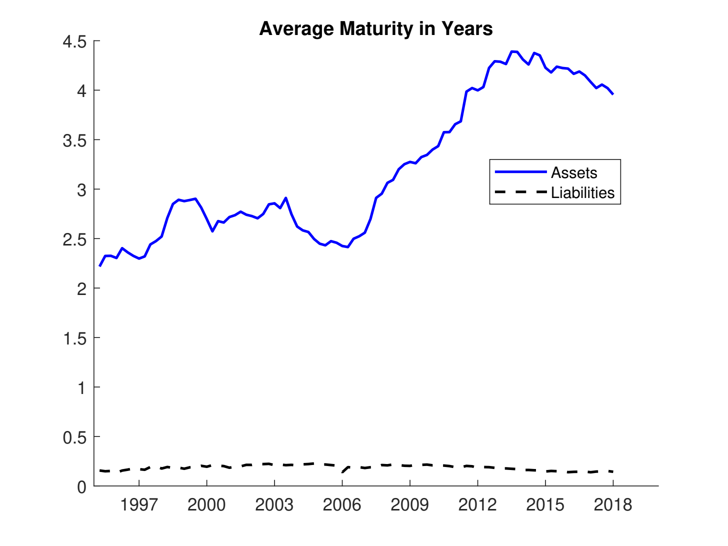
Stable Net-Interest Margin and Interest Rate Exposure of US Banks

Juliane Begenau (Stanford & NBER & CEPR)
Erik Stafford (HBS)

April 21, 2020

Maturity/Repricing of Bank Assets and Liabilities

Maturity transformation without interest rate risk?



Are banks exposed to interest rate risk?
How to measure interest risk exposure of banks?

Literature: Measuring Interest Rate Risk Exposure of Banks

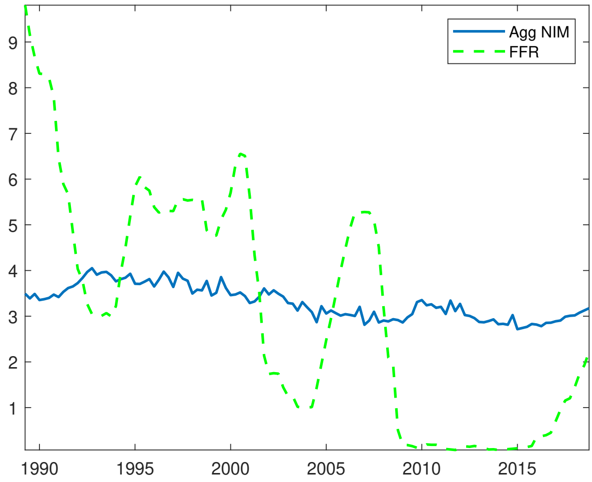
Value approach

- Stock return regressions on interest rates:
  - E.g. Flannery & James (1984); Hirtle (1997); English et al (2018).
- Model of the retail deposit business
  - E.g. Pennacchi & Hutchinson (1996); Jarrow & Van Deventer (1998)
- Banks as fixed income portfolios
  - E.g. Begenau, Piazzesi, Schneider (2015); Begenau & Stafford (2020), Meiselman, Nagel, Purnanandam (2020)

Income approach

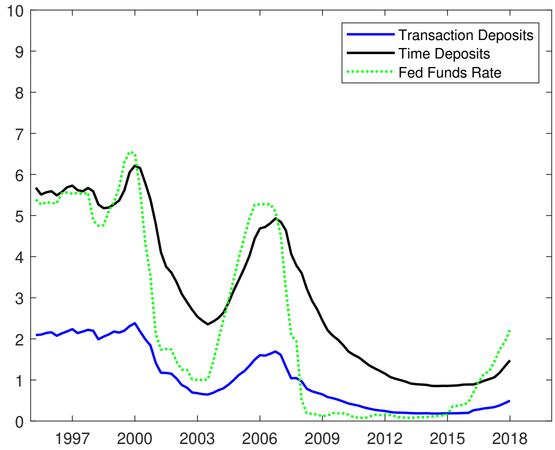
- Income and expense sensitivity to interest rates/income gap:
  - E.g. Landier et al (2013); Haddad & Sraer (2019); Paul (2020)
- Drechsler, Savov and Schnabl (2019): banks have no IRE
  - Banks use market power to match interest expenses to interest income $\Rightarrow$ stable NIM $\Rightarrow$ no interest rate risk
  - Consistent with bankers' view

Banks have very stable net-interest-margins



Partial rate adjustment of deposits

- Recent view: stable NIM enabled via market power in deposits
- Partial market rate pass-through in deposits (long term)
- Transaction deposits rates distinct from time deposits rates



Stable NIM

Two potential sources for stable NIM

1. Price rigidity due to bank market power
   e.g., Ausubel (1990), Berger and Hannan (1989), Hannan and Berger (1991), Hannan and Liang (1990), Neumark and Sharpe (1992), Diebold and Sharpe (1990), Drechsler, Schnabl, and Savov (2017)

   Newer Idea: stable NIM means banks have no IRE (common banker view reflected in annual reports; Drechsler et al JF 2021)

2. Partial adjustment occurs mechanically due to the income profile of long horizon fixed income assets /funding

This paper

1. Duration risk exposure vs income exposure to federal funds rate

   Income return exposure to short rate is commonly referred to as a partial adjustment measure

2. Duration is poorly identified from cash flows

   $\Rightarrow$ stable net cash flows $\neq$ no duration exposure

   $\Rightarrow$ Income/expense rates do not identify interest rate risk

3. Literature explains imperfect pass-through of market rates on income rates with intentional rate setting behavior by banks

   $\Rightarrow$ We show partial adjustment in income rates can be mechanical

4. Neither deposit franchise nor market power required for stable NIM

5. Stable NIM Treasury portfolio has duration exposure

Defining interest rate risk exposure

Empirical case for no-interest rate risk exposure at banks

Drechsler, Schnabl, Savov (forthcoming)
"Banking on deposits: Maturity transformation without interest rate risk"

- Empirical fact: net interest margins (NIM) are very stable

$$\text{NIM}_t = \frac{\text{Interest Income}_t - \text{Interest Expense}_t}{\text{Assets}_{t-1}}$$

$S_i = \sigma\left(\text{NIM}_{i,t}\right)$ and the 95% percentile of $S_i = 0.44\%$

- DSS interpret this fact that banks have no IRE

Empirical case for no-interest rate risk exposure at banks ctd

- How do banks achieve stability of NIM?

- Hypothesis: deposit franchise enables stable NIM
  - Market power leads to partial adjustment deposit rates
  - Banks match asset interest rate sensitivity to the expense rate sensitivity given by market power

- Define interest income and interest expense sensitivity via regression

  $\Delta(\frac{\text{interest income}_t}{\text{asset}_{t-1}})$ and $\Delta(\frac{\text{interest expense}_t}{\text{asset}_{t-1}})$ on $\Delta FFR_{t-\tau}$ for $\tau \in 0, .., 3$
  or

  $\Delta(r_t - \frac{\text{interest income}_t}{\text{asset}_{t-1}})$ and $\Delta(r_t - \frac{\text{interest expense}_t}{\text{asset}_{t-1}})$
- Run regression for each bank

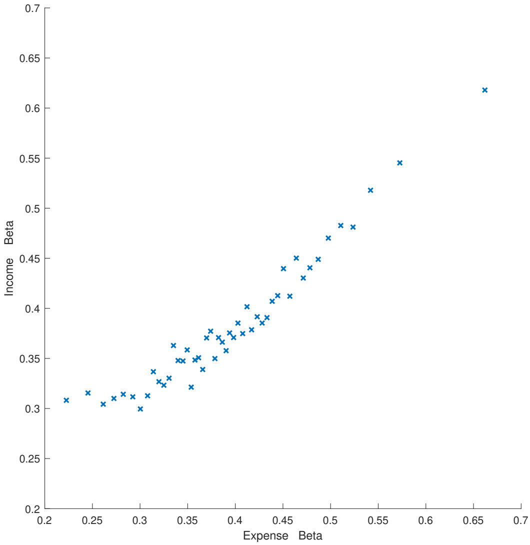
- Winsorize (at 5% level) and bin coefficients

Interest Rate Exposure (IRE) Definition

1. Duration risk = change in value due to change in interest rates

2. Income/expense risk = change in income/expense due to change in short-rate (e.g., federal funds rate)

Empirical fact: matching income and expense FFR coefficients



Illustrating the difference b/w duration risk vs Exposure to FFR

- One-factor term structure w/ risk-neutral pricing to illustrate point
- Factor exposed to shocks ε_{t+1} $i.i.N(0,1)$

$$
\begin{aligned}
f_{t+1} =& \phi f_t + \sigma \varepsilon_{t+1} \\
r_t =& \delta_0 + \delta_1 f_t \\
y_t^m =& -\frac{A_m}{m} - \frac{B_m}{m} f_t \\
P_t^m =& \exp(A_m + B_m f_t) \\
A_{n+1} =& A_n + \frac{1}{2} B_n' \sigma \sigma B_n - \delta_0 \\
B_{n+1}' =& B_n' \phi - \delta_1 \\
y_t^m =& r_t + \frac{\delta_1}{m} \sum_{j=1}^{m} \phi^j f_t + \text{Jensen term}
\end{aligned}
$$

Simple Treasury Portfolio

- Form UST zero-coupon bond portfolios
  - Each t, invest ω_t into zero-duration ($< 3m$) and (1-ω_t) in UST bonds with maturity M and hold until maturity
  - Par value of bond issued in s is Par_s
  - Bond was bought at $P_s^M \times Par_s$ invested in s periods ago
  - Asset position $A_t = \sum_{j=0}^{M} P_{t-j}^{M} Par_{t-j}$

$$\text{Inc}_t = \omega_t A_t r_t + (1 - \omega_t)\,\text{Par}_{t-M}$$

Value of the portfolio

$$V_t^B = \omega_t A_t r_t + (1 - \omega_t) \sum_{j=0}^{M} P_t^{M-j} Par_{t-j}$$

- With coupon-bonds, income will be a weighted average of past yields and principals

Two interest rate risk measures

[1.] How does income change with a change in r_t?

$$\frac{\delta \text{Inc}_t / A_t}{\delta r_t} = \omega_t$$

- Higher "interest rate exposure" with higher zero-duration share
- Independent of M

[2.] How does the value change with a change in interest rates (r_t)?

$$\frac{\delta V_t^B / A_t}{\delta r_t} = \omega_t + (1 - \omega_t) \sum_{j=0}^{M} \frac{\delta}{\delta r_t} \left(\frac{P_t^{M-j}}{P_{t-j}^{M}} \right)$$

$$\frac{\delta V_t^B / A_t}{\delta r_t} \neq \frac{\delta \text{Inc}_t}{\delta r_t}$$

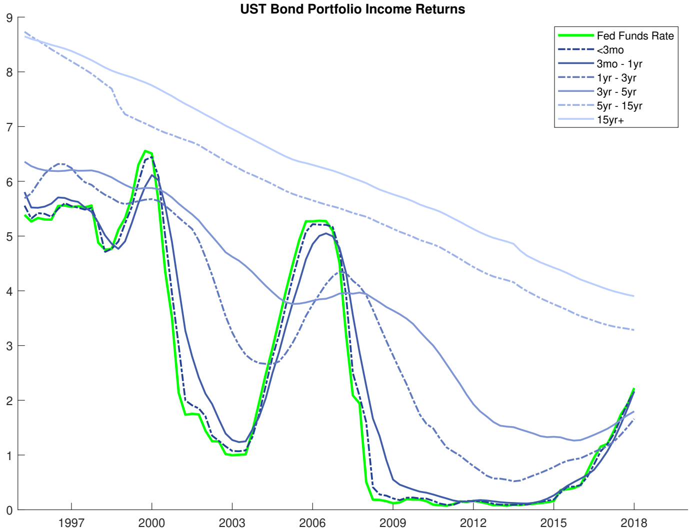
- Higher "interest rate exposure" if more sensitive to discount rate shocks
- Increasing in M

Poor identification of duration exposure in income rates

Construction of Treasury Portfolios that can be mapped to banks

- Form UST coupon bond portfolios with maturity M
    - Each t, invest ω_t into zero-duration ($< 3m$) and (1-ω_t) in UST bonds with maturity $> 3m$
    - Portfolios based on banks' maturity buckets (M^U and M^L)
    - Each t, buy M^U bond at par and sell when remaining maturity M^L
    - Ex w/ bucket 3y-5yr: each t, buy 5yr bond at par; sell bonds w/ $< 3y$ remaining maturity; collect coupons and value at sale of all bonds in the bucket
    - Reinvest principal
    - Calculate income return as all income received across all positions in a given quarter over the initial amount invested
- Measure the interest rate risk from the UST portfolio (i.e. change in position value in response to $+1\%$ increase in interest rates)

Income returns on held-to-maturity UST bond portfolios



Properties of UST portfolios and IRE Measures

	0-3m	3m-12m	1y-3y	3y-5y	5y-15y	15y+
			Market Returns			
Mean	2.43	2.58	3.42	4.41	5.78	7.07
Std	1.12	1.17	2.01	3.72	7.17	9.94
Delta	0.00	-0.01	-0.02	-0.04	-0.08	-0.12
5y-TERM Coef	0.01	0.06	0.31	0.72	1.39	1.83
5y-TERM t-stat	2.57	7.24	14.9	21.9	19.99	15.27
5y-TERM R2	0.07	0.37	0.71	0.84	0.82	0.72
			Interest Income Return			
Mean	2.43	2.53	3.12	3.52	5.16	4.96
Std	1.11	1.08	1.01	0.91	0.73	0.72
chgFFR Coef	0.98	0.83	0.51	0.37	0.01	0.01
chgFFR t-stat	59.81	27.96	15.6	11.72	1.72	0.82
chgFFR R2	0.98	0.92	0.74	0.62	0.00	0.01
			Income Spread = FFR - Inc. Return			
Mean	-0.05	-0.15	-0.74	-1.14	-2.78	-2.58
Std	0.11	0.21	0.52	0.57	0.74	0.77
chgSpread Coef	0.02	0.17	0.49	0.63	0.99	0.99
chgSpread t-stat	1.53	5.57	14.93	19.63	146.46	84.09
chgSpread R2	0.95	0.86	0.93	0.94	1.00	0.99

Same income rate FFR sensitivity but different duration risk

Sell	Buy	Cash Shr	Spread Beta	5yTERM	Mean(Inc)	Mean(MV)
1	3	0.00	0.50	0.31	3.12	3.42
2	4	0.11	0.50	0.46	3.20	3.74
3	5	0.23	0.50	0.55	3.22	3.90
4	6	0.26	0.50	0.65	3.27	4.03
5	7	0.31	0.50	0.70	3.27	4.04
6	8	0.33	0.50	0.77	3.32	4.21

$$\Delta\left(r_t - \frac{\text{Inc}_t}{A_t}\right) = c + \sum_{\tau=0}^{3} \beta_\tau \Delta r_{t-\tau} + \nu_t$$

$$\text{Spread Beta} = \sum_{\tau=0}^{3} \hat{\beta}_\tau$$

Portfolio that each period buys bonds with remaining maturity "Buy" and sells when remaining maturity has fallen to "Sell".

Interim take-aways from UST portfolio

1. Duration exposure poorly identified by income/expense rates
   a. When term $\geq$ 5 years, no sensitivity to FFR coefficient

   b. Varying the zero-duration asset share varies the sensitivity to FFR even in a zero duration portfolio

   c. Varying the zero-duration asset together with term of long term security can deliver identical FFR coefficient with various exposures

2. Partial adjustment of rates to shocks in r_t is mechanical in a long-term bond portfolio

Implications of Stable NIM

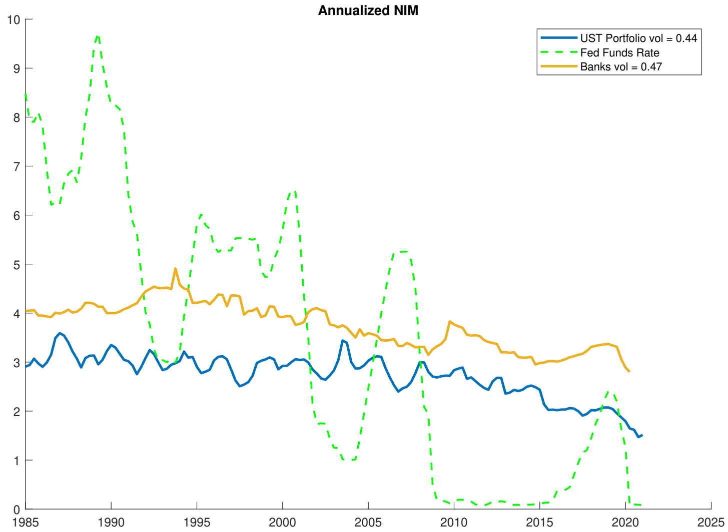
Stable Net-Interest-Margins & IRE at banks

- Does stable NIM require a deposit franchise?
- Construct a cross-section of price-taking Treasury portfolios that target a stable NIM by buying long term UST funded with shorter term bonds

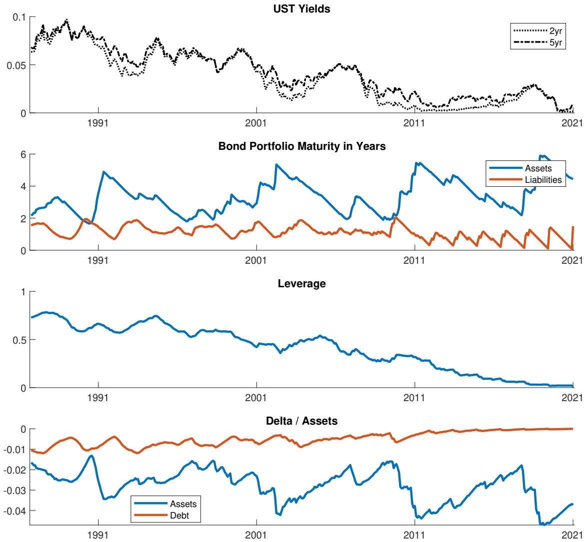
Stable NIM UST Portfolio Strategy

- Targets for each $i \in 1, ..., N$
  - Annual net interest margin (income - expense)/Assets b/w 1-3%
  - Debt to asset target ratio b/w 50-80% and 90% max
  - Asset cash target ratio b/w 5-40%
  - Initial asset maturity 4-7 years
  - Initial debt maturity 18-30m
- Each month
  - invest in cash & long term UST bond
  - Fund with debt maturity
  - Distribute interest & repay maturing debt by issuing new debt
- Check whether current portfolio hits target NIM under current rates
  - If yes move to next period
  - If not can change leverage (within 4% up and 1% down), asset maturity, debt maturity, or cash share

Bond Portfolio NIM and (untargeted) Bank NIM



Bond Portfolio Characteristics



Implications of constant NIM for spread betas

Suppose

$$NIM_t = \frac{\text{Inc}_t^{M^A} - \text{Exp}_t^{M^L}}{A_{t-1}} = \frac{\text{Inc}_{t-1}^{M^A} - \text{Exp}_{t-1}^{M^L}}{A_{t-2}} = NIM_{t-1} \;\; \forall\, t \in \{1, ..., T\}\,.$$

1. $\Rightarrow$ Any change needs to be proportional $\text{Inc}_t^{M^A}$, $\text{Exp}_t^{M^L}$ or A_{t-1}
2. $\text{COV}\left(NIM_t, X_t\right) = 0$ for any X_t.

Implications of constant NIM for spread betas ctd

Expanding the the components of NIM_t and recognizing that $\mathrm{COV}\left(X, Y+Z\right) = \mathrm{COV}\left(X, Y\right) + \mathrm{COV}\left(X, Z\right)$, we can write

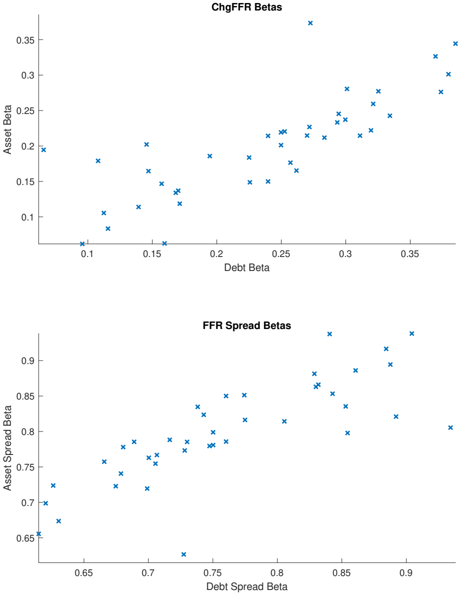
$$
\begin{aligned}
\mathrm{COV}\left(\mathrm{Inc}_t^{M^A}/A_{t-1}, X_t\right) - \mathrm{COV}\left(\mathrm{Exp}_{t-1}^{M^L}/A_{t-1}, X_t\right) &= 0 \\
&\Rightarrow \\
\underbrace{\frac{\mathrm{COV}\left(\mathrm{Inc}_t^{M^A}/A_{t-1}, X_t\right)}{VAR\left(X_t\right)}}_{:=\beta^{\mathrm{Inc}/A}} - \underbrace{\frac{\mathrm{COV}\left(\mathrm{Exp}_{t-1}^{M^L}/A_{t-1}, X_t\right)}{VAR\left(X_t\right)}}_{:=\beta^{\mathrm{Exp}/A}} &= 0
\end{aligned}
$$

This means, income and expense betas have to satisfy

$$\beta^{\mathrm{Inc}/A} = \beta^{\mathrm{Exp}/A}$$

for any random variable X_t.

Matching income & expense betas and spread betas



Stable Net-Interest-Margins & IRE at banks

- Does stable NIM require a deposit franchise?

  No!

  - Can generate as stable NIM with a price-taking (i.e. no market power) UST portfolio
  - Banks' NIM also contain a credit premium on loans but not losses and below market rate deposit funding without non-interest expense of deposits
  - As our treasury portfolio, banks could vary funding ratio and term, asset composition etc to hit stable NIM

- Does stable NIM mean that there is no interest rate risk?

  No!

  - NIM stable but duration risk of equity sizable
  - Stable "cash flows" $\neq$ no duration risk exposure
  - Matching spread betas uninformative about exposure

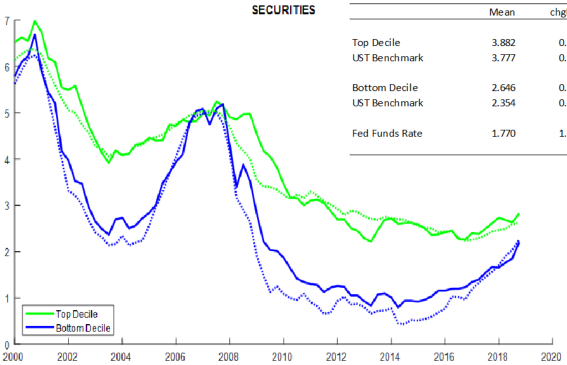
Narrow bank NIM

- Banks' securities and time deposits produce also a fairly stable NIM
- Banks not likely to have market power in time deposits and securities (gov bonds and mortgages)
- Show that duration risk of a UST replicating portfolio remains sizable despite "stable NIM"
- To this end, build synthetic version of banks' securities and time deposit position with UST bonds

Bank Duration Exposure: Map bank activities to UST portfolios

- Simple benchmark procedure (as in Begenau, Piazzesi, and Schneider (2015))
  - From call reports: maturity/repricing buckets (<3m, 3m-1y, 1y-3y, 3y-5y, 5-15y, >15y) of bank positions (e.g. securities, time deposits)
  - Form UST coupon bond portfolios based on empirical mat. dist.
  - Each t, invest ω_t into zero-duration ($< 3m$) and (1-ω_t) in UST bonds with maturity $> 3m$
  - Ex w/ bucket 3y-5yr: each t, buy 5yr bond at par; sell bonds w/ $< 3y$ remaining maturity; collect coupons and value at sale of all bonds in the bucket
  - Calculate accounting return as income received across all positions in a given quarter over the initial amount invested
- Check fit by comparing reported returns of banks to "accounting" returns of benchmark
- Measure the interest rate risk from the UST portfolio (i.e. change in position value in response to $+1\%$ increase in interest rates)

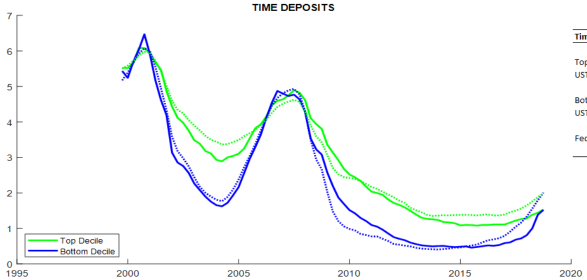
Securities: Banks vs Benchmark



	Mean	chgFFR	Delta
Top Decile	3.882	0.205	n.a.
UST Benchmark	3.777	0.222	-0.073
Bottom Decile	2.646	0.527	n.a.
UST Benchmark	2.354	0.539	-0.019
Fed Funds Rate	1.770	1.000	0.000

- Sort banks into deciles based on average maturity of securities
- Report mean, coefficient on the change in the FFR, and delta: the duration risk exposure measure
- UST portfolio returns fit bank securities returns reasonably well
- Do the same for time deposits

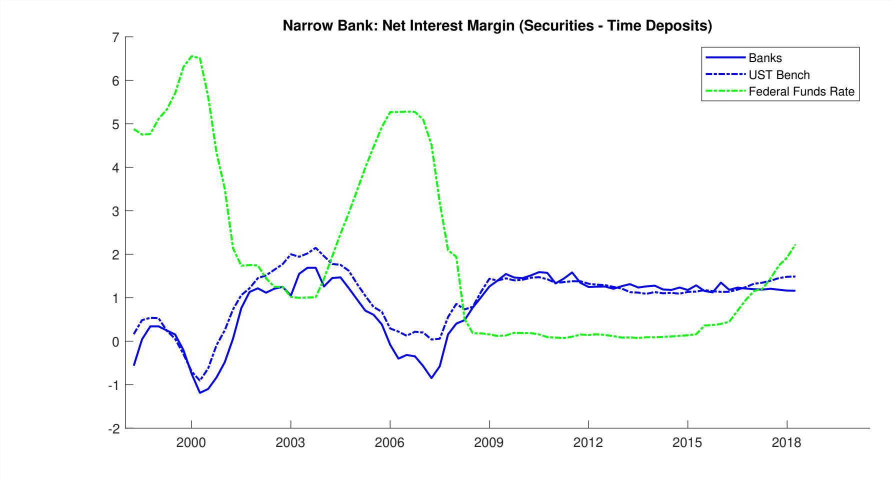
Time Deposits: Banks vs Benchmark



Time Deposits	Mean	chgFFR	Delta
Top Decile	2.90	0.280	n.a.
UST Benchmark	3.01	0.231	-0.027
Bottom Decile	2.23	0.474	n.a.
UST Benchmark	2.23	0.470	-0.010
Fed Funds Rate	1.82	1.000	0.000

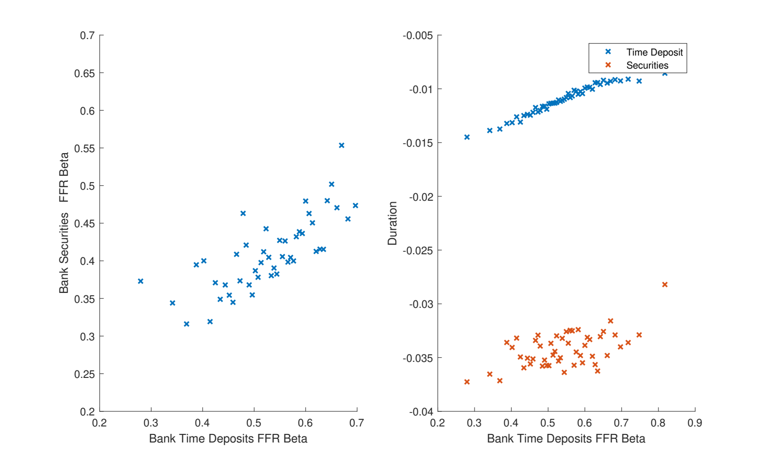
- Sort banks into deciles based on average maturity of time deposits
- Report mean, coefficient on the change in the FFR, and delta: the duration risk exposure measure
- UST portfolio returns fit time deposits rates reasonably well
- Calculate narrow bank NIM

Stable Net-Interest Margins without interest rate hedge



- Fairly stable: narrow bank NIM vol is 1/3 of FFR vol

How reliable are stable NIM as predictors of no interest rate risk exposure



- Despite stable NIM and roughly matching betas, narrow bank is exposed to interest rate risk

Conclusion

Conclusions

Findings:

- Duration risk is poorly identified from income expense rates of US Treasury portfolios
- Spread betas tautologically match once NIM is targeted
- Intentional rate setting applies only to transaction deposits. Other partial adjustment consistent with mechanical income properties of fixed income portfolios
- A price taking investment strategy that invests in US Treasury bond portfolios can produce a highly stable NIM and transparently earns positive NIM by bearing positive duration risk exposure
- A narrow bank (securities funded with time deposits) has fairly stable NIM and positive interest rate exposure

Results call into question notion that

- stable NIM implies no interest rate risk
- deposit taking is required to produce stable NIM
- market power is an important component to producing stable NIM