Forecasting Inflation in a Data-Rich Environment: The Benefits of Machine Learning Methods

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BIG DATA, MACHINE LEARNING AND THE MACROECONOMY
Norges Bank, Oslo, 2-3 October 2017

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Motivation

- **Forecasting inflation is important**
  - Monetary/fiscal policy
  - Pricing derivatives
- **Forecasting inflation is hard**
  - Difficult to beat simple benchmark models such as the random walk – Atkeson and Ohanian (2001)
  - Competing models were usually some sort of (linear and nonlinear) Phillips Curve – Stock and Watson (2008).
  - Comparisons before the Machine Learning/Big Data boom in Economics!
- **Machine learning is now hot topic in Economics**
  - Myriad of different models/methods being proposed
  - Varian (2014); Mullainathan and Spiess (2017); Chernozhukov, Chetverikov, Demirer, Duflo, Hansen and Newey (2017); Chernozhukov, Chetverikov, Demirer, Duflo, Hansen, Newey and Robins (2017) and many more...
  - Data-rich environments (Big Data)

One-Page Summary

- **Monthly US inflation forecasting with**
  - large set of predictors (>500) and
  - new statistical (machine) learning (ML) methods as well as benchmark specifications:
    - Benchmark: RW, AR, UCSV
    - Factor models: Factors + AR and Target Factors + AR
    - 16 ML methods: LASSO-family (shrinkage), Bayesian VAR, Bagging, Boosting, CSR and Random Forests.
    - Four combinations of forecasts
- **Two subsamples:**
  - 1990–2000: low volatility ($\sigma = 0.001675$)
  - 2001–2015: high volatility ($\sigma = 0.003206$)
- **Forecasting horizons:**
  - 1 to 12 months-ahead
- **Evaluation tools:**
  - RMSEs and MSEs;
  - Model Confidence Sets;
  - NBER expansions versus recessions.

Summary of the Results

- Is it possible to beat benchmark models (AR, RW, UC-SV models)?
  - Stock and Watson (1999, 2007, 2008, 2016) say **No!**
  - We say **Yes!**
- Is this a robust finding?
  - **Yes!**
- Do factor models produce precise forecasts?
  - **Not really!**
- Is there a winning model?
  - **Surprisingly, there is: Random Forests!**
  - Shrinkage methods also perform well.
  - Results are even stronger in the 1990-2000 subsample.
- Is there nonlinearity in the dynamics of inflation?
  - **It looks like the answer is yes!**

Benchmark Models

Univariate Models

- **Random Walk: RW**

$$\pi_{t+h} = \pi_t + u_{t+h}$$

- **Autoregressive model of order p: AR(p)**

$$\pi_{t+h} = \phi_0 + \phi_1 \pi_t + \cdots + \phi_p \pi_{t-p+1} + u_{t+h}$$

  - Order determined by the SBIC (maximum of 12 possible lags).
  - Results are invariant to the choice of maximum number of lags.
  - Usually the estimated order is very low.

Benchmark Models

Univariate Models

- **Unobserved Component Stochastic Volatility: UCSV**

$$\begin{aligned}\pi_t &= \tau_t + e^{h_t/2}\varepsilon_t, \\ \tau_t &= \tau_{t-1} + u_t, \\ h_t &= h_{t-1} + v_t,\end{aligned}$$

where:

  - $\{\varepsilon_t\} \sim \mathsf{NID}(0, 1)$;
  - u_t and v_t are also normal with zero mean and variance given by inverse-gamma priors;
  - $\tau_1 \sim \mathsf{N}(0,\, V_\tau)$ and $h_1 \sim \mathsf{N}(0,\, V_h)$, where $V_\tau = V_h = 0.12$.
  - The model is estimated by Markov Chain Monte Carlo (MCMC) methods.
  - The h-steps-ahead forecast is computed as $\widehat{\pi}_{t+h} = \widehat{\tau}_{t|t}$.

Models

Factor Models

- **Linear AR + factors:**

$$\pi_{t+h} = \phi_0 + \sum_{i=0}^{p-1} \left[\phi_i \pi_{t-i} + \boldsymbol{\beta}_i' \boldsymbol{f}_{t-i}\right] + u_{t+h},$$

  where $\boldsymbol{f}_t$ is a set of latent factors computed by PCA on a set of n candidate predictors, $\boldsymbol{x}_t$.
- The number of factors considered is fixed in four. Results are robust to other specifications.
- Number of lags are determined by BIC.

Models

Target Factor Models: Bai and Ng (2008)

- If many variables in $\boldsymbol{x}_t$ are irrelevant predictors of π_{t+h}, factor analysis using all variables may result in noisy factors with poor forecasting ability.
- Idea: pre-test to select only relevant variables to be included in the factor analysis.
- Let $x_{i,t}$, $i = 1, \ldots, n$, be the candidate variables and $\boldsymbol{w}_t$ a set of AR terms. The procedure is described as follows.
  1. For $i = 1, \ldots, n$, regress π_{t+h} on $\boldsymbol{w}_t$ and $x_{i,t}$ and compute the t-statistics for the coefficient corresponding to $x_{i,t}$.
  2. Sort all t-statistics computed in Step 1 in descending order.
  3. Choose a significance level α, and select all variables which are significant using the computed t-statistics.
  4. Let $\boldsymbol{x}_t(\alpha)$ be the selected variables from Steps 1–3. Estimate the factors $\boldsymbol{f}_t$ from $\boldsymbol{x}_t(\alpha)$ by principal components.

Models

Boosting Factors: Bai and Ng (2009)

- The algorithm is defined as follows:
  1. Let $\Phi_{t,0} = \frac{1}{t}\sum_{i=1}^{t} \pi_i$.
  2. for $m = 1, \ldots, M$:
     - Compute $\widehat{u}_{t+h} = \pi_{t+h} - \Phi_{t,m-1}$, defined as the current residuals.
     - For each candidate factor $i = 1, \ldots, k$ regress the current residual on $f_{i,t}$ to obtain $\widehat{b}_i$ and compute $\widehat{e}_{t+h,i} = \widehat{u}_{t+h} - f_{i,t}\widehat{b}_i$. Compute $SSR_i = \widehat{\boldsymbol{e}}_i'\widehat{\boldsymbol{e}}_i$,
     - Select i_m^* as the smallest SSR and define $\widehat{\phi}_{m,t} = f_{i_m^*,t}\widehat{b}_{i_m^*}$,
     - Update $\widehat{\Phi}_{t,m} = \widehat{\Phi}_{t,m-1} + \nu\phi_{m,t}$, where ν is the step length. We set $\nu = 0.2$.
  3. Stop the algorithm after M iterations or when some information criterion starts to increase.

Models

Shrinkage Methods: $\pi_{t+h} = \boldsymbol{\beta}' \boldsymbol{x}_t + u_{t+h}$

- $\boldsymbol{x}_t \in \mathbb{R}^n$ is a set of four lags of a set predictors, including autoregressive terms and factors.
- The parameter $\boldsymbol{\beta}$ is estimated as follows:

$$\widehat{\boldsymbol{\beta}} = \arg\min_{\boldsymbol{\beta}} \left[\sum_{t=1}^{T-h} \left(\pi_{t+h} - \boldsymbol{\beta}' \boldsymbol{x}_t \right)^2 + \lambda \sum_{i=1}^{n} p(\beta_i; \omega_i) \right]$$

- $p(\beta_i; \omega_i)$ is the penalty term:
  - Ridge: $p(\beta_i; \omega_i) = \beta_i^2$
  - LASSO: $p(\beta_i; \omega_i) = |\beta_i|$
  - adaptive LASSO: $p(\beta_i; \omega_i) = \omega_i |\beta_i|$, $\omega_i = 1/|\beta_{i,\mathsf{LASSO}}|$
  - Elastic Net: $p(\beta_i; \omega_i) = \alpha \beta_i^2 + (1-\alpha)|\beta_i|$, $0 \leq \alpha \leq 1$
  - adaptive Elastic Net: $p(\beta_i; \omega_i) = \alpha \omega_i \beta_i^2 + (1-\alpha)\omega_i |\beta_i|$

Models

Complete Subset Regression (CSR): Elliott, Gargano and Timmermann (2013, 2015)

- Selecting the optimal subset of $\boldsymbol{x}_t \in \mathbb{R}^n$ to predict π_{t+h} by testing all possible combinations is unfeasible when n is large.
- Idea: select a number $q \leq n$ and compute all combinations of regressions using only q variables.
- The forecast of the model will be the average forecast of all regressions.
- For large sets the number of regressions increases very fast. With $n = 25$ and $q = 4 \longrightarrow 12,650$ regressions.
- Pre-testing procedure: Fit a regression of π_{t+h} on each of the candidate variable (including lags) and rank the t-stats.
- Select the $\tilde{n}$ variables which are the most relevant ones. The CSR forecast is computed on these variables.
- We use $\tilde{n} = 25$ and $q = 4$.

Models

Bagging: Breiman (1996) and Inoue and Kilian (2008)

- Idea: Combination of forecasts from unstable models.
- The Bagging steps are as follows:
  1. For each bootstrap sample b, run a regression with all candidate variables and select those with $|t - stat| \geq k$.
  2. Estimate a new regression only with the variables selected in the previous step.
  3. The coefficients from the second regression are finally used to compute the forecasts **on the actual sample**.
  4. Repeat the first three steps for $B = 100$ bootstrap samples compute the final forecast as the average of the B forecasts.
- In our case the number of observations may be smaller than the number of variables.
- New source of instability: Instead of doing a single pre-testing, we randomly divide all variables into groups and run the pre-testing on each group.

Models

Other Alternatives

- **Jackknife Model Averaging (JMA):** Hansen and Racine (2012) and Zhang, Wan and Zou (2013)
  - Idea: Instead of using the naive average of the forecasts, the JMA uses leave-one-out cross-validation to estimate optimal weights.
  - Weights are positive and sum one.
- **Bayesian VAR (BVAR):** Bańbura, Giannone, and Reichlin (2010)
  - Normal–inverted Wishart priors
- **Random Forests:** Breiman (2001) and Wager and Athey (2017)
  - Bootstrap aggregation of deep regression trees.
  - Each regression tree is grown based on a random subset of the available regressors.
  - Fully-grown trees.

Data

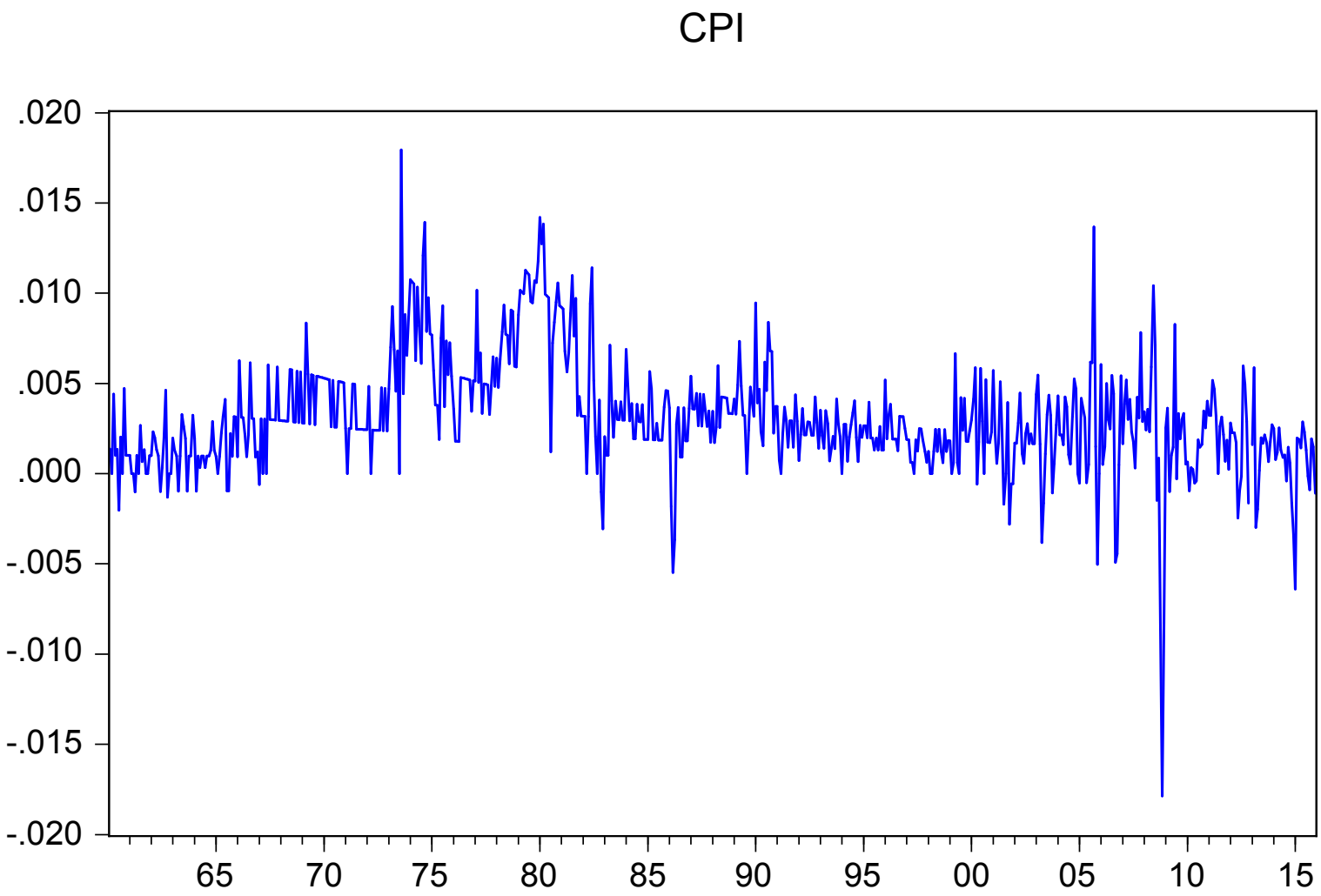
Description

- Data from FRED-MD – Federal Reserve Bank of St. Louis – McCracken and Ng (JBES, 2017).
- Data available from Michael McCracken's webpage

  https://research.stlouisfed.org/econ/mccracken/fred-databases/
- Data description:
  - 135 monthly US indicators from Jan 1960 to Dec 2015 (672 observations)
  - Data grouped into 8 different groups: Output and Income (17); Labor Market (32); Consumption (10), Orders and Inventories (14); Money and Credit (14); Interest and Exchange Rates (22); Prices (21); and Stock Market (5)
  - After removal of variables with missing data we have 124 variables.

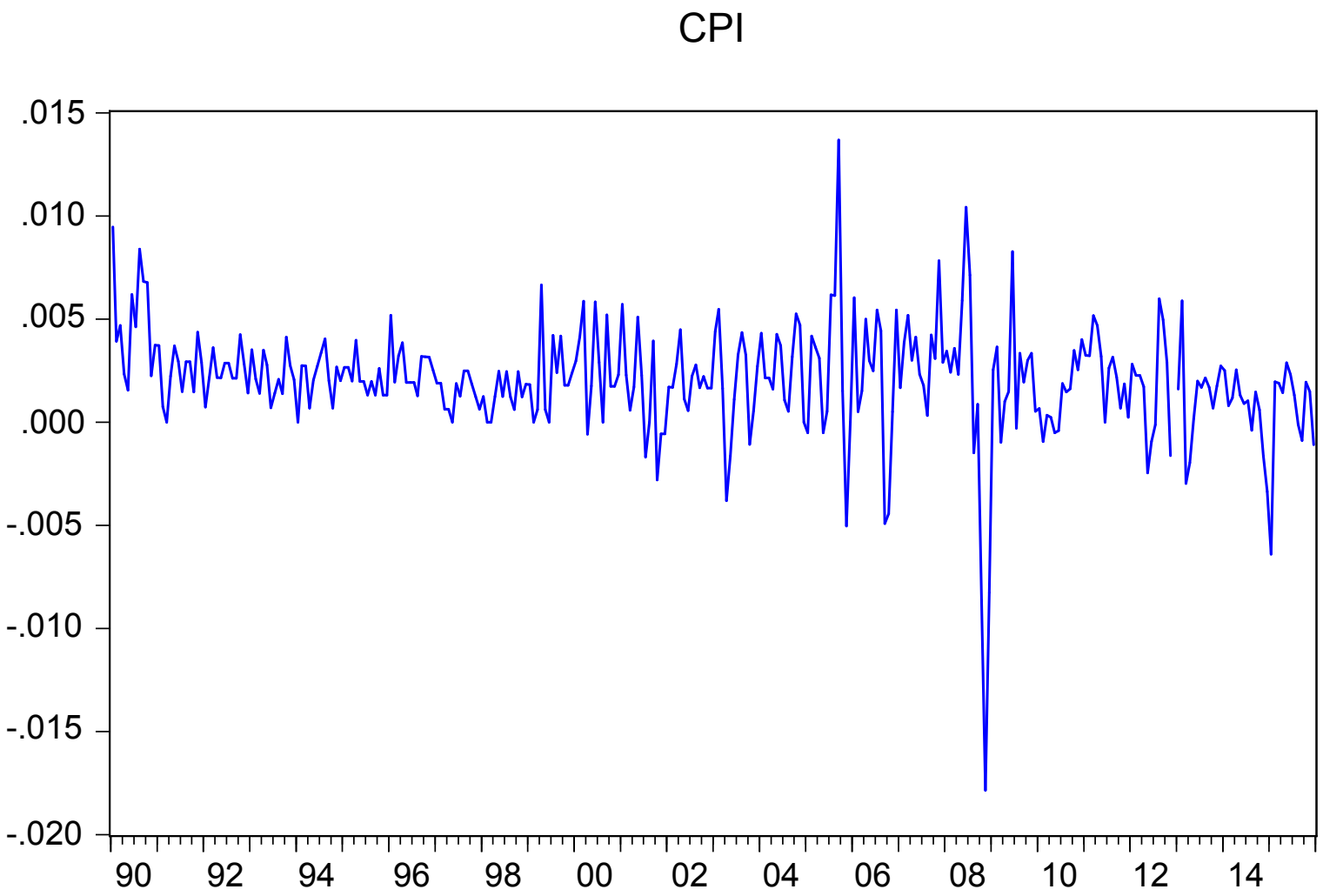
Data

CPI – all items



Data

CPI – all items



Results 1990 – 2000

Forecasting Errors

Consumer Price Index 1990-2000

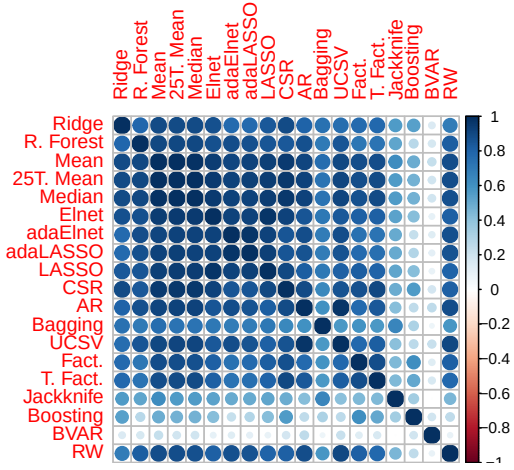
Forecasting Horizon

RMSE (MAE)	$t+1$	$t+2$	$t+3$	$t+4$	$t+5$	$t+6$	$t+7$	$t+8$	$t+9$	$t+10$	$t+11$	$t+12$	count RMSE (count MAE)
AR	0.84	0.82	0.88	0.82	0.78	0.79	0.79	0.80	0.87	0.89	0.95	0.85	11
	(0.88)	(0.83)	(0.92)	(0.83)	(0.81)	(0.84)	(0.84)	(0.80)	(0.94)	(0.98)	(1.04)	(0.94)	(4)
UCSV	0.86	0.84	0.87	0.87	0.85	0.85	0.86	0.85	0.86	0.89	0.94	0.88	6
	(0.88)	(0.85)	(0.88)	(0.87)	(0.86)	(0.86)	(0.87)	(0.84)	(0.88)	(0.91)	(0.96)	(0.89)	(9)
BVAR	0.97	0.80	0.92	0.83	0.77	0.84	0.87	0.90	1.00	0.98	1.02	0.88	5
	(1.00)	**(0.77)**	(0.96)	(0.88)	(0.84)	(0.93)	(0.98)	(0.95)	(1.12)	(1.10)	(1.16)	(1.01)	(1)
LASSO	0.83	0.82	0.88	0.83	0.79	0.78	0.80	0.81	0.88	0.92	0.97	0.85	4
	(0.88)	(0.84)	(0.92)	(0.84)	(0.83)	(0.84)	(0.88)	(0.83)	(0.96)	(1.02)	(1.08)	(0.96)	(2)
Ridge	**0.79**	**0.77**	0.86	0.80	0.76	0.80	0.80	0.80	0.86	0.85	0.88	0.76	10
	(0.83)	(0.78)	(0.90)	(0.81)	(0.78)	(0.84)	(0.85)	(0.79)	(0.90)	(0.92)	(0.96)	(0.82)	(10)
Elnet	0.81	0.81	0.88	0.83	0.80	0.79	0.82	0.81	0.92	0.92	1.00	0.89	3
	(0.86)	(0.84)	(0.92)	(0.86)	(0.86)	(0.85)	(0.92)	(0.83)	(1.02)	(1.02)	(1.14)	(1.02)	(2)
adaLASSO	0.81	0.82	0.87	0.83	0.75	**0.75**	0.77	0.77	0.85	0.87	0.92	0.82	11
	(0.84)	(0.82)	(0.86)	(0.80)	(0.73)	**(0.77)**	(0.81)	(0.77)	(0.90)	(0.92)	(1.00)	(0.89)	(12)
adaElnet	0.81	0.82	0.86	0.80	0.74	0.75	0.77	0.78	0.87	0.87	0.92	0.87	11
	(0.85)	(0.83)	**(0.86)**	(0.77)	**(0.73)**	(0.78)	(0.81)	(0.78)	(0.92)	(0.93)	(1.00)	(0.95)	(11)
Fact.	0.87	0.85	0.98	0.90	0.89	0.86	0.84	0.90	1.02	0.97	1.04	0.98	0
	(0.96)	(0.92)	(1.05)	(0.97)	(0.92)	(0.90)	(0.88)	(0.91)	(1.14)	(1.09)	(1.15)	(1.14)	(0)
T. Fact.	0.87	0.91	1.01	0.98	0.92	0.94	0.86	0.91	1.04	1.02	1.02	0.95	0
	(0.93)	(0.98)	(1.13)	(1.07)	(1.02)	(1.05)	(0.94)	(0.93)	(1.16)	(1.18)	(1.15)	(1.10)	(0)
CSR	0.83	0.85	0.89	0.81	0.77	0.76	**0.76**	**0.76**	0.85	0.88	0.91	0.81	10
	(0.89)	(0.89)	(0.92)	(0.82)	(0.79)	(0.81)	(0.82)	(0.76)	(0.91)	(0.95)	(0.97)	(0.89)	(7)
Bagging	0.85	0.86	1.02	0.92	0.90	0.91	0.90	0.86	0.91	0.91	0.93	0.79	5
	(0.86)	(0.87)	(1.04)	(0.95)	(0.93)	(0.95)	(0.92)	(0.82)	(0.94)	(0.95)	(0.99)	(0.87)	(6)
Boosting	0.96	0.90	1.05	0.91	0.88	0.95	0.95	0.97	1.02	0.96	0.97	0.81	1
	(1.09)	(0.98)	(1.16)	(0.98)	(0.97)	(1.06)	(1.06)	(1.03)	(1.12)	(1.06)	(1.07)	(0.89)	(1)
Jackknife	0.94	1.01	1.17	0.99	1.03	1.01	1.06	1.03	1.21	1.13	1.13	0.93	0
	(1.00)	(1.02)	(1.19)	(1.01)	(1.07)	(1.05)	(1.06)	(1.01)	(1.29)	(1.19)	(1.20)	(0.98)	(0)
R. Forest	0.79	0.78	0.85	**0.77**	**0.73**	0.76	0.76	0.77	**0.82**	**0.82**	**0.85**	**0.72**	12
	(0.82)	(0.78)	(0.88)	**(0.77)**	(0.76)	(0.79)	**(0.78)**	**(0.75)**	**(0.86)**	**(0.86)**	**(0.89)**	**(0.76)**	(11)
Mean	0.80	0.79	0.85	0.79	0.76	0.77	0.77	0.77	0.84	0.84	0.87	0.78	9
	(0.83)	(0.81)	(0.87)	(0.80)	(0.79)	(0.81)	(0.81)	(0.76)	(0.90)	(0.91)	(0.94)	(0.85)	(8)
25T. Mean	0.80	0.80	**0.85**	0.79	0.75	0.76	0.77	0.77	0.85	0.84	0.89	0.79	7
	(0.84)	(0.82)	(0.87)	(0.79)	(0.77)	(0.80)	(0.81)	(0.78)	(0.91)	(0.91)	(0.97)	(0.87)	(10)
Median	0.80	0.80	0.85	0.79	0.75	0.76	0.77	0.77	0.85	0.85	0.89	0.79	9
	(0.84)	(0.83)	(0.88)	(0.79)	(0.78)	(0.80)	(0.82)	(0.77)	(0.91)	(0.91)	(0.97)	(0.87)	(9)
RMSE count	12	12	13	8	10	10	9	9	10	10	10	1	
(MAE count)	(10)	(12)	(8)	(7)	(2)	(8)	(8)	(10)	(12)	(10)	(9)	(7)	

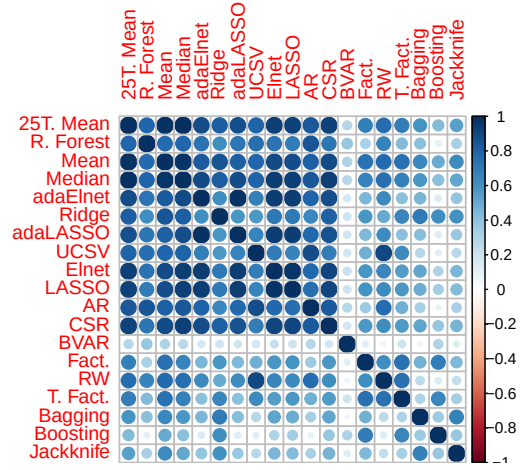
Results 1990–2000

Forecasts Correlation

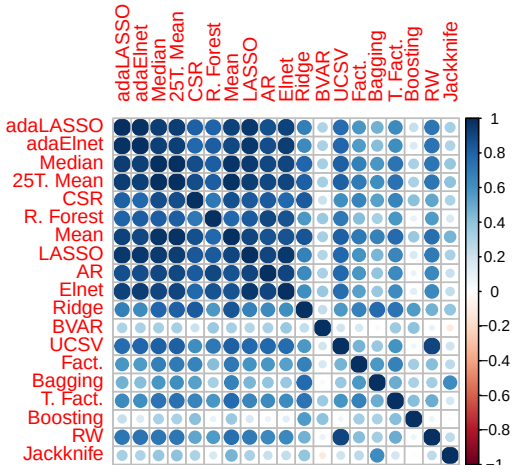
(a) t+1



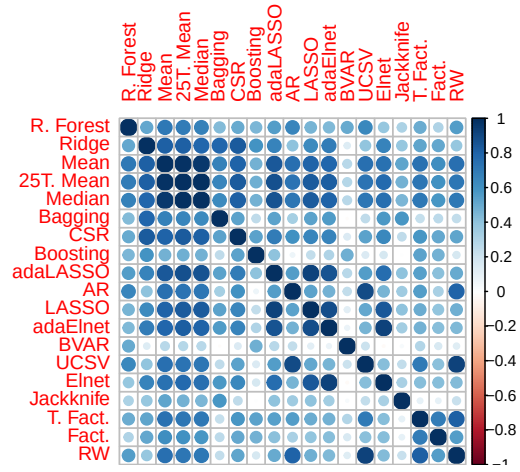
(b) t+3



(c) t+6



(d) t+12



Results 1990 – 2000

Percentage of Times Each Model is the Best (Worst)

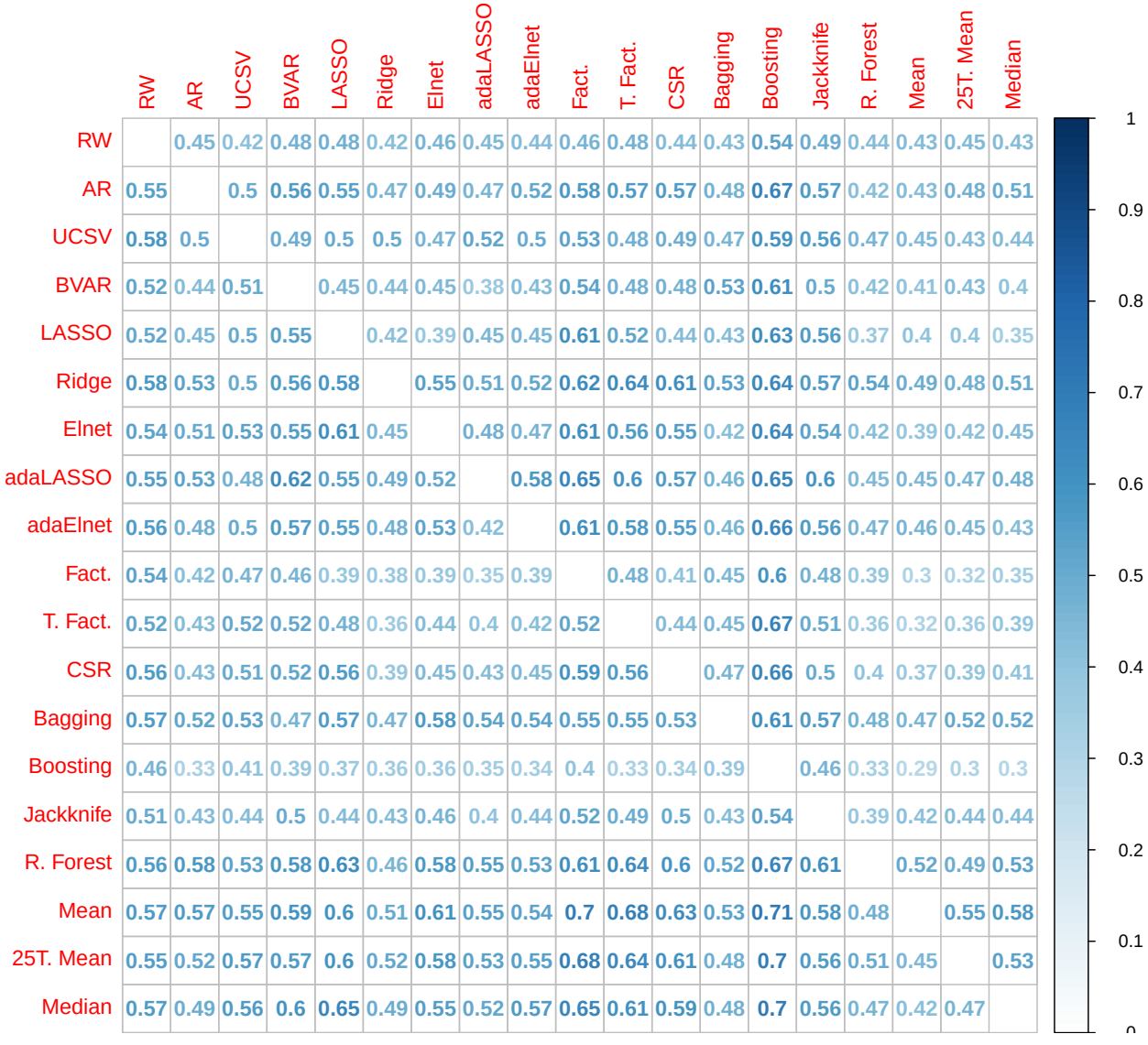
Consumer Price Index - Ranking - 1990-2000

Forecasting Horizon

%best (%worst)	$t+1$	$t+2$	$t+3$	$t+4$	$t+5$	$t+6$	$t+7$	$t+8$	$t+9$	$t+10$	$t+11$	$t+12$
RW	**21.37**	**16.79**	**19.85**	**15.91**	**14.39**	**17.56**	14.62	10.69	**18.60**	**15.38**	12.88	11.36
	(20.61)	**(20.93)**	(15.62)	(18.46)	(19.53)	(16.67)	(18.32)	**(24.24)**	(14.62)	(17.19)	(11.36)	(16.15)
AR	1.53	4.58	4.58	6.82	2.27	6.11	2.31	3.05	4.65	3.85	1.52	6.82
	(2.29)	(3.88)	(3.12)	(2.31)	(0.78)	(0.76)	(3.05)	(2.27)	(3.08)	(3.91)	(5.30)	(5.38)
UCSV	4.58	0.76	7.63	6.06	6.82	5.34	6.92	5.34	5.43	10.00	7.58	3.79
	(1.53)	(0.00)	(0.78)	(0.77)	(1.56)	(3.03)	(1.53)	(2.27)	(0.00)	(0.78)	(5.30)	(3.08)
BVAR	11.45	14.50	7.63	6.06	6.82	7.63	4.62	3.05	3.88	3.08	5.30	3.03
	(9.16)	(7.75)	(6.25)	(3.85)	(3.91)	(9.09)	(9.16)	(6.82)	(6.15)	(10.94)	(7.58)	(6.92)
LASSO	3.82	5.34	2.29	2.27	6.06	2.29	0.77	1.53	2.33	1.54	1.52	2.27
	(0.76)	(0.78)	(0.00)	(0.77)	(1.56)	(0.76)	(0.00)	(1.52)	(0.77)	(1.56)	(1.52)	(0.00)
Ridge	6.11	5.34	3.05	2.27	4.55	4.58	3.08	3.05	6.98	3.08	5.30	6.06
	(1.53)	(0.00)	(0.78)	(0.00)	(0.00)	(0.00)	(0.76)	(0.00)	(0.00)	(0.00)	(1.52)	(0.77)
Elnet	2.29	1.53	0.76	3.79	4.55	3.05	2.31	3.82	3.88	0.77	1.52	2.27
	(1.53)	(3.10)	(0.00)	(3.08)	(2.34)	(1.52)	(5.34)	(0.00)	(0.00)	(0.78)	(5.30)	(5.38)
adaLASSO	3.82	3.05	6.11	3.03	4.55	3.05	2.31	6.87	4.65	6.15	3.79	4.55
	(0.76)	(0.78)	(2.34)	(3.08)	(0.00)	(0.00)	(0.00)	(0.76)	(0.00)	(0.78)	(0.76)	(0.00)
adaElnet	2.29	5.34	2.29	3.03	5.30	4.58	2.31	2.29	0.78	0.77	0.76	1.52
	(0.00)	(0.78)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(4.62)
Fact.	1.53	1.53	5.34	3.79	5.30	4.58	4.62	4.58	6.98	6.15	7.58	2.27
	(1.53)	(0.78)	(6.25)	(6.15)	(5.47)	(6.06)	(5.34)	(8.33)	(14.62)	(12.50)	(16.67)	(15.38)
T. Fact.	2.29	6.11	0.00	6.82	3.79	3.82	3.08	8.40	3.10	2.31	3.79	1.52
	(3.05)	(8.53)	(14.06)	(13.08)	(9.38)	(9.85)	(3.82)	(3.79)	(6.15)	(6.25)	(3.79)	(6.15)
CSR	2.29	1.53	1.53	2.27	3.03	1.53	5.38	3.05	1.55	3.08	2.27	5.30
	(0.76)	(0.00)	(0.78)	(1.54)	(0.78)	(1.52)	(0.00)	(0.76)	(1.54)	(0.78)	(0.00)	(2.31)
Bagging	16.03	9.92	11.45	8.33	9.09	8.40	8.46	9.92	8.53	13.08	9.85	9.85
	(12.98)	(13.95)	(11.72)	(11.54)	(9.38)	(6.06)	(9.16)	(4.55)	(6.92)	(9.38)	(6.82)	(8.46)
Boosting	9.16	9.16	4.58	11.36	7.58	11.45	9.23	9.16	11.63	9.23	**15.15**	14.39
	(24.43)	(18.60)	(14.84)	(15.38)	(18.75)	**(21.97)**	**(23.66)**	(23.48)	(19.23)	(11.72)	(9.85)	(5.38)
Jackknife	5.34	8.40	9.92	9.85	10.61	9.16	**15.38**	**12.21**	8.53	11.54	11.36	**16.67**
	(19.08)	(19.38)	**(23.44)**	**(19.23)**	**(26.56)**	(21.21)	(19.08)	(20.45)	**(25.38)**	**(22.66)**	**(21.97)**	**(19.23)**
R. Forest	2.29	3.82	6.87	4.55	3.03	4.58	10.00	9.16	2.33	5.38	6.06	3.79
	(0.00)	(0.78)	(0.00)	(0.77)	(0.00)	(1.52)	(0.76)	(0.76)	(1.54)	(0.78)	(2.27)	(0.77)
Mean	2.29	2.29	3.05	2.27	1.52	1.53	3.08	1.53	2.33	3.08	1.52	3.79
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
25T. Mean	0.76	0.00	0.76	0.76	0.76	0.76	1.54	0.76	3.10	0.77	0.76	0.76
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Median	0.76	0.00	2.29	0.76	0.00	0.00	0.00	1.53	0.78	0.77	1.52	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Results 1990 – 2000

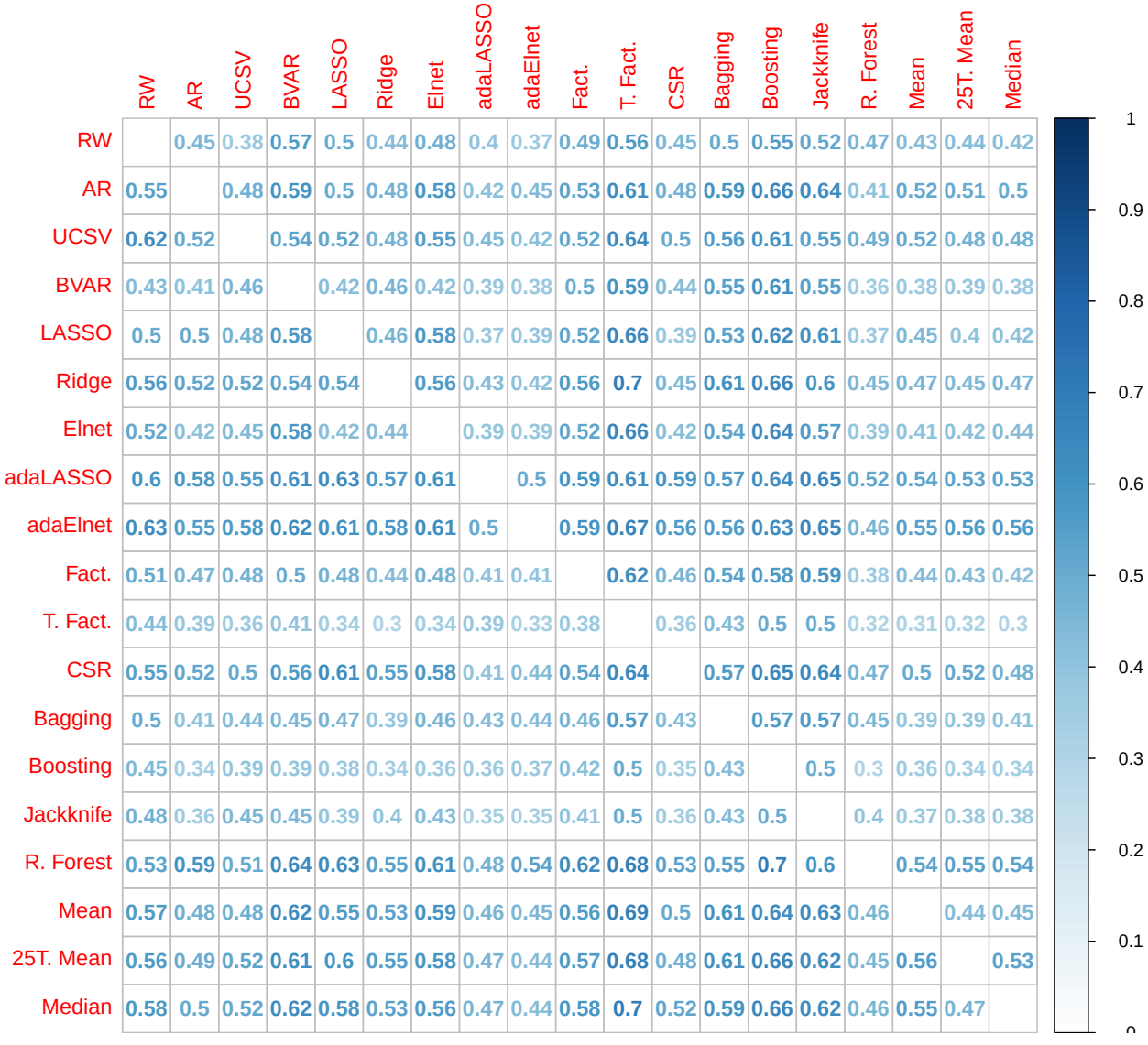
Model Comparison – One-step-Ahead



	RW	AR	UCSV	BVAR	LASSO	Ridge	Elnet	adaLASSO	adaElnet	Fact.	T. Fact.	CSR	Bagging	Boosting	Jackknife	R. Forest	Mean	25T. Mean	Median
RW		0.45	0.42	0.48	0.48	0.42	0.46	0.45	0.44	0.46	0.48	0.44	0.43	0.54	0.49	0.44	0.43	0.45	0.43
AR	0.55		0.5	0.56	0.55	0.47	0.49	0.47	0.52	0.58	0.57	0.57	0.48	0.67	0.57	0.42	0.43	0.48	0.51
UCSV	0.58	0.5		0.49	0.5	0.5	0.47	0.52	0.5	0.53	0.48	0.49	0.47	0.59	0.56	0.47	0.45	0.43	0.44
BVAR	0.52	0.44	0.51		0.45	0.44	0.45	0.38	0.43	0.54	0.48	0.48	0.53	0.61	0.5	0.42	0.41	0.43	0.4
LASSO	0.52	0.45	0.5	0.55		0.42	0.39	0.45	0.45	0.61	0.52	0.44	0.43	0.63	0.56	0.37	0.4	0.4	0.35
Ridge	0.58	0.53	0.5	0.56	0.58		0.55	0.51	0.52	0.62	0.64	0.61	0.53	0.64	0.57	0.54	0.49	0.48	0.51
Elnet	0.54	0.51	0.53	0.55	0.61	0.45		0.48	0.47	0.61	0.56	0.55	0.42	0.64	0.54	0.42	0.39	0.42	0.45
adaLASSO	0.55	0.53	0.48	0.62	0.55	0.49	0.52		0.58	0.65	0.6	0.57	0.46	0.65	0.6	0.45	0.45	0.47	0.48
adaElnet	0.56	0.48	0.5	0.57	0.55	0.48	0.53	0.42		0.61	0.58	0.55	0.46	0.66	0.56	0.47	0.46	0.45	0.43
Fact.	0.54	0.42	0.47	0.46	0.39	0.38	0.39	0.35	0.39		0.48	0.41	0.45	0.6	0.48	0.39	0.3	0.32	0.35
T. Fact.	0.52	0.43	0.52	0.52	0.48	0.36	0.44	0.4	0.42	0.52		0.44	0.45	0.67	0.51	0.36	0.32	0.36	0.39
CSR	0.56	0.43	0.51	0.52	0.56	0.39	0.45	0.43	0.45	0.59	0.56		0.47	0.66	0.5	0.4	0.37	0.39	0.41
Bagging	0.57	0.52	0.53	0.47	0.57	0.47	0.58	0.54	0.54	0.55	0.55	0.53		0.61	0.57	0.48	0.47	0.52	0.52
Boosting	0.46	0.33	0.41	0.39	0.37	0.36	0.36	0.35	0.34	0.4	0.33	0.34	0.39		0.46	0.33	0.29	0.3	0.3
Jackknife	0.51	0.43	0.44	0.5	0.44	0.43	0.46	0.4	0.44	0.52	0.49	0.5	0.43	0.54		0.39	0.42	0.44	0.44
R. Forest	0.56	0.58	0.53	0.58	0.63	0.46	0.58	0.55	0.53	0.61	0.64	0.6	0.52	0.67	0.61		0.52	0.49	0.53
Mean	0.57	0.57	0.55	0.59	0.6	0.51	0.61	0.55	0.54	0.7	0.68	0.63	0.53	0.71	0.58	0.48		0.55	0.58
25T. Mean	0.55	0.52	0.57	0.57	0.6	0.52	0.58	0.53	0.55	0.68	0.64	0.61	0.48	0.7	0.56	0.51	0.45		0.53
Median	0.57	0.49	0.56	0.6	0.65	0.49	0.55	0.52	0.57	0.65	0.61	0.59	0.48	0.7	0.56	0.47	0.42	0.47	

Results 1990 – 2000

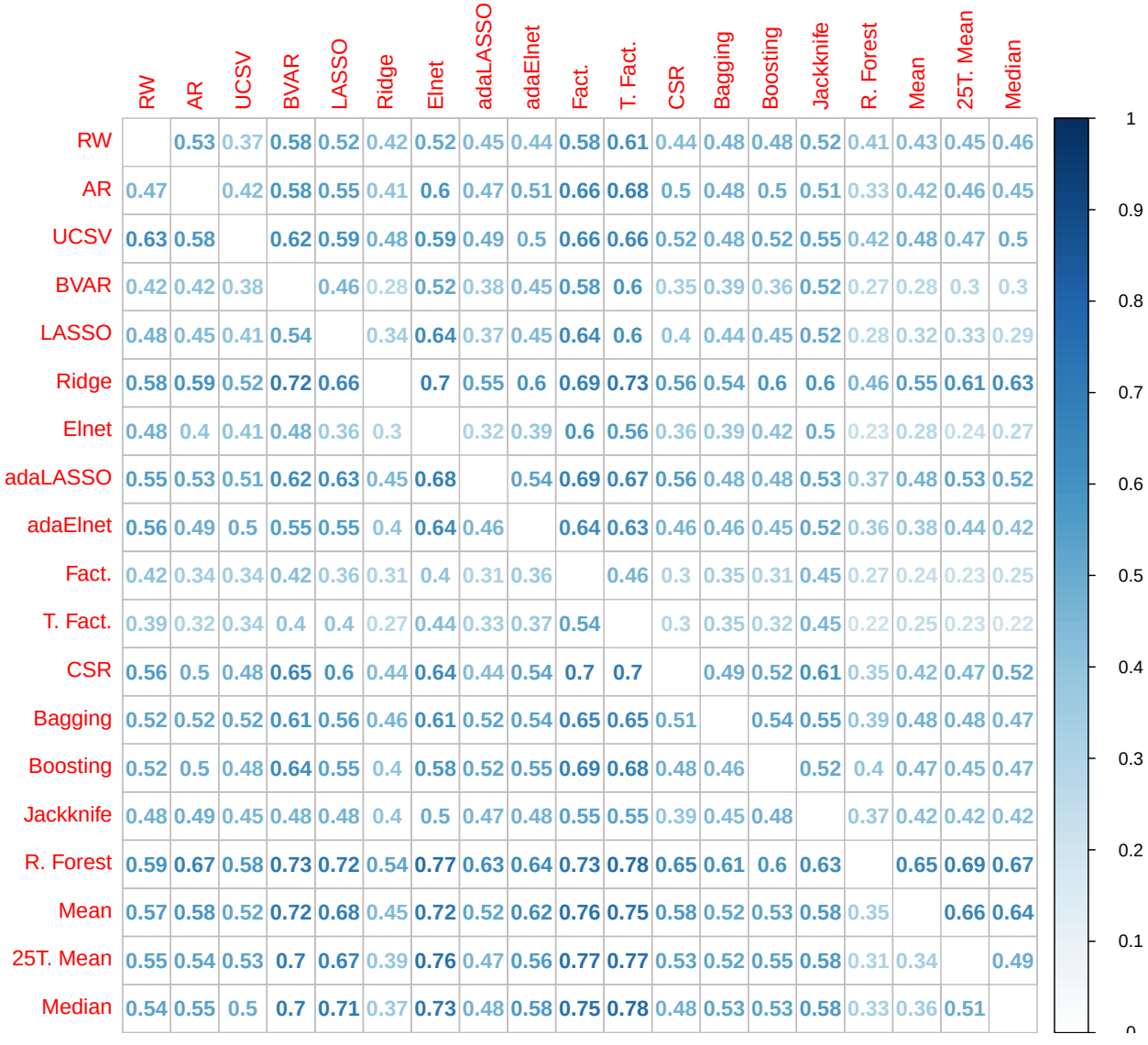
Model Comparison – Six-steps-Ahead



	RW	AR	UCSV	BVAR	LASSO	Ridge	Elnet	adaLASSO	adaElnet	Fact.	T. Fact.	CSR	Bagging	Boosting	Jackknife	R. Forest	Mean	25T. Mean	Median
RW		0.45	0.38	0.57	0.5	0.44	0.48	0.4	0.37	0.49	0.56	0.45	0.5	0.55	0.52	0.47	0.43	0.44	0.42
AR	0.55		0.48	0.59	0.5	0.48	0.58	0.42	0.45	0.53	0.61	0.48	0.59	0.66	0.64	0.41	0.52	0.51	0.5
UCSV	0.62	0.52		0.54	0.52	0.48	0.55	0.45	0.42	0.52	0.64	0.5	0.56	0.61	0.55	0.49	0.52	0.48	0.48
BVAR	0.43	0.41	0.46		0.42	0.46	0.42	0.39	0.38	0.5	0.59	0.44	0.55	0.61	0.55	0.36	0.38	0.39	0.38
LASSO	0.5	0.5	0.48	0.58		0.46	0.58	0.37	0.39	0.52	0.66	0.39	0.53	0.62	0.61	0.37	0.45	0.4	0.42
Ridge	0.56	0.52	0.52	0.54	0.54		0.56	0.43	0.42	0.56	0.7	0.45	0.61	0.66	0.6	0.45	0.47	0.45	0.47
Elnet	0.52	0.42	0.45	0.58	0.42	0.44		0.39	0.39	0.52	0.66	0.42	0.54	0.64	0.57	0.39	0.41	0.42	0.44
adaLASSO	0.6	0.58	0.55	0.61	0.63	0.57	0.61		0.5	0.59	0.61	0.59	0.57	0.64	0.65	0.52	0.54	0.53	0.53
adaElnet	0.63	0.55	0.58	0.62	0.61	0.58	0.61	0.5		0.59	0.67	0.56	0.56	0.63	0.65	0.46	0.55	0.56	0.56
Fact.	0.51	0.47	0.48	0.5	0.48	0.44	0.48	0.41	0.41		0.62	0.46	0.54	0.58	0.59	0.38	0.44	0.43	0.42
T. Fact.	0.44	0.39	0.36	0.41	0.34	0.3	0.34	0.39	0.33	0.38		0.36	0.43	0.5	0.5	0.32	0.31	0.32	0.3
CSR	0.55	0.52	0.5	0.56	0.61	0.55	0.58	0.41	0.44	0.54	0.64		0.57	0.65	0.64	0.47	0.5	0.52	0.48
Bagging	0.5	0.41	0.44	0.45	0.47	0.39	0.46	0.43	0.44	0.46	0.57	0.43		0.57	0.57	0.45	0.39	0.39	0.41
Boosting	0.45	0.34	0.39	0.39	0.38	0.34	0.36	0.36	0.37	0.42	0.5	0.35	0.43		0.5	0.3	0.36	0.34	0.34
Jackknife	0.48	0.36	0.45	0.45	0.39	0.4	0.43	0.35	0.35	0.41	0.5	0.36	0.43	0.5		0.4	0.37	0.38	0.38
R. Forest	0.53	0.59	0.51	0.64	0.63	0.55	0.61	0.48	0.54	0.62	0.68	0.53	0.55	0.7	0.6		0.54	0.55	0.54
Mean	0.57	0.48	0.48	0.62	0.55	0.53	0.59	0.46	0.45	0.56	0.69	0.5	0.61	0.64	0.63	0.46		0.44	0.45
25T. Mean	0.56	0.49	0.52	0.61	0.6	0.55	0.58	0.47	0.44	0.57	0.68	0.48	0.61	0.66	0.62	0.45	0.56		0.53
Median	0.58	0.5	0.52	0.62	0.58	0.53	0.56	0.47	0.44	0.58	0.7	0.52	0.59	0.66	0.62	0.46	0.55	0.47	

Results 1990 – 2000

Model Comparison – 12-steps-Ahead



	RW	AR	UCSV	BVAR	LASSO	Ridge	Elnet	adaLASSO	adaElnet	Fact.	T. Fact.	CSR	Bagging	Boosting	Jackknife	R. Forest	Mean	25T. Mean	Median
RW		0.53	0.37	0.58	0.52	0.42	0.52	0.45	0.44	0.58	0.61	0.44	0.48	0.48	0.52	0.41	0.43	0.45	0.46
AR	0.47		0.42	0.58	0.55	0.41	0.6	0.47	0.51	0.66	0.68	0.5	0.48	0.5	0.51	0.33	0.42	0.46	0.45
UCSV	0.63	0.58		0.62	0.59	0.48	0.59	0.49	0.5	0.66	0.66	0.52	0.48	0.52	0.55	0.42	0.48	0.47	0.5
BVAR	0.42	0.42	0.38		0.46	0.28	0.52	0.38	0.45	0.58	0.6	0.35	0.39	0.36	0.52	0.27	0.28	0.3	0.3
LASSO	0.48	0.45	0.41	0.54		0.34	0.64	0.37	0.45	0.64	0.6	0.4	0.44	0.45	0.52	0.28	0.32	0.33	0.29
Ridge	0.58	0.59	0.52	0.72	0.66		0.7	0.55	0.6	0.69	0.73	0.56	0.54	0.6	0.6	0.46	0.55	0.61	0.63
Elnet	0.48	0.4	0.41	0.48	0.36	0.3		0.32	0.39	0.6	0.56	0.36	0.39	0.42	0.5	0.23	0.28	0.24	0.27
adaLASSO	0.55	0.53	0.51	0.62	0.63	0.45	0.68		0.54	0.69	0.67	0.56	0.48	0.48	0.53	0.37	0.48	0.53	0.52
adaElnet	0.56	0.49	0.5	0.55	0.55	0.4	0.64	0.46		0.64	0.63	0.46	0.46	0.45	0.52	0.36	0.38	0.44	0.42
Fact.	0.42	0.34	0.34	0.42	0.36	0.31	0.4	0.31	0.36		0.46	0.3	0.35	0.31	0.45	0.27	0.24	0.23	0.25
T. Fact.	0.39	0.32	0.34	0.4	0.4	0.27	0.44	0.33	0.37	0.54		0.3	0.35	0.32	0.45	0.22	0.25	0.23	0.22
CSR	0.56	0.5	0.48	0.65	0.6	0.44	0.64	0.44	0.54	0.7	0.7		0.49	0.52	0.61	0.35	0.42	0.47	0.52
Bagging	0.52	0.52	0.52	0.61	0.56	0.46	0.61	0.52	0.54	0.65	0.65	0.51		0.54	0.55	0.39	0.48	0.48	0.47
Boosting	0.52	0.5	0.48	0.64	0.55	0.4	0.58	0.52	0.55	0.69	0.68	0.48	0.46		0.52	0.4	0.47	0.45	0.47
Jackknife	0.48	0.49	0.45	0.48	0.48	0.4	0.5	0.47	0.48	0.55	0.55	0.39	0.45	0.48		0.37	0.42	0.42	0.42
R. Forest	0.59	0.67	0.58	0.73	0.72	0.54	0.77	0.63	0.64	0.73	0.78	0.65	0.61	0.6	0.63		0.65	0.69	0.67
Mean	0.57	0.58	0.52	0.72	0.68	0.45	0.72	0.52	0.62	0.76	0.75	0.58	0.52	0.53	0.58	0.35		0.66	0.64
25T. Mean	0.55	0.54	0.53	0.7	0.67	0.39	0.76	0.47	0.56	0.77	0.77	0.53	0.52	0.55	0.58	0.31	0.34		0.49
Median	0.54	0.55	0.5	0.7	0.71	0.37	0.73	0.48	0.58	0.75	0.78	0.48	0.53	0.53	0.58	0.33	0.36	0.51	

Results 2001 – 2015

Forecasting Errors

Consumer Price Index 2001-2015

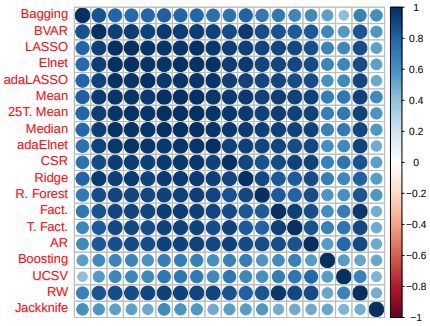
Forecasting Horizon

RMSE (MAE)	$t+1$	$t+2$	$t+3$	$t+4$	$t+5$	$t+6$	$t+7$	$t+8$	$t+9$	$t+10$	$t+11$	$t+12$	count RMSE (count MAE)
AR	0.92	0.81	0.78	0.80	0.79	0.79	0.78	0.76	0.77	0.81	0.82	0.73	6
	(0.87)	(0.78)	(0.74)	(0.79)	(0.80)	(0.80)	(0.75)	(0.75)	(0.76)	(0.80)	(0.79)	(0.70)	(1)
UCSV	0.98	0.81	0.79	0.80	0.77	0.77	0.77	0.76	0.76	0.79	0.81	0.76	8
	(0.93)	(0.81)	(0.76)	(0.77)	(0.78)	(0.77)	(0.77)	(0.77)	(0.75)	(0.76)	(0.81)	(0.73)	(4)
BVAR	0.83	0.75	0.72	0.75	0.74	0.74	0.75	0.74	0.74	0.79	0.79	0.72	12
	(0.81)	(0.72)	(0.68)	(0.75)	(0.75)	(0.73)	(0.69)	(0.69)	(0.70)	(0.73)	(0.74)	(0.67)	(12)
LASSO	0.84	0.74	0.71	0.75	0.74	0.74	0.75	0.72	0.74	0.78	0.79	0.70	11
	(0.79)	(0.71)	(0.67)	(0.75)	(0.74)	(0.72)	(0.69)	(0.67)	(0.69)	(0.73)	(0.75)	(0.65)	(10)
Ridge	0.86	0.72	0.70	0.75	0.73	0.74	0.74	0.72	0.72	0.76	0.77	0.69	8
	(0.83)	(0.70)	(0.67)	(0.75)	(0.75)	(0.74)	(0.69)	(0.68)	(0.69)	(0.71)	(0.73)	(0.67)	(11)
Elnet	0.84	0.74	0.71	0.74	0.73	0.74	0.74	0.73	0.73	0.79	0.79	0.70	9
	(0.80)	(0.70)	(0.67)	(0.74)	(0.74)	(0.72)	(0.69)	(0.67)	(0.69)	(0.73)	(0.74)	(0.64)	(10)
adaLASSO	0.84	0.75	0.72	0.76	0.75	0.75	0.76	0.74	0.75	0.79	0.81	0.70	12
	(0.80)	(0.72)	(0.68)	(0.76)	(0.76)	(0.73)	(0.71)	(0.69)	(0.71)	(0.75)	(0.78)	(0.67)	(7)
adaElnet	0.85	0.74	0.72	0.76	0.75	0.75	0.75	0.74	0.74	0.79	0.80	0.70	12
	(0.81)	(0.71)	(0.68)	(0.76)	(0.76)	(0.73)	(0.70)	(0.68)	(0.70)	(0.74)	(0.76)	(0.67)	(9)
Fact.	0.87	0.77	0.75	0.77	0.76	0.77	0.79	0.80	0.79	0.81	0.81	0.74	7
	(0.84)	(0.76)	(0.72)	(0.77)	(0.78)	(0.76)	(0.74)	(0.76)	(0.78)	(0.79)	(0.77)	(0.69)	(3)
T. Fact.	0.88	0.76	0.74	0.76	0.74	0.76	0.78	0.78	0.76	0.78	0.80	0.74	8
	(0.85)	(0.75)	(0.71)	(0.74)	(0.75)	(0.76)	(0.75)	(0.75)	(0.74)	(0.76)	(0.76)	(0.69)	(4)
CSR	0.86	0.75	0.74	0.78	0.78	0.79	0.80	0.77	0.78	0.82	0.83	0.75	9
	(0.82)	(0.71)	(0.69)	(0.78)	(0.79)	(0.78)	(0.74)	(0.73)	(0.75)	(0.78)	(0.80)	(0.73)	(4)
Bagging	**0.82**	0.74	0.72	0.78	0.76	0.77	0.81	0.80	0.76	0.80	0.81	0.73	10
	(0.84)	(0.74)	(0.71)	(0.83)	(0.84)	(0.82)	(0.80)	(0.79)	(0.76)	(0.80)	(0.82)	(0.74)	(3)
Boosting	0.95	0.75	0.72	0.76	0.74	0.76	0.77	0.75	0.76	0.81	0.81	0.73	10
	(0.91)	(0.72)	(0.70)	(0.79)	(0.78)	(0.79)	(0.76)	(0.75)	(0.76)	(0.79)	(0.79)	(0.69)	(4)
Jackknife	1.00	0.78	0.79	0.83	0.80	0.77	0.89	0.83	0.79	0.91	0.88	0.77	5
	(0.99)	(0.78)	(0.79)	(0.92)	(0.91)	(0.84)	(0.85)	(0.82)	(0.81)	(0.88)	(0.87)	(0.78)	(0)
R. Forest	0.86	**0.72**	**0.69**	**0.73**	**0.71**	**0.71**	**0.71**	**0.70**	**0.71**	**0.75**	**0.76**	**0.68**	12
	(0.81)	**(0.70)**	**(0.66)**	**(0.74)**	**(0.71)**	**(0.70)**	**(0.67)**	**(0.66)**	**(0.67)**	**(0.70)**	(0.72)	**(0.63)**	(12)
Mean	0.84	0.74	0.72	0.75	0.74	0.74	0.75	0.74	0.73	0.76	0.77	0.69	12
	(0.80)	(0.71)	(0.69)	(0.74)	(0.75)	(0.73)	(0.70)	(0.70)	(0.70)	(0.71)	**(0.72)**	(0.65)	(10)
25T. Mean	0.85	0.73	0.71	0.75	0.73	0.74	0.74	0.73	0.73	0.77	0.78	0.70	11
	(0.80)	(0.71)	(0.67)	(0.74)	(0.74)	(0.72)	(0.69)	(0.68)	(0.69)	(0.72)	(0.72)	(0.64)	(12)
Median	0.85	0.73	0.71	0.75	0.73	0.74	0.74	0.73	0.73	0.77	0.78	0.70	11
	(0.80)	(0.70)	(0.67)	(0.74)	(0.75)	(0.72)	(0.69)	(0.68)	(0.69)	(0.72)	(0.73)	(0.65)	(12)
RMSE count	11	14	9	17	15	15	14	14	18	17	16	13	
MAE count	(11)	(13)	(14)	(16)	(13)	(13)	(8)	(9)	(9)	(8)	(6)	(8)	

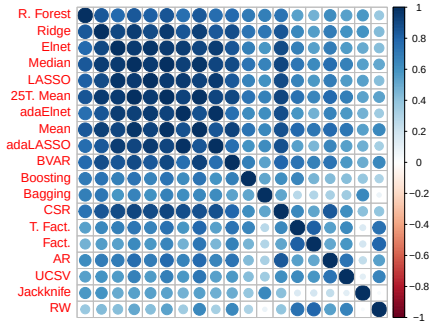
Results 2001–2015

Forecasts Correlation

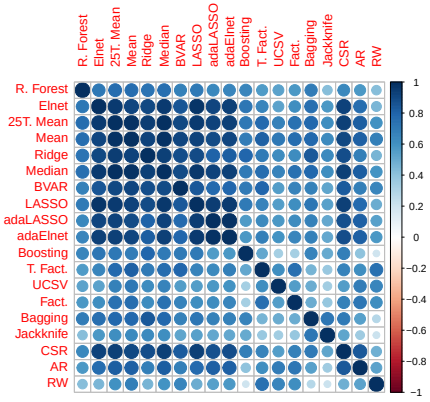
(a) t+1



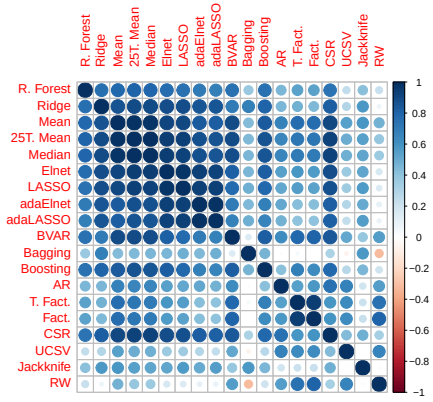
(b) t+3



(c) t+6



(d) t+12



Results 2001 – 2015

Percentage of Times Each Model is the Best (Worst)

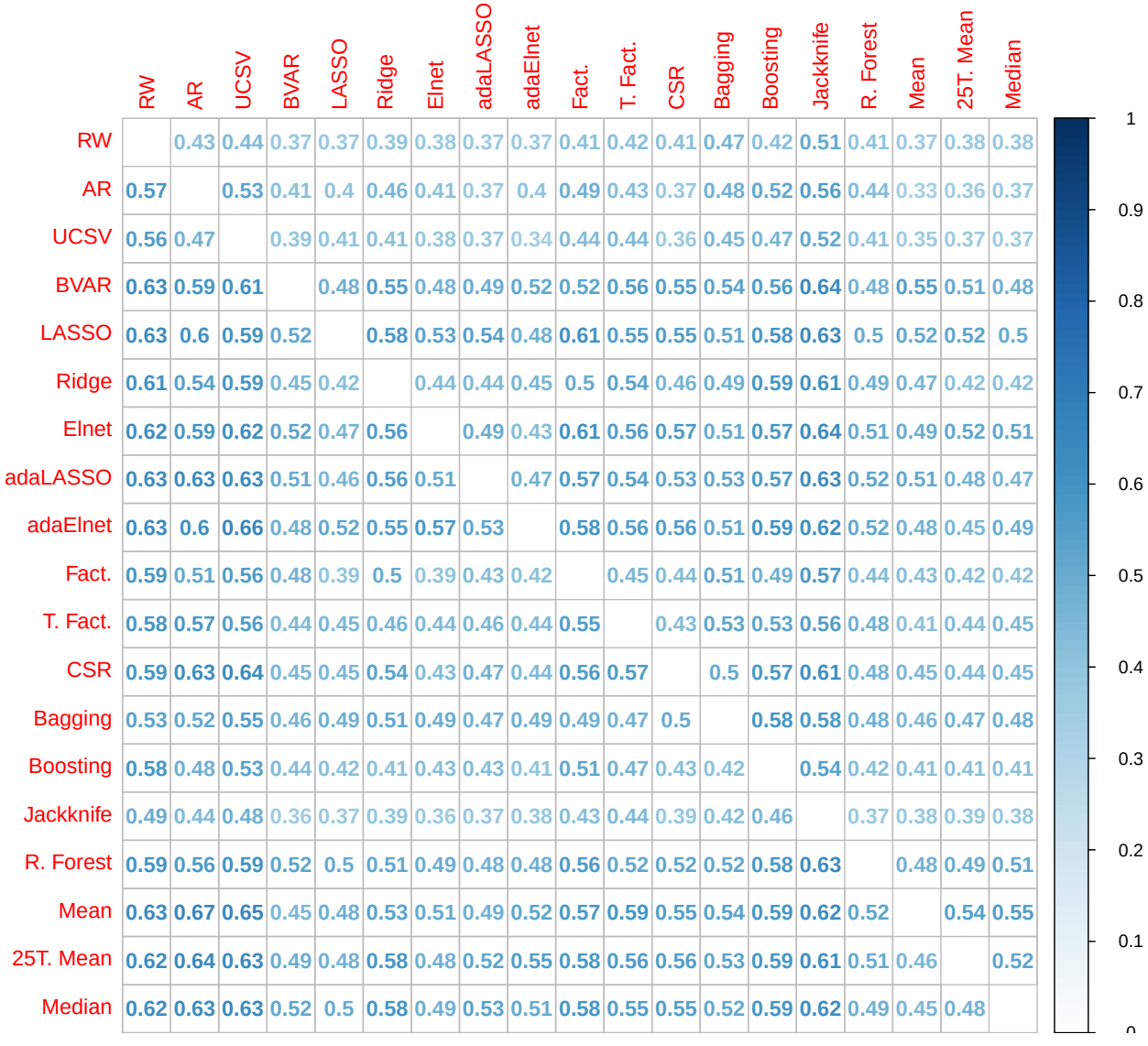
Consumer Price Index - Ranking - 1990-2000

Forecasting Horizon

%best (%worst)	$t+1$	$t+2$	$t+3$	$t+4$	$t+5$	$t+6$	$t+7$	$t+8$	$t+9$	$t+10$	$t+11$	$t+12$
RW	14.44	12.22	11.67	**16.67**	**17.78**	11.11	**11.11**	**13.33**	12.22	10.56	10.00	6.67
	(22.78)	**(34.44)**	**(36.11)**	**(29.44)**	**(30.56)**	**(29.44)**	**(35.00)**	**(33.33)**	**(30.00)**	**(28.33)**	**(30.00)**	**(33.33)**
AR	3.89	5.56	5.00	6.67	6.11	5.00	3.89	3.89	4.44	6.11	6.67	5.00
	(2.78)	(5.00)	(6.67)	(8.33)	(8.89)	(7.22)	(6.11)	(5.56)	(7.22)	(5.56)	(7.78)	(4.44)
UCSV	5.00	4.44	3.33	7.22	5.56	6.67	6.67	5.56	6.11	10.56	5.56	7.22
	(9.44)	(4.44)	(3.89)	(2.22)	(1.11)	(3.89)	(2.22)	(0.00)	(1.67)	(3.89)	(7.22)	(3.89)
BVAR	5.56	2.78	5.00	3.89	0.56	3.89	3.89	4.44	6.11	5.00	5.00	6.67
	(2.22)	(0.56)	(0.00)	(0.00)	(0.00)	(0.56)	(0.00)	(0.56)	(1.11)	(1.11)	(2.22)	(1.11)
LASSO	2.78	1.67	3.89	0.56	1.11	3.89	2.78	1.11	2.22	1.11	2.78	2.22
	(0.00)	(0.56)	(0.00)	(0.56)	(0.56)	(0.56)	(0.56)	(0.56)	(0.56)	(0.56)	(0.56)	(0.00)
Ridge	2.22	3.33	3.89	3.89	6.67	3.89	3.89	6.11	7.78	5.00	7.78	3.33
	(0.56)	(0.00)	(0.56)	(0.56)	(0.56)	(0.00)	(0.00)	(1.11)	(0.56)	(1.11)	(1.11)	(0.00)
Elnet	0.56	1.11	1.11	3.89	2.78	5.00	3.89	2.78	1.11	3.33	1.67	3.33
	(0.56)	(0.56)	(1.11)	(1.11)	(0.56)	(0.56)	(1.11)	(0.00)	(1.67)	(2.22)	(0.56)	(0.00)
adaLASSO	3.33	4.44	2.78	2.22	2.78	3.89	3.33	4.44	2.22	2.22	1.67	7.22
	(0.00)	(1.67)	(0.56)	(0.56)	(0.56)	(0.00)	(1.67)	(2.22)	(1.11)	(2.78)	(2.78)	(3.33)
adaElnet	1.11	2.22	1.11	1.67	1.11	2.78	1.67	2.78	1.67	1.11	2.22	0.56
	(0.00)	(0.00)	(0.00)	(0.00)	(0.56)	(0.00)	(0.00)	(0.00)	(0.56)	(0.00)	(0.56)	(0.56)
Fact.	4.44	4.44	10.56	7.22	8.33	9.44	7.22	6.11	3.89	2.22	1.67	3.33
	(1.67)	(3.33)	(6.11)	(4.44)	(4.44)	(2.78)	(3.89)	(5.00)	(3.33)	(0.56)	(0.56)	(1.11)
T. Fact.	5.56	3.89	5.00	6.67	5.56	4.44	3.33	3.89	4.44	2.78	3.33	4.44
	(4.44)	(2.78)	(1.11)	(0.56)	(2.78)	(4.44)	(1.67)	(2.78)	(1.67)	(2.78)	(0.56)	(0.56)
CSR	2.78	5.00	5.56	2.78	2.22	1.67	3.89	6.67	1.67	5.56	4.44	4.44
	(1.11)	(1.67)	(0.56)	(1.11)	(1.67)	(3.89)	(2.78)	(3.33)	(3.33)	(1.11)	(3.33)	(4.44)
Bagging	12.22	**17.22**	**12.22**	5.56	8.89	8.33	8.89	9.44	11.11	7.78	7.78	9.44
	(10.56)	(13.89)	(8.33)	(12.22)	(11.67)	(8.89)	(11.11)	(11.67)	(11.11)	(13.89)	(12.22)	(10.00)
Boosting	**15.56**	11.67	11.67	11.67	13.89	10.00	10.00	11.11	**16.11**	10.00	11.67	7.78
	(17.78)	(11.11)	(11.11)	(14.44)	(11.11)	(15.00)	(16.67)	(13.33)	(17.22)	(13.33)	(11.11)	(11.11)
Jackknife	9.44	11.11	11.67	9.44	6.67	**11.67**	9.44	10.00	8.33	**12.78**	**17.22**	**14.44**
	(22.78)	(18.33)	(21.67)	(22.22)	(22.22)	(19.44)	(15.00)	(18.33)	(17.22)	(20.00)	(17.78)	(23.33)
R. Forest	6.67	5.56	4.44	5.00	7.22	4.44	**11.11**	7.22	7.78	6.11	5.56	6.11
	(3.33)	(1.67)	(2.22)	(2.22)	(2.78)	(3.33)	(2.22)	(2.22)	(1.67)	(2.78)	(1.67)	(2.78)
Mean	2.22	1.67	0.00	1.67	1.67	1.67	1.67	0.56	1.11	2.78	3.33	3.33
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
25T. Mean	0.00	0.56	1.11	1.67	1.11	1.11	1.67	0.56	1.11	2.78	0.56	2.78
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Median	2.22	1.11	0.00	1.67	0.00	1.11	1.67	0.00	0.56	2.22	1.11	1.67
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Results 2001 – 2015

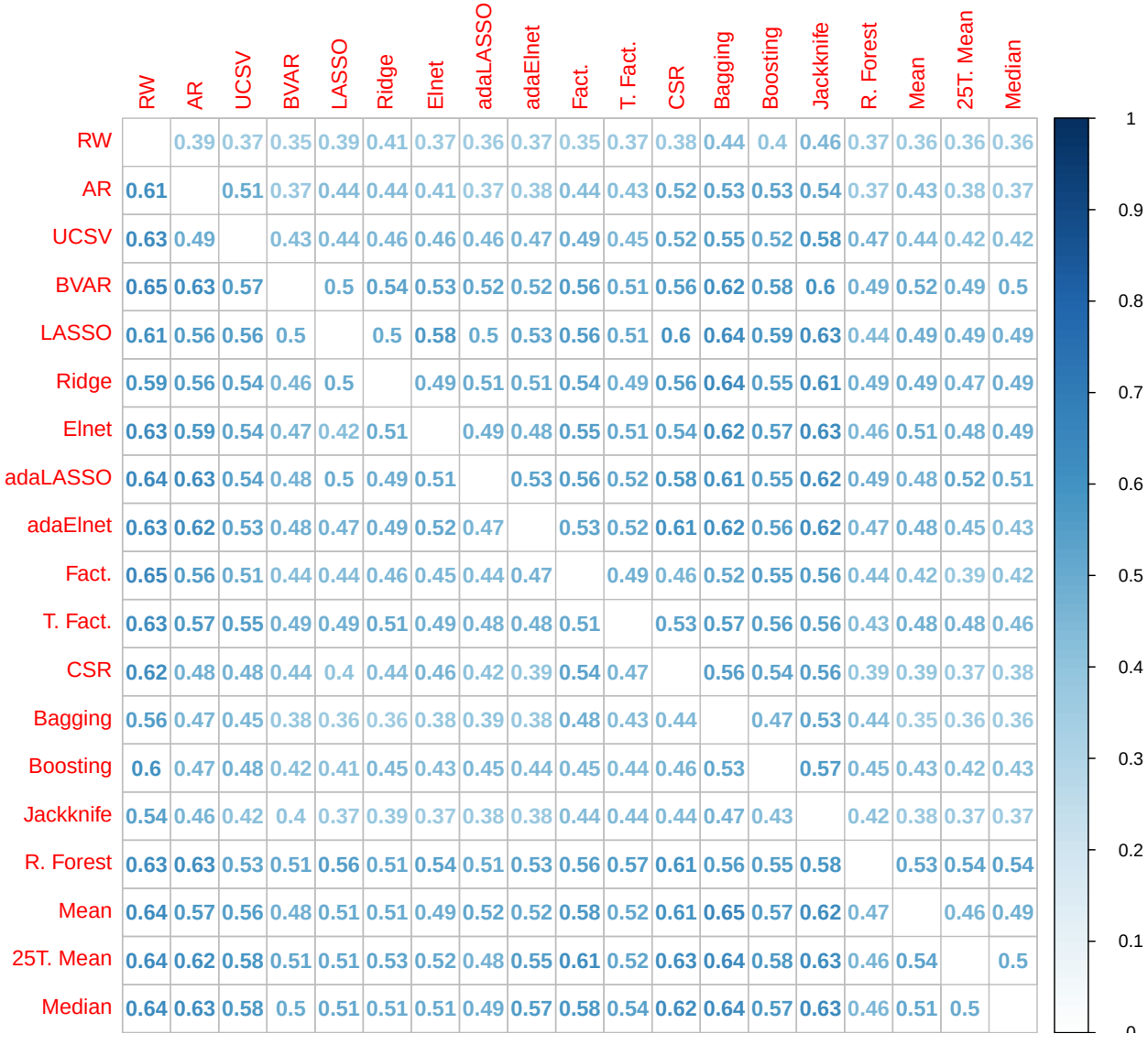
Model Comparison – One-step-Ahead



	RW	AR	UCSV	BVAR	LASSO	Ridge	Elnet	adaLASSO	adaElnet	Fact.	T. Fact.	CSR	Bagging	Boosting	Jackknife	R. Forest	Mean	25T. Mean	Median
RW		0.43	0.44	0.37	0.37	0.39	0.38	0.37	0.37	0.41	0.42	0.41	0.47	0.42	0.51	0.41	0.37	0.38	0.38
AR	0.57		0.53	0.41	0.4	0.46	0.41	0.37	0.4	0.49	0.43	0.37	0.48	0.52	0.56	0.44	0.33	0.36	0.37
UCSV	0.56	0.47		0.39	0.41	0.41	0.38	0.37	0.34	0.44	0.44	0.36	0.45	0.47	0.52	0.41	0.35	0.37	0.37
BVAR	0.63	0.59	0.61		0.48	0.55	0.48	0.49	0.52	0.52	0.56	0.55	0.54	0.56	0.64	0.48	0.55	0.51	0.48
LASSO	0.63	0.6	0.59	0.52		0.58	0.53	0.54	0.48	0.61	0.55	0.55	0.51	0.58	0.63	0.5	0.52	0.52	0.5
Ridge	0.61	0.54	0.59	0.45	0.42		0.44	0.44	0.45	0.5	0.54	0.46	0.49	0.59	0.61	0.49	0.47	0.42	0.42
Elnet	0.62	0.59	0.62	0.52	0.47	0.56		0.49	0.43	0.61	0.56	0.57	0.51	0.57	0.64	0.51	0.49	0.52	0.51
adaLASSO	0.63	0.63	0.63	0.51	0.46	0.56	0.51		0.47	0.57	0.54	0.53	0.53	0.57	0.63	0.52	0.51	0.48	0.47
adaElnet	0.63	0.6	0.66	0.48	0.52	0.55	0.57	0.53		0.58	0.56	0.56	0.51	0.59	0.62	0.52	0.48	0.45	0.49
Fact.	0.59	0.51	0.56	0.48	0.39	0.5	0.39	0.43	0.42		0.45	0.44	0.51	0.49	0.57	0.44	0.43	0.42	0.42
T. Fact.	0.58	0.57	0.56	0.44	0.45	0.46	0.44	0.46	0.44	0.55		0.43	0.53	0.53	0.56	0.48	0.41	0.44	0.45
CSR	0.59	0.63	0.64	0.45	0.45	0.54	0.43	0.47	0.44	0.56	0.57		0.5	0.57	0.61	0.48	0.45	0.44	0.45
Bagging	0.53	0.52	0.55	0.46	0.49	0.51	0.49	0.47	0.49	0.49	0.47	0.5		0.58	0.58	0.48	0.46	0.47	0.48
Boosting	0.58	0.48	0.53	0.44	0.42	0.41	0.43	0.43	0.41	0.51	0.47	0.43	0.42		0.54	0.42	0.41	0.41	0.41
Jackknife	0.49	0.44	0.48	0.36	0.37	0.39	0.36	0.37	0.38	0.43	0.44	0.39	0.42	0.46		0.37	0.38	0.39	0.38
R. Forest	0.59	0.56	0.59	0.52	0.5	0.51	0.49	0.48	0.48	0.56	0.52	0.52	0.52	0.58	0.63		0.48	0.49	0.51
Mean	0.63	0.67	0.65	0.45	0.48	0.53	0.51	0.49	0.52	0.57	0.59	0.55	0.54	0.59	0.62	0.52		0.54	0.55
25T. Mean	0.62	0.64	0.63	0.49	0.48	0.58	0.48	0.52	0.55	0.58	0.56	0.56	0.53	0.59	0.61	0.51	0.46		0.52
Median	0.62	0.63	0.63	0.52	0.5	0.58	0.49	0.53	0.51	0.58	0.55	0.55	0.52	0.59	0.62	0.49	0.45	0.48	

Results 2001 – 2015

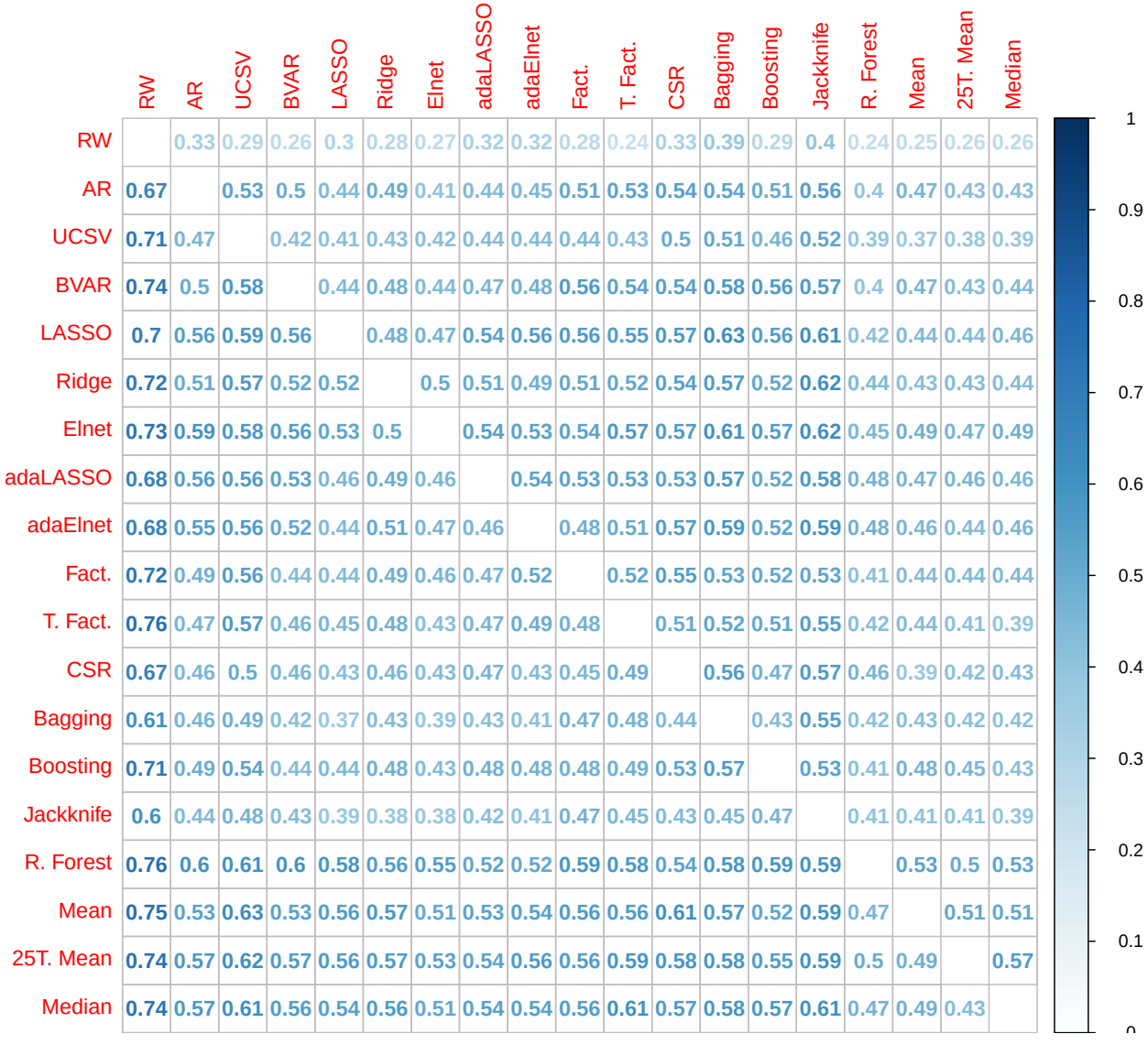
Model Comparison – Six-steps-Ahead



	RW	AR	UCSV	BVAR	LASSO	Ridge	Elnet	adaLASSO	adaElnet	Fact.	T. Fact.	CSR	Bagging	Boosting	Jackknife	R. Forest	Mean	25T. Mean	Median
RW		0.39	0.37	0.35	0.39	0.41	0.37	0.36	0.37	0.35	0.37	0.38	0.44	0.4	0.46	0.37	0.36	0.36	0.36
AR	0.61		0.51	0.37	0.44	0.44	0.41	0.37	0.38	0.44	0.43	0.52	0.53	0.53	0.54	0.37	0.43	0.38	0.37
UCSV	0.63	0.49		0.43	0.44	0.46	0.46	0.46	0.47	0.49	0.45	0.52	0.55	0.52	0.58	0.47	0.44	0.42	0.42
BVAR	0.65	0.63	0.57		0.5	0.54	0.53	0.52	0.52	0.56	0.51	0.56	0.62	0.58	0.6	0.49	0.52	0.49	0.5
LASSO	0.61	0.56	0.56	0.5		0.5	0.58	0.5	0.53	0.56	0.51	0.6	0.64	0.59	0.63	0.44	0.49	0.49	0.49
Ridge	0.59	0.56	0.54	0.46	0.5		0.49	0.51	0.51	0.54	0.49	0.56	0.64	0.55	0.61	0.49	0.49	0.47	0.49
Elnet	0.63	0.59	0.54	0.47	0.42	0.51		0.49	0.48	0.55	0.51	0.54	0.62	0.57	0.63	0.46	0.51	0.48	0.49
adaLASSO	0.64	0.63	0.54	0.48	0.5	0.49	0.51		0.53	0.56	0.52	0.58	0.61	0.55	0.62	0.49	0.48	0.52	0.51
adaElnet	0.63	0.62	0.53	0.48	0.47	0.49	0.52	0.47		0.53	0.52	0.61	0.62	0.56	0.62	0.47	0.48	0.45	0.43
Fact.	0.65	0.56	0.51	0.44	0.44	0.46	0.45	0.44	0.47		0.49	0.46	0.52	0.55	0.56	0.44	0.42	0.39	0.42
T. Fact.	0.63	0.57	0.55	0.49	0.49	0.51	0.49	0.48	0.48	0.51		0.53	0.57	0.56	0.56	0.43	0.48	0.48	0.46
CSR	0.62	0.48	0.48	0.44	0.4	0.44	0.46	0.42	0.39	0.54	0.47		0.56	0.54	0.56	0.39	0.39	0.37	0.38
Bagging	0.56	0.47	0.45	0.38	0.36	0.36	0.38	0.39	0.38	0.48	0.43	0.44		0.47	0.53	0.44	0.35	0.36	0.36
Boosting	0.6	0.47	0.48	0.42	0.41	0.45	0.43	0.45	0.44	0.45	0.44	0.46	0.53		0.57	0.45	0.43	0.42	0.43
Jackknife	0.54	0.46	0.42	0.4	0.37	0.39	0.37	0.38	0.38	0.44	0.44	0.44	0.47	0.43		0.42	0.38	0.37	0.37
R. Forest	0.63	0.63	0.53	0.51	0.56	0.51	0.54	0.51	0.53	0.56	0.57	0.61	0.56	0.55	0.58		0.53	0.54	0.54
Mean	0.64	0.57	0.56	0.48	0.51	0.51	0.49	0.52	0.52	0.58	0.52	0.61	0.65	0.57	0.62	0.47		0.46	0.49
25T. Mean	0.64	0.62	0.58	0.51	0.51	0.53	0.52	0.48	0.55	0.61	0.52	0.63	0.64	0.58	0.63	0.46	0.54		0.5
Median	0.64	0.63	0.58	0.5	0.51	0.51	0.51	0.49	0.57	0.58	0.54	0.62	0.64	0.57	0.63	0.46	0.51	0.5	

Results 2001 – 2015

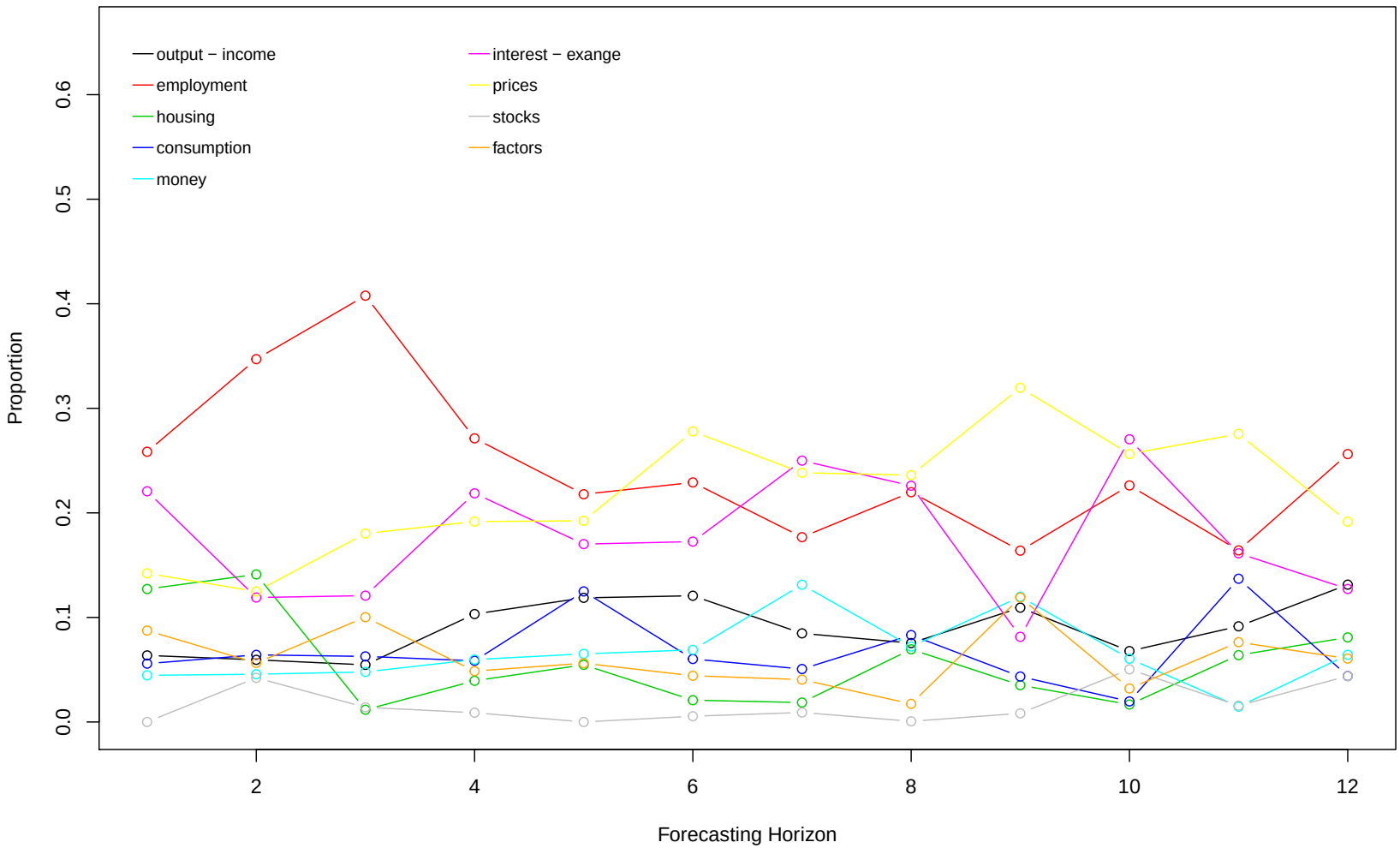
Model Comparison – 12-steps-Ahead



	RW	AR	UCSV	BVAR	LASSO	Ridge	Elnet	adaLASSO	adaElnet	Fact.	T. Fact.	CSR	Bagging	Boosting	Jackknife	R. Forest	Mean	25T. Mean	Median
RW		0.33	0.29	0.26	0.3	0.28	0.27	0.32	0.32	0.28	0.24	0.33	0.39	0.29	0.4	0.24	0.25	0.26	0.26
AR	0.67		0.53	0.5	0.44	0.49	0.41	0.44	0.45	0.51	0.53	0.54	0.54	0.51	0.56	0.4	0.47	0.43	0.43
UCSV	0.71	0.47		0.42	0.41	0.43	0.42	0.44	0.44	0.44	0.43	0.5	0.51	0.46	0.52	0.39	0.37	0.38	0.39
BVAR	0.74	0.5	0.58		0.44	0.48	0.44	0.47	0.48	0.56	0.54	0.54	0.58	0.56	0.57	0.4	0.47	0.43	0.44
LASSO	0.7	0.56	0.59	0.56		0.48	0.47	0.54	0.56	0.56	0.55	0.57	0.63	0.56	0.61	0.42	0.44	0.44	0.46
Ridge	0.72	0.51	0.57	0.52	0.52		0.5	0.51	0.49	0.51	0.52	0.54	0.57	0.52	0.62	0.44	0.43	0.43	0.44
Elnet	0.73	0.59	0.58	0.56	0.53	0.5		0.54	0.53	0.54	0.57	0.57	0.61	0.57	0.62	0.45	0.49	0.47	0.49
adaLASSO	0.68	0.56	0.56	0.53	0.46	0.49	0.46		0.54	0.53	0.53	0.53	0.57	0.52	0.58	0.48	0.47	0.46	0.46
adaElnet	0.68	0.55	0.56	0.52	0.44	0.51	0.47	0.46		0.48	0.51	0.57	0.59	0.52	0.59	0.48	0.46	0.44	0.46
Fact.	0.72	0.49	0.56	0.44	0.44	0.49	0.46	0.47	0.52		0.52	0.55	0.53	0.52	0.53	0.41	0.44	0.44	0.44
T. Fact.	0.76	0.47	0.57	0.46	0.45	0.48	0.43	0.47	0.49	0.48		0.51	0.52	0.51	0.55	0.42	0.44	0.41	0.39
CSR	0.67	0.46	0.5	0.46	0.43	0.46	0.43	0.47	0.43	0.45	0.49		0.56	0.47	0.57	0.46	0.39	0.42	0.43
Bagging	0.61	0.46	0.49	0.42	0.37	0.43	0.39	0.43	0.41	0.47	0.48	0.44		0.43	0.55	0.42	0.43	0.42	0.42
Boosting	0.71	0.49	0.54	0.44	0.44	0.48	0.43	0.48	0.48	0.48	0.49	0.53	0.57		0.53	0.41	0.48	0.45	0.43
Jackknife	0.6	0.44	0.48	0.43	0.39	0.38	0.38	0.42	0.41	0.47	0.45	0.43	0.45	0.47		0.41	0.41	0.41	0.39
R. Forest	0.76	0.6	0.61	0.6	0.58	0.56	0.55	0.52	0.52	0.59	0.58	0.54	0.58	0.59	0.59		0.53	0.5	0.53
Mean	0.75	0.53	0.63	0.53	0.56	0.57	0.51	0.53	0.54	0.56	0.56	0.61	0.57	0.52	0.59	0.47		0.51	0.51
25T. Mean	0.74	0.57	0.62	0.57	0.56	0.57	0.53	0.54	0.56	0.56	0.59	0.58	0.58	0.55	0.59	0.5	0.49		0.57
Median	0.74	0.57	0.61	0.56	0.54	0.56	0.51	0.54	0.54	0.56	0.61	0.57	0.58	0.57	0.61	0.47	0.49	0.43	

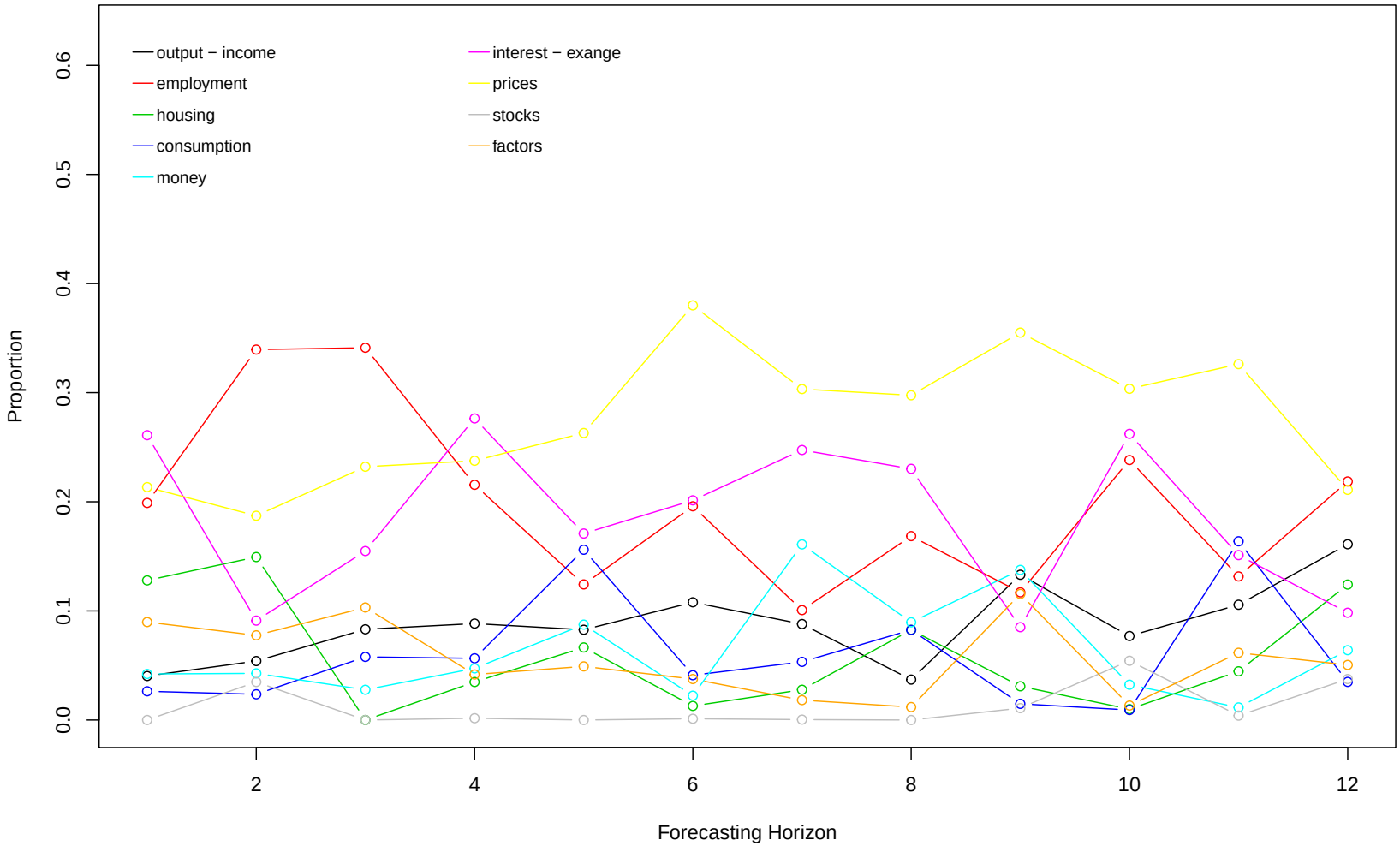
Results 1990 – 2015

LASSO Variable Selection



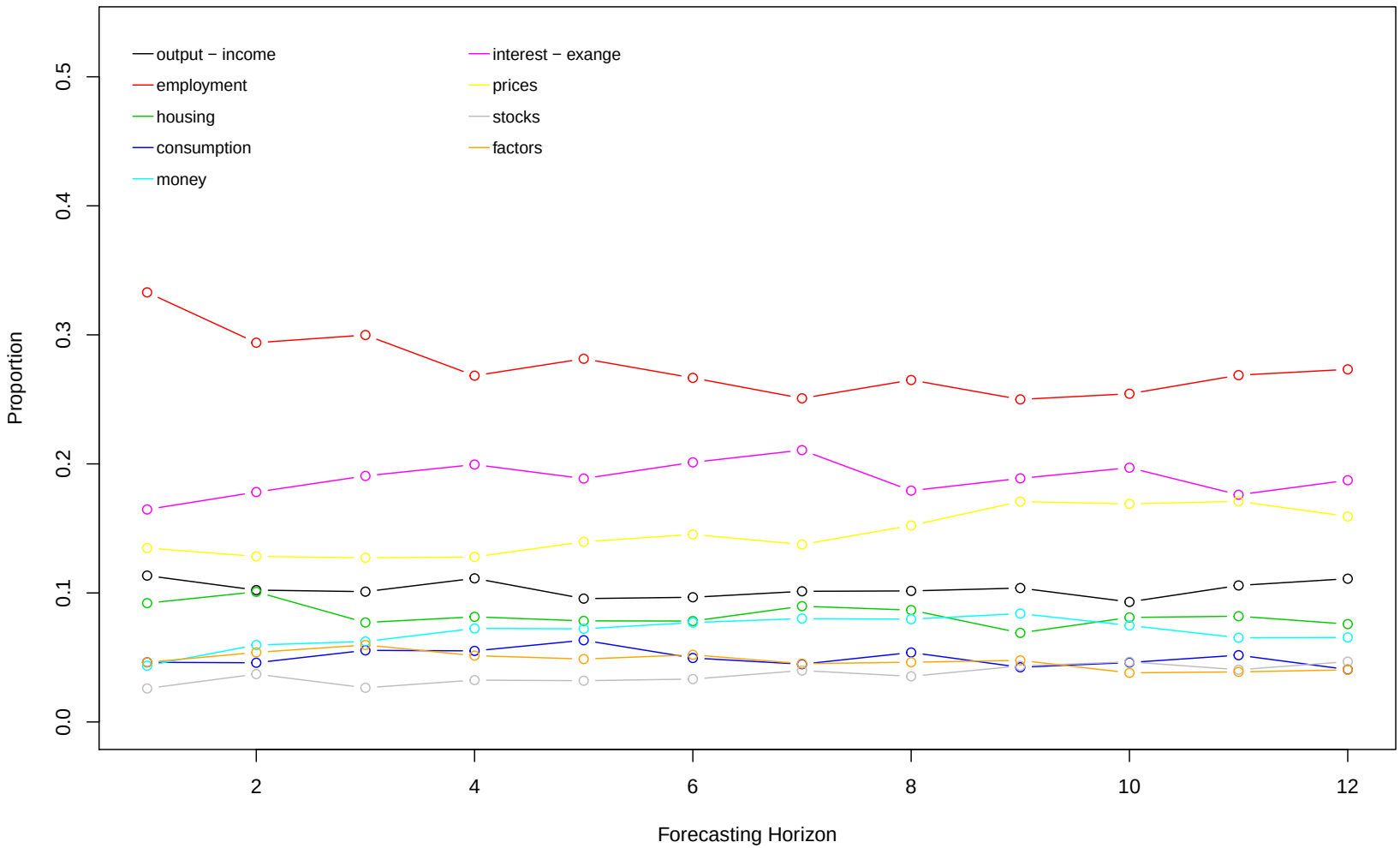
Results 1990 – 2015

adaLASSO Variable Selection



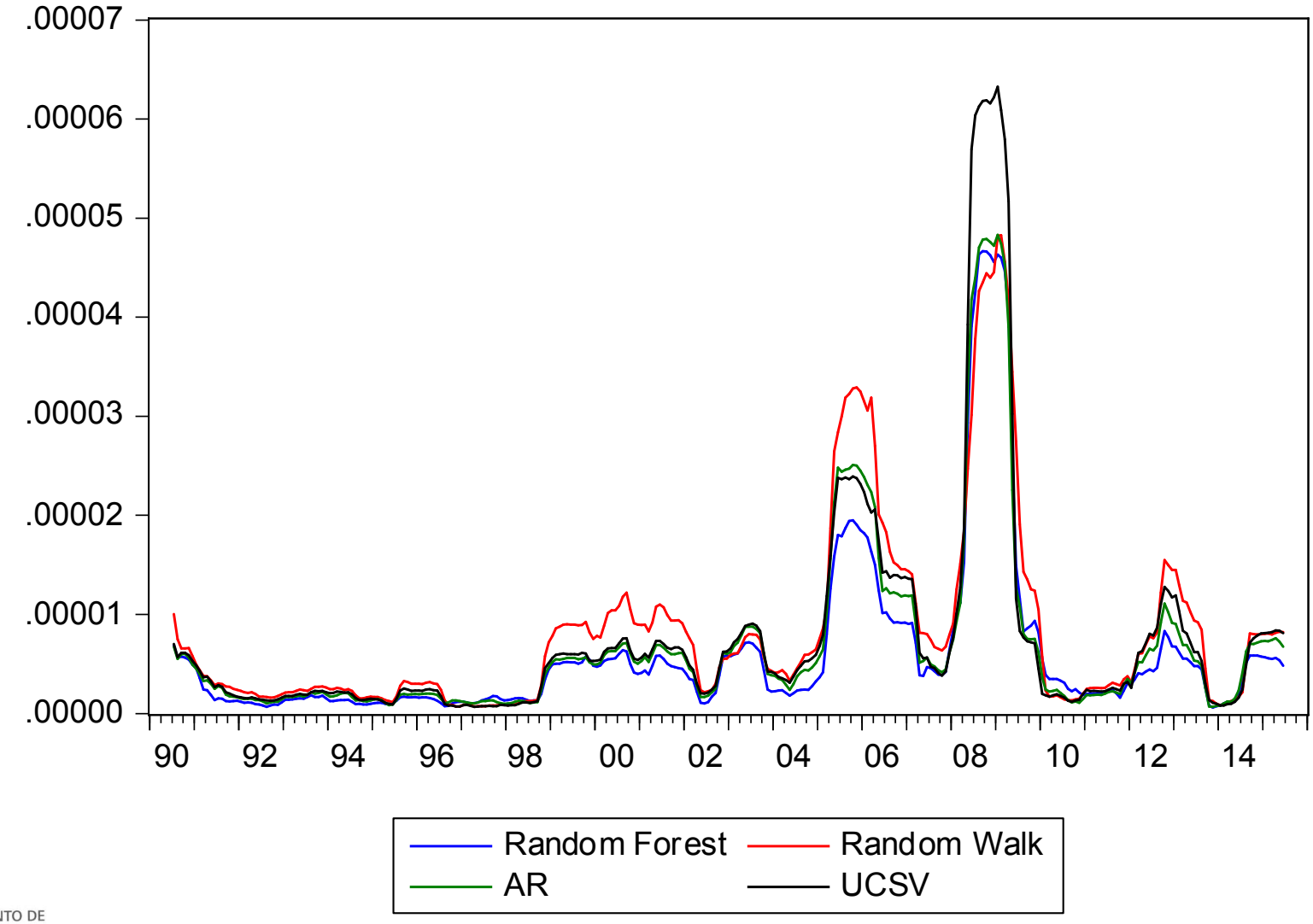
Results 1990 – 2015

Random Forest Variable Selection



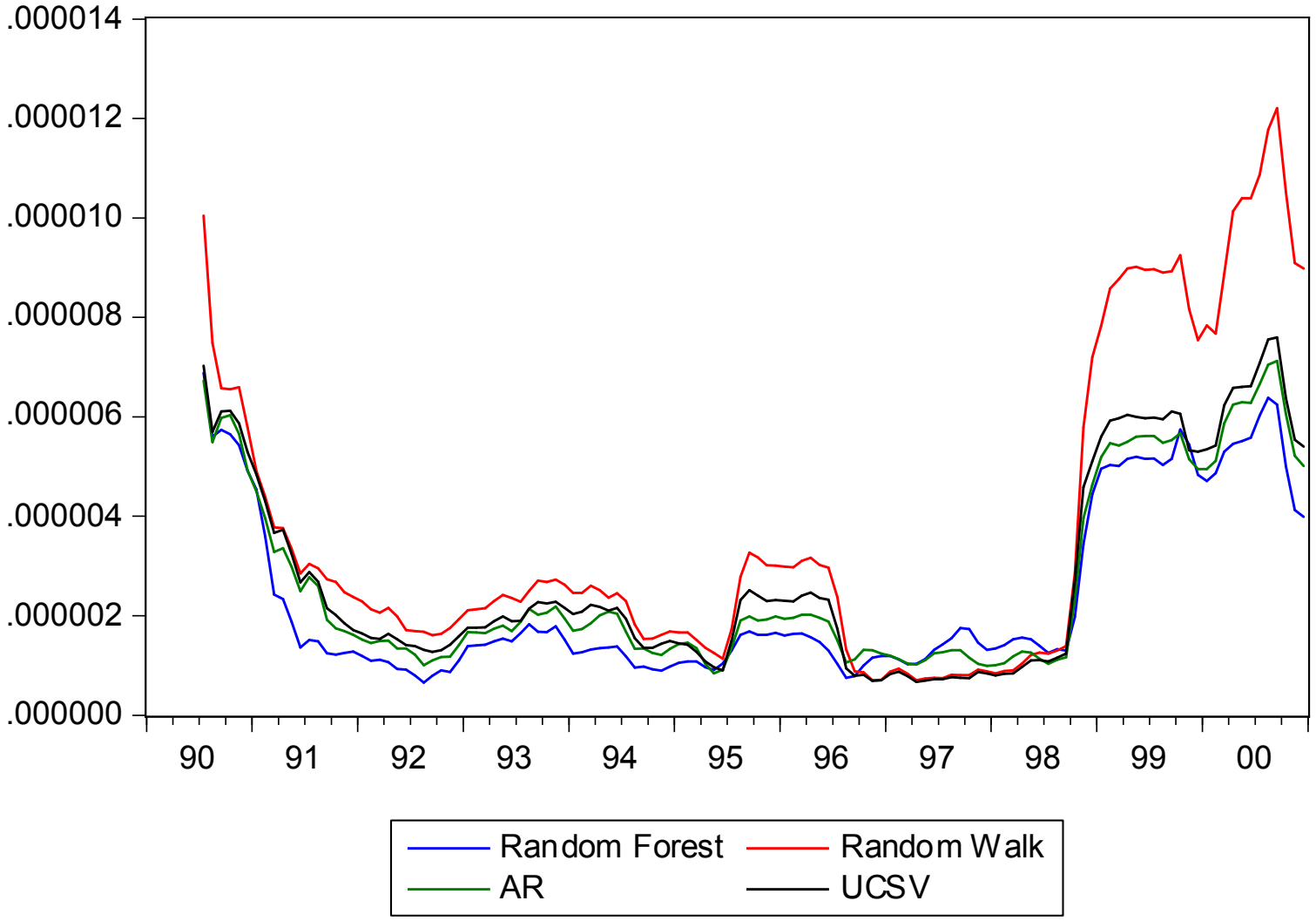
Results 1990 – 2015

Rolling RMSEs (One year centered window)



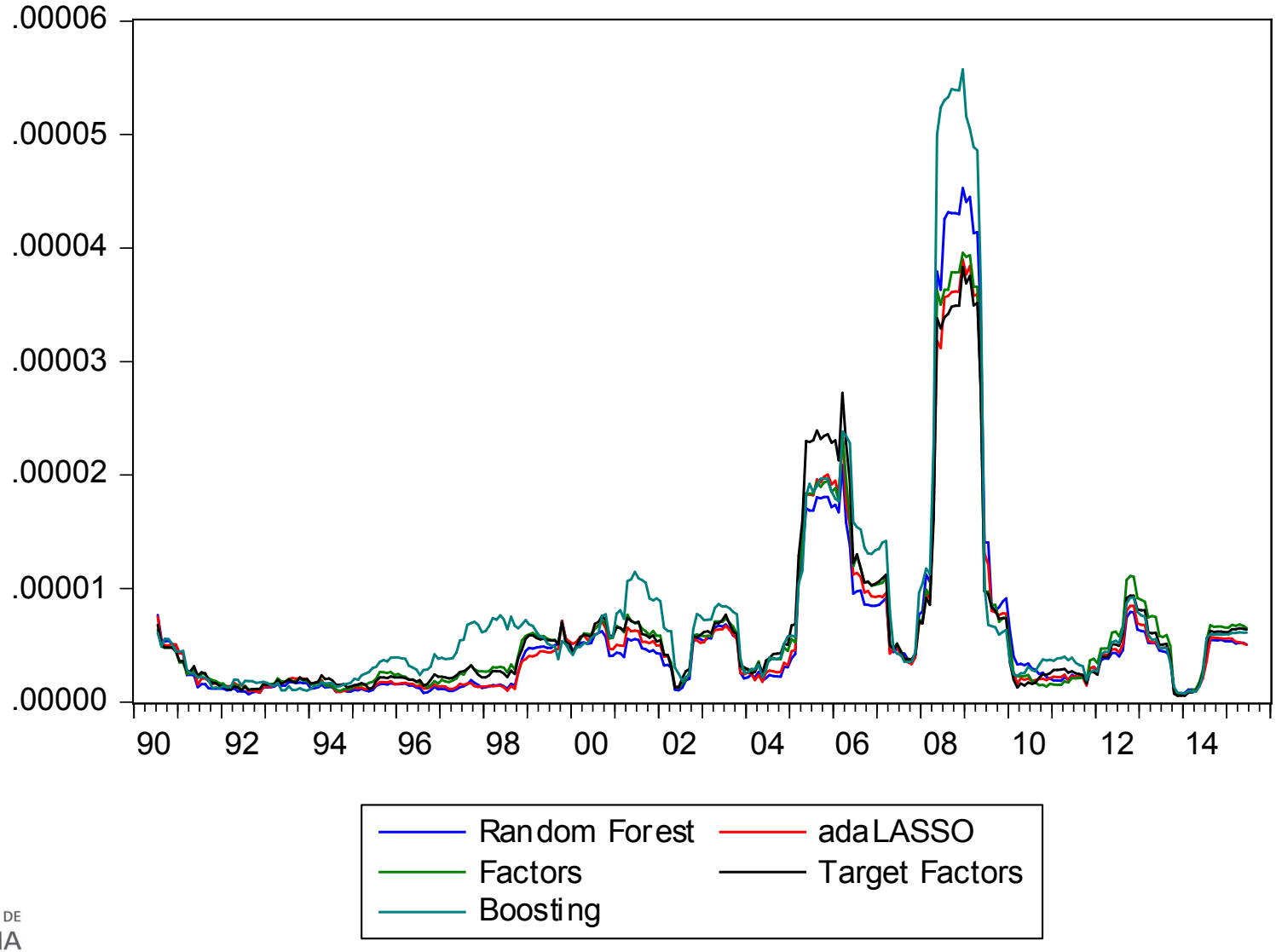
Results 1990 – 2015

Rolling RMSEs (One year centered window)



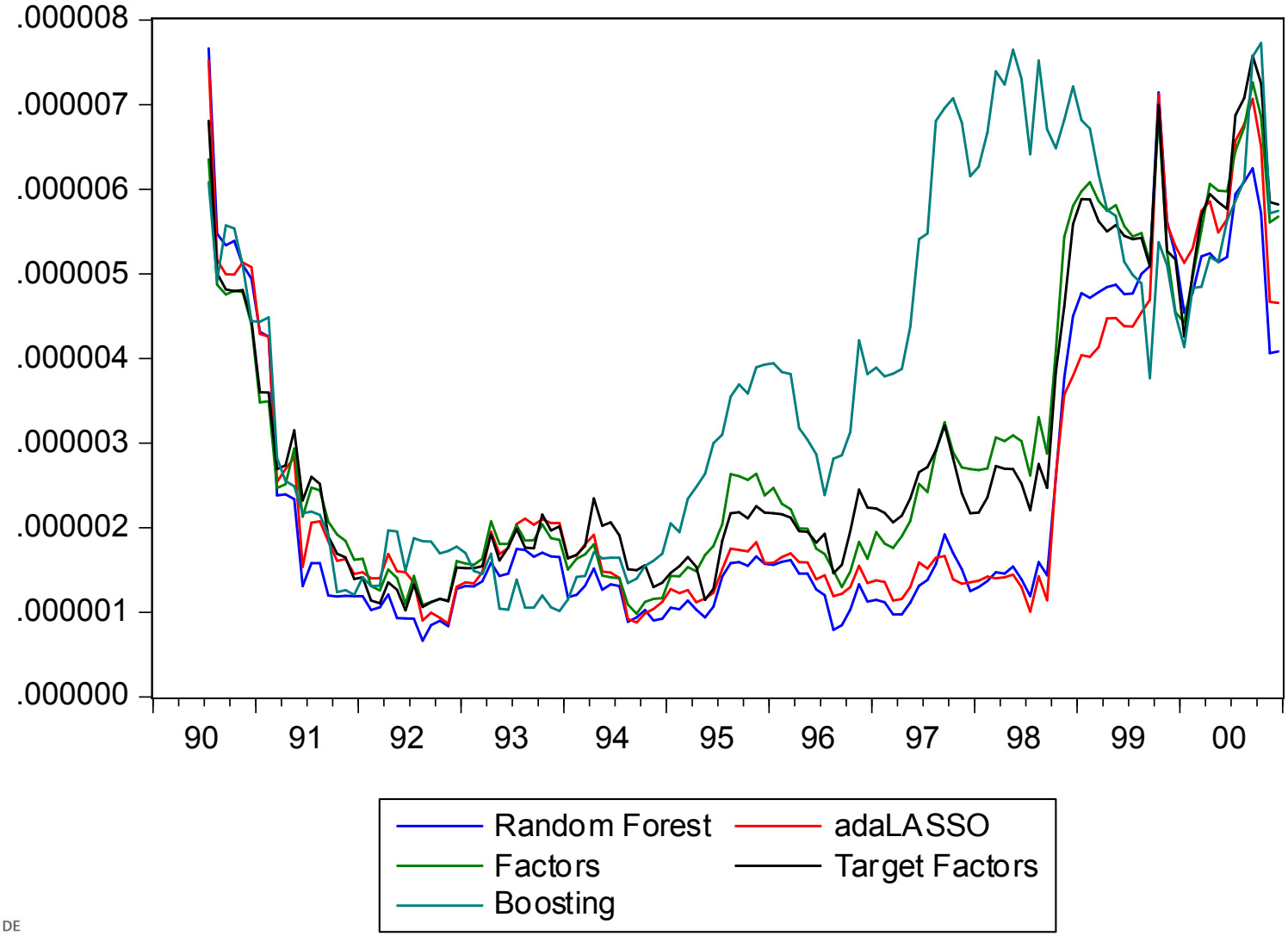
Results 1990 – 2015

Rolling RMSEs (One year centered window)



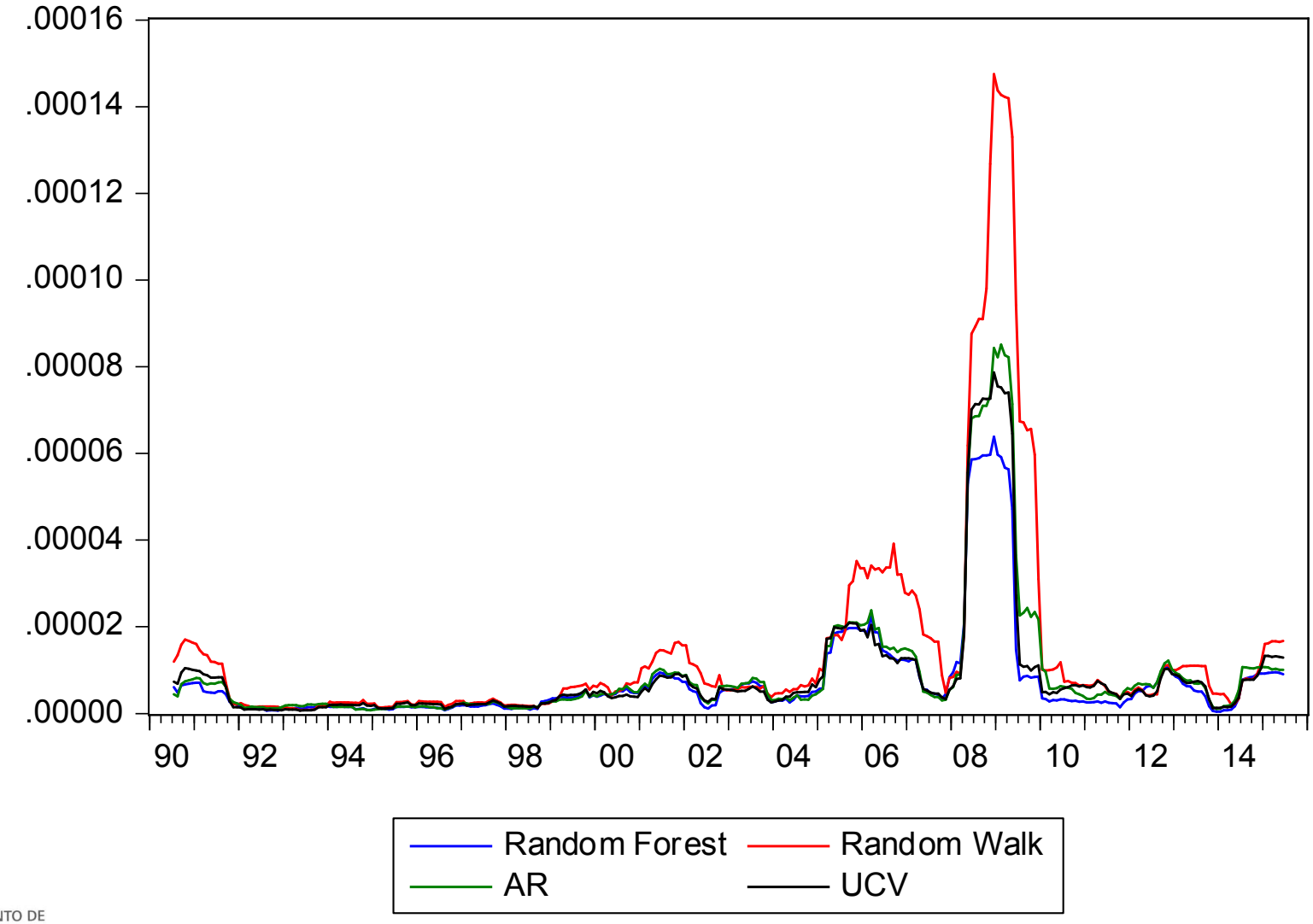
Results 1990 – 2015

Rolling RMSEs (One year centered window)



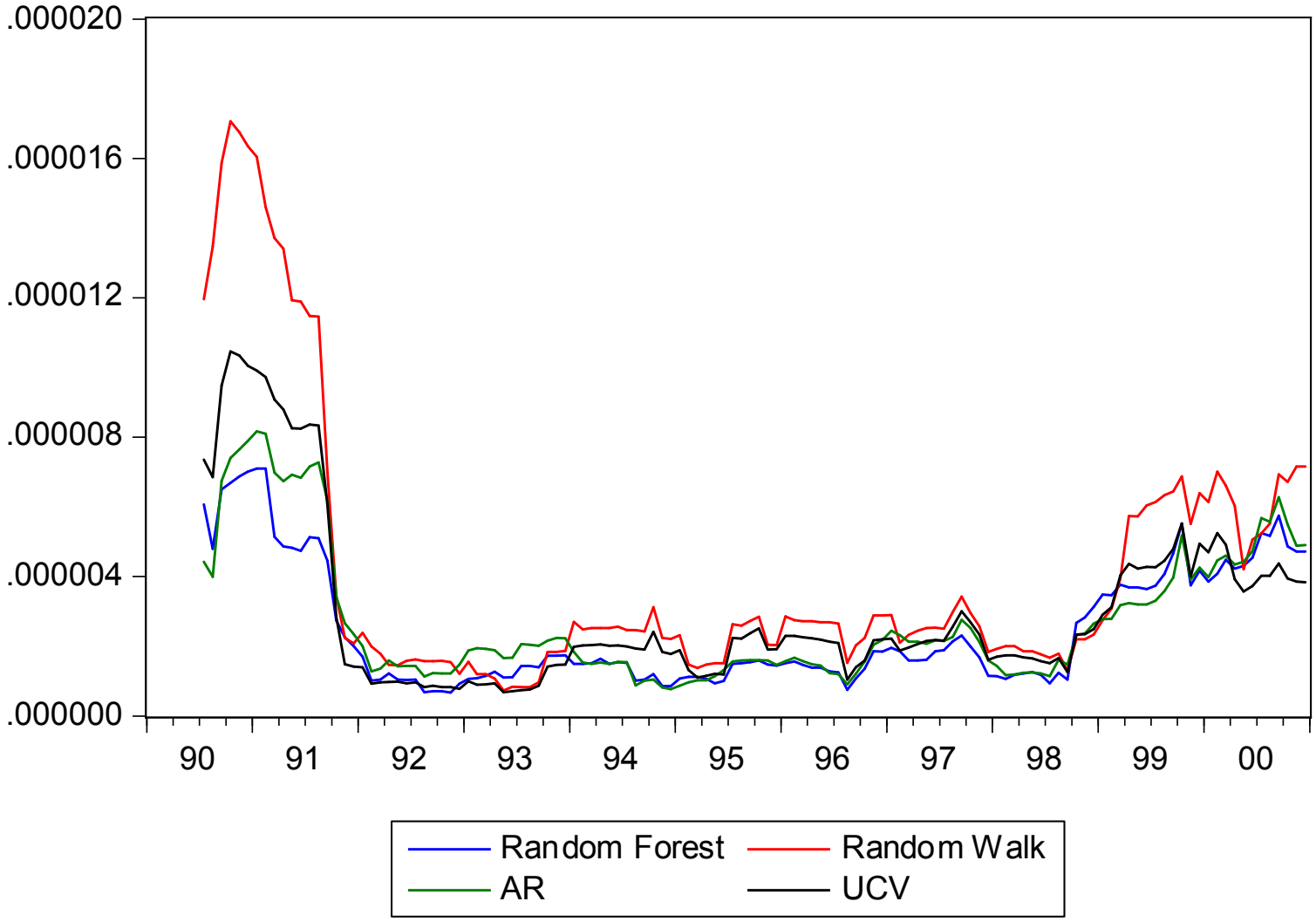
Results 1990 – 2015

Rolling RMSEs (One year centered window, six-steps-ahead)



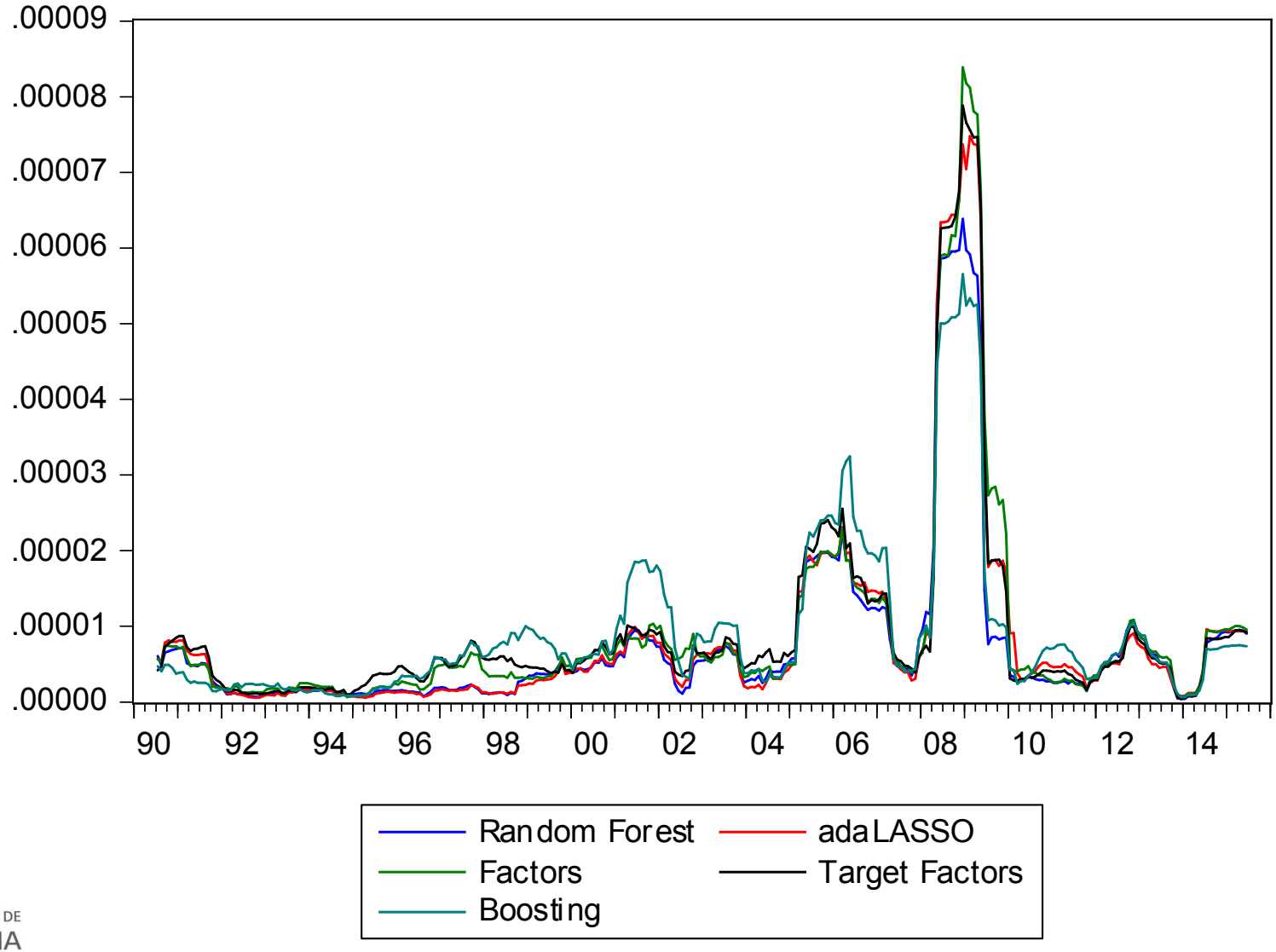
Results 1990 – 2015

Rolling RMSEs (One year centered window, six-steps-ahead)



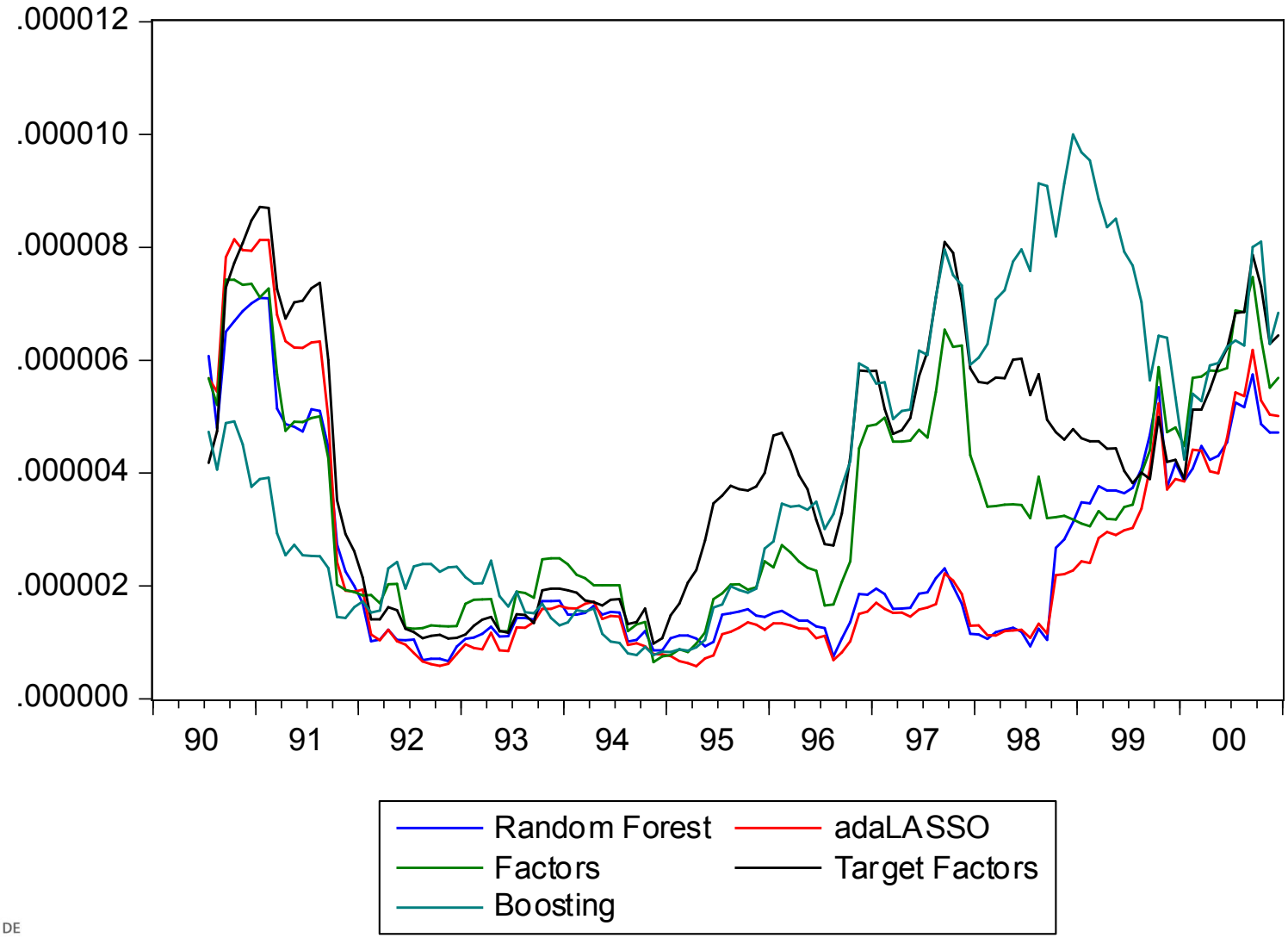
Results 1990 – 2015

Rolling RMSEs (One year centered window, six-steps-ahead)



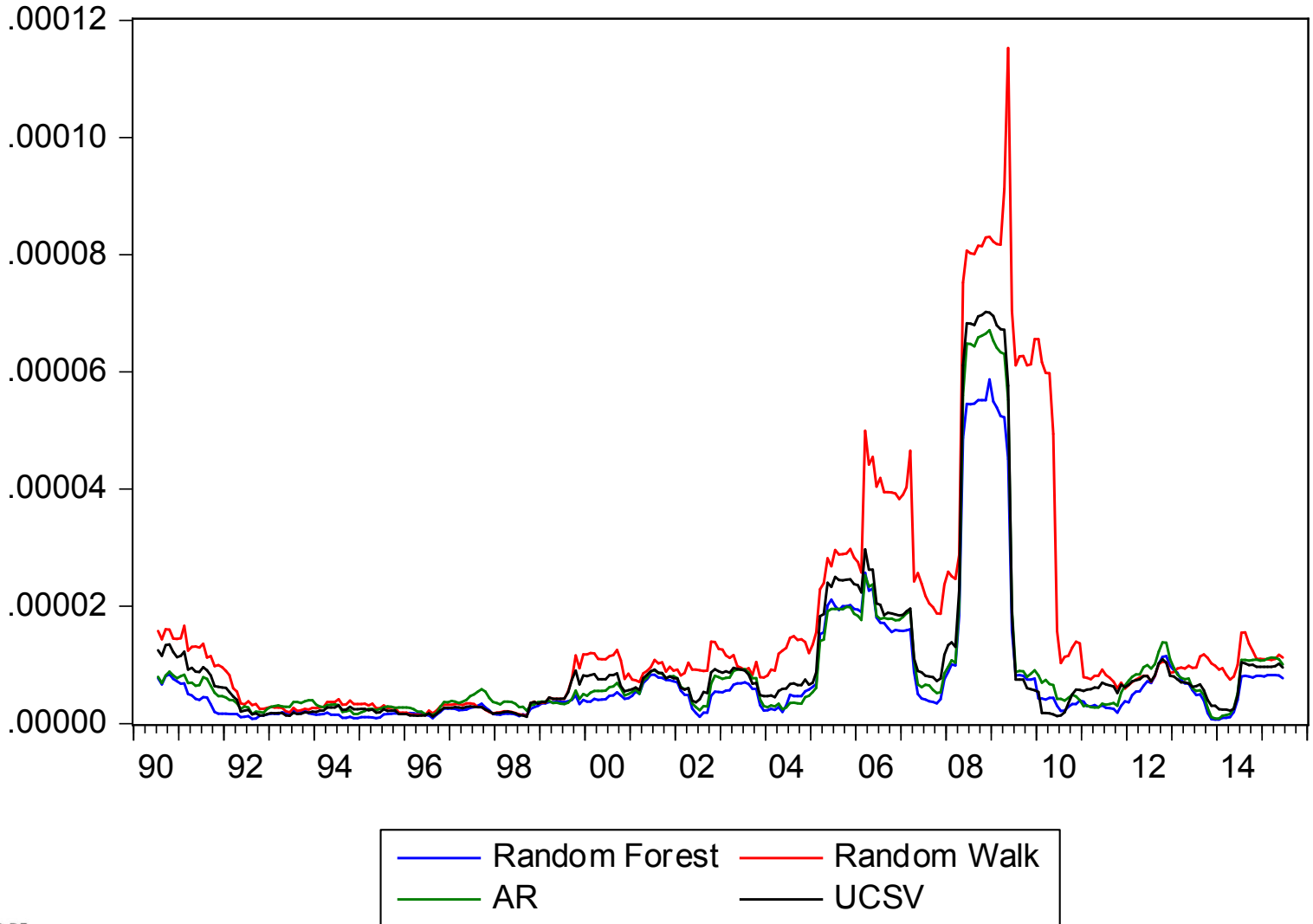
Results 1990 – 2015

Rolling RMSEs (One year centered window, six-steps-ahead)



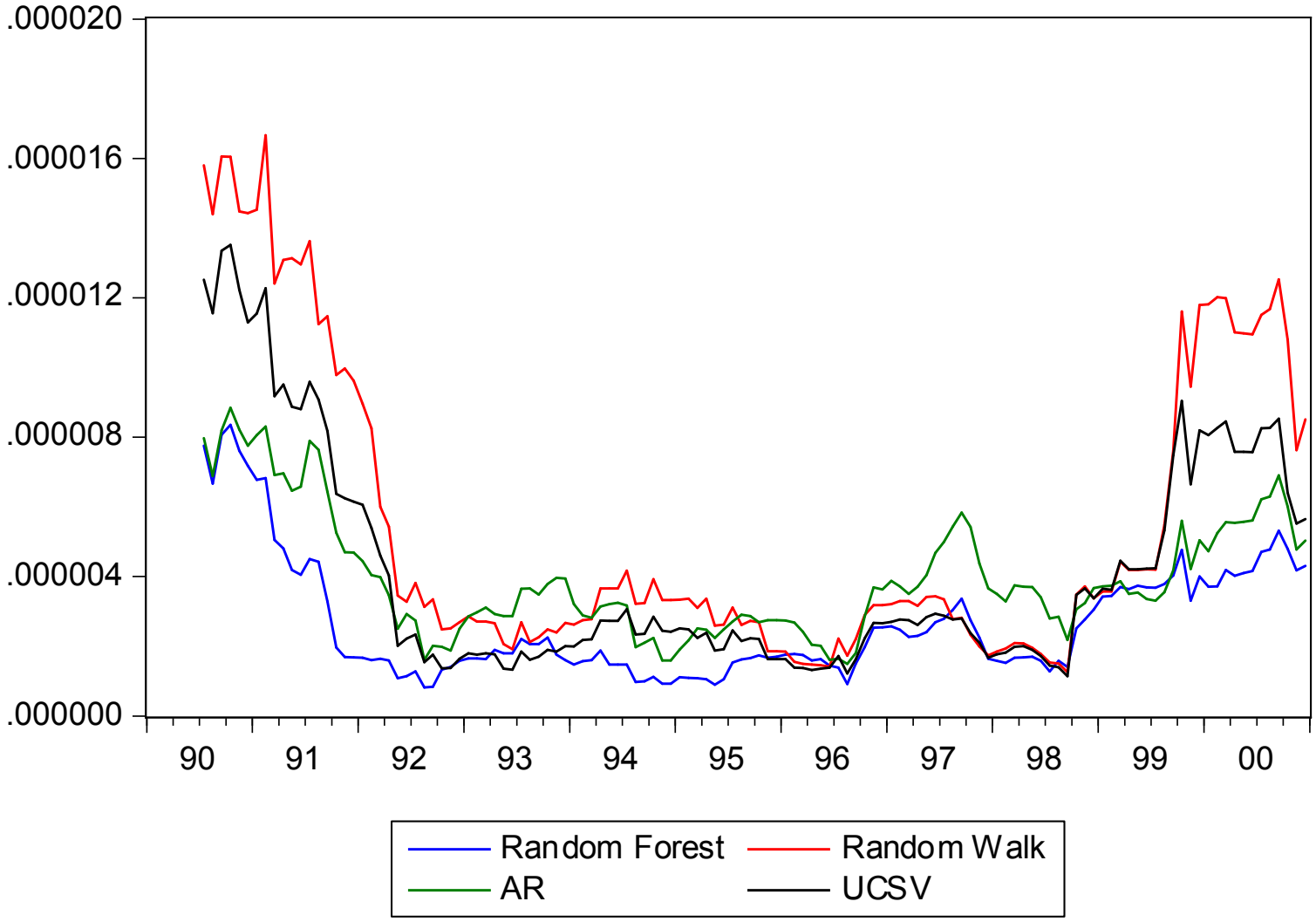
Results 1990 – 2015

Rolling RMSEs (One year centered window, twelve-steps-ahead)



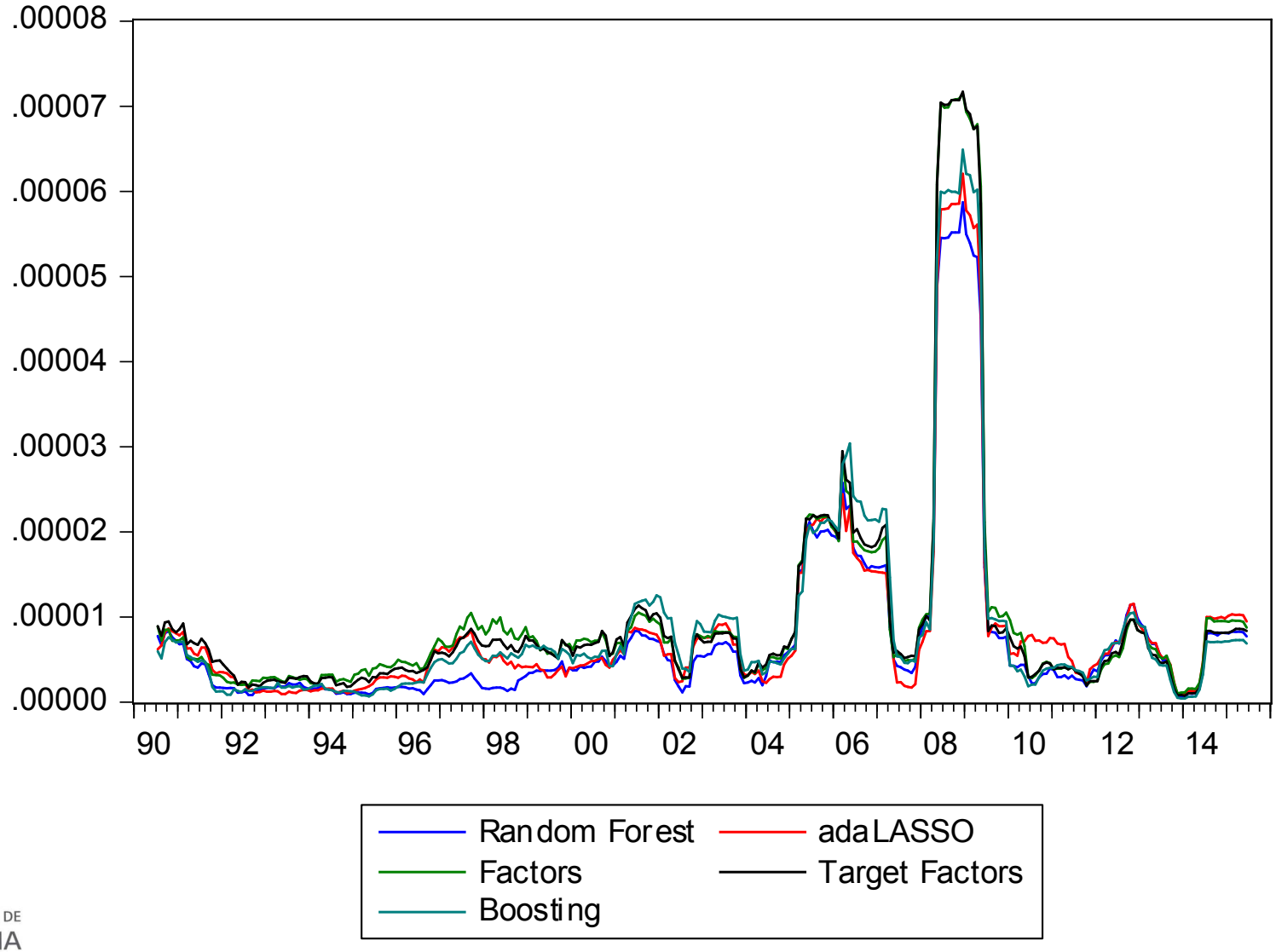
Results 1990 – 2015

Rolling RMSEs (One year centered window, twelve-steps-ahead)



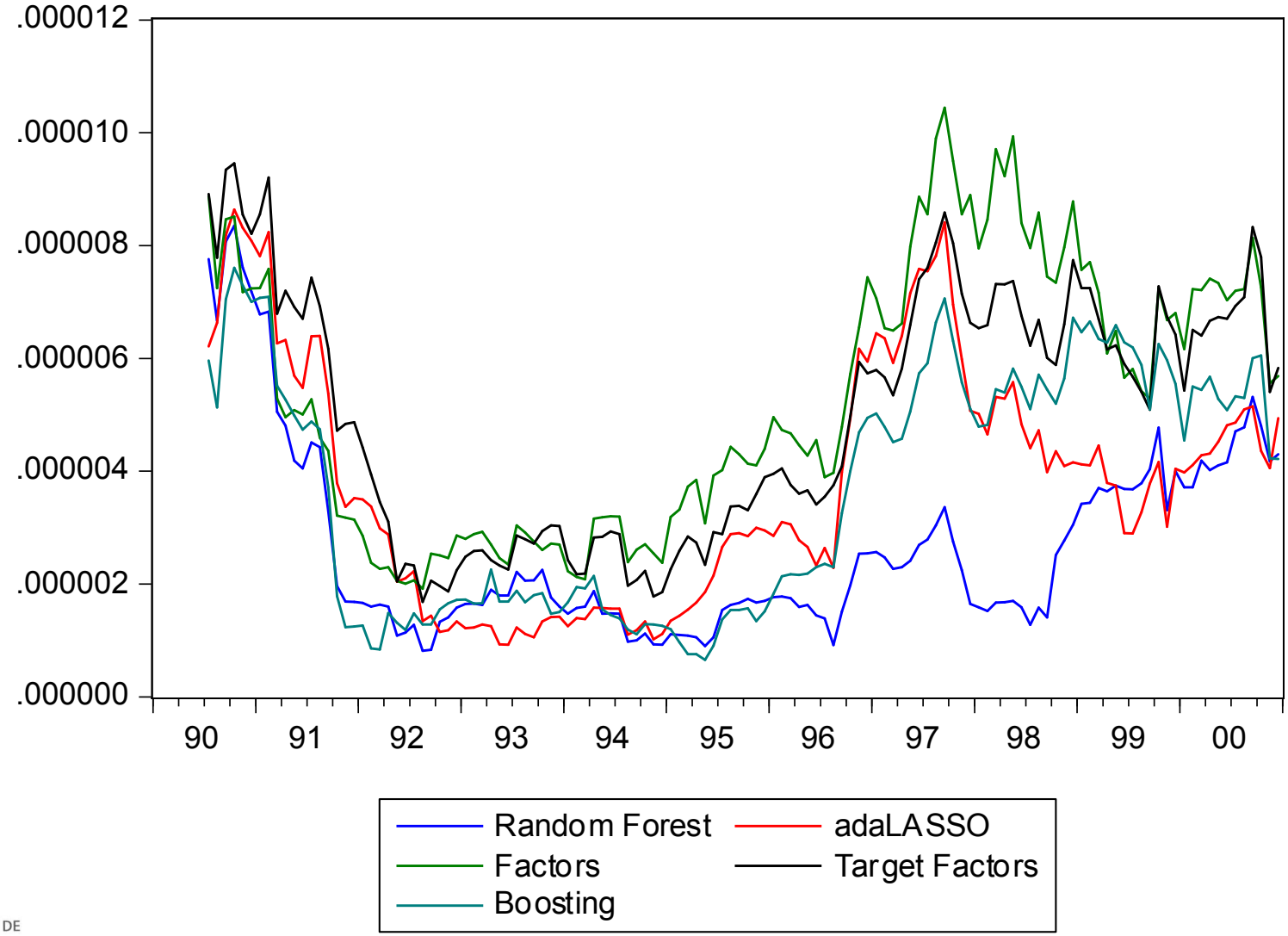
Results 1990 – 2015

Rolling RMSEs (One year centered window, twelve-steps-ahead)



Results 1990 – 2015

Rolling RMSEs (One year centered window, twelve-steps-ahead)



Results 1990 – 2015

Forecasts RMSEs on NBER Expansion and Recession Periods

Consumer Price Index RMSE - Expansion and Recession

exp (*rec*)	Forecasting Horizon t+1	t+2	t+3	t+4	t+5	t+6	t+7	t+8	t+9	t+10	t+11	t+12	count
AR	0.86	0.76	0.74	0.77	0.80	0.82	0.77	0.69	0.70	0.77	0.78	0.70	5
	(0.99)	(0.89)	(0.86)	(0.84)	(0.77)	(0.76)	(0.80)	(0.92)	(0.94)	(0.92)	(0.94)	(0.89)	(9)
UCSV	0.88	0.79	0.77	0.80	0.79	0.81	0.81	0.72	0.69	0.74	0.78	0.72	4
	(1.12)	(0.86)	(0.83)	(0.83)	(0.78)	(0.74)	(0.75)	(0.89)	(0.93)	(0.91)	(0.93)	(0.92)	(12)
BVAR	0.83	0.70	0.71	0.77	0.78	0.80	0.77	0.70	0.72	0.79	0.79	0.69	7
	(0.94)	(0.85)	(0.79)	(0.76)	(0.71)	(0.71)	(0.77)	(0.87)	(0.88)	(0.87)	(0.89)	(0.88)	(12)
LASSO	0.80	0.72	0.70	0.77	0.78	0.78	0.76	0.66	0.67	0.75	0.76	0.66	7
	(0.91)	(0.81)	(0.77)	(0.75)	(0.71)	(0.72)	(0.75)	(0.88)	(0.91)	(0.90)	(0.93)	(0.88)	(12)
Ridge	0.80	**0.69**	0.70	0.77	0.78	0.81	0.76	0.67	0.66	0.71	0.72	0.63	8
	(0.95)	(0.80)	(0.76)	(0.74)	(0.69)	(0.68)	(0.74)	(0.87)	(0.88)	(0.87)	(0.89)	(0.86)	(12)
Elnet	0.80	0.71	0.70	0.76	0.78	0.78	0.75	0.67	0.68	0.74	0.76	0.67	6
	(0.92)	(0.81)	(0.77)	(0.76)	(0.70)	(0.70)	(0.75)	(0.88)	(0.91)	(0.91)	(0.92)	(0.88)	(12)
adaLASSO	0.80	0.72	0.71	0.77	0.76	0.78	0.77	0.68	0.69	0.74	0.76	0.66	9
	(0.92)	(0.82)	(0.78)	(0.76)	(0.73)	(0.72)	(0.75)	(0.88)	(0.90)	(0.91)	(0.94)	(0.87)	(12)
adaElnet	0.80	0.72	0.70	0.76	0.76	0.78	0.75	0.67	0.68	0.74	0.75	0.67	8
	(0.95)	(0.81)	(0.79)	(0.78)	(0.73)	(0.73)	(0.75)	(0.88)	(0.90)	(0.91)	(0.93)	(0.87)	(12)
Fact.	0.85	0.78	0.79	0.82	0.83	0.81	0.79	0.75	0.77	0.80	0.79	0.73	1
	(0.93)	(0.79)	(0.77)	(0.76)	(0.72)	(0.75)	(0.80)	(0.93)	(0.92)	(0.91)	(0.94)	(0.91)	(12)
T. Fact.	0.86	0.79	0.79	0.81	0.81	0.84	0.79	0.73	0.72	0.77	0.77	0.71	1
	(0.91)	(0.79)	(0.77)	(0.78)	(0.73)	(0.74)	(0.80)	(0.94)	(0.94)	(0.90)	(0.94)	(0.92)	(9)
CSR	0.82	0.73	0.72	0.77	0.79	0.83	0.81	0.73	0.74	0.80	0.81	0.72	6
	(0.92)	(0.83)	(0.82)	(0.81)	(0.75)	(0.74)	(0.77)	(0.87)	(0.89)	(0.89)	(0.90)	(0.85)	(11)
Bagging	0.84	0.77	0.78	0.87	0.89	0.89	0.86	0.76	0.71	0.76	0.79	0.68	3
	(0.81)	**(0.76)**	**(0.73)**	**(0.70)**	(0.66)	(0.67)	(0.78)	(0.90)	(0.93)	(0.90)	(0.91)	(0.87)	(12)
Boosting	0.89	0.75	0.77	0.84	0.86	0.89	0.85	0.75	0.76	0.82	0.80	0.68	0
	(1.10)	(0.81)	(0.76)	(0.71)	**(0.65)**	(0.66)	**(0.72)**	**(0.86)**	**(0.86)**	**(0.85)**	(0.90)	(0.88)	(12)
Jackknife	0.96	0.83	0.85	0.93	0.98	0.95	0.99	0.85	0.79	0.96	0.91	0.76	0
	(1.07)	(0.80)	(0.81)	(0.75)	(0.66)	**(0.63)**	(0.79)	(0.88)	(0.96)	(0.93)	(0.94)	(0.88)	(12)
R. Forest	**0.79**	0.70	**0.68**	**0.75**	**0.75**	**0.76**	**0.71**	**0.63**	**0.63**	**0.70**	0.71	**0.62**	12
	(0.98)	(0.79)	(0.74)	(0.73)	(0.66)	(0.67)	(0.72)	(0.87)	(0.90)	(0.87)	**(0.89)**	**(0.84)**	(12)
Mean	0.80	0.71	0.71	0.76	0.77	0.77	0.74	0.67	0.67	0.70	**0.71**	0.64	7
	(0.92)	(0.80)	(0.77)	(0.76)	(0.71)	(0.71)	(0.76)	(0.88)	(0.90)	(0.89)	(0.91)	(0.87)	(12)
25T. Mean	0.80	0.71	0.70	0.75	0.76	0.77	0.74	0.66	0.66	0.71	0.72	0.64	6
	(0.92)	(0.80)	(0.77)	(0.76)	(0.71)	(0.71)	(0.76)	(0.88)	(0.90)	(0.89)	(0.91)	(0.87)	(12)
Median	0.80	0.71	0.70	0.75	0.76	0.77	0.74	0.66	0.66	0.71	0.72	0.64	6
	(0.93)	(0.80)	(0.76)	(0.76)	(0.71)	(0.71)	(0.75)	(0.88)	(0.90)	(0.90)	(0.92)	(0.87)	(12)
RMSE count	11	3	10	13	11	7	10	7	7	9	7	1	
MAE count	(18)	(18)	(18)	(16)	(17)	(17)	(17)	(17)	(17)	(18)	(18)	(18)	

Results 1990 – 2015

Forecasts MAEs on NBER Expansion and Recession Periods

Consumer Price Index MAE - Expansion and Recession

	Forecasting Horizon												
exp / (*rec*)	t+1	t+2	t+3	t+4	t+5	t+6	t+7	t+8	t+9	t+10	t+11	t+12	count
AR	0.88	0.76	0.76	0.78	0.83	0.83	0.76	0.72	0.78	0.84	0.84	0.74	1
	(0.86)	(0.92)	(0.84)	(0.88)	(0.72)	(0.73)	(0.84)	(0.94)	(0.91)	(0.89)	(0.96)	(0.90)	(7)
UCSV	0.90	0.81	0.79	0.80	0.83	0.83	0.80	0.77	0.76	0.78	0.83	0.75	1
	(0.98)	(0.85)	(0.77)	(0.81)	(0.72)	(0.70)	(0.77)	(0.88)	(0.88)	(0.86)	(0.93)	(0.93)	(11)
BVAR	0.85	0.70	0.75	0.78	0.81	0.81	0.76	0.74	0.80	0.84	0.85	0.74	3
	(0.94)	(0.85)	(0.77)	(0.81)	(0.70)	(0.69)	(0.78)	**(0.83)**	**(0.82)**	**(0.79)**	**(0.88)**	(0.88)	(11)
LASSO	0.83	0.73	0.73	0.78	0.81	0.77	0.73	0.68	0.73	0.80	0.82	0.71	6
	(0.78)	(0.81)	(0.74)	(0.76)	(0.66)	(0.69)	(0.77)	(0.87)	(0.85)	(0.83)	(0.94)	(0.89)	(12)
Ridge	0.82	0.70	0.72	0.76	0.79	0.80	0.73	0.68	0.72	0.76	0.77	0.68	7
	(0.87)	(0.81)	(0.73)	(0.77)	(0.65)	(0.66)	(0.76)	(0.85)	(0.84)	(0.81)	(0.90)	(0.88)	(10)
Elnet	0.82	0.73	0.73	0.78	0.82	0.78	0.74	0.67	0.75	0.80	0.83	0.72	4
	(0.80)	(0.81)	(0.75)	(0.77)	(0.66)	(0.68)	(0.77)	(0.87)	(0.85)	(0.85)	(0.93)	(0.88)	(12)
adaLASSO	0.81	0.73	0.71	0.77	0.77	0.76	0.72	0.68	0.73	0.78	0.81	0.70	8
	(0.81)	(0.83)	(0.75)	(0.77)	(0.68)	(0.69)	(0.77)	(0.87)	(0.84)	(0.84)	(0.96)	(0.87)	(12)
adaElnet	0.81	0.73	**0.71**	0.76	0.77	0.76	0.72	0.68	0.73	0.78	0.80	0.72	6
	(0.85)	(0.82)	(0.75)	(0.80)	(0.68)	(0.70)	(0.77)	(0.87)	(0.84)	(0.84)	(0.94)	(0.87)	(12)
Fact.	0.89	0.80	0.83	0.84	0.87	0.81	0.77	0.78	0.86	0.87	0.85	0.80	0
	(0.80)	(0.80)	(0.70)	(0.77)	(0.68)	(0.75)	(0.83)	(0.91)	(0.88)	(0.87)	(0.96)	(0.91)	(12)
T. Fact.	0.89	0.82	0.84	0.84	0.87	0.88	0.79	0.76	0.82	0.87	0.84	0.78	0
	(0.80)	(0.81)	(0.73)	(0.83)	(0.71)	(0.71)	(0.83)	(0.95)	(0.91)	(0.88)	(0.96)	(0.93)	(10)
CSR	0.85	0.74	0.74	0.78	0.82	0.82	0.75	0.71	0.77	0.82	0.83	0.75	1
	(0.81)	(0.83)	(0.78)	(0.85)	(0.70)	(0.71)	(0.80)	(0.88)	(0.86)	(0.86)	(0.93)	(0.86)	(11)
Bagging	0.85	0.78	0.82	0.90	0.93	0.91	0.83	0.78	0.78	0.83	0.85	0.75	1
	(0.81)	**(0.74)**	(0.71)	(0.74)	(0.67)	(0.67)	(0.82)	(0.90)	(0.88)	(0.86)	(0.93)	(0.91)	(12)
Boosting	0.96	0.79	0.84	0.88	0.91	0.92	0.86	0.81	0.85	0.87	0.84	0.71	0
	(0.99)	(0.80)	(0.71)	(0.74)	(0.62)	(0.67)	(0.79)	(0.89)	(0.84)	(0.82)	(0.93)	(0.91)	(11)
Jackknife	1.00	0.85	0.92	0.98	1.05	0.97	0.92	0.86	0.91	0.97	0.95	0.81	0
	(0.97)	(0.84)	(0.79)	(0.81)	(0.69)	(0.70)	(0.86)	(0.92)	(1.00)	(0.93)	(1.00)	(0.93)	(10)
R. Forest	0.81	**0.70**	0.71	0.75	**0.77**	**0.75**	**0.68**	**0.64**	**0.68**	**0.73**	**0.73**	**0.63**	12
	(0.82)	(0.80)	**(0.70)**	**(0.74)**	**(0.60)**	**(0.65)**	**(0.76)**	(0.87)	(0.85)	(0.83)	(0.90)	**(0.85)**	(12)
Mean	**0.81**	0.72	0.73	0.75	0.78	0.77	0.72	0.68	0.72	0.74	0.74	0.67	7
	(0.80)	(0.81)	(0.74)	(0.78)	(0.68)	(0.69)	(0.78)	(0.85)	(0.86)	(0.84)	(0.92)	(0.86)	(12)
25T. Mean	0.81	0.72	0.72	**0.75**	0.78	0.76	0.71	0.67	0.72	0.75	0.76	0.67	7
	(0.80)	(0.80)	(0.74)	(0.77)	(0.67)	(0.68)	(0.77)	(0.86)	(0.85)	(0.84)	(0.92)	(0.87)	(12)
Median	0.82	0.72	0.72	0.75	0.78	0.76	0.71	0.67	0.72	0.75	0.76	0.67	6
	(0.81)	(0.80)	(0.73)	(0.77)	(0.67)	(0.69)	(0.77)	(0.86)	(0.85)	(0.84)	(0.93)	(0.87)	(12)
RMSE count	11	6	9	12	8	7	3	7	1	3	2	1	
MAE count	(13)	(17)	(16)	(17)	(17)	(18)	(18)	(16)	(15)	(18)	(18)	(18)	

Conclusions and Future Research

- ML methods with a large set of covariates are superior than univariate benchmarks and factor models.
- Gains are higher during expansions.
- The Random Forests is the best model indicating a degree of nonlinearity in the dynamics of inflation.
- **What to do?**
  - Other nonlinear models: Deep networks, extreme learning machines, etc.
  - Interpretation?
  - Text data