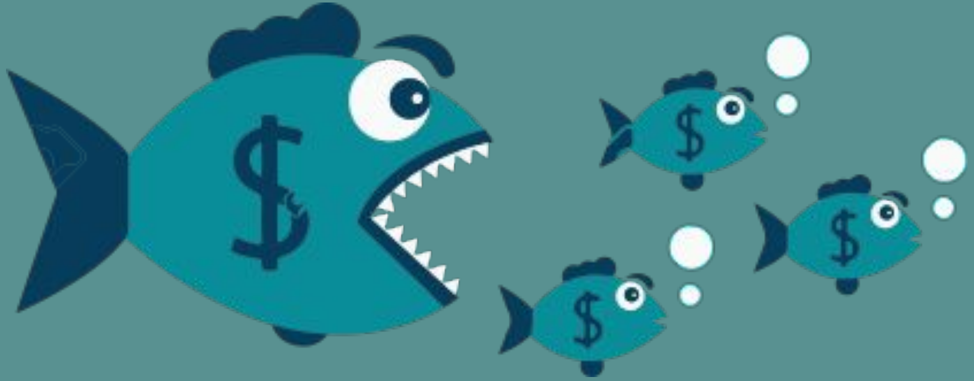
Nateé & Dmitry explore:

What's happening to the small banks?

An analysis of the shrinking US bank market



Dramatic decline in the number of *de novo* banks

Figure 1: Number of Independent Banks in the United States

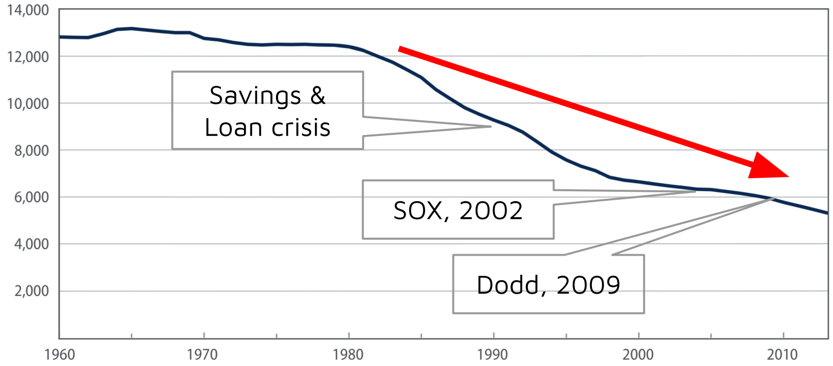
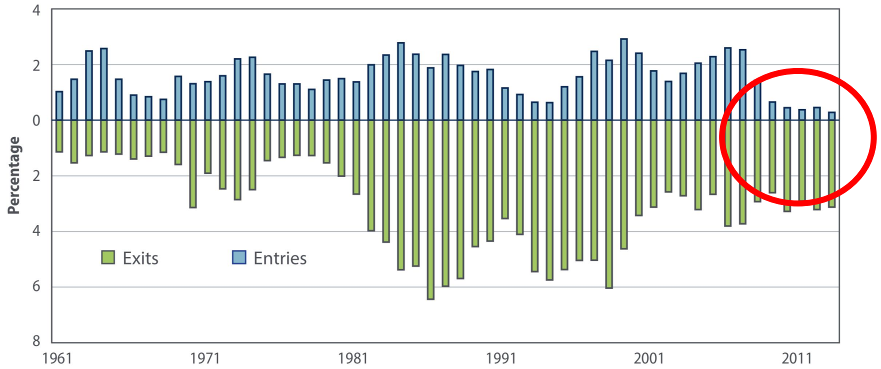


Figure 2: Bank Entries and Exits as Percentages of Total Banks



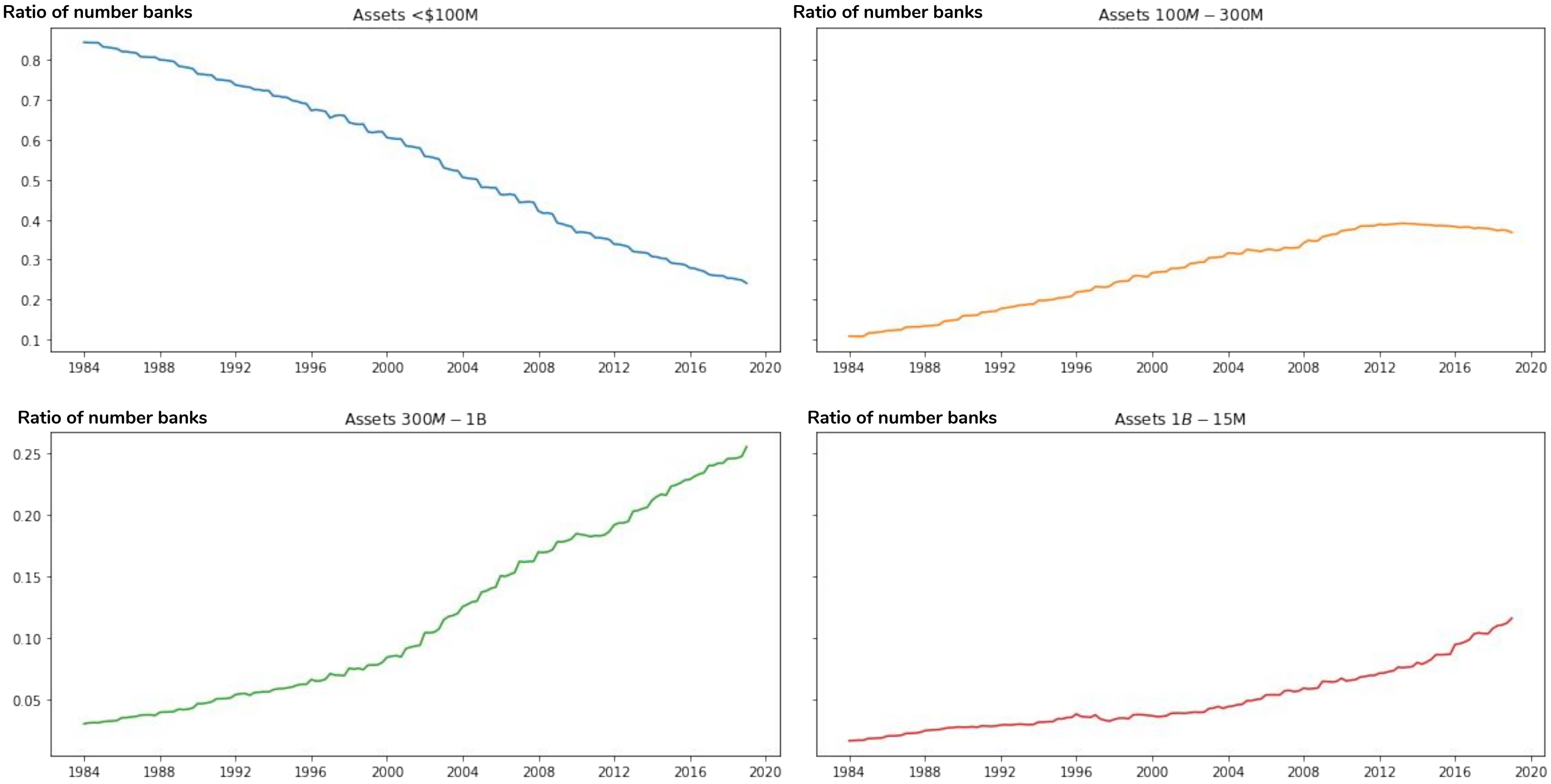
Although many banks failed during the crisis and its aftermath, this decline was driven largely by a lack of new banks.

The number of newly formed banks (called *de novo* banks) has fallen sharply since 2010. In 2012, there were no *de novos*, and in 2013 there was only one: Bank of Bird-in-Hand, formed in Lancaster County, Pa., to serve the Amish community.

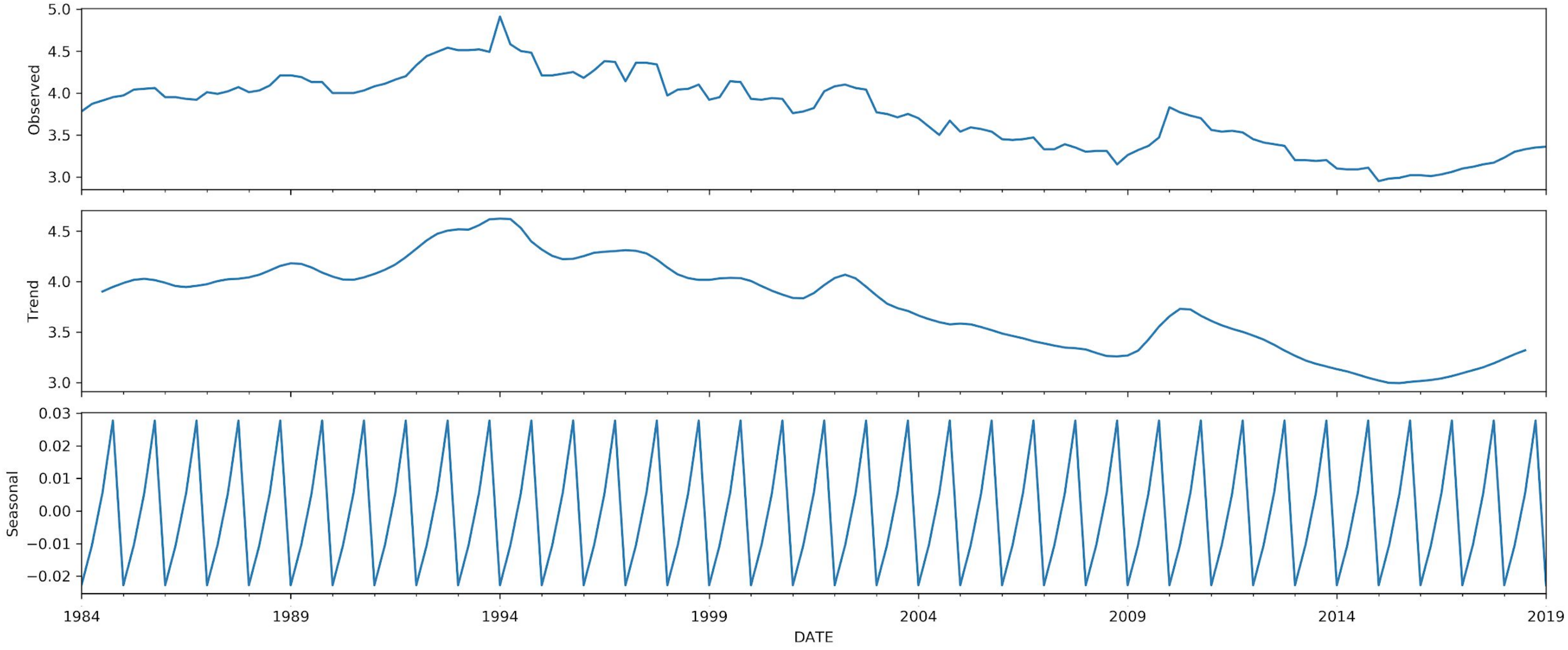
This collapse in new bank entry has no precedent during the past 50 years, and it could have significant economic repercussions. In particular, the decline in new bank entry disproportionately decreases the number of community banks because most new banks start small.

Source:https://www.richmondfed.org/~/media/richmondfedorg/publications/research/economic_brief/2015/pdf/eb_15-03.pdf

Figure 3: Ratio of number of banks by asset size

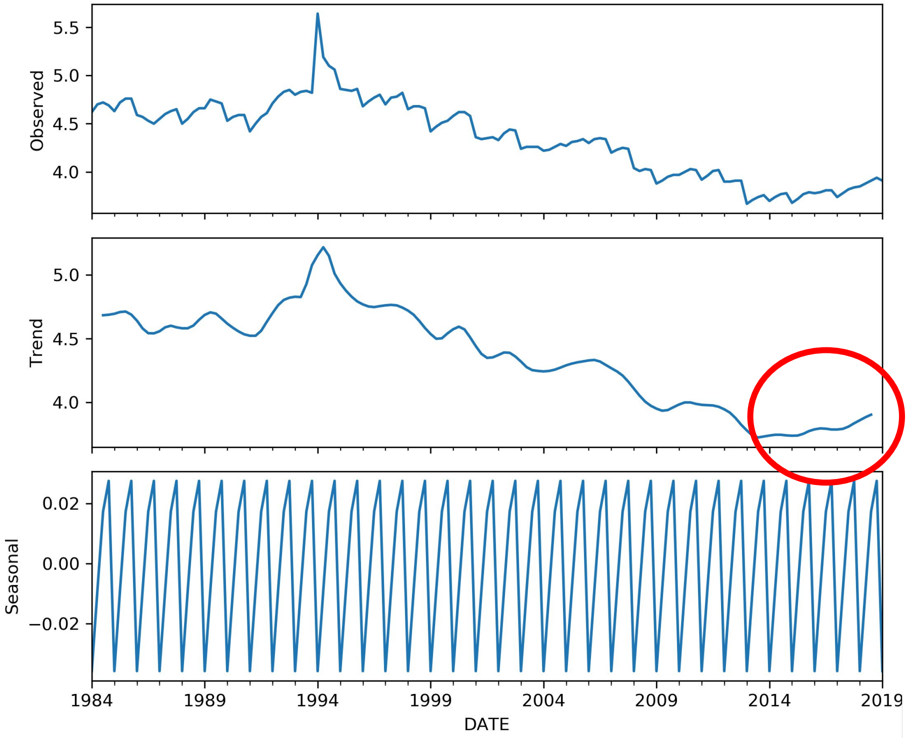


Net Income Seasonal Decomposition for all US Banks

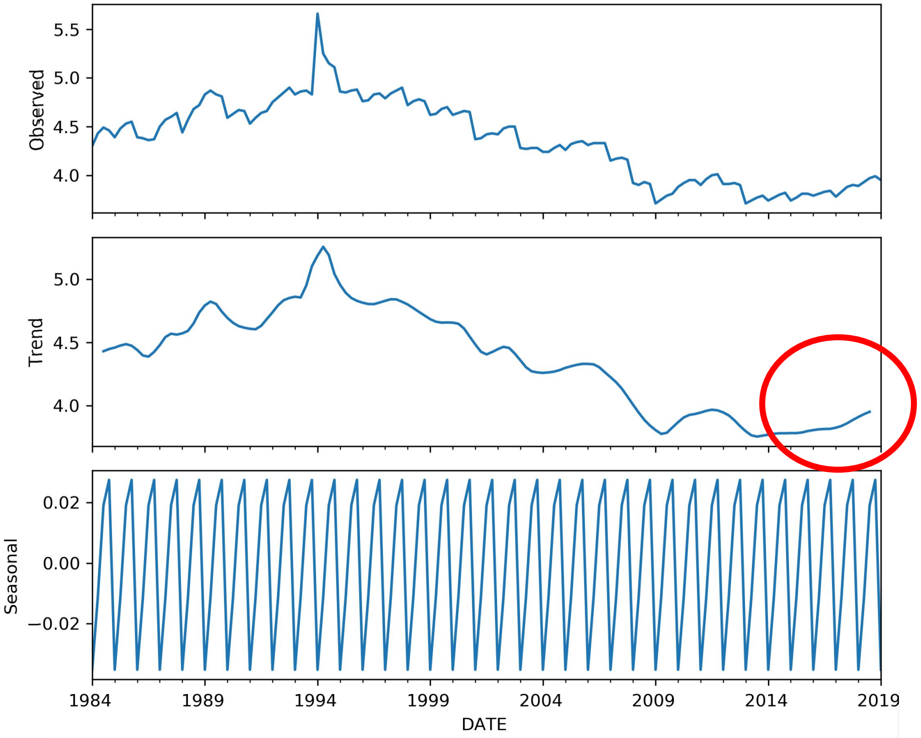


Net Income Seasonal Decomposition for Small & Mid-size Banks

Small (<$100M)



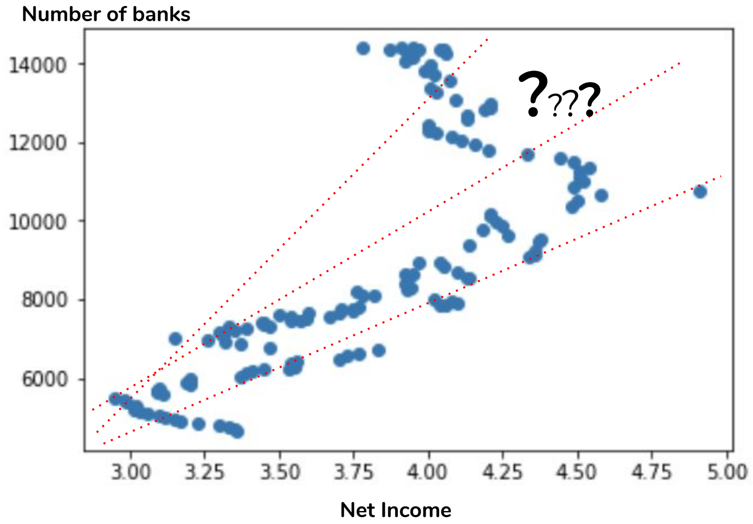
Mid-Size ($100M - $300M)



Basic linear regression for Number of banks

Number of banks from 1984-2018 and Net Income: NUM = b_0 + b_1(NI)

```
                            OLS Regression Results
==============================================================================
Dep. Variable:               BanksNum   R-squared:                       0.525
Model:                            OLS   Adj. R-squared:                  0.521
Method:                 Least Squares   F-statistic:                     153.4
Date:                Wed, 31 Jul 2019   Prob (F-statistic):           3.31e-24
Time:                        09:34:59   Log-Likelihood:                -1273.4
No. Observations:                 141   AIC:                             2551.
Df Residuals:                     139   BIC:                             2557.
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const      -9047.0984   1460.536     -6.194      0.000   -1.19e+04   -6159.360
USNIM       4753.2461    383.766     12.386      0.000    3994.473    5512.019
==============================================================================
Omnibus:                       20.543   Durbin-Watson:                   0.058
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               25.308
Skew:                           1.032   Prob(JB):                     3.20e-06
Kurtosis:                       3.220   Cond. No.                         34.6
==============================================================================
```



Multivariate linear regression for Net Income of the banks

Net Income in 1990s and now NI = b_0 + b_1(ROA)+b_2(ROE)+B_3(LLR)+b_4(NPL)

OLS Regression Results

Dep. Variable:	US100NIM	R-squared:	0.581
Model:	OLS	Adj. R-squared:	0.493
Method:	Least Squares	F-statistic:	6.590
Date:	Wed, 31 Jul 2019	Prob (F-statistic):	0.00168
Time:	11:20:41	Log-Likelihood:	37.199
No. Observations:	24	AIC:	-64.40
Df Residuals:	19	BIC:	-58.51
Df Model:	4		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	5.2453	0.255	20.558	0.000	4.711	5.779
US100ROA	4.0582	1.403	2.892	0.009	1.121	6.995
US100ROE	-0.3598	0.129	-2.798	0.011	-0.629	-0.091
US100LLRTL	-0.3098	0.106	-2.922	0.009	-0.532	-0.088
US100NPTL	-0.0317	0.039	-0.805	0.431	-0.114	0.051

Omnibus:	0.082	Durbin-Watson:	1.275
Prob(Omnibus):	0.960	Jarque-Bera (JB):	0.081
Skew:	0.073	Prob(JB):	0.960
Kurtosis:	2.755	Cond. No.	1.18e+03

OLS Regression Results

Dep. Variable:	US100NIM	R-squared:	0.763
Model:	OLS	Adj. R-squared:	0.713
Method:	Least Squares	F-statistic:	15.26
Date:	Wed, 31 Jul 2019	Prob (F-statistic):	9.60e-06
Time:	09:36:07	Log-Likelihood:	48.042
No. Observations:	24	AIC:	-86.08
Df Residuals:	19	BIC:	-80.19
Df Model:	4		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	4.4632	0.782	5.710	0.000	2.827	6.099
US100ROA	0.5342	0.584	0.915	0.372	-0.688	1.756
US100ROE	-0.0166	0.073	-0.227	0.823	-0.170	0.137
US100LLRTL	-0.9968	0.645	-1.546	0.139	-2.347	0.353
US100NPTL	0.3690	0.243	1.518	0.145	-0.140	0.878

Omnibus:	1.234	Durbin-Watson:	1.296
Prob(Omnibus):	0.540	Jarque-Bera (JB):	1.148
Skew:	-0.420	Prob(JB):	0.563
Kurtosis:	2.335	Cond. No.	1.16e+03

Removing parameters to model Net Income today

Today's small banks model: NI = b_0 + b_1(ROA)+b_2(ROE)+B_3(LLR)+b_4(NPL)

```
                            OLS Regression Results
==============================================================================
Dep. Variable:                US100NIM   R-squared:                       0.76
Model:                             OLS   Adj. R-squared:                  0.71
Method:                  Least Squares   F-statistic:                     15.2
Date:                 Wed, 31 Jul 2019   Prob (F-statistic):           9.60e-0
Time:                         09:36:07   Log-Likelihood:                 48.04
No. Observations:                   24   AIC:                            -86.0
Df Residuals:                       19   BIC:                            -80.1
Df Model:                            4
Covariance Type:             nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975
------------------------------------------------------------------------------
const          4.4632      0.782      5.710      0.000       2.827       6.09
US100ROA       0.5342      0.584      0.915      0.372      -0.688       1.75
US100ROE      -0.0166      0.073     -0.227      0.823      -0.170       0.13
US100LLRTL    -0.9968      0.645     -1.546      0.139      -2.347       0.35
US100NPTL      0.3690      0.243      1.518      0.145      -0.140       0.87
==============================================================================
Omnibus:                         1.234   Durbin-Watson:                   1.29
Prob(Omnibus):                   0.540   Jarque-Bera (JB):                1.14
Skew:                           -0.420   Prob(JB):                        0.56
Kurtosis:                        2.335   Cond. No.                     1.16e+0
==============================================================================
```

```
                            OLS Regression Results
==============================================================================
Dep. Variable:                US100NIM   R-squared:                       0.736
Model:                             OLS   Adj. R-squared:                  0.711
Method:                  Least Squares   F-statistic:                     29.30
Date:                 Tue, 30 Jul 2019   Prob (F-statistic):           8.38e-07
Time:                         15:10:59   Log-Likelihood:                 44.676
No. Observations:                   24   AIC:                            -83.35
Df Residuals:                       21   BIC:                            -79.82
Df Model:                            2
Covariance Type:             nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          3.9619      0.238     16.675      0.000       3.468       4.456
US100ROA       1.1794      0.219      5.378      0.000       0.723       1.636
US100NPTL     -0.7241      0.111     -6.550      0.000      -0.954      -0.494
==============================================================================
Omnibus:                         9.318   Durbin-Watson:                   0.796
Prob(Omnibus):                   0.009   Jarque-Bera (JB):                7.290
Skew:                            1.254   Prob(JB):                       0.0261
Kurtosis:                        3.999   Cond. No.                        67.8
==============================================================================
```

Penalized estimation with Ridge and Lasso algorithms

```
y = df.SmallBanksNum
x = df[['US100NIM', 'US100ROA', 'US100ROE', 'US100LLRTL', 'US100NPTL']]
# Perform test train split
X_train , X_test, y_train, y_test = train_test_split(x, y, test_size=0.3, random_state=12)
# Note how in scikit learn, the regularization parameter is denoted by alpha (and not lambda)
ridge = Ridge(alpha=0.1)
ridge.fit(X_train, y_train)
print('Ridge parameter coefficients:', ridge.coef_)
print('Training r^2:', ridge.score(X_train, y_train))
print('Testing r^2:', ridge.score(X_test, y_test))
print('Training MSE:', mean_squared_error(y_train, ridge.predict(X_train)))
print('Testing MSE:', mean_squared_error(y_test, ridge.predict(X_test)))
lasso = Lasso(alpha=0.1)
lasso.fit(X_train, y_train)
print('Lasso parameter coefficients:', lasso.coef_)
print('Training r^2:', lasso.score(X_train, y_train))
print('Testing r^2:', lasso.score(X_test, y_test))
print('Training MSE:', mean_squared_error(y_train, lasso.predict(X_train)))
print('Testing MSE:', mean_squared_error(y_test, lasso.predict(X_test)))
```

```
Ridge parameter coefficients: [-0.12505165  0.22573377 -0.03018296  0.0744907  -0.03678268]
Training r^2: 0.9561552215149846
Testing r^2: 0.890746063803487
Training MSE: 0.00035583514725787976
Testing MSE: 0.0011686933813400183
Lasso parameter coefficients: [-0.         -0.         -0.00965202  0.         -0.        ]
Training r^2: 0.3245168726875955
Testing r^2: 0.0794844482073205
Training MSE: 0.005482081250782666
Testing MSE: 0.009846788777162566
```

Regressing proportion of small banks on all the features of small banks: NIM, ROA, ROE, LLR, and NPL

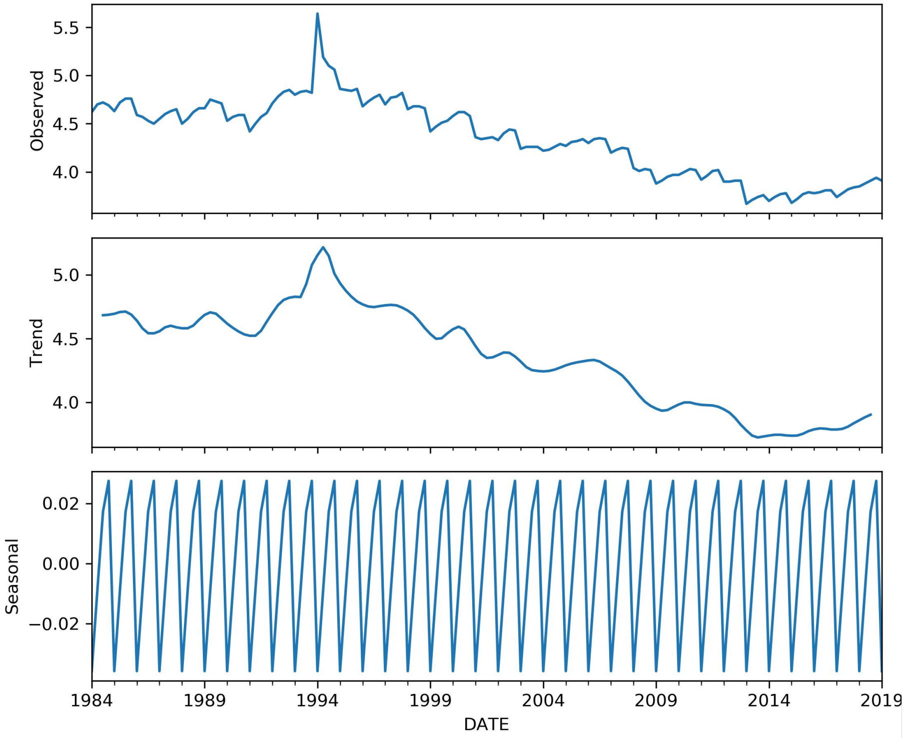
Findings are not conclusive: Ridge vs. Lasso

Further research: drop net income from and also consider adding asset size or non-interest expense to account for costs of compliance.

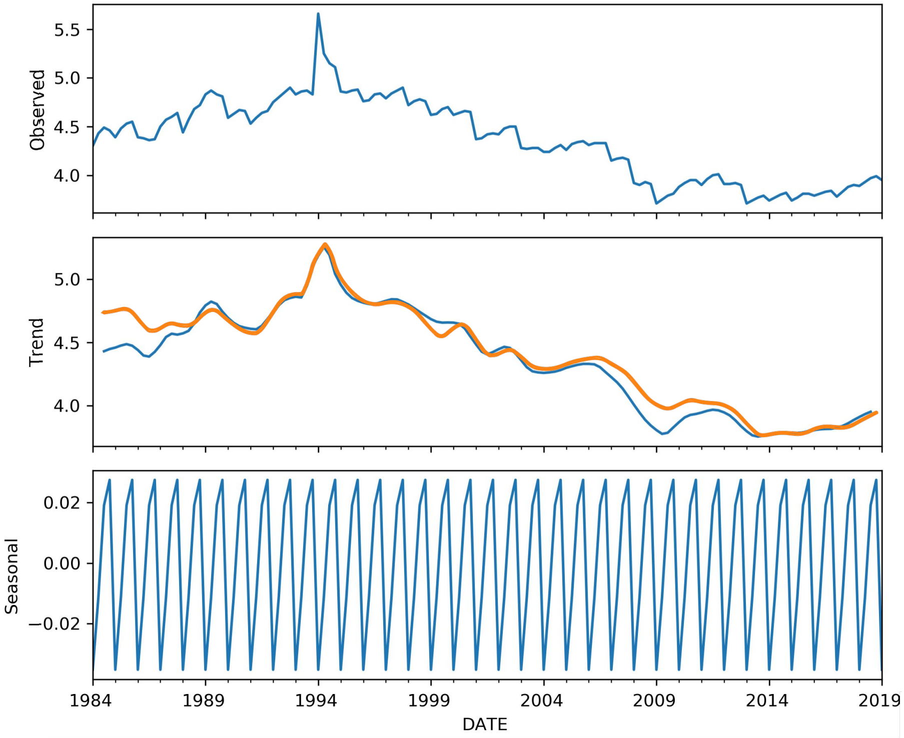
So maybe open a small bank…?

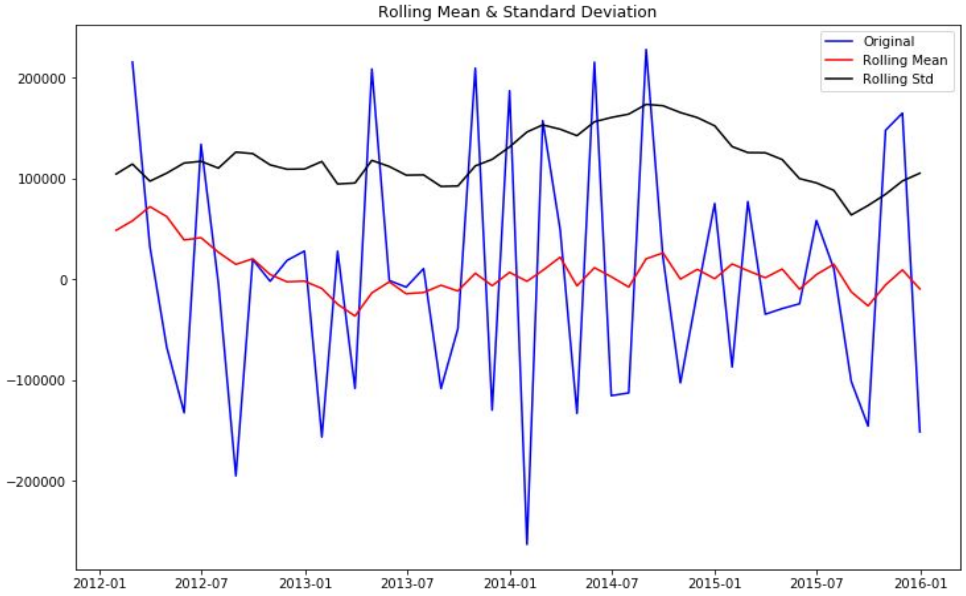
Net Income Seasonal Decomposition for Small & Mid-size Banks

Small (<$100M)



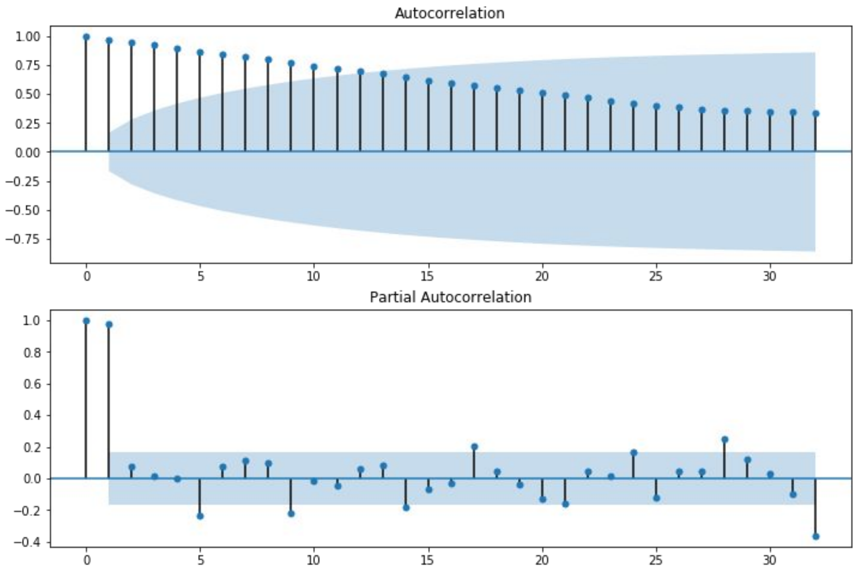
Mid-Size ($100M - $300M)

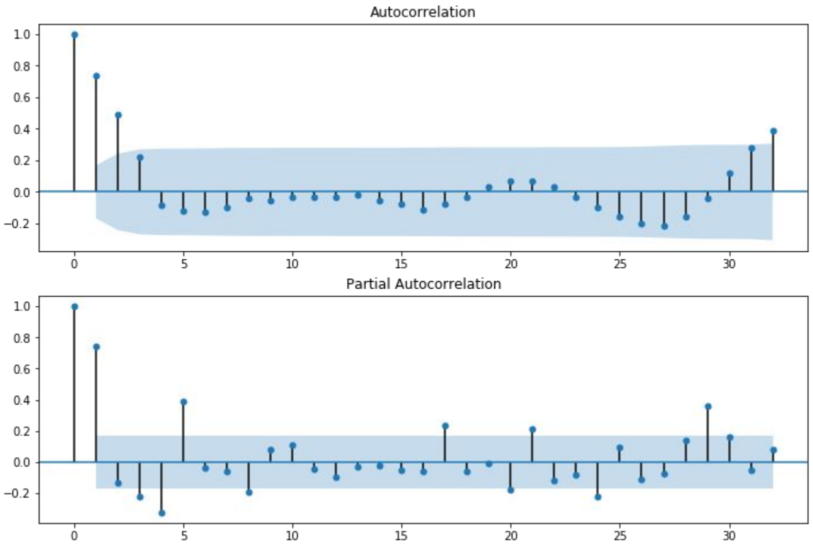




Results of Dickey-Fuller Test:

Test Statistic	-7.956275e+00
p-value	3.031374e-12
#Lags Used	1.000000e+00
# of Observations Used	5.700000e+01
Critical Value (1%)	-3.550670e+00
Critical Value (5%)	-2.913766e+00
Critical Value (10%)	-2.594624e+00


Autocorrelation
Partial Autocorrelation


Autocorrelation
Partial Autocorrelation