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

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- 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: Mandalinci (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

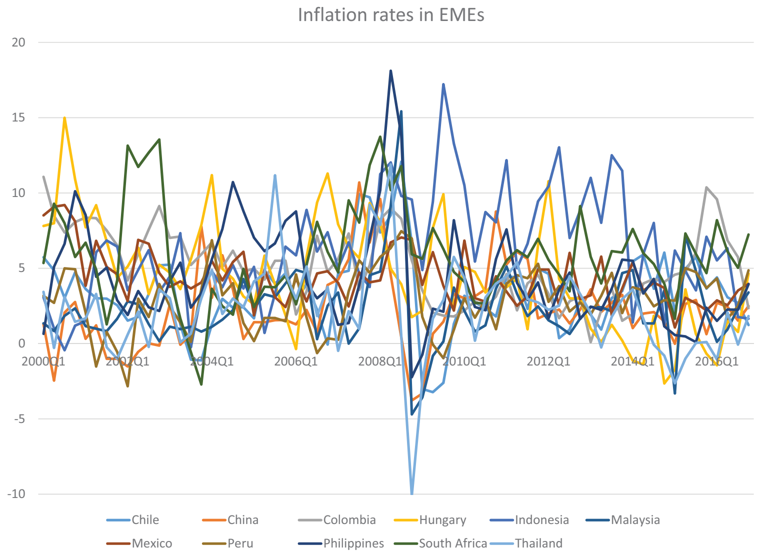
- The RW-AO has, in general, a superior predictive power to forecast inflation across EMEs
- If we interpret our findings as deviations from rational expectations coupled with partial credibility, we get sensible theoretical predictions about inflation dynamics.
- The RW-AO is a missing model in the literature for EMEs
- Hammond (2012) reports the list of forecasting models used by inflation targeters: the RW-AO is not one of them.

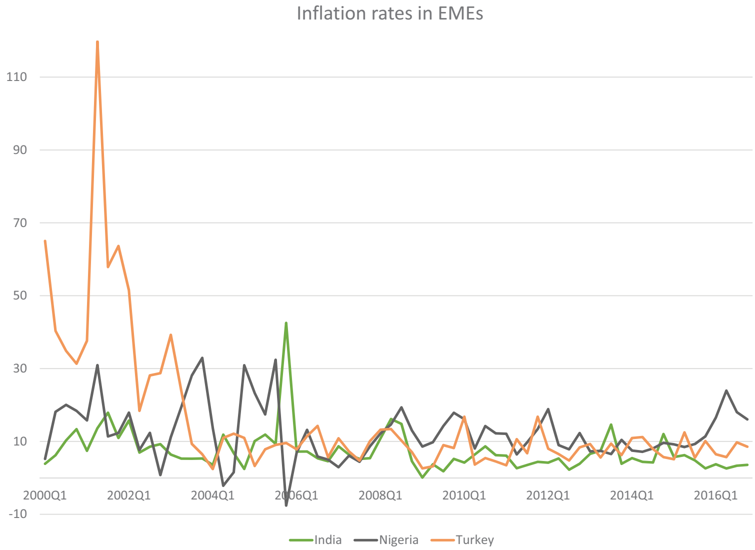
Outline

- Quarter-on-quarter headline-CPI inflation rates (π_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.


Inflation rates in EMEs
20
15
10
5
0
-5
-10
2000Q1
2002Q1
2004Q1
2006Q1
2008Q1
2010Q1
2012Q1
2014Q1
2016Q1
Chile
China
Colombia
Hungary
Indonesia
Malaysia
Mexico
Peru
Philippines
South Africa
Thailand


Inflation rates in EMEs
110
90
70
50
30
10
-10
2000Q1
2002Q1
2004Q1
2006Q1
2008Q1
2010Q1
2012Q1
2014Q1
2016Q1
India
Nigeria
Turkey

- 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

Random Walk (RW-AO)

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

π_{t+h}: the inflation rate
h: forecast horizon
ϵ_{t+h}: forecast error
$q = 4$
AO = Atkeson and Ohanian (2001), Faust and Wright (2013).

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)

Along the lines of: Doan *et al.* (1984), Litterman (1986), Stock and Watson (1999, 2002, 2007), Ciccarelli and Mojon (2010), Faust and Wright (2013), Primiceri (2005), among others.

Recursive autoregression, AR(p) model (RAR)

$$M_1 : \quad \pi_t = \phi_0 + \Phi(L)\pi_t + \epsilon_t$$

where $\Phi(L) = \phi_1 L + ... + \phi_p L^p$.

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

$$M_2,\ M_3 : \quad \pi_{t+h} = \phi_{0,h} + \Phi(L,h)\pi_t + \epsilon_{t+h}$$

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).

Factor-Augmented AR(p) model (FAR)

$$M_4 : \quad \pi_{t+h} = \phi_{0,h} + \Phi(L,h)\pi_t + \Theta(L,h)\widehat{F}_t + \epsilon_{t+h}$$

where $\widehat{F}_t$ 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^c: commodity price index (agricultural raw materials, beverages, food, metals and crude oil).
All expressed in percent changes.

Bivariate BVAR (BVAR2)

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

where
$X_t = (\pi_t,\ \widehat{F}_t)'$
$\Phi_{0,h}$: vector of parameters
$\Phi(L,h)$: matrix of lag polynomials
Minnesota priors.

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.

Time Varying Parameter specification (TVP)

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

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.

(1) Relative RMSPE

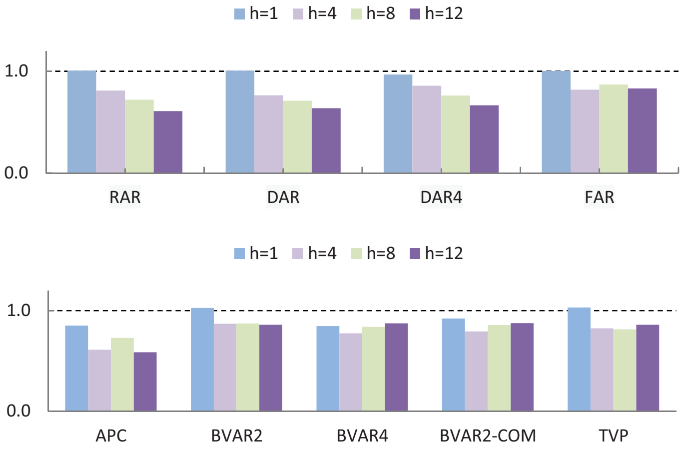
- The relative RMSPE or Theil-U statistic is

$$Theil - U^h_{m,c} = \frac{RMSPE^h_{RW-AO,c}}{RMSPE^h_{m,c}}$$

for $c = 1, 2, ..., 14$, $m = 1, 2, ..., 9$, $h = 1, 4, 8, 12$.

- If $Theil - U^h_{m,c} < 1$, 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)

Relative RMSPEs (medians)



RMSPE of the RW-AO Relative to Competing Models

	M_4 FAR	M_6 BVAR2	M_7 BVAR4	M_9 TVP	Average M1-M9
One-quarter ahead					
Median	1.001	1.027	0.848	1.030	0.962
#<1	7	6	9	5	8
#pv<.1	4	4	7	2	5
Eight-quarter ahead					
Median	0.870	0.871	0.839	0.813	0.797
#<1	10	13	12	14	12
#pv<.1	8	9	11	11	10
Averages (all horizons)					
Median	0.880	0.907	0.834	0.882	0.826
#<1	9	11	12	12	11
#pv<.1	7	7	9	8	8

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

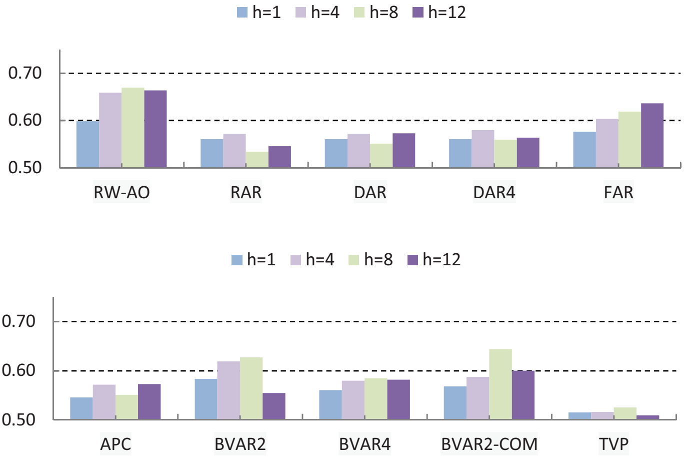
Number of Statistical Significant Cases (U-Theils; #pv<.1)

	Average (h=1,4)	Average (h=8,12)	Average (all horizons)
Mexico	9	9	9
Peru	8	9	9
Hungary	7	9	8
Colombia	8	6	7
Nigeria	7	7	7
Indonesia	5	8	6
Philippines	5	8	6
Turkey	6	5	6
Chile	5	5	5
India	3	5	4
China	1	6	4
Thailand	2	3	2
Malaysia	1	2	1
South Africa	1	0	0

(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
- Statistical significance: Pesaran and Timmermann (2009).

Success Ratios (Medians)



Directional Accuracy: Success Ratios

	M_0 RW-AO	M_4 FAR	M_6 BVAR2	M_7 BVAR4	M_9 TVP	Average M1-M9
One-quarter ahead						
Mean	0.615	0.575	0.573	0.540	0.519	0.549
Median	0.598	0.576	0.583	0.561	0.515	0.559
#>0.5	14	12	11	9	8	10
Eight-quarter ahead						
Mean	0.663	0.599	0.611	0.559	0.534	0.564
Median	0.669	0.619	0.627	0.585	0.525	0.577
#>0.5	14	9	12	9	9	9
Averages (all horizons)						
Mean	0.652	0.589	0.583	0.566	0.522	0.564
Median	0.648	0.608	0.596	0.577	0.516	0.571
#>0.5	14	11	12	11	9	10

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

	Relative RMSPE		Directional accuracy	
	M1-M9 Average	M4 and M6 Average	M1-M9 Average	M4 and M6 Average
One-quarter ahead				
Mean	0.944	0.920	0.559	0.575
Median	0.999	1.015	0.561	0.576
#<1; #>0.5	7	6	10	12
#pv<.1	3	4	8	8
Eight-quarter ahead				
Mean	0.783	0.809	0.561	0.611
Median	0.883	0.915	0.576	0.661
#<1; #>0.5	12	12	9	10
#pv<.1	6	7	9	9
Averages (all horizons)				
Mean	0.828	0.832	0.570	0.593
Median	0.909	0.927	0.577	0.615
#<1; #>0.5	10	10	10	11
#pv<.1	6	6	8	8

Consider an open-economy Phillips curve:

$$\widehat{\pi}_t = \beta \mathbb{E}_t \left(\widehat{\pi}_{t+1} \right) + \kappa \widehat{x}_t^W + \varepsilon_t, \tag{1}$$

$$\widehat{x}_t^W \equiv (1 - \xi) \, \widehat{x}_t + \xi \widehat{x}_t^* \tag{2}$$

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

$$\widehat{\pi}_t = \beta \left((1 - \theta) \, \widehat{\pi}_{t-1}^q + \theta \widehat{\pi}^T \right) + \kappa \widehat{x}_t^W + \varepsilon_t \tag{3}$$

where $\widehat{\pi}_t^q = \frac{1}{q} \sum_{j=1}^{q} \widehat{\pi}_{t+1-j}$, and $0 \leq \theta \leq 1$ can be interpreted as a measure of credibility in the inflation target, $\widehat{\pi}^T$.

Lack of credibility ($\theta = 0$)

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

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

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

Full credibility ($\theta = 1$)

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

$$\widehat{\pi}_t = \beta \widehat{\pi}^T + \kappa \widehat{x}_t^W + \varepsilon_t. \tag{5}$$

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.

- 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 signicant
- The RW-AO should be a new benchmark for inflation forecasting in EMEs
- Specifications with macroeconomic variables cannot beat it!