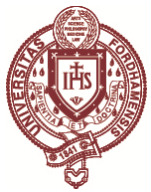
Machine Learning in Finance

Overview

Overview

- Financial Contagion
- Indices of Economic Policy Uncertainty
- Chinese Banking and the Offshore Foreign Exchange Market, Part I
- Chinese Banking and the Offshore Foreign Exchange Market, Part II
- Regularization of a Big VAR-X Model
- Extracting Information from VAR-X Estimation
- Estimation Results
- Network Connectedness
- Conclusions



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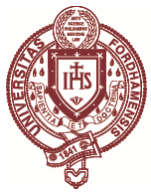
Financial Contagion

Financial Contagion

- We are not only interested in predicting risk but also in finding out how risks are transmitted from one market or financial institution to another
- This is what "contagion" is all about. Are certain banks, for example, sources of wider financial contagion than others?
- Alternatively are certain banks more vulnerable to financial contagion from other banks?
- In this week we will put to use the VAR framework with LASSO to study this issue.
- The results come from a paper with Dr. Jennifer Lai, *Deep Learning and Financial Contagion: Global News, Off-Shore Exchange Rates and Banking Sector Volatility in China*

Financial Contagion

- Basic message: banks in China are vulnerable to risk from the off-shore Hong Kong RMB exchange market
- Another message: the offshore RMB exchange market responds to changes in global Economic Policy Uncertainty indices.
- This means that news about China and Global Trade affect the offshore exchange rate which in turn affects risk in Chinese banks.



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Indices of Economic Policy Uncertainty (EPU)

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No.	Index	Mean	Median	Std Dev	Max	Min
1	Econ Pol	0.272	0.233	0.150	Aug-11	Aug-15
2	Monetary	0.206	0.165	0.141	Aug-11	Oct-18
3	Fiscal	0.292	0.235	0.180	Aug-11	Aug-15
4	Taxes	0.290	0.236	0.175	Dec-12	Aug-15
5	Spending	0.189	0.127	0.165	Aug-11	Aug-15
6	Health	0.320	0.280	0.170	Oct-13	Aug-15
7	Nat. Sec	0.365	0.326	0.194	Dec-18	Feb-18
8	Entitlements	0.299	0.238	0.189	Aug-11	Aug-15
9	Regulation	0.263	0.217	0.149	Oct-10	Feb-18
10	Fin. Reg.	0.236	0.184	0.162	Oct-11	Aug-15
11	Trade	0.190	0.131	0.171	Jul-18	Aug-15
12	Sov. Debt Crisis	0.170	0.110	0.155	Aug-11	Dec-18
13	China	0.249	0.218	0.155	Dec-18	May-11
14	3-Component	0.239	0.212	0.129	Aug-11	Feb-18
15	Global Policy	0.247	0.223	0.134	Aug-11	Aug-14
16	VIX	0.189	0.154	0.141	Aug-11	Nov-17

Indices of Economic Policy Uncertainty (EPU)

- Basic message: banks in China are vulnerable to risk from the off-shore Hong Kong RMB exchange market
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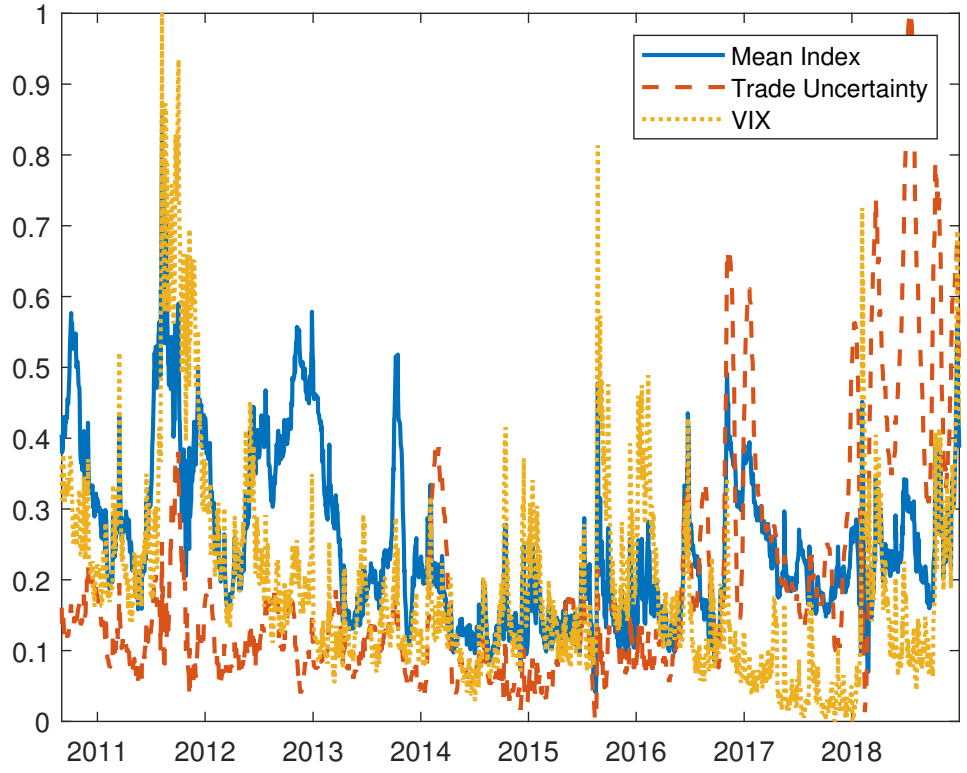
Indices of Economic Policy Uncertainty (EPU)



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Conclusion

Chinese Banking and the Offshore Foreign Exchange Market, Part I

Chinese Banks and the Offshore Foreign Exchange Market, Part I

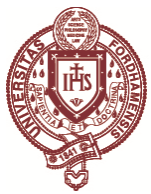
No	Code	Name	EY Classification*	Center	Mean	Std Dev
1	PAB	Ping An Bank	National-Joint Stock	Shenzhen	0.169	0.276
2	BONB	Bank of Ningbo	City-Rural	Ningbo	0.123	0.406
3	SPDB	Shanghai Pudong Development	National-Joint Stock	Shanghai	0.126	0.311
4	HX	Huaxia Bank Co.	National-Joint Stock	Beijing	0.102	0.248
5	CMBC	Chinga Minsheng Bank Co	National-Joint Stock	Beijing	0.416	0.266
6	ComBC	China Merchants Bank	National-Joint Stocl	Shenzhen	0.100	0.354
7	BONJ	Bank of Nanging	City-Rural	Nanjung	0.150	0.380
8	IBC	Industrial Bank of China	National-Joint Stock	Fuzhou	0.222	0.275
9	BOB	Bank of Beijing	City-Rural	Beijing	-0.003	0.291
10	ABC	Agricultural Bank of China	Five Largest	Beijing	0.110	0.161

Range: September 2010 to December 2018.

* Ernst and Young Classification

Chinese Banks and the Offshore Foreign Exchange Market, Part I

No	Code	Name	EY Classification*	Center	Mean	Std Dev
11	BOCOMM	Bank of Communications-Sh.	Five Largest	Shanghai	-0.078	0.181
12	ICBC	Industrial and Commercial Bank	Five Largest	Beijing	0.087	0.163
13	CEB	China Everright Bank	National-Joint Stock	Beijing	-0.018	0.201
14	CCB	China Construction Bank	Five Largest	Beijing	0.103	0.202
15	BOC	Bank of China	Five Largest	Beijing	-0.006	0.166
16	CITIC	China Citic Bank International	National-Joint Stock	Beijing	-0.032	0.226
17	CNH	HK China/USD Spot Rate		HK	-0.045	0.039



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Chinese Banking and the Offshore Foreign Exchange Market, Part II

Chinese Banks and the Offshore Foreign Exchange Market, Part II

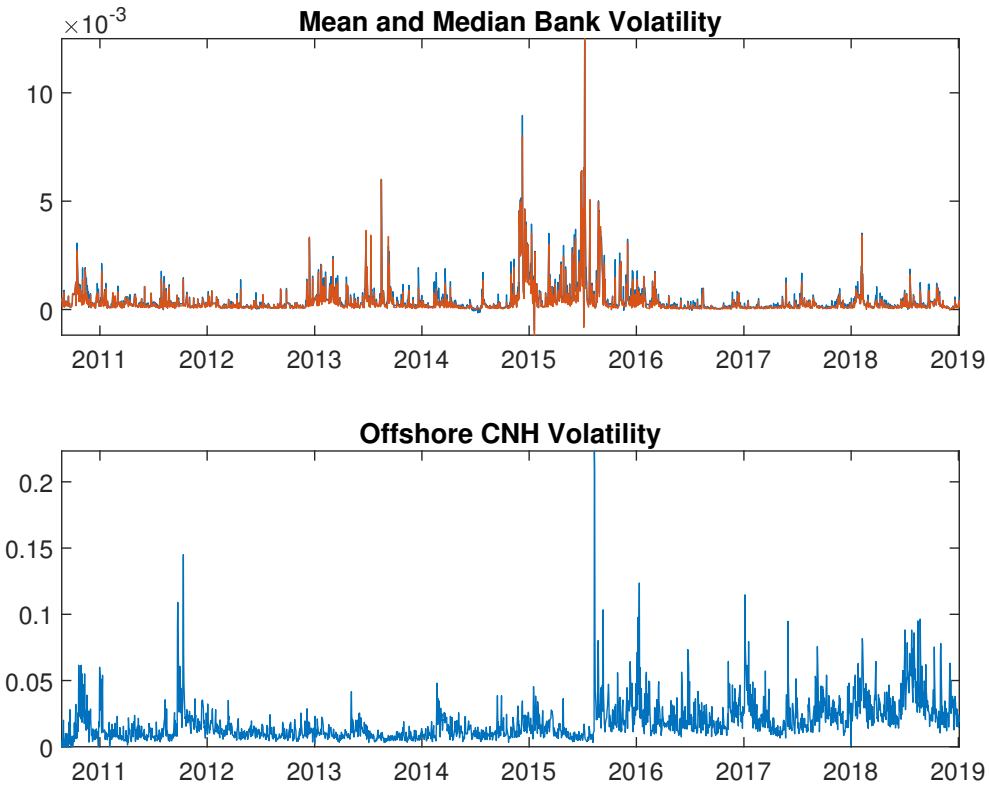
- The realized daily range volatility measure, denoted by σ_t^R, comes from an approximation based on spreads between the daily opening (o) and closing (c) , as well as maximum (h) and minimum (l) of the natural logarithmic values of the share prices observed each day.
- The following formula is used:

$$\sigma_t^R = .511(h-l)^2 - .\hat{0}19[(c-o)(h-l-2o)$$

$$-2(h-o)(l-o)] - .383(c-o)^2 \qquad (1)$$

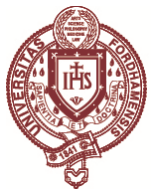
- This approximation is based on M.B. German and M.J. Klass,, "On the estimation of security price volatility from historical data", Journal of Business (1980) and is widely used.

Chinese Banks and the Offshore Foreign Exchange Market, Part II



Chinese Banks and the Offshore Foreign Exchange Market, Part II

- We see that at the time of the Euro Debt crisis at the beginning of the sample, there were closely related patterns of volatility.
- However in the middle of the sample and at the end of the sample, we see that the CNH market displayed greater volatility than the onshore banks.
- Volatilities tend to have right skewness so one can approximate normality by taking the logarithms of the range volatilities.



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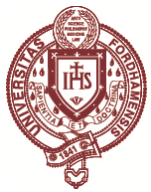
Regularization of a Big VAR-X Model

Regularization of a Big VAR-X model

- We have 17 state or target variables and we specify a lag of 5 days, so 85 parameters for each target.
- We also have the 15 control variables (aka covariates or characteristics) and a constant term for each.
- So we have 17 equations with each having 101 coefficients.
- **Elastic Net** (EN) with **Cross Validation** (CV)

$$\beta_{Enet} = \overset{Min}{\beta} \left\{ \sum_{t=1}^{T} \left(y_t - \sum_i \beta_i x_{it} \right)^2 + \lambda \sum_{i=1}^{k} \left[(\alpha|\beta_i|) + (1-\alpha)\beta_i^2 \right] \right\} \quad (2)$$

- With CV, select a grid of values for λ, between $\lambda = 0$, and λ^*, the minimum λ which sets all of the coefficients $\beta_i = 0$.
- We then select a set of out-of-sample Mean Squared Error measures, based on holding out 20% of the sample for each specified λ over the grid. The optimal λ minimizes the average out-of-sample mean squared error



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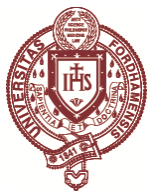
Extracting Information from VAR-X Estimation

Extracting Information from VAR-X Estimation

- How do we extract information from the estimated VAR parameters, even with Elastic Net estimation with Cross-Validation?
- The parameters do not have any information by themselves. We are not interested in tests about specific values of any of the parameters.
- We are interested in the dynamics of the system: how do forecast errors in one variable explain the total forecast error variance after two or three weeks of itself and other variables? We call this the **Forecast Error Variance Decomposition** (FEVD).
- The variance decomposition indicates the amount of information each variable contributes to the other variables in the autoregression. It determines how much of the forecast error variance of each of the variables can be explained by exogenous shocks to the other variables after a given horizon.

Extracting Information from VAR-X Estimation

- This decomposition matrix is an asymmetric matrix, and serves as a measure of both the inward and outward connectedness of each variable in the model.
- In particular, off-diagonal measures tell us how much of the innovations in each variable can be accounted by the innovations in the other variables (**inward connectedness**) as well as how much each variable contributed to the overall forecast error of the other variables **(outward connectedness**).
- For linear VAR models it is very easy to calculate the FEVD from the estimated coefficients and the Variance-Covariance Matrix of the residuals of the model.



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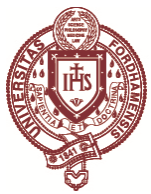
Results

Results

	Trade Policy	China News
PAB	0.0000	-0.0002
BONB	0.0000	0.0000
SPDB	0.0000	-0.0001
HX	0.0000	-0.0002
CMBC	0.0000	-0.0001
ComBC	0.0000	0.0000
BONJ	0.0000	-0.0002
IBC	0.0000	-0.0003
BOB	0.0000	0.0000
ABC	0.0000	0.0000
BOCOMM	0.0000	0.0000
ICBC	0.0000	0.0000
CEB	0.0000	0.0000
CCB	0.0001	0.0000
BOC	0.0000	0.0000
CITIC	0.0000	0.0000
CNH	**0.0092**	**0.0047**

Results

- The results show the ruthlessness of the Elastic Net-CV method.
- All of the coefficients of the controls were zeroed out, but for Trade and China uncertainty.
- These effects only showed up on the CNH market.
- This means that the CNH market is the key link between external news on policy uncertainty and the volatility or riskiness of on-shore Chinese banks.



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Connectedness

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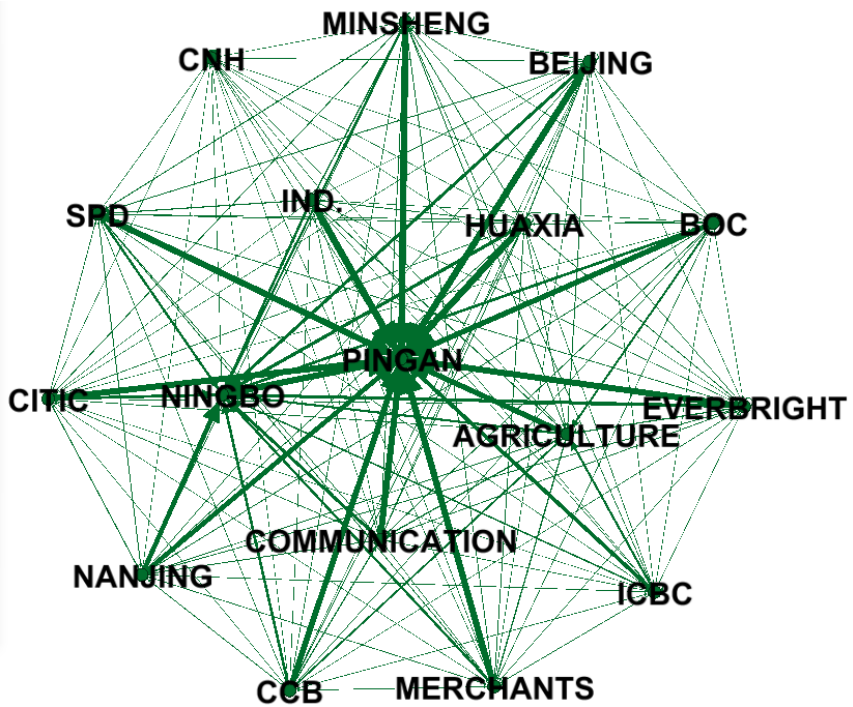
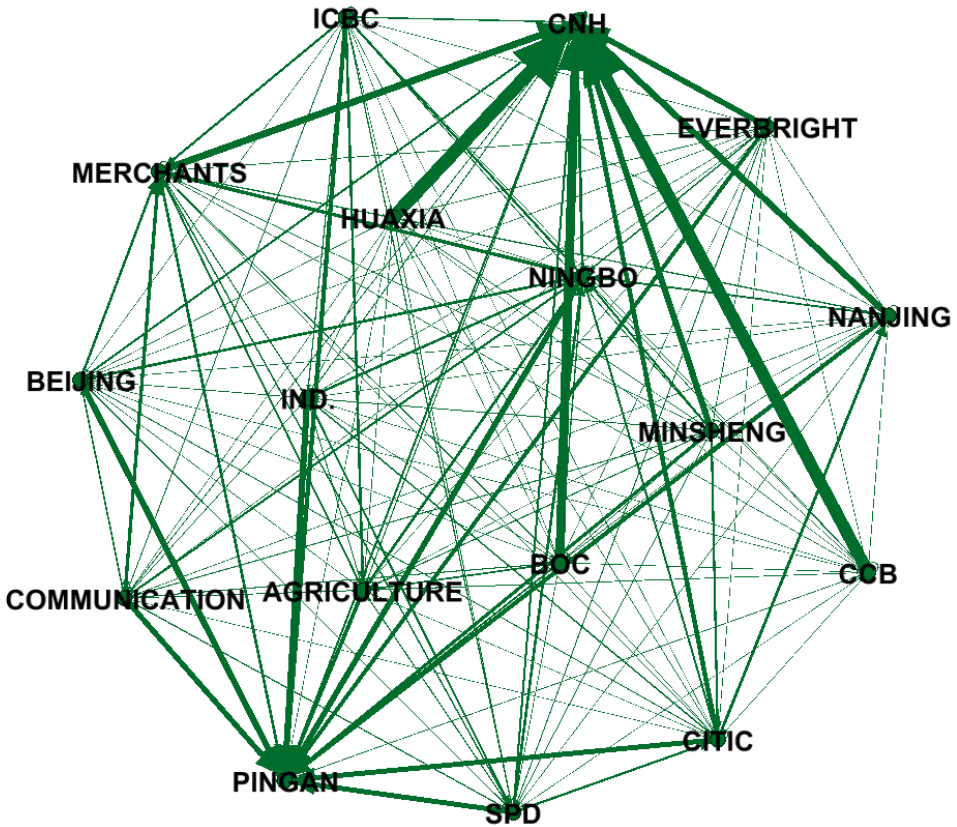


Connectedness

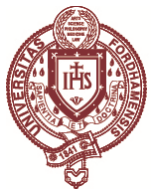
- For the full sample estimation, Ping An bank is at the center of connectedness.
- The thickness of the connecting lings gives the relative strength of the connections.
- What is uprising for the full sample estimation is the low degree of connectedness of the CNH market with any of the Chinese banks.
- This result requires a closer look.
- There has been quite a degree of deregulation and structural change in Finance during the estimation period.
- An alternative is to use a rolling window regression.
- This means a series of regressions based on smaller samples moving forward in time.

Connectedness



Connectedness

- We see that different patterns of connectedness emerged at the end of the period
- The banking system is much more connected to the offshore Hong Kong CNH market
- Of course, financial deregulation has taken place
- The process of capital account liberalization has allowed Chinese banks to extend credit to Hong Kong firms through banks in Hong Kong



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