Online Appendix

Methods for Backcasting, Nowcasting and Forecasting Using Factor-MIDAS: With An Application To Korean GDP*

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Abstract

This is the appendix to the above paper. Included are omitted discussions of techniques used in the paper, as well as various table and figures.

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A1. Constructing factors using ragged edge data

Since we model real-time GDP, it is critical to match monthly data availability with GDP release vintages. In particular, some of our monthly variables are not available at certain calendar dates even though new vintages of GDP have been released by said calendar dates. For example, the consumer price index for the previous month is released early in the current month, whereas the producer price index is released in the middle of the month. In between these releases, new vintages of GDP are often released. This is called a ragged-edge data problem. When utilizing ordinary PCA, the dataset should be balanced, which precludes allowing for missing values. In order to tackle this problem, we apply vertical alignment and AR interpolation when there are missing data. Additionally, we alternatively use the EM algorithm coupled with a state-space modeling approach to tackle this so-called ragged-edge problem. This allows the issue to be addressed without interpolation.

EM algorithm for estimating missing data:

The ragged-edge problem essentially concerns estimating missing values. Stock and Watson (2002) propose using the EM algorithm to replace missing values and subsequently carry out PCA. The EM algorithm is initialized with an estimate of the missing data, which is usually set equal to the unconditional mean (this is also the approach that we use). Then, the completed dataset is used to estimate factors using PCA. This algorithm is repeated in two steps, the E-step and the M-step. We briefly explain these steps, and the reader is refereed Schumacher and Breitung (2008) for details. Consider a dataset, X_{t_m}, and pick variable i, say $X_i = (x_{i,1}, ..., x_{i,t_m})'$. Suppose that variable i has missing values due to publication lags. Set $X_i^{obs} = P_i X_i$, where P_i represents the relationship between the full vectors and the ones with missing values. If no missing values are found, then P_i is the identity matrix. As we only observe a subset of X, initialize the EM algorithm by replacing missing values with the unconditional mean of X_i^{obs}, yielding initial estimates of factors and loadings (using PCA), say F^0 and Λ^0. Now iterate this procedure. In the $(j-1)$-th iteration, the E-step updates the estimates of the missing observations using the expectation of the variable X_i conditional on X_i^{obs}, with factors and loadings from the $j-th$ iteration, F^{j-1} and Λ^{j-1}, as follows:

$$X_i^j = F^{j-1}\Lambda^{j-1} + P_i^{'}\left(P_i^{'}P_i\right)^{-1}\left(X_i^{obs} - P_i F^{j-1}\Lambda_i^{j-1}\right), \tag{1}$$

Run the E-step for all i, in each iteration. The M-step involves re-estimating the factors and loadings using ordinary PCA. Continue until convergence is achieved.

State-space model (Kalman filtering) for estimating missing data:

Another popular approach for estimating factors from large datasets is the state-space approach based on Doz et al. (2012) and Giannone et al. (2008). The factor model represented in state-space form is based on the (**??**), with factors represented using an autoregressive structure, as follows:

$$\Psi(L_m)F_{t_m} = \mathbf{A}\eta_{t_m}, \tag{2}$$

where $\Psi(L_m)$ is a lag polynomial, given by $\sum_{i=1}^{p} \Psi_i L_m^i$, and η_{t_m} is an orthogonal dynamic shock. The state and transition equation can easily be estimated via maximum likelihood (ML). Doz et al. (2012) propose using quasi-ML for large datasets, when conventional ML is not feasible. In particular, as ML estimation involves initialization of factors based on the use of ordinary PCA, one needs a completed data matrix. Marcellino and Schumacher (2010) remove missing values from the end of sample to make it balanced, and estimate initial factors using ordinary PCA. In our forecasting experiments, initial factors are extracted from the completed matrix that is completed using VA and AR interpolation. Then, likelihoods are calculated and evaluated using the Kalman filter. More specifically, given an initial set of factors, estimate loadings by regressing X_{t_m} on the factors. Then, obtain the covariance matrix of the idiosyncratic part from (**??**), $\sum_{\xi}$, where $\xi_{t_m} = X_{t_m} - \Lambda F_{t_m}$. Now, estimate a vector AR(p) on the factors, F_{t_m}, yielding coefficient matrix, $\Psi(L)$, and residual covariance matrix, $\sum_{\varsigma}$ where $\varsigma_{t_m} = \Psi(L_m)F_{t_m}$. Let V be the eigenvectors corresponding to E, where E is a diagonal matrix whose diagonal elements are the eigenvalues in descending order, and zero otherwise. Then, set $P = VE^{-1/2}$. As a final step, the Kalman smoother is used to yield new estimates of the factors.

A2. Recursive Principal Component Analysis

PCA is widely used to estimate factors or diffusion indices in large data environments (see Kim and Swanson (2016) and the references cited therein). In this paper, we utilize PCA, called OPCA in our later discussion of our empirical findings to differentiate it from recursive PCA (discussed below). Our implementation follows the approach of Stock and Watson (2002), and is standard to the literature. For a discussion of the generated regressor problem associated with our empirical implementation of factor augmented prediction models, see Bai and Ng (2008). We conjecture that their results also apply in the context of the MIDAS models considered in this paper, although proof thereof is left to future research.

In general, PCA is quite convenient as it uses standard eigenvalue decompositions of data covariance matrices. However, these matrix operations may be time consuming in certain real-time environments. In light of this, RPCA has been proposed by Peddaneni et al. (2004),

and is a natural approach to use in our context, as new data arrive in real-time and need to be incorporated into our prediction models. Details about RPCA is revealed in the Appendix

Also, suppose that F_{t_m} is estimated using PCA. Principal components (factors) in this context are linear combinations of variables that maximize the variance of the data, and there is no guarantee that factor loadings are stationary at each point in time, particularly with large datasets. For example, the factor loadings at times t and $t+1$ may have different signs. Recursive PCA attempts to address these issues, in part by not requiring the calculation of the whole covariance matrix of data with the arrival of each new datum. Without loss of generality, consider a standardized random vector at time t, say x_t, with dimension n. Our aim is to find the principal components of x at time t. To begin, define the covariance (or correlation) matrix of x as:

$$\boldsymbol{R}_t = \frac{1}{t}\sum_{i=1}^{t} x_i x_i' = \frac{t-1}{t}\boldsymbol{R}_{t-1} + \frac{1}{t}x_t x_t'. \tag{3}$$

If $\boldsymbol{Q}$ and $\boldsymbol{\Lambda}$ are the orthonormal eigenvector and diagonal eigenvalue matrices of $\boldsymbol{R}$, respectively, then: $\boldsymbol{R}_t = \boldsymbol{Q}_t\boldsymbol{\Lambda_t}\boldsymbol{Q}_t'$ and $\boldsymbol{R}_{t-1} = \boldsymbol{Q}_{t-1}\boldsymbol{\Lambda}_{t-1}\boldsymbol{Q}_{t-1}'$. We can rewrite (3) as:

$$\boldsymbol{Q}_t\left(t\boldsymbol{\Lambda}_t\right)\boldsymbol{Q}_t' = x_t x_t' + \left(t-1\right)\boldsymbol{Q}_{t-1}\boldsymbol{\Lambda}_{t-1}\boldsymbol{Q}_{t-1}'. \tag{4}$$

If we let $\alpha_t = \boldsymbol{Q}_{t-1}'x_t$, (4) can be written as: $\boldsymbol{Q}_t\left(t\boldsymbol{\Lambda}_t\right)\boldsymbol{Q}_t' = \boldsymbol{Q}_{t-1}\left[\left(t-1\right)\boldsymbol{\Lambda}_{t-1} + \alpha_t\alpha_t'\right]\boldsymbol{Q}_{t-1}'$. If $\boldsymbol{V}_t$ and $\boldsymbol{D}_t$ are the orthonormal eigenvector and diagonal eigenvalue matrices of $\left(t-1\right)\boldsymbol{\Lambda}_{t-1} + \alpha_t\alpha_t'$, then:

$$\left(t-1\right)\boldsymbol{\Lambda}_{t-1} + \alpha_t\alpha_t' = \boldsymbol{V}_t\boldsymbol{D}_t\boldsymbol{V}_t'. \tag{5}$$

Therefore,

$$\boldsymbol{Q}_t\left(t\boldsymbol{\Lambda}_t\right)\boldsymbol{Q}_t' = \boldsymbol{Q}_{t-1}\boldsymbol{V}_t\boldsymbol{D}_t\boldsymbol{V}_t\boldsymbol{Q}_{t-1}'. \tag{6}$$

By comparing both sides of (6), the recursive eigenvector and eigenvalue update rules turn out to be $\boldsymbol{Q}_t = \boldsymbol{Q}_{t-1}\boldsymbol{V}_t$ and $\boldsymbol{\Lambda}_t = \boldsymbol{D}_t/t$. Now,it remains to estimate the eigenvectors and eigenvalues of $\left(t-1\right)\boldsymbol{\Lambda}_{t-1} + \alpha_t\alpha_t'$, which is equivalent to estimating $\boldsymbol{V}_t$ and $\boldsymbol{D}_t$. It is very difficult to analytically solve for $\boldsymbol{V}_t$ and $\boldsymbol{D}_t$, and so Peddaneni et al. (2004) instead use first order perturbation analysis. Consider the following sample perturbation to the eigenvalue matrix, $\left(t-1\right)\boldsymbol{\Lambda}_{t-1} + \alpha_t\alpha_t'$. When t is large, this matrix is essentially a diagonal matrix, which means that $\boldsymbol{D}_t$ will be close to $\left(t-1\right)\boldsymbol{\Lambda}_{t-1}$, and $\boldsymbol{V}_t$ will be close to the identity matrix, $\boldsymbol{I}$. The matrix $\alpha_t\alpha_t'$ is said to perturb the diagonal matrix $\left(t-1\right)\boldsymbol{\Lambda}_{t-1}$, and as a result, $\boldsymbol{D}_t = \left(t-1\right)\boldsymbol{\Lambda}_{t-1} + \boldsymbol{P}_\Lambda$ and $\boldsymbol{V}_t = \boldsymbol{I} + \boldsymbol{P}_V$, where $\boldsymbol{P}_\Lambda$ and $\boldsymbol{P}_V$ are small

perturbation matrices. Once we find these perturbation matrices, we can solve the problem. Let $\mathbf{\Lambda} = (t-1)\,\mathbf{\Lambda}_{t-1}$. Then:

$$\begin{aligned}\boldsymbol{V}_t\boldsymbol{D}_t\boldsymbol{V}_t' &= (\boldsymbol{I}+\boldsymbol{P}_V)\,(\mathbf{\Lambda}+\boldsymbol{P}_\Lambda)\,(\boldsymbol{I}+\boldsymbol{P}_V)' \\ &= \mathbf{\Lambda} + \mathbf{\Lambda}\boldsymbol{P}_V' + \boldsymbol{P}_\Lambda + \boldsymbol{P}_\Lambda\boldsymbol{P}_V' + \boldsymbol{P}_V\mathbf{\Lambda} + \boldsymbol{P}_V\mathbf{\Lambda}\boldsymbol{P}_V' + \boldsymbol{P}_V\boldsymbol{P}_\Lambda + \boldsymbol{P}_V\boldsymbol{P}_\Lambda\boldsymbol{P}_V' \\ &= \mathbf{\Lambda} + \boldsymbol{P}_\Lambda + \boldsymbol{D}\boldsymbol{P}_V' + \boldsymbol{P}_V\boldsymbol{D} + \boldsymbol{P}_V\mathbf{\Lambda}\boldsymbol{P}_V' + \boldsymbol{P}_V\boldsymbol{P}_\Lambda\boldsymbol{P}_V'\end{aligned} \tag{7}$$

Substituting this equation into (5), and assuming that $\boldsymbol{P}_V\mathbf{\Lambda}\boldsymbol{P}_V'$ and $\boldsymbol{P}_V\boldsymbol{P}_\Lambda\boldsymbol{P}_V'$ are negligible, we have that: $\alpha_t\alpha_t' = \boldsymbol{P}_\Lambda + \boldsymbol{D}\boldsymbol{P}_V' + \boldsymbol{P}_V\boldsymbol{D}$**.** The fact that $\boldsymbol{V}$ is orthonormal yields an additional characterization of $\boldsymbol{P}_V$. Substituting $\boldsymbol{V} = \boldsymbol{I} + \boldsymbol{P}_V$ into $\boldsymbol{V}\boldsymbol{V}' = \boldsymbol{I}$, and assuming that $\boldsymbol{P}_V\boldsymbol{P}_V' \approx 0$, we have that $\boldsymbol{P}_V = -\boldsymbol{P}_V'$. Thus, combining the fact that the $\boldsymbol{P}_V$ is anti-symmetric with the fact that $\boldsymbol{P}_\Lambda$, and $\boldsymbol{D}_t$ are diagonal, yields the following solution to our problem:

$$\begin{aligned}\alpha_i^2 &= (i,i)^{th} \text{ element of } \boldsymbol{P}_\Lambda \\ \frac{\alpha_i\alpha_j}{\lambda_j + \alpha_j^2 - \lambda_i - \alpha_i^2} &= (i,j)^{th} \text{ element of } \boldsymbol{P}_V,\ i \neq j, \text{ and } 0 = (i,i)^{th} \text{ element of } \boldsymbol{P}_V.\end{aligned} \tag{8}$$

This leads to the following algorithm.

Algorithm: Recursive Principal Component Analysis At time t, use the covariance matrix, $\mathbf{R}_{k-1}$, which is available for period $t-1$, and collect eigenvalues and eigenvectors into Λ_{t-1} and $\mathbf{Q}_{k-1}$, respectively. The following algorithm is implemented in real-time, as each new observation becomes available.

The following algorithm is implemented in real-time, as each new observation becomes available.

1. With each a new datum, x_t, calculate $\alpha_t = \mathbf{Q}_{t-1}'x_t$.
2. Use (8), to find the perturbation matrices, $\mathbf{P}_V$ and $\mathbf{P}_\Lambda$.
3. Estimate the eigenvector matrix, $\tilde{\mathbf{Q}}_t = \mathbf{Q}_{t-1}\,(I + \mathbf{P}_\Lambda)$.
4. Standardize $\tilde{\mathbf{Q}}_t$, using $\hat{\mathbf{Q}}_t = \tilde{\mathbf{Q}}_t\tilde{\mathbf{S}}_t$, where $\tilde{\mathbf{S}}_t$ is a diagonal matrix containing the inverse of the norms of each column of $\tilde{\mathbf{Q}}_t$.
5. Estimate the eigenvalue, $\hat{\Lambda}_t = \hat{\mathbf{Q}}_t'\mathbf{R}_t\hat{\mathbf{Q}}_t$.

Table A 1: Relative MSFEs When Backcasting, Nowcasting, and Forecasting Korean GDP*

Panel (a): First Available

Factors	Recursive		Backcast prev. qtr. -1	Nowcast current quarter 1	Nowcast current quarter 2	Nowcast current quarter 3	Forecast 1 quarter ahead 4	Forecast 1 quarter ahead 5	Forecast 1 quarter ahead 6	Forecast 2 quarter ahead 7	Forecast 2 quarter ahead 8	Forecast 2 quarter ahead 9
	RW		1.45	1.35	1.12	**0.94**	**0.94**	1.01	1.14	1.13	1.20	1.68
	CBADL		5.49	4.67	3.28	1.73**	1.63**	1.63**	1.36**	1.32**	1.37**	1.46
	BEX		3.48*	3.25*	2.16	**0.89**	**0.87**	**0.85**	**0.64***	**0.62***	**0.64***	**0.71****
	Mean of Benchmarks		4.38	3.85	2.73	1.55	1.47	1.42	**0.92**	**0.89**	**0.93**	1.10
1	Basic w/o AR	OPCA	3.01	2.46	1.70	**0.80***	**0.77***	**0.84***	**0.72***	**0.69***	**0.73***	**0.87**
		RPCA	3.01	2.46	1.70	**0.80***	**0.77***	**0.84***	**0.72***	**0.69***	**0.73***	**0.87**
		EM	3.25	2.96**	2.00**	1.07	1.08	1.09	**0.88**	**0.82**	**0.81**	**0.86***
		KF	2.72	2.32**	1.73**	**0.91**	**0.90**	**0.98**	**0.82**	**0.77**	**0.80**	**0.90**
	Basic w/ AR	OPCA	**0.70$_{GB}$**	**0.83$_{FB}$**	**0.70***	**0.49****	**0.57****	**0.66***	**0.75***	**0.75***	**0.80***	**0.97**
		RPCA	**0.70**	**0.83**	**0.70***	**0.49****	**0.57****	**0.66***	**0.75***	**0.75***	**0.80***	**0.97**
		EM	1.18	1.45*	1.12	1.00	1.09	1.07	1.05	**0.95**	**0.97**	1.12
		KF	**0.90**	**0.99**	**0.93**	**0.71**	**0.78**	1.06	1.02	**0.98**	**0.98**	1.21
	Unrestricted w/o AR	OPCA	3.10	2.63	1.82	**0.83***	**0.75****	**0.75***	**0.61****	**0.58****	**0.62***	**0.74***
		RPCA	3.10	2.63	1.82	**0.83***	**0.75****	**0.75***	**0.61****	**0.58****	**0.62***	**0.74***
		EM	3.33	3.10**	2.14**	1.13	**0.98**	1.05	**0.78**	**0.69**	**0.78**	**0.80***
		KF	2.81	2.45**	1.80**	**0.90***	**0.75****	**0.80****	**0.72***	**0.57***	**0.62***	**0.79**
	Unrestricted w/ AR	OPCA	**0.76**	**0.88**	**0.68*$_{FB}$**	**0.47**$_{FB}$**	**0.49****	**0.59*$_{FB}$**	**0.49**$_{FB}$**	**0.53****	**0.70***	**0.73*$_{FB}$**
		RPCA	**0.76**	**0.88**	**0.68***	**0.47****	**0.49**$_{FB}$**	**0.59***	**0.49****	**0.53****	**0.70***	**0.73*$_{FB}$**
		EM	1.33	1.39	1.03	**0.80**	**0.75**	**0.85**	**0.75**	**0.82**	**0.73**	1.09
		KF	**0.91**	**0.99**	**0.76**	**0.57****	**0.50****	**0.66**	**0.58****	**0.48**$_{FB}$**	**0.55*$_{FB}$**	1.07
	Smoothed	OPCA	2.47	2.16	1.51	**0.70***	**0.71****	**0.77****	**0.64****	**0.65***	**0.69***	**0.81***
		RPCA	2.47	2.16	1.51	**0.70***	**0.71****	**0.77****	**0.64****	**0.65***	**0.69***	**0.81***
		EM	2.44	2.43**	1.75*	**0.84***	**0.92**	**0.95**	**0.75**	**0.75**	**0.74**	**0.83***
		KF	2.32	2.11**	1.58*	**0.78****	**0.81**	**0.89**	**0.72***	**0.72**	**0.74**	**0.84***
	Mean with 1 factor		1.43	1.42	1.08	**0.62****	**0.62****	**0.72****	**0.67***	**0.65***	**0.70***	**0.84**
2	Basic w/o AR	OPCA	3.10	2.28	1.53	**0.65***	**0.52***	**0.51****	**0.41****	**0.40****	**0.44****	**0.57*$_{GB}$**
		RPCA	3.10	2.28	1.53	**0.65***	**0.52***	**0.51****	**0.41**$_{FB}$**	**0.40****	**0.44****	**0.57***
		EM	3.34	3.11**	1.74**	**0.80**	**0.79**	**0.69****	**0.56***	**0.56***	**0.56****	**0.71**
		KF	2.61	2.29*	1.59	**0.61****	**0.54****	**0.53****	**0.43****	**0.44****	**0.47****	**0.60***
	Basic w/ AR	OPCA	**0.71$_{FB}$**	**0.85**	**0.69***	**0.41**$_{FB}$**	**0.38**$_{GB}$**	**0.42****	**0.48****	**0.39**$_{GB}$**	**0.44****	**0.57***
		RPCA	**0.71**	**0.84$_{FB}$**	**0.67***	**0.42****	**0.38****	**0.42****	**0.48****	**0.39****	**0.44****	**0.57***
		EM	1.18	1.55*	**0.88**	**0.56****	**0.63***	**0.58****	**0.56***	**0.55***	**0.54****	**0.72***
		KF	**0.87**	**0.94**	**0.65*$_{FB}$**	**0.41****	**0.39****	**0.40**$_{GB}$**	**0.43****	**0.41****	**0.41**$_{GB}$**	**0.66***
	Unrestricted w/o AR	OPCA	3.08	2.78	1.72	**0.66***	**0.52****	**0.52****	**0.48****	**0.42****	**0.44****	**0.62***
		RPCA	3.08	2.78	1.72	**0.66***	**0.52****	**0.52****	**0.48****	**0.42****	**0.44****	**0.62***
		EM	3.72*	3.20**	1.88**	**0.83**	**0.90**	1.02	**0.72**	**0.77**	**0.83**	**0.94**
		KF	2.72	2.43**	1.56	**0.69***	**0.69**	**0.85**	**0.57***	**0.46****	**0.50****	**0.65***
	Unrestricted w/ AR	OPCA	**0.73**	**0.89**	**0.76**	**0.49****	**0.41****	**0.59****	**0.43****	**0.56***	**0.65**	**0.61***
		RPCA	**0.73**	**0.89**	**0.76**	**0.49****	**0.41****	**0.59****	**0.43****	**0.56***	**0.65**	**0.61***
		EM	1.31	1.29	1.35	**0.78**	**0.82**	1.15	**0.76**	**0.97**	1.43	1.05
		KF	1.12	1.16	**0.96**	**0.57***	**0.68**	**0.83**	**0.65**	**0.60**	**0.58***	**0.85**
	Smoothed	OPCA	3.41*	2.54**	1.61	**0.60****	**0.56****	**0.53****	**0.41****	**0.42****	**0.45****	**0.59***
		RPCA	3.41*	2.54**	1.61	**0.60****	**0.56****	**0.53****	**0.41****	**0.42****	**0.45****	**0.59***
		EM	3.18**	2.76**	1.62	**0.69****	**0.70***	**0.62****	**0.50****	**0.52***	**0.52****	**0.65***
		KF	2.99**	2.31**	1.44	**0.58****	**0.56****	**0.54****	**0.42****	**0.44****	**0.46****	**0.60***
	Mean of 2 factors		1.59	1.49	1.01	**0.48****	**0.48****	**0.52****	**0.44****	**0.44****	**0.48****	**0.62***
3	Basic w/o AR	OPCA	2.38	1.95	1.42	**0.65***	**0.62**	**0.66**	**0.57***	**0.79**	**0.92**	1.17
		RPCA	2.41	1.92	1.42	**0.66**	**0.62**	**0.64**	**0.57***	**0.78**	**0.95**	1.19
		EM	2.90	2.29**	1.50	**0.78**	**0.73**	**0.78***	**0.73**	1.12	1.06	1.49
		KF	2.14	1.58	1.09	**0.53***	**0.49***	**0.58***	**0.58***	**0.78**	**0.98**	1.38
	Basic w/ AR	OPCA	**0.72**	**0.83**	**0.81**	**0.40****	**0.46***	**0.52***	**0.60***	**0.80**	**0.96**	1.29
		RPCA	**0.72$_{FB}$**	**0.83$_{GB}$**	**0.75***	**0.40****	**0.46***	**0.52***	**0.60***	**0.80**	**0.99**	1.29
		EM	1.29	1.42	**0.86**	**0.56***	**0.64***	**0.69***	**0.62***	**0.97**	**0.80**	1.62

		KF	**0.97**	**0.99**	**0.60$^{*}_{\mathbf{GB}}$**	**0.40$^{**}_{\mathbf{GB}}$**	**0.39$^{**}_{\mathbf{FB}}$**	**0.43$^{**}_{\mathbf{FB}}$**	**0.43****	**0.62**	**0.90**	1.21
	Unrestricted w/o AR	OPCA	3.03	2.59	1.48	**0.59***	**0.51***	**0.62**	**0.51***	**0.60***	1.16	2.42
		RPCA	3.03	2.59	1.48	**0.59***	**0.51***	**0.62**	**0.51***	**0.60***	1.16	2.42
		EM	3.04	3.04**	1.58	**0.88**	**0.72**	1.05	1.09	1.24	1.73	3.08
		KF	2.32	1.96	1.37	**0.63***	**0.52****	**0.51***	**0.60***	1.30	1.11	2.13
	Unrestricted w/ AR	OPCA	1.11	1.20	**0.79**	**0.53****	**0.52***	**0.81**	**0.49****	**0.78**	1.32	1.11
		RPCA	1.11	1.20	**0.79**	**0.53****	**0.52***	**0.81**	**0.49****	**0.78**	1.32	1.11
		EM	1.23	1.36	1.18	**0.77***	**0.79**	1.16	1.07	1.37	2.06	2.94
		KF	1.17	1.32	1.08	**0.53***	**0.59****	**0.84**	**0.59***	1.29	1.13	1.66
	Smoothed	OPCA	3.00	2.35	1.42	**0.55****	**0.53****	**0.48****	**0.41****	**0.41$^{**}_{\mathbf{FB}}$**	**0.46****	**0.62$^{*}_{\mathbf{FB}}$**
		RPCA	3.00	2.35	1.42	**0.55****	**0.53****	**0.48****	**0.41****	**0.41$^{**}_{\mathbf{FB}}$**	**0.46****	**0.62$^{*}_{\mathbf{FB}}$**
		EM	2.72**	2.43**	1.31	**0.61****	**0.64***	**0.57****	**0.47****	**0.53***	**0.54****	**0.73***
		KF	2.47**	1.99**	1.19	**0.51****	**0.50****	**0.47****	**0.39$^{**}_{\mathbf{GB}}$**	**0.42****	**0.46$^{**}_{\mathbf{FB}}$**	**0.63***
	Mean of 3 factors		1.39	1.34	**0.90**	**0.45****	**0.43****	**0.47****	**0.42****	**0.57***	**0.71**	1.01
	Basic w/o AR	OPCA	1.69	1.98	1.45	**0.64***	**0.57****	**0.61***	**0.54***	**0.78**	1.33	2.85*
		RPCA	1.61	1.98	1.41	**0.65***	**0.55****	**0.63***	**0.54***	**0.87**	1.32	2.87*
		EM	2.66	2.14*	1.31	**0.69***	**0.74**	**0.74**	**0.87**	1.68	2.07	3.88**
		KF	1.72	1.53**	**0.94**	**0.45****	**0.44****	**0.52****	**0.56***	1.06	1.73	2.66
	Basic w/ AR	OPCA	**0.84$_{\mathbf{FB}}$**	1.23	**0.99**	**0.54***	**0.43****	**0.50****	**0.94**	1.46	**0.72***	3.91*
		RPCA	**0.85**	1.25	**0.93**	**0.53***	**0.43****	**0.50****	**0.94**	1.43	**0.82**	3.91*
		EM	1.66	1.65	**0.97**	**0.60***	**0.65***	**0.71**	**0.98**	1.45	2.36	4.05*
		KF	1.11	1.13$_{\mathrm{FB}}$	**0.80**	**0.43****	**0.39$^{**}_{\mathbf{FB}}$**	**0.44****	**0.55**	1.31	2.06	2.55
4	Unrestricted w/o AR	OPCA	1.97	2.18*	1.11	**0.45****	**0.57***	**0.99**	1.51	1.61	2.99	6.92
		RPCA	1.97	2.18*	1.11	**0.45****	**0.57***	**0.99**	1.51	1.61	2.99	6.92
		EM	2.86	3.05**	1.39	1.08	**0.86**	1.00	1.55	4.75	2.94**	4.68**
		KF	1.72	1.72**	1.49	**0.62****	**0.61****	2.77	3.17	1.96	5.64*	8.16**
	Unrestricted w/ AR	OPCA	1.72	1.36	**0.80**	**0.42****	1.58	1.17	1.61	1.11	1.70	6.22
		RPCA	1.72	1.36	**0.80$_{\mathbf{FB}}$**	**0.42$^{**}_{\mathbf{FB}}$**	1.58	1.17	1.61	1.11	1.70	6.22
		EM	1.52	1.89	1.18	1.05	**0.88**	1.50*	2.02	2.20	2.85	4.63**
		KF	1.17	1.51	1.22	1.51	1.57	1.82	3.97	1.85	5.00*	6.92**
	Smoothed	OPCA	2.31	2.02**	1.27	**0.53****	**0.53****	**0.49****	**0.43****	**0.43****	**0.48****	**0.64***
		RPCA	2.31	2.02**	1.27	**0.53****	**0.53****	**0.49****	**0.43****	**0.43****	**0.48****	**0.64$^{*}_{\mathbf{FB}}$**
		EM	2.51**	2.32*	1.23	**0.61****	**0.64***	**0.58****	**0.48****	**0.53***	**0.53****	**0.73***
		KF	2.11**	1.79	1.07	**0.50****	**0.49****	**0.47****	**0.40$^{**}_{\mathbf{FB}}$**	**0.42$^{**}_{\mathbf{FB}}$**	**0.46$^{**}_{\mathbf{FB}}$**	**0.64***
	Mean of 4 factors		1.25	1.41*	**0.85**	**0.44****	**0.45****	**0.41$^{**}_{\mathbf{FB}}$**	**0.73**	**0.83**	1.05	2.57**
	Basic w/o AR	OPCA	1.31	1.27	1.07	**0.59***	**0.55***	**0.62***	**0.67**	**0.92**	1.22	2.18
		RPCA	1.37	1.25	1.09	**0.59***	**0.55***	**0.62***	**0.66**	**0.92**	1.44	2.18
		EM	2.09	1.80*	1.06	**0.67***	1.57	1.08	1.21	2.45*	3.83	4.68*
		KF	1.24	1.28*	**0.79**	**0.43$^{**}_{\mathbf{FB}}$**	**0.55***	**0.59**	**0.66**	1.59	1.45	2.00
	Basic w/ AR	OPCA	**0.95$_{\mathbf{FB}}$**	1.20	1.00	**0.55***	**0.55****	**0.57***	**0.82**	1.56	2.14	3.06
		RPCA	1.01	1.21	**0.99**	**0.55***	**0.55****	**0.57***	**0.82**	1.53	1.85	3.37*
		EM	1.37	1.66*	**0.73$^{*}_{\mathbf{FB}}$**	**0.61***	1.60	1.24	1.32	4.16	4.07	5.19*
		KF	1.06	1.13$_{\mathrm{FB}}$	**0.77**	**0.46****	**0.56**	**0.57**	**0.65**	1.18	1.82	2.60
5	Unrestricted w/o AR	OPCA	1.88	1.92	1.20	**0.70**	2.08	3.72**	1.65	3.66	11.54	13.07
		RPCA	1.88	1.92	1.20	**0.70**	2.08	3.72**	1.65	3.66	11.54	13.07
		EM	2.67**	3.55**	1.48*	1.53	1.35	3.28	2.18**	3.94*	5.10	10.15*
		KF	1.78	1.58*	1.21	1.08	1.77	**0.85**	1.25	2.23*	24.51	6.78
	Unrestricted w/ AR	OPCA	2.09	1.61	1.09	**0.52***	2.09	3.91	2.34*	3.06**	3.90	5.83**
		RPCA	2.09	1.61	1.09	**0.52***	2.09	3.91	2.34*	3.06**	3.90	5.83**
		EM	1.82	1.62	1.18	1.18	1.48	2.48	2.03**	4.03**	4.97	11.82**
		KF	1.31	1.42	10.28	**0.74***	2.39	**0.75**	1.24	1.74	4.07	9.36
	Smoothed	OPCA	2.25	1.91*	1.13	**0.51****	**0.51****	**0.51****	**0.44****	**0.49****	**0.52****	**0.68$^{*}_{\mathbf{FB}}$**
		RPCA	2.25	1.91*	1.13	**0.51****	**0.51****	**0.51****	**0.44****	**0.49****	**0.52****	**0.68$^{*}_{\mathbf{FB}}$**
		EM	2.27**	2.10	1.06	**0.55****	**0.61****	**0.60****	**0.52****	**0.68**	**0.74**	1.05
		KF	1.93**	1.68	**0.95**	**0.47****	**0.49$^{**}_{\mathbf{FB}}$**	**0.47$^{**}_{\mathbf{FB}}$**	**0.42$^{**}_{\mathbf{FB}}$**	**0.49$^{**}_{\mathbf{FB}}$**	**0.52$^{**}_{\mathbf{FB}}$**	**0.71***
	Mean of 5 factors		1.09	1.26	**0.84**	**0.45****	**0.78**	**0.72**	**0.57***	1.09	1.85	2.71*
	Basic w/o AR	OPCA	1.15	1.30	**0.87**	**0.57**	**0.75**	1.39	1.08	2.25	3.89	3.18
		RPCA	1.24	1.32	**0.94**	**0.58**	**0.78**	1.38	1.09	2.13	3.80	2.90
		EM	1.91	1.75	1.03	**0.89**	3.11	1.70	1.70	2.43	3.14	4.53
		KF	1.22	1.15	**0.79**	**0.51****	1.03	**0.99**	1.22	2.43	4.27	5.91*
	Basic w/ AR	OPCA	**0.95$_{\mathbf{FB}}$**	1.16	**0.90**	**0.56***	**0.70**	1.38	**0.88**	1.61	5.41	4.72

	RPCA	**0.98**	1.16	**0.86**	**0.56***	**0.69**	1.37	**0.88**	1.56	4.95	4.76
	EM	1.49	1.65	**0.84**	**0.76**	1.66	1.85	1.53	4.09	4.43	2.46
	KF	1.11	1.06$_{\mathrm{FB}}$	**0.72$_{\mathbf{FB}}$**	**0.64***	**0.86**	1.11	**0.91**	2.06	4.14	7.19*
	OPCA	3.17	1.74	1.21	1.96	1.73	3.39**	5.00	2.35*	6.53**	18.97
Unrestricted	RPCA	3.17	1.74	1.21	1.96	1.73	3.39**	5.00	2.35*	6.53**	18.97
w/o AR	EM	3.13**	2.11*	2.33	**0.94**	1.42	1.88*	2.36	2.96**	3.33	8.79**
	KF	1.46	1.40	1.71	**0.65****	1.32	1.60	2.00	3.84	5.03**	3.84*
	OPCA	2.27	1.21	1.16	**0.67**	1.96	2.63*	2.19	2.30	6.57**	9.20**
Unrestricted	RPCA	2.27	1.21	1.16	**0.67**	1.96	2.63*	2.19	2.30	6.57**	9.20**
w/ AR	EM	2.58	1.90**	2.06	**0.92**	2.11	3.04**	2.57*	6.30	3.79**	7.83**
	KF	1.36	1.66	1.90*	**0.63****	2.28	5.44	2.11	6.27**	4.60*	5.70
	OPCA	1.47	1.43	**0.99**	**0.48****	**0.54$^{**}_{\mathbf{FB}}$**	**0.57$^{**}_{\mathbf{FB}}$**	**0.48$^{**}_{\mathbf{FB}}$**	**0.59$^{*}_{\mathbf{FB}}$**	**0.59$^{*}_{\mathbf{FB}}$**	**0.83$_{\mathbf{FB}}$**
	RPCA	1.47	1.43	**0.99**	**0.48****	**0.54$^{**}_{\mathbf{FB}}$**	**0.57$^{**}_{\mathbf{FB}}$**	**0.48$^{**}_{\mathbf{FB}}$**	**0.59$^{*}_{\mathbf{FB}}$**	**0.59$^{*}_{\mathbf{FB}}$**	**0.83$_{\mathbf{FB}}$**
Smoothed	EM	1.60	1.87	1.04	**0.62****	**0.68****	**0.71****	**0.57***	**0.73**	**0.73***	**0.98**
	KF	1.45	1.45	**0.95**	**0.52****	**0.57****	**0.60****	**0.51****	**0.60***	**0.62***	**0.85**
Mean of 6 factors		1.02	1.16	**0.89**	**0.47$^{**}_{\mathbf{FB}}$**	**0.82**	1.03	**0.72**	1.36	2.29	2.78*
Mean of MIDAS		1.16	1.25	**0.86**	**0.45****	**0.50****	**0.52****	**0.47****	**0.61***	**0.77**	1.12
Mean of All		1.19	1.26	**0.93**	**0.53****	**0.58****	**0.61****	**0.53****	**0.60****	**0.70***	**0.86**

Panel (b): Most Recent

Factors	Recursive		Backcast prev. qtr. -1	Nowcast current quarter 1	2	Forecast 1 quarter ahead 3	4	5	6	2 quarter ahead 7	8	9
	RW		1.07	1.11	1.15	1.25**	1.29**	1.27**	1.41**	1.49**	1.49**	1.60**
	CBADL		4.31*	3.46*	2.53*	1.86**	1.74**	1.71**	1.50**	1.43*	1.50**	1.71
	BEX		2.36*	2.23*	1.49	**0.86**	**0.85**	**0.81**	**0.61**	**0.59***	**0.61***	**0.67****
	Mean of Benchmarks		3.22*	2.69*	2.01*	1.62	1.54	1.44	**0.96**	**0.89**	**0.94**	1.25
1	Basic w/o AR	OPCA	2.26	1.78	1.17	**0.76***	**0.73***	**0.76****	**0.67***	**0.63***	**0.69***	**0.83***
		RPCA	2.26	1.78	1.17	**0.76***	**0.73***	**0.76****	**0.67***	**0.63***	**0.69***	**0.83***
		EM	2.71**	2.38**	1.40	1.06	1.07	**1.00**	**0.83**	**0.76**	**0.77**	**0.82****
		KF	2.04	1.69	1.16	**0.86***	**0.85**	**0.89**	**0.77**	**0.71**	**0.76**	**0.86***
	Basic w/ AR	OPCA	**0.75$_{FB}$**	**0.81*$_{GB}$**	**0.61****	**0.51****	**0.59****	**0.67***	**0.70***	**0.70***	**0.76***	**0.94**
		RPCA	**0.75**	**0.86***	**0.61****	**0.51****	**0.59****	**0.67***	**0.70***	**0.70***	**0.76***	**0.94**
		EM	1.17	1.31	**0.83**	**0.99**	1.21	1.00	1.01	**0.90**	**0.94**	1.11
		KF	**0.84**	**0.84**	**0.72****	**0.71**	**0.84**	1.06	**0.99**	**0.95**	**0.97**	1.22
	Unrestricted w/o AR	OPCA	2.32	1.88	1.25	**0.79***	**0.70****	**0.66****	**0.56****	**0.51****	**0.56***	**0.68****
		RPCA	2.32	1.88	1.25	**0.79***	**0.70****	**0.66****	**0.56****	**0.51****	**0.56***	**0.68****
		EM	2.74*	2.48**	1.50	1.10	**0.94**	**0.93**	**0.74**	**0.60**	**0.72**	**0.76****
		KF	2.10	1.79	1.19	**0.82****	**0.68****	**0.67****	**0.64***	**0.48****	**0.54***	**0.71****
	Unrestricted w/ AR	OPCA	**0.84**	**0.89***	**0.57****	**0.46$^{**}_{FB}$**	**0.46****	**0.54$^{**}_{FB}$**	**0.44$^{**}_{FB}$**	**0.46****	**0.67**	**0.68$^{**}_{FB}$**
		RPCA	**0.84**	**0.89***	**0.57****	**0.46****	**0.46$^{**}_{FB}$**	**0.54****	**0.44****	**0.46****	**0.67**	**0.68$^{**}_{FB}$**
		EM	1.23	1.18	**0.76**	**0.82**	**0.77**	**0.85**	**0.74**	**0.79**	**0.69**	1.08
		KF	**0.85**	**0.86**	**0.55$^{**}_{FB}$**	**0.54****	**0.46****	**0.59***	**0.52****	**0.40$^{**}_{FB}$**	**0.49$^{**}_{FB}$**	1.06
	Smoothed	OPCA	1.65	1.45	**0.99**	**0.63****	**0.64****	**0.68****	**0.58****	**0.59****	**0.64***	**0.76****
		RPCA	1.65	1.45	**0.99**	**0.63****	**0.64****	**0.68****	**0.58****	**0.59****	**0.64***	**0.76****
		EM	1.74	1.78	1.15	**0.75****	**0.86**	**0.84**	**0.69**	**0.68**	**0.70**	**0.79****
		KF	1.53	1.43	1.00	**0.69****	**0.74**	**0.78**	**0.66**	**0.66**	**0.70**	**0.80****
	Mean with 1 factor		1.03	1.02	**0.69****	**0.54****	**0.56****	**0.62****	**0.61***	**0.57***	**0.64***	**0.78****
2	Basic w/o AR	OPCA	2.29	1.63	1.06	**0.59****	**0.47****	**0.43****	**0.35****	**0.34****	**0.39****	**0.51****
		RPCA	2.29	1.63	1.06	**0.59****	**0.47****	**0.43****	**0.35****	**0.34****	**0.39****	**0.51****
		EM	2.74*	2.50**	1.22	**0.78**	**0.79**	**0.60****	**0.51***	**0.50***	**0.51****	**0.67***
		KF	1.91	1.66	1.04	**0.54****	**0.49****	**0.44****	**0.37****	**0.37****	**0.41****	**0.54****
	Basic w/ AR	OPCA	**0.78**	**0.86***	**0.61****	**0.40****	**0.35$^{**}_{GB}$**	**0.37****	**0.47****	**0.33$^{**}_{GB}$**	**0.40****	**0.50****
		RPCA	**0.79**	**0.86***	**0.59****	**0.40****	**0.35****	**0.37****	**0.47****	**0.33****	**0.40****	**0.50$^{**}_{GB}$**
		EM	1.15	1.40	**0.69****	**0.55****	**0.67***	**0.53****	**0.55***	**0.51****	**0.50****	**0.66****
		KF	**0.80**	**0.81$_{FB}$**	**0.50$^{**}_{FB}$**	**0.36$^{**}_{GB}$**	**0.38****	**0.36$^{**}_{FB}$**	**0.41****	**0.37****	**0.36$^{**}_{GB}$**	**0.60****
	Unrestricted w/o AR	OPCA	2.25	1.97	1.18	**0.61****	**0.48****	**0.44****	**0.40****	**0.35****	**0.39****	**0.53****
		RPCA	2.25	1.97	1.18	**0.61****	**0.48****	**0.44****	**0.40****	**0.35****	**0.39****	**0.53****
		EM	2.98**	2.55**	1.30	**0.81**	**0.88**	**0.97**	**0.68**	**0.70**	**0.84**	**0.94**
		KF	1.99	1.77	1.01	**0.62****	**0.63***	**0.77**	**0.50****	**0.37****	**0.44****	**0.59****
	Unrestricted w/ AR	OPCA	**0.62$_{GB}$**	**0.82**	**0.62***	**0.50****	**0.38****	**0.55****	**0.35$^{**}_{FB}$**	**0.57**	**0.72**	**0.53****
		RPCA	**0.62**	**0.82**	**0.62***	**0.50****	**0.38****	**0.55****	**0.35****	**0.57**	**0.72**	**0.53****
		EM	1.18	1.02	**0.95**	**0.76**	**0.79**	1.17	**0.71**	1.00	1.63	1.05
		KF	**0.89**	**0.87**	**0.64***	**0.51****	**0.59**	**0.76**	**0.58**	**0.54**	**0.53***	**0.80**
	Smoothed	OPCA	2.41*	1.73	1.06	**0.52****	**0.48****	**0.43****	**0.35****	**0.35****	**0.39****	**0.53****
		RPCA	2.41*	1.73	1.06	**0.52****	**0.48****	**0.43****	**0.35****	**0.35****	**0.39****	**0.53****
		EM	2.32*	2.02*	1.04	**0.59****	**0.64***	**0.51****	**0.43****	**0.44****	**0.46****	**0.60****
		KF	2.07	1.57	**0.89**	**0.48****	**0.48****	**0.43****	**0.35****	**0.36****	**0.40****	**0.53****
	Mean of 2 factors		1.11	1.05	**0.64****	**0.41****	**0.41****	**0.42****	**0.37****	**0.37****	**0.44****	**0.55****
3	Basic w/o AR	OPCA	1.81	1.47	1.07	**0.72**	**0.71**	**0.73**	**0.66**	**0.92**	1.08	1.36
		RPCA	1.83	1.44	1.07	**0.73**	**0.71**	**0.71**	**0.66**	**0.91**	1.11	1.37
		EM	2.38*	1.86	1.02	**0.85**	**0.79**	**0.81**	**0.80**	1.30	1.24	1.69*
		KF	1.49	1.11	**0.70**	**0.53****	**0.52**	**0.61**	**0.67**	**0.90**	1.16	1.64
	Basic w/ AR	OPCA	**0.70**	**0.84**	**0.75****	**0.42****	**0.49**	**0.58**	**0.68**	**0.92**	1.12	1.49
		RPCA	**0.69$_{FB}$**	**0.84**	**0.68****	**0.42****	**0.49**	**0.58**	**0.68**	**0.92**	1.15	1.49
		EM	1.16	1.32	**0.72***	**0.61***	**0.74**	**0.77**	**0.69**	1.12	**0.89**	1.87*

		KF	**0.81**	**0.81$_{\mathbf{FB}}$**	**0.47$^{**}_{\mathbf{FB}}$**	**0.40$^{**}_{\mathbf{FB}}$**	**0.40****	**0.46****	**0.47****	**0.69**	1.00	1.38
	Unrestricted w/o AR	OPCA	2.37	1.97	1.03	**0.60****	**0.54****	**0.67**	**0.55**	**0.63**	1.40	2.97
		RPCA	2.37	1.97	1.03	**0.60****	**0.54****	**0.67**	**0.55**	**0.63**	1.40	2.97
		EM	2.43	2.46**	1.08	**0.90**	**0.75**	1.07	1.16	1.34	2.14	3.77
		KF	1.60	1.36	**0.89**	**0.63****	**0.47****	**0.45****	**0.60***	1.55	1.28	2.59*
	Unrestricted w/ AR	OPCA	1.00	1.05	**0.61**	**0.56****	**0.49**	**0.89**	**0.46****	**0.81**	1.59	1.21
		RPCA	1.00	1.05	**0.61**	**0.56****	**0.49**	**0.89**	**0.46****	**0.81**	1.59	1.21
		EM	1.22	1.06	**0.88**	**0.75**	**0.82**	1.19	1.15	1.51	2.54	3.57
		KF	1.02	**0.97**	**0.71**	**0.55****	**0.55****	**0.80**	**0.55***	1.53	1.26	1.94
	Smoothed	OPCA	2.16	1.67	**0.96**	**0.51****	**0.49****	**0.41****	**0.38****	**0.36****	**0.43****	**0.57$^{**}_{\mathbf{FB}}$**
		RPCA	2.16	1.67	**0.96**	**0.51****	**0.49****	**0.41****	**0.38****	**0.36****	**0.43****	**0.57$^{**}_{\mathbf{FB}}$**
		EM	1.96	1.77*	**0.82**	**0.51****	**0.60***	**0.46****	**0.42****	**0.48****	**0.50****	**0.71****
		KF	1.62	1.32	**0.69****	**0.41****	**0.42****	**0.37$^{**}_{\mathbf{FB}}$**	**0.34$^{**}_{\mathbf{FB}}$**	**0.36$^{**}_{\mathbf{FB}}$**	**0.41$^{**}_{\mathbf{FB}}$**	**0.58****
	Mean of 3 factors		**0.98**	**0.97**	**0.58****	**0.42****	**0.40$^{**}_{\mathbf{FB}}$**	**0.43****	**0.40****	**0.58**	**0.77**	1.10
	Basic w/o AR	OPCA	1.42	1.59	1.05	**0.67***	**0.57****	**0.59****	**0.59***	**0.92**	1.69	3.71*
		RPCA	1.32	1.59	1.03	**0.67***	**0.54****	**0.61****	**0.59***	1.04	1.69	3.73*
		EM	2.29*	1.80*	**0.84**	**0.73**	**0.80**	**0.77**	1.02	2.07	2.64*	5.01*
		KF	1.28	1.14	**0.53****	**0.43****	**0.44****	**0.54***	**0.65**	1.29	2.23	3.43*
	Basic w/ AR	OPCA	**0.71$_{\mathbf{FB}}$**	**0.97**	**0.75**	**0.55****	**0.42****	**0.45****	1.14	1.83	**0.77**	5.09*
		RPCA	**0.75**	1.00	**0.70**	**0.54****	**0.42****	**0.44****	1.14	1.79	**0.89**	5.10*
		EM	1.44	1.51*	**0.70***	**0.64***	**0.70**	**0.72**	1.21	1.77	3.05*	5.14**
		KF	**0.81**	**0.86$_{\mathbf{FB}}$**	**0.49****	**0.38****	**0.39$^{**}_{\mathbf{FB}}$**	**0.46***	**0.62**	1.63	2.73	3.17
4	Unrestricted w/o AR	OPCA	1.60	1.57	**0.71****	**0.48****	**0.64**	1.11	1.88	2.00	3.71	8.90
		RPCA	1.60	1.57	**0.71****	**0.48****	**0.64**	1.11	1.88	2.00	3.71	8.90
		EM	2.63**	2.51**	**0.94**	1.17	**0.95**	1.10	1.80	5.92	3.73**	6.06**
		KF	1.37	1.27	**0.92**	**0.60****	**0.55****	3.56	4.11	2.33	7.36*	10.58**
	Unrestricted w/ AR	OPCA	1.50	**0.99**	**0.49****	**0.46****	1.84	1.20	1.97	1.34	1.98	7.96
		RPCA	1.50	**0.99**	**0.49$^{**}_{\mathbf{FB}}$**	**0.46****	1.84	1.20	1.97	1.34	1.98	7.96
		EM	1.62	1.78	**0.92**	1.14	**0.92**	1.64*	2.40	2.57	3.65	5.92*
		KF	**0.80**	1.07	**0.81**	1.49	1.64	2.17	5.01	2.09	6.40*	8.85**
	Smoothed	OPCA	1.82	1.51	**0.87**	**0.47****	**0.48****	**0.41****	**0.39****	**0.37****	**0.44****	**0.57****
		RPCA	1.82	1.51	**0.87**	**0.47****	**0.48****	**0.41****	**0.39****	**0.37****	**0.44****	**0.57****
		EM	1.93*	1.70*	**0.73**	**0.49****	**0.56**	**0.44****	**0.40****	**0.46****	**0.48****	**0.69****
		KF	1.51	1.24	**0.60****	**0.38$^{**}_{\mathbf{FB}}$**	**0.39****	**0.35****	**0.33$^{**}_{\mathbf{GB}}$**	**0.35$^{**}_{\mathbf{FB}}$**	**0.40$^{**}_{\mathbf{FB}}$**	**0.57$^{**}_{\mathbf{FB}}$**
	Mean of 4 factors		**0.97**	1.04	**0.49****	**0.39****	**0.40****	**0.33$^{**}_{\mathbf{GB}}$**	**0.83**	**0.94**	1.24	3.23**
	Basic w/o AR	OPCA	1.03	**1.00**	**0.76**	**0.58****	**0.61**	**0.69**	**0.79**	1.06	1.49	2.78*
		RPCA	1.06	**0.98**	**0.77**	**0.58****	**0.62**	**0.69**	**0.79**	1.07	1.80	2.77*
		EM	2.08	1.64*	**0.75**	**0.76**	2.03	1.26	1.50	3.10*	5.00	6.03*
		KF	1.02	**1.00**	**0.44$^{**}_{\mathbf{GB}}$**	**0.41****	**0.60**	**0.64**	**0.80**	1.98	1.81	2.56
	Basic w/ AR	OPCA	**0.78$_{\mathbf{FB}}$**	**0.97**	**0.69**	**0.57***	**0.62**	**0.65**	**1.00**	1.98	2.79*	3.98
		RPCA	**0.86**	**0.97**	**0.70**	**0.57***	**0.62**	**0.65**	**1.00**	1.94	2.34	4.40*
		EM	1.47	1.59**	**0.57****	**0.71**	2.11	1.57	1.71	5.31	5.38	6.67**
		KF	**0.96**	**0.92$_{\mathbf{FB}}$**	**0.47****	**0.45****	**0.65**	**0.66**	**0.82**	1.41	2.31	3.33
5	Unrestricted w/o AR	OPCA	1.57	1.35	**0.79**	**0.87**	2.71	4.79**	1.97	4.65*	15.11	16.96
		RPCA	1.57	1.35	**0.79**	**0.87**	2.71	4.79**	1.97	4.65*	15.11	16.96
		EM	2.81**	3.33*	1.17	1.87*	1.74	3.80	2.61**	4.95**	6.61	13.37*
		KF	1.37	1.19	**0.75**	1.28	2.10	**0.92**	1.47	2.62*	32.57	8.94
	Unrestricted w/ AR	OPCA	1.55	1.12	**0.70**	**0.56**	2.73	4.99*	2.82*	3.88**	5.08	7.56**
		RPCA	1.55	1.12	**0.70**	**0.56**	2.73	4.99*	2.82*	3.88**	5.08	7.56**
		EM	1.93	1.45	1.08	1.30	1.85	2.71	2.45**	5.18**	6.44	15.53**
		KF	1.02	1.01	9.28	**0.70**	2.92	**0.75**	1.40	1.99	5.26	12.29
	Smoothed	OPCA	1.64	1.36	**0.79**	**0.46****	**0.49****	**0.47****	**0.43****	**0.48****	**0.52****	**0.66$^{**}_{\mathbf{FB}}$**
		RPCA	1.64	1.36	**0.79**	**0.46****	**0.49****	**0.47****	**0.43****	**0.48****	**0.52****	**0.66****
		EM	1.75	1.59	**0.68***	**0.50****	**0.59****	**0.56****	**0.52***	**0.70**	**0.82**	1.17
		KF	1.38	1.19	**0.57***	**0.40$^{**}_{\mathbf{FB}}$**	**0.45$^{**}_{\mathbf{FB}}$**	**0.41$^{**}_{\mathbf{FB}}$**	**0.39$^{**}_{\mathbf{FB}}$**	**0.48$^{**}_{\mathbf{FB}}$**	**0.51$^{*}_{\mathbf{FB}}$**	**0.70***
	Mean of 5 factors		**0.85**	**0.94**	**0.53****	**0.44****	**0.93**	**0.81**	**0.62**	1.29	2.36	3.46*
	Basic w/o AR	OPCA	1.00	1.08	**0.66****	**0.63**	**0.91**	1.75	1.37	2.91	5.17*	4.18
		RPCA	1.12	1.09	**0.70****	**0.64**	**0.94**	1.75	1.38	2.75	5.04*	3.79
		EM	2.02	1.55	**0.72***	**0.90**	4.04	2.04	2.11	2.97	4.07	5.83
		KF	**0.97**	**0.94**	**0.50$^{**}_{\mathbf{FB}}$**	**0.53****	1.25	1.16	1.54	3.14	5.61	7.75*
	Basic w/ AR	OPCA	**0.83$_{\mathbf{FB}}$**	**0.94**	**0.68***	**0.62**	**0.87**	1.76	1.07	2.00	7.21	6.29
6												

	RPCA	**0.85**	**0.94**	**0.65****	**0.62**	**0.86**	1.77	1.08	1.93	6.61	6.33
	EM	1.64	1.61*	**0.60****	**0.81**	2.21	2.30	1.94	5.11	5.87	3.01
	KF	1.07	**0.91**	**0.51****	**0.69**	1.07	1.37	1.13	2.60	5.52	9.40*
	OPCA	2.85	1.39	**0.77**	2.57	2.27	4.31**	6.38	2.85**	8.56**	24.56
Unrestricted	RPCA	2.85	1.39	**0.77**	2.57	2.27	4.31**	6.38	2.85**	8.56**	24.56
w/o AR	EM	3.11**	1.70*	1.77*	1.18	1.76**	2.01**	2.79	3.70**	4.14	11.50**
	KF	1.15	1.01	1.27	**0.54****	1.62**	1.93*	2.49**	4.87	6.49**	4.73**
	OPCA	1.91	**0.92**	**0.78**	**0.71**	2.51	3.20*	2.56	2.83	8.56**	11.75**
Unrestricted	RPCA	1.91	**0.92**	**0.78**	**0.71**	2.51	3.20*	2.56	2.83	8.56**	11.75**
w/ AR	EM	2.69**	1.77*	1.59	1.10	2.69	3.30**	3.02*	8.41	4.57**	10.15**
	KF	**0.94**	1.15	1.44	**0.58****	2.79*	6.71	2.58*	7.95**	5.86*	7.00
	OPCA	1.05	1.02	**0.67****	**0.41**$^{**}_{\mathbf{FB}}$	**0.51****	**0.52****	**0.45**$^{**}_{\mathbf{FB}}$	**0.59***	**0.57**$^{*}_{\mathbf{FB}}$	**0.85**
	RPCA	1.05	1.02	**0.67****	**0.41**$^{**}_{\mathbf{FB}}$	**0.51**$^{**}_{\mathbf{FB}}$	**0.52**$^{**}_{\mathbf{FB}}$	**0.45**$^{**}_{\mathbf{FB}}$	**0.59***	**0.57**$^{*}_{\mathbf{FB}}$	**0.85**$_{\mathbf{FB}}$
Smoothed	EM	1.21	1.40	**0.66***	**0.56****	**0.66****	**0.67****	**0.54***	**0.73**	**0.77**	1.03
	KF	1.01	1.02	**0.57**	**0.44****	**0.52****	**0.54****	**0.48****	**0.59**$^{*}_{\mathbf{FB}}$	**0.61***	**0.86**
Mean of 6 factors		**0.85**	**0.89**$_{\mathbf{FB}}$	**0.57***	**0.47****	**0.98**	1.19	**0.81**	1.66	2.92*	3.49*
Mean of MIDAS		**0.84**	**0.89**	**0.52****	**0.40****	**0.49****	**0.47****	**0.45****	**0.63**	**0.86**	1.27
Mean of All		**0.76**	**0.82**	**0.58****	**0.46****	**0.54****	**0.56****	**0.50****	**0.58***	**0.72**	**0.91**

* Notes: See notes to Tables 1-4. Entries in this table are ratios of point MSFEs of our benchmark or 'strawman' AR(SIC) model to each other model, for various estimation methods and horizons. Panel (a) reports MSFEs based on experiments using 'first available' real-time quarterly historical data, and Panel (b) reports results based on the use of 'most recent' real-time quarterly historical data. All results are based on recursively estimated models. The column denoted by 'Backcast' contains MSFEs for quarterly forecasts of GDP made 1-month prior to the calendar date of the quarterly GDP datum being predicted, and the columns denoted by 'Nowcast' contain MSFEs for forecasts of the first, second and third months of each quarterly calendar dated GDP observation. Finally, the columns denoted by 'Forecast' contain MSFEs based on 1-quarter ahead predictions made from 1 month after the end of the quarter (called month 4) to 3 month ahead (called month 6). Months 7-9 correspondingly refer to 2-quarter ahead predictions. Bold entires denote cases for which the point MSFE of a given model is lower than the point MSFE of the AR(SIC) model. Entries superscripted by a ** (5% level) and a * (10% level) are significantly better than the AR(SIC) model, based on application of the DM predictive accuracy test. Finally, entries subscripted with 'FB' denote the MSFE-best models for a given number of estimated factors and for each horizon, while entries subscripted with 'GB' denote MSFE-best models across all specification permutations, for a given horizon. See Section 5 for complete details.

Table A 2: Relative MSFEs When Backcasting, Nowcasting, and Forecasting Korean GDP*

Panel (a): First Available

Factors	Recursive		Backcast prev. qtr. -1	Nowcast current quarter 1	Nowcast current quarter 2	Nowcast current quarter 3	Forecast 1 quarter ahead 4	Forecast 1 quarter ahead 5	Forecast 1 quarter ahead 6	Forecast 2 quarter ahead 7	Forecast 2 quarter ahead 8	Forecast 2 quarter ahead 9
	RW		1.45	1.35	1.12	**0.94**	**0.94**	1.01	1.14	1.13	1.20	1.68
	CBADL		5.16	4.84	3.42	2.02**	1.91**	1.97**	1.75**	1.73**	1.84**	1.54
	BEX		2.63	2.56	1.76	**0.94**	**0.93**	**0.97**	**0.85**	**0.85**	**0.91**	**0.82**
	Mean of Benchmarks		4.24	3.94	2.83	1.81	1.73*	1.73	1.24**	1.22**	1.31**	1.14
1	Basic w/o AR	OPCA	1.22	1.42	1.12	**0.71**	**0.81**	**0.95**	**0.98**	1.08*	1.09	**0.94**
		RPCA	1.22	1.42	1.12	**0.71**	**0.81**	**0.95**	**0.98**	1.08*	1.09	**0.94**
		EM	1.26	1.59	1.23	**0.82**	**0.95**	1.12	1.06	1.05	1.09	**0.86**
		KF	1.16	1.35	1.14	**0.76**	**0.89**	1.05	1.02	1.04	1.07	**0.87**
	Basic w/ AR	OPCA	**0.70**	**0.86**	**0.81**	**0.71**	**0.86**	1.05	**0.96**	1.16	1.21	**0.97**
		RPCA	**0.70**	**0.80**	**0.81**	**0.71**	**0.86**	1.05	**0.96**	1.16	1.21	**0.97**
		EM	**0.73**	**0.90**	**1.00**	**0.95**	**0.98**	1.34	1.14	1.28	1.39	1.03
		KF	**0.65$_{FB}$**	**0.78$_{GB}$**	**0.92**	**0.84**	**0.92**	1.31*	1.07	1.20	1.34	1.04
	Unrestricted w/o AR	OPCA	1.52	1.58**	1.08	**0.70**	**0.72**	**0.76**	**0.97**	**0.73$_{GB}$**	**0.84**	**0.89**
		RPCA	1.52	1.58**	1.08	**0.70**	**0.72**	**0.76**	**0.97**	**0.73**	**0.84**	**0.89**
		EM	1.56	1.58	1.08	**0.69**	**0.68**	**0.97**	1.08	**0.96**	1.15	1.41
		KF	1.28	1.45	**1.00**	**0.68**	**0.65*$_{FB}$**	**0.73*$_{FB}$**	**0.85**	**0.81**	**0.73$_{GB}$**	**0.80$_{GB}$**
	Unrestricted w/ AR	OPCA	**0.92**	1.14	**0.78****	**0.65*$_{FB}$**	**0.73**	**0.94**	**0.88**	1.03	1.30	1.22
		RPCA	**0.92**	1.14	**0.78**$_{FB}$**	**0.65***	**0.73**	**0.94**	**0.88**	1.03	1.30	1.22
		EM	1.03	1.11	**0.87**	**0.71**	**0.96**	1.42	1.04	1.16	1.31	1.14
		KF	**0.80**	1.02	**0.88**	**0.69**	**0.74***	**0.91**	**0.84$_{FB}$**	1.08	1.18	1.07
	Smoothed	OPCA	1.71	1.58	1.18	**0.74**	**0.80**	**0.95**	**0.88**	**0.95**	1.04	**0.94**
		RPCA	1.71	1.58	1.18	**0.74**	**0.80**	**0.95**	**0.88**	**0.95**	1.04	**0.94**
		EM	1.50	1.61	1.27	**0.74**	**0.86**	1.03	**0.90**	**0.96**	1.05	**0.90**
		KF	1.46	1.48	1.20	**0.73**	**0.83**	**0.98**	**0.88**	**0.94**	1.03	**0.90**
	Mean with 1 factor		**0.93**	1.11	**0.91**	**0.66**	**0.75**	**0.89**	**0.86**	**0.91**	**0.94**	**0.83**
2	Basic w/o AR	OPCA	1.35	1.29	**0.93**	**0.59**	**0.59**	**0.76**	**0.88**	1.00	1.13	1.03
		RPCA	1.35	1.29	**0.93**	**0.59**	**0.59**	**0.76**	**0.89**	1.01	1.13	1.03
		EM	1.31	1.32	**0.89**	**0.61**	**0.65**	**0.90**	1.09	1.01	1.17	1.11
		KF	1.21	1.23	**0.95**	**0.57**	**0.63**	**0.82**	**0.95**	**0.98**	1.07	1.08
	Basic w/ AR	OPCA	**0.89**	**0.82**	**0.77**	**0.52***	**0.59**	**0.88**	**0.79**	**0.87**	1.03	1.12
		RPCA	**0.89**	**0.82$_{FB}$**	**0.77**	**0.51*$_{FB}$**	**0.59**	**0.87**	**0.79**	**0.87**	1.03	1.12
		EM	**0.77**	**0.86**	**0.81**	**0.68**	**0.56***	1.10	1.04	**0.98**	1.20	1.30
		KF	**0.73$_{FB}$**	**0.82**	**0.67$_{FB}$**	**0.51***	**0.59**	**0.97**	**0.81**	**0.85**	1.06	1.52
	Unrestricted w/o AR	OPCA	1.54	1.61	**0.94**	**0.66***	**0.57****	**0.75*$_{FB}$**	**0.99**	**0.86**	1.80	1.27
		RPCA	1.54	1.61	**0.94**	**0.66***	**0.57****	**0.75***	**0.99**	**0.86**	1.80	1.27
		EM	1.38	1.51	1.06	**0.59***	**0.78**	1.30	1.38	1.43	1.80	1.87
		KF	1.48	1.38	**0.99**	**0.72**	**0.65**	1.05	1.02	**0.95**	1.74	1.53
	Unrestricted w/ AR	OPCA	**0.96**	**0.90**	**0.86**	**0.61***	**0.84**	1.28	1.12	1.34	3.26	1.59
		RPCA	**0.96**	**0.90**	**0.86**	**0.61***	**0.84**	1.28	1.12	1.34	3.26	1.59
		EM	**0.94**	1.21	1.01	**0.76**	**0.92**	1.48	1.53	1.50	2.32*	2.00*
		KF	1.01	1.24	**0.86**	**0.77**	1.13	1.44	1.57**	1.33	2.91*	3.08
	Smoothed	OPCA	2.46*	1.82	1.17	**0.70***	**0.67****	**0.75****	**0.73**$^{**}_{GB}$**	**0.78**	**0.93$_{FB}$**	**0.94$_{FB}$**
		RPCA	2.46*	1.82	1.17	**0.70***	**0.67****	**0.75****	**0.73**$^{**}_{GB}$**	**0.78**	**0.93$_{FB}$**	**0.94$_{FB}$**
		EM	2.16*	1.77	1.19	**0.67***	**0.71***	**0.81***	**0.80**	**0.80**	**0.99**	1.02
		KF	2.05	1.61	1.08	**0.65***	**0.67****	**0.76****	**0.74**	**0.79**	**0.94**	**0.95**
	Mean of 2 factors		1.05	1.07	**0.80**	**0.54***	**0.55*$_{FB}$**	**0.77***	**0.78***	**0.77$_{FB}$**	1.03	**0.96**
3	Basic w/o AR	OPCA	1.18	1.20	**0.80**	**0.45***	**0.49***	**0.66**	1.13	1.07	2.19	3.17*
		RPCA	1.16	1.19	**0.80**	**0.44***	**0.49***	**0.67**	1.14	1.08	2.19	3.18*
		EM	1.23	1.32	**0.85**	**0.46***	**0.70**	**0.86**	1.14	2.74*	2.64**	4.43**
		KF	**0.98**	1.00	**0.74**	**0.40***	**0.65**	**0.65**	**0.99**	1.90	2.21	3.78**
	Basic w/ AR	OPCA	**0.79**	**0.81**	**0.71**	**0.36***	**0.39****	**0.68**	1.05	**0.75**	1.67	2.32*
		RPCA	**0.79**	**0.81$_{FB}$**	**0.72**	**0.39***	**0.38****	**0.68**	1.04	**0.76**	1.69	2.39**
		EM	**0.70**	**0.91**	1.12	**0.46***	**0.43***	**0.92**	1.39	2.82**	1.79	3.76**

		KF	**0.63$_{GB}$**	**0.96**	**0.71$_{FB}$**	**0.36$^{*}_{GB}$**	**0.38$^{**}_{GB}$**	**0.57$^{*}_{FB}$**	1.23	1.71	1.39	3.51*
	Unrestricted w/o AR	OPCA	2.18	2.05	1.50	**0.99**	**0.73**	2.87	3.72**	6.12**	15.43*	22.62*
		RPCA	2.18	2.05	1.50	**0.99**	**0.73**	2.87	3.72**	6.12**	15.43*	22.62*
		EM	1.26	2.42	1.65	1.32	**0.75**	2.44*	4.45**	3.84	9.43**	7.64*
		KF	1.57	1.35	**0.93**	**0.49***	**0.88**	1.79	2.93*	2.77*	6.11**	18.92
	Unrestricted w/ AR	OPCA	1.89	2.68	2.02*	1.66	1.39	3.12	4.99	5.71*	29.49	30.06**
		RPCA	1.89	2.68	2.02*	1.66	1.39	3.12	4.99	5.71*	29.49	30.06**
		EM	1.28	2.25	1.93	1.67	1.12	2.91**	4.48**	4.54**	10.23**	8.62**
		KF	1.97	1.54	1.69	**0.82**	1.10	1.44	2.56	3.24	8.48*	16.87*
	Smoothed	OPCA	2.12*	1.66	1.18	**0.78**	**0.75**	**0.77**	**0.78**	**0.75$_{FB}$**	**0.88**	**0.90**
		RPCA	2.12*	1.66	1.18	**0.78**	**0.75**	**0.77**	**0.78**	**0.75$_{FB}$**	**0.88**	**0.90**
		EM	1.85	1.83	1.22	**0.80**	**0.83**	**0.92**	**0.84**	**0.86**	1.02	1.00
		KF	1.80	1.62	1.13	**0.75**	**0.75**	**0.77**	**0.76$_{FB}$**	**0.76**	**0.87$_{FB}$**	**0.89$_{FB}$**
	Mean of 3 factors		1.00	1.08	**0.75**	**0.45***	**0.50***	**0.80**	1.05	1.23	2.31*	4.01**
	Basic w/o AR	OPCA	1.10	1.04	**0.77**	**0.58**	**0.47***	**0.63***	1.44	2.61**	2.94*	4.66**
		RPCA	1.03	1.08	**0.82**	**0.59**	**0.47***	**0.54$^{**}_{GB}$**	1.43	2.55**	2.94*	5.30**
		EM	1.10	1.21	**0.92**	**0.48***	**0.43$^{*}_{FB}$**	**0.87**	1.60	2.07	3.48**	4.93**
		KF	1.01	1.02	**0.73**	**0.46***	**0.47***	**0.73**	1.26	1.95	3.48*	5.29**
	Basic w/ AR	OPCA	**0.76$_{FB}$**	**0.87$_{FB}$**	**0.78**	**0.44***	**0.53***	**0.83**	1.25	2.02*	3.86*	4.35*
		RPCA	**0.79**	**0.90**	**0.74**	**0.48***	**0.46***	**0.73**	1.29	1.96*	3.74*	4.41*
		EM	**0.83**	1.15	1.06	**0.43***	**0.51***	**0.83**	1.31	2.58	1.97	4.68*
		KF	**0.99**	**0.90**	**0.66$_{FB}$**	**0.43$^{*}_{FB}$**	**0.47***	**0.74**	1.43	1.66	1.29	2.79*
4	Unrestricted w/o AR	OPCA	3.64	2.83	2.30	1.99	9.56	5.94	2.11	4.32*	12.33	11.90**
		RPCA	3.64	2.83	2.30	1.99	9.56	5.94	2.11	4.32*	12.33	11.90**
		EM	3.29**	2.64	2.45	2.57	4.44	2.53	2.84**	3.64	7.00	7.88**
		KF	2.40	1.14	4.59**	1.64	3.11*	3.95**	2.26	2.41	8.49	12.45**
	Unrestricted w/ AR	OPCA	5.84	3.55	3.32	1.07	1.89	4.20**	1.57	5.05	19.21	14.52**
		RPCA	5.84	3.55	3.32	1.07	1.89	4.20**	1.57	5.05	19.21	14.52**
		EM	2.27	2.43	1.85	1.36	3.13	1.49	6.39	2.95	5.99*	12.15**
		KF	4.24	2.33	3.67*	**0.55***	**0.99**	3.76	4.46	3.04*	10.51	34.47
	Smoothed	OPCA	2.01*	1.60	1.21	**0.78**	**0.85**	**0.75**	**0.90**	**0.85$_{FB}$**	**0.95$_{FB}$**	1.40
		RPCA	2.01*	1.60	1.21	**0.78**	**0.85**	**0.75**	**0.90**	**0.85$_{FB}$**	**0.95$_{FB}$**	1.40
		EM	1.84	1.82	1.22	**0.81**	**0.85**	**0.95**	**0.83**	1.03	1.19	1.39
		KF	1.86	1.64	1.20	**0.80**	**0.82**	**0.76**	**0.83$_{FB}$**	**0.87**	**0.95**	1.27$_{FB}$
	Mean of 4 factors		1.16	1.07	**0.80**	**0.46***	**0.80**	**0.87**	**0.96**	1.38	2.31	3.71**
	Basic w/o AR	OPCA	1.14	1.18	**0.71**	**0.58**	**0.85**	1.08	2.31**	4.21**	5.25*	5.97*
		RPCA	1.13	1.26	**0.75**	**0.66**	**0.86**	1.12	2.14**	4.09**	4.86*	5.86**
		EM	1.18	1.21	**0.82**	**0.63**	**0.95**	1.30	1.98	4.75*	5.82**	8.54**
		KF	**0.87$_{FB}$**	1.12	**0.64$_{GB}$**	**0.48$_{FB}$**	**0.82**	1.29	2.41	3.15*	5.21**	5.76**
	Basic w/ AR	OPCA	1.30	1.12$_{FB}$	1.01	**0.59***	**0.80**	1.47	2.29**	3.40*	5.89**	3.89**
		RPCA	1.20	1.16	**0.89**	**0.71**	**0.79**	1.36	2.20*	4.74*	6.22*	4.13**
		EM	1.05	1.20	**0.90**	**0.67**	**0.57$_{FB}$**	2.00	2.94	4.42*	7.65	8.65**
		KF	**0.89**	1.14	**0.69**	**0.50***	**0.76**	1.51	2.04	4.72**	6.02*	6.39**
5	Unrestricted w/o AR	OPCA	2.55**	3.89*	9.23	1.23	1.60	1.91	2.21	3.77	6.50	5.20**
		RPCA	2.55**	3.89*	9.23	1.23	1.60	1.91	2.21	3.77	6.50	5.20**
		EM	2.75	7.84	2.98	1.30	1.25	2.24*	3.38**	9.52**	12.61	24.89
		KF	7.28	2.11	1.96	**0.50***	**0.77**	2.44	2.82	6.20	7.77**	5.90*
	Unrestricted w/ AR	OPCA	1.91	1.71	1.74	1.40	2.64	1.48	2.70	10.46	36.48	6.55*
		RPCA	1.91	1.71	1.74	1.40	2.64	1.48	2.70	10.46	36.48	6.55*
		EM	1.20	1.42	1.33	1.16	3.68	3.84**	5.07**	13.46**	14.87	21.59
		KF	1.26	1.39	1.17	**0.59***	1.93	3.25	1.72	9.63*	9.51	4.99
	Smoothed	OPCA	2.25*	1.80*	1.36	**0.84**	**1.00**	**0.80**	1.06	1.02	1.16$_{FB}$	2.10$_{FB}$
		RPCA	2.25*	1.80*	1.36	**0.84**	**1.00**	**0.80$_{FB}$**	1.06	1.02$_{FB}$	1.16$_{FB}$	2.10$_{FB}$
		EM	1.99*	2.02	1.40	**0.83**	**0.93**	1.11	1.02	1.38	1.72	2.32*
		KF	1.94*	1.84*	1.29	**0.83**	**0.92**	**0.84**	**0.95$_{FB}$**	1.18	1.25	2.53
	Mean of 5 factors		1.07	1.14	**0.89**	**0.53***	**0.68**	**0.85**	1.21	2.25	3.99	4.13*
	Basic w/o AR	OPCA	1.12	1.03	**0.77**	**0.82**	1.36	2.30	3.59**	5.58	7.34*	6.66
		RPCA	1.17	1.04	**0.76**	**0.70**	1.37	2.30	3.13**	8.36	7.37	11.54
		EM	**0.88**	1.05	**0.94**	**0.75**	**0.92**	2.25	4.16*	8.54	14.89**	14.67**
		KF	**0.78$_{FB}$**	**0.95$_{FB}$**	**0.67$_{FB}$**	**0.58**	2.30	2.08	3.35*	8.92*	11.05	13.63
	Basic w/ AR	OPCA	1.06	1.21	**0.89**	**0.77**	1.19	2.13	3.37*	12.20	8.06*	6.90
6												

	RPCA	1.23	1.09	**0.79**	**0.72**	1.21	2.03	3.07*	7.42	8.33*	11.92
	EM	**0.92**	1.10	**0.88**	**0.78**	1.40	2.67*	4.23*	9.32*	9.30**	16.23
	KF	**0.78**	**0.95**	**0.78**	**0.60***	2.31	2.53**	2.72*	7.40	16.85**	18.13**
	OPCA	2.28**	2.44	2.61	2.99*	1.60	5.83**	2.48	7.88	12.69	9.07
Unrestricted	RPCA	2.28**	2.44	2.61	2.99*	1.60	5.83**	2.48	7.88	12.69	9.07
w/o AR	EM	2.10	1.61	1.83	1.86	8.44	5.74*	2.38	6.50*	12.49	7.49*
	KF	1.89	1.45	3.07	2.92	2.78**	3.51*	2.95*	5.65	9.31	11.61*
	OPCA	3.87	5.31	2.82	**0.74***	**0.85**	2.19	2.82	14.04	17.96	10.39
Unrestricted	RPCA	3.87	5.31	2.82	**0.74***	$\mathbf{0.85_{FB}}$	2.19	2.82	14.04	17.96	10.39
w/ AR	EM	2.17	1.71	1.70	1.15	2.79	4.86	3.53**	13.40*	15.19*	10.39*
	KF	1.53	1.70**	2.54	**0.75**	2.45	1.74	2.40*	12.01	20.57	11.68
	OPCA	2.10	1.68*	1.45	1.07	1.35*	$\mathbf{0.92_{FB}}$	1.69	1.29^{*}_{FB}	1.26_{FB}	2.92^{*}_{FB}
	RPCA	2.10	1.68*	1.45	1.07	1.35*	$\mathbf{0.92_{FB}}$	1.69	1.29^{*}_{FB}	1.26_{FB}	2.92^{*}_{FB}
Smoothed	EM	1.93	1.80	1.36	1.18	1.15	1.17	2.11	2.04*	1.76	4.12
	KF	2.01	1.78	1.33	1.21	1.26	**0.96**	2.25	1.82*	1.39	5.14*
Mean of 6 factors		1.05	1.04	**0.95**	$\mathbf{0.54^{*}_{FB}}$	1.10	1.55	1.59_{FB}	5.09	6.46	6.11
Mean of MIDAS		**0.94**	**0.99**	**0.74**	**0.45***	**0.56***	**0.71***	**0.80**	1.12	1.64	2.00
Mean of All		1.15	1.19	**0.89**	**0.61****	**0.68***	**0.80***	**0.82**	**0.94**	1.23	1.32

Panel (b): Most Recent

Factors	Recursive		Backcast prev. qtr. -1	Nowcast current quarter 1	2	3	Forecast 1 quarter ahead 4	5	6	2 quarter ahead 7	8	9
	RW		1.07	1.11	1.15	1.25**	1.29**	1.27**	1.41**	1.49**	1.49**	1.60**
	CBADL		4.40*	3.83*	2.74*	2.18**	2.04**	2.07**	2.04**	1.98**	2.17**	1.97*
	BEX		1.88	1.81*	1.21	**0.90**	**0.91**	**0.91**	**0.86**	**0.84**	**0.93**	**0.83**
	Mean of Benchmarks		3.42*	2.95*	2.17*	1.91*	1.84*	1.78	1.35**	1.27	1.40*	1.41
1	Basic w/o AR	OPCA	**0.92**	1.01	**0.73**	**0.63**	**0.75**	**0.86**	**0.94**	1.06	1.13	1.02
		RPCA	**0.92**	1.01	**0.73**	**0.63**	**0.75**	**0.86**	**0.94**	1.06	1.13	1.02
		EM	1.00	1.26	**0.83**	**0.79**	**0.94**	1.05	1.05	1.04	1.14	**0.97**
		KF	**0.88**	1.01	**0.76**	**0.71**	**0.87**	**0.98**	**1.00**	1.03	1.12	**0.97**
	Basic w/ AR	OPCA	**0.71**	**0.78**	**0.56****	**0.73**	**0.82**	**0.92**	**0.94**	1.21	1.34	1.08
		RPCA	**0.71**	**0.73**	**0.56**$_{\mathbf{FB}}^{**}$	**0.73**	**0.82**	**0.92**	**0.94**	1.21	1.34	1.08
		EM	**0.71**	**0.80**	**0.67***	**0.99**	1.05	1.25	1.15	1.37	1.60	1.20
		KF	**0.61**$_{\mathbf{FB}}$	**0.63**$_{\mathbf{GB}}$	**0.61****	**0.82**	**0.90**	1.19	1.07	1.28	1.53	1.20
	Unrestricted w/o AR	OPCA	1.04	1.04	**0.70***	**0.61****	**0.65**	**0.61***	**0.92**	**0.67**	**0.77**	**0.93**
		RPCA	1.04	1.04	**0.70***	**0.61****	**0.65**	**0.61***	**0.92**	**0.67**$_{\mathbf{GB}}$	**0.77**	**0.93**
		EM	1.13	1.18	**0.73***	**0.65***	**0.60***	**0.84**	1.03	**0.88**	1.24	1.66
		KF	**0.89**	1.02	**0.64****	**0.58****	**0.56**$_{\mathbf{FB}}^{**}$	**0.58**$_{\mathbf{FB}}^{**}$	**0.74**$_{\mathbf{FB}}$	**0.71****	**0.69**$_{\mathbf{GB}}^{*}$	**0.80**$_{\mathbf{GB}}$
	Unrestricted w/ AR	OPCA	**0.90**	1.04	**0.65****	**0.62****	**0.66**	**0.82**	**0.85**	1.01	1.38	1.40
		RPCA	**0.90**	1.04	**0.65****	**0.62****	**0.66**	**0.82**	**0.85**	1.01	1.38	1.40
		EM	**0.94**	1.07	**0.68****	**0.69***	1.02	1.48	1.02	1.21	1.47	1.29
		KF	**0.70**	**0.95**	**0.63****	**0.61****	**0.69***	**0.81**	**0.78***	1.13	1.32	1.19
	Smoothed	OPCA	1.08	1.00	**0.74**	**0.62***	**0.70**	**0.82**	**0.82**	**0.90**	1.04	**0.96**
		RPCA	1.08	1.00	**0.74**	**0.62***	**0.70**	**0.82**	**0.82**	**0.90**	1.04	**0.96**
		EM	**0.83**	1.05	**0.79**	**0.61***	**0.76**	**0.91**	**0.84**	**0.91**	1.06	**0.92**
		KF	**0.79**	**0.92**	**0.75**	**0.59***	**0.73**	**0.85**	**0.82**	**0.90**	1.04	**0.92**
	Mean with 1 factor		**0.63**	**0.80**	**0.58****	**0.58**$_{\mathbf{FB}}^{**}$	**0.67***	**0.75**	**0.78***	**0.86**	**0.93**	**0.86**
2	Basic w/o AR	OPCA	**0.95**	**0.93**	**0.57****	**0.47****	**0.52****	**0.66**	**0.80**	**0.96**	1.16	1.09
		RPCA	**0.95**	**0.94**	**0.57****	**0.47****	**0.52****	**0.66**	**0.81**	**0.96**	1.16	1.09
		EM	**0.99**	**0.98**	**0.57****	**0.53***	**0.59**	**0.80**	1.04	**0.98**	1.22	1.32
		KF	**0.87**	**0.88**	**0.57****	**0.50****	**0.56***	**0.72**	**0.89**	**0.94**	1.10	1.26
	Basic w/ AR	OPCA	**0.78**	**0.71**	**0.59****	**0.45****	**0.53****	**0.79**	**0.77**	**0.87**	1.06	1.25
		RPCA	**0.79**	**0.70**	**0.58****	**0.44****	**0.53****	**0.78**	**0.77**	**0.87**	1.06	1.25
		EM	**0.75**	**0.71**	**0.57****	**0.66**	**0.60**	1.01	1.06	**0.97**	1.35	1.55
		KF	**0.66**$_{\mathbf{FB}}$	**0.66**$_{\mathbf{FB}}$	**0.47****	**0.43****	**0.55****	**0.89**	**0.79**	**0.88**	1.17	1.85
	Unrestricted w/o AR	OPCA	1.04	1.08	**0.59****	**0.53****	**0.48****	**0.56**$_{\mathbf{FB}}^{**}$	**0.89**	**0.79**	2.35	1.36
		RPCA	1.04	1.08	**0.59****	**0.53****	**0.48****	**0.56****	**0.89**	**0.79**	2.35	1.36
		EM	**0.94**	1.14	**0.63****	**0.48****	**0.69**	1.20	1.36	1.46	2.14	2.37*
		KF	**0.94**	**0.94**	**0.57****	**0.58****	**0.51****	**0.88**	**0.92**	**0.85**	1.98	1.78
	Unrestricted w/ AR	OPCA	**0.91**	**0.75***	**0.64***	**0.53****	**0.85**	1.26	1.19	1.66	4.50	1.95
		RPCA	**0.91**	**0.75***	**0.64***	**0.53****	**0.85**	1.26	1.19	1.66	4.50	1.95
		EM	**0.91**	**0.93**	**0.71**	**0.58****	**0.84**	1.43	1.65*	1.68	2.93*	2.58**
		KF	**0.77**	**0.94**	**0.52****	**0.59**	1.04	1.36	1.67*	1.43	3.68*	3.88
	Smoothed	OPCA	1.62	1.12	**0.70****	**0.55****	**0.55****	**0.61****	**0.66**$_{\mathbf{GB}}^{**}$	**0.71**	**0.91**$_{\mathbf{FB}}$	**0.99**$_{\mathbf{FB}}$
		RPCA	1.62	1.12	**0.70****	**0.55****	**0.55****	**0.61****	**0.66**$_{\mathbf{GB}}^{**}$	**0.71**	**0.91**$_{\mathbf{FB}}$	**0.99**$_{\mathbf{FB}}$
		EM	1.31	1.10	**0.68***	**0.50****	**0.60****	**0.67****	**0.75***	**0.76***	**1.00**	1.11
		KF	1.21	**0.96**	**0.62****	**0.48****	**0.55****	**0.62****	**0.68****	**0.73**	**0.93**	1.01
	Mean of 2 factors		**0.67**	**0.71**	**0.47**$_{\mathbf{FB}}^{**}$	**0.40**$_{\mathbf{FB}}^{**}$	**0.43**$_{\mathbf{FB}}^{**}$	**0.61****	**0.68****	**0.70**$_{\mathbf{FB}}^{*}$	1.11	1.02
3	Basic w/o AR	OPCA	**0.93**	**0.90**	**0.52****	**0.43****	**0.44**	**0.62**	1.41	1.22	3.02	4.40*
		RPCA	**0.91**	**0.89**	**0.52****	**0.43****	**0.45**	**0.62**	1.41	1.30	3.02	4.41*
		EM	**0.99**	1.00	**0.52****	**0.43****	**0.68**	**0.78**	1.24	3.74**	3.65**	6.14**
		KF	**0.71**	**0.77**	**0.45**$_{\mathbf{GB}}^{**}$	**0.34****	**0.70**	**0.59**	1.11	2.50*	3.03*	5.22**
	Basic w/ AR	OPCA	**0.66**	**0.77***	**0.67**	**0.31****	**0.32****	**0.58**	1.25	**0.78**	2.24	3.11**
		RPCA	**0.67**	**0.75***	**0.68**	**0.33****	**0.32****	**0.58**	1.23	**0.79**	2.28	3.22**
		EM	**0.69**	**0.95**	**0.77***	**0.41****	**0.35****	**0.81**	1.69	3.84**	2.35	5.28**

		KF	**0.58$_{\mathbf{GB}}$**	**0.84**	**0.46****	**0.29**$^{**}_{\mathbf{GB}}$	**0.31**$^{**}_{\mathbf{GB}}$	**0.45**$^{**}_{\mathbf{FB}}$	1.46	2.23*	1.84	4.90**
	Unrestricted w/o AR	OPCA	1.67	1.60	1.28	1.12	**0.72**	3.33	4.75**	8.25**	21.83*	32.30*
		RPCA	1.67	1.60	1.28	1.12	**0.72**	3.33	4.75**	8.25**	21.83*	32.30*
		EM	1.08	2.11	1.32	1.56	**0.72**	2.92**	5.42**	5.07	13.39**	10.58*
		KF	1.06	1.04	**0.54****	**0.41****	**0.97**	2.12**	3.80*	3.51*	8.65**	26.71
	Unrestricted w/ AR	OPCA	1.57	2.05	1.79	1.88*	1.49	3.53	6.43	7.77*	41.79*	42.56**
		RPCA	1.57	2.05	1.79	1.88*	1.49	3.53	6.43	7.77*	41.79*	42.56**
		EM	1.08	2.06	1.73	2.08*	1.25	3.43**	5.52**	6.10**	14.45**	12.01**
		KF	1.58	1.32	1.34	**0.91**	1.20	1.71	3.25	4.10	11.66*	23.72*
	Smoothed	OPCA	1.55	1.10	**0.78**	**0.66**	**0.66**	**0.66**	**0.79**	**0.74$_{\mathbf{FB}}$**	**0.97$_{\mathbf{FB}}$**	1.01$_{\mathrm{FB}}$
		RPCA	1.55	1.10	**0.78**	**0.66**	**0.66**	**0.66**	**0.79**	**0.74$_{\mathbf{FB}}$**	**0.97$_{\mathbf{FB}}$**	1.01$_{\mathrm{FB}}$
		EM	1.22	1.20	**0.75**	**0.66**	**0.75**	**0.81**	**0.86**	**0.95**	1.18	1.21
		KF	1.14	1.03	**0.67**	**0.61**	**0.65**	**0.65**	**0.78$_{\mathbf{FB}}$**	**0.80**	**0.97**	1.04
	Mean of 3 factors		**0.65**	**0.74$_{\mathbf{FB}}$**	**0.48****	**0.38****	**0.40****	**0.74**	1.17	1.53	3.22*	5.60**
	Basic w/o AR	OPCA	**0.80**	**0.82**	**0.49****	**0.57**	**0.45****	**0.56****	1.67*	3.26**	4.06*	6.54**
		RPCA	**0.75**	**0.86**	**0.53***	**0.59**	**0.45****	**0.44**$^{**}_{\mathbf{GB}}$	1.66*	3.21**	4.06*	7.49**
		EM	**0.87**	1.09	**0.61****	**0.49****	**0.34**$^{**}_{\mathbf{FB}}$	**0.72**	2.08**	2.61	4.87*	7.03**
		KF	**0.71**	**0.87**	**0.52****	**0.41****	**0.44***	**0.71**	1.39	2.51	4.83*	7.46**
	Basic w/ AR	OPCA	**0.63$_{\mathbf{FB}}$**	**0.83**	**0.47****	**0.39****	**0.54***	**0.89**	1.53	2.63*	5.59*	6.17*
		RPCA	**0.69**	**0.85**	**0.46**$^{**}_{\mathbf{FB}}$	**0.45****	**0.43****	**0.72**	1.59	2.60*	5.41*	6.22*
		EM	**0.79**	**0.93**	**0.66****	**0.39****	**0.47****	**0.73**	1.59	3.44*	2.61	6.77
		KF	**0.91**	**0.74$_{\mathbf{FB}}$**	**0.47****	**0.37**$^{**}_{\mathbf{FB}}$	**0.45****	**0.64**	1.64	2.13	1.49	3.87**
4	Unrestricted w/o AR	OPCA	3.09*	2.89*	2.03	2.40**	11.77	7.15	2.73	5.71**	16.77	16.91**
		RPCA	3.09*	2.89*	2.03	2.40**	11.77	7.15	2.73	5.71**	16.77	16.91**
		EM	3.01**	2.75*	2.39	3.09	5.23*	2.72	3.57**	4.61	9.44	11.05**
		KF	2.06	1.03	3.95**	1.91	3.87*	4.79**	2.91	3.03*	11.82	17.63**
	Unrestricted w/ AR	OPCA	5.61	3.34*	2.99	1.16	2.31*	4.86**	1.83	6.80	26.54	20.78**
		RPCA	5.61	3.34*	2.99	1.16	2.31*	4.86**	1.83	6.80	26.54	20.78**
		EM	2.21	2.25	1.81	1.51	3.93	1.49	8.08	3.63	7.96**	17.35**
		KF	3.90	2.25	3.07**	**0.49****	1.14	4.35	5.89	3.85*	14.53	48.74*
	Smoothed	OPCA	1.49	1.12	**0.81**	**0.70**	**0.82**	**0.65**	**0.97**	**0.90**	1.07$_{\mathrm{FB}}$	1.72
		RPCA	1.49	1.12	**0.81**	**0.70**	**0.82**	**0.65**	**0.97**	**0.90$_{\mathbf{FB}}$**	1.07$_{\mathrm{FB}}$	1.72
		EM	1.29	1.28	**0.76**	**0.67**	**0.80**	**0.85**	**0.85$_{\mathbf{FB}}$**	1.17	1.39	1.77
		KF	1.25	1.11	**0.75**	**0.69**	**0.77**	**0.65**	**0.87**	**0.96**	1.08	1.56$_{\mathrm{FB}}$
	Mean of 4 factors		**0.80**	**0.89**	**0.51****	**0.38****	**0.77**	**0.78***	1.08	1.69	3.02*	5.25*
	Basic w/o AR	OPCA	**0.96**	**0.98**	**0.53**$^{**}_{\mathbf{FB}}$	**0.63**	1.00	1.32	2.90**	5.39**	7.16*	8.22*
		RPCA	**0.96**	1.04	**0.58****	**0.74**	1.06	1.41	2.68**	5.22**	6.60*	8.21**
		EM	1.26	1.16	**0.71****	**0.74**	1.32	1.54	2.60*	6.40*	8.08**	12.13**
		KF	**0.96**	1.09	**0.54****	**0.52**	1.00	1.58	3.15**	4.23*	7.21**	8.22**
	Basic w/ AR	OPCA	1.09	**0.92**	**0.71**	**0.60**	**0.97**	1.78*	2.98**	4.53**	8.32**	5.25**
		RPCA	**0.99**	**0.95**	**0.59****	**0.80**	**0.92**	1.64*	2.87**	6.15**	8.83*	5.59**
		EM	1.25	1.26	**0.75***	**0.70**	**0.73$_{\mathbf{FB}}$**	2.42*	3.90	6.00**	10.68	12.29**
		KF	1.05	1.14	**0.54****	**0.51**	**0.94**	1.81	2.69**	6.41**	8.38*	9.16*
5	Unrestricted w/o AR	OPCA	2.22**	3.59*	8.08	1.37	1.96	2.40	2.76	4.94	8.79	7.04**
		RPCA	2.22**	3.59*	8.08	1.37	1.96	2.40	2.76	4.94	8.79	7.04**
		EM	2.68	7.01	2.74	1.45	1.52	2.56**	4.33**	12.69**	17.92	35.37
		KF	7.10	1.70	1.66	**0.45**$^{**}_{\mathbf{FB}}$	**0.89**	3.04	3.61	7.99*	10.73**	8.36*
	Unrestricted w/ AR	OPCA	1.45	1.17	1.34	1.58	3.19	1.72	3.41	14.01	51.21	8.91*
		RPCA	1.45	1.17	1.34	1.58	3.19	1.72	3.41	14.01	51.21	8.91*
		EM	1.31	1.51	1.27	1.29	4.55	4.62**	6.63**	18.09**	20.95	30.76
		KF	**0.81**	1.19	**0.87**	**0.49****	2.44	3.84	2.05	12.68*	12.98	7.01
	Smoothed	OPCA	1.58	1.17	**0.96**	**0.77**	1.04	**0.75$_{\mathbf{FB}}$**	1.21	1.18$_{\mathrm{FB}}$	1.38$_{\mathrm{FB}}$	2.78$_{\mathrm{FB}}$
		RPCA	1.58	1.17	**0.96**	**0.77**	1.04	**0.75$_{\mathbf{FB}}$**	1.21	1.18$_{\mathrm{FB}}$	1.38$_{\mathrm{FB}}$	2.78$_{\mathrm{FB}}$
		EM	1.46	1.51	1.01	**0.79**	**0.98**	1.16	1.22	1.74	2.21	3.18**
		KF	1.35	1.32	**0.92**	**0.78**	**0.95**	**0.84**	1.11$_{\mathrm{FB}}$	1.44	1.55	3.49
	Mean of 5 factors		**0.80$_{\mathbf{FB}}$**	**0.85$_{\mathbf{FB}}$**	**0.58****	**0.49****	**0.76**	**0.94**	1.47	2.87	5.49	5.75**
	Basic w/o AR	OPCA	**0.89**	**0.97**	**0.71**	1.06	1.77	3.05	4.85**	7.67	10.30*	9.27
		RPCA	**0.98**	**0.91**	**0.67**	**0.86**	1.80	3.00	4.20**	11.54	10.31	16.40
		EM	1.02	1.07	**0.87***	**0.93**	1.19	2.86*	5.82*	11.75	21.13**	20.92**
		KF	**0.83$_{\mathbf{FB}}$**	**0.96**	**0.61****	**0.66**	3.17	2.67	4.63*	12.18*	15.73	19.44
	Basic w/ AR	OPCA	**0.87**	**0.97**	**0.68***	**0.86**	1.58	2.79	4.57**	16.88	11.43*	9.58
6												

	RPCA	**0.97**	**0.98**	**0.58$^{**}_{\mathbf{FB}}$**	**0.78**	1.60	2.66	4.12*	10.12	11.76*	17.07
	EM	1.12	1.21	**0.88**	**1.00**	1.97	3.35*	5.76**	12.72*	13.16**	22.86
	KF	**0.86**	**0.94**	**0.63****	**0.67**	3.08	3.17*	3.68*	10.09	23.93*	25.87**
	OPCA	2.23*	1.96	2.28	3.99*	2.01*	7.14**	3.36	10.95	18.15	12.90
Unrestricted	RPCA	2.23*	1.96	2.28	3.99*	2.01*	7.14**	3.36	10.95	18.15	12.90
w/o AR	EM	2.39	1.80	1.55	2.51	11.03	7.34*	2.83	8.83*	17.76	10.61*
	KF	1.90	1.42	2.70	3.39	3.75**	4.54**	4.03*	7.75	13.24	16.63*
	OPCA	3.50*	4.03	2.36	**0.71***	1.10	2.66	3.75	19.39	25.66	14.75
Unrestricted	RPCA	3.50*	4.03	2.36	**0.71***	1.10$_{\mathrm{FB}}$	2.66	3.75	19.39	25.66	14.75
w/ AR	EM	2.45	1.63	1.48	1.27	3.70	6.44	4.23**	18.23*	21.46*	14.84*
	KF	1.65	1.42	1.99	**0.76**	3.19	2.14	3.06*	16.51	29.45	16.39
	OPCA	1.38	1.01	1.01	1.02	1.38*	**0.85$_{\mathbf{FB}}$**	1.92$_{\mathrm{FB}}$	1.50$^{**}_{\mathrm{FB}}$	1.48$_{\mathrm{FB}}$	3.91$^{*}_{\mathrm{FB}}$
	RPCA	1.38	1.01	1.01	1.02	1.38*	**0.85$_{\mathbf{FB}}$**	1.92	1.50**	1.48$_{\mathrm{FB}}$	3.91*
Smoothed	EM	1.29	1.23	**0.96**	1.18	1.19	1.25	2.53	2.63*	2.30	5.76
	KF	1.33	1.16	**0.91**	1.20	1.29	**0.94**	2.73	2.29	1.74*	7.24*
Mean of 6 factors		**0.86**	**0.73$^{**}_{\mathbf{FB}}$**	**0.70**	**0.56$^{**}_{\mathbf{FB}}$**	1.39	1.91	2.06	7.00	9.21	8.67
Mean of MIDAS		**0.62**	**0.69**	**0.45****	**0.36****	**0.52****	**0.65****	**0.84**	1.34	2.15	2.71*
Mean of All		**0.75***	**0.80***	**0.57****	**0.52****	**0.63****	**0.74****	**0.85**	1.04	1.49	1.68

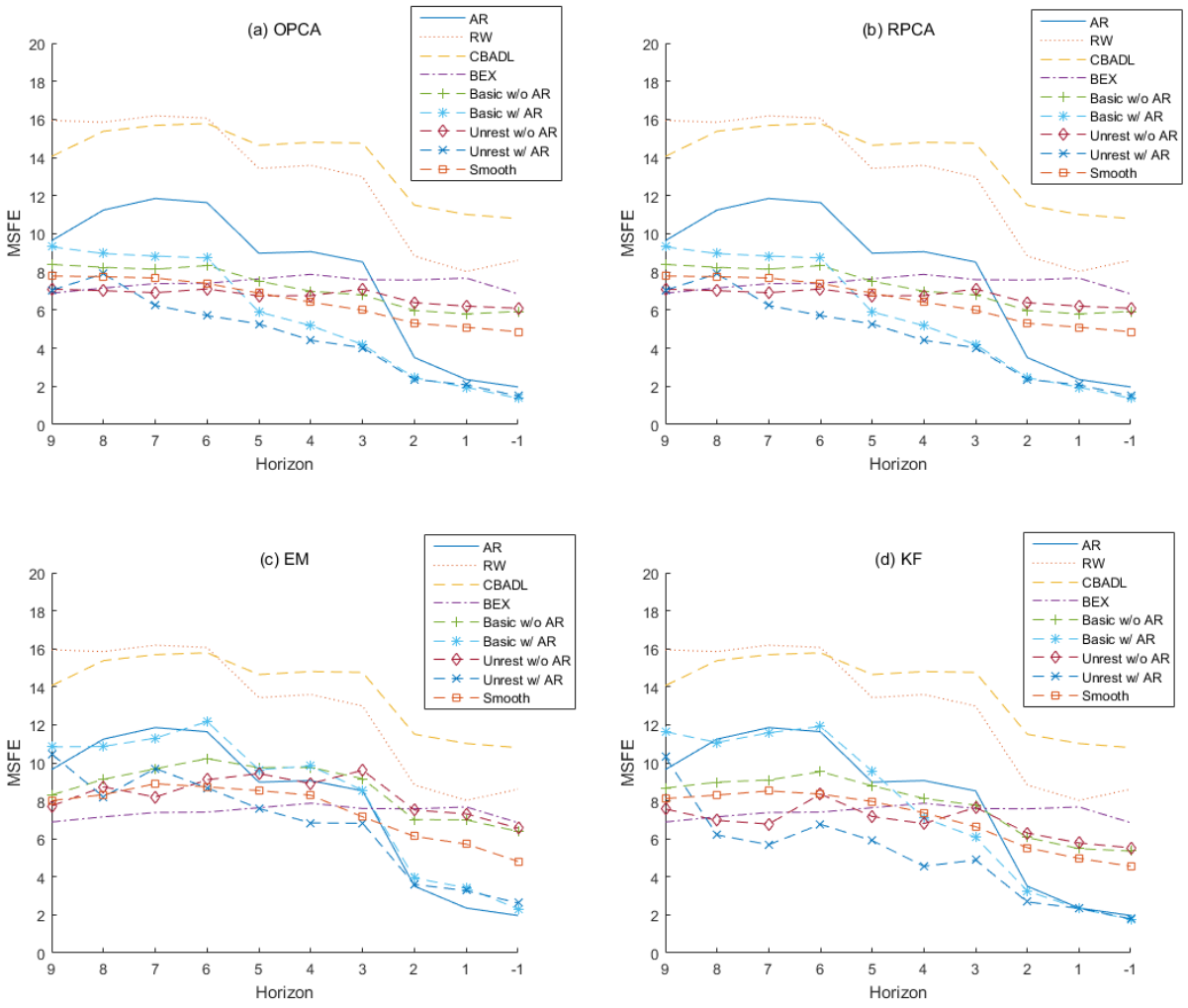
* Notes: See notes to Tables 1-4.

Table A 3: Summary of MSFE-Best Models Across All Modelling Permutations in Rolling Estimation*

		Backcast	Nowcast			Forecast					
		prev. qtr.	current quarter			1 quarter ahead			2 quarter ahead		
	Fac. No.	-1	1	2	3	4	5	6	7	8	9
First Available	1	Basic w/ AR KF	**Basic w/ AR KF**	Unrestricted w/ AR RPCA	Unrestricted w/ AR OPCA	Unrestricted w/o AR KF	Unrestricted w/o AR KF	Unrestricted w/ AR KF	**Unrestricted w/o AR OPCA**	**Unrestricted w/o AR KF**	**Unrestricted w/o AR KF**
	2	Basic w/ AR KF	Basic w/ AR RPCA	Basic w/ AR KF	Basic w/ AR RPCA	Mean -	Basic w/ AR OPCA	**Smoothed Both PCAs**	Mean	Smoothed Both PCAs	Smoothed Both PCAs
	3	**Basic w/ AR KF**	Basic w/ AR RPCA	Basic w/ AR KF	**Basic w/ AR KF**	**Basic w/ AR KF**	Basic w/ AR KF	Smoothed KF	Smoothed Both PCAs	Smoothed KF	Smoothed KF
	4	Basic w/ AR OPCA	Basic w/ AR OPCA	Basic w/ AR KF	Basic w/ AR KF	Basic w/o AR EM	**Basic w/o AR RPCA**	Smoothed KF	Smoothed Both PCAs	Smoothed Both PCAs	AR -
	5	Basic w/o AR KF	AR -	**Basic w/o AR KF**	Basic w/o AR KF	Basic w/ AR EM	Smoothed RPCA	Smoothed KF	AR -	AR -	AR -
	6	Basic w/o AR KF	Basic w/o AR KF	Basic w/o AR KF	Mean -	Unrestricted w/ AR RPCA	Smoothed Both PCAs	AR -	AR -	AR -	AR -
Most Recent	1	Basic w/ AR KF	**Basic w/ AR KF**	Basic w/ AR RPCA	Mean -	Unrestricted w/o AR KF	Unrestricted w/o AR KF	Unrestricted w/o AR KF	**Unrestricted w/o AR RPCA**	**Unrestricted w/o AR KF**	**Unrestricted w/o AR KF**
	2	Basic w/ AR KF	Basic w/ AR KF	Mean -	Mean -	Mean -	Unrestricted w/o AR OPCA	**Smoothed Both PCAs**	Mean -	Smoothed Both PCAs	Smoothed Both PCAs
	3	**Basic w/ AR KF**	Mean -	**Basic w/o AR KF**	**Basic w/ AR KF**	**Basic w/ AR KF**	Basic w/ AR KF	Smoothed KF	Smoothed Both PCAs	Smoothed Both PCAs	AR -
	4	Basic w/ AR OPCA	Basic w/ AR KF	Basic w/ AR RPCA	Basic w/ AR KF	Basic w/o AR EM	**Basic w/o AR KF**	Smoothed EM	Smoothed RPCA	AR -	AR -
	5	Mean -	Mean -	Basic w/o AR OPCA	Unrestricted w/o AR KF	Basic w/ AR EM	Smoothed Both PCAs	AR -	AR -	AR -	AR -
	6	Basic w/o AR KF	Mean -	Basic w/ AR RPCA	Mean -	AR -	Smoothed Both PCAs	AR -	AR -	AR -	AR -

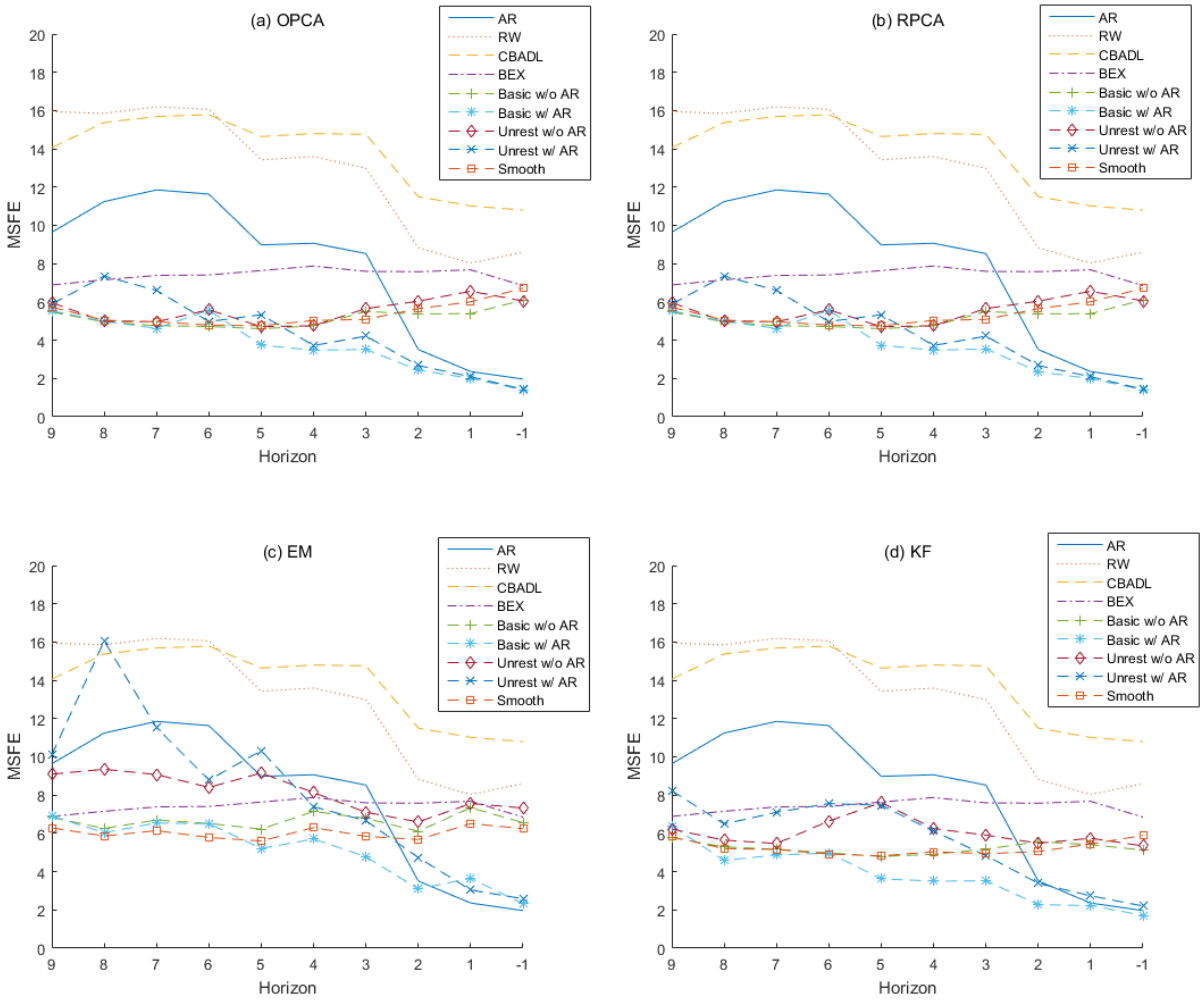
* Notes: See notes to Table 5. Entries indicate the model and estimation methods for all 'MSFE-best' specifications, by historical data type, number of factors used, and horizon. Entries in the row labeled 'All' are the 'MSFE-best' models across all factor specifications, for a given historical data type. All model estimation is done recursively and AR interpolation is used for missing value construction. For example, for the 'Backcast' horizon, the 'Basic factor-MIDAS' model with AR terms and with factors estimated using OPCA is the 'globally best' performer when experiments are conducted using 'first available' real-time historical data. When MSFEs based on the use of OPCA and RPCA are the same up to three decimal places, the PCA method is denoted by 'both PCA'. Bold entries are the best performer among models with different number of factors in each vintage.

Figure A 1: MSFEs of Forecasting Models Constructed Using One Factor ($r = 1$)*



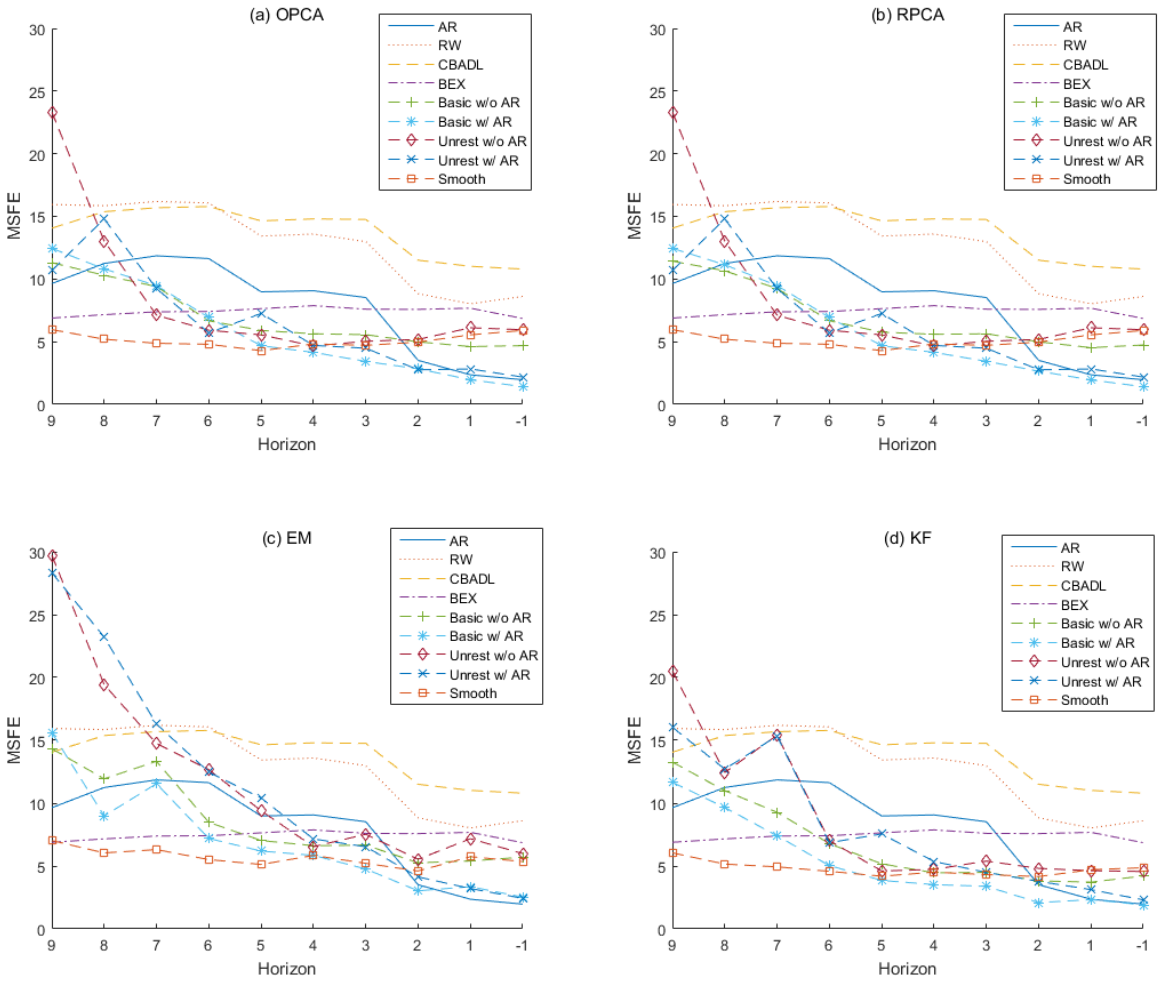
* Notes: See notes to Figure 5 in main paper. Each panel plots the MSFEs of various models for a different estimation method. Benchmark models, including AR, CBADL and BEX, are redundantly included in all panels of this figure, for comparability. 'Basic w/o AR' and 'Basic w/ AR' are the basic factor-MIDAS models with and without AR terms. 'Unrest' and 'Smooth' denote alternative factor-MIDAS specifications (see Section 4). OPCA and RPCA are implemented with AR interpolation, and all forecasts are based on recursively estimated models. See Section 5 for complete details.

Figure A 2: MSFEs of Forecasting Models Constructed Using Two Factors ($r = 2$)*



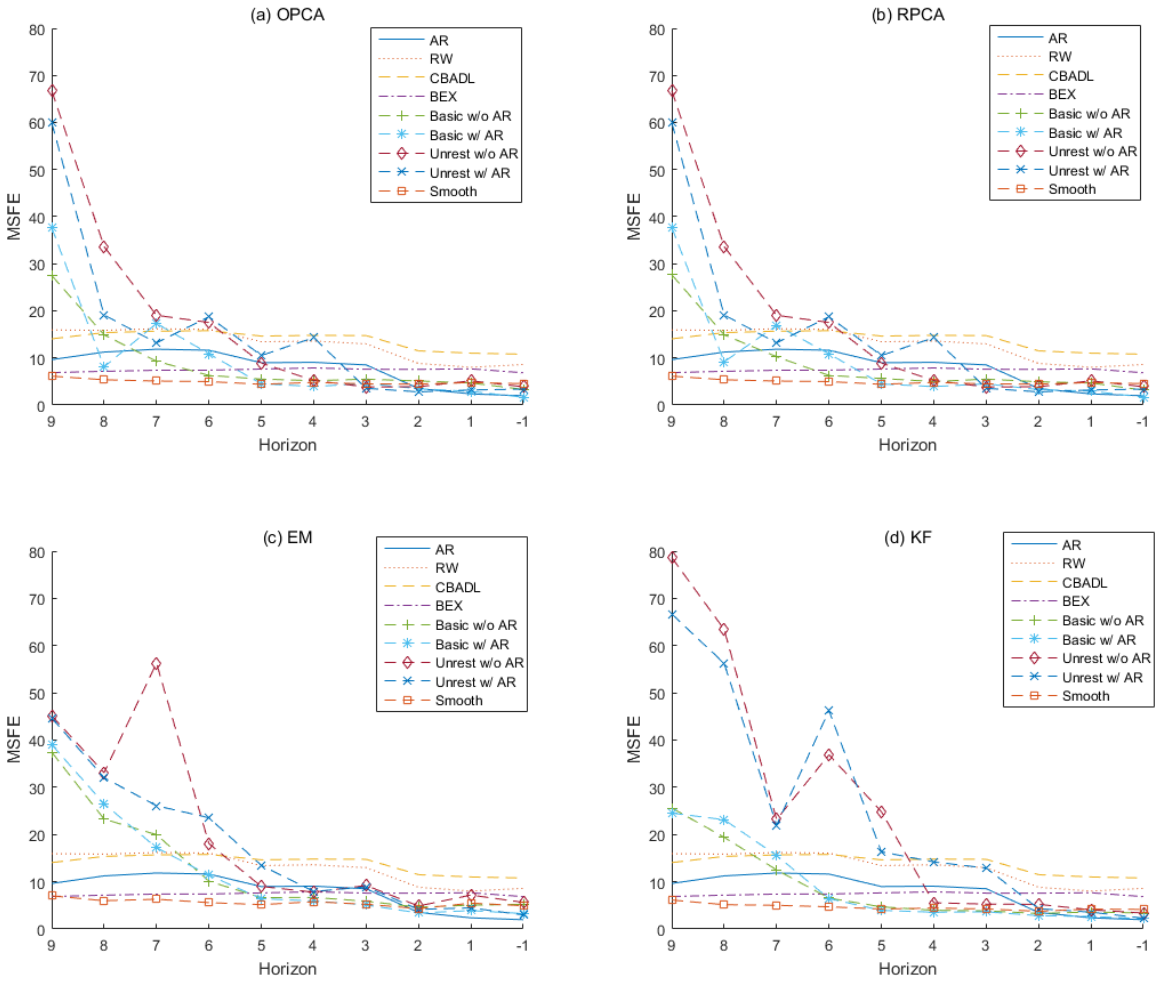
* Notes: See notes to Figure A1.

Figure A 3: MSFEs of Forecasting Models Constructed Using Three Factors ($r = 3$)*



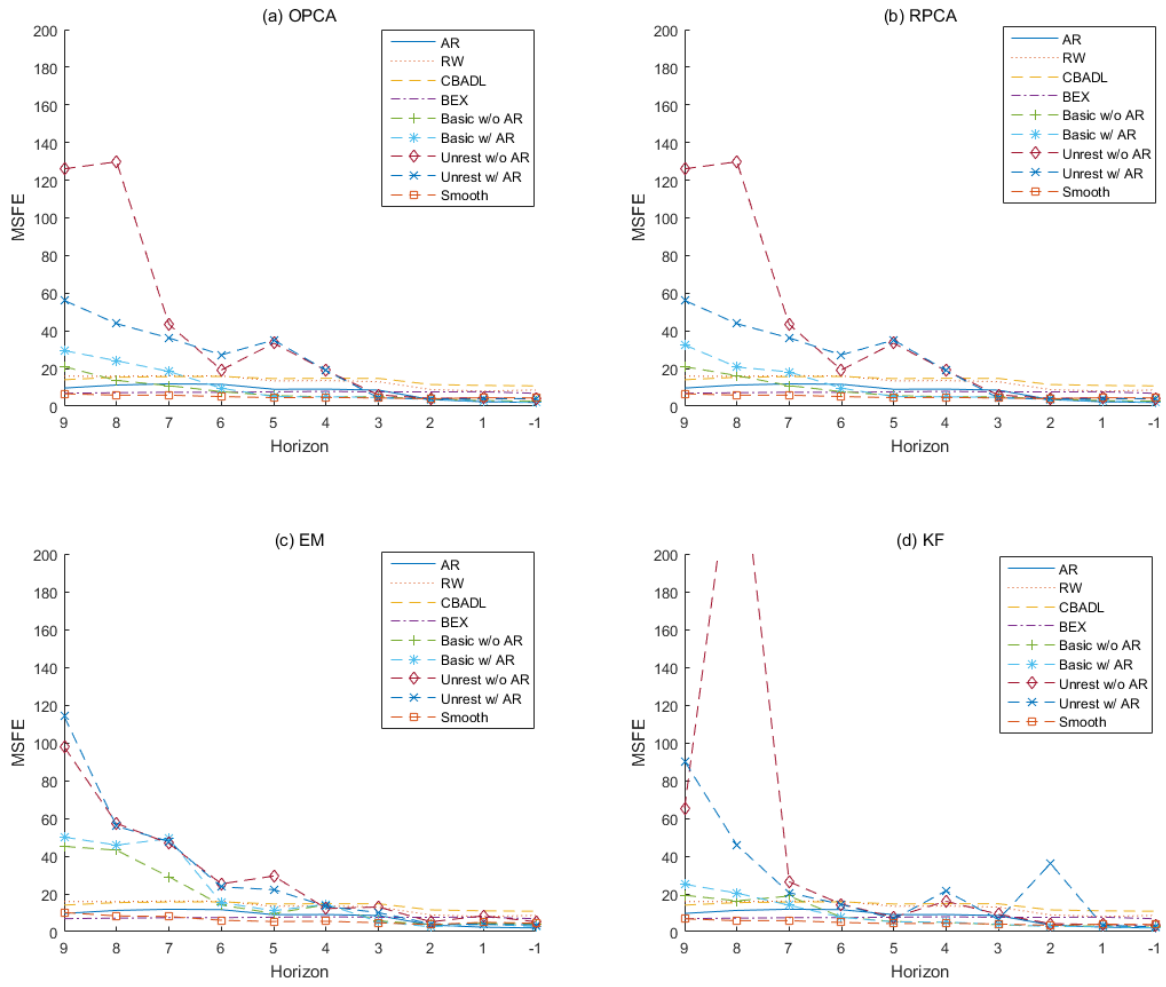
* Notes: See notes to Figure A1.

Figure A 4: MSFEs of Forecasting Models Constructed Using Four Factors ($r = 4$)*



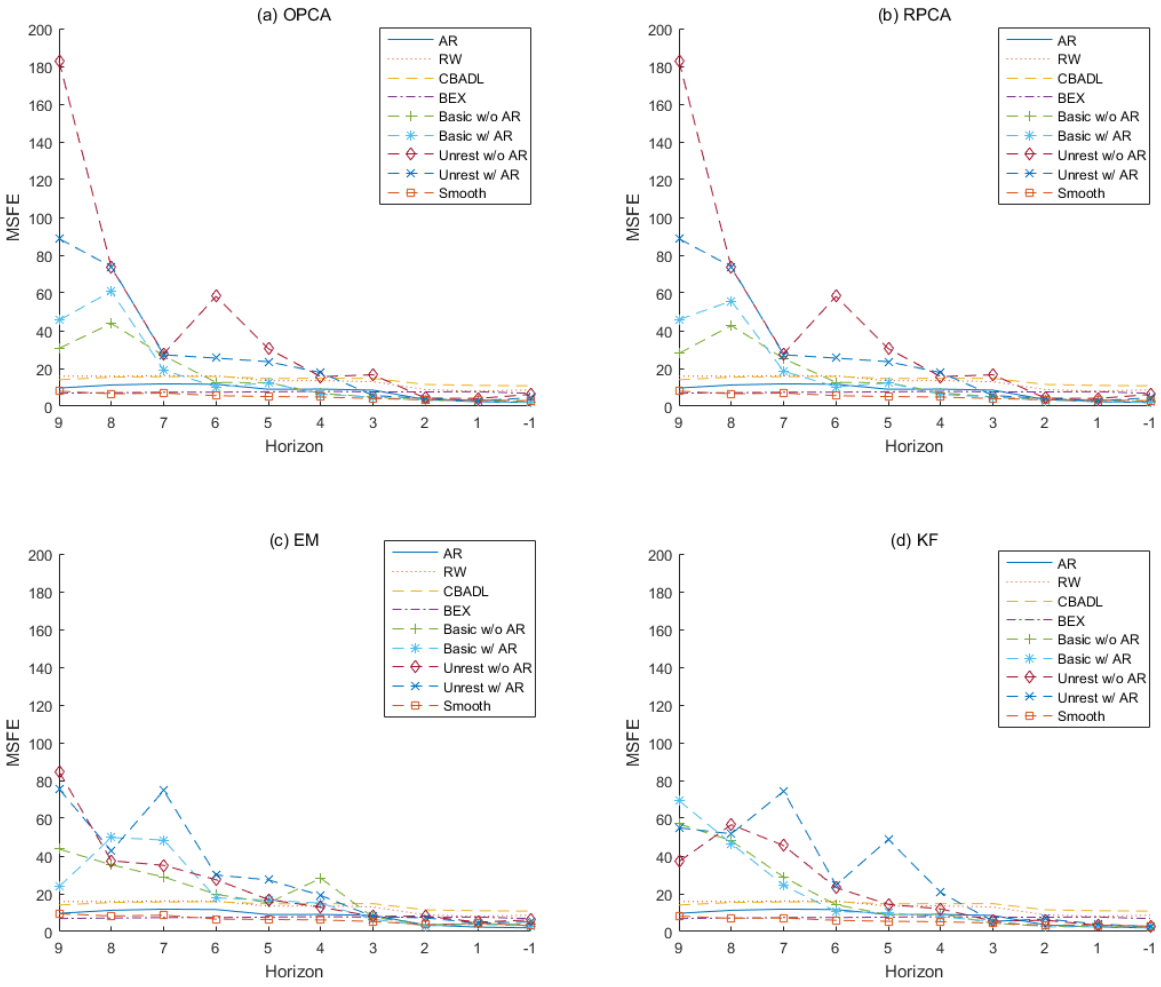
* Notes: See notes to Figure A1.

Figure A 5: MSFEs of Forecasting Models Constructed Using Five Factors ($r = 5$)*



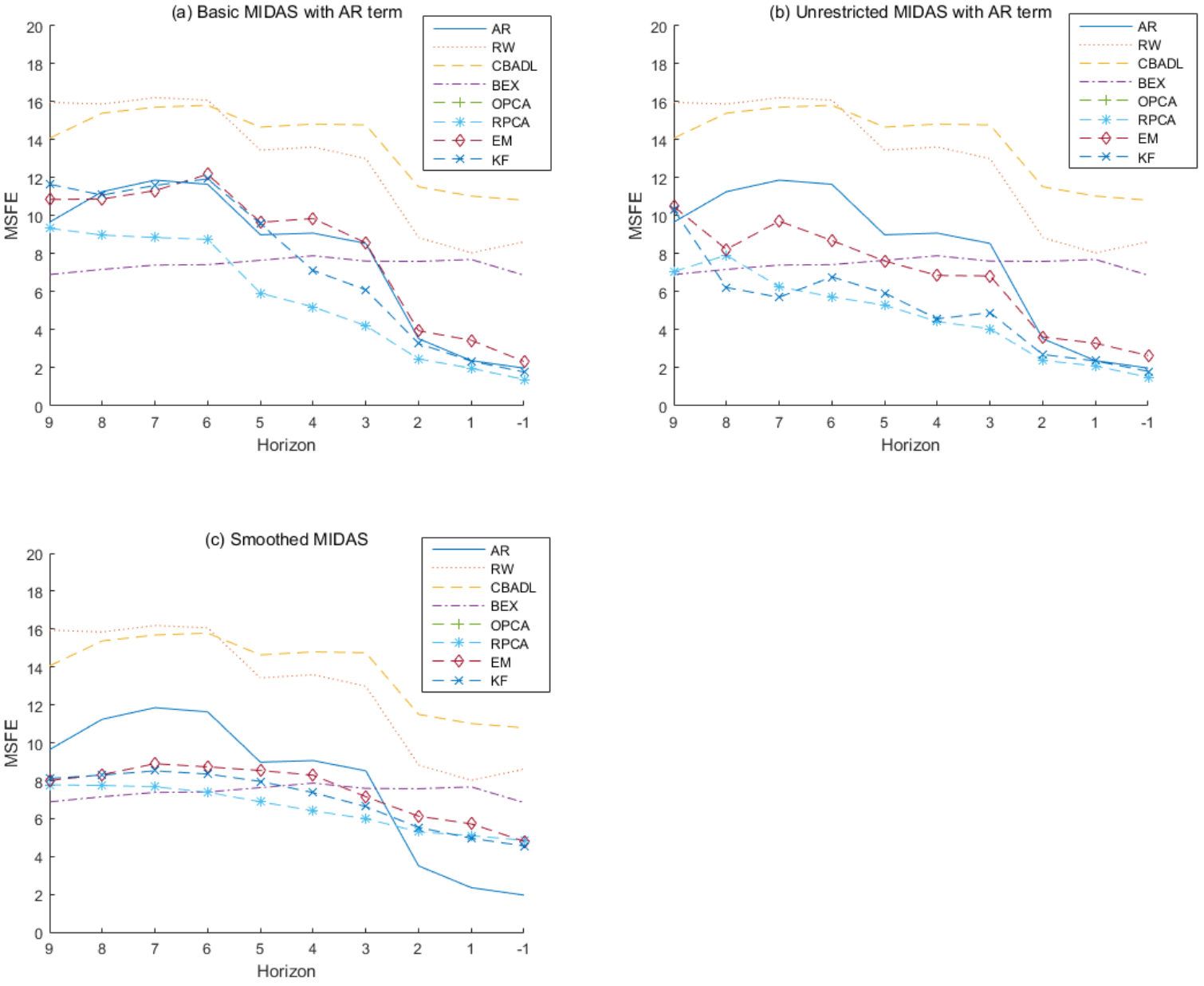
* Notes: See notes to Figure A1.

Figure A 6: MSFEs of Forecasting Models Constructed Using Six Factors ($r = 6$)*



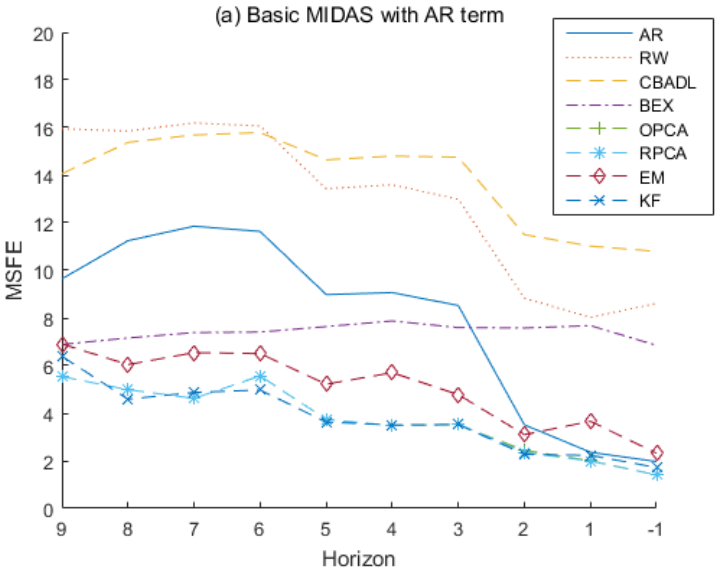
* Notes: See notes to Figure A1.

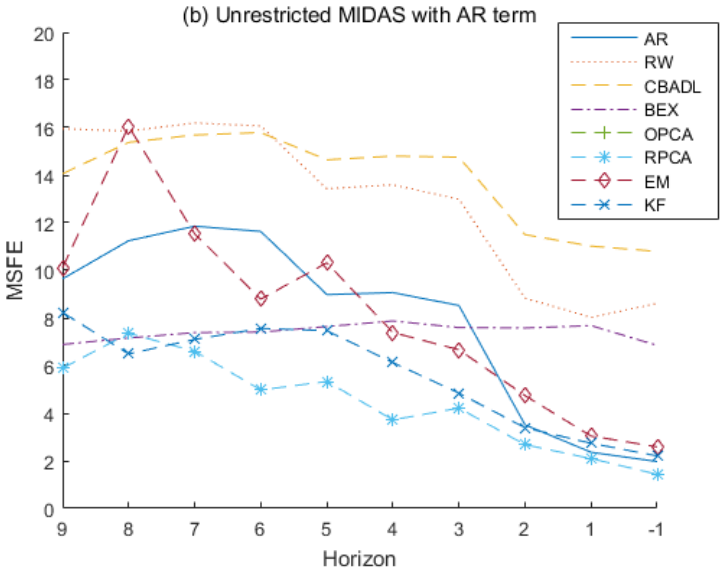
Figure A 7: MSFEs of Factor-MIDAS Models with One Factor ($r = 1$)*

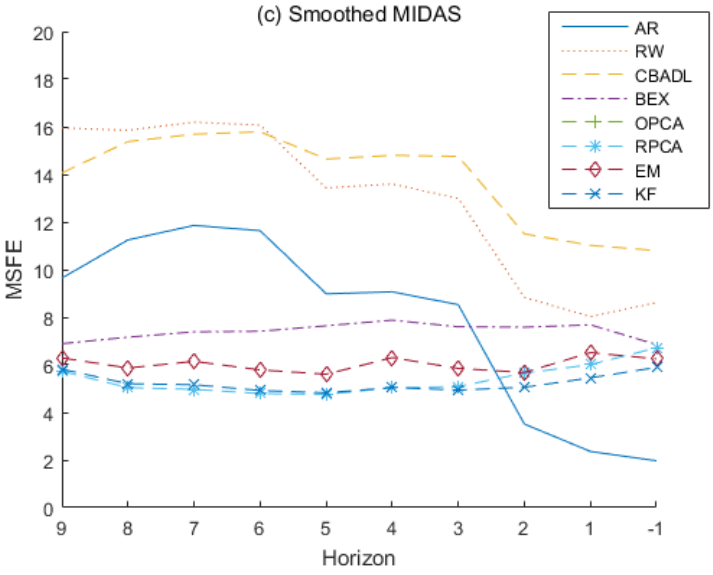


* Notes: See the Notes to Figure A1.

Figure A 8: MSFEs of Factor-MIDAS Models with with Two Factors ($r = 2$)*

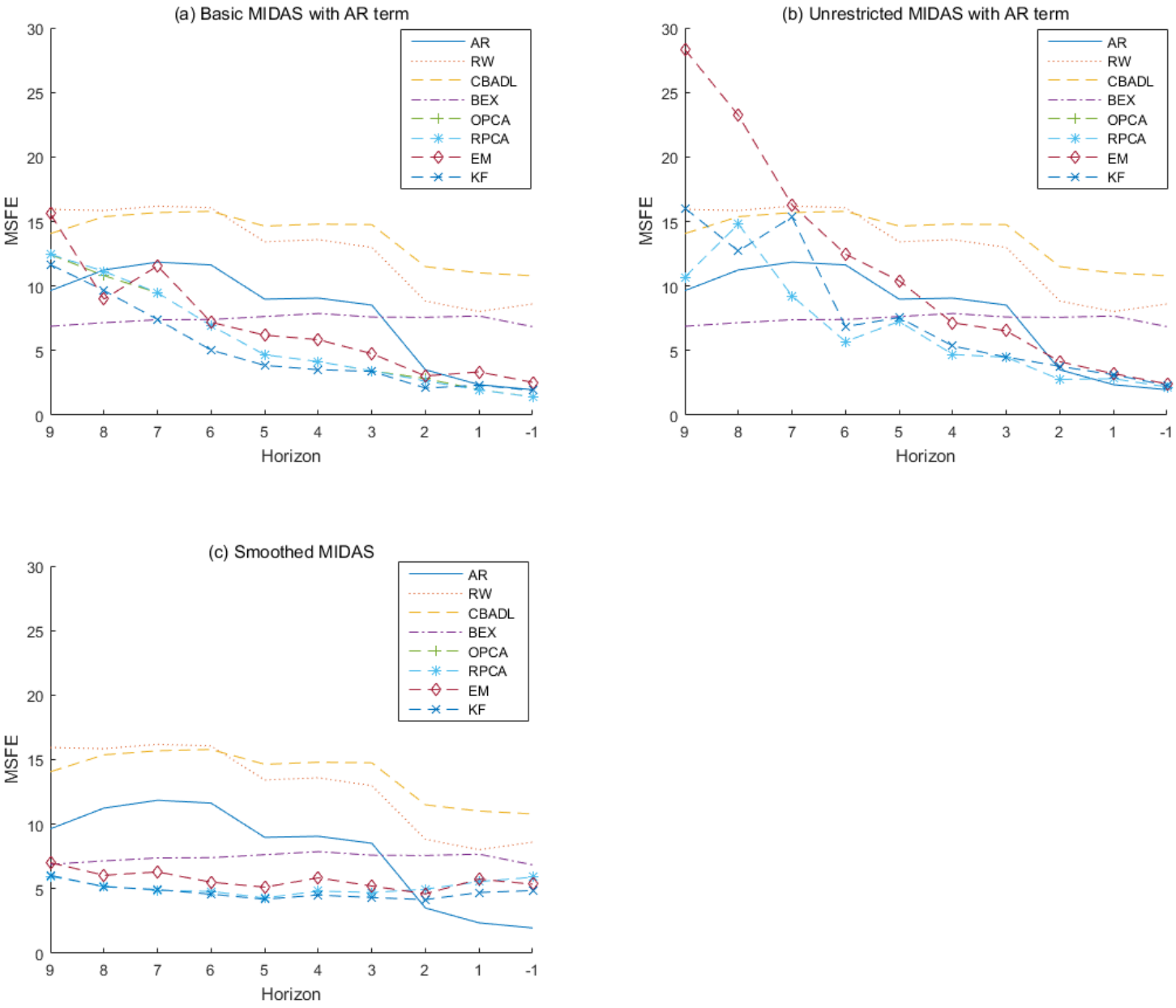






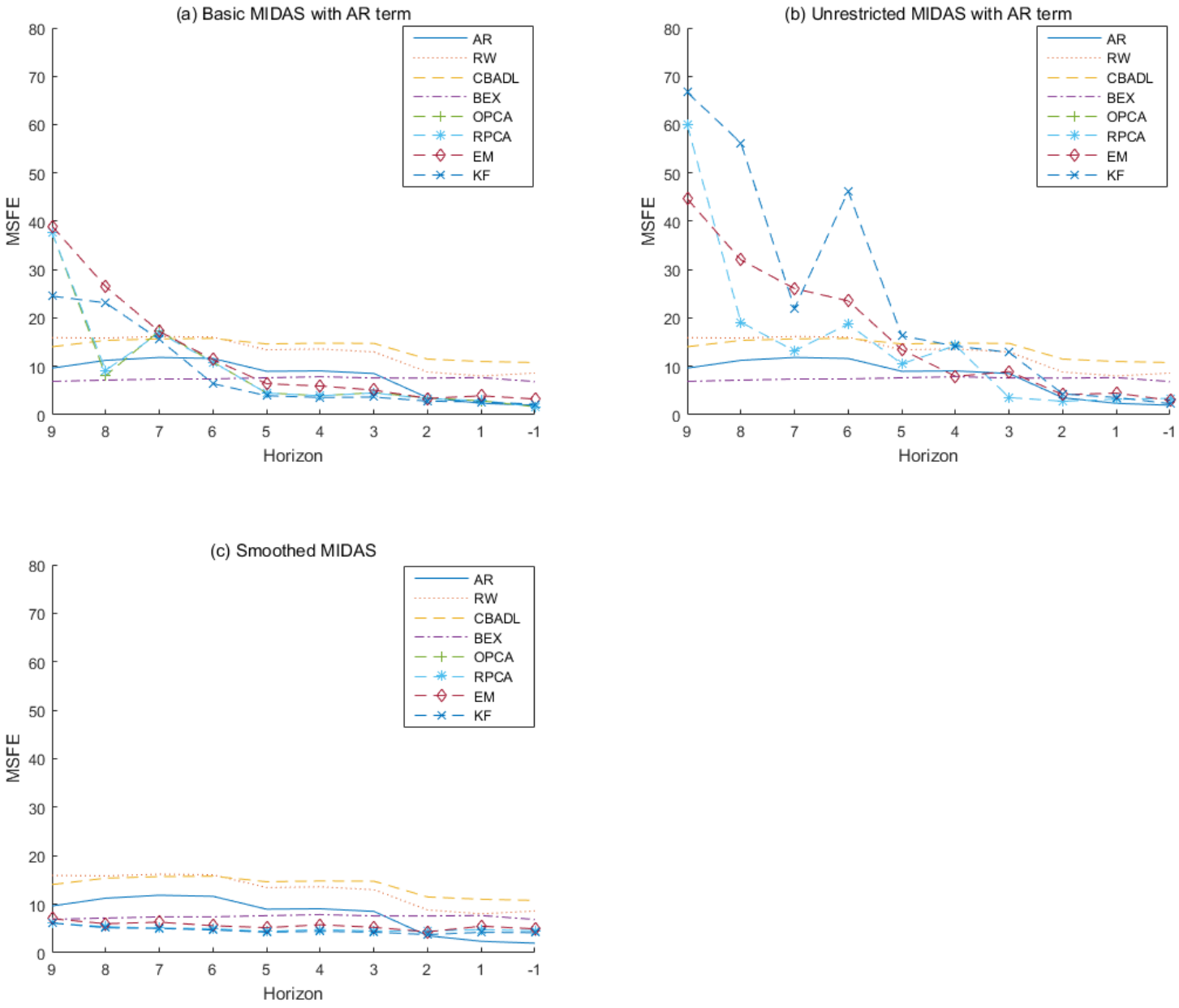
* Notes: See the Notes to Figure A1.

Figure A 9: MSFEs of Factor-MIDAS Models with with Three Factors ($r = 3$)*



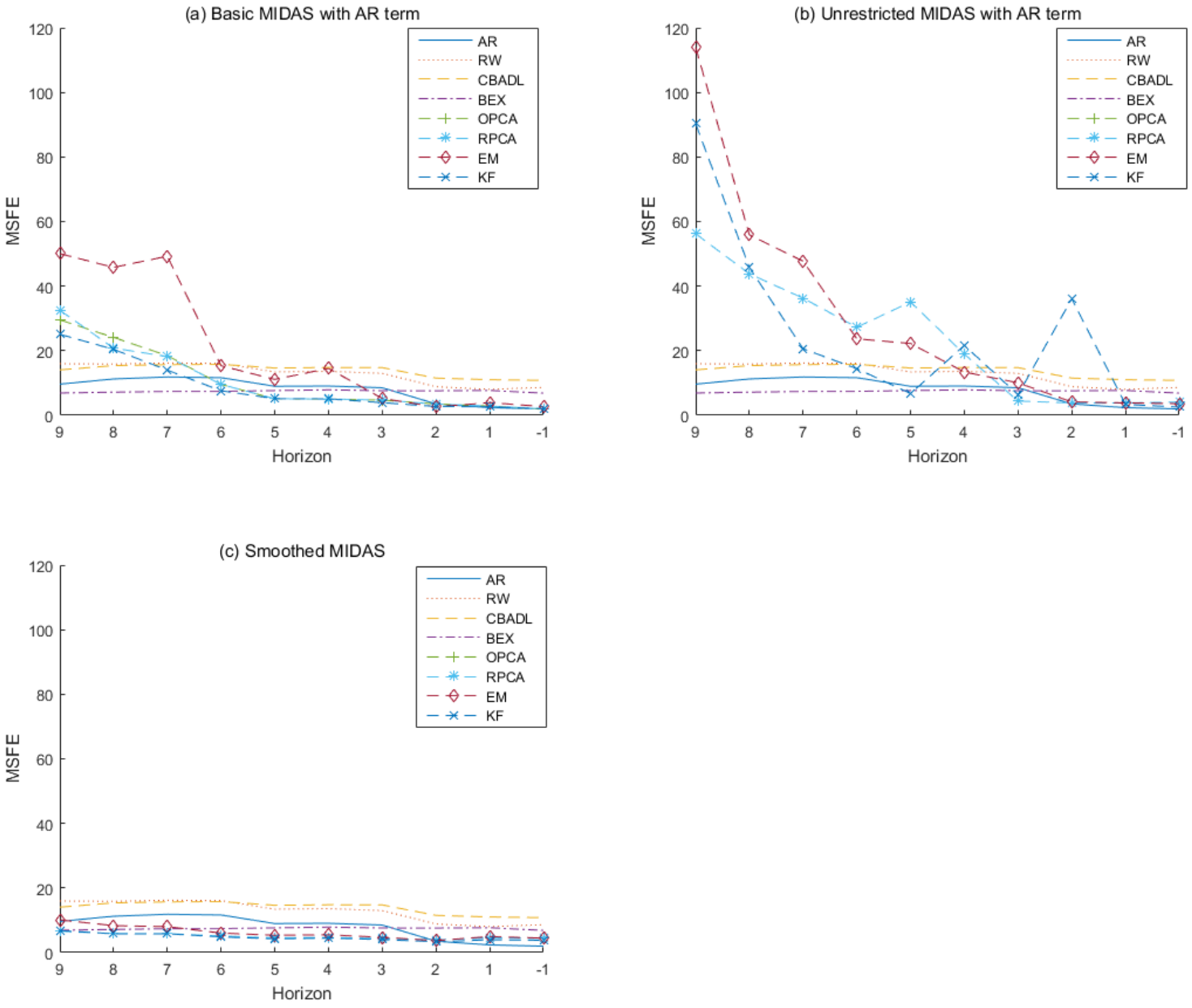
* Notes: See the Notes to Figure A1.

Figure A 10: MSFEs of Factor-MIDAS Models with with Four Factors ($r = 4$)*



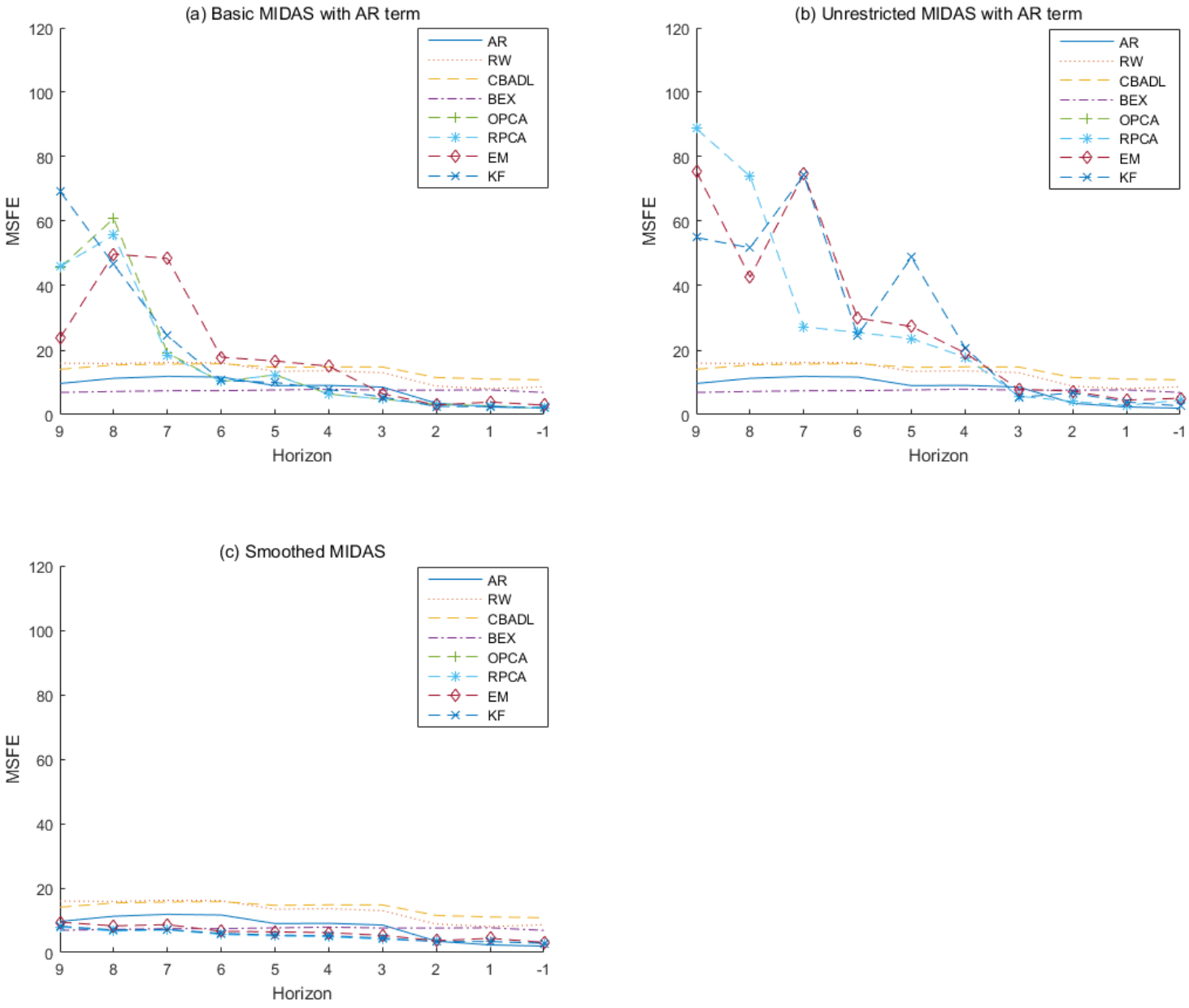
* Notes: See the Notes to Figure A1.

Figure A 11: MSFEs of Factor-MIDAS Models with with Five Factors ($r = 5$)*



* Notes: See the Notes to Figure A1.

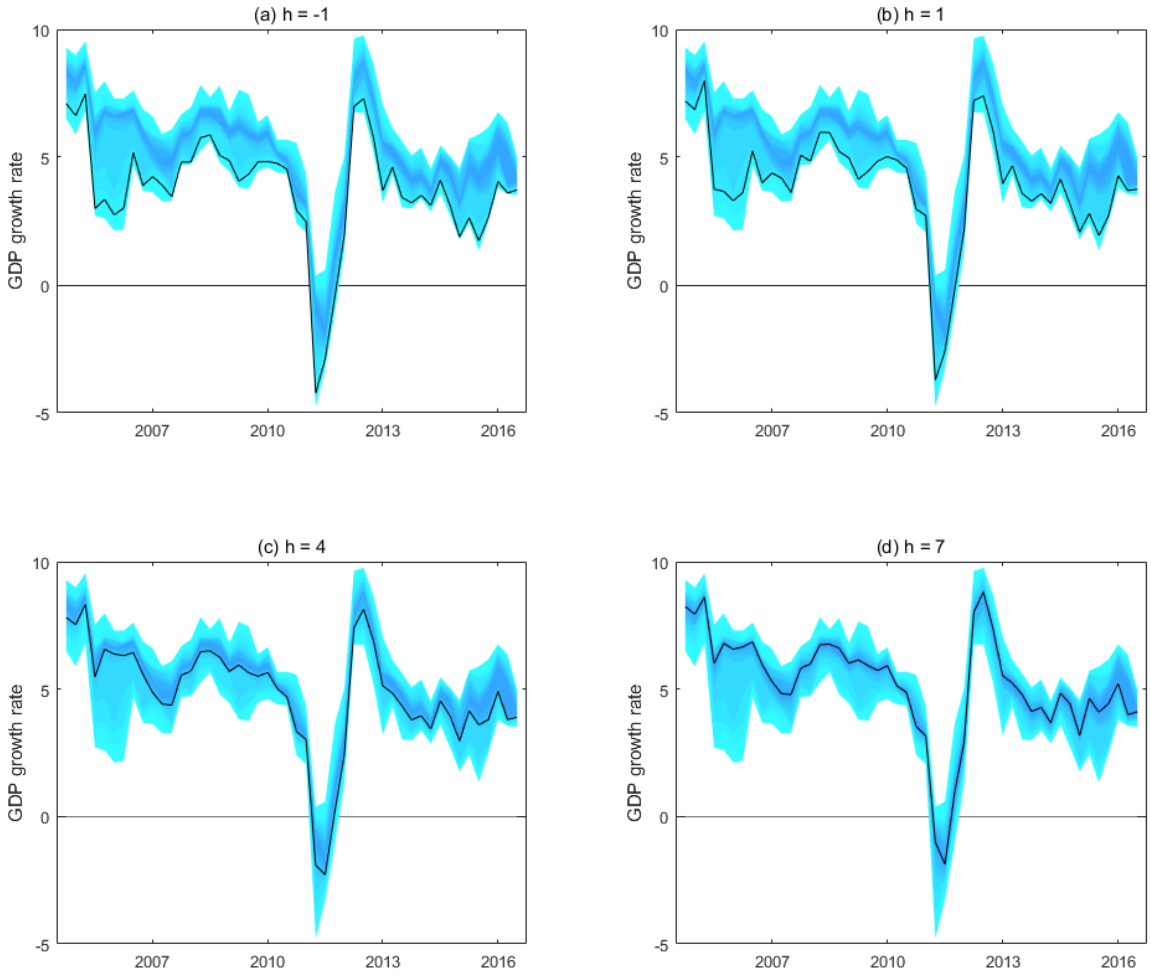
Figure A 12: MSFEs of Factor-MIDAS Models with with Six Factors ($r = 6$)*



* Notes: See the Notes to Figure A1.

In the main paper we note that "As pointed out by a referee, one important area of ongoing research in the current context involves the construction of density forecasts. Although this topic is left to future research, it is useful to note that many types of density forecasts are available to the practitioner. For example, in the following figures, we provide selected kernel density plots, for various values of $h = 1$, which are simply based on the distribution of all models' predictions from our experiments. Interestingly, at least based on these naive figures, it appears that downside risk is greater than upside risk, prior to the Great Recession around 2008."

Figure A 13: Kernel Density of all factor MIDAS permutation



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