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March 28th, 2017

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▶ We fit several models to 9 time series of currency data

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▶ We fit several models to 9 time series of currency data

▶ We use MSE to compare model performance

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- ▶ We fit several models to 9 time series of currency data
- ▶ We use MSE to compare model performance
- All analysis is performed in R

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- ▶ We fit several models to 9 time series of currency data
- We use MSE to compare model performance
- ▶ All analysis is performed in R
- For purposes of this presentation, unless otherwise noted, MSEs are averaged across currencies as presenting them by currency as well proved visually overwhelming. The numbers for this, however, are available in our code if so desired.

Data preprocessing

► Take log returns - day over day

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returns

► Take log returns - day over day

▶ Take annualized daily standard deviations of these

- ► Take log returns day over day
- ► Take annualized daily standard deviations of these returns
- Change to log of vols

- Take log returns day over day
- ► Take annualized daily standard deviations of these returns
- Change to log of vols
- Instead of cleaning constants at the beginning leading to data frame sizing compatibility issues - we check for 0 vols in modeling phases

returns

Change to log of vols

0 vols in modeling phases

Take log returns - day over day

► Take annualized daily standard deviations of these

Instead of cleaning constants at the beginning - leading to data frame sizing compatibility issues - we check for

Split train vs. test data - 3.5 yrs in train, 1.5 yrs in test

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► Package: vars

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Implementation

Package: vars

▶ Iterate through lags 1,2, and 3 - for each lag fit unregularized VAR model on all of train

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- Package: vars
- ▶ Iterate through lags 1,2, and 3 for each lag fit unregularized VAR model on all of train
- Use model for testing errors

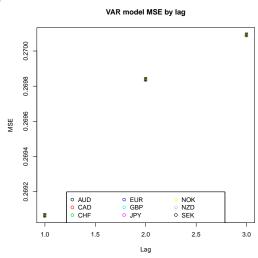


Figure: Average MSE by currency by lag

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Results

▶ MSEs increase as a function of lag used

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MSEs increase as a function of lag used

▶ Likely due to overfitting since we are not regularizing

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► Package: BigVAR

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Package: BigVAR

▶ Iterate through lags 1,2, and 3 - for each lag fit model on all of train

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Implementation

Package: BigVAR

- ▶ Iterate through lags 1,2, and 3 for each lag fit model on all of train
- Cross-validate over training data to obtain an optimal lambda for each lag

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Implementation

Package: BigVAR

- Iterate through lags 1,2, and 3 for each lag fit model on all of train
- Cross-validate over training data to obtain an optimal lambda for each lag
- Use optimal lambda for each lag to fit regularized VAR models on expanding window for test predictions

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Package: BigVAR

- Iterate through lags 1,2, and 3 for each lag fit model on all of train
- Cross-validate over training data to obtain an optimal lambda for each lag
- Use optimal lambda for each lag to fit regularized VAR models on expanding window for test predictions

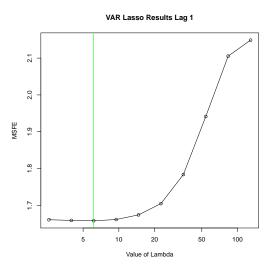


Figure: In-Sample MSE vs. Lambda

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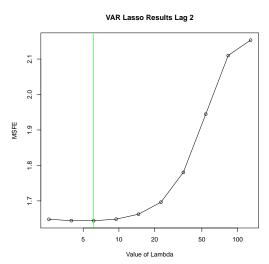


Figure: In-Sample MSE vs. Lambda

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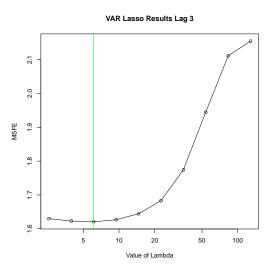


Figure: In-Sample MSE vs. Lambda

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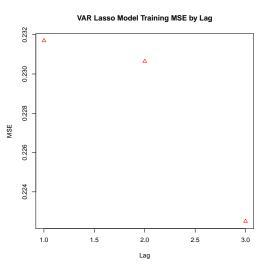


Figure: Test MSE by lag

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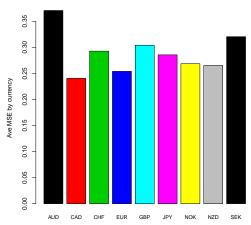


Figure: Test MSE by currency



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Average MSE by currency for 2-lag VAR lasso

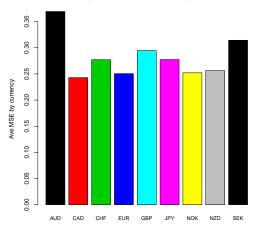


Figure: Test MSE by currency



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Average MSE by currency for 3-lag VAR lasso

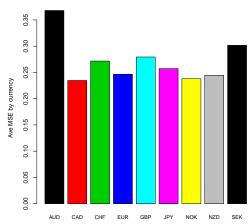


Figure: Test MSE by currency



MSEs decrease as a function of lag used

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MSEs decrease as a function of lag used

overfit in the previous section

► As we are regularizing we are no longer modeling

insignificant daily noise that was causing our models to

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- MSEs decrease as a function of lag used
- ► As we are regularizing we are no longer modeling insignificant daily noise that was causing our models to overfit in the previous section
- ▶ The success of this model varies by currency with the relative efficacy appearing to be independent of lag used

► Package: orderedLasso

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Package: orderedLasso

all parameters to 0

▶ For each currency fit a lasso to all of train data to obtain the maximum lambda - the lambda which sets

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4 D > 4 A > 4 B > 4 B > B

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Package: orderedLasso

- ► For each currency fit a lasso to all of train data to obtain the maximum lambda - the lambda which sets all parameters to 0
- Iterate through lags 2 and 3 for each lag fit models for each lambda in sequence from 0 to max lambda

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- ► Package: orderedLasso
- For each currency fit a lasso to all of train data to obtain the maximum lambda - the lambda which sets all parameters to 0
- ▶ Iterate through lags 2 and 3 for each lag fit models for each lambda in sequence from 0 to max lambda
- ▶ Use model for training and testing errors

Training MSEs by lambda 0.194726 0 2 3 0.194724 Ave MSE over all currencies 0.194722 0.194720 0.194718 0.0 0.1 0.2 0.3 Lambdas

Figure: Training MSEs

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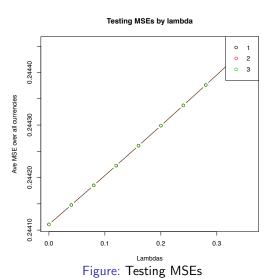
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Results

► As expected out-of-sample error is significantly higher than in-sample error

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than in-sample error

MSEs change minimally with lag used

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As expected out-of-sample error is significantly higher

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Discussion

- As expected out-of-sample error is significantly higher than in-sample error
- MSEs change minimally with lag used
- ▶ For ordered lasso, however, regularization does not appear to improve the results

Implementation of KNN regression

▶ Iterate through training data by, finding k nearest neighbors in sense of $||\sigma - \sigma_i||^2$

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Implementation of KNN regression

neighbors in sense of $||\sigma - \sigma_i||^2$ • Create regression matrix of size

volatilities of the k nearest neighbors

Iterate through training data by, finding k nearest

number observations $\times k$ consisting of the next day

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- ▶ Iterate through training data by, finding k nearest neighbors in sense of $||\sigma \sigma_i||^2$
- ► Create regression matrix of size number observations × k consisting of the next day volatilities of the k nearest neighbors
- ▶ Fit regression model on training data using Im package

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- ▶ Iterate through training data by, finding k nearest neighbors in sense of $||\sigma \sigma_i||^2$
- ▶ Create regression matrix of size number observations × k consisting of the next day volatilities of the k nearest neighbors
- ▶ Fit regression model on training data using Im package
- Use regression fit to predict on train, choose k as mse minimizer

Adding a time feature

▶ Modified data to include time stamp

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► Find k-Nearest Neighbors where proximity is given by $||\sigma - \sigma_i||_2^2 + c||t - t_i||_2^2$

Adding a time feature

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Implementation

- Modified data to include time stamp
- ► Find k-Nearest Neighbors where proximity is given by $||\sigma - \sigma_i||_2^2 + c||t - t_i||_2^2$
- Grid search on both k and c to find optimal fit



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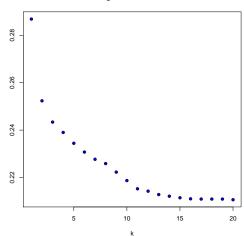
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Training MSE v k for for AUD





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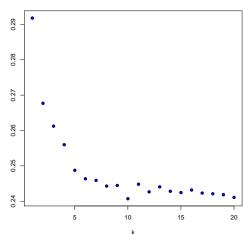
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Testing MSE v k for AUD



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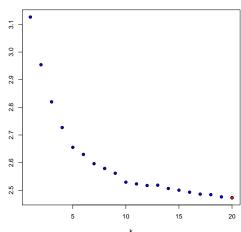
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Aggregate Testing MSE v k



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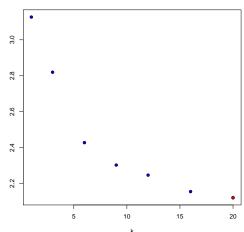
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Aggregate Testing MSE v k with time factor





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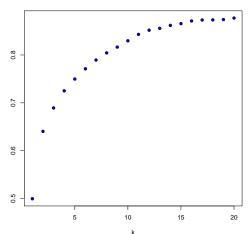
/NN Democal

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Sum of Coefficients v k for AUD



	mse	mse_time
AUD	0.240703190493472	0.214044675092349
CAD	0.316645013626961	0.231361961862307
CHF	0.275172816278026	0.237387590343597
EUR	0.241593679178633	0.224679179357182
GBP	0.339759992691741	0.237943342004655
JPY	0.277731656777348	0.244249661672532
NOK	0.273525323365556	0.242030767414946
NZD	0.242115046363221	0.223409448392819
SEK	0.244820645012621	0.244389566411547

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The time effect improves mse

the look back period.

Regression coefficients do not align with our intuition MSEs decrease with k, future work should expand grid for k. Moreover, this result is not robust to changing

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