t$$

where $\Delta \pi_t = \pi_t - \pi_{t-1}$.

If $\rho=1$, the inflation process is non-stationary, which would indicate an economic environment where inflation is badly controlled (Gerlach and Tillmann, 2010).

It can be shown that the conventional approach to the estimation of equation (3) is equivalent to running OLS regressions based on the following equation:

$$\pi_t - \bar{\pi} = \rho (\pi_{t-1} - \bar{\pi}) + \sum_{k=1}^{p-1} \phi_k \Delta \pi_{t-k} + \epsilon_t$$

where $\bar{\pi} = T^{-1} \sum_{t=1}^{T} \pi_t$ is the sample mean.
It is well-known that OLS estimation of $\rho$ in (3a) tends to produce underestimates and the magnitude of underestimation increases as $\rho$ increases and approaches unity (e.g., Andrews, 1993; Andrews and Chen, 1994). To alleviate this problem, Shin and So (2001) suggest recursive mean adjustment (RMA), such that regressions would be based instead on the following equation:

$$\pi_t - \bar{\pi}_{t-1} = \rho(\pi_{t-1} - \bar{\pi}_{t-1}) + \sum_{k=1}^{p-1} \phi_k \Delta \pi_{t-k} + \epsilon_t$$  

(4)

where $\bar{\pi}_{t-1} = (t-1) \sum_{s=1}^{t-1} \pi_s$ is the recursive mean at $t-1$.

Following this suggestion, we shall use equation (4) to conduct some regressions.

To determine the appropriate lag length $p$ in the main regressions where monthly data are used, we allow for up to 12 lags and select regressions with high $R^2$, low AIC, low SIC and low standard error of regression (SER). To obtain an initial indication of the stability over time of the intercept term $\alpha$, which indicates the mean inflation rate, and the slope coefficient $\rho$, which measures inflation persistence, we estimate rolling regressions of (3) and (4), each with a window of 4 years of data.

To formally test for possible linkages between ERR and inflation persistence, we follow the example of Alogoskoufis and Smith (1991) and introduce a slope dummy variable, $D$, which represents periods when the ERR can be described as more flexible than usual (for more details, see below). We also follow Bleaney (2000) and introduce intercept dummy terms to represent periods when the mean inflation rate was higher than usual. The inclusion of these dummy variables yields the following equations which correspond to (3) and (4), respectively:
\[
\pi_t = \alpha + \gamma_1 dms_{1t} + \gamma_2 dms_{2t} + \rho_2 \pi_{t-1} + (\rho_1 - \rho_2) (\pi_{t-1} \times D) \\
+ \sum_{k=1}^{p-1} \phi_k \Delta \pi_{t-k} + \sum_{k=1}^{p-1} \psi_k (\Delta \pi_{t-k} \times D) + \epsilon_t
\]

(5)

\[
\pi_t - \bar{\pi}_{t-1} = \rho_2 (\pi_{t-1} - \bar{\pi}_{t-1}) + (\rho_1 - \rho_2) [(\pi_{t-1} - \bar{\pi}_{t-1}) \times D] \\
+ \sum_{k=1}^{p-1} \phi_k \Delta \pi_{t-k} + \sum_{k=1}^{p-1} \psi_k (\Delta \pi_{t-k} \times D) + \epsilon_t
\]

(6)

where \( D \) is a dummy variable taking the value 1 for periods when the VND/USD exchange rate was more flexible than usual (i.e., a “softer” peg was in effect) and zero elsewhere, and \( \rho_1 \) and \( \rho_2 \) are measures of inflation persistence during periods of “softer” and “harder” pegs, respectively. The intercept dummies \( dms_{1t} \) and \( dms_{2t} \) are meant to capture the mean shifts in 2 sub-periods when the mean rate of inflation was higher than usual. The exact dates of these sub-periods depend on the relevant regression (e.g., whether monthly or annual data are used); further details are provided in the main text below as well as in Tables 1 and 2. Regressions based on equations (5) and (6) allow us to test whether \( \rho_1 - \rho_2 > 0 \), i.e., whether greater inflation persistence is associated with softer peg regimes. The null hypothesis is that \( \rho_1 - \rho_2 = 0 \).

There is, to our knowledge, no consistent and convincing classification of Vietnam’s ERRs for the entire period being studied. For example, the classification proposed by Reinhart and Rogoff (2004) covers only the period January 1990 to December 2001. Further, in their classification, Vietnam’s ERR is considered a “crawling peg” for all this period, despite the fact that the VND/USD rate experienced very large movements during 1997-1998. Similarly, the IMF classified Vietnam’s ERR in 2003 and 2004 as a “managed float”, even though variations in the VND/USD rate during this period were extremely small (typically less than 1% on a monthly
basis). In 2006, the IMF revised its classification, placing Vietnam in the category of “conventional fixed peg”.

For the purposes of this paper, we follow the example of authors such as Shambaugh (2004) and Klein and Shambaugh (2006) and propose a number of rules to differentiate, at a *de facto* level, periods when the ERR in Vietnam could be described as “more flexible” (or a “softer peg”) than in other periods, which might reasonably be described as “less flexible” (or a “harder peg”). Rule (i) focuses on the width of the allowable trading band within which the authorities permitted ERs to vary. Under this rule, periods during which trading could deviate by more than 1% from the announced, official ER would be classified as operating under a “softer peg”.

Rules (ii) to (iv) focus on the actual month-end ($E_t$) and monthly average ($A_t$) values of the ER, in the absence of daily data. Variations of 1% or more per month are considered representative of a softer-peg regime. Accordingly, rule (ii) specifies that a month $t$ would be a candidate for classification as part of a softer-peg period if $|\ln(E_t/A_t)| > 1\%$. Rule (iii) is a similar decision rule based on $|\ln(E_t/E_{t-1})|$, and Rule (iv) on $|\ln(A_t/A_{t-1})|$. Judgment is to be exercised to ensure that each softer-peg or harder-peg regime covers a multi-month period rather than isolated monthly observations.

Monthly data for the consumer price index (CPI) and the VND/USD exchange rate are obtained for the period Jan 1992 – June 2010 from the International Financial Statistics (online), Nguyen-Van-Tien (2002), the State Bank of Vietnam (SBV) and the General Statistics Office of Vietnam (GSO). Data for the CPI are seasonally adjusted whilst data for the ER are not. Data for the period prior to January 1992 are fragmentary and are considered insufficiently reliable for the estimation and analysis to be undertaken below.
4 Empirical analysis

4.1 Classification of exchange rate regimes

Applying Rule (i) to daily data for the allowable trading band around the official VND/USD exchange rate (see Figure 3 above) yields the following classification. Periods of more flexible ERRs (softer pegs) include February 1997 to January 1999 (inclusive), and July 2008 to June 2010. For the remaining periods (January 1992 to January 1996, and February 1999 to June 2008), the relevant ERR is considered “less flexible” (harder pegs).

The application of Rules (ii) to (iv) to monthly data produces results that are very similar to one another, as can be seen in Figure 4. Using these results as a guide, and resolving to use the term ER regime only to describe a period of some reasonable length rather than some brief and/or isolated monthly observations, we identify the following periods as episodes when the ERR is more flexible (softer pegs): January 1992 to January 1993, March 1997 to August 1998, and June 2008 to June 2010.

Combining the above two sets of dates (using the union rule) yields the following, preferred classification. The periods January 1992 to January 1993, February 1997 to January 1999, and June 2008 to June 2010 are classified as periods of more flexible ERRs, and the remaining periods are classified as episodes of less flexible ERRs.

4.2 Preliminary estimation: rolling regressions

As a first step, we estimate AR versions of equations (3) and (4), using a moving 4-year window, in order to obtain an indication of the stability of both the mean inflation rate $\alpha$ and of the measure of inflation persistence $\rho$. For simplicity, at this
stage, we only considered lag lengths of 1 and 2 periods. The data provide 15 rolling samples, for the years 1992 to 1995 (inclusive), 1993 to 1996, ..., and 2006 to 2009.

As shown in Figure 5, rolling estimates of $\alpha$ suggest that the mean inflation rate was much higher during the initial and final years of our study period than during the middle years. Indeed, closer inspection (see Figure 1 above) suggests that there were two structural breaks, one occurring around the beginning of 1999 which heralds a period of very low inflation, and another occurring around the end of 2003 which signals a period of resurgent inflation.

[Insert Figure 5 about here]

Figure 6 illustrates some rolling estimates of $\rho$. To reduce clutter, we have shown only estimates obtained via, first, AR(1) and AR(2) without RMA and, second, AR(2) with RMA. The estimates suggest that inflation persistence became higher in the latter part of the study period. In particular, the sub-period 2004-2007 appears to be associated with the highest levels of measured inflation persistence. Interestingly, this sub-period is classified as a time of less flexible ERR (harder peg) according to our analysis in Sub-section 4.1.

[Insert Figure 6 about here]

### 4.3 Full-sample estimation and significance tests

Our main regressions are based on equations (5) and (6), with monthly data for the full sample period. For the regressions that are based on (5), i.e., without RMA, we experiment with lags order of up to 12. The best results are those obtained with 12 lags. For regressions of equation (6), i.e., with RMA, we experiment with a smaller set of alternative AR models, focusing on AR(1), AR(2) and AR(12). Again, the best
results are obtained for 12 lags. Table 1 presents estimates obtained for selected regressions.⁴

[Insert Table 1 about here]

The dependent variable in each of the regressions shown in Table 1 is the monthly rate of inflation, calculated as \(\ln(CPI_t/CPI_{t-1})\). With one lag, the sample is reduced to 220 observations (for March 1992 to June 2009 inclusive), and with 12 lags it is further reduced to 209 observations (starting from February 1993). Regressions 1.1, 1.2 and 1.3, all of which are based on equation (5), incorporate two dummy intercept terms to account for the sub-periods of high inflation mean in the early and latter parts of the sample period. Regression 1.4, which is based on equation (6) and, therefore, incorporates RMA, does not have such intercept dummies because RMA has already taken account implicitly of changes in the mean inflation rate – indeed, if intercept dummies were included anyway, their estimated coefficients would typically be insignificantly different from zero.

Estimates of \(\rho_2\) in Table 1 relate to inflation persistence during periods of less flexible ERRs (harder pegs). Estimates of the coefficient for the dummy variable, D, i.e., \(\rho_1 - \rho_2\), allow us to formally test the hypothesis that \(\rho_1 > \rho_2\), i.e., that inflation persistence is higher under more flexible ERRs, against the null hypothesis that \(\rho_1 = \rho_2\). As shown clearly in Table 1, the estimated values of \(\rho_1 - \rho_2\) do not have the “expected” sign. Indeed, in all relevant regressions, the estimated value indicates that \(\rho_1 - \rho_2\) is negative and this result is typically significant at the 1% level.

We have experimented with small variations in the end date of the intercept dummy term \(dms_{1t}\) and the start date of \(dms_{2t}\). Selection of the preferred regression in each case is based on comparison of \(R^2\), AIC, SIC, and SER.
4.4 Regressions with alternative measures of inflation

It is recognised that there are alternatives to the measure of inflation used in the above analysis. To check for robustness, a second monthly measure is used, namely \( \ln(CPI_t/CPI_{t-12}) \), as well as an annual measure, namely \( \ln(CPI_t/CPI_{t-1}) \), where \( CPI_t \) is the average CPI for the year \( t \). Regressions 2.1 and 2.2 shown in Table 2 relate to the second measure of inflation, while Regressions 2.3 and 2.4 relate to the third measure. As before, while Regressions 2.1 and 2.3 are conducted without RMA, Regressions 2.2 and 2.4 are obtained with RMA.

[Insert Table 2 about here]

Estimates from Regressions 2.1 and 2.2 (alternative monthly measure of inflation) suggest that \( \rho_1 - \rho_2 \) may be negative, but this result is not statistically significant. Regressions 2.3 and 2.4 (annual measure of inflation) yield a similar finding.

5 Conclusion

In this paper, we have investigated a possible association between periods of more flexible ERRs and higher inflation persistence, using monthly and annual data for Vietnam over the period January 1992 to June 2010. While we follow the basic approach of Alogoskoufis and Smith (1991) and Huang and Gu (2007), we also allow for changes in the mean inflation rate via either recursive mean adjustment (Shin and So 2001) or intercept dummy terms.

We find no evidence that inflation persistence in Vietnam was higher under more flexible ERRs. On the contrary, estimates from many of our full-sample regressions suggest that such “softer-peg” periods may have coincided with lower inflation persistence. Further, rolling regressions suggest that inflation persistence reached its
highest level during the sub-period 2004-2007, which is identified as a time of less flexible ERs. Whatever else might be the merits of the authorities’ apparent preference for a stable bilateral VND/USD exchange rate, it does not appear to date to have contributed to reducing inflation persistence.

Our findings are consistent with those of Anderton (1997), Bleaney (2000), and others who have found, in the context of various countries, that a more rigid ERR is neither a necessary nor a sufficient condition for a decrease in inflation persistence. They are, however, not in accordance with the findings of Alogoskoufis and Smith (1991), Alogoskoufis (1992), and Huang and Gu (2007) or with standard theoretical predictions. One possible way to reconcile our findings with these theoretical predictions is to focus on the theoretically presumed linkage between a more rigid ERR and a less accommodating stance in monetary policy. Anderton (1997) and Bleaney (2000) have found that this potential linkage did not hold in practice for various developed countries. In future research, it may be useful to investigate this possible link in the context of Vietnam: if this link turned out to be non-operative, that would go a long way toward explaining why the theoretical predictions were not borne out.

Anderton (1997) and Burdekin and Siklos (1999) point out that the analysis by Alogoskoufis and Smith (1991), and similar analyses by other authors, do not take into account other important factors, such as oil price shocks, wars, political crises and institutional changes, which could have a material impact on inflation persistence. Although our use of recursive mean adjustment and intercept dummy terms reduces the severity of this caveat to some extent, it does not fully address the fundamental issue involved. To do so, future research could make use of more detailed models of inflation. Alternatively, evidence could continue to be gathered from analyses like
ours but relating to other sets of circumstances: as more studies are completed, they would shed additional light on the role of those “other” factors which exert strong influence over inflation persistence.

As a response to our findings, some advocates of “hard” pegs might argue that the results would have been different had the authorities stuck resolutely to the hardest possible pegs – in other words, that the benefits of a peg ERR would materialise only if the peg itself were totally immovable or nearly so. The results of Bleaney and Francisco (2005) provide some support in principle for this argument. It is arguable, however, that on a number of occasions during the past two decades, international financial conditions were such that the authorities in Vietnam would have found it exceedingly difficult to enforce greater rigidity in the VND/USD exchange rate.
Notes

1. Under the Bretton Woods system, as the United States acted as reserve center, it was allowed considerable freedom in conducting monetary policy (Obstfeld 1995). For some countries, data were then available for only up to 1993.

2. Monthly data for the consumer price index are available from the International Financial Statistics (online) only for 1995 and subsequent years. Data for this variable for the earlier years are obtained and estimated from Nguyen-Van-Tien (2002), the SBV and GSO.

3. The full results of rolling regressions for equations (3) and (4) with AR(1) and AR(2) are available upon request.

4. The full set of regression results for equations (5) and (6) are available upon request.
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Figure 1

Inflation Rate (%), January 1992–June 2010

Note: Inflation rate is calculated as the annualized percentage rate of change over the previous month of the seasonally adjusted consumer price index. The monthly variations have been smoothed via a centered 7-term moving average.

Source: Nguyen-Van-Tien (2002); SBV; GSO; IMF, IFS (Online)

Figure 2

Nominal VND/USD Exchange Rate, January 1992 – June 2010

Note: Data shown are for monthly averages.

Source: IMF, IFS (Online).
Figure 3
Allowable Variations around Official Exchange Rate
January 1992 – June 2010

Note: There was no stipulated lower band for the periods Jan 92–Sept 94 and Jan 98–Jun 02
Source: Various Decisions by the SBV from 1989 to 2010

Figure 4
Monthly Variations in the VND/USD Rate, 1992-2010

Note: Et and At denote the month’s-end and monthly-average observations, respectively, of the VND/USD exchange rate.
Source: IMF IFS (Online).
Figure 5
Rolling 4-year Estimates of $\alpha$

Note: Estimates relate to regressions of equation (3) in the main text.

Figure 6
Rolling 4-year Estimates of $\rho$

Note: Estimates relate to regressions based on equations (3) and (4) in the main text.
### Table 1
Regressions of month-on-month inflation rate
(Data coverage: Jan 1992-June 2010)

<table>
<thead>
<tr>
<th>Regression</th>
<th>1.1</th>
<th>1.2</th>
<th>1.3</th>
<th>1.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of lags</td>
<td>12</td>
<td>1</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>Sample period (adjusted)</td>
<td>02/93-06/10</td>
<td>03/92-06/10</td>
<td>12/92-06/10</td>
<td>02/93-06/10</td>
</tr>
<tr>
<td>Number of observations</td>
<td>209</td>
<td>220</td>
<td>211</td>
<td>209</td>
</tr>
<tr>
<td>Dates of 1st mean</td>
<td>02/93-01/99</td>
<td>03/92-01/99</td>
<td>12/92-01/99</td>
<td>N/A</td>
</tr>
<tr>
<td>Dates of 3rd mean</td>
<td>11/03-06/10</td>
<td>11/03-06/10</td>
<td>11/03-06/10</td>
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<tr>
<td>Recursive mean adj.</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>$\alpha \times 10^2$</td>
<td>0.06</td>
<td>0.03</td>
<td>0.04</td>
<td></td>
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<tr>
<td>$\gamma_1 \times 10^2$</td>
<td>0.34</td>
<td>0.33</td>
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<td>$\gamma_2 \times 10^2$</td>
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<td>$\rho_2$</td>
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<td>R-squared</td>
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<td>0.538</td>
<td>0.553</td>
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<td>0.419</td>
<td>0.484</td>
<td>0.498</td>
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<td>S.E.R $\times 10^2$</td>
<td>0.49</td>
<td>0.52</td>
<td>0.49</td>
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<td>-7.64</td>
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<td>-7.27</td>
<td>-7.57</td>
<td>-7.32</td>
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<tr>
<td>Durbin-Watson stat.</td>
<td>1.94</td>
<td>2.27</td>
<td>2.03</td>
<td>1.93</td>
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</tbody>
</table>

**Notes:**
- Dependent variable in the above regressions is $p_t = \ln (CPI_t/CPI_{t-1})$, where CPI is the consumer price index for month $t$.
- Estimates relate to regressions of equations (5) and (6) in the main text.
- Figures in brackets are t-statistics.
- N/A indicates “Not Applicable”
- (**) and (*) indicate that the relevant coefficient is significant at the 1% and 5% levels, respectively.
<table>
<thead>
<tr>
<th>Regression</th>
<th>2.1</th>
<th>2.2</th>
<th>2.3</th>
<th>2.4</th>
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<tr>
<td>Data frequency</td>
<td>Monthly</td>
<td>Monthly</td>
<td>Annual</td>
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<tr>
<td>Number of lags</td>
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<td>12</td>
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<tr>
<td>Sample period (adjusted)</td>
<td>01/94-06/10</td>
<td>01/94-06/10</td>
<td>1994-2010</td>
<td>1994-2010</td>
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<tr>
<td>Number of observations</td>
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<td>17</td>
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<tr>
<td>Dates of 1st mean</td>
<td>01/94-03/99</td>
<td>NA</td>
<td>1994-1998</td>
<td>NA</td>
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<tr>
<td>Dates of 3rd mean</td>
<td>11/03-06/10</td>
<td>NA</td>
<td>2004-2010</td>
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<tr>
<td>Recursive mean adj.</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>$\alpha \times 10^2$</td>
<td>0.03</td>
<td>1.35</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>(0.30)</td>
<td>(0.60)</td>
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</tr>
<tr>
<td>$\gamma_1 \times 10^2$</td>
<td>0.58</td>
<td>6.6</td>
<td></td>
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<tr>
<td></td>
<td>(3.20**)</td>
<td>(2.01#)</td>
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<td>$\gamma_2 \times 10^2$</td>
<td>0.65</td>
<td>6.4</td>
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<tr>
<td></td>
<td>(3.57**)</td>
<td>(1.75)</td>
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<tr>
<td>$\rho_2$</td>
<td>0.93</td>
<td>0.997</td>
<td>0.35</td>
<td>0.83</td>
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<tr>
<td></td>
<td>(48.98**)</td>
<td>(63.36**)</td>
<td>(0.63)</td>
<td>(2.11#)</td>
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<tr>
<td>$\rho_1-\rho_2$</td>
<td>-0.01</td>
<td>-0.05</td>
<td>-0.33</td>
<td>-0.78</td>
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<td>(-0.58)</td>
<td>(-1.75#)</td>
<td>(-0.75)</td>
<td>(-1.49)</td>
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<tr>
<td>R-squared</td>
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<td>0.985</td>
<td>0.438</td>
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<tr>
<td>Adjusted R-squared</td>
<td>0.984</td>
<td>0.983</td>
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<td>0.176</td>
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<td>S.E.R $\times 10^2$</td>
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<td>1.98</td>
<td>2.05</td>
<td>2.19</td>
<td>1.96</td>
</tr>
</tbody>
</table>

Notes:
- Dependent variable in Regressions 2.1 and 2.2 is $p_t = \ln \left(\frac{CPI_t}{CPI_{t-12}}\right)$, where $CPI_t$ is the consumer price index for month $t$.
- Dependent variable in Regression 2.3 and 2.4 is $p_t = \ln \left(\frac{CPI_t}{CPI_{t,\text{avg}}}\right)$, where $CPI_t$ is the average consumer price index for year $t$.
- Estimates relate to regressions of equations (5) and (6) in the main text.
- Figures in brackets are t-statistics.
- N/A indicates “Not Applicable”
- (**) and (#) indicate the relevant coefficient is significant at the 1% and 10% levels, respectively.