New Perspectives on Forecasting Inflation in Emerging Market Economies: An Empirical Assessment

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Forecasting Issues in Developing Economies
Washington, DC, April 26-27, 2017
New Perspectives on Forecasting Inflation in Emerging Market Economies

1. Introduction

Motivation

- Inflation forecasting has resurged in advanced economies
  - global inflation
    - Ciccarelli and Mojon (2010); Duncan and Martínez-García (2015)
  - surveys of expectations
    - Faust and Wright (2013)

- A few studies for emerging market economies (EMEs)
  - Limited cross-section and time series dimension
  - Few models; exception: Mandalincí (2015)
  - Some key models are virtually ignored (e.g., RW by Atkeson and Ohanian (2001))
What we do

- A horse race with a broad-range set of specifications to forecast inflation in EMEs
- Discuss the implications of our main finding in an open-economy New Keynesian model
What we find and its importance

- The RW-AO has, in general, a superior predictive power to forecast inflation across EMEs.

- If we interpret our findings as deviations from rational expectations coupled with partial credibility, we get sensible theoretical predictions about inflation dynamics.

- The RW-AO is a missing model in the literature for EMEs.

- Hammond (2012) reports the list of forecasting models used by inflation targeters: the RW-AO is not one of them.
Outline

1. Introduction
2. Forecasting exercise
3. Models
4. Forecast comparison
5. Discussion
6. Final remarks
2. Forecasting exercise

The data

- Quarter-on-quarter headline-CPI inflation rates ($\pi_t$)

$$\pi_t \equiv 100 \left[ \left( \frac{CPI_t}{CPI_{t-1}} \right)^4 - 1 \right]$$

- Seasonally-adjusted, average data, 1980Q1-2016Q4.

- Sample of 14 EMEs: Chile, China, Colombia, Hungary, Indonesia, India, Malaysia, Mexico, Nigeria, Peru, Philippines, South Africa, Thailand, and Turkey.
New Perspectives on Forecasting Inflation in Emerging Market Economies

2. Forecasting exercise

The data

Inflation rates in EMEs

2000Q1 2001Q1 2004Q1 2006Q1 2008Q1 2010Q1 2012Q1 2014Q1 2016Q1

Chile China Colombia Hungary Indonesia Malaysia Mexico Peru Philippines South Africa Thailand
2. Forecasting exercise

The data
2. Forecasting exercise

- Horse race to forecast inflation, the RW-AO vs competing models
- Pseudo out-of-sample forecasts, recursive estimation
- Forecast horizons: $h = \{1, 4, 8, 12\}$ quarters
- Training sample: 1980Q2-2000Q2
3. Models

The null model

**Random Walk (RW-AO)**

\[ M_0 : \pi_{t+h} = \frac{1}{q} \sum_{i=1}^{q} \pi_{t+1-i} + \epsilon_{t+h} \]

- \( \pi_{t+h} \): the inflation rate
- \( h \): forecast horizon
- \( \epsilon_{t+h} \): forecast error
- \( q = 4 \)
3. Models

Competing models

We consider

- univariate and multivariate specifications
- frequentist and Bayesian techniques
- constant and time-varying parameter models
- purely statistical and econometric specifications (exchange rates, commodity prices, global inflation via factor components)

3. Models

Competing models

Recursive autoregression, AR(p) model (RAR)

\[ M_1 : \pi_t = \phi_0 + \Phi(L)\pi_t + \epsilon_t \]
where \( \Phi(L) = \phi_1 L + ... + \phi_p L^p \).

Direct forecast, AR(p) model (DAR, DAR4)

\[ M_2, M_3 : \pi_{t+h} = \phi_{0,h} + \Phi(L,h)\pi_t + \epsilon_{t+h} \]
where
\[ \Phi(L,h) = \phi_{1,h} + \phi_{2,h} L + ... + \phi_{p,h} L^{p-1} \] (for a given \( h \)),
\( p = 2 \) (\( M_2 \)) and \( p = 4 \) (\( M_3 \)).
3. Models

Competing models

**Factor-Augmented AR(p) model (FAR)**

\[ M_4 : \pi_{t+h} = \phi_{0,h} + \Phi(L, h)\pi_t + \Theta(L, h)\hat{F}_t + \epsilon_{t+h} \]

where \( \hat{F}_t \) is a static factor component of the inflation rates of the 14 EMEs plus 18 advanced economies.
Augmented Phillips Curve (APC)

\[ M_5 : \pi_{t+h} = \phi_{0,h} + \Phi(L, h)\pi_t + A(L, h)y_t + B(L, h)e_t + C(L, h)p_{t}^{c} + \epsilon_{t+h} \]

where
\( y \): industrial production index,
\( e \): real exchange rate,
\( p_{t}^{c} \): commodity price index (agricultural raw materials, beverages, food, metals and crude oil).
All expressed in percent changes.
3. Models

Competing models

**Bivariate BVAR (BVAR2)**

\[ M_6 : \quad X_{t+h} = \Phi_{0,h} + \Phi(L,h)X_t + \epsilon_{t+h} \]

where

- \( X_t = (\pi_t, \hat{F}_t)' \)
- \( \Phi_{0,h} \): vector of parameters
- \( \Phi(L,h) \): matrix of lag polynomials
- Minnesota priors.
3. Models

Competing models

**Multivariate BVAR (BVAR4)**

\[ M_7 : \quad X_{t+h} = \Phi_{0,h} + \Phi(L, h)X_t + \epsilon_{t+h} \]

where

\[ X_t = (\pi_t, y, e, p^c)' \]

Minnesota priors.
Bivariate BVAR with commodity prices (BVAR2-COM)

\[ M_8 : \quad X_{t+h} = \Phi_{0,h} + \Phi(L, h)X_t + \epsilon_{t+h} \]

where

\[ X_t = (\pi_t, p^c)' \]

Minnesota priors.
3. Models

Competing models

**Time Varying Parameter specification (TVP)**

\[ M_9 : \pi_{t+h} = \phi_{0h,t} + \phi_{1h,t}\pi_t + \epsilon_{t+h} \]

where \( \phi_{0h,t} \) and \( \phi_{1h,t} \) follow

\[ \phi_{0h,t+h} = \phi_{0h,t} + \nu_{0,t+h} \]
\[ \phi_{1h,t+h} = \phi_{1h,t} + \nu_{1,t+h} \]

and \( \nu_{0,t} \) and \( \nu_{1,t} \) are i.i.d. shocks.
4. Forecast evaluation

Predictive ability: Relative RMSPE

(1) Relative RMSPE

- The relative RMSPE or Theil-U statistic is

\[
\text{Theil} - U_{m,c}^h = \frac{\text{RMSPE}_{RW-AO,c}^h}{\text{RMSPE}_{m,c}^h}
\]

for \( c = 1, 2, \ldots, 14, m = 1, 2, \ldots, 9, h = 1, 4, 8, 12 \).

- If \( \text{Theil} - U_{m,c}^h < 1 \), the RW-AO has a lower RMSPE than does the competitive model \( m \) for country \( c \) at the forecast horizon \( h \).

- Statistical significance:
  - Diebold-Mariano-West test + Harvey et al. (1997)
  - Clark and West (2007)
4. Forecast evaluation

Findings

Relative RMSPEs (medians)

- RAR
- DAR
- DAR4
- FAR
- APC
- BVAR2
- BVAR4
- BVAR2-COM
- TVP
## 4. Forecast evaluation

### Findings

<table>
<thead>
<tr>
<th></th>
<th>M4 FAR</th>
<th>M6 BVAR2</th>
<th>M7 BVAR4</th>
<th>M9 TVP</th>
<th>Average M1-M9</th>
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<tbody>
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<tr>
<td>Median</td>
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<td>7</td>
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<td><strong>Eight-quarter ahead</strong></td>
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<tr>
<td>Median</td>
<td>0.870</td>
<td>0.871</td>
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<td><strong>Averages (all horizons)</strong></td>
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<tr>
<td>Median</td>
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<td>0.907</td>
<td>0.834</td>
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</table>

RMSPE of the RW-AO Relative to Competing Models
4. Forecast evaluation

Findings

Where is the RW-AO more successful in terms of RMSPE?

<table>
<thead>
<tr>
<th>Number of Statistical Significant Cases (U-Theils; #pv&lt;.1)</th>
</tr>
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<tbody>
<tr>
<td></td>
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<tr>
<td>Mexico</td>
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<tr>
<td>Peru</td>
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<td>Hungary</td>
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<td>Thailand</td>
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<td>Malaysia</td>
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<tr>
<td>South Africa</td>
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</table>
4. Forecast evaluation

Predictive ability: Success ratios

(2) Success ratio

- An estimate of the probability that a given forecast correctly anticipates the direction of change in inflation
- Tossing a fair coin predicts the direction of change correctly 50% of the time
- So a model needs to attain a success ratio greater than 0.5
4. Forecast evaluation

Findings

Success Ratios (Medians)

- RW-AO
- RAR
- DAR
- DAR4
- FAR

- APC
- BVAR2
- BVAR4
- BVAR2-COM
- TVP
## 4. Forecast evaluation

### Findings

<table>
<thead>
<tr>
<th></th>
<th>M₀</th>
<th>M₄</th>
<th>M₆</th>
<th>M₇</th>
<th>M₉</th>
<th>Average</th>
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<tr>
<td></td>
<td>RW-AO</td>
<td>FAR</td>
<td>BVAR2</td>
<td>BVAR4</td>
<td>TVP</td>
<td>M1-M9</td>
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<tr>
<td>One-quarter ahead</td>
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<tr>
<td>Mean</td>
<td>0.615</td>
<td>0.575</td>
<td>0.573</td>
<td>0.540</td>
<td>0.519</td>
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<tr>
<td>Median</td>
<td>0.598</td>
<td>0.576</td>
<td>0.583</td>
<td>0.561</td>
<td>0.515</td>
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<tr>
<td>Eight-quarter ahead</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>0.663</td>
<td>0.599</td>
<td>0.611</td>
<td>0.559</td>
<td>0.534</td>
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<tr>
<td>Median</td>
<td>0.669</td>
<td>0.619</td>
<td>0.627</td>
<td>0.585</td>
<td>0.525</td>
<td>0.577</td>
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<tr>
<td>Averages (all horizons)</td>
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</tr>
<tr>
<td>Mean</td>
<td>0.652</td>
<td>0.589</td>
<td>0.583</td>
<td>0.566</td>
<td>0.522</td>
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<tr>
<td>Median</td>
<td>0.648</td>
<td>0.608</td>
<td>0.596</td>
<td>0.577</td>
<td>0.516</td>
<td>0.571</td>
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</tbody>
</table>
Robustness checks

- RW-AO(q=4) $\succ$ RW-AO(q=1,6)
- RW-AO $\succ$ specifications with $\Delta \pi_t$
- $\sim$ with normal-flat priors in BVAR2, BVAR4
- Training sample (1990-2000)
- Forecast combination
### Forecast Averages

<table>
<thead>
<tr>
<th></th>
<th>Relative RMSPE</th>
<th>Directional accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M1-M9 Average</td>
<td>M4 and M6 Average</td>
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<tr>
<td>One-quarter ahead</td>
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<tr>
<td>Mean</td>
<td>0.944</td>
<td>0.920</td>
</tr>
<tr>
<td>Median</td>
<td>0.999</td>
<td>1.015</td>
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<td>6</td>
</tr>
<tr>
<td>#pv&lt;.1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Eight-quarter ahead</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>0.783</td>
<td>0.809</td>
</tr>
<tr>
<td>Median</td>
<td>0.883</td>
<td>0.915</td>
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<tr>
<td>#pv&lt;.1</td>
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<tr>
<td>Averages (all horizons)</td>
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<tr>
<td>Mean</td>
<td>0.828</td>
<td>0.832</td>
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<tr>
<td>Median</td>
<td>0.909</td>
<td>0.927</td>
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<tr>
<td>#&lt;1; #&gt;0.5</td>
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<td>#pv&lt;.1</td>
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</table>
Can we reconcile our findings with the open-economy NK model?

Consider an open-economy Phillips curve:

\[
\hat{\pi}_t = \beta \mathbb{E}_t (\hat{\pi}_{t+1}) + \kappa \hat{x}_t^W + \varepsilon_t, \tag{1}
\]
\[
\hat{x}_t^W \equiv (1 - \xi) \hat{x}_t + \xi \hat{x}_t^* \tag{2}
\]

Assume that inflationary expectations are based on a weighted average of past inflation and on the central bank’s inflation target

\[
\hat{\pi}_t = \beta ((1 - \theta) \hat{\pi}_{t-1}^q + \theta \hat{\pi}^T) + \kappa \hat{x}_t^W + \varepsilon_t \tag{3}
\]

where \( \hat{\pi}_t^q = \frac{1}{q} \sum_{j=1}^{q} \hat{\pi}_{t+1-j} \), and \( 0 \leq \theta \leq 1 \) can be interpreted as a measure of credibility in the inflation target, \( \hat{\pi}^T \).
Can we reconcile our findings with the open-economy NK model?

**Lack of credibility \((\theta = 0)\)**

Assume now that inflationary expectations are purely backward-looking (adaptive). Hence,

\[
\hat{\pi}_t = \beta \hat{\pi}^q_{t-1} + \kappa \hat{x}^W_t + \varepsilon_t, \tag{4}
\]

If \(\beta \to 1\), a positive global output gap shock will not simply lead to higher inflation, it will lead to steadily increasing inflation.
5. Discussion

Can we reconcile our findings with the open-economy NK model?

**Full credibility** \((\theta = 1)\)

Suppose instead that inflationary expectations are firmly anchored (e.g., an advanced economy). Then,

\[
\hat{\pi}_t = \beta \hat{\pi}^T + \kappa \hat{x}_W + \varepsilon_t. \tag{5}
\]

A shock that produces a positive global output gap will increase inflation above the central bank’s target, but will not unleash an inflationary spiral as before.
6. Final remarks

Summary and final thoughts

- The RW-AO mostly produces lower RMSPEs than its competitors
- In a number of cases, these gains are statistically significant
- The RW-AO produces success ratios $> 0.5$, and very often, statistically significant
- The RW-AO should be a new benchmark for inflation forecasting in EMEs
- Specifications with macroeconomic variables cannot beat it!