Monetary Transmission and Portfolio Rebalancing: A Cross-Sectional Approach

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How does the Fed move the market so much?

A longstanding puzzle

- Conventional view: monetary shocks are transitory
- Empirical evidence: monetary shocks have a large effect on stock prices

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    (Bernanke-Kuttner '05)

Cash flow	Future risk-free rate	Future excess returns
19-22%	3-15%	63-78%

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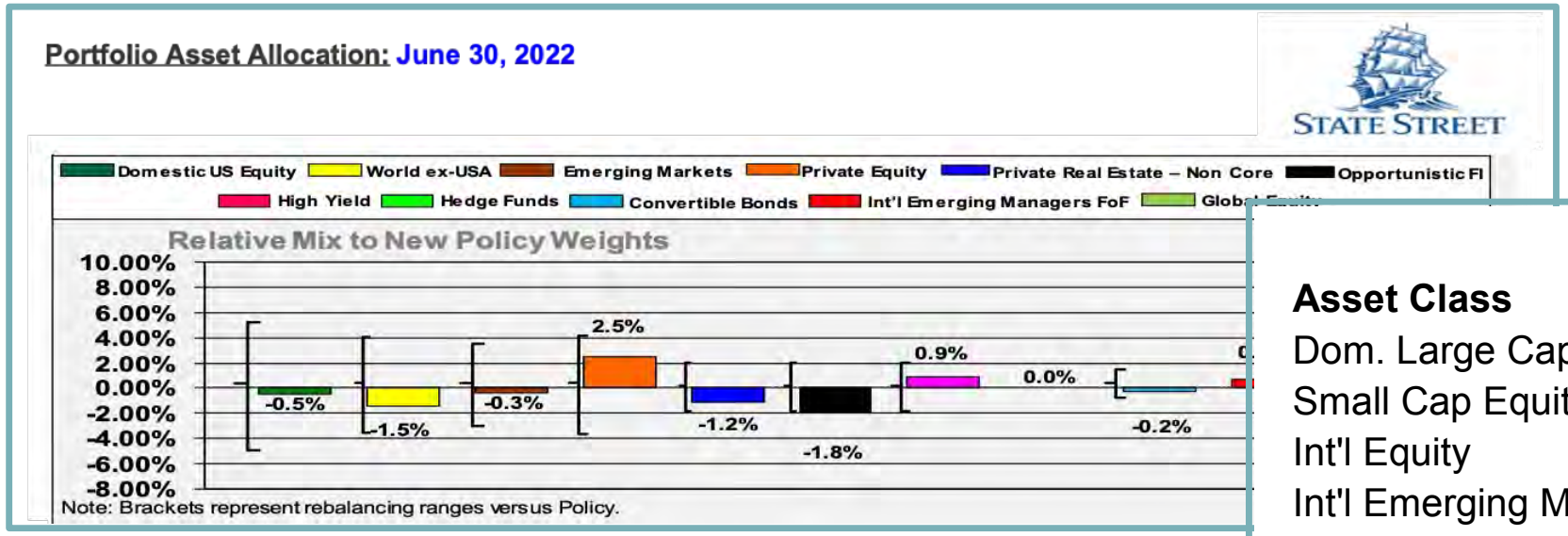
This paper: a demand-based channel

- **Rebalancing demand from institutions accounts for 1/3~2/3 of risk premia following shocks**

Institutional rebalancing demand

Sovereign wealth funds, balanced funds and pensions investing with a mandate

> **Central to our mandate is the benchmark index consisting of 70 percent equities and 30 percent fixed income.**
>
> *-- Strategy Plan 2021-2022, Norges Bank Investment Management*

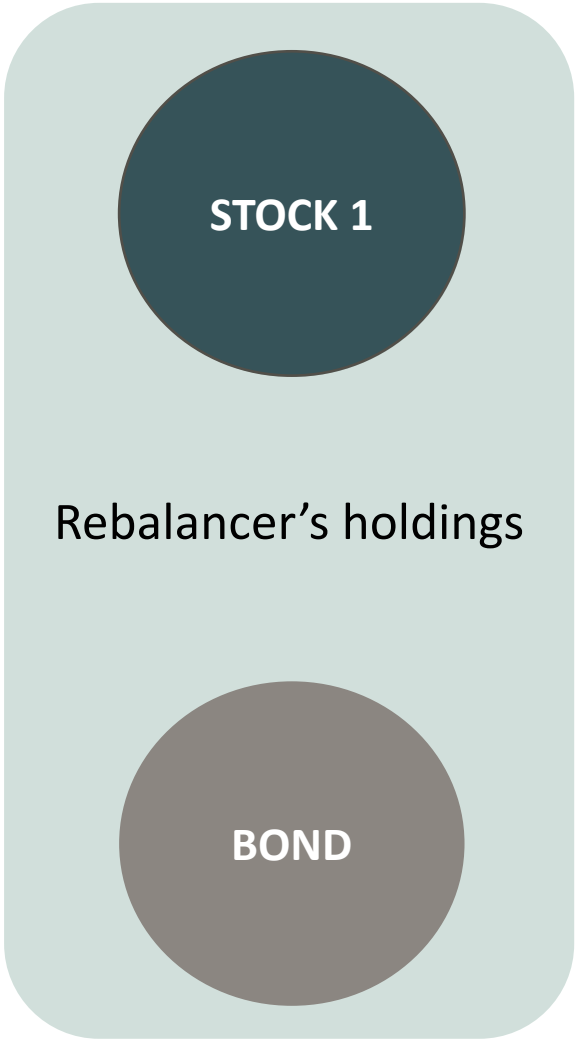


New York City Employee's Retirement System

Investment Guidelines Policy, LA Fire and Police Pensions

Asset Class	Target Allocation
Dom. Large Cap Equity	23.0%
Small Cap Equity	6.0%
Int'l Equity	16.0%
Int'l Emerging Markets	5.0%
Core Bonds	14.0%

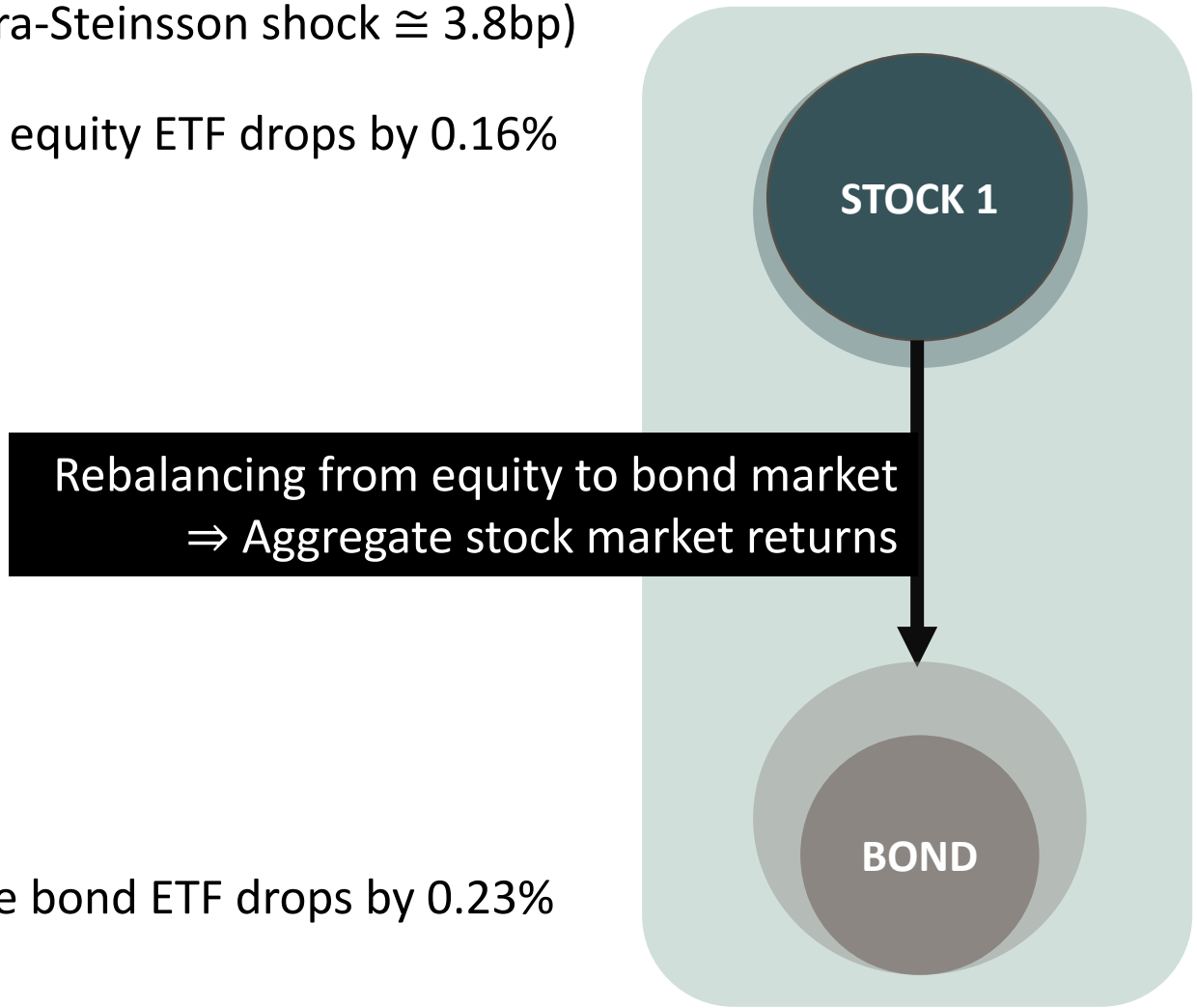
Rebalancing demand: identification



Monetary transmission and rebalancing demand: identification

Sep 20th, 2017: Monetary tightening (Nakamura-Steinsson shock ≅ 3.8bp)

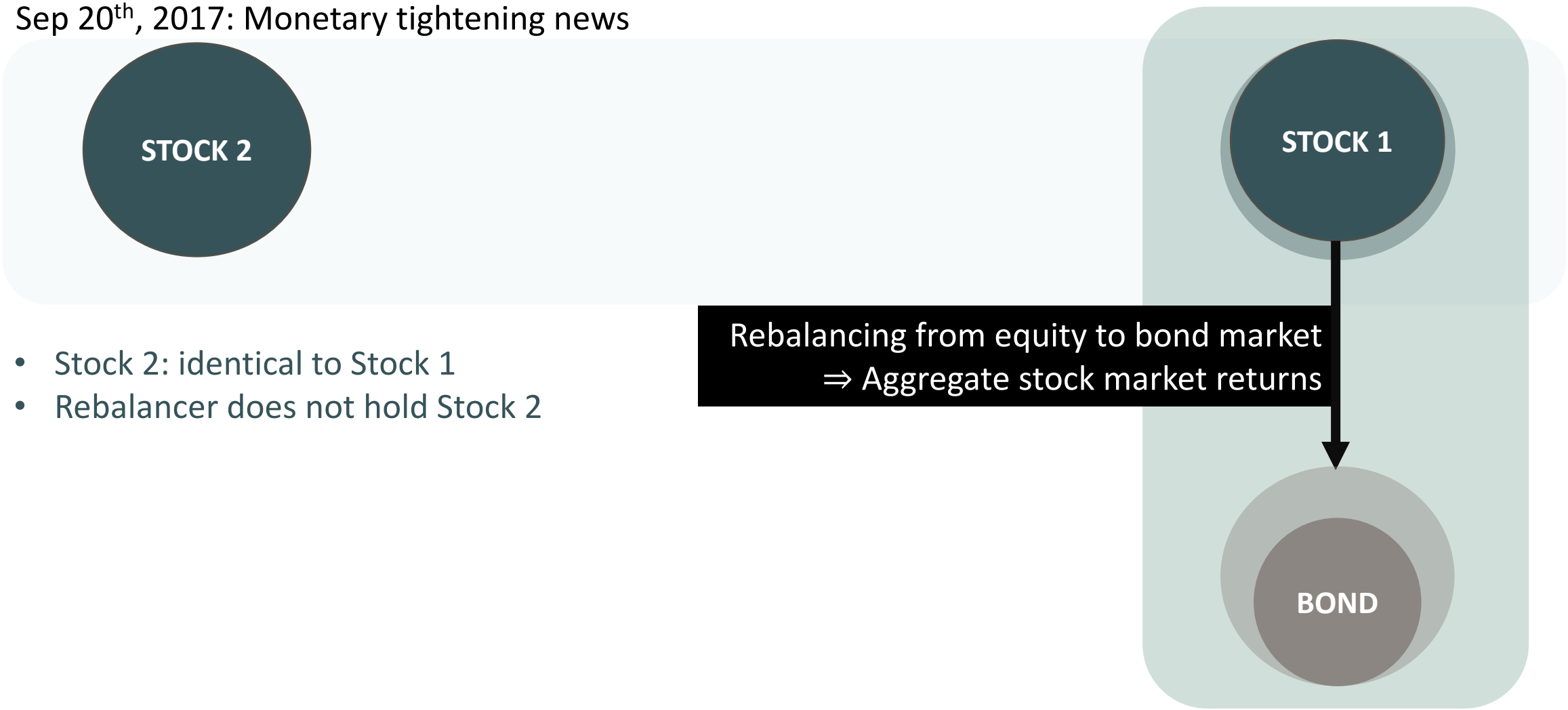
Price of equity ETF drops by 0.16%



Price of investment grade bond ETF drops by 0.23%

Monetary transmission and rebalancing demand: identification

Sep 20th, 2017: Monetary tightening news



- Stock 2: identical to Stock 1
- Rebalancer does not hold Stock 2

Monetary transmission and rebalancing demand: identification

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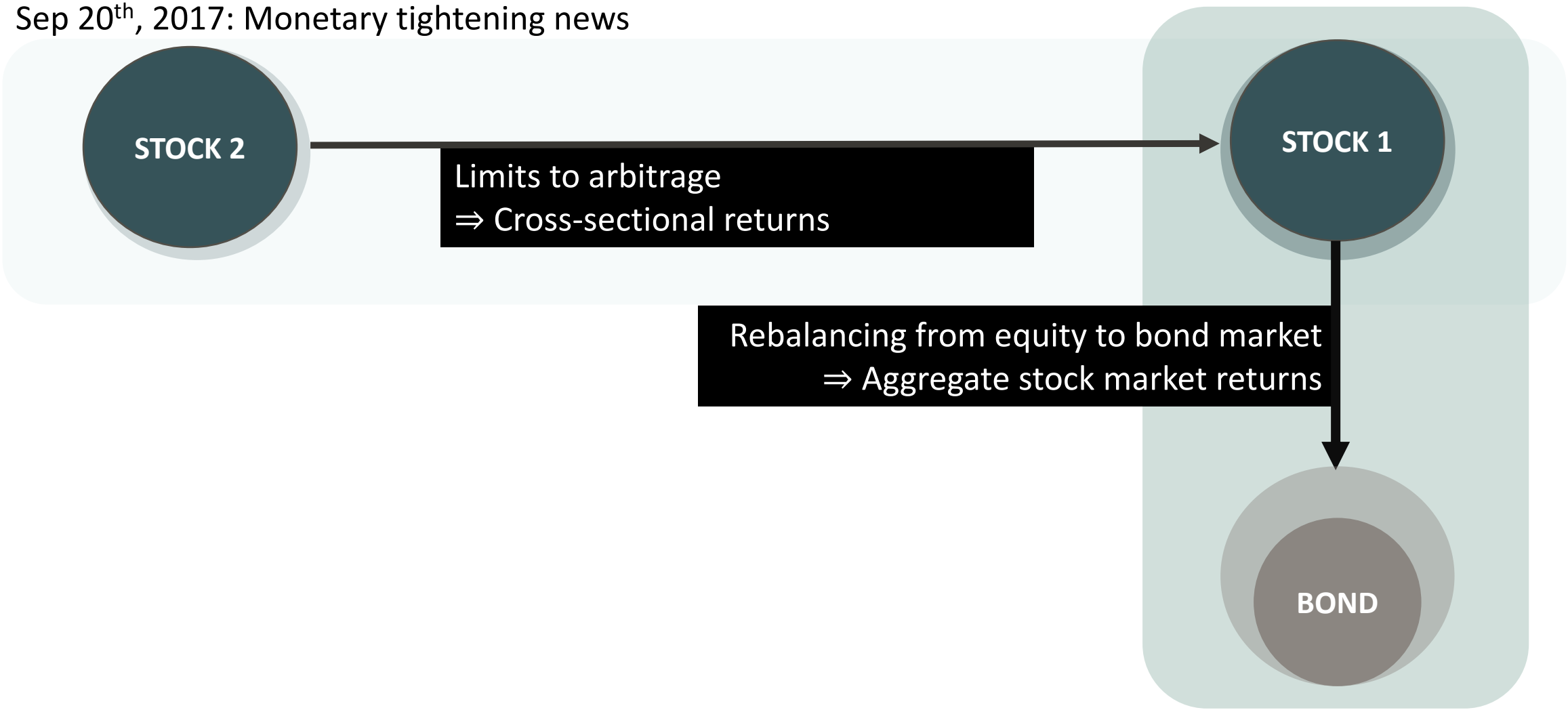
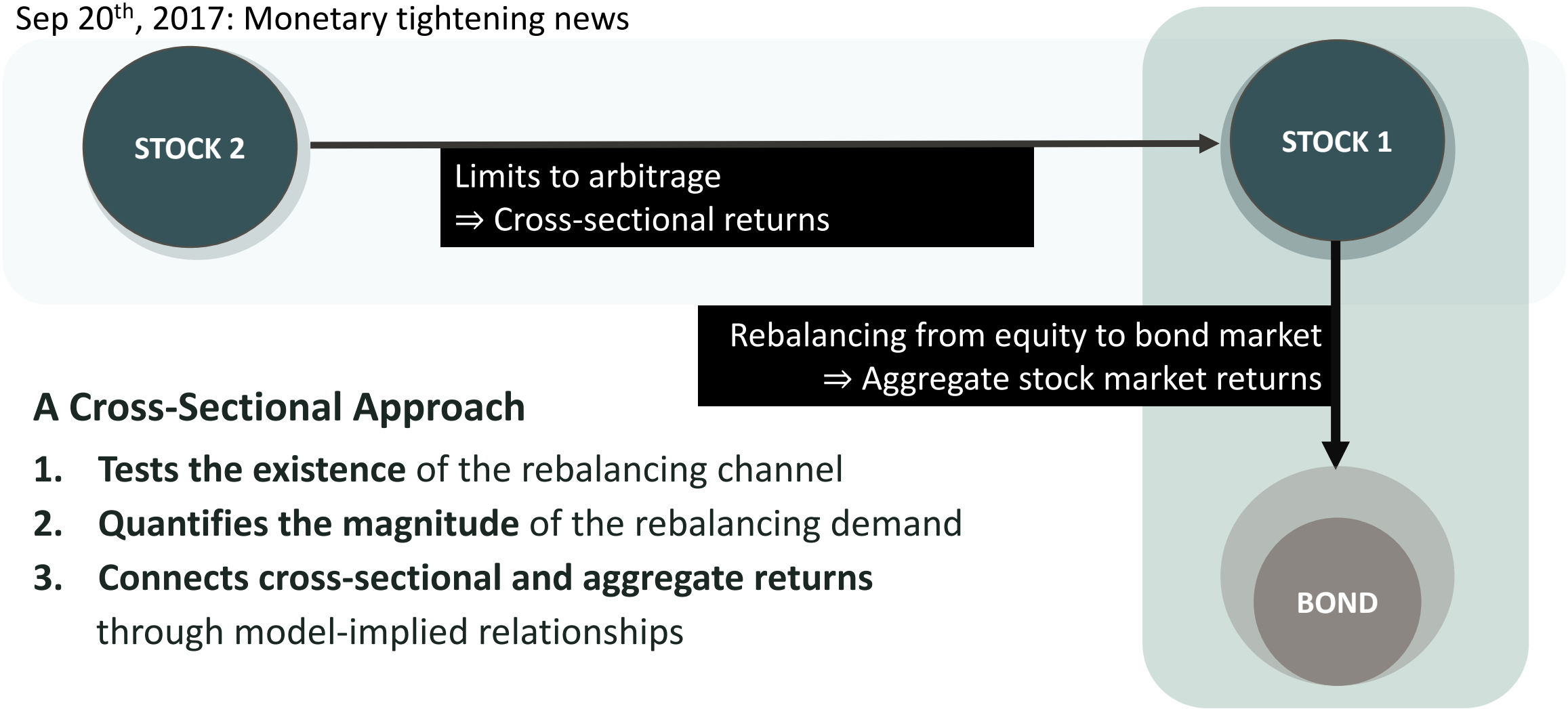


Monetary transmission & rebalancing demand: a cross-sectional approach

Sep 20th, 2017: Monetary tightening news



A Cross-Sectional Approach

1. **Tests the existence** of the rebalancing channel
2. **Quantifies the magnitude** of the rebalancing demand
3. **Connects cross-sectional and aggregate returns** through model-implied relationships

Contribution

Monetary transmission and risk premia

Equity market: Bernanke-Kuttner '05, Gorodnichenko-Weber '16, Chava-Hsu '20, Ozdagli-Velikov '20, Ai-Han-Pan-Xu '22, Gürkaynak-Karasoy-Can-Lee '22, Hirshleifer-Sheng '22, Kekre-Lenel '22, Pflueger-Rinaldi '22

Bond market: Cook-Hahn '89, Cochrane-Piazzesi '02, Gürkaynak-Swanson-Sack '05, Gilchrist-López-Salido-Zakrajšek '15, Hanson-Stein '15, Brooks-Katz-Lustig '20, d'Arienzo '20, Hanson-Lucca-Wright '22

Bernanke-Kuttner Puzzle

Rebalancers

Financial market fluctuations

- **Macro announcements:** DellaVigna-Pollet '09, Savor-Wilson '14
- **Idiosyncratic shocks:** Camanho-Hau-Rey '22, Gabaix-Koijen '22

Demand of financial intermediaries

- **Intermediary & demand-based asset pricing:** Deuskar-Johnson '11, Chien-Cole-Lustig '12, He-Krishnamurthy '13, Koijen-Yogo '19, Gabaix-Koijen '22
- **Rebalancing investors:** Merton '69, Samuelson '69, Ameriks-Zeldes '04, Duarte-Fonseca-Goodman-Parker 22', Mitchell-Utkus '22, Parker-Schoar-Sun '22

Outline

I. *The Rebalancing Channel*

II. *Empirical Evidence*

III. *Calibration*

Set-up

- Two periods: $t = 0, 1$
- Two asset classes: Bond B, and two stocks ($i = 1$ & 2)
  - Stocks have pre-shock stock price $\bar{P}$ & are in unit supply
  - Stock dividends are normally distributed, with correlation ρ and variance σ^2
  - Monetary shock at $t = 0$ changes price of bond by r_B percent. Stocks reevaluate by $r_i := (P_i - \bar{P})/\bar{P}$
- Two investors:
  - Rebalancer holds ω share of stock 1 and trades stock 1 with bond, with a preference for a target mix

    θ : Target equity share
  - Mean-variance arbitrageur with risk aversion Γ trades stocks 1 & 2 with funding cost η

The rebalancing channel

$\Rightarrow$ Demands for stocks:

- Rebalancer: $\Delta Q_1^R = (1-\theta)(r_B - r_1)\omega$
- Arbitrageur: $\Delta Q_i^E = -\psi^A r_i - \psi^C(r_i - r_{-i})$, where $\psi^A = \frac{(1+\eta)\bar{P}}{\Gamma(1+\rho)\sigma^2}$ & $\psi^C = \frac{(1+\eta)\rho\bar{P}}{\Gamma(1-\rho^2)\sigma^2}$

- Market clearing conditions: $\Delta Q_1^R + \Delta Q_1^E = 0$, and $\Delta Q_2^E = 0$

Implications for cross-sectional and aggregate returns

When the bond revaluates by r_B due to monetary shock MS ($\partial r_B/\partial MS < 0$), stocks revaluate by

$$r_1 = \frac{\omega(1-\theta)}{\Psi + \omega(1-\theta)} r_B \quad \& \quad r_2 = \frac{\psi^C}{\psi^C + \psi^A} r_1, \quad \text{with } \Psi := \frac{\psi^A + 2\psi^C}{\psi^A + \psi^C}\psi^A \in (\psi^A, 2\psi^A).$$

a. The return difference between two stocks is larger if rebalancer owns more shares of stock 1: $\frac{\partial^2(r_1 - r_2)}{\partial r_B \partial \omega} > 0$

b. The aggregate stock price reactions $\bar{r} = \frac{r_1 + r_2}{2}$ satisfy $\bar{r} = \left(\frac{1}{2} + \frac{\psi^C}{\psi^A}\right)(r_1 - r_2)$

Model extension: delayed rebalancing

- Assumption so far: immediate rebalancing after monetary shocks
- Reality: Rebalancing in practice happens at month- and quarter-ends

REUTERS

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2 minute read · June 24, 2022 8:45 AM PDT

JP Morgan sees portfolio rebalancing lift U.S. stocks 7% next week

By Saqib Iqbal Ahmed

NEW YORK, June 24 (Reuters) - U.S. equities could see a 7% move up next week a investors rebalance their portfolios after a brutal first half of the year, J.P. Morgan's global markets strategist, Marko Kolanovic, said on Friday.

Next week marks the end of the month, second quarter and first half of the year, m for a busy time for investors with fixed-weight portfolios, who must rebalance their exposure to account for past market moves.

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Pension Rebalancing Threatens to Spur $26 Billion Equity Selloff

- Credit Suisse sees September US stock sales from rebalancing
- Expects international equities could see $46 billion in buying

By Vildana Hajric and Denitsa Tsekova
September 29, 2022 at 9:49 AM PDT

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Every quarter- and month-end, pension funds and other institutional investors check their market exposures to make sure they meet strict allocation limits between equities and bonds, as well as between domestic and international stocks. Even amid a global rout, US equities still outperformed many other asset classes, leaving portfolio managers needing to cut their exposure.

Model extension: delayed rebalancing

- Reality: Rebalancing in practice happens at month- and quarter-ends
- Suppose monetary shock at $t = 0$ triggers bond revaluation r_B at $t = T$; rebalancer only trades at $t = T$

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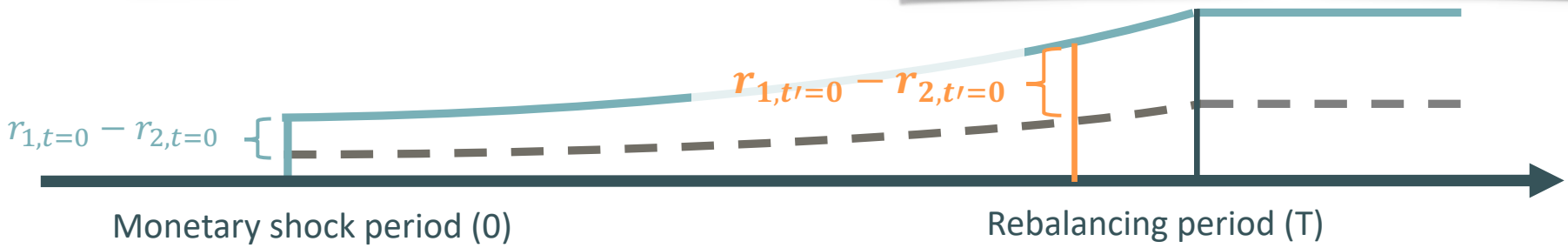
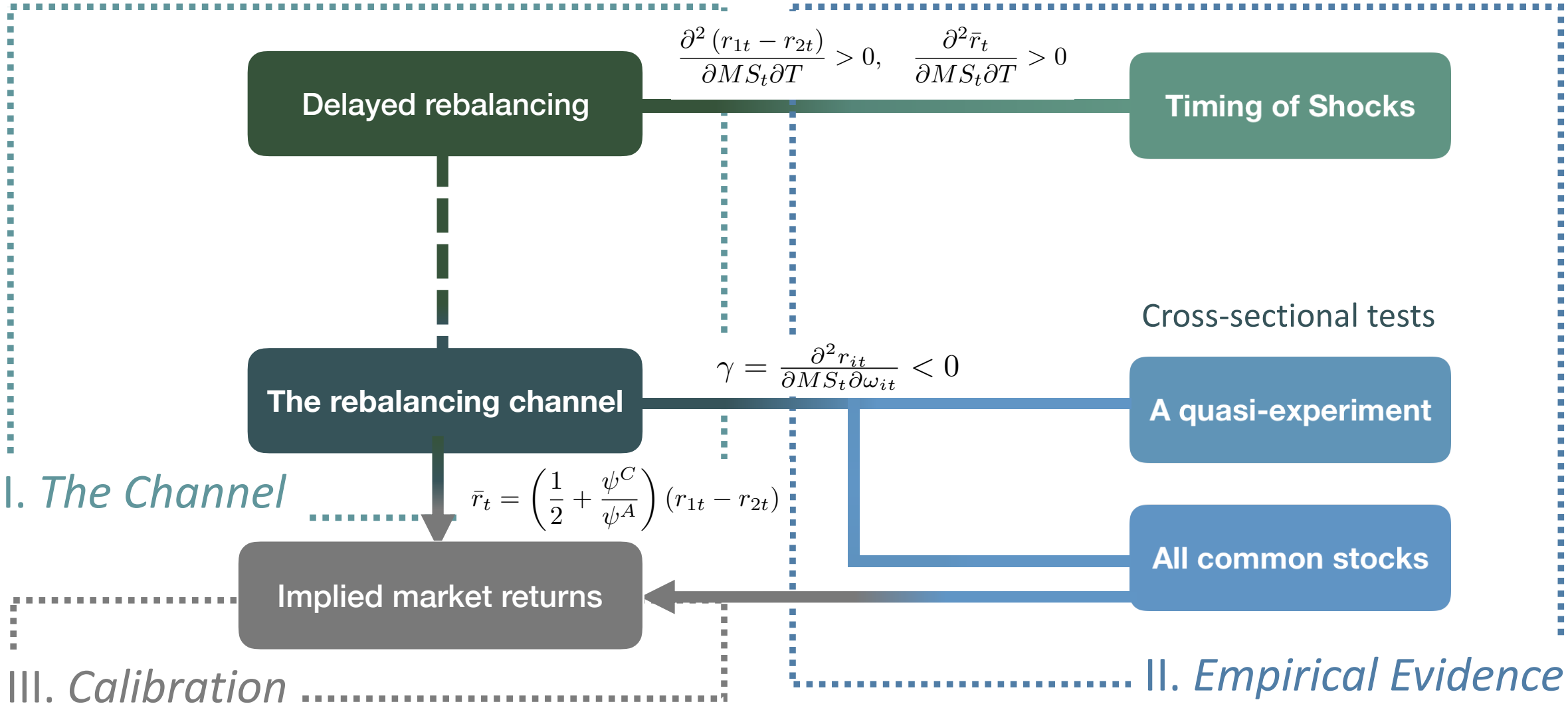


Takeaway


$\frac{\partial^2 (r_{1t} - r_{2t})}{\partial MS_t \partial T} > 0, \quad \frac{\partial^2 \bar{r}_t}{\partial MS_t \partial T} > 0$
Delayed rebalancing
Timing of Shocks
Cross-sectional tests
$\gamma = \frac{\partial^2 r_{it}}{\partial MS_t \partial \omega_{it}} < 0$
The rebalancing channel
A quasi-experiment
All common stocks
$\bar{r}_t = \left(\frac{1}{2} + \frac{\psi^C}{\psi^A}\right)(r_{1t} - r_{2t})$
Implied market returns
I. The Channel
II. Empirical Evidence
III. Calibration

Empirical challenges

To test prediction $\gamma = \frac{\partial^2 r_{it}}{\partial MS_t \partial \omega_{it}} < 0$

I. Monetary policy announcements are expected and endogenous to market fundamentals
   1. High frequency shocks

II. Institutions do not report investment mandates systematically
   1. Inferred ownership based on large institutions' stock holdings
   2. A complementary proxy constructed from mutual funds' entire holdings

III. Monetary policy affects equity returns in myriad ways
   1. A sample of liquid dual-class shares sharing the same fundamentals as a quasi-experiment
   2. For all common stocks: Size, MPE, duration, beta, FF4 controls + factors from double-selection LASSOs

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Data

- High frequency identification of monetary shocks (Nakamura-Steinsson '18, Acosta-Saia '20)
  - **Principal component of 5 interest rate futures over 30-minute window around FOMC announcements**
    - Regularly scheduled FOMC meetings from 2004Q4 to 2019Q3 (except between Jul '08 and Jun '09)
    - Unit: 1 MS = 100 bp change in one-year Treasury yield
    - Standard deviation around 2.8bp
- Intraday stock prices
  - **30-minute returns, from Millisecond TAQ**
    - Aligned with monetary shock estimation windows
    - Excluding penny stocks; securities filtered based on intraday liquidity (Aït-Sahalia-Kalnina-Xiu '20)
- Institutional ownership for each stock
  - **Measure 1: FactSet (13F) stock holdings (quarterly)**
    - **Rebalancers (~15% market share)**
    - Other institutions include equity investors and possibly some rebalancing institutions

Summary statistics of holdings at stock level

Snapshot of 2004Q4

	All common stocks			S&P 500 index constituents		
	Mean (%)	Median (%)	SD (%)	Mean (%)	Median (%)	SD (%)
Institutional Wealth Mngmt.	10.10	8.92	8.34	18.40	17.40	5.24
Long Term Investor	2.15	1.38	2.02	4.48	4.42	0.91
Advisor	22.00	20.50	16.20	31.60	31.30	10.10
Broker	0.94	0.54	1.33	1.37	1.13	0.83
Hedge Fund	5.59	3.23	6.63	2.39	1.34	2.94
Mutual Fund	9.92	8.22	8.33	15.20	14.20	6.67

- **Sizeable variations in stock-level ownership, even for S&P 500 index constituents**

Full Table

ETPs

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A quasi-experiment

- Ideal experiment: two stocks with same characteristics & only differ in rebalancer ownership
- A quasi-experiment with dual-listed firms: public companies with two classes of common stocks
  - Different share classes of the same company share the same fundamentals

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  - Different share classes of the same company share the same fundamentals

We have two classes of authorized common stock, Class A common stock and Class B common stock. The rights of the holders of Class A common stock and Class B common stock are identical, except with respect to voting and conversion. Each share of Class A common stock is entitled to one vote per share. Each share of Class B common stock is entitled to ten votes per share and is convertible at any time into one share of Class A common stock.

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Voting Rights: Holders of Class A common stock are entitled to one vote per share. Holders of Class B common stock do not have any voting rights, except as required by Delaware law. Generally, all matters to be voted on by Viacom stockholders must be approved by a majority of the aggregate voting power of the shares of Class A common stock present in person or represented by proxy at a meeting of stockholders, except in certain limited circumstances and as required by Delaware law.

Dividends: Stockholders of Class A common stock and Class B common stock will share ratably in any cash dividend declared the Board of Directors, subject to any preferential rights of any outstanding preferred stock.

Paramount

A quasi-experiment

- Ideal experiment: two stocks with same characteristics & only differ in rebalancer ownership
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Data

- A collection of 100+ dual-listed firms during 2004 and 2019
  - Voting rights and dividend rights collected from SEC regulatory filings (form S-1, S-3, S-4, 13-D, 10-K, etc.)
  - Restrict to firms with both shares traded with value-weighted realized spread (Lee-Ready '91, Holden-Jacobsen '14) < 5%
  - Stationarity tests (Harris-Tzavalis '19) for price gaps during FOMC days (Savor-Wilson '14, Lucca-Moench '15)
- Final sample: 68 firms with high intraday liquidity

Stationarity tests

Research design

- Identifying **within-firm variation** in monetary sensitivities (OLS)

$$r_{ift} = \gamma I_{HRO,ift} \cdot MS_t + \theta I_{HRO,ift} + \delta_{ft} + \epsilon_{ift},$$

  - r_{ift} : 30-minute returns for share class i of firm f around FOMC announcement t
  - MS_t: high-frequency monetary shocks
  - $I_{HRO,ift}$: a high rebalancer ownership indicator that equals one if $\omega_{i,f,t} > \omega_{-i,f,t}$ and zero otherwise
  - δ_{ft}: firm-meeting FE

- The rebalancing channel predicts $\gamma = \frac{\partial^2 r_{it}}{\partial MS_t \partial \omega_{it}} < 0$

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What causes variations in rebalancers ownership between dual-class shares?

Instrumenting rebalancer ownership with voting rights

- Relevance
  - Preference over voting rights: institutions vote in line with management recommendations (Larcker-Tayan '15)
  - Revealed preference in sample: rebalancers hold 21% (/9%) of the share class with lower (/higher) voting rights for dual-listed firms

Summary statistics

Instrumenting rebalancer ownership with voting rights

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  - Revealed preference in sample: rebalancers hold 21% (/9%) of the share class with lower (/higher) voting rights for dual-listed firms
- Assumption: monetary shocks at scheduled FOMC do not affect voting right premium
  - Existing evidence on voting right premium: value increases around special shareholder meetings, periods of hedge fund activism, and M&A (Cox-Roden '02, Kalay-Karakas-Pant '14)
  - Monetary shocks are small with a 3bp standard deviation

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$\Rightarrow$ Two stage least square with instrument: voting rights (2SLS)

I. $$\begin{pmatrix} I_{HRO,ift} \cdot MS_t \\ I_{HRO,ift} \end{pmatrix} = \mathbf{\Phi} \begin{pmatrix} I_{HVR,ift} \cdot MS_t \\ I_{HVR,ift} \end{pmatrix} + \delta_{ft} + \epsilon_{ift}$$

II. $$r_{ift} = \gamma \widehat{I_{HRO,ift} \cdot MS_t} + \theta \widehat{I_{HRO,ift}} + \delta_{ft} + \epsilon'_{ift}$$

$I_{HRO,ift}$: High Rebalancer Ownership Indicator
$I_{HVR,ift}$: High Voting Rights Indicator

Summary statistics

Results from OLS and 2SLS

	OLS	1st Stage		2SLS	OLS
	(1)	(2)	(3)	(4)	(5)
	I_{HRO}	I_{HRO}	MS$\times I_{HRO}$	Returns	Returns
I_{HVR}	-0.282***	-0.299**	0.000550		
	(0.0149)	(0.145)	(0.000609)		
MS$\times I_{HVR}$		0.355	-0.383***		
		(0.556)	(0.139)		
MS$\times I_{HRO}$				-7.110***	-2.719**
				(2.415)	(1.126)
I_{HRO}				$\times$	$\times$
Firm-Meeting FE	N	Y	Y	Y	Y
N	4,164	4,164	4,164	4,164	4,164
Adj. R^2	0.0796	0.0821	0.568		0.840

$I_{HRO,ift}$: High Rebalancer Ownership Indicator

$I_{HVR,ift}$: High Voting Rights Indicator

- Returns and monetary shocks are in percentage points. $I_{\textit{High Rebalancer Ownership}}$ is an indicator function.

Results from OLS and 2SLS

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	(1)	(2)	(3)	(4)	(5)
	I_{HRO}	I_{HRO}	MS$\times I_{HRO}$	Returns	Returns
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	(0.0149)	(0.145)	(0.000609)		
MS$\times I_{HVR}$		0.355	-0.383***		
		(0.556)	(0.139)		
MS$\times I_{HRO}$				-7.110***	-2.719**
				(2.415)	(1.126)
I_{HRO}				$\times$	$\times$
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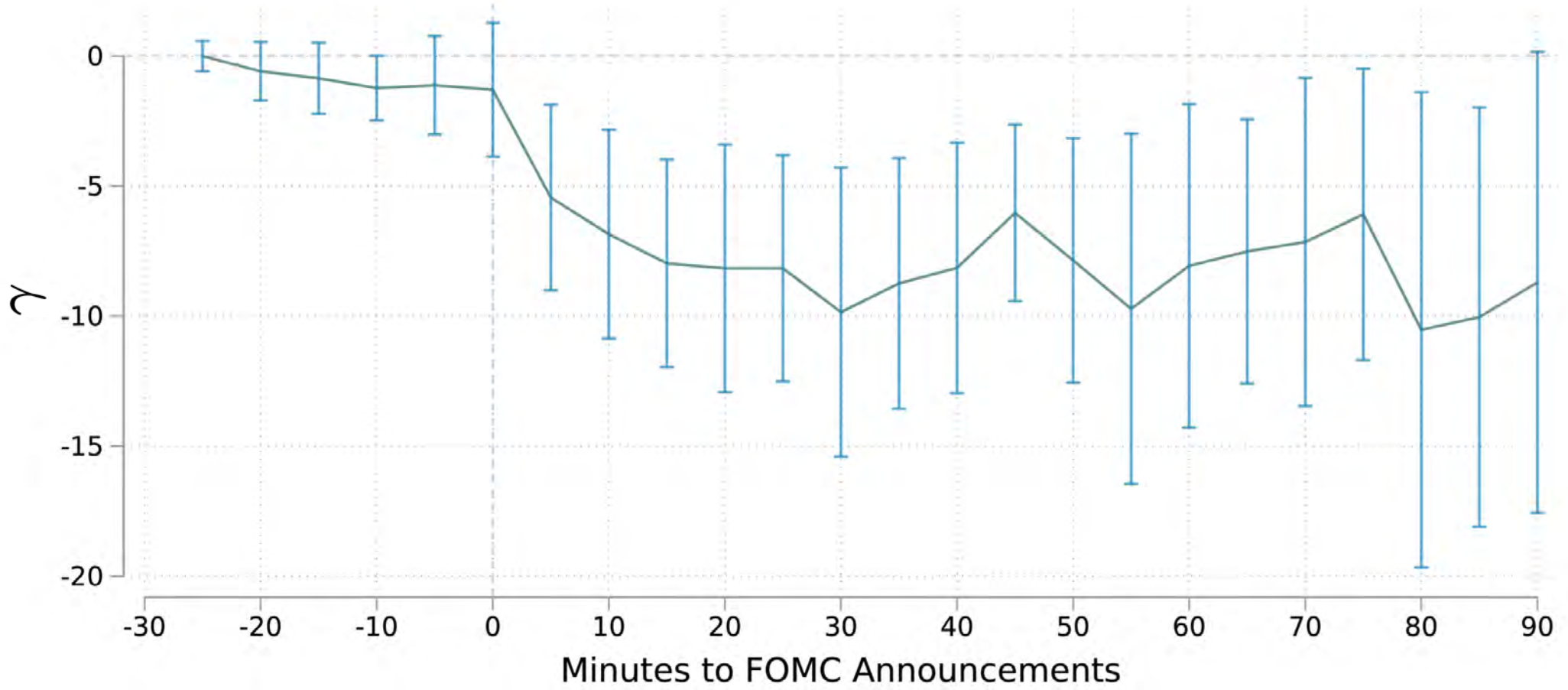
$I_{HRO,ift}$: High Rebalancer Ownership Indicator

$I_{HVR,ift}$: High Voting Rights Indicator

- Returns and monetary shocks are in percentage points. $I_{High\ Rebalancer\ Ownership}$ is an indicator function.
- Returns for the share class with higher rebalancer ownership respond 27~71bp more given a 10bp monetary shock

Within firm variation

$$r_{ift} = \gamma \widehat{I_{HRO,ift} \cdot MS_t} + \theta \widehat{I_{HRO,ift}} + \delta_{ft} + \epsilon'_{ift}$$



- Returns and monetary shocks are in percentage points. $I_{high\ rebalancer\ ownership}$ is an indicator function.
- 95% confidence intervals are displayed.

Common stocks

Research design

Double Selection LASSOs
Ownership Determinants

$$r_{it} = \gamma\omega_{it} \cdot MS_t + \boldsymbol{\phi}'\boldsymbol{X}_{it} \cdot MS_t + \vartheta\omega_{it} + \boldsymbol{\varphi}'\boldsymbol{X}_{it} + \delta_t + \epsilon_{it}$$

Identifying assumptions: monetary shocks are exogenous, and variations in institutional ownership don't correlate with factors that affect return sensitivities beyond controls

- r_{it}: 30-minute return of stock i around FOMC announcement t
- MS_t: High-frequency monetary shocks
- ω_{it}: FactSet rebalancer ownership of security i from filings before t in percentage terms
- $\boldsymbol{X}_{it}$: Covariates that likely correlate with $\omega_{it} \cdot MS_t$
  - Cash-flow duration: Dechow-Sloan-Soliman '04; Weber '18; Gormsen-Lazarus '21
  - Market beta, and market equity: Frazzini-Pedersen '14, Koijen-Yogo '19
  - Monetary policy exposure (MPE) index: Ozdagli-Velikov '20
  - Industry fixed effects (SIC3): Bernanke-Kuttner '05, Gorodnichenko-Weber '16, Pelger '20

Results

Double Selection LASSOs

Ownership Determinants

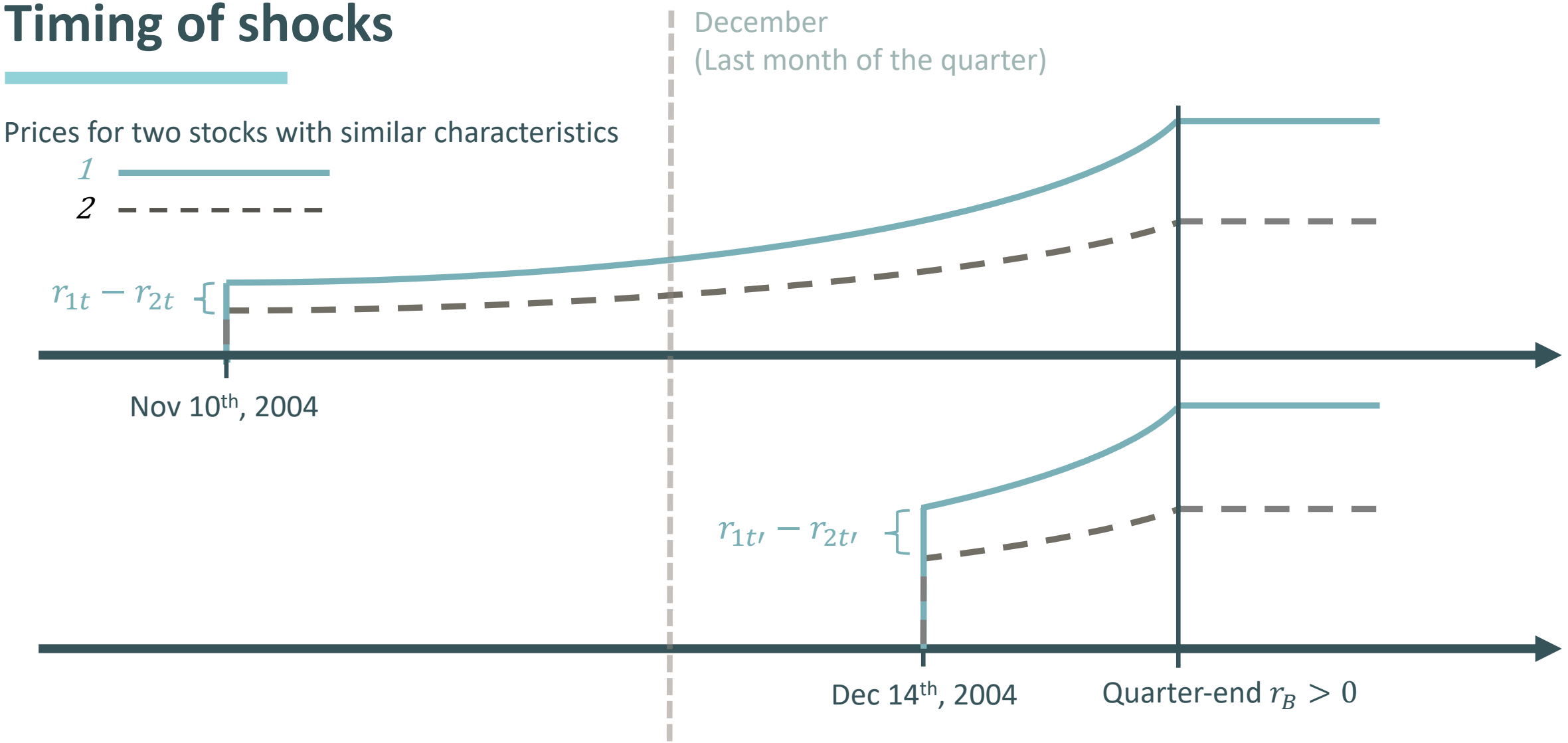
$$r_{it} = \gamma \omega_{it} \cdot MS_t + \boldsymbol{\phi}' \boldsymbol{X}_{it} \cdot MS_t + \vartheta \omega_{it} + \boldsymbol{\varphi}' \boldsymbol{X}_{it} + \delta_t + \epsilon_{it}$$

	Aggregate	*Type* = Rebalancers							*Type* = Other Institutions	
	(0)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(7)	(8)
MS	-8.900***	×	×	×	×	×	×	-3.757	×	×
	(1.200)							(2.947)		
Ownership$_{Type}$×MS		-2.817*	-3.353**	-3.413**	-3.758**	-3.659**	-3.718**	-6.823***	0.332	0.698
		(1.561)	(1.590)	(1.589)	(1.554)	(1.565)	(1.564)	(1.903)	(0.770)	(0.796)
Ownership$_{Type}$		×	×	×	×	×	×	×	×	×
MPE			×	×	×	×	×	×		×
MPE×MS			×	×	×	×	×	×		×
DSS Duration×MS				×	×	×	×	×		×
DSS Duration				×	×	×	×	×		×
β×MS					×	×	×	×		×
β					×	×	×	×		×
$Log(me)$ ×MS						×	×	×		×
$Log(me)$						×	×	×		×
FF4 Factors ×MS							×	×		×
FF4 Factors							×	×		×
Meeting FE	N	Y	Y	Y	Y	Y	Y	N	Y	Y
$I\_ind.\times$ MS	N	Y	Y	Y	Y	Y	Y	N	Y	Y
N	110	58,497	58,497	58,497	58,497	58,497	58,497	58,497	58,497	58,497
Adj. R^2	0.267	0.592	0.592	0.592	0.594	0.594	0.596	0.153	0.592	0.596

1% increase in MS relates to 0.37% (0.26%) decrease in returns for stocks with 10% (1sd) higher ownership

Timing of shocks

Timing of shocks



- Delayed rebalancing: cross-sectional and aggregate returns' monetary sensitivity decrease with T
- We split the sample by proximity to quarter-ends and test if $|\frac{\partial^2 r_{it}}{\partial MS_t \partial \omega_{it}}| < |\frac{\partial^2 r_{it'}}{\partial MS_{t'} \partial \omega_{it'}}|$

Results

$$r_{it} = \gamma\omega_{it} \cdot MS_t + \boldsymbol{\phi}'\boldsymbol{X}_{it} \cdot MS_t + \vartheta\omega_{it} + \boldsymbol{\varphi}'\boldsymbol{X}_{it} + \delta_t + \epsilon_{it}$$

	Month-End			Quarter-End				Full	
	(1)	(2)	(3)	(4)	(5)	(6)		(7)	(8)
MS	-9.820***	×	×	-10.140***	×	×		-8.900***	×
	(1.112)			(1.518)				(1.200)	
Rebalancer Ownership×MS		-3.725***	-4.670***		-4.850***	-5.621***			-3.659**
		(1.750)	(1.738)		(1.855)	(1.827)			(1.565)
Rebalancer Ownership		×	×		×	×			×
Duration×MS			×			×			×
DSS Duration			×			×			×
MPE			×			×			×
MPE×MS			×			×			×
β×MS			×			×			×
β			×			×			×
$Log(me)$ ×MS			×			×			×
$Log(me)$			×			×			×
Meeting FE	N	Y	Y	Y	N	Y		Y	Y
$I\_ind.\times$ MS	N	Y	Y	Y	N	Y		Y	Y
N	70	37,270	37,270	55	29,329	29,329		110	58,497
Adj. R^2	0.444	0.584	0.588	0.391	0.626	0.631		0.267	0.594

VS

- Difference in γ: $\chi^2_{month-end} = 3.16\ (p = 0.07),\ \chi^2_{quarter-end} = 3.12\ (p = 0.08)$.

Robustness

01 Dual-Class Shares

a. Stationarity on FOMC days

b.IRF without instruments

02 Pricing Evidence

a. Weighted OLS
b. Ownership ranks
c. FF4 factors
d. Duration measures
e. Index effect

03 Delayed Rebalancing

a. Quarter-/Month-ends without rebalancers

04 Holdings

a. Extensive margins
b. Spanning tests
c. Ownership determinants

05 Balanced Funds

a. Pricing regressions with balanced fund holdings

06 Delayed Rebalancing

a. Quarter-/Month-ends with mutual fund holdings

An alternative measure of rebalancer ownership

07 Sample Selection

a. Without restrictions on fundamentals or prices

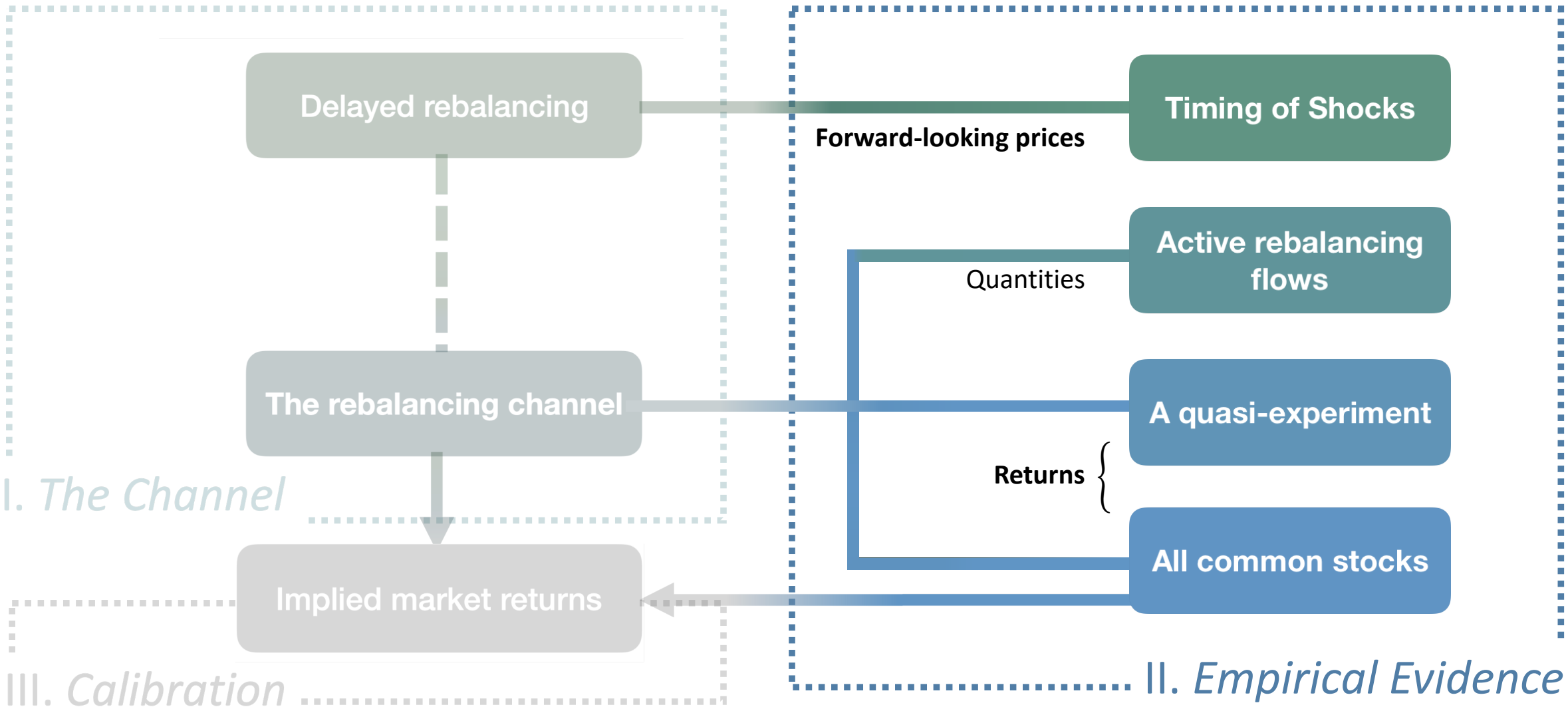
08 Holding Correlation

a. Correlation between FactSet and Morningstar

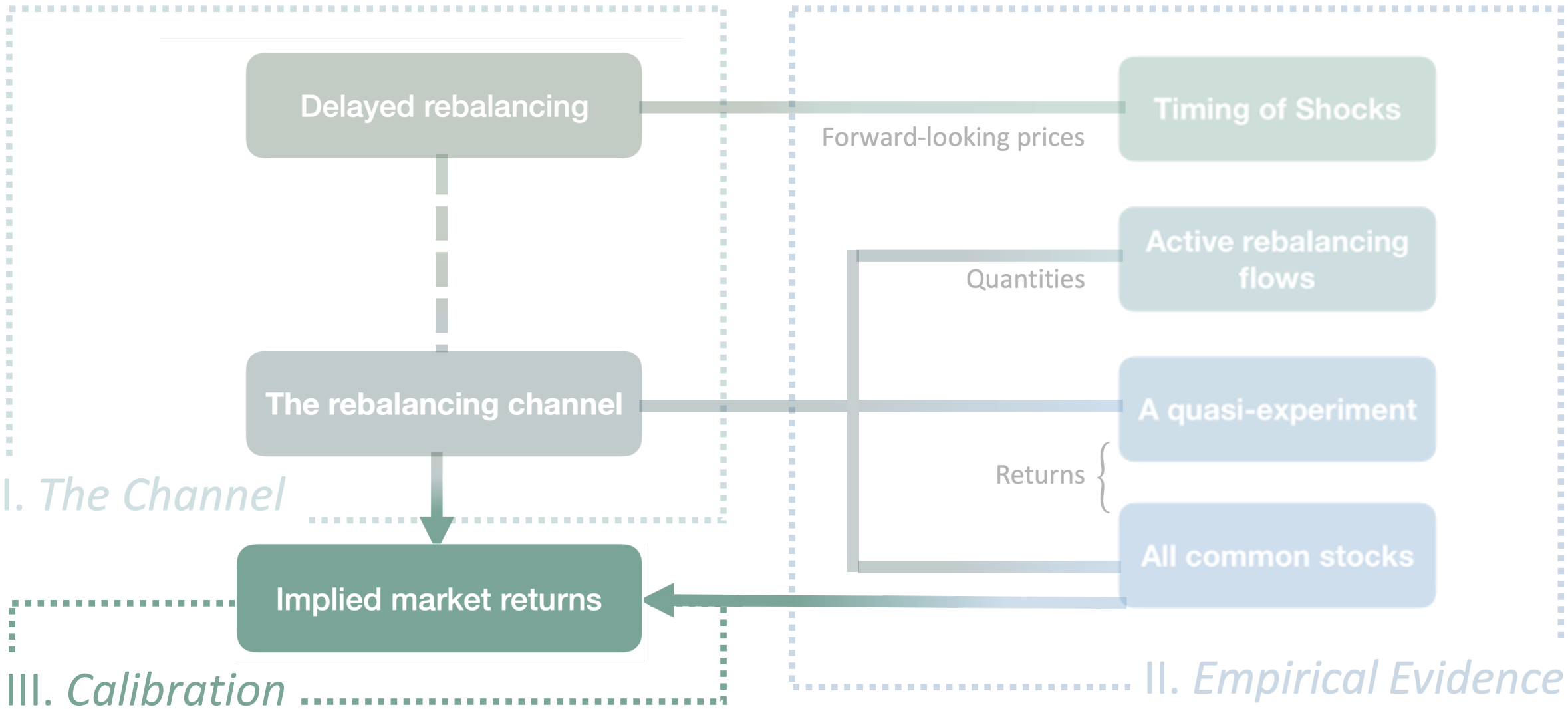
09 Plots

a. Intraday Bernanke-Kuttner
b. Repeated cross-section

Outline


Delayed rebalancing
The rebalancing channel
Implied market returns
I. The Channel
III. Calibration
Forward-looking prices
Timing of Shocks
Quantities
Active rebalancing flows
A quasi-experiment
Returns
All common stocks
II. Empirical Evidence

Outline


Delayed rebalancing
The rebalancing channel
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III. Calibration
Forward-looking prices
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A quasi-experiment
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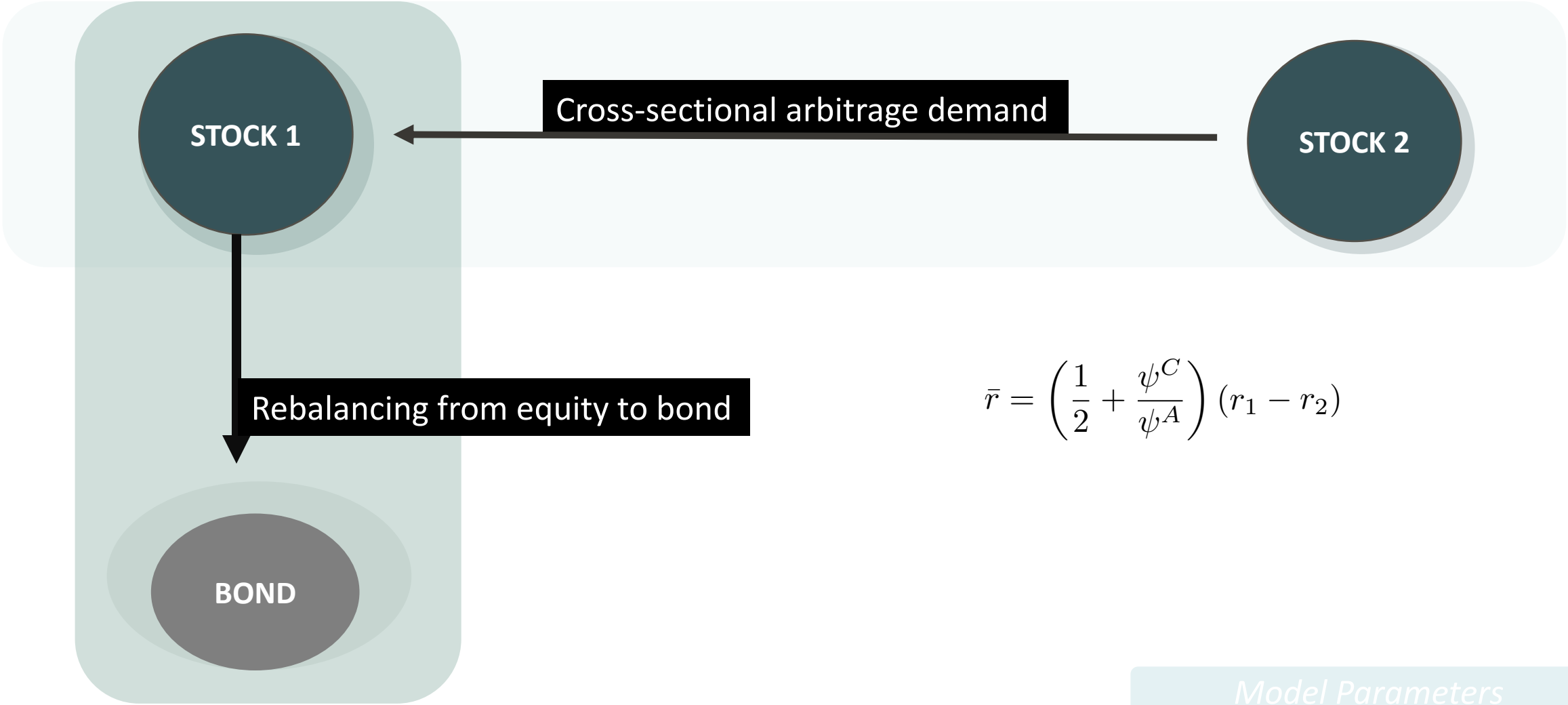
All common stocks
II. Empirical Evidence

Calibration: an example

September 20th, 2017: Monetary tightening news (Nakamura-Steinsson shock ≅ 3.8bp)

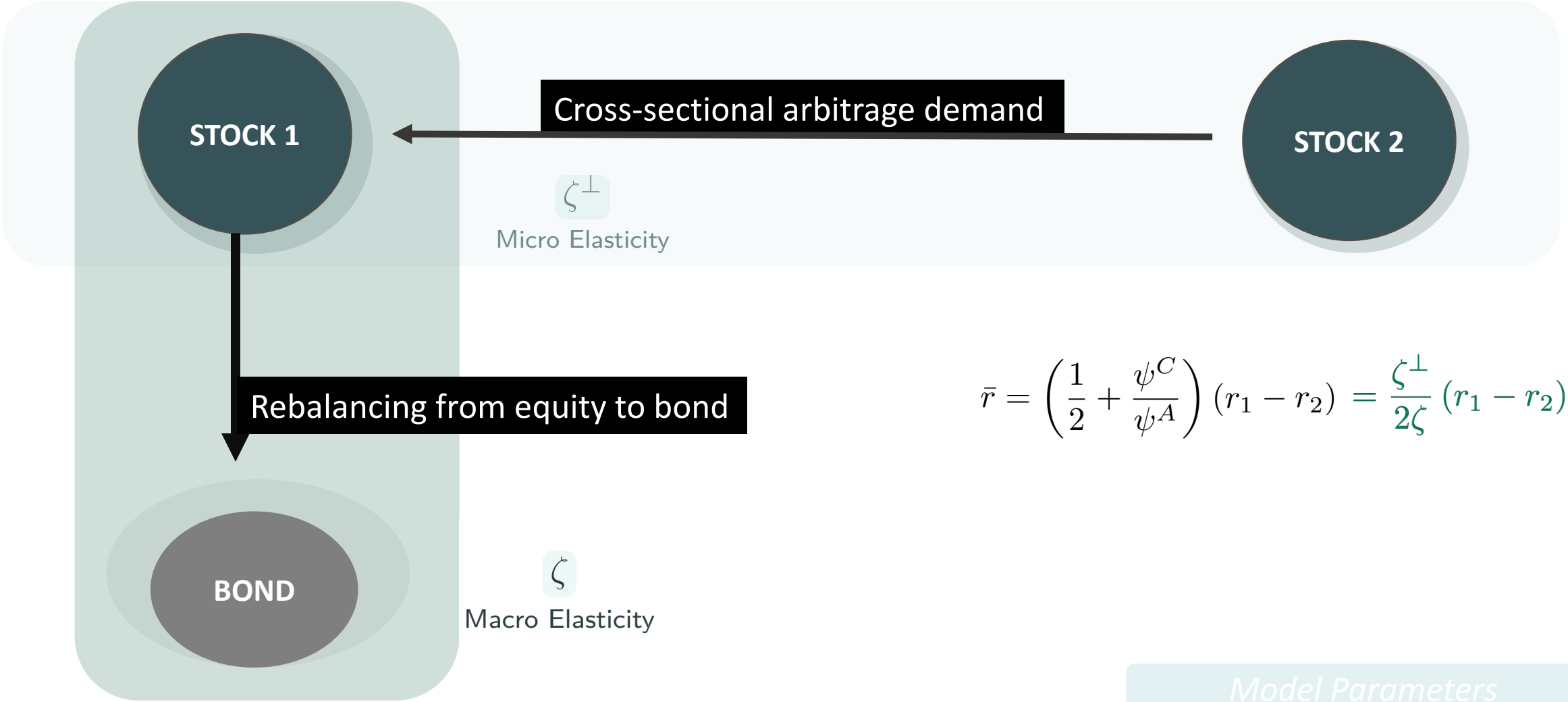


$$\bar{r} = \left(\frac{1}{2} + \frac{\psi^C}{\psi^A}\right)(r_1 - r_2)$$

Model Parameters

Calibration: an example

September 20th, 2017: Monetary tightening news (Nakamura-Steinsson shock ≅ 3.8bp)

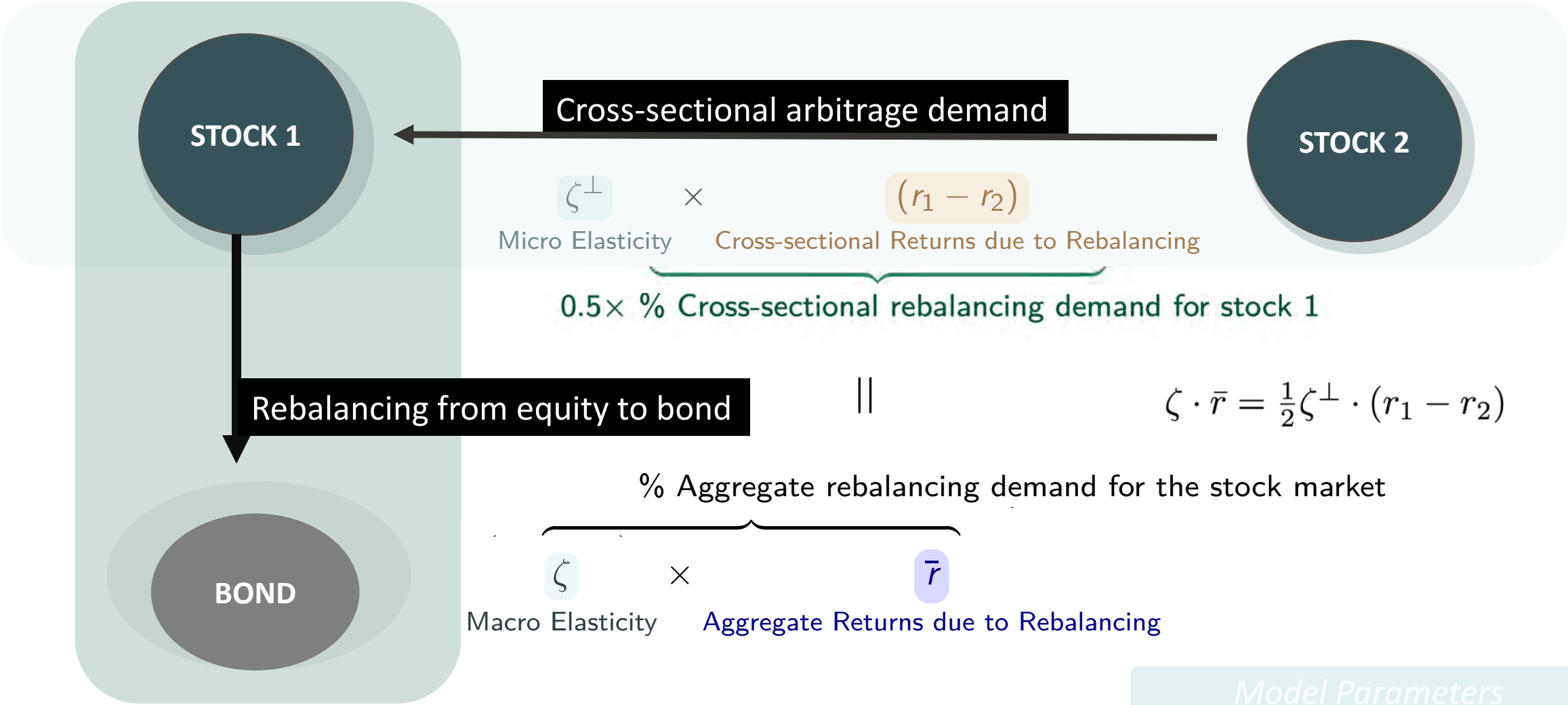


$$\bar{r} = \left(\frac{1}{2} + \frac{\psi^C}{\psi^A}\right)(r_1 - r_2) = \frac{\zeta^{\perp}}{2\zeta}(r_1 - r_2)$$

Model Parameters

Calibration: an example

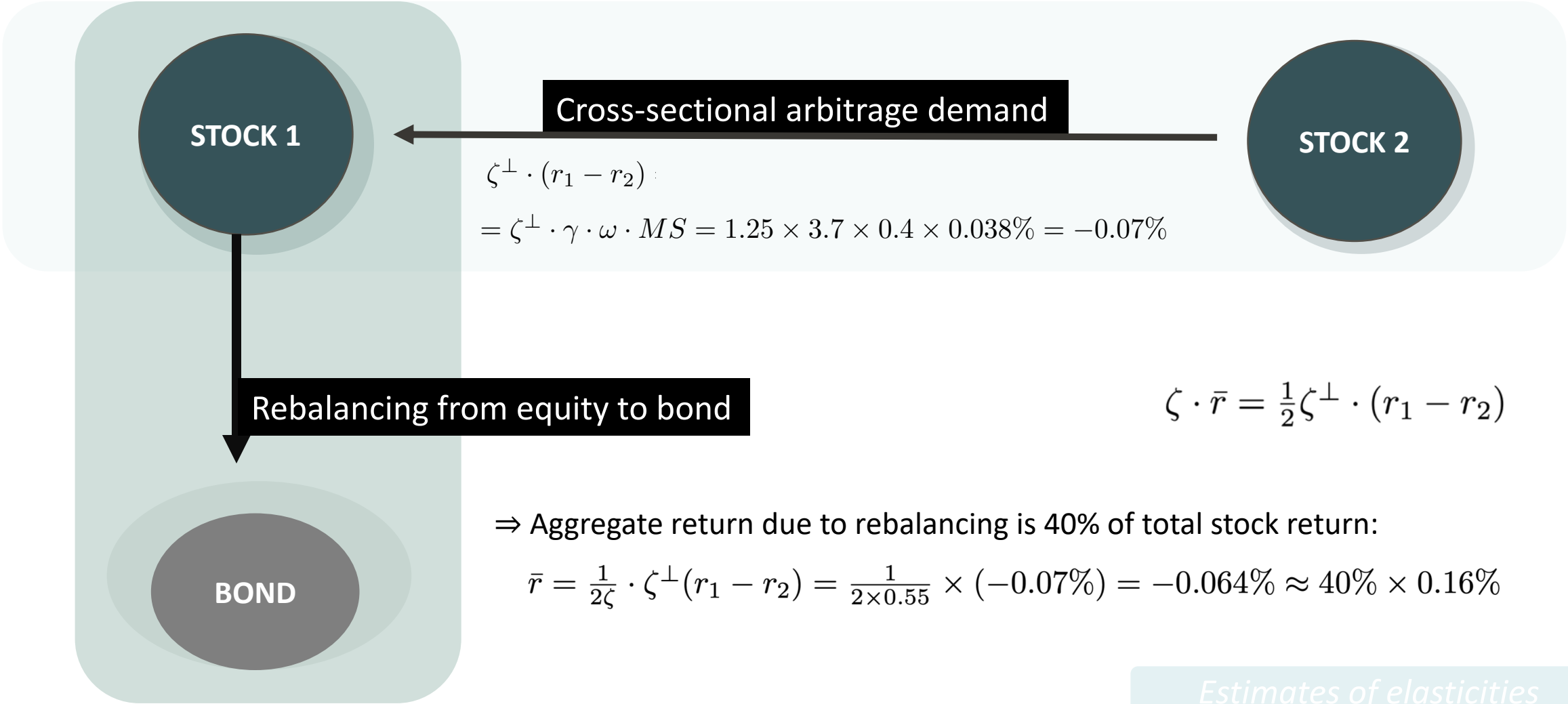
September 20th, 2017: Monetary tightening news (Nakamura-Steinsson shock ≅ 3.8bp)



Model Parameters

Calibration: an example

September 20th, 2017: Monetary tightening news (Nakamura-Steinsson shock ≅ 3.8bp)



$$\zeta \cdot \bar{r} = \tfrac{1}{2}\zeta^{\perp} \cdot (r_1 - r_2)$$

⇒ Aggregate return due to rebalancing is 40% of total stock return:

$$\bar{r} = \tfrac{1}{2\zeta} \cdot \zeta^{\perp}(r_1 - r_2) = \tfrac{1}{2 \times 0.55} \times (-0.07\%) = -0.064\% \approx 40\% \times 0.16\%$$

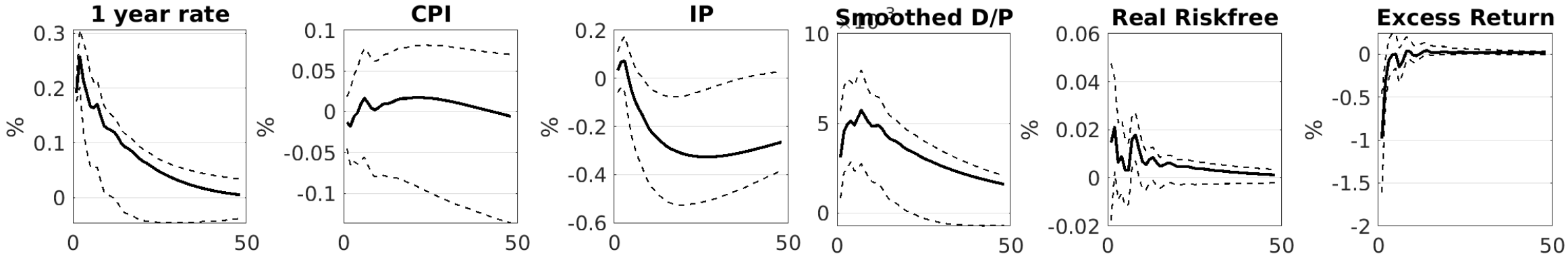
Estimates of elasticities

Conclusion

- A new channel for monetary transmission to the equity market
  - Unveiling the crucial role of **rebalancing demands from financial intermediaries**
- A **cross-sectional approach**
  - Evidence unique to the rebalancing channel
    - **Existence & magnitude:** quasi-experiments & common stocks with controls
    - **Quantity** evidence on the assumption: active rebalancing to target equity share
    - Evidence on forward-looking prices: timing of the shocks
  - **Implied aggregate returns** based on cross-sectional estimates & demand elasticities
    - Rebalancing channel accounts for one-third to two-third of changes in equity risk premia after monetary shocks
- **Applications** of the demand-based mechanism and the cross-sectional approach in other contexts
  - How does the rebalancing of international investors contribute to monetary spillover?
  - How do credit market disturbances propagate across financial markets?

Return decomposition with SVAR-IV

- First-stage VAR (October '79 – September '19): 6 variables & 6 lags (1-year Treasury yield, CPI, IP, S&P 500 excess returns, 1-month Treasury Bill, smoothed dividend price ratio from S&P 500 index)
- Estimated residuals instrumented by monthly MS (Nakamura-Steinsson '18, Gertler-Karadi '15): 1-sd positive MS leads to 0.17% increase in 1-year Treasury; real excess returns decrease by 1.63%
  - Assumption: monetary shocks are correlated with the structural shocks to the interest rate in the SVAR
  - Impulse responses to a one-standard-deviation monetary shock:



- Finally, apply Campbell-Shiller decomposition for returns:

$$r_t - \mathbb{E}_{t-1}[r_t] = (\mathbb{E}_t - \mathbb{E}_{t-1})\Sigma_{j=0}^{\infty}\rho^j \Delta d_{t+j} - (\mathbb{E}_t - \mathbb{E}_{t-1})\Sigma_{j=1}^{\infty}\rho^j r^f_{t+j} - (\mathbb{E}_t - \mathbb{E}_{t-1})\Sigma_{j=1}^{\infty}\rho^j er_{t+j}$$

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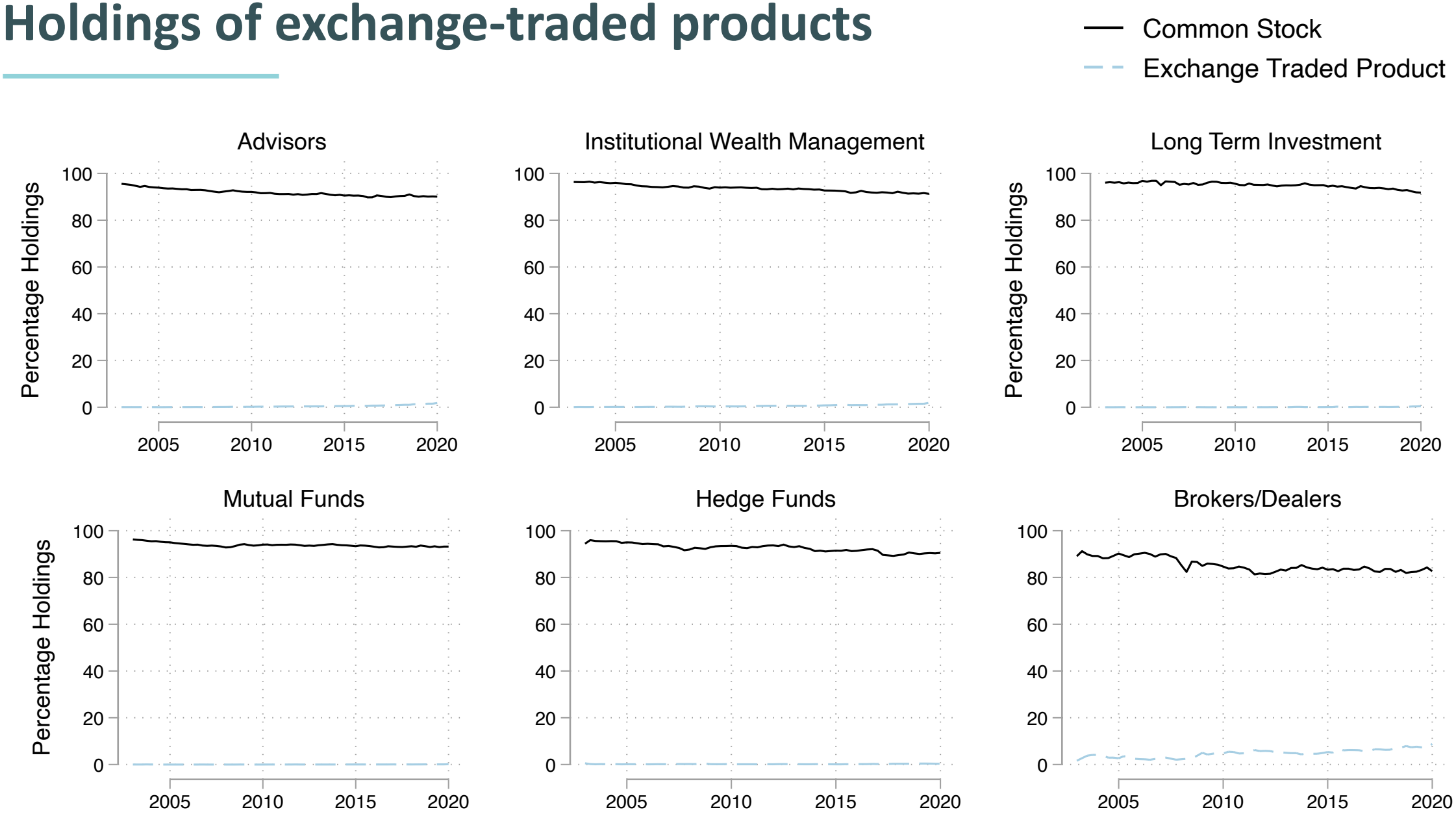
Holdings of exchange-traded products



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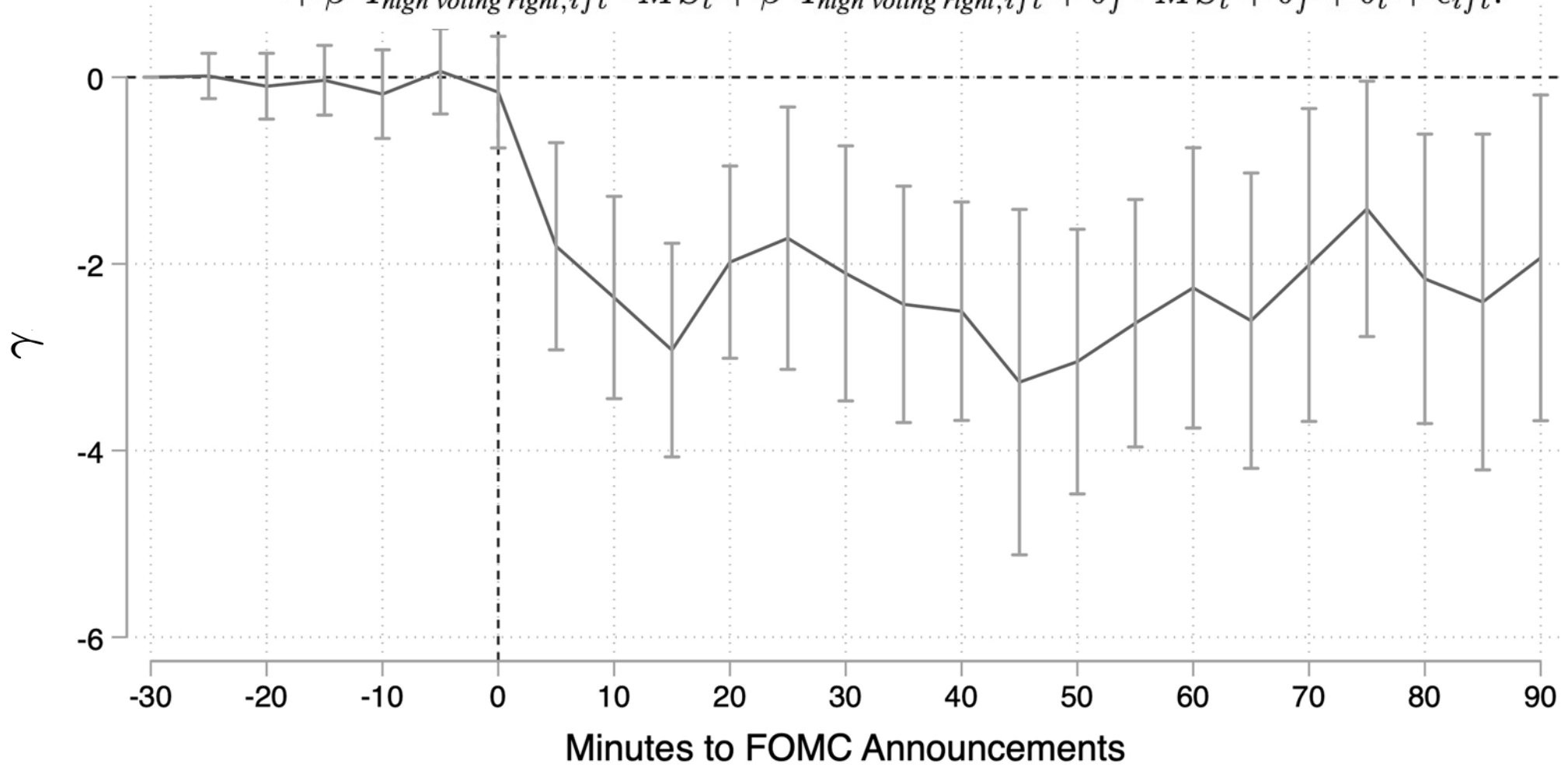
Dual-class shares: OLS

$$r_{ift} = \gamma I_{\text{high rebalancer ownership},ift} \cdot MS_t + \theta I_{\text{high rebalancer ownership},ift}$$
$$+ \check{\beta}^1 I_{\text{high voting right},ift} \cdot MS_t + \check{\beta}^2 I_{\text{high voting right},ift} + \delta_f \cdot MS_t + \delta_f + \delta_t + \epsilon_{ift}.$$



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Return-sensitive rebalancers

- Time: $t = 0, 1$.
- Assets: Bond B, and two stocks ($i = 1$ & 2).
  Pre-shock stock prices $P_i = \bar{P}$, dividends $D_i \sim N(\bar{D}, \sigma^2)$ and $corr(D_1, D_2) = \rho$. $Q_i = 1$.
- Monetary shock at period 0 moves price of bond by r_B. Stocks endogenously revaluate by $r_i = \frac{P_i - \bar{P}}{\bar{P}}$.

Investors	Rebalancer		Equity Arbitrageur	
Stock 1	θW_0^R		$\bar{P} - \theta W_0^R$	
Stock 2	0	W_0^R	$1 \cdot \bar{P}$	W_0^E
Bond	$(1-\theta) W_0^R$		0	

Preferences

$\frac{P_1 Q_1^R}{W^R} = \theta e^{\kappa_\pi(-\mathcal{R}_1 r_1 + \mathcal{R}_B r_B) + \kappa_B \mathcal{R}_B r_B} := \theta e^{-K_\pi r_1 + K_B r_B}$.

Equity risk premium: $-\mathcal{R}_1 r_1 + \mathcal{R}_B r_B$

$max_{Q_i^E} \mathbb{E}[W_1^E] - \Gamma Var[W_1^E]$,
$s.t.\ \ W_1^E = \Sigma_i Q_i^E \left(D_i + \bar{P} - (1+\eta) P_i\right)$.

Demand for:

Stock 1: $\Delta Q_1^R = \omega\left[(1 - \theta + K_\pi + K_B) r_B - (1 - \theta + K_\pi) r_1\right]$

Stock 2: $\Delta Q_2^R = 0$.

$\Delta Q_1^E = -\psi^A r_1 - \psi^C (r_1 - r_2)$,
$\Delta Q_2^E = -\psi^A r_2 - \psi^C (r_2 - r_1)$,
where $\psi^A = \frac{(1+\eta)\bar{P}}{\Gamma(1+\rho)\sigma^2}$ & $\psi^C = \frac{(1+\eta)\rho\bar{P}}{\Gamma(1-\rho^2)\sigma^2}$.

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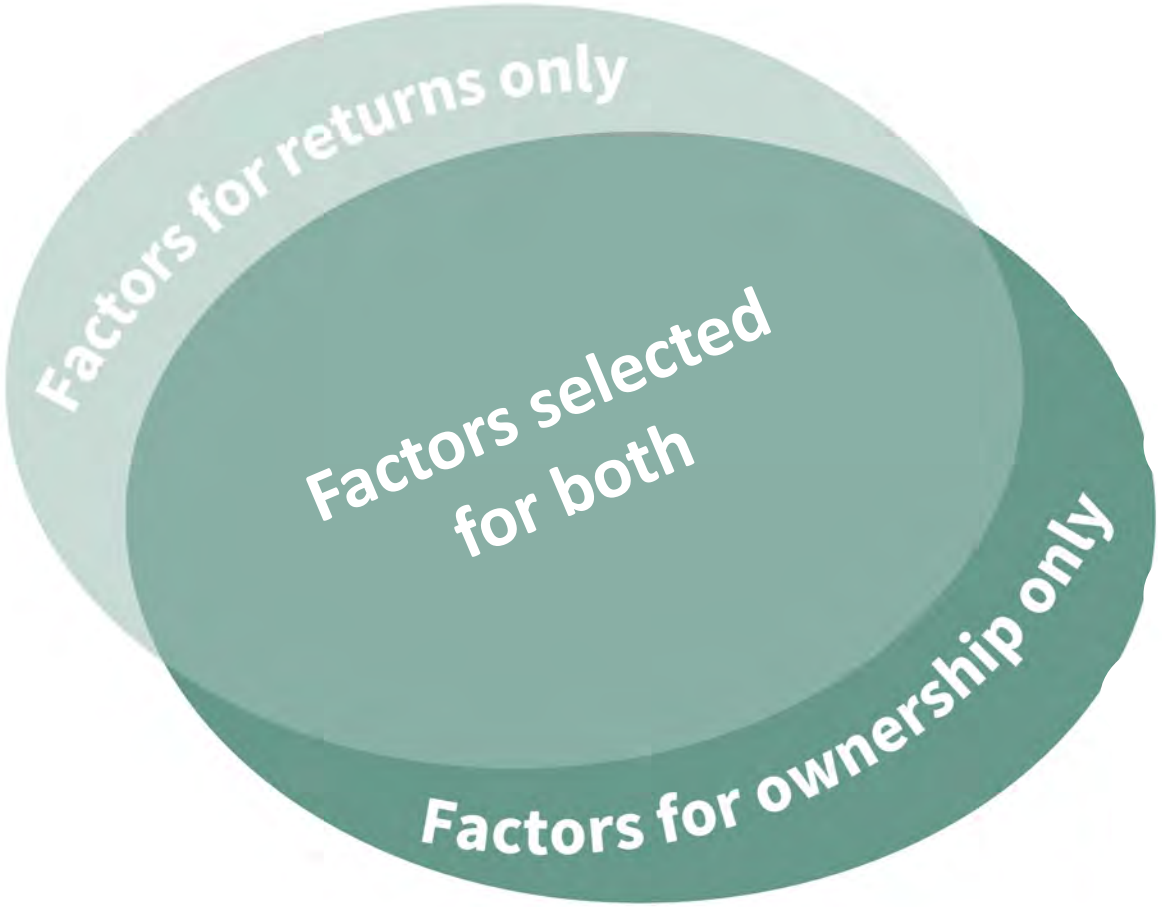
What's driving rebalancers' ownership?



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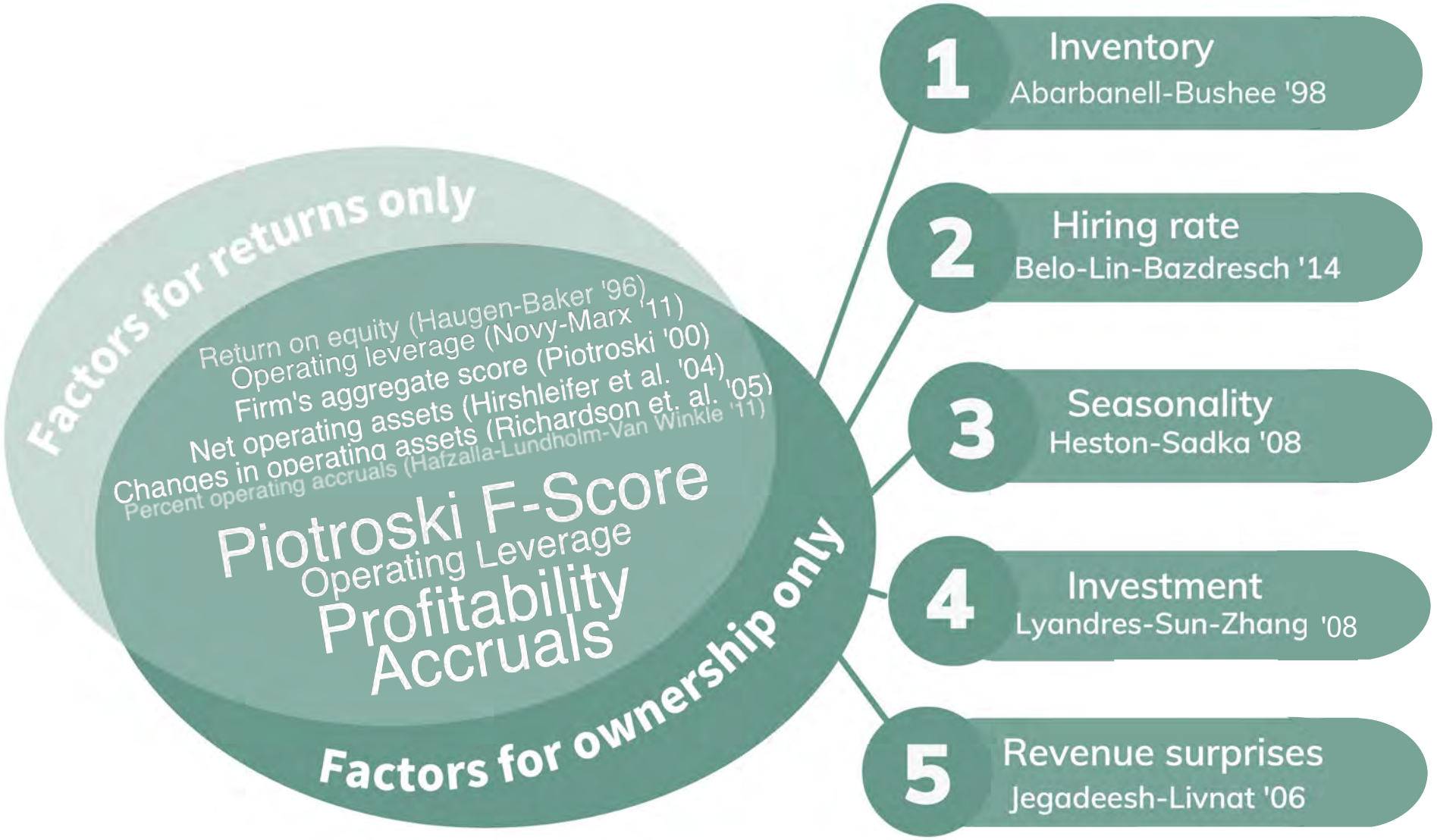

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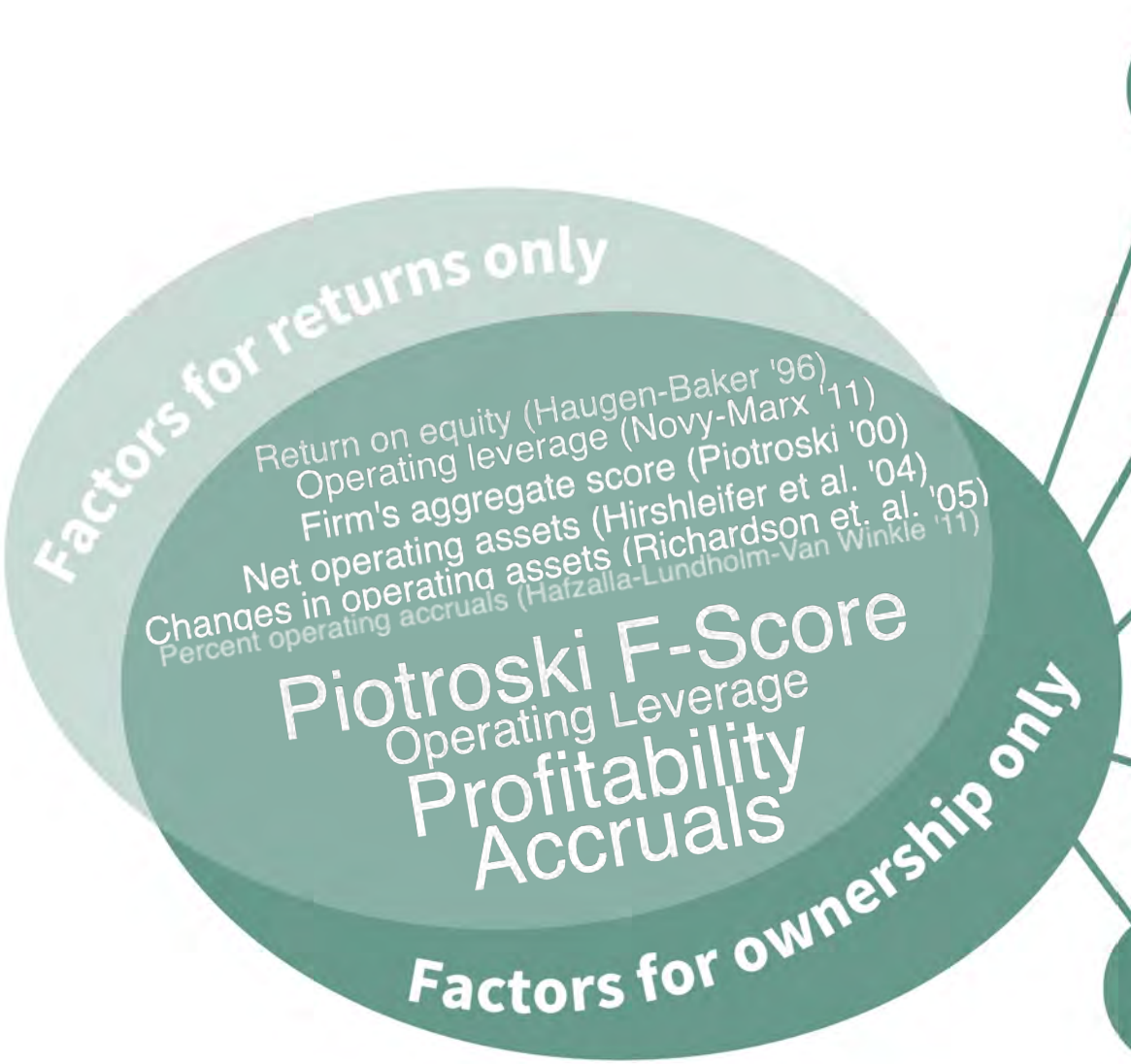
What's driving rebalancers' ownership?



1	Inventory Abarbanell-Bushee '98	-2.4% (1.4%)	
2	Hiring rate Belo-Lin-Bazdresch '14	6.6% (1.9%)	
3	Seasonality Heston-Sadka '08	1.0% (1.5%)	
4	Investment Lyandres-Sun-Zhang '08	3.7% (1.2%)	
5	Revenue surprises Jegadeesh-Livnat '06	-4.5% (2.3%)	Standardized $\tilde{\lambda}^k$ (Robust s.e.)

$$\bar{\omega}_i = \sum_k \tilde{\lambda}^k \cdot \bar{\beta}_i^k + \epsilon_i$$

Adj. R^2 *~ 29%*

Back

Local projection specifications

a. Assume after the monetary shock, the bond revaluates by r_B, but stock prices do not change. Then the post-shock equity share θ_{ft} for a fund f is:

$$\frac{\theta_{ft}}{\theta_{ft} + (1-\theta_{ft})(1+r_B)} \approx \theta_{ft} - \theta_{ft}(1-\theta_{ft})r_B.$$

$\rightarrow \theta_f(1-\theta_f)r_B$ reflects the rebalancing needed for the target share.

b. When funds hold bonds of different duration n. Suppose a fund holds bond with duration n and yield y_{nt}.

   – Posit a mean-reverting monetary shock ($\hat{y}_{1,t+i} = \phi^i \hat{r}_{1,t}$), under expectation hypothesis,

$$\hat{y}_{nt} = \frac{1}{n}\sum_{i=0}^{n-1} \hat{y}_{1,t+i} = \frac{1-\phi^n}{n(1-\phi)} y_{1,t},$$

   and revaluation return for bond: $r_B = -n\hat{y}_{nt}$.

   – Coupled with a., the post-shock equity share θ_{ft} for a fund f is:

$$\frac{\theta_{ft}}{\theta_{ft} + (1-\theta_{ft})(1+r_B)} \approx \theta_{ft} - \theta_{ft}(1-\theta_{ft})r_B = \theta_{ft} + n\theta_{ft}(1-\theta_{ft})\hat{y}_{nt}.$$

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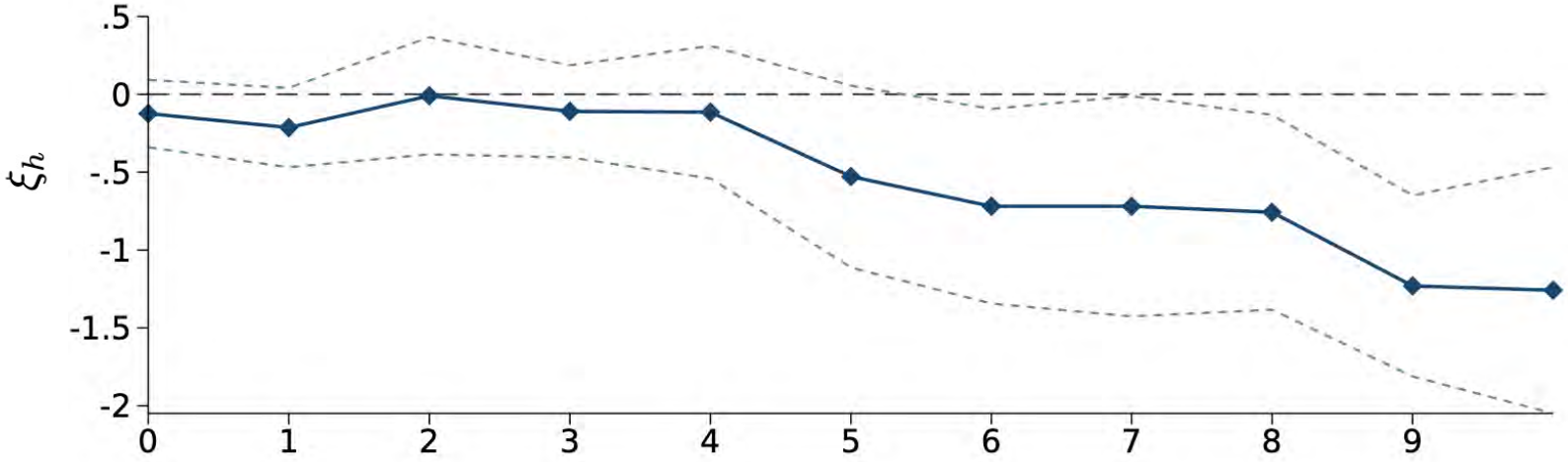
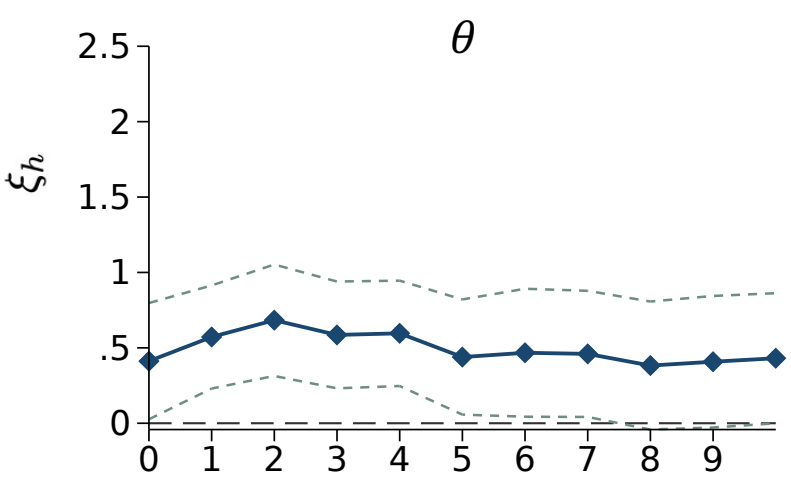
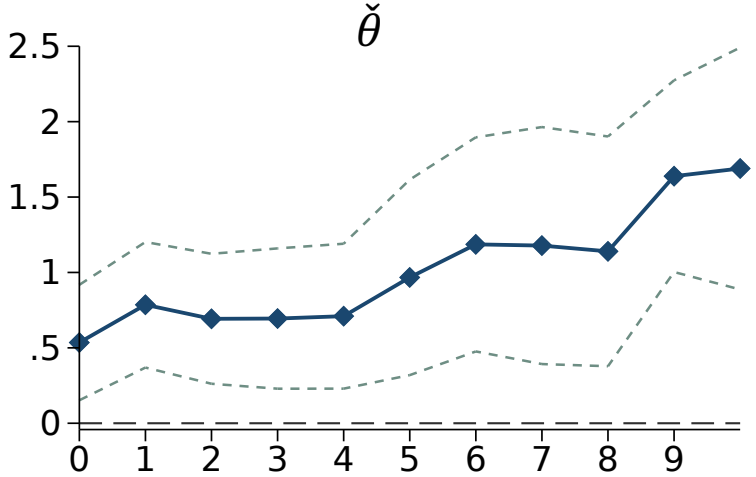
Results (duration)

- Active rebalancing: $\theta_{f,t+h} - \check{\theta}_{f,t-1\to t+h} = \xi_h \left[\theta_{f,t-1}(1-\theta_{f,t-1})Dur_{f,t-1}MS_t\right] + \boldsymbol{\varphi}'\boldsymbol{X}_{f,t+h} + \epsilon_{f,t-1\to t+h}$







- We compute duration for 30% of the bond holdings in MV from pricing data in GovPx (Treasuries, 2.2%) and TRACE (Corporate bonds, 27%) through CRSP and WRDS.
- Controls: 4 lags of main variables, quarter-end and fund fixed effects.
- 95% CI w/ standard errors clustered at fund level.

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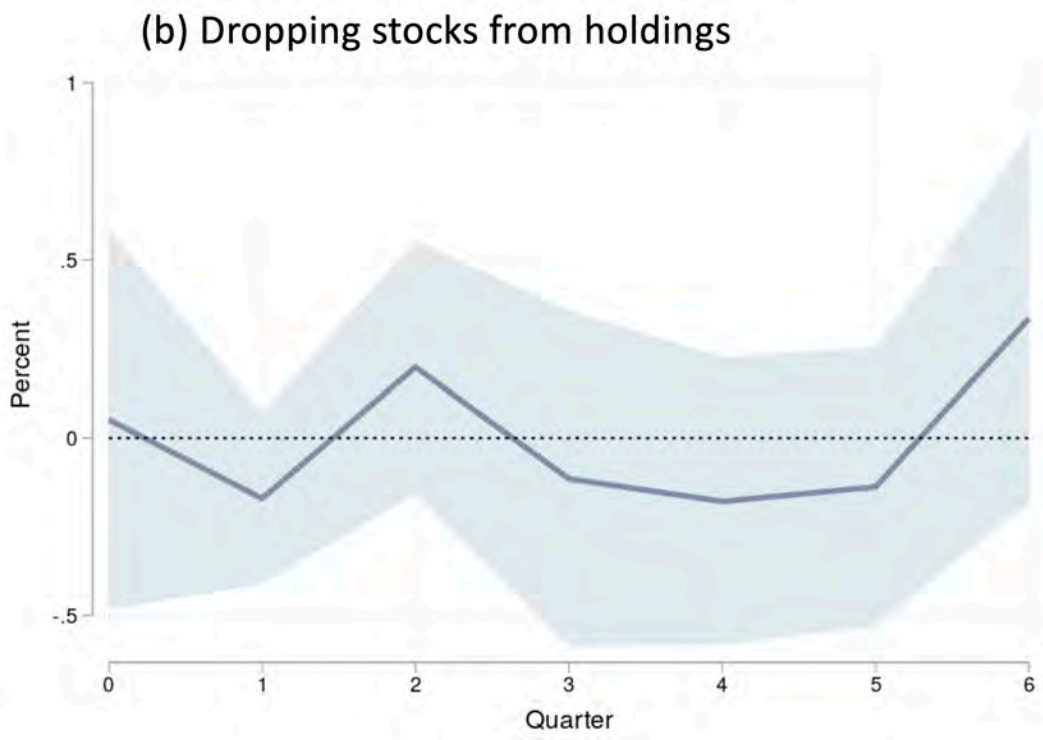
Extensive margins

- % Securities added to rebalancer i's holdings: $Added_{i,t} = \frac{\#\text{ of securities added to } i\text{'s portfolio in quarter } t}{\#\text{ of securities in } i\text{'s portfolio in quarter } t-1}$.
- % Securities dropped from rebalancer i's holdings: $Dropped_{i,t} = \frac{\#\text{ of securities dropped from } i\text{'s portfolio in quarter } t}{\#\text{ of securities in } i\text{'s portfolio in quarter } t-1}$.
- Local projections of $\overline{Added_{t+h}}$ ($/\overline{Dropped_{t+h}}$) on negative ($/$positive) monetary shocks at t with 4 lags:



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Robustness checks

	Stock FE	Duration Measure		Ownership Measure	Weighted OLS	FF4 Factors	SP500 Index Constituents		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Ownership$_{Rebalancers}$×MS	-3.278**	-3.507**	-3.626**		-2.967**	-3.937**	-3.011*	-2.236	-3.942*
	(1.560)	(1.550)	(1.570)		(1.469)	(1.564)	(1.588)	(2.107)	(2.057)
Ownership$_{Rebalancers}$	×	×	×		×	×	×	×	×
MS	×	×	×	×	×	×	×	×	×
DSS Duration×MS	×			×	×	×	×	×	×
DSS Duration	×			×	×	×	×	×	×
GL Duration×MS		×							
GL Duration		×							
Weber Duration×MS			×						
Weber Duration			×						
Rank$_{Rebalancers}$×MS				-0.709*					
				(0.374)					
Rank$_{Rebalancers}$				×					
FF4 Factors×MS						×			
FF4 Factors						×			
Stock FE	Y	N	N	N	N	N	N	N	N
$I\_SP500\times$ MS	N	N	N	N	N	N	Y	N	N
N	55,730	55,766	58,489	58,497	58,387	58,497	58,497	20,837	37,657
Adj. R^2	0.601	0.599	0.594	0.594	0.633	0.596	0.595	0.677	0.579

Controls across (1)-(9): MPE, beta, log market equity, meeting FE; interactions between monetary shocks and MPE, beta, log market equity, industry fixed effects

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Sample-split analysis: excluding rebalancers

	Quarter-End			Month-End		
	(1)	(2)	(3)	(4)	(5)	(6)
Ownership of Other Institutions×MS	-0.223	0.465	0.0621	-0.00393	0.848	0.704
	(0.946)	(0.932)	(0.966)	(0.869)	(0.854)	(0.887)
Ownership of Other Institutions	×	×	×	×	×	×
Duration×MS		×	×		×	×
DSS Duration		×	×		×	×
MPE		×	×		×	×
MPE×MS		×	×		×	×
β×MS		×	×		×	×
β		×	×		×	×
$Log(me)$ ×MS			×			×
$Log(me)$			×			×
Meeting FE	Y	Y	Y	Y	Y	Y
$I\_ind.\times$ MS	Y	Y	Y	Y	Y	Y
N	29,329	29,329	29,329	37,270	37,270	37,270
Adj. R^2	0.626	0.631	0.631	0.584	0.588	0.588

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An alternative Sample

	(1)	(2)	(3)	(4)	(5)
Ownership of Rebalancers×MS	-3.057***	-4.248***	-4.114***	-3.778**	-3.677**
	(0.758)	(1.271)	(1.286)	(1.548)	(1.559)
Ownership of Rebalancers	×	×	×	×	×
MPE		×	×	×	×
MPE×MS		×	×	×	×
Duration×MS			×	×	×
DSS Duration			×	×	×
β×MS				×	×
β				×	×
log(size)×MS					×
log(size)					×
Stock FE	N	N	N	N	N
Meeting FE	Y	Y	Y	Y	Y
$I\_ind.\times$ MS	Y	Y	Y	Y	Y
N	214,547	83,879	82,458	58,898	58,898
Adj. R^2	0.506	0.571	0.574	0.594	0.594

Sample without restrictions based on data availability in Compustat / IBES or prices.

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Alternative measure of rebalancing demand

- *Ideally*: portfolio level mandate information across asset classes for all institutions
- *Reality*: only **equity** holdings at **quarterly** frequency in FactSet.
- Measuring rebalancing demand using monthly mutual fund holdings from Morningstar
  - Identify balanced funds from two criteria: name & investment styles
  - Underestimation:
    - No data on collective investment vehicles
    - During the sample period, balanced funds hold ~0.3% of the market **directly**

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Alternative measure: results

	Balanced Funds				Pure Equity Funds	
	(1)	(2)	(3)	(4)	(5)	(6)
Ownership$_{BalancedFunds}$×MS	-59.55**	-62.32**	-64.15**	-58.90**		
	(29.64)	(29.64)	(29.73)	(29.54)		
Ownership$_{BalancedFunds}$	×	×	×	×		
Ownership$_{EquityFunds}$×MS					2.701	3.334
					(2.563)	(2.729)
Ownership$_{EquityFunds}$					×	×
MS	×	×	×	×	×	×
MPE ×MS		×	×	×		×
MPE		×	×	×		×
Duration×MS			×	×		×
DSS Duration			×	×		×
$Log(me)$×MS			×	×		×
$Log(me)$			×	×		×
β×MS				×		×
β				×		×
Meeting FE	Y	Y	Y	Y	Y	Y
$I\_ind.\times$ MS	Y	Y	Y	Y	Y	Y
N	27182	27182	27182	27182	27182	27182
Adj. R^2	0.593	0.594	0.594	0.595	0.593	0.597

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Alternative measure: delayed rebalancing

	Quanter-End				Month-End			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ownership$_{BalancedFunds}$×MS	-124.1***	-129.3***			-31.82	-27.88		
	(36.82)	(36.84)			(31.26)	(31.10)		
Ownership$_{BalancedFunds}$	×	×			×	×		
Ownership$_{PureFunds}$×MS			7.001**	7.180**			2.710	4.032
			(3.073)	(3.122)			(2.775)	(2.909)
Ownership$_{PureFunds}$			×	×			×	×
Controls		×		×		×		×
Meeting FE	Y	Y	Y	Y	Y	Y	Y	Y
$I\_ind.\times$ MS	Y	Y	Y	Y	Y	Y	Y	Y
N	12330	12330	12330	12330	18724	18724	18724	18724
Adj. R^2	0.632	0.636	0.631	0.635	0.595	0.598	0.595	0.598

- Controls include $Duration$, $Duration \times MS$, MPE, $MPE \times MS$, β,$\beta \times MS$, $log(size)$ and $log(size) \times MS$.

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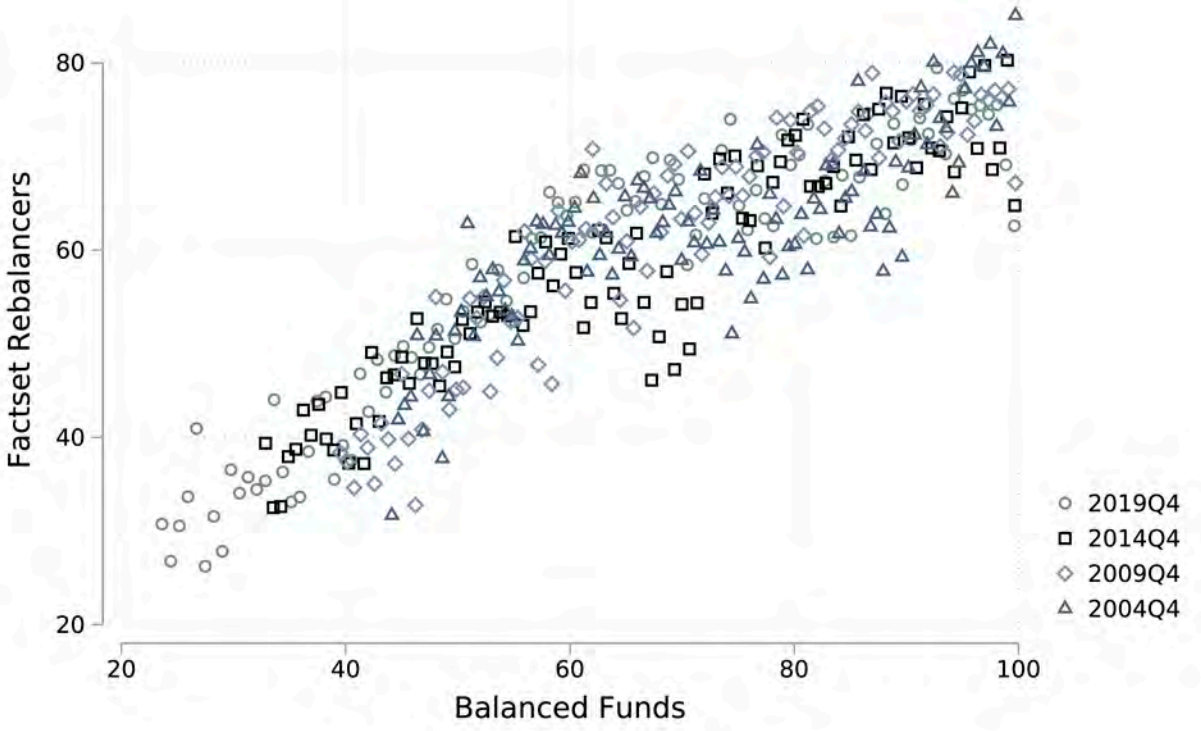
Correlation between the rebalancing demand proxies

- Measuring rebalancing demand using mutual fund holdings from Morningstar
  - Rebalancers: balanced funds with target shares only
  - Morningstar v. FactSet: less coverage, but more precision
- Holdings of balanced funds in sample persistently correlate with FactSet rebalancers (>30%)



Binned scatterplot of balanced funds' **direct** holdings against rebalancers' holdings in ranks

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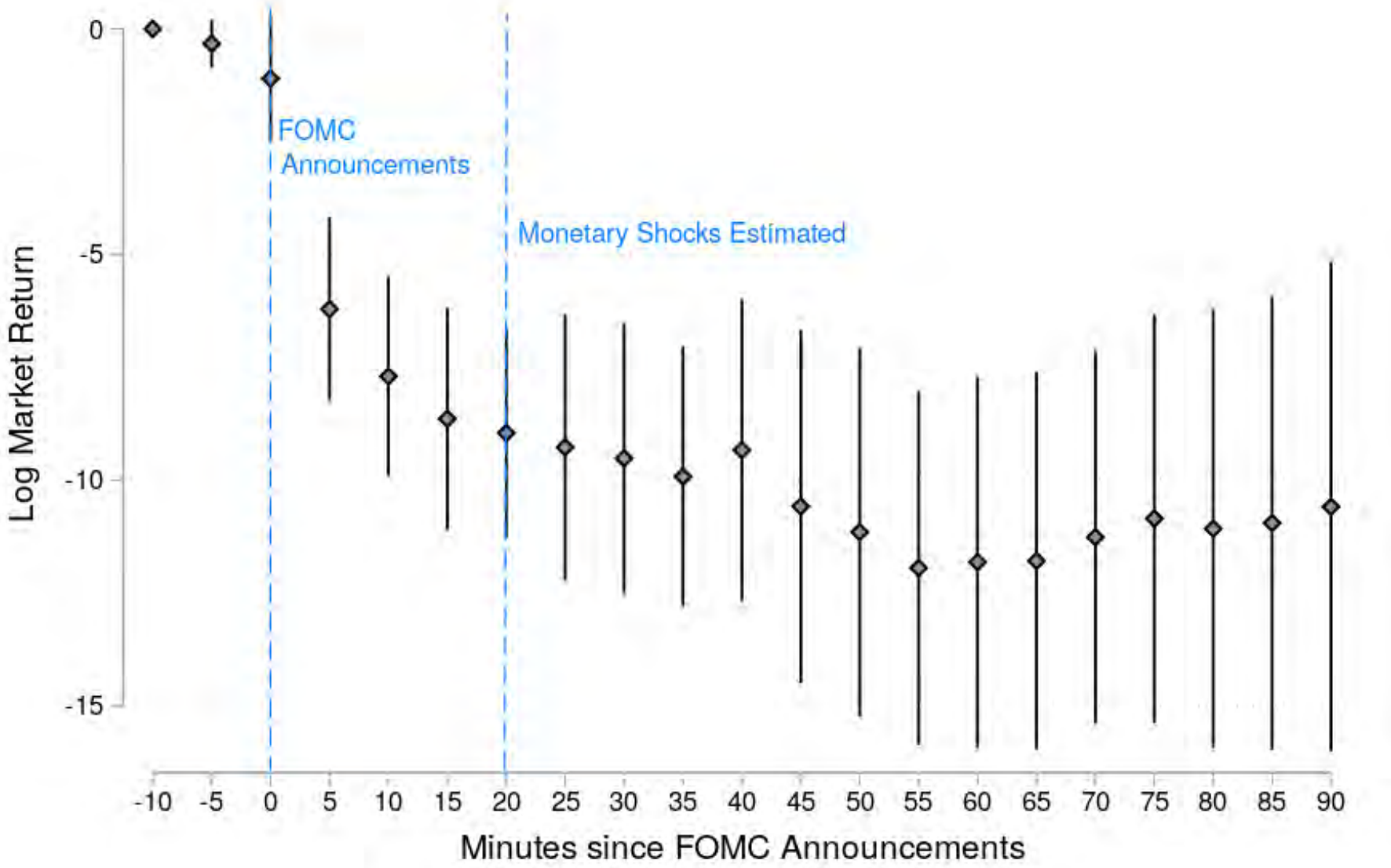
Bernanke-Kuttner meets Nakamura-Steinsson



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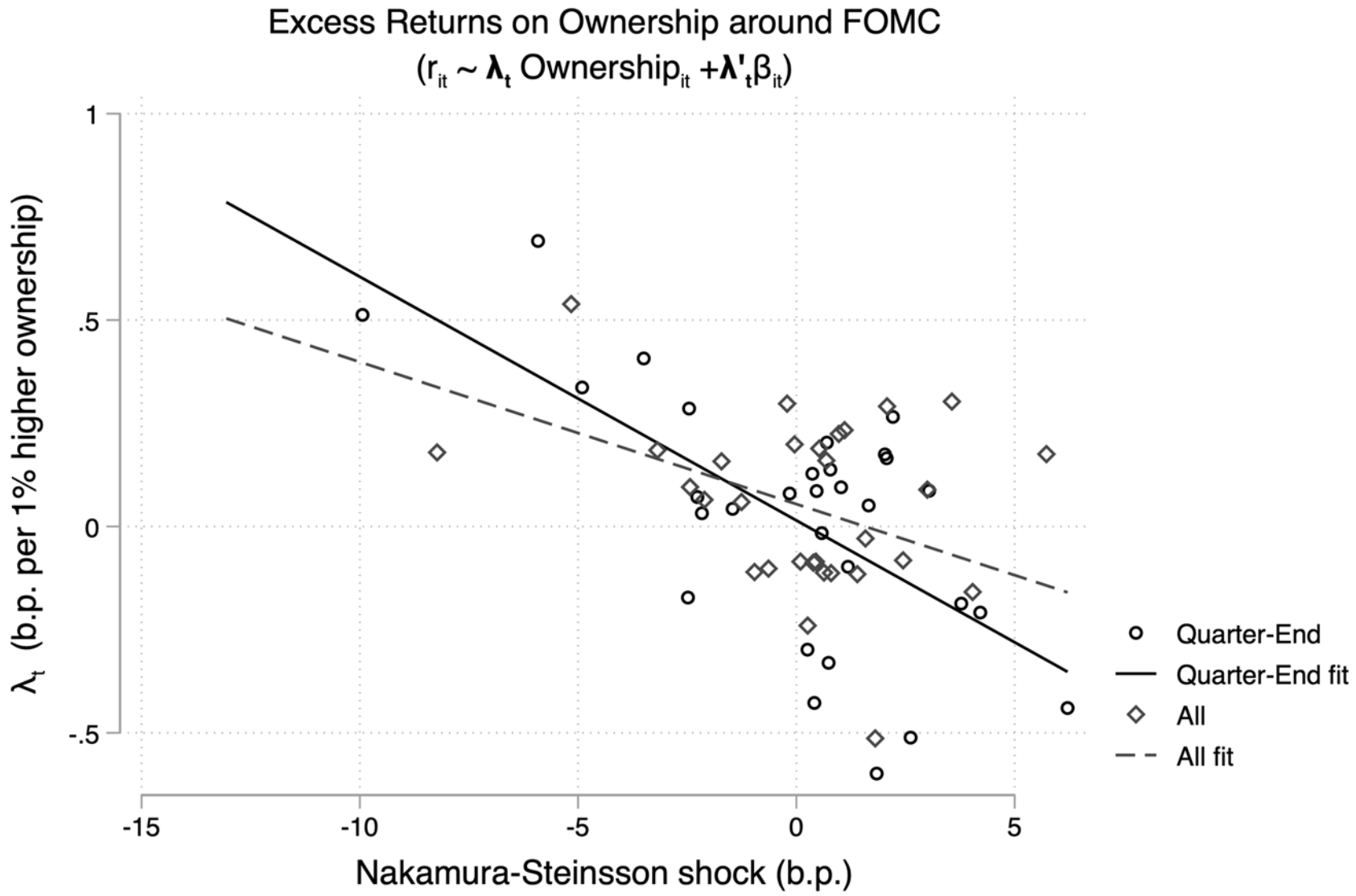
Summary: loadings on ownership v. monetary shocks



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Elasticity estimates in literature

	Estimate Type[1]	Market	Event Type	Sample Period	Elasticity
micro elasticity $\zeta^{\perp}$ (in absolute value)					
Schmickler and Tremacoldi-Rossi (2022)	Drift	US	Dividend payouts	1980-2017	1.25
Greenwood et al. (2022)	Drift	Hong Kong	Fiscal stimuli	2020-2021	0.25-0.5
Lou (2012)	Drift	US	Idiosyncratic demand shocks	1980-2006	0.83
Pavlova and Sikorskaya (2022)	Announcement/Full	US	Index inclusion/deletion	1998-2018	1-3.3
Chang et al. (2015)	Announcement/Full	US	Index inclusion/deletion	1996-2012	0.37-1.43
Barbon and Gianinazzi (2019)	Announcement	Japan	Equity QE	2013-2017	1
Haddad et al. (2022)	Structural	US	-	2001-2020	0.5
Koijen and Yogo (2019)	Structural	US	-	2017	0.38[2]
macro elasticity ζ (in absolute value)					
Gabaix and Koijen (2022)	Full/GIV	US	Idiosyncratic demand shocks	1993-2019	0.17
Hartzmark and Solomon (2022)	Drift	US	Dividend payouts	1926-2018	0.43-0.67
Li et al. (2021)	Drift	China	Locked up funds for IPO subscriptions	2006-2018	0.21-0.33
Da et al. (2018)	Announcement/Full	Chile	Pension funds' reallocations	2011-2014	0.45

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Implied aggregate market returns with alternative estimates

	Gabaix and Koijen (2022)		Hartzmark and Solomon (2022)		Li et al. (2021)		Da et al. (2018)	
	$\frac{\zeta^{\perp}}{\zeta}$	r_{mt}	$\frac{\zeta^{\perp}}{\zeta}$	r_{mt}	$\frac{\zeta^{\perp}}{\zeta}$	r_{mt}	$\frac{\zeta^{\perp}}{\zeta}$	r_{mt}
Schmickler and Tremacoldi-Rossi (2022)	7.35	6.03	**2.38**	**1.95**	**4.88**	**4.00**	2.78	2.28
Greenwood et al. (2022)	2.21	1.81	0.71	0.58	**1.46**	**1.20**	0.83	0.68
Lou (2012)	**4.90**	**4.02**	1.58	1.30	**3.26**	**2.67**	1.85	1.52
Pavlova and Sikorskaya (2022)	**12.65**	**10.37**	4.09	3.35	8.40	6.89	**4.78**	**3.92**
Chang et al. (2015)	**5.29**	**4.34**	1.71	1.40	3.52	2.88	**2.00**	**1.64**
Barbon and Gianinazzi (2019)	5.88	4.82	1.90	1.56	3.91	3.20	**2.22**	**1.82**
Haddad et al. (2022)	2.94	2.41	0.95	0.78	1.95	1.60	1.11	0.91
Koijen and Yogo (2019)	2.24	1.83	0.72	0.59	1.48	1.22	0.84	0.69

Bold: implied returns estimated with same estimation windows/events

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Marginal contribution of rebalancer ownership

Is rebalancers' ownership spanned by existing factors?

- Factors: 153 existing asset pricing factors (Jensen-Kelly-Pedersen '21) + tercile VW portfolio returns sorted by ω_{it}.
- Method: Double-selection LASSOs + two-pass regressions (Belloni-Chernozhukov-Hansen '14, Feng-Giglio-Xiu '20)
  - First pass (TS): Compute $Cov(r_{it}, F_{xt} \cdot MS_t)$ and $Cov(r_{it}, F_{xt})$ for each security i
  - Second pass (XS): $E(r_{it}) = \gamma_0 + \Lambda Cov(r_{it}, [F_{\omega t} \cdot MS_t, F_{\omega t}]) + \Lambda_x \cdot Cov(r_{it}, [F_{xt} \cdot MS_t, F_{xt}]) + \epsilon_i$

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	Fundamental Factors Only
	(1)
$(r_{it}, F_{ownership,t} \cdot MS_t) \cdot T^{-1}$	160.2**
	(62.25)
N	103
# of Selected Controls	11
# of Controls	169
Adj. R^2	0.575

Fundamental factors are factors in clusters *Accruals, Investment, Debt Issuance, Quality, Profit Growth, & Profitability* (Jensen-Kelly-Pedersen '21)

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	Fundamental Factors Only	All Asset Pricing Factors
	(1)	(2)
$(r_{it}, F_{ownership,t} \cdot MS_t) \cdot T^{-1}$	160.2**	162.0**
	(62.25)	(63.54)
N	103	103
# of Selected Controls	11	15
# of Controls	169	307
Adj. R^2	0.575	0.625

Fundamental factors are factors in clusters *Accruals, Investment, Debt Issuance, Quality, Profit Growth, & Profitability* (Jensen-Kelly-Pedersen '21)

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Additional information on dual-class share data

- Stationarity tests (Harris-Tzavalis '19)

$$g_{f,d,t} = c_f + \rho_f g_{f,d,t-1} + \epsilon_{f,d,t}, \text{ where } g_{f,d,t} = \frac{P_{f,d,t}^{\textit{low voting right share}} - P_{f,d,t}^{\textit{high voting right share}}}{P_{f,d,t}^{\textit{low voting right share}}}$$

Significance Levels	Rejection Rate ($H_0 : \lvert\rho_f\rvert = 1$)	Rejection Rate ($H_0 : c_f = 0$)
10%	100.00%	12.20%
5%	100.00%	9.76%
1%	100.00%	4.88%

$\rightarrow$ Median $\rho_f \sim 0.8$,
Half life $\sim 15.5min$.

- Rebalancers prefer share classes with low voting rights

Holdings in percentage by voting rights

	Share Class with High Voting Rights						Share Class with Low Voting Rights					
	N	Mean	SD	p10	Median	p90	N	Mean	SD	p10	Median	p90
Institutional Wealth Mngmt. %	64	8.17	7.40	0.17	6.65	18.20	68	19.60	7.19	10.40	20.00	27.80
Long Term Investor %	46	0.70	0.90	0.02	0.42	1.60	62	0.93	1.12	0.11	0.71	1.59

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Details on delayed rebalancing

- Suppose monetary shock at $t = 0$ triggers bond revaluation r_B at $t = T$. $(0, 1. \to T, T + 1.)$
- Rebalancer only buys/sells stock 1 at time T.For periods $t = 0, 1, ..., T - 1$:

Investors	Rebalancer		Equity Arbitrageur	
Stock 1	ωP_{1t}		$(1-\omega)P_{1t}$	
Stock 2	0	W_t^R	$1 \cdot P_{2t}$	W_t^E
Bond	$W_t^R - \omega P_{1t}$		0	

Preferences

$$Q_{1T}^R P_{1T} = \theta W_T^R.$$

$$max_{Q_{it}^E} \mathbb{E}_t[W_{t+1}^E] - \Gamma Var_t[W_{t+1}^E],$$
$$s.t.\ W_{t+1}^E = \Sigma_i Q_{it}^E \left(D_{it+1} + P_{it+1} - (1+\eta)P_{it}\right).$$

Demand for Stock i

$$\Delta Q_{it}^R = 0.$$

$$\Delta Q_{it}^E = -\psi^A \Delta_{t,t+1} r_i - \psi^C \left[\Delta_{t,t+1} r_i - (\Delta_{t,t+1} r_{-i})\right],$$
where $\Delta_{t,t+1} r_i = r_{i,t} - \frac{r_{i,t+1}}{1+\eta}$.

Proposition 2: Delayed rebalancing

The time-t price changes in stocks are $r_{1t} = \frac{1}{(1+\eta)^{T-t}} \frac{\omega(1-\theta)}{\Psi+\omega(1-\theta)} r_B$ & $r_{2t} = \frac{\psi^C}{\psi^C+\psi^A} r_{1t}$. Consequently

$$\frac{\partial^2 (r_{10} - r_{20})}{\partial r_B \partial T} < 0, \quad \frac{\partial^2 \bar{r}_0}{\partial r_B \partial T} < 0, \quad \text{and} \quad \bar{r}_0 = \left(\frac{1}{2} + \frac{\psi^C}{\psi^A}\right)(r_{10} - r_{20})$$

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Additional Summary Statistics at Stock Level

	All common stocks				S&P 500 index constituents			
	N	Mean	Median	SD	N	Mean	Median	SD
Institutional Wealth Mngmt. %	4,849	10.10	8.92	8.34	476	18.40	17.40	5.24
Long Term Investor %	4,516	2.15	1.38	2.02	475	4.48	4.42	0.91
Advisor %	4,913	22.00	20.50	16.20	477	31.60	31.30	10.10
Broker %	4,662	0.94	0.54	1.33	475	1.37	1.13	0.83
Hedge Fund %	4,322	5.59	3.23	6.63	475	2.39	1.34	2.94
Mutual Fund %	4,291	9.92	8.22	8.33	477	15.20	14.20	6.67
Market Value ($ million)	4,938	2,536	355.20	8,444	475	17,110	9,762	20,080

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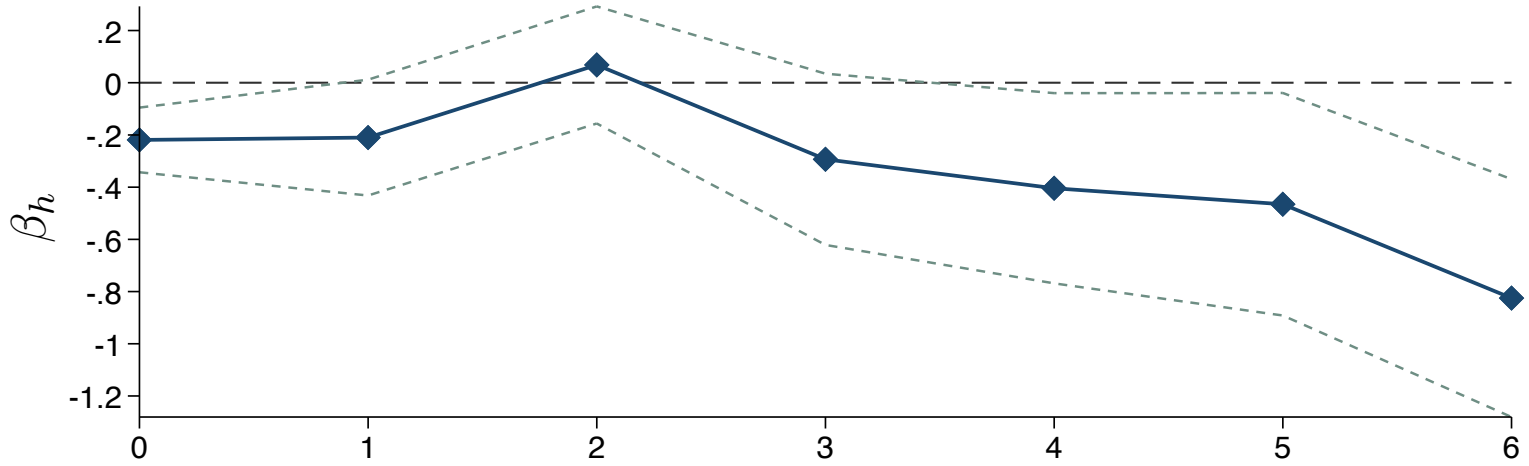
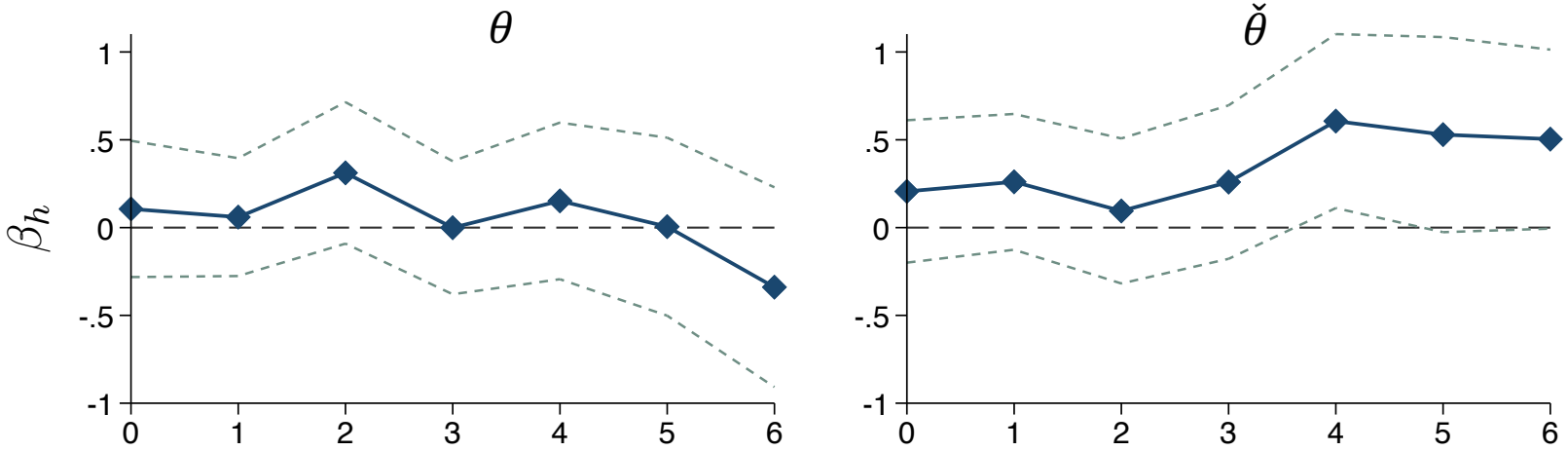
Results

Duration weighted projections

- Active rebalancing: $\theta_{f,t+h} - \check{\theta}_{f,t-1\to t+h} = \beta_h \left[\theta_{f,t-1}(1-\theta_{f,t-1})MS_t\right] + \boldsymbol{\varphi}' \boldsymbol{X}_{f,t+h} + \epsilon_{f,t-1\to t+h}$



- Equity shares:



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From model parameters to empirical moments

- Rebalancing model implies aggregate stock return $\bar{r} = \frac{r_1+r_2}{2}$ and cross-sectional return difference $r_1 - r_2$ satisfy

$$\bar{r} = \left(\frac{1}{2} + \frac{\psi^C}{\psi^A}\right)(r_1 - r_2)$$

- Parameters ψ^C and ψ^A are pinned down by macro and micro elasticities (Gabaix-Koijen '22):

a. Macro elasticity: aggregate price response to an aggregate stock market demand shock ε

The equity arbitrageur's demand is $\Delta\bar{Q} = \frac{\Delta Q_1+\Delta Q_2}{2} = -\frac{\psi^A}{2}(r_1+r_2) = -\psi^A\bar{r}$

Market clearing $\Rightarrow$ $\zeta := \varepsilon/\bar{r} = -\Delta\bar{Q}/\bar{r} = \psi^A$

b. Micro elasticity: individual stock price response to offsetting demand shocks $\varepsilon^\perp$ $(\Delta Q_1 + \varepsilon^\perp = 0)$

Relative demand of the equity arbitrageur is $\Delta Q_1 - \Delta Q_2 = -(\psi^A + 2\psi^C)(r_1 - r_2)$

Market clearing $\Rightarrow$ $\zeta^\perp := \frac{2\varepsilon^\perp}{r_1-r_2} = -\frac{\Delta Q_1-\Delta Q_2}{r_1-r_2} = \psi^A + 2\psi^C$

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$\Rightarrow$ The aggregate price reaction is a function of cross-sectional return differences and elasticities ζ & $\zeta^\perp$

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From cross-section to aggregate

SVAR-IV decomposition
Bernanke-Kuttner HF IRF
Elasticities in literature
Alternative estimates

- The cross-sectional estimate $r_1 - r_2$
  - Around 20% of the aggregate market is held by rebalancers
  - With a 1% positive shock, a stock with 10% higher rebalancer ownership drops 37 bp more

$$\Rightarrow r_1 - r_2 = \gamma \cdot \omega \cdot MS = -3.7 \cdot 40\% \cdot 1\% = -1.48\%$$

- Macro and micro elasticities in literature $\frac{\zeta^{\perp}}{\zeta}$
  - Dividend payments: $\zeta^{\perp} \approx 1.25$ (Schmickler-Tremacoldi-Rossi '22) & $\zeta \approx 0.55$ (Hartzmark-Solomon '22)

$$\frac{\zeta^{\perp}}{\zeta} \approx 2.3 \Rightarrow \bar{r} \approx -1.48\% \cdot 2.3/2 = -1.7\%$$

  - Institutional flow induced demand shocks: $\zeta^{\perp} \approx 0.83$ (Lou '12) & $\zeta \approx 0.17$ (Gabaix-Koijen '22)

$$\frac{\zeta^{\perp}}{\zeta} \approx 4.9 \Rightarrow \bar{r} \approx -1.48\% \cdot 4.9/2 = -3.6\%$$

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- Overall response attributed to future excess return: $-63\% \cdot 8.9\% = -5.6\%$

$\Rightarrow$ The rebalancing channel accounts for about 30%–64% of the measured risk premia reaction

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Active rebalancing

Active rebalancing to the target equity share

local projection specifications

- Equity share θ can change because of changes in prices (revaluation), or quantities (rebalancing)
  - Actual equity share for rebalancer f at time $t+h$ after shock at t

$$\theta_{f,t+h} = \frac{\Sigma_{i=1}^{N} P_{i,t+h} Q_{if,t+h}}{\Sigma_{i=1}^{N} P_{i,t+h} Q_{if,t+h} + \Sigma_{j=1}^{M} P_{j,t+h}^{B} Q_{jf,t+h}^{B}}$$

  - Counterfactual equity share with revaluation effect at time $t+h$ after shock at t

$$\breve{\theta}_{f,t-1\to t+h} = \frac{\Sigma_{i=1}^{N} P_{i,t+h} Q_{if,t-1}}{\Sigma_{i=1}^{N} P_{i,t+h} Q_{if,t-1} + \Sigma_{j=1}^{M} P_{j,t+h}^{B} Q_{jf,t-1}^{B}}$$

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$\Rightarrow$ The difference between the actual and counterfactual equity share captures active rebalancing

$$\theta_{f,t+h} - \check{\theta}_{f,t-1\to t+h} = \beta_h \left[\theta_{f,t-1}(1-\theta_{f,t-1}) MS_t\right] + \boldsymbol{\varphi}' \boldsymbol{X}_{f,t+h} + \epsilon_{f,t-1\to t+h}$$

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- We compute actual and counterfactual equity shares at *institution* level for balanced funds in *Morningstar*, and run panel local projection with shift-share to test if $\beta_h \neq 0$ (Jordà '05, Chodorow-Reich-Nenov-Simsek '21)

Equity shares at fund-level: data

Fund holdings

- **Morningstar**: monthly mutual funding holdings
- Mandated funds identified from names, and investment styles
  - 691 funds in sample (2004Q4 – 2019Q3)
  - Average (/Median) AuM is $252bn (/$6bn)

Shocks and security information

- Monetary shocks aggregated to monthly level (Gertler-Karadi '15)
- Asset class: Classification of Financial Instruments code from **CUSIP Master File** (ISO 10962)
  - Bond, equity, mutual funds, etc.
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Top 10 AuM by Institutional Categories, December 2004

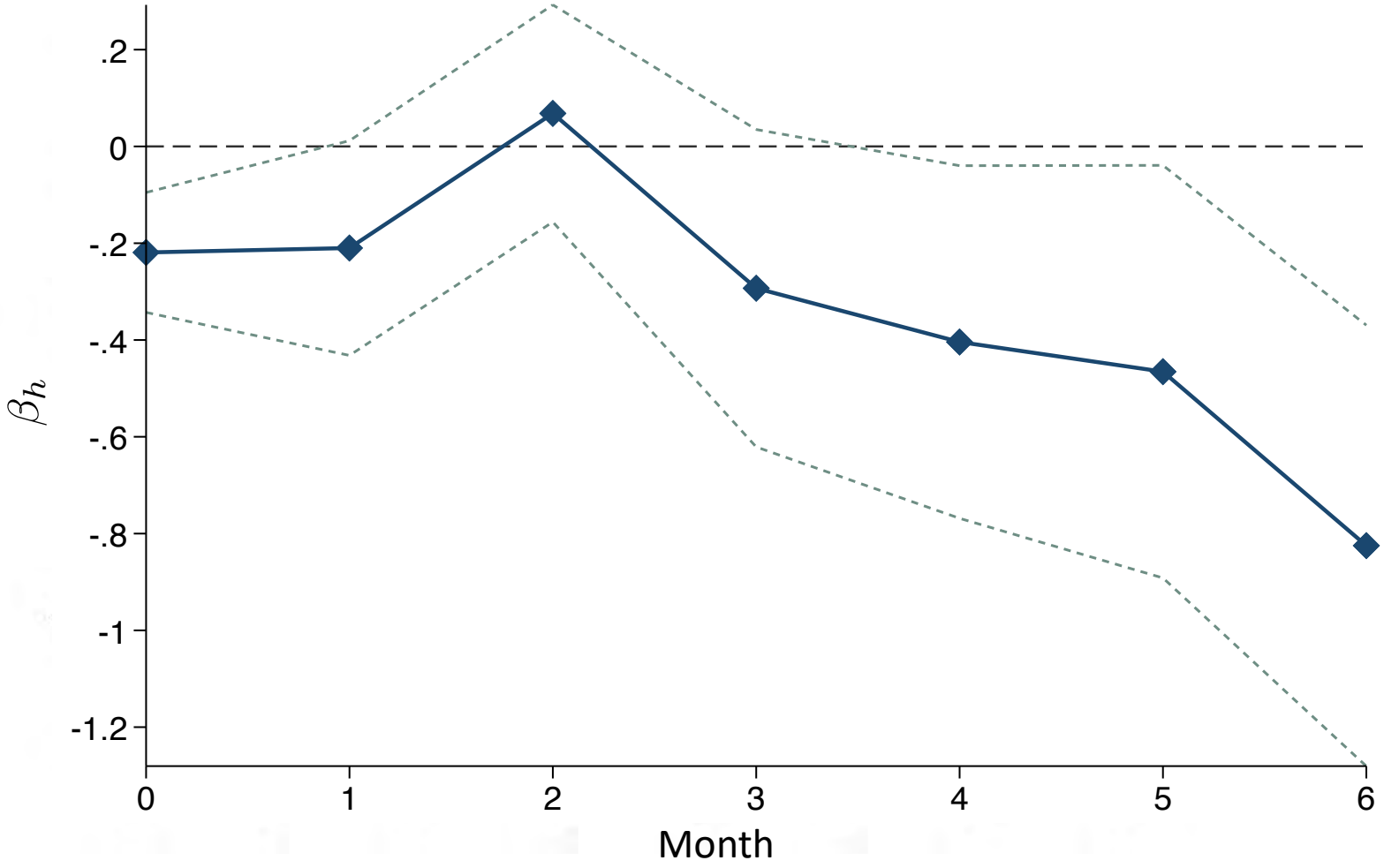
Category	AuM ($bn)	N	Equity Share	Bond Share
Target Date 2026-2030 Moderate	54.75	5	86.7%	4.5%
Target Date 2016-2020 Moderate	55.02	5	84.4%	6.8%
Target Date 2000-2010 Aggressive	100.30	2	74.8%	13.5%
Moderate Allocation	124.81	75	64.6%	27.5%
Target Date Retirement Income Moderate	128.51	3	82.0%	8.2%
Target Date 2041-2045 Moderate	133.95	2	72.5%	10.9%
Target Date 2011-2015 Moderate	136.26	2	71.7%	11.8%
Target Date 2031-2035 Moderate	144.53	3	80.2%	5.5%
Target Date 2021-2025 Moderate	144.55	3	80.2%	5.5%
Target Date 2000-2010 Moderate	153.79	4	83.6%	4.9%

Top 10 AuM by Institutional Categories, September 2019

Category	AuM ($bn)	N	Equity Share	Bond Share
Moderate Allocation	1186.08	44	61.4%	28.2%
Target Risk	1345.07	6	71.8%	14.5%
Target Date 2050+ Aggressive	1746.20	12	63.4%	16.6%
Target Date 2036-2040 Moderate	3662.35	11	72.2%	18.8%
Target Date 2041-2045 Moderate	3739.63	13	72.9%	17.3%
Target Date 2031-2035 Moderate	3740.38	12	71.1%	18.7%
Target Date 2026-2030 Moderate	3849.43	12	69.4%	20.5%
Target Date 2016-2020 Moderate	3921.22	13	67.9%	21.2%
Target Date 2021-2025 Moderate	3955.83	13	68.0%	21.0%
Target Date 2050+ Moderate	11333.84	40	73.7%	15.7%

Results

- Active rebalancing: $\theta_{f,t+h} - \check{\theta}_{f,t-1\to t+h} = \beta_h \left[\theta_{f,t-1}(1-\theta_{f,t-1})MS_t\right] + \boldsymbol{\varphi}' \boldsymbol{X}_{f,t+h} + \epsilon_{f,t-1\to t+h}$

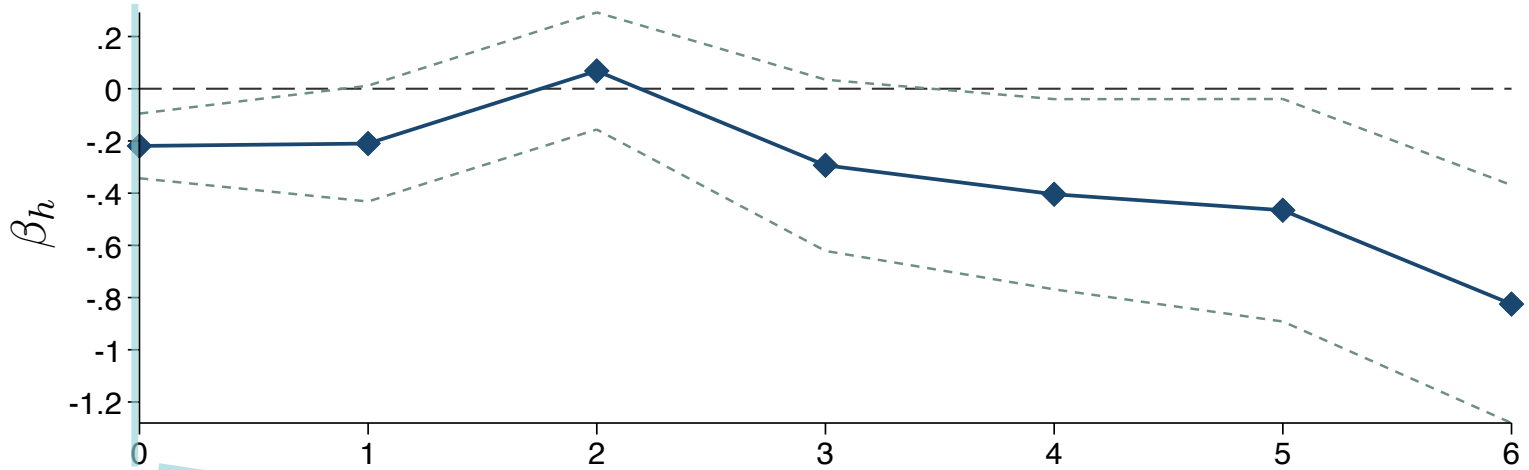


- Controls include 4 lags of main variables plus fixed effects
- 95% CI
- Standard errors clustered at fund level

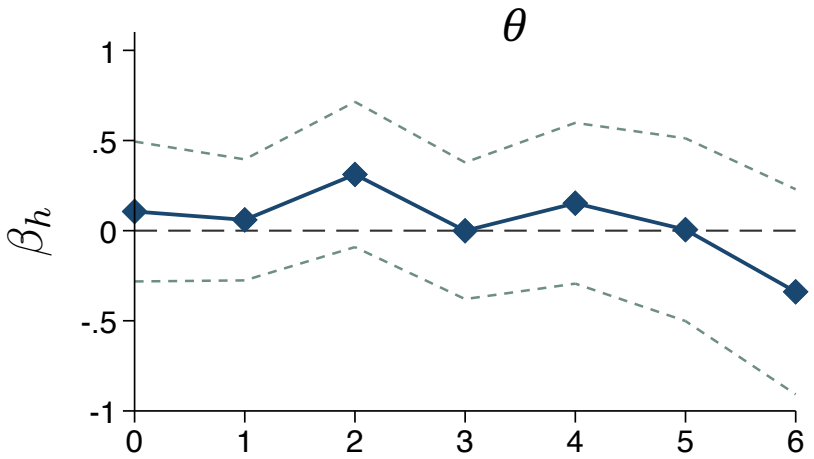
Results

Counterfactual equity shares

- Active rebalancing: $\theta_{f,t+h} - \check{\theta}_{f,t-1\to t+h} = \beta_h \left[\theta_{f,t-1}(1-\theta_{f,t-1})MS_t\right] + \boldsymbol{\varphi}' \boldsymbol{X}_{f,t+h} + \epsilon_{f,t-1\to t+h}$



- Equity shares:



- Rebalancing flows at t = 0 :

$$\bar{\theta} \cdot (1-\bar{\theta}) \cdot \overline{AuM} \cdot \hat{\beta}_0 \cdot 10bp$$
$$\approx 0.64 \cdot 0.36 \cdot 11.5tn \cdot (-0.22) \cdot 10bp$$
$$\approx -58bn(\$)$$