Institutional Corporate Bond Pricing

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Motivation

- As of 2021, the total value corporate bonds outstanding in the U.S. was around $10 trillion

  The corporate bond market is thus both

  - one of the major sources of funding for U.S. corporations
  - a major asset class for investors

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  - a major asset class for investors
- There is no shortage of quantitative corporate bond pricing models
  - structural models / intensity-based models / factor models
- These models are mostly at least implicitly based on a **representative investor**

Who is the Representative Investor in Corporate Bond Markets?

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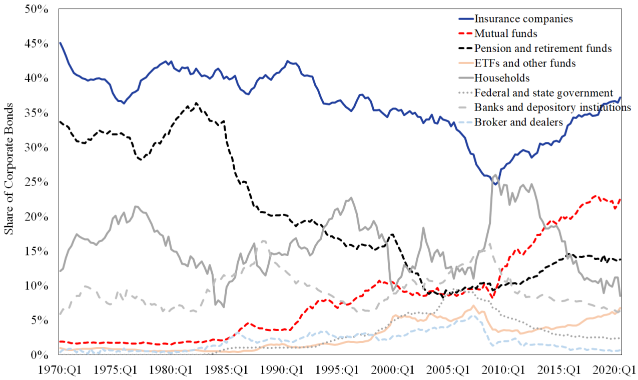

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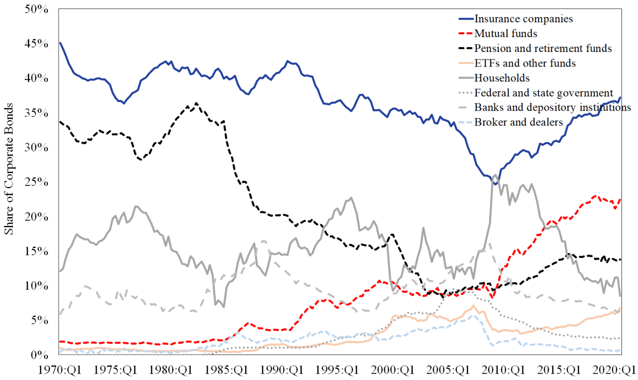

- The share held by the ”representative” household is relatively small
- Corporate bond market is dominated by institutional investors

What We Do

- In the spirit of Koijen and Yogo (2019), we evaluate a demand-based approach to corporate bond pricing in equilibrium
- We compile a rich dataset of institutional investors' bond holdings
- We estimate institutions' bond demand functions by linking their holdings to bond characteristics
- We document **significant differences** between demand functions of different institutional investors
- We evaluate counterfactual equilibrium prices induced by hypothetical movements in interest rates, credit quality, Fed interventions, and mutual fund redemptions

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Our results highlight the composition of institutional demand as an important state variable for corporate bond pricing

Data Sources and Sample Construction

We construct a rich and novel dataset that links institutional corporate bond holdings to bond yields, returns, and characteristics.

Our sample combines data from three sources:

- Monthly prices, yields, and ratings for corporate bonds → WRDS Bond Returns (built from transaction level data from TRACE)
- Quarterly holdings data of bonds → Thomson Reuters eMAXX
  - eMAXX provides comprehensive coverage of fixed income holdings by asset managers and institutional investors at the security level
  - The database predominantly covers the holdings of insurance companies, mutual funds, and pension funds (Becker and Ivashina (2015))
- Bond and issuer characteristics (maturity, coupon rate, currency, etc) → Fixed Income Securities Database (FISD)

Market Coverage

Year	Number of Institutions	% of Market Held	AUM (USD Million)		Number of Bonds Held	
			Median	90th Percentile	Median	90th Percentile
2006	1281	49	54	629	48	162
2007	1360	45	55	623	51	168
2008	1570	45	55	618	53	182
2009	1972	46	59	639	57	212
2010	2036	50	63	726	58	216
2011	2172	48	65	757	60	229
2012	2444	49	68	770	64	236
2013	2486	48	71	831	68	252
2014	2622	47	70	853	67	258
2015	2676	46	70	872	69	278
2016	3260	45	67	792	68	282
2017	3666	48	69	848	74	305
2018	3297	45	72	879	79	331
2019	3960	45	68	806	78	328
2020	3478	44	76	983	86	377

Financial institutions in our sample hold roughly 50% of the bond outstanding. The number of institutions increases from 1,281 at the start (Q1 2006) to 3,478 by the end of the sample period (Q3 2020).

Characteristics-Based Equilibrium Bond Pricing

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Characteristic-Based Demand

- We write the portfolio weight of investor i in bond n as a function of the yield $y_t(n)$, a vector of characteristics $\mathbf{x}_t(n)$, and latent demand $u_{i,t}(n)$ (Koijen and Yogo (2019))

$$\ln \frac{w_{i,t}(n)}{w_{i,t}(0)} = \ln \delta_{i,t}(n) = \alpha_i + \beta_{0,i} y_t(n) + \beta_{1,i}' \mathbf{x}_t(n) + u_{i,t}(n)$$

- Bond characteristics (time to maturity, liquidity, offering amount, ratings) capture key sources of risk and other determinants of demand

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Market Clearing

- Market value $M_t(n)$ of bond n must equal the wealth-weighted sum of portfolio weights across all investors

$$M_t(n) = \sum_{i=1}^{I} A_{i,t} w_{i,t}(n)$$

Instrumental Variable Estimation

Idea: Rely on investment mandates

- Institutions can only invest in bonds that belong to their investment universe (e.g., Vanguard corporate bond index fund)

98% of bonds that are currently held by an institution were also held in the previous 3 years

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Instrumented yields:

$$\widehat{y}_{i,t}(n) = \log\left(\sum_{j \neq i} A_{j,t} \frac{\mathbb{1}_j(n)}{1 + \sum_{m=1}^{N} \mathbb{1}_j(m)}\right)$$

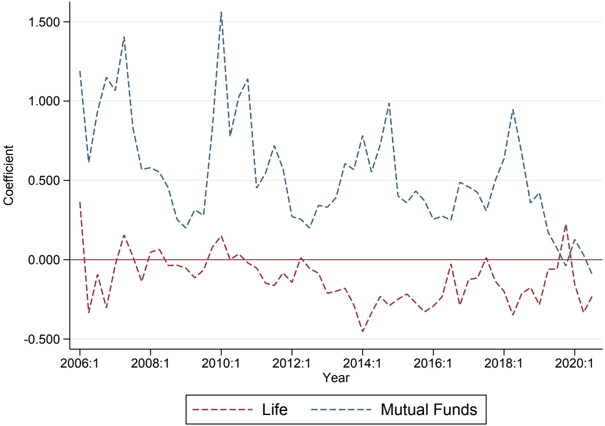
A larger exogenous component of demand generates higher prices and, hence, lower yields that are unrelated to latent demand.

Demand Heterogeneity

	Insurance		Mutual Funds		Others	
	Life	P&C	Traditional	Variable Annuity	Others & Pension	Foreign
	I	II	III	IV	V	VI
$\overline{Yield}_{b,t}$	-0.134**	0.134	0.337***	0.379***	0.459**	0.277***
	(0.062)	(0.111)	(0.078)	(0.068)	(0.204)	(0.054)
$Maturity_{b,t}$	0.062**	-0.043	-0.065***	-0.096***	-0.094	-0.018*
	(0.025)	(0.027)	(0.018)	(0.012)	(0.059)	(0.009)
$Bid\text{-}Ask_{b,t}$	0.018*	-0.047	-0.065***	-0.092***	-0.081**	-0.113***
	(0.010)	(0.033)	(0.018)	(0.020)	(0.034)	(0.018)
$Issuance\ Size_{b,t}$	0.079***	0.057***	0.271***	0.169***	0.082***	0.159***
	(0.013)	(0.010)	(0.024)	(0.029)	(0.013)	(0.014)
$Rating_{b,t}$	-0.048*	-0.215***	-0.103***	-0.218***	-0.268***	-0.146***
	(0.026)	(0.044)	(0.033)	(0.038)	(0.056)	(0.041)
Fund × Quarter Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6,873,182	3,314,272	5,044,257	1,354,470	364,796	1,754,718
Adjusted R-squared	0.04	0.05	0.11	-0.09	-0.19	-0.11
Kleibergen-Paap F-statistic	283.91	293.63	59.81	165.58	82.25	207.55

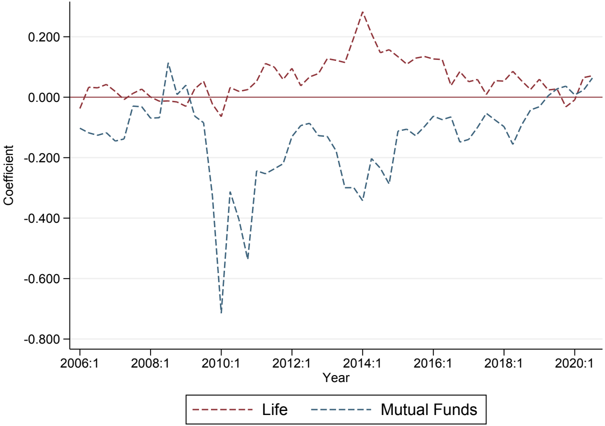
Significant heterogeneity in magnitudes and signs of estimated demand parameters across institutions

Yield Elasticity



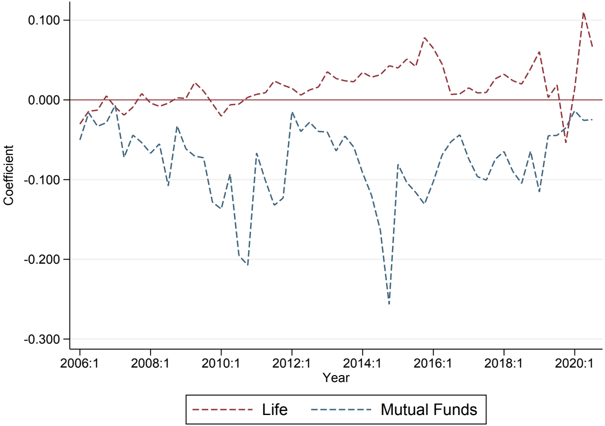
Demand is downward-sloping for life insurers up until 2011 and becomes upward-sloping after 2011 with respect to bond prices.

Time to Maturity Elasticity



Mutual funds tilt their portfolios toward bonds with shorter maturities. In contrast, insurance companies tilt toward longer maturity bonds.

Bid-Ask Spread Elasticity



Mutual funds act as consumers of liquidity in bond market. In contrast, insurers, driven by the preference for illiquid bonds, act as liquidity providers.

Counterfactual Equilibrium Simulations

In equilibrium, bond prices are fully determined by

- bond supply $\mathbf{s}_t$
- bond characteristics $\mathbf{x}_t$
- the wealth distribution given by asset under management of all investors $\mathbf{A}_t$
- the estimated coefficients on characteristics $\boldsymbol{\beta}_t$
- latent demand u_t

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Formally,

$$\mathbf{p}_t = \mathbf{g}\left(\mathbf{s}_t, \mathbf{x}_t, \mathbf{A}_t, \boldsymbol{\beta}_t, u_t\right).$$

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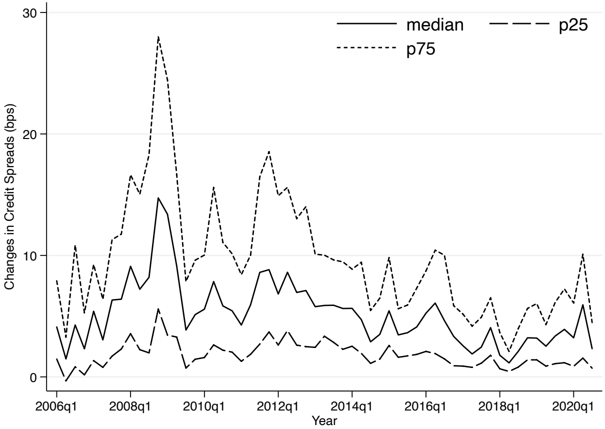
$$\mathbf{p}_t = \mathbf{g}\left(\mathbf{s}_t, \mathbf{x}_t, \mathbf{A}_t, \boldsymbol{\beta}_t, u_t\right).$$

In counterfactuals, we can change, for example, the wealth distribution from $\mathbf{A}_t$ to $\mathbf{A_t^{CF}}$ and calculate the associated corporate bond price changes as

$$\Delta\mathbf{p}_t = \mathbf{g}\left(\mathbf{s}_t, \mathbf{x}_t, \mathbf{A_t^{CF}}, \boldsymbol{\beta}_t, u_t\right) - \mathbf{g}\left(\mathbf{s}_t, \mathbf{x}_t, \mathbf{A}_t, \boldsymbol{\beta}_t, u_t\right)$$

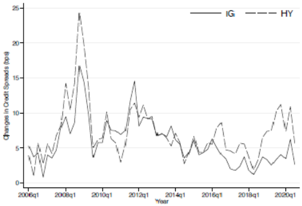
Counterfactual: Run on Large Bond Mutual Funds



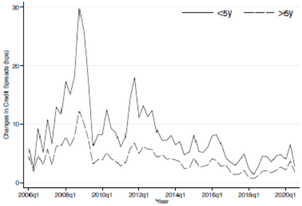
- Largest mutual funds experience a 20% outflow in AUM - redistributed proportionally to all remaining investors

Counterfactual: Run on Bond Mutual Funds: Heterogeneity

(a) High yield vs investment grade bonds.



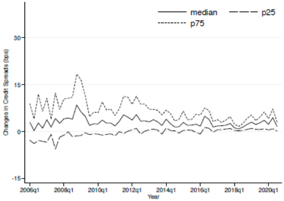
(b) Short- vs long-term bonds.



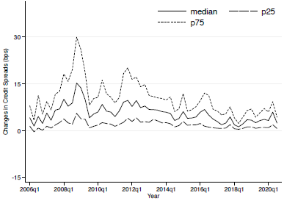
- Impact on shorter term and high yield bonds larger - remaining investors are more reluctant to absorb them

Counterfactual: Run on Bond Mutual Funds: Who provides Liquidity?

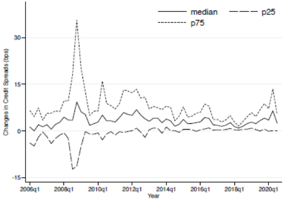
(a) Mutual funds buy.



(b) Insurance companies buy.



(c) Other investors buy.



- Preferences of liquidity providers determine price responses and disruptions in corporate bond markets

Interest Rate Liftoff

	Counterfactual Changes in Credit Spreads						
	AAA	AA	A	BBB	BB	B	CCC
A. Changes in Demand Functions							
$<$ 5 years	28	30	34	39	39	36	35
5 - 10 years	12	13	15	16	16	19	17
$>$ 10 years	4	6	7	7	5	6	4
B. Changes in AuM							
$<$ 5 years	1	0	-1	0	3	4	2
5 - 10 years	0	0	-1	0	2	3	0
$>$ 10 years	-1	0	-1	-1	0	0	2
C. Changes in Demand Functions & AuM							
$<$ 5 years	22	26	28	32	37	35	31
5 - 10 years	9	11	12	13	16	18	19
$>$ 10 years	2	5	4	4	4	4	6

- How would equilibrium prices shift if short rates were to rise by 100bps?
- Exploit time-series variation of estimated coefficients and AUM with respect to fed funds rate
- Small effects of redistributing AUM as those are absorbed by inelastic life insurers

Fed Bond Facility Tapering

	Counterfactual Credit Spreads			
	AAA	AA	A	BBB
All	25	29	46	104
$<$ 3 years	23	25	42	94
$>$ 3 years	32	42	57	125
	Credit Spreads Changes			
	AAA	AA	A	BBB
All	2	2	2	2
$<$ 3 years	2	2	3	2
$>$ 3 years	2	1	1	1

- What if the Fed sold off all corporate bonds purchased under the Secondary Market Corporte Credit Facility (SMCCF)?

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- What if the Fed sold off all corporate bonds purchased under the Secondary Market Corporte Credit Facility (SMCCF)?
- A: Nothing!

Conclusion

- We find significant heterogeneity in demand elasticities across the main players in the corporate bond market
- Our results emphasize the relevance of the composition of institutional demand as an important state variable for corporate bond pricing
- Our model predicts substantial disruptions in corporate bond prices for impending interest rate changes through shifts in institutional demand
- In equilibrium, such disruptions are reflected in the real economy through firms' financing decisions

Appendix

Rating Distribution

Rating	Overall Market	Holdings Data	Holdings By Institution Type		
			Insurers	Mutual Funds	Others
	I	II	III	IV	V
AAA	2.0%	1.4%	0.8%	0.3%	0.3%
AA	9.7%	7.7%	4.9%	1.9%	0.9%
A	34.1%	34.6%	25.0%	7.1%	2.5%
BBB	37.7%	41.8%	27.9%	10.8%	3.2%
BB	8.2%	7.7%	2.8%	3.8%	1.1%
B	5.7%	5.2%	1.0%	3.3%	0.9%
CCC	2.1%	1.4%	0.2%	1.1%	0.2%
CC	0.1%	0.1%	0.0%	0.1%	0.0%
C	0.1%	0.0%	0.0%	0.0%	0.0%
D	0.2%	0.1%	0.0%	0.1%	0.0%
Total	100.0%	100.0%	62.6%	28.4%	9.0%

Comparison between the distribution of the bonds outstanding with the distribution of bond holdings, show that the holdings in our sample are not skewed towards a particular rating category.

Maturity Distribution

Maturity	Overall Market	Holdings Data	Holdings By Institution Type		
			Insurers	Mutual Funds	Others
	I	II	III	IV	V
Less than 5 Years	44.6%	34.6%	20.0%	12.2%	2.5%
5 to 10 Years	30.9%	36.6%	22.4%	11.5%	2.7%
10 to 30 Years	23.5%	27.7%	19.6%	4.6%	3.5%
Greater than 30 Years	1.0%	1.0%	0.6%	0.2%	0.2%
Total	100.0%	100.0%	62.6%	28.4%	9.0%

Holdings in our sample constitutes of 35% short, 37% medium, and 28% long maturity bond.

Instrument

we instrument the yield of bond n by

$$\widehat{y}_{i,t}(n) = \log\left(\sum_{j \neq i} A_{j,t} \frac{\mathbb{1}_j(n)}{1 + \sum_{m=1}^{N} \mathbb{1}_j(m)}\right)$$

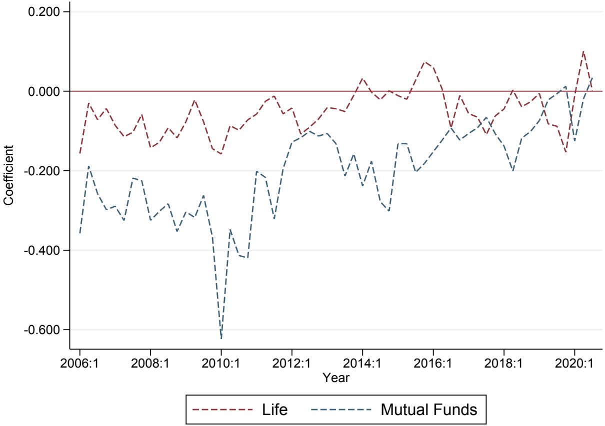
where $A_{i,t}$ is aum of investor i and the indicator function $\mathbb{1}_j(n)$ equals one if bond n belongs to investment universe of investor i

$\rightarrow$ Instrument depends only on the investment universe of other investors and the wealth distribution, which are exogenous under our identifying assumptions.

The instrument exploits variation in the investment universe across investors and the size of potential investors across assets
$\rightarrow$ An asset that is included in the investment universe of more investors, especially if those investors are large, has a larger exogenous component of demand.

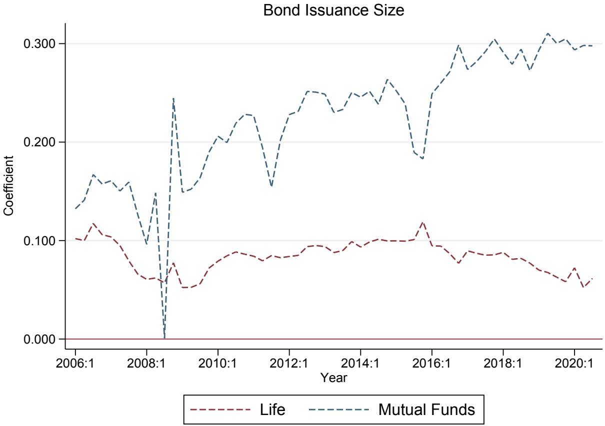
A larger exogenous component of demand generates higher prices and, hence, lower yields that are unrelated to latent demand.

Rating Elasticity



Corporate bond market is less segmented along credit rating as compared to other bond characteristics, such as maturity, liquidity, and bond size.

Issuance Size Elasticity



Mutual funds tilt portfolios toward bonds with higher offering amounts (large bonds). In contrast, insurance companies tilt toward smaller bonds.

Implementation

Many institutions have concentrated portfolios and cross section of holdings may not be large enough to accurately estimate demand equation.

Panel Estimation

- All financial institutions that belong to the same institution type (life, PC, mutual funds, variable annuities, and pension funds)
- AUM weighted IV regression

Pooled Estimation

- We estimate the coefficients by institution whenever there are more than 1,000 strictly positive holdings in the cross section.
- For institutions with fewer than 1,000 holdings, we pool them with similar institutions in order to estimate their coefficients.

Institutional Holdings by Type

Year	Number of Funds	% of Market Held	Fund AUM (USD Million)		Number of Bonds Held	
			Median	90th Percentile	Median	90th Percentile
Panel A: Life Insurers						
2006	518	38	103	1733	74	247
2020	696	18	120	2694	135	545
Panel B: P&C Insurers						
2006	430	5	36	257	29	95
2020	800	5	58	616	77	274
Panel C: Mutual Funds						
2006	196	4	46	320	43	104
2020	946	13	104	1199	88	388
Panel D: Variable Annuities						
2006	69	1	38	193	56	113
2020	201	1	84	496	113	339
Panel E: Others & Pension Funds						
2006	59	1	74	582	43	155
2020	42	1	265	3490	134	516
Panel F: Foreign						
2006	10	0	51	976	32	71
2020	793	7	47	472	46	237

Insurance companies hold around 40% of the total outstanding, whereas mutual funds hold around 4% at the start of the sample period. The share of the market held by mutual funds increase to 13% by the end of the sample period.

Demand Elasticities

	Mean	Median	p5	p95	sd
A. 2006:1 - 2020:3					
Life Insurers	0.50	0.49	-2.34	3.37	2.02
P&C Insurers	2.68	2.08	-0.81	6.29	3.37
Mutual Funds	11.62	9.85	5.74	19.78	5.49
Variable Annuities	7.24	7.02	3.38	12.26	4.16
Others & Pension Funds	7.51	5.75	1.73	16.38	5.50
Foreign Investors	4.76	3.65	0.30	10.58	4.73
AUM-weighted average	3.73				
B: 2010:1 - 2020:3					
Life Insurers	0.10	-0.01	-2.34	3.34	1.89
P&C Insurers	2.76	1.60	-1.19	8.29	3.89
Mutual Funds	11.50	10.39	6.16	18.31	5.26
Variable Annuities	8.11	8.10	4.31	12.28	4.46
Others & Pension Funds	8.06	5.72	1.73	18.24	6.32
Foreign Investors	3.42	3.13	0.30	7.60	2.61
AUM-weighted average	3.84				

- Demand elasticities consistent with with small effects of Fed bond sales

Aggregate Price Impact

Our estimated model allows us to estimate price impact of demand shocks for all bonds in our sample.

In particular, we estimate the price impact of idiosyncratic shocks to an investor's latent demand.

$$\frac{\partial \mathbf{p}_t}{\partial \log (u_{i,t})'} = \left(\mathbf{I} - \sum_{j=1}^{I} A_{j,t} \mathbf{H}_t^{-1} \frac{\partial \mathbf{w}_{j,t}}{\partial \mathbf{p}_t'} \right)^{-1} A_{i,t} \mathbf{H}_t^{-1} \frac{\partial \mathbf{w}_{i,t}}{\partial \log (u_{i,t})'}$$

- The (n, m)th element of this matrix is the elasticity of asset price n with respect to investor i's latent demand for asset m
- The matrix inside the inverse is the aggregate demand elasticity $\rightarrow$ **larger price impact for assets that are held by less elastic investors**
- The expression outside the inverse implies a **larger price impact for investors whose holdings are large relative to other investors that hold the asset**

Aggregate Price Impact

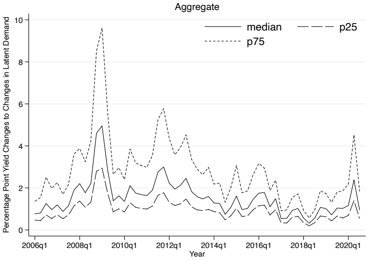


Figure: Yield Changes

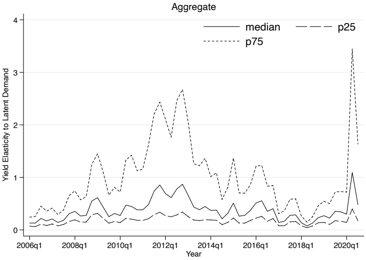


Figure: Yield Elasticity

Price impact was low before the financial crisis and increased during the financial crisis, and has remained high for most of the post-crisis period.