Monetary Policy Transmission with Adjustable and Fixed Rate Mortgages: The Role of Credit Supply

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    - Larger the share of ARM in an economy, the stronger MP transmission
  - Maggio et al (2017, AER):
    - A sizable decline in mortgage payments (up to 50 percent) $\rightarrow$ a $\uparrow$ increase in car purchases (up to 35 percent)
    - Regions with a larger share of ARMs $\rightarrow$ a relative $\downarrow$ in defaults, an $\uparrow$ in house prices, car purchases, and employment

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    - Paul (2023) (maturity mismatch)
- In a **closed economy,** the net effect depends on the **"marginal"** agent in the economy.
- During a banking crises, banks will likely dominate (2008 Crisis)
- The current episode of increasing interest rates: Indebted households

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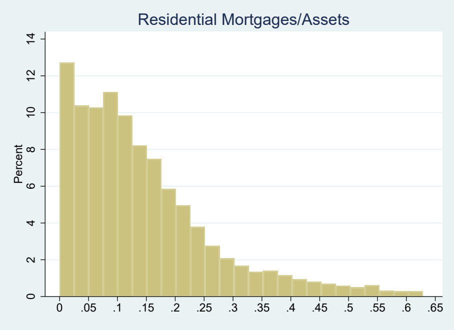
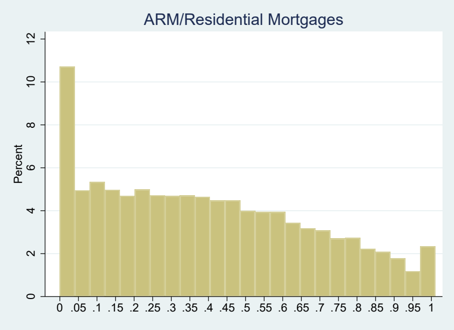
- Two-fold composition of an ARM contract:
  - index : U.S. prime rate and the Constant Maturity Treasury rate
  - margin: borrower's creditworthiness
- A typical ARM contract:
  - initial fixed term period: The most common; 3/1, 5/1, 7/1 and 10/1
  - adjustable period: ARM with caps of 2/2/5
    - initial adjustment cap (2%)
    - subsequent adjustment cap (2%)
    - lifetime adjustment cap (5%)

Motivation: Mortgages and ARMs in the US

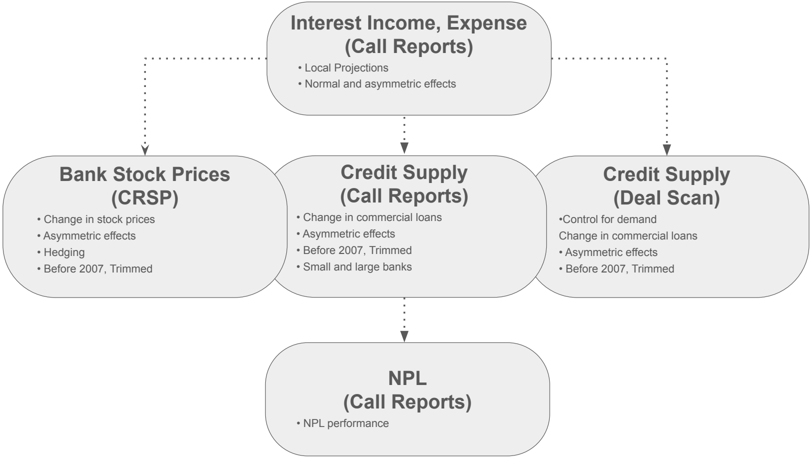




Source: Call Reports.

Hypothesis and Strategy

Hypothesis: When Fed tightens, banks with higher ARM share perform better due to higher expected interest income.



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- High frequency MP shock series
  - Ferrari et al. (2021): monetary policy decisions, releases of minutes of policy meeting, and press releases.

Data

Data	Variable	# Observations	Mean	Median	SD	Min	Max
CRSP	% Change in Stock Prices (daily)	44967	0.190	0.000	4.143	-36.84	35.667
CRSP	Assets (Billion, in 2010 USD)	44967	28.89	1.846	182.25	0.05	2626.67
CRSP	ARM/A (%)	44967	5	3.2	5.3	0.00	31.4
CRSP	RELoans/A (%)	44967	49.8	51.4	15.7	0.00	86.3
CR	% Δ in Commercial Loans (Quarterly)	30519	2.8	1.58	14.33	-176.6	107.4
CR	Assets (Billion, in 2010 USD)	30519	15.77	1.77	88.98	0.45	1873.86
CR	ARM/A (%)	30519	6	3	7.5	0.00	42.80
CR	RELoans/A (%)	30519	41.8	42.6	17.9	0.00	83.60
DS	Log(Loans)	150177	16.9	16.9	1.252	5.145	23.153
DS	Assets (Billion, in 2010 USD)	150177	424.30	160.68	496.721	0.493	1873.869
DS	ARM/A (%)	150177	3.9	2.9	3.6	0.00	33.5
DS	RELoans/A (%)	150177	24.5	25.9	12.3	0.00	80.4

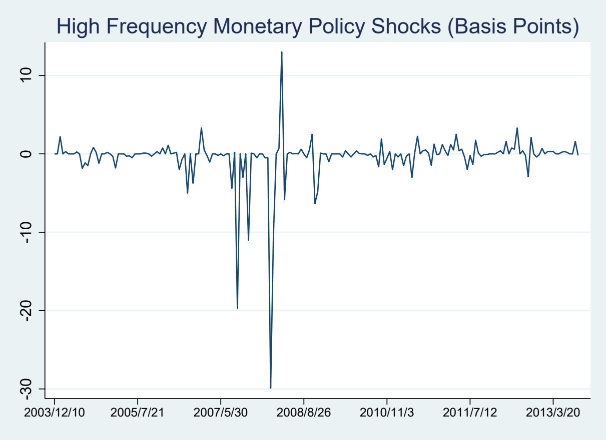
How does ARM share affect bank stock price response to monetary policy surprises?

Bank Stock Price Regression Model

$$\Delta Y_{i,t} = \boldsymbol{\alpha} * \boldsymbol{ARM_{i,t}} * \boldsymbol{MP_{shock,t}} + \sum \boldsymbol{\gamma}_{\boldsymbol{i}}(\boldsymbol{BV_{i,t}} * \boldsymbol{MP_{shock,t}}) + \beta * Y_{i,t-1} + \nu_t + \theta_i + \epsilon_{i,t}$$

- $\boldsymbol{\Delta Y_{i,t}}$ percent change in stock prices of bank i between day $t+1$ and $t-1$,
- $\boldsymbol{ARM_{i,t}}$ share of ARM loans relative to assets,
- $\boldsymbol{MP_{shock,t}}$ surprise change in short term (1 month) yields around monetary policy events,
- $\boldsymbol{BV_{i,t}}$ is bank balance sheet variables : Kashyap (1995), Kashyap (2000), Kishan (2000), Drechsler (2017)
- Log(Assets), Equity, Liquidity, NPL, Balances due From Fed, HHI (deposits), Assets Maturing in Less than a Year, Deposits
- Structure of Bank Liabilities: Saving Deposits, Time Sensitive Deposits, Fed Repo Liabilities
- $\boldsymbol{\nu_t}$ and $\boldsymbol{\theta_i}$ are time and bank fixed effects.

High Frequency Monetary Policy Shocks



Source: Ferrari et al. (2021)

Stock Market Reactions to High Frequency Shocks

Dependent Variable: Change in bank stock prices						
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
$\alpha * ARM_{i,t} * MP_{shock}$	0.015***	0.008*	0.011**	0.011**	0.012***	0.012***
standard errors	(0.005)	(0.005)	(0.005)	(0.0064)	(0.004)	(0.004)
TIME FE	N	N	N	**Y**	Y	Y
YEAR*MONTH FE	N	N	**Y**	-	-	-
BANK FE, DEPENDENT VAR. LAGS, BANK CONTROLS	**Y**	Y	Y	Y	Y	Y
BANK CONTROLS*MP_{shock}	N	**Y**	Y	Y	Y	Y
BANK LIABILITY CONTROLS	N	N	N	N	**Y**	**Y**
BANK LIABILITY CONTROLS*MP_{shock}	N	N	N	N	**Y**	**Y**
BANK FED FUNDS LIABILITY	N	N	N	N	N	**Y**
BANK FED FUNDS LIABILITY*MP_{shock}	N	N	N	N	N	**Y**
Impact of 25bp Increase in MP Shock (PP)	2.17	1.16	1.59	1.59	1.73	1.73
(Diff. between 75th (0.071) and 25th (0.014) percentiles)						
Observations	25008	25008	25008	25008	25008	25008
R-squared	0.159	0.161	0.314	0.367	0.367	0.367

Stock Market Asymmetric Reactions

Dependent Variable: Change in bank stock prices						
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
$\alpha^{+} * ARM_{i,t} * MP^{+}_{shock}$	0.026***	0.019*	0.02**	0.02**	0.021**	0.021**
standard errors	(0.01)	(0.011)	(0.01)	(0.01)	(0.01)	(0.01)
$\alpha^{-} * ARM_{i,t} * MP^{-}_{shock}$	-0.004	-0.013	-0.008	-0.008	-0.007	-0.007
	(0.015)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
TIME FE	N	N	N	Y	Y	Y
YEAR*MONTH FE	N	N	Y	-	-	-
BANK FE, DEPENDENT VAR. LAGS, BANK CONTROLS	Y	Y	Y	Y	Y	Y
BANK CONTROLS	Y	Y	Y	Y	Y	Y
BANK CONTROLS*MP_{shock}	N	Y	Y	Y	Y	Y
BANK LIABILITY CONTROLS	N	N	N	N	**Y**	**Y**
BANK LIABILITY CONTROLS*MP_{shock}	N	N	N	N	**Y**	**Y**
BANK FED FUNDS LIABILITY	N	N	N	N	N	**Y**
BANK FED FUNDS LIABILITY*MP_{shock}	N	N	N	N	N	**Y**
Observations	7906	7906	7906	7906	7906	7906
R-squared	0.256	0.269	0.399	0.399	0.399	0.399

How does ARM share affect bank lending?

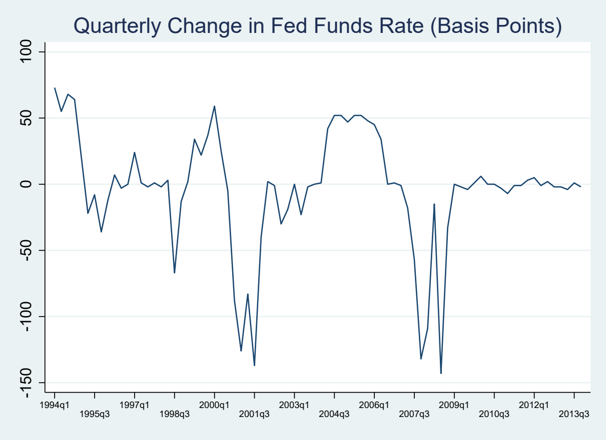
Bank Lending Regression Model

$$\Delta Y_{it} = \sum_{k=0}^{k=4} \alpha_k (ARM_{i,t-1} * \Delta FFR_{t-k}) + \sum_{k=0}^{k=4} \sigma_k (ARM_{i,t-1} * \Delta Macros_{t-k})$$

$$+ \sum_{k=0}^{k=4} \gamma_{i,k} (BV_{i,t-1} * \Delta FFR_{t-k}) + \sum_{k=0}^{k=4} \lambda_k Y_{i,t-k} + \nu_t + \theta_i + \epsilon_{i,t}$$

- $\Delta Y_{i,t}$ percent change in C&I lending,
- $ARM_{i,t}$ share of ARM loans relative to assets,
- ΔFFR quarterly change in federal funds rate:
  - Data constraints, small magnitude of shocks, unexpected macroeconomic developments, actual change in interest rate
- $BV_{i,t-1}$ bank balance sheet variables
- *Macros* GDP, inflation, house prices, mortgage demand,
- ν_t and θ_i are time and bank fixed effects.

Quarterly Change in Federal Funds Rate



Commercial Loans at Bank Level

Dependent Variable: Change in Commercial Loans					
Explanatory Variables	(1)	(2)	(3)	(4)	(5)
$\sum_{k=0}^{k=4} \alpha_k (ARM_{i,t-1} * \Delta FFR_{t-k})$	0.153***	0.134**	0.133**	0.136**	0.129**
standard errors	(0.052)	(0.069)	(0.067)	(0.067)	(0.067)
TIME FE, BANK FE	**Y**	Y	Y	Y	Y
DEPENDENT VAR. LAGS, BANK CONTROLS	**Y**	Y	Y	Y	Y
$\sum_{k=0}^{k=4} \gamma_k^{+,-}$ (BANK CONT. $* \Delta FFR_{t-k}$)	N	N	**Y**	Y	Y
$\sum_{k=0}^{k=4} \sigma_k (ARM_{i,t-1} * MACROS_{t-k})$	N	**Y**	Y	Y	Y
BANK LIABILITY CONTROLS	N	N	N	**Y**	**Y**
$\sum_{k=0}^{k=4} \gamma_k^{+,-}$ (BANK LIABILITY CONT. $* \Delta FFR_{t-k}$)	N	N	N	**Y**	**Y**
BANK FED FUNDS LIABILITY	N	N	N	N	**Y**
$\sum_{k=0}^{k=4} \gamma_k^{+,-}$ (BANK FED FUNDS LIAB. $* \Delta FFR_{t-k}$)	N	N	N	N	**Y**
Impact of 1 SD Increase (0.38) in FFR (PP)	0.438	0.384	0.381	0.389	0.369
(Diff. between 75th (0.083)and 25th (0.009) percentiles)					
Observations	27825	27825	27825	27825	27825
R-squared	0.114	0.115	0.117	0.118	0.118

Commercial Loans at Bank Level: Asymmetric Effects

Dependent Variable: Change in Commercial Loans					
Explanatory Variables	(1)	(2)	(3)	(4)	(5)
$\sum_{k=0}^{k=4} \alpha_k^+ (ARM_{i,t-1} * \Delta FFR_{t-k}^+)$	0.161	0.386*	0.386*	0.396*	0.389*
standard errors	(0.121)	(0.244)	(0.244)	(0.247)	(0.246)
$\sum_{k=0}^{k=4} \alpha_k^- (ARM_{i,t-1} * \Delta FFR_{t-k}^-)$	0.116	-0.022	-0.022	-0.018	-0.021
p-values	(0.075)	(0.097)	(0.097)	(0.097)	(0.097)
TIME FE, BANK FE	**Y**	Y	Y	Y	Y
BANK CONTROLS, DEPENDENT VAR. LAGS	**Y**	Y	Y	Y	Y
$\sum_{k=0}^{k=4} \gamma_k^{+,-}$ (BANK CONT. $* \Delta FFR_{t-k}^{+,-}$)	N	N	**Y**	Y	Y
$\sum_{k=0}^{k=4} \sigma_k (ARM_{i,t-1} * MACROS_{t-k})$	N	**Y**	Y	Y	Y
BANK LIABILITY CONTROLS	N	N	N	**Y**	**Y**
$\sum_{k=0}^{k=4} \gamma_k^{+,-}$ (BANK LIABILITY CONT. $* \Delta FFR_{t-k}^{+,-}$)	N	N	N	**Y**	**Y**
BANK FED FUNDS LIABILITY	N	N	N	N	**Y**
$\sum_{k=0}^{k=4} \gamma_k^{+,-}$ (BANK FED FUNDS LIAB. $* \Delta FFR_{t-k}^{+,-}$)	N	N	N	N	**Y**
Observations	27825	27825	27825	27825	27825
R-squared	0.114	0.116	0.116	0.115	0.116

How does ARM share affect bank lending?—Controlling for loan demand

Identifying the credit supply channel

$$\log(L)_{ift} = \boldsymbol{\delta_{f,t}} + \sum_{k=0}^{k=4} \boldsymbol{\alpha_k (ARM_{i,t-1} * \Delta FFR_{t-k})} + \sum_{k=0}^{k=4} \boldsymbol{\sigma_k (ARM_{i,t-1} * \Delta Macros)}$$

$$+ \sum_{k=0}^{k=4} \boldsymbol{\gamma_{i,k} (BV_{i,t-1} * \Delta FFR_{t-k})} + \theta_i + \epsilon_{i,t}$$

- $\boldsymbol{Log(L)_{ift}}$ log of new loans from bank i to firm f at the time t,
- $\boldsymbol{\delta_{ft}}$ is firm*time fixed effects: Khwaja and Mian (2008)
- $\boldsymbol{ARM_{i,t}}$ share of ARM loans relative to assets,
- $\boldsymbol{\Delta FFR}$ quarterly change in federal funds rate,
- $\boldsymbol{BV_{i,t}}$ bank balance sheet, variables,
- $\boldsymbol{Macros}$ GDP, inflation, house prices, mortgage demand,
- $\boldsymbol{\theta_i}$ bank fixed effects.

Bank-Firm Level (DealScan) Evidence-Controlling for Loan Demand

Dependent Variable: Change in loans of borrower f from bank i					
Explanatory Variables	(1)	(2)	(3)	(4)	(5)
$\sum_{k=0}^{k=4} \alpha_k (ARM_{i,t-1} * \Delta FFR_{t-k})$	0.868***	1.585**	1.275*	1.378*	1.184*
standard errors	(0.327)	(0.773)	(0.72)	(0.789)	(0.708)
BORROWER*TIME FE	**Y**	Y	Y	Y	Y
BANK FE, BANK CONTROLS	**Y**	Y	Y	Y	Y
DEPENDENT VAR. LAGS	**Y**	Y	Y	Y	Y
$\sum_{k=0}^{k=4} \gamma_k^{+,-}$ (BANK CONT. $* \Delta FFR_{t-k}$)	N	N	**Y**	Y	Y
$\sum_{k=0}^{k=4} \sigma_k (ARM_{i,t-1} * MACROS_{t-k})$	N	**Y**	Y	Y	Y
BANK LIABILITY CONTROLS	N	N	N	**Y**	**Y**
$\sum_{k=0}^{k=4} \gamma_k^{+,-}$ (BANK LIABILITY CONT. $* \Delta FFR_{t-k}$)	N	N	N	**Y**	**Y**
BANK FED FUNDS LIABILITY	N	N	N	N	**Y**
$\sum_{k=0}^{k=4} \gamma_k^{+,-}$ (BANK FED FUNDS LIAB. $* \Delta FFR_{t-k}$)	N	N	N	N	**Y**
Impact of 1 SD Increase (0.39) in FFR (%)	1.396	2.549	2.050	2.216	1.904
(Difference between 75th (0.054)and 25th (0.013) percentiles)					
Observations	47877	47877	47877	47877	47877
R-squared	0.779	0.78	0.78	0.78	0.78

Bank-Firm Level (DealScan) Evidence- Asymmetric Effects

Dependent Variable: Change in loans of borrower f from bank i			
Explanatory Variables	(1)	(2)	(3)
$\sum_{k=0}^{k=4} \alpha_k^+ (ARM_{i,t-1} * \Delta FFR_{t-k}^+)$	4.264**	5.01***	4.534***
standard errors	(2.062)	(1.897)	(1.677)
$\sum_{k=0}^{k=4} \alpha_k^- (ARM_{i,t-1} * \Delta FFR_{t-k}^-)$	-0.867	-0.897	-0.941
standard errors	(1.154)	(1.067)	(1.134)
BORROWER*TIME FE	Y	Y	Y
BANK FE, BANK CONTROLS	Y	Y	Y
DEPENDENT VAR. LAGS	Y	Y	Y
$\sum_{k=0}^{k=4} \gamma_k^{+,-}$ (BANK CONT. $* \Delta FFR_{t-k}^{+,-}$)	Y	Y	Y
$\sum_{k=0}^{k=4} \sigma_k (ARM_{i,t-1} * MACROS_{t-k})$	Y	Y	Y
BANK LIABILITY CONTROLS	N	**Y**	**Y**
$\sum_{k=0}^{k=4} \gamma_k^{+,-}$ (BANK LIABILITY CONT. $* \Delta FFR_{t-k}^{+,-}$)	N	**Y**	**Y**
BANK FED FUNDS LIABILITY	N	N	**Y**
$\sum_{k=0}^{k=4} \gamma_k^{+,-}$ (BANK FED FUNDS LIAB. $* \Delta FFR_{t-k}^{+,-}$)	N	N	**Y**
Observations	47877	47877	47877
R-squared	0.781	0.781	0.781

The Mechanism: Interest Income

Local Projections of interest income and expenses

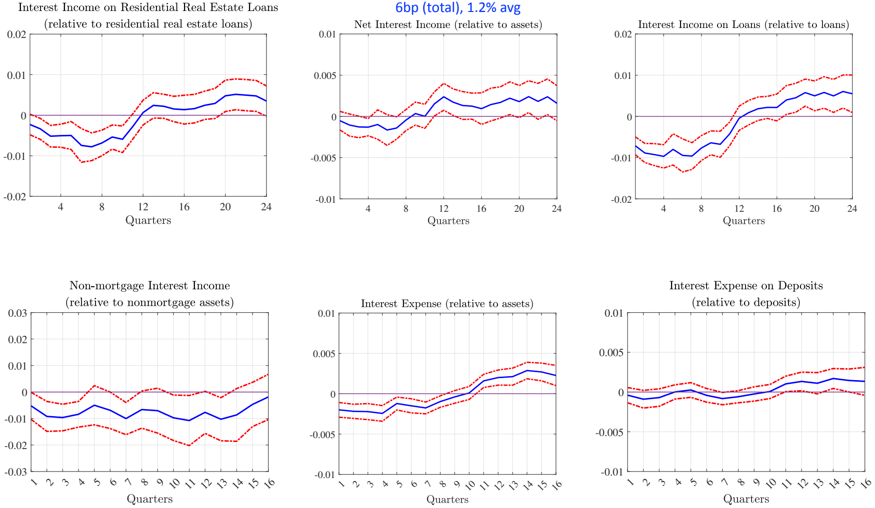
$$\Delta Y_{i,t+d} = \sum_{k=0}^{k=4} \alpha_{k,d}(ARM_{i,t-1} * \Delta FFR_{t-k}) + \sum_{k=0}^{k=4} \sigma_{k,d}(ARM_{i,t-1} * \Delta Macros)$$

$$+ \sum_{k=0}^{k=4} \gamma_{i,k,d}(BV_{,i,t-1} * \Delta FFR_{t-k}) + \sum_{k=0}^{k=4} \lambda_{k,d} Y_{i,t-k} + \nu_t + \theta_i + \epsilon_{i,t+d}$$

- **ARM contracts :** long term, adjustments take time
- **Jorda (2005)**
- $\Delta Y_{i,t+d}$ interest income or expense,
- $ARM_{i,t}$ share of ARM loans relative to assets,
- ΔFFR quarterly change in federal funds rate,
- $BV_{i,t}$ bank balance sheet, variables,
- $Macros$ GDP, inflation, house prices, mortgage demand,
- ν_t and $\theta_i$are time and bank fixed effects.

ARM share and Interest income

75th vs 25th: 1 SD Increase in FFR (%)
6bp (total), 1.2% avg



NPL performance

Dependent Variable: Change in NPL for Real Estate Loans/Real Estate Loans			
Explanatory Variables	(1)	(2)	(3)
$\sum_{k=0}^{k=4} \alpha_k (ARM_{i,t-1} * \Delta FFR_{t-k})$	-0.016	-0.016	-0.016
standard errors	(0.011)	(0.011)	(0.011)
TIME FE	Y	Y	Y
BANK FE	Y	Y	Y
DEPENDENT VAR. LAGS	Y	Y	Y
BANK CONTROLS	Y	Y	Y
$\sum_{k=0}^{k=4} \gamma_k (\text{BANK CONT.} * \Delta FFR_{t-k})$	Y	Y	Y
MACRO VARIABLES	-	-	-
$\sum_{k=0}^{k=4} \mu_k (ARM_{i,t-1} * MACROS_{t-k})$	Y	Y	Y
BANK LIABILITY CONTROLS	N	**Y**	**Y**
$\sum_{k=0}^{k=4} \mu_k (\text{BANK LIABILITY CONT.} * \Delta FFR_{t-k})$	N	**Y**	**Y**
BANK FED FUNDS LIABILITY	N	N	**Y**
$\sum_{k=0}^{k=4} \delta_k (\text{BANK FED FUNDS LIAB.} * \Delta FFR_{t-k})$	N	N	**Y**
Observations	12256	12256	12256
R-squared	0.077	0.079	0.079

Extra exercises/robustness

- Robust to:
  - Smaller/larger banks, trimmed sample, before 2007, hedging controls
- Alternative ARM measures:
  - Average of ARM in the last 8 quarters, ARM/Loans, ARM/ Real Estate Loans

Extra exercises/robustness

- Robust to:
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- Alternative Macro Variables: only inflation and GDP growth

Conclusions

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  - The overall effect : Marginal agents; lenders or borrowers
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Some considerations

- Mortgages are held by also non-banks
- and some internationals
- Recent banking crisis