

Variance Risk Premiums in Emerging Markets

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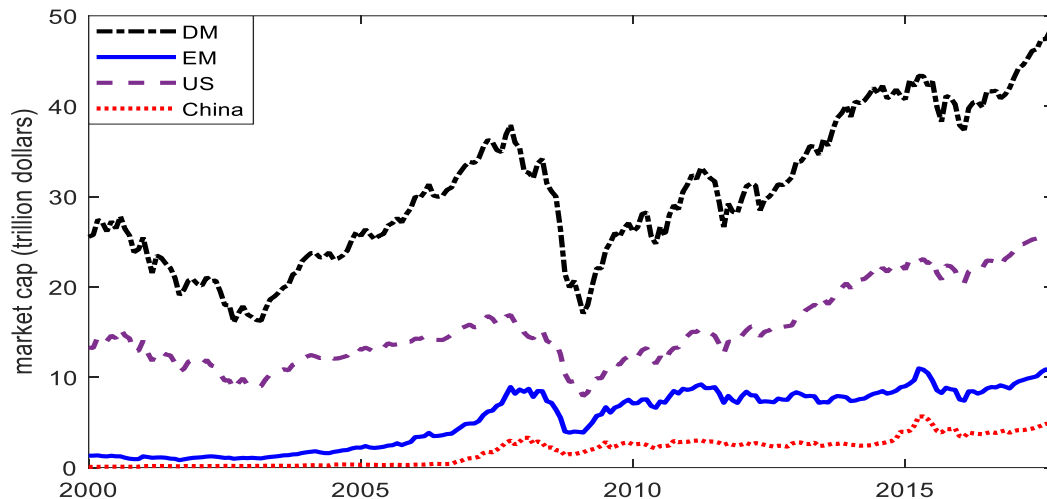
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Variance Risk Premium (VRP)

- The difference between risk-neutral (implied) variance and physical expectations of the future return variance (e.g. Bollerslev, Tauchen and Zhou, 2009; Carr and Wu, 2009).
- Economic Interpretation
 - Economic uncertainty, see e.g. Bollerslev, Tauchen and Zhou (2009); Drechsler and Yaron (2011); Drechsler (2013)
- Empirically
 - Predict stock returns in the U.S. (Bollerslev, Tauchen, and Zhou, 2009) and in eight developed markets (Bollerslev, Marrone, Xu, and Zhou, 2014)
 - Predict 22 currency returns (Londono and Zhou, 2017)
 - Predict other asset risk premiums, e.g. credit default spreads (Wang et al., 2013), bond risk premiums (Mueller, et al. 2011)

Our Research Question

- We examine VRPs in emerging markets.
 - Emerging markets are becoming more important in the global capital market.



- Emerging markets are different from developed markets.
 - Higher volatility (Bekaert and Havey, 2014)
 - More positive skewness (Ghysels, Plazzi, and Valkanov, 2016)

Stock and Implied Volatility Indices

Market	Equity Index	Index Start	IV	IV Start
Brazil	EWZ ETF	200007	VXEWZ	201103
China	SSE50	199701	IVX	201502
India	Nifty 50	199604	INVIXN	200701
Korea	KOSP 200	199001	VKOSPI	200301
Mexico	Mexico IPC	198801	VIMEX	200403
Poland	Wig 20	199406	VWIG20	200309
Russia	RTS	199509	RTSVX	200601
South Africa	FTSE/JSE Top 40	199507	JSAVI	200702
Taiwan	TAIEX	197101	TAIEX VIX	200712

What We Do

- We are the first to construct long-sample VRPs for 9 important emerging countries.
 - Data on options are short, some only starts from 2015. It is challenge to study VRPs in emerging countries.
 - We apply the sample-extension method as in Lynch and Wachter (2013), and extend the sample back to 2000.
- We document the predictive power of EM VRP, and compare with DM VRP.
 - The EM VRP can significantly predict equity market returns, currency returns, and capital inflows.
 - The predictive power of EM VRP differs significantly from DM VRP, with former more important for longer horizons, and latter more important for shorter horizons.

Data

- Sample period
 - January 2000 – October 2017
 - Data lengths for index options varies.

- Markets
 - 9 emerging markets: Brazil, China, India, Korea, Poland, Russia, South Africa, and Taiwan
 - 11 developed markets: Australia, Belgium, Canada, France, Germany, Hong Kong, Japan, the Netherlands, Switzerland, the U.K., and the U.S.

- Data source: Datastream, Bloomberg, Fed Reserve website
 - Capital flows scaled by GDP (Bluedorn, Duttagupta, Guajardo, and Topalova, 2013) .

Constructing VRPs: Definitions

■ Country-level VRP

$$VRP_t^i = IV_t^i - E_t(RV_{t+1}^i)$$

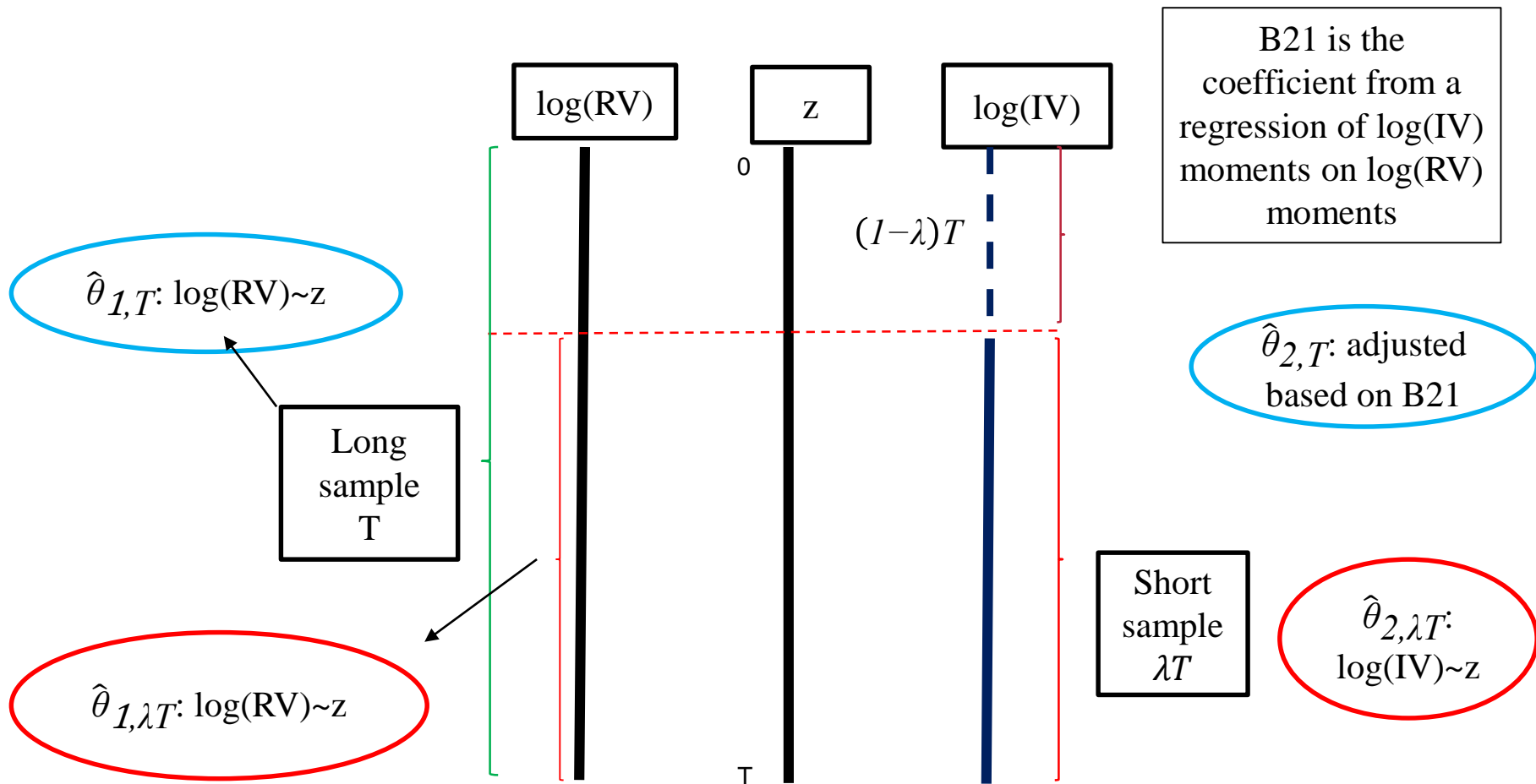
- IV is the model-free implied variance (e.g. the square of U.S. VIX index), and $E_t(RV_{t+1}^i)$ is the expected realized variance under the physical measure.
- The realized variance (RV) is

$$RV_t^i = \frac{252}{n} \sum_{d \in t} r_d^2$$

■ Aggregate VRP

- Global VRP: the value weighted average of all country VRPs.
- EM VRP: the value weighted average of country VRPs in EM.
- DM VRP: the value weighted average of country VRPs in DM.

Constructing VRP: Extending IV



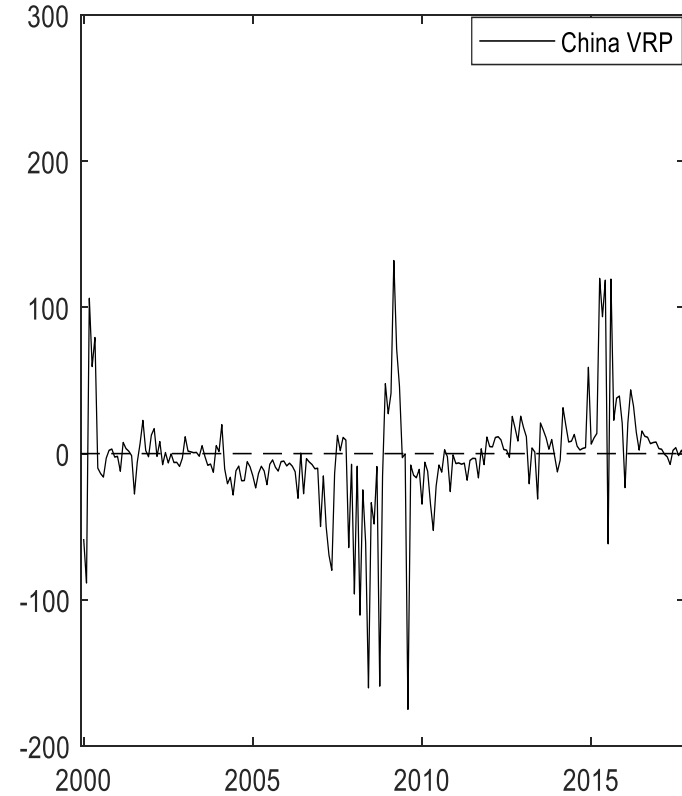
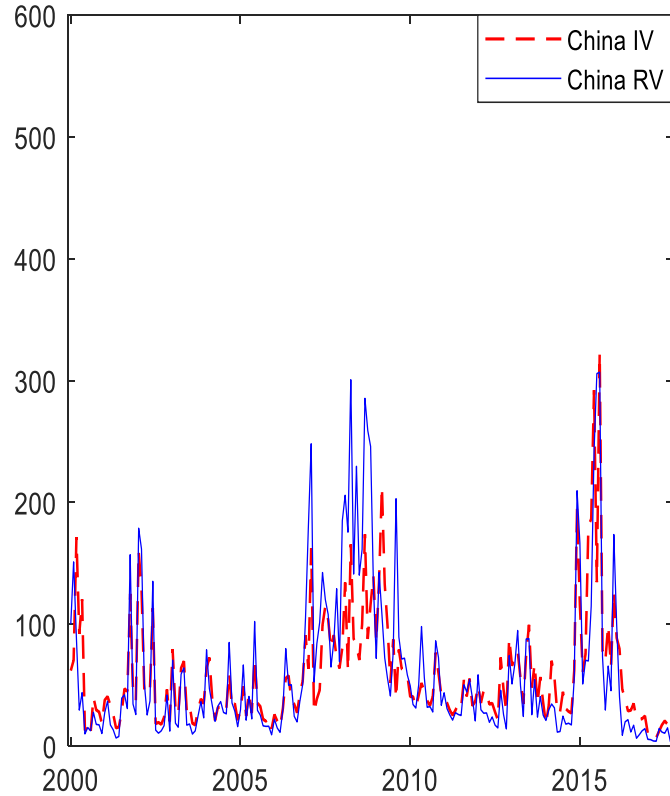
Constructing VRP: Predictors Z

- Bekaert and Hoerova (2014)
 - Lagged $\log(RV)$
 - Downside monthly return (Return21)
 - Downside weekly return (Return5)
 - Downside daily return (Return1)
- Bollerslev et al (2011): Inflation rate CPI
- Barras and Malkhozov (2016): Unemployment rate (UEMP)
- Paye (2012): Real GDP growth rate (rGDP), M1 growth rate
- Boutchkova et al (2012): Economic Policy Uncertainty (EPU) index by Baker, et al. (2016)

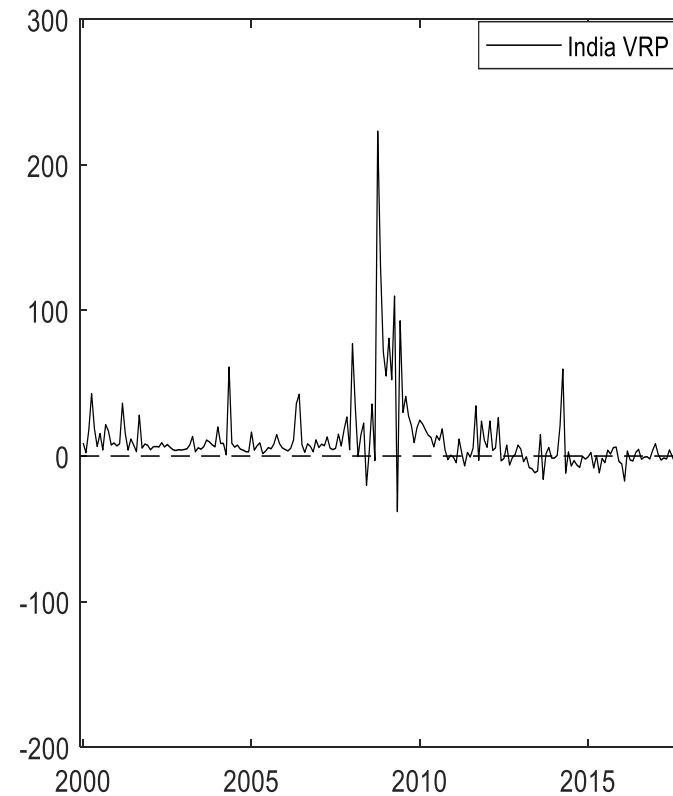
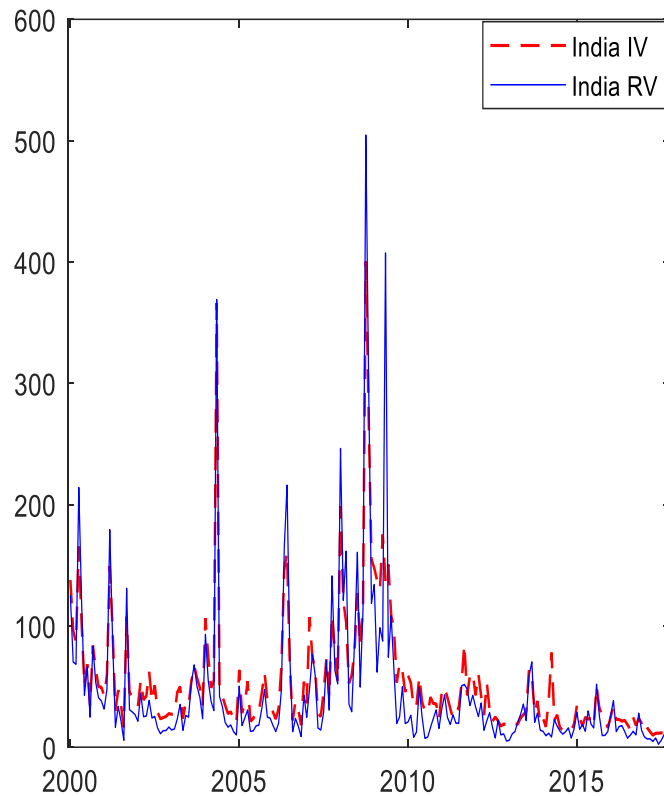
Extended IV and VRP: China

	Short Sample				Long Sample			
	log(RV_{t+1})		log(IV_t)		log(RV_{t+1})		log(IV_t)	
	coeff	t	coeff	t	coeff	t	coeff	t
Constant	1.81	3.72	1.59	4.33	1.07	4.52	1.63	6.10
log(RV_t)	0.52	4.90	0.74	9.12	0.68	12.97	0.70	9.33
Return1	-2.83	-1.84	-0.41	-0.40	0.16	0.53	0.50	2.01
Return5	-3.17	-2.52	0.87	1.46	0.17	0.26	0.34	0.47
Return21	-1.66	-0.57	0.99	0.67	-2.12	-2.09	1.49	1.69
CPI	-0.06	-0.18	-0.12	-0.86	-0.01	-0.11	-0.03	-0.35
M1	-0.03	-0.26	0.12	1.88	0.02	0.52	0.09	1.95
EPU	-0.29	-3.89	-0.02	-0.46	-0.09	-2.15	0.01	0.18
rGDP	0.19	1.26	-0.19	-1.99	0.07	1.85	-0.18	-3.04
adj-R²	75%		90%		52%			

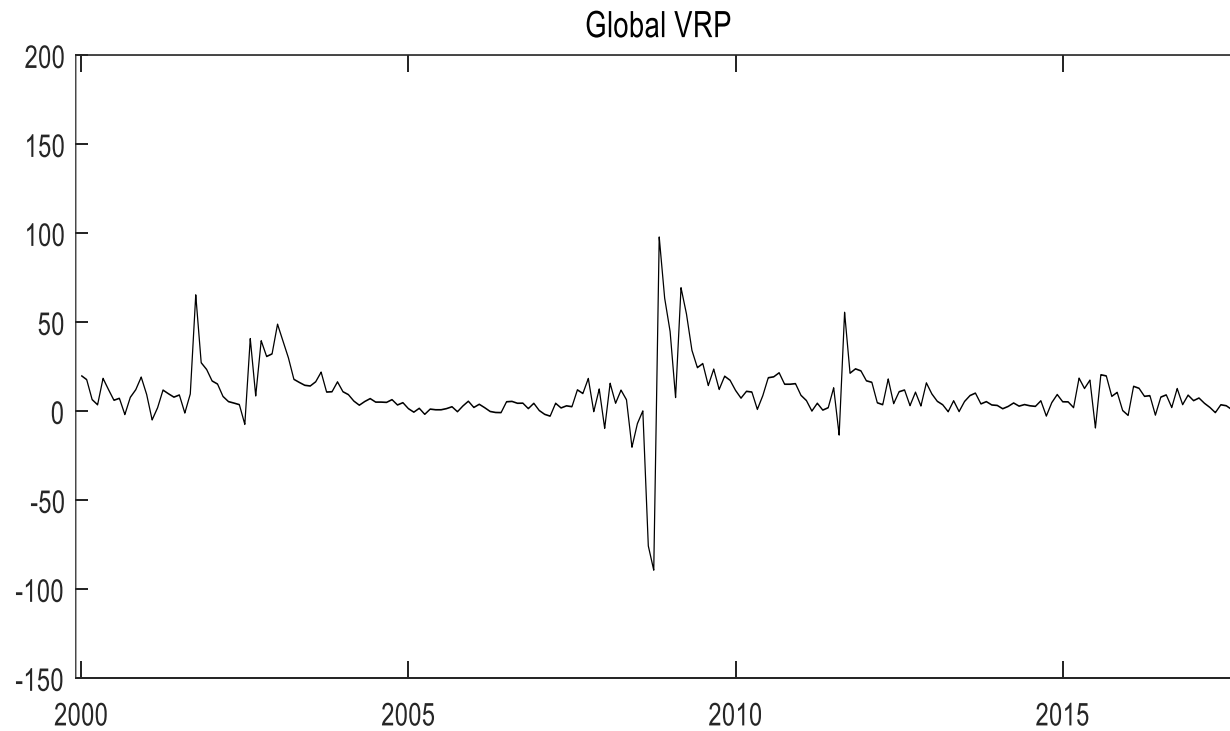
Extended IV and VRP: China



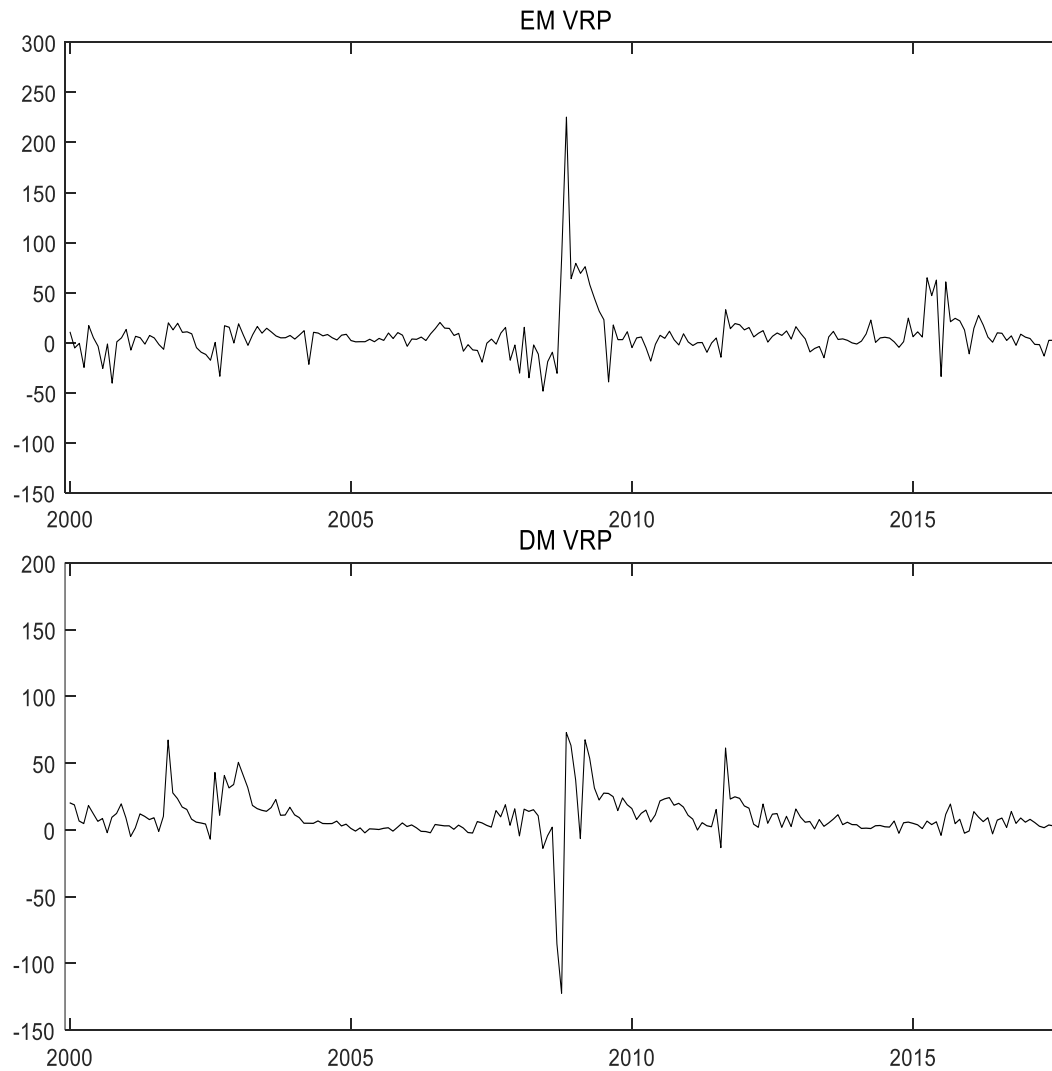
Extended IV and VRP: India



Global VRP



EM and DM VRPs



EM VRP

correlation

	mean	std	EM	DM	Global
Brazil	-5.58	42.24	0.07	0.48	0.43
China	-2.48	36.69	0.42	0.29	0.37
India	10.84	24.32	0.51	-0.06	0.07
Korea	7.94	32.69	0.58	-0.03	0.09
Mexico	8.86	31.45	0.61	0.37	0.45
Poland	13.69	27.36	0.58	0.46	0.55
Russia	34.67	164.44	0.74	-0.01	0.16
South Africa	11.25	14.68	0.46	0.47	0.52
Taiwan	7.75	27.23	0.52	0.39	0.45
EM	7.08	23.90		0.31	0.51
DM	9.53	17.46			0.97
Global	9.38	16.56			

DM VRP

correlation

	mean	std	EM	DM	Global
Australia	9.98	26.38	0.38	0.42	0.45
Belgium	5.13	26.94	0.10	0.75	0.69
Canada	5.01	19.08	0.46	0.66	0.69
France	6.06	25.77	-0.03	0.73	0.66
Germany	8.12	22.89	0.30	0.55	0.56
HK	11.48	24.95	0.58	0.55	0.62
Japan	15.01	32.15	0.68	0.07	0.22
Netherlands	8.58	37.69	0.27	0.72	0.71
Switzerland	7.49	18.75	0.40	0.39	0.46
UK	8.17	28.24	0.18	0.80	0.77
US	9.06	25.23	-0.01	0.87	0.78
EM	7.08	23.90		0.31	0.51
DM	9.53	17.46			0.97
Global	9.38	16.56			

Predict Equity Market Returns

- Model specification

$$r_{t+1,t+h}^i = a_h + b_h VRP_t + CountryFE^i + \varepsilon_{t+1,t+h}^i$$

- $r_{t+1,t+h}^i$ denotes the cumulative stock market returns over month $t+1$ to month $t+h$ for market i , and $h=1, 2, \dots, 24$ months.
- VRP_t can be VRP^i , VRP^{EM} , VRP^{DM} or VRP^{Global} in month t .
- The standard errors are estimated using the Newey and West (1987) method with h lags.

Predict EM Equity Market Returns 2000-2017, Country vs. Global

h months	1	2	3	6	9	12	18	24
VRP^i	0.01	0.01	0.02	0.09	0.07	0.07	0.04	0.04
	(0.15)	(0.20)	(0.35)	(3.14)	(3.18)	(4.56)	(2.90)	(2.65)
R^2	0.0%	0.0%	0.0%	1.6%	1.3%	1.6%	0.7%	0.7%

h months	1	2	3	6	9	12	18	24
VRP^{Global}	1.12	0.77	0.64	0.57	0.28	0.23	0.09	0.16
	(6.16)	(5.26)	(5.61)	(6.44)	(3.29)	(3.09)	(1.41)	(2.39)
R^2	4.3%	3.7%	3.6%	4.8%	1.6%	1.3%	0.3%	0.9%

Predict EM Equity Market Returns 2000-2017, EM vs. DM

h	1	2	3	6	9	12	18	24
VRP^{EM}	0.39	0.35	0.31	0.48	0.42	0.36	0.21	0.21
	(3.53)	(3.06)	(2.92)	(6.61)	(7.05)	(6.73)	(5.29)	(5.45)
R^2	1.1%	1.6%	1.7%	7.3%	7.3%	6.6%	2.9%	3.4%

h	1	2	3	6	9	12	18	24
VRP^{DM}	1.07	0.70	0.56	0.42	0.14	0.11	0.01	0.08
	(6.53)	(5.42)	(5.77)	(5.49)	(1.84)	(1.60)	(0.21)	(1.31)
R^2	4.4%	3.4%	3.1%	3.0%	0.5%	0.3%	0.0%	0.3%

h	1	2	3	6	9	12	18	24
VRP^{EM}	0.16	0.21	0.20	0.43	0.43	0.37	0.23	0.21
	(1.61)	(2.00)	(1.96)	(5.87)	(6.76)	(6.36)	(5.26)	(5.14)
VRP^{DM}	1.00	0.61	0.48	0.24	-0.04	-0.05	-0.08	-0.01
	(6.23)	(5.05)	(5.00)	(3.41)	(-0.48)	(-0.63)	(-1.32)	(-0.15)
R^2	4.5%	3.9%	3.8%	8.1%	7.3%	6.7%	3.2%	3.4%

Potential Explanation for Differences in EM and DM VRPs

- As in Bollerslev and Zhou (2008), the VRP can be driven by two volatility factors: **cash flow volatility** vs. **discount rate volatility** in a consumption-based asset pricing model.
 - Cash flow volatility would be more persistent than discount rate volatility.
 - Cash flow volatility would predict returns in longer horizons, while discount rate volatility would predict returns in short horizons.

Potential Explanation for Differences in EM and DM VRPs

- In our sample, the DM VRP has AR(1) of **0.36**, and is more significant for short horizons. The EM VRP has AR(1) of **0.46**, and is more significant for long horizons.
- Discount rate volatility (DRV) correlation:
 $\text{corr}(\text{EMVRP}, \text{DRV})=0.09$, $\text{corr}(\text{DMVRP}, \text{DRV})=0.24$
- Cash flow volatility (CFV) correlation:
 $\text{corr}(\text{EMVRP}, \text{CFV})=0.33$, $\text{corr}(\text{DMVRP}, \text{CFV})=0.21$.
- The EM VRP is more correlated with cash flow volatility, while the DM VRP is more correlated with discount rate volatility.

Other Findings

- Similar findings for predicting currency returns
- Similar findings for predicting capital inflows

Robustness Tests

- Alternative methods for predictability
 - VRPs without sample extension
 - The out-of-sample test for predictability of VRPs
 - The predictability of VRPs period by period
- Alternative ways to measure VRPs
 - Log VRP: $\log(IV) - \log(E(RV))$
 - Equally weighted VRPs
- Expand to all MSCI EM and DM countries
 - EM and DM VRPs
 - Regional VRPs

Conclusion

- Using the sample-extension method by Lynch and Wachter (2013), we are the first to extend VRPs in 9 major emerging markets.
- Global, EM and DM VRPs can all significantly predict future equity market returns, currency returns, and capital flows.
- Different predictive patterns of EM and DM VRPs: The DM VRP has a higher degree of predictability at the shorter horizon; while the EM VRP has stronger predictability in the longer horizon.