Whatever It Takes?
The Impact of Conditional Policy Promises

Valentin Haddad
UCLA & NBER

Alan Moreira
University of Rochester & NBER

Tyler Muir
UCLA & NBER

Kellogg
October 2023

Policy announcement $\rightarrow$ market infers **state-contingent plan**

This paper: measuring perception of the state-contingent response at announcement

Asset Purchases

- Fed announces purchases $\rightarrow$ asset price responds
  - QE during 2008 crisis, corporate bond purchases during the COVID-19 crash
- **View 1**: headline number taken at face value
  - Compare to price response

Asset Purchases

- Fed announces purchases $\rightarrow$ asset price responds
  - QE during 2008 crisis, corporate bond purchases during the COVID-19 crash
- **View 1**: headline number taken at face value
  - Compare to price response
- **View 2**: (implicit) promise: Fed will do more if conditions worsen
  - Price response driven by potential policy expansions (e.g., "policy put")
  - Future interventions are priced in
    - Distort asset price dynamics
    - Weak response to subsequent announcements
    - Distort inference of policy effectiveness

Why Promises Matter

Intense debate

- Useful tool: promise to do more if situation worsens stabilizes prices today (e.g. Draghi)
- Criticism: moral hazard, excessive risk taking $\rightarrow$ distortions
- Promises often ignored in analyzing policy effects (hard to measure)

Relevant in many other contexts

- Bank bailouts, yield curve or exchange rate control, expansionary fiscal policy, ...
- Explicit or implicit, voluntary or involuntary

What we do

Measure the state-contingent nature of announced policy

- **Simple framework to understand and quantify impact of state-contingent policy**
  - Role in announcement returns
  - Option prices reveal state-contingent policy impact
- **2020 Fed corporate bond purchases**
  - Downside support explains 1/2 of price recovery
  - Much larger intervention in bad states of the world
- **Pervasive presence of promises**
  - Quantitative easing (Fed, BoE, ECB), Bank of Japan stock purchases, 2008 equity injections

What we do

Measure the state-contingent nature of announced policy

- **Simple framework to understand and quantify impact of state-contingent policy**
  - Role in announcement returns
  - Option prices reveal state-contingent policy impact
- **2020 Fed corporate bond purchases**
  - Downside support explains 1/2 of price recovery
  - Much larger intervention in bad states of the world
- **Pervasive presence of promises**
  - Quantitative easing (Fed, BoE, ECB), Bank of Japan stock purchases, 2008 equity injections

Implications of the promise view for market dynamics

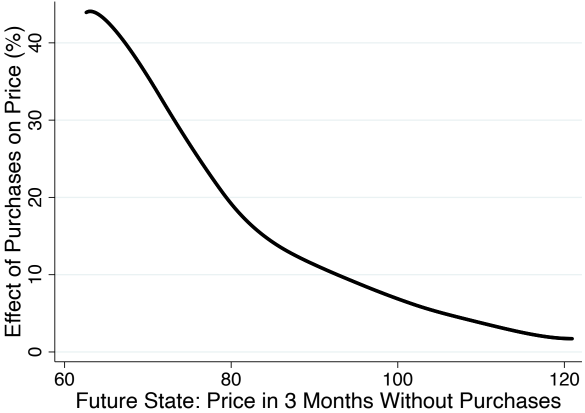
- **Hidden risks**: "too little" tail risk in corporate bond markets after COVID-19
- **Weakening QE announcement response** $\neq$ weakening effect of policy

Corp bond purchases, March 23rd 2020

- Fed announces purchase of IG corp bonds $\rightarrow$ prices $\uparrow$ 7-14%, $\approx$ \$0.5-1 trillion in value, ultimately purchase $\approx$ \$15 billion. Huge multiplier or implicit promise?

Corp bond purchases, March 23rd 2020

- Fed announces purchase of IG corp bonds → prices ↑ 7-14%, ≈ $0.5-1 trillion in value, ultimately purchase ≈ $15 billion. Huge multiplier or implicit promise?



- 30x larger price support in bad states (e.g. purchase 30x more than realized)

(Some) Related Literature

- Asset purchase announcements
  - QE: Krishnamurthy Vissing-Jorgensen (2011), Gagnon et al (2018), Bernanke (2020)...
  - Weakening announcement effects: Hesse Hofman Weber (2018), Meaning and Zhu (2011)
  - Corp bonds: Haddad Moreira Muir (2021), Boyarchenko Kovner Shachar (2021), ...
- (Implicit) policy promises: e.g., “Fed put” Cieslak Vissing-Jorgensen (2021), forward guidance (Nakamura McKay Steinsson 2016), ...
- Information from option prices
  - Kelly, Lustig, van Nieuwerburgh (2016), Kelly, Pastor, Veronesi (2016), Reis (2021), ...

Promises as Conditional Policy

Simple Example: No Promises

- Announcement at date 0, purchases at date 1
- Pre-Announcement: price p_0, p_1

$$p_0 = E[p_1]$$

  - $E[.]$: risk-neutral expectation
- Announcement: quantity of purchases Q

$$p_0' = E[p_1(1 + \mathcal{M}Q)] = p_0(1 + \mathcal{M}Q)$$

$$\frac{p_0' - p_0}{p_0} = \mathcal{M}Q$$

$\mathcal{M}$: effectiveness per unit policy

Simple Example: No Promises

- Announcement at date 0, purchases at date 1
- Pre-Announcement: price p_0, p_1

$$p_0 = E[p_1]$$

  - $E[.]$: risk-neutral expectation
- Announcement: quantity of purchases Q

$$p_0' = E[p_1(1 + \mathcal{M}Q)] = p_0(1 + \mathcal{M}Q)$$

$$\frac{p_0' - p_0}{p_0} = \mathcal{M}Q$$

$\mathcal{M}$: effectiveness per unit policy

  - Paper: model as in Vayanos Vila (2021), Fed absorb assets from specialists $\rightarrow$ low risk premia from date 1 on
  - E.g. $p_0' - p_0 = \$0.5\text{-}1$ trillion, $Qp_0 = \$15$ billion $\rightarrow \mathcal{M} = (p_0' - p_0)/(Qp_0) =$30-60

Simple Example: With Promises

Market may infer stronger intervention if conditions worsen

- Fed buys additional $Q_{promise}$ if $p_1 < \underline{p}$
- Distortion in announcement effect due to promises

$$\underbrace{\frac{p_0' - p_0}{p_0}}_{\text{Announcement return}} = \underbrace{\mathcal{M}\, Q}_{\text{Base effect}} + \underbrace{\mathcal{M}\, \frac{E[p_1 \mathbf{1}_{p_1 < \underline{p}}]}{E[p_1]}\, Q_{promise}}_{\text{(Implicit) promises}}$$

Simple Example: With Promises

Market may infer stronger intervention if conditions worsen

- Fed buys additional $Q_{promise}$ if $p_1 < \underline{p}$
- Distortion in announcement effect due to promises

$$\underbrace{\frac{p_0' - p_0}{p_0}}_{\text{Announcement return}} = \underbrace{\mathcal{M}\, Q}_{\text{Base effect}} + \underbrace{\mathcal{M}\, \frac{E[p_1 1_{p_1 < \underline{p}}]}{E[p_1]}\, Q_{promise}}_{\text{(Implicit) promises}}$$

  - E.g. $Q_{promise}/Q = 5$, $\frac{E[p_1 1_{p_1 < \underline{p}}]}{E[p_1]} = 20\%$, $\Rightarrow$ doubles announcement response

Simple Example: With Promises

Market may infer stronger intervention if conditions worsen

- Fed buys additional $Q_{promise}$ if $p_1 < \underline{p}$
- Distortion in announcement effect due to promises

$$\underbrace{\frac{p_0' - p_0}{p_0}}_{\text{Announcement return}} = \underbrace{\mathcal{M}\, Q}_{\text{Base effect}} + \underbrace{\mathcal{M}\, \frac{E[p_1 1_{p_1 < \underline{p}}]}{E[p_1]}\, Q_{promise}}_{\text{(Implicit) promises}}$$

  - E.g. $Q_{promise}/Q = 5$, $\frac{E[p_1 1_{p_1 < \underline{p}}]}{E[p_1]} = 20\%$, $\Rightarrow$ doubles announcement response
- No reaction at date 1 if promise fulfilled
  - Meaning and Zhu (2011), Hesse et al. (2018), etc: initial announcements of asset purchases in US / Europe have large effect, later stage announcements do not
  - Promise already "priced in"

Framework

- State-contingent impact of policy: price support function $g(.)$

$$p_1' = p_1(1 + g(p_1))$$

  - Ex: $g(p_1) = \mathcal{M}\left(Q + 1_{\{p_1 < \underline{p}\}} Q_{promise}\right)$
  - Policy not fixed number, but mapping from state of world to intervention
  - Focus on price space: states are values of price absent intervention
  - $g(p)$: total impact of policy in each state, doesn't separate $\mathcal{M}, Q$, or other types of policy mechanisms

Framework

- State-contingent impact of policy: price support function $g(.)$

$$p_1' = p_1(1 + g(p_1))$$

  - Ex: $g(p_1) = \mathcal{M}\left(Q + 1_{\{p_1 < \underline{p}\}} Q_{promise}\right)$
  - Policy not fixed number, but mapping from state of world to intervention
  - Focus on price space: states are values of price absent intervention
  - $g(p)$: total impact of policy in each state, doesn't separate $\mathcal{M}, Q$, or other types of policy mechanisms
- How to recover g from data?
  - Announcement effect gives $E[p_1' - p_1]/E[p_1] \approx E[g(p_1)]$
  - **Key idea: option prices reveal change in distribution from p_1 to $p_1' \rightarrow g(p_1)$**

Recovering Conditional Price Support: Assumptions

1. *The same risk-neutral distribution* $F : p_1 \to p_0$ *maps implementation date prices into announcement date prices before and after the announcement*
   - Pricing kernel *between dates 0 and 1* doesn't change over announcement
   - No assumption on relation of risk-neutral vs physical
   - Pricing kernel can change when purchases happen (from date 1 on) as in models (e.g. Vayanos Vila 2022)
   - Later: supporting evidence, generalization to endogenous pricing kernel
2. *Order-preserving policy: post-policy price* $p_1' = p_1 + g(p_1)$ *is increasing in* p_1
   - E.g., policy does not flip order of bad states and good states

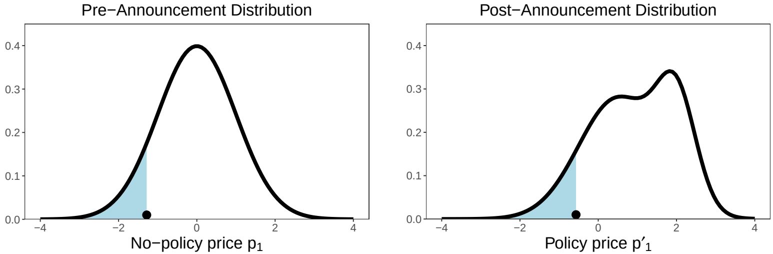
Theorem: under assumptions (1) and (2) option prices reveal unique $g(p)$

Recovering Conditional Price Support

1. Breeden Litzenberger 1978: Put/call prices across strikes reveal distributions of p_1 and p_1'
2. Solve function $g(.)$ that gets from one distribution to the other (transport problem)

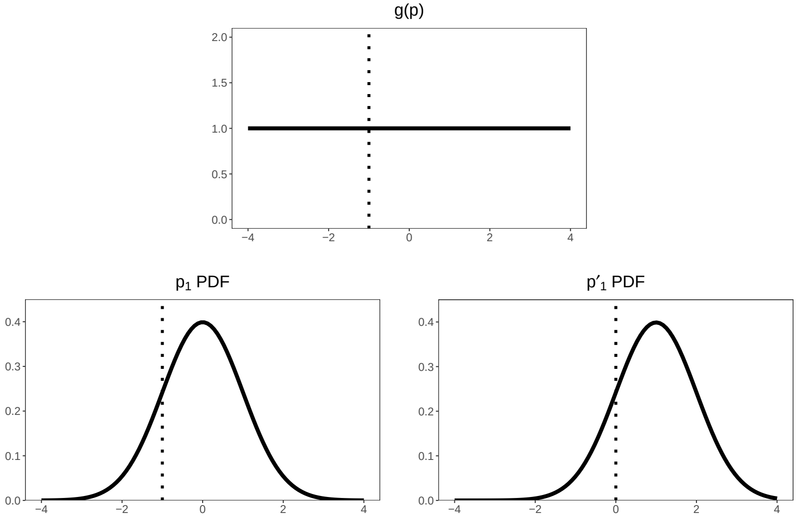
$$F_{p_1}(p_1) = F_{p_1'}(p_1(1+g(p_1))) \Rightarrow g(p_1) = [F^{-1}_{p_1'}(F_{p_1}(p_1)) - p_1]/p_1$$

- x-th percentile of p_1 maps to x-th percentile of p_1' ("Q-Q plot")



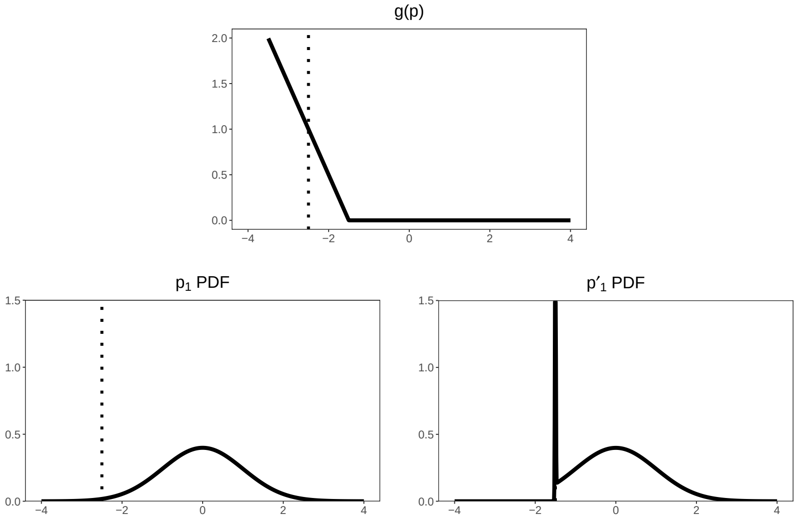
Example 1: Constant Policy

$p' = p + \mathcal{M}Q$



Example 2: Price Floor

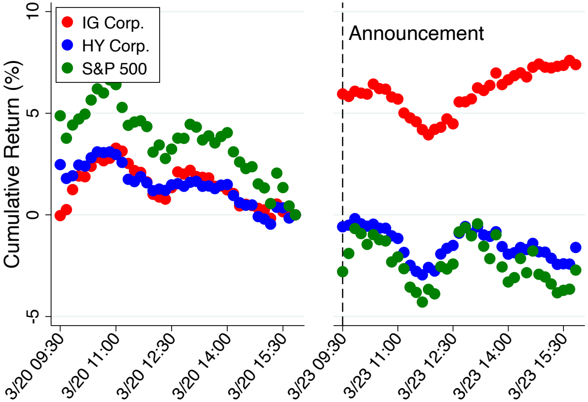
$p' = max(p, \underline{p})$



Fed Promises during 2020 Corporate Bond Purchases

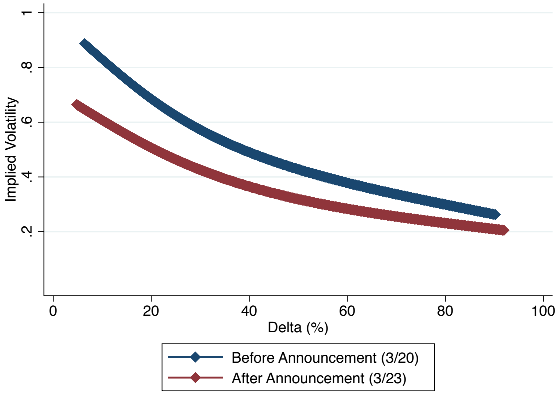
March 23: Fed Announces Corporate Bond Purchases

- Investment-grade (IG) ETF return 7% ≈ \$0.5 trillion mkt value
- 3 day return 14% ≈ \$1 trillion



Investment-Grade Bond Options

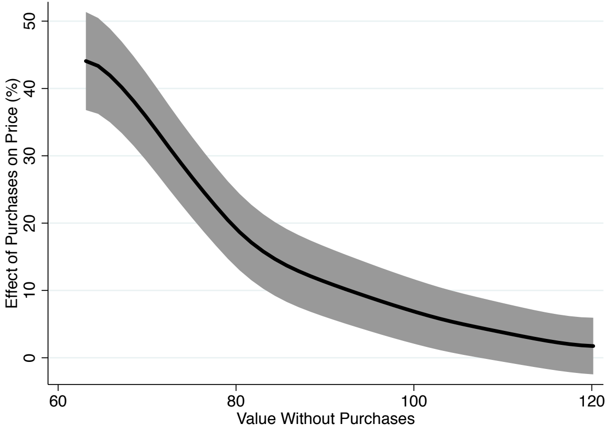
- LQD: largest investment-grade corporate bond ETF (by iShares)
- Volatility curve for 3 month LQD options before-after 3/23 announce (OptionMetrics)



$\rightarrow$ *largest volatility drop in the left tail*

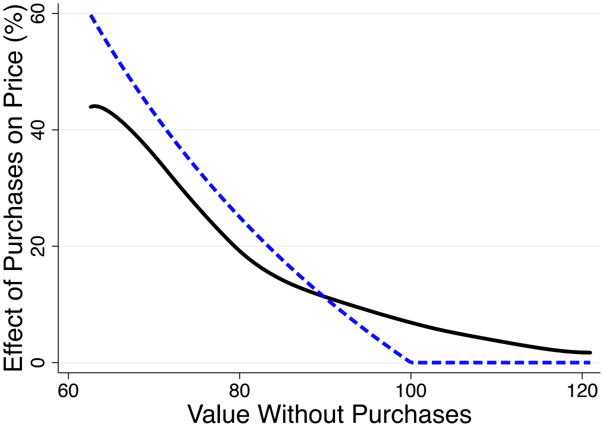
Impact of Conditional Fed Policy

- $g(p)$ in %: price change due to intervention as a function of no-policy state
  - Ex: if, absent policy, price dropped 20%, Fed would push up by additional $\approx$ 20%



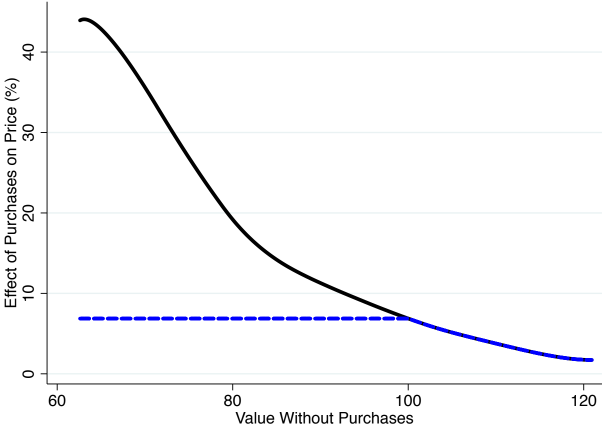
Policy Put

Left tail price support close to a price floor



(Re)Interpreting Announcement Effects

- What would the announcement return have been if $g(p) = g(p_{med})$ for $p \leq p_{med}$?



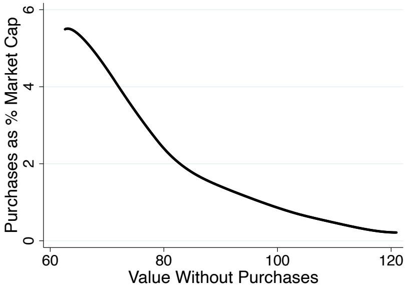
$\Rightarrow$ **53% of announcement return from conditional promises**

Interpreting Conditional Price Support

- Conditional effectiveness: $g(p) = \mathcal{M}(p)Q$
  - $Q_{realized}$ =0.2% mkt cap, in bad state $g = 40\%$ need $\mathcal{M}(bad)$=200, average $E[\mathcal{M}]$ =30

Interpreting Conditional Price Support

- Conditional effectiveness: $g(p) = \mathcal{M}(p)Q$
  - $Q_{realized}$ =0.2% mkt cap, in bad state $g = 40\%$ need $\mathcal{M}(bad)$=200, average $E[\mathcal{M}]$ =30
- Conditional quantity: $g(p) = \mathcal{M}Q(p)$, i.e., $\mathcal{M}$ constant
  - $g(p)$ informative about *relative* quantities, $\Rightarrow Q(bad)/Q(med) = 5$, $Q(bad)/Q(good) = 30$
  - Use realized price & $Q_{realized}$ =0.2% mkt cap $\Rightarrow \mathcal{M} \approx 8$, then do $Q(p) = g(p)/\mathcal{M}$



$\Rightarrow$ **Expect about \$500b purchases in bad states**

"Markets are functioning pretty well, so purchases will be at the bottom end of the range" (Powell, June 2020)

What About Changes in SDF?

- Potential concern: changing value of asset in given state could modify marginal utility in this state
  - Example: changing risk of asset between 0 and 1 modifies price of risk between 0 and 1

What About Changes in SDF?

- Potential concern: changing value of asset in given state could modify marginal utility in this state
  - Example: changing risk of asset between 0 and 1 modifies price of risk between 0 and 1
  - High-yield, S&P500 show no change, cuts against broad "macro-SDF" effects

What About Changes in SDF?

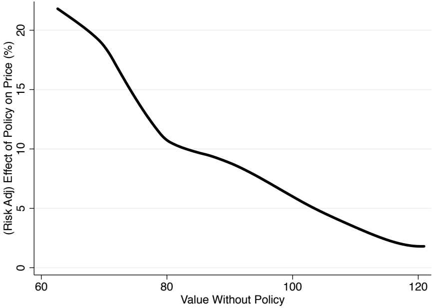
- Potential concern: changing value of asset in given state could modify marginal utility in this state
  - Example: changing risk of asset between 0 and 1 modifies price of risk between 0 and 1
  - High-yield, S&P500 show no change, cuts against broad "macro-SDF" effects
- Test remains valid under the null: If the **true** g **is constant**, generally recover correctly
  - Intuition: parallel shift in marginal utility, so no risk pricing effect
  - Formally: true for all SDF that can be written as $M = f(p_1'/p_0')\tilde{M}$, with $\tilde{M}$ containing exogenous sources of risks
  - Includes power utility, loss aversion, specialist or not, ...

Allowing an endogenous SDF

- Assume $M = \tilde{M}\frac{p_0'}{p_1'}$
  - Asset return p_1'/p_0' endogenous to intervention, $\tilde{M}$ arbitrary but invariant to announcement
    - If $\tilde{M} = 1$, specialized investor with log utility
  - Consistent with full model in the paper

Allowing an endogenous SDF

- Assume $M = \tilde{M}\frac{p_0'}{p_1'}$
  - Asset return p_1'/p_0' endogenous to intervention, $\tilde{M}$ arbitrary but invariant to announcement
    - If $\tilde{M} = 1$, specialized investor with log utility
  - Consistent with full model in the paper
- Price support adjusting for change in SDF



- *Aggressive risk-adjustment*: risk premium 20× unconditional avg for IG bonds

In which states was the Fed expected to buy?

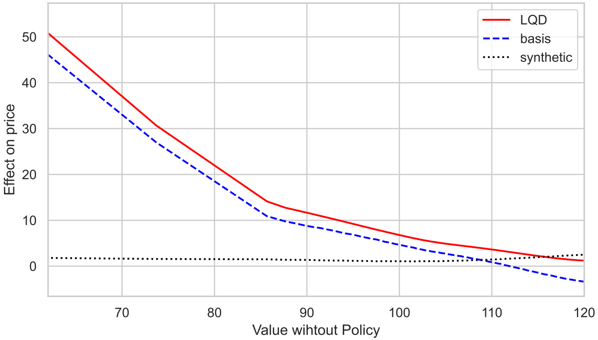
Low corp bond prices (high yields) from 3 channels:

$$\text{yield}_{corp} = \underbrace{\text{risk-free rate} + \text{credit risk premium}}_{synthetic\ corporate\ bond} + \text{dislocation}$$

1. Risk-free yield: Options on 10 year Treasury Futures
2. Credit risk: Options on IG CDS index
3. Dislocation: bond/CDS basis, copula method gives distribution

In which states was the Fed expected to buy?

Announcement works through reduction in dislocation/basis risk ⇒ **strongest intervention in high dislocation states**



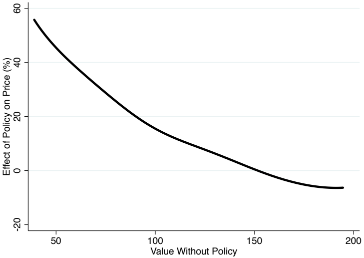
Powell: purchases depend on "market functioning"

Promises Everywhere: Evidence from Other Announcements

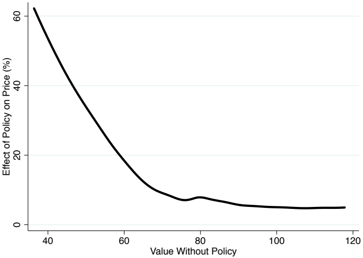
Additional Events

Event	**Fraction Explained by Promises**
High-Yield April 9th 2020	9%
Oct 13th 2008 (Paulson Plan)	37%
BoJ Purchase Speech	11%
US Quantitative Easing Events:	
Nov 25th 2008	2%
Dec 16th	14%
March 19th	14%
June 19th, 2013 (Tantrum)	9%
ECB Announcements:	
May 10, 2010	24%
Aug 7, 2011	26%
July 26, 2012	9%
Aug 2, 2012	39%
Sep 6, 2012	17%
Average	**18%**

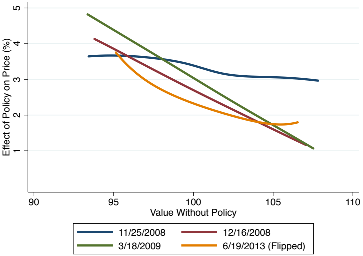
2008 US Financial Sector Bailout



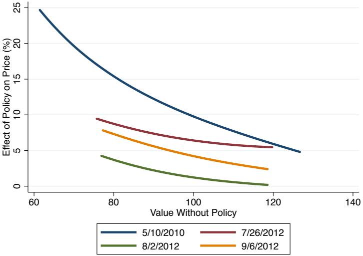
2013 Bank of Japan Equity Purchases



2008-2013 US Quantitative Easing



2010-2012 ECB Asset Purchases



Implications of Promises

1. Asset prices distorted even when no intervention
2. Weakening announcement response $\neq$ weakening policies

Hidden risks

Are corporate bond prices distorted after intervention is over?

- Markets may still price in future interventions in case of crash
- Challenge: relative to what?

Hidden risks

Are corporate bond prices distorted after intervention is over?

- Markets may still price in future interventions in case of crash
- Challenge: relative to what?

Three pieces of evidence, post June 2020:

1. Corporate bond tail risk (options) far less sensitive to equity market tail risk
2. Corp bond returns less sensitive to changes in VIX
3. Spreads low relative to pseudo-spreads from equity options (Culp Nozawa Veronesi, 2018)

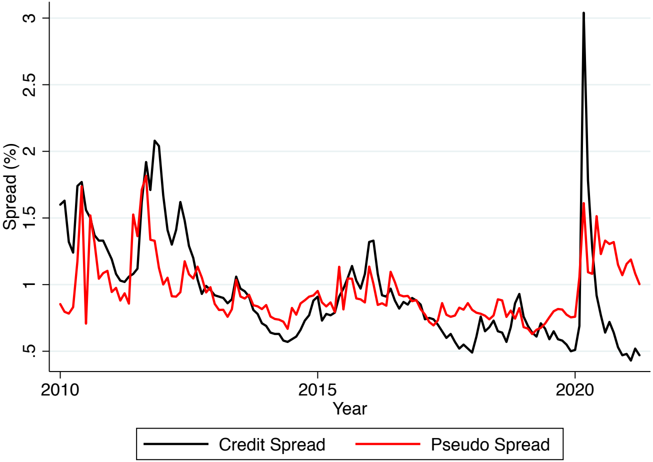
Corporate Bond and Stock Market Tail Risk

$$Tail_t^{CorpBond} = \alpha + \alpha_{post} \times post + \beta\ Tail_t^{SP500} + \beta_{post}\ Tail_t^{SP500} \times post + \varepsilon_t$$

	(1) $Tail_t^{CorpBond}$	(2) $Tail_t^{CorpBond}$
$Tail_t^{SP500}$	0.59***	0.43***
	(0.05)	(0.02)
$Tail_t^{SP500} \times post$	-0.78***	-0.63***
	(0.07)	(0.05)
$Tail_t^{SP500} \times covid$		0.68***
		(0.15)
$post$	0.16***	0.14***
	(0.01)	(0.01)
$covid$		-0.12***
		(0.03)
Constant	-0.04***	-0.02***
	(0.01)	(0.00)
Observations	2,769	2,769
R-squared	0.25	0.29

$Tail$ is slope of implied volatility 90-10 delta

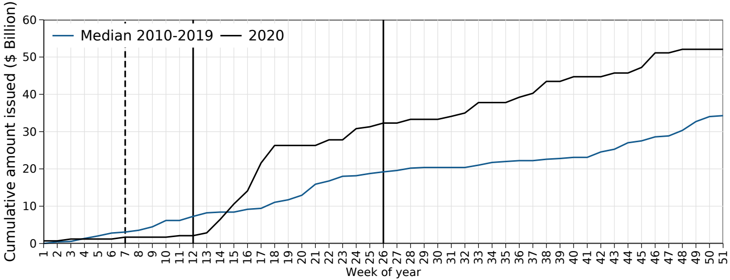
Corporate Bond Spreads vs Pseudo Spreads



- Correlation in changes near zero after interventions

Implications of Hidden Risks

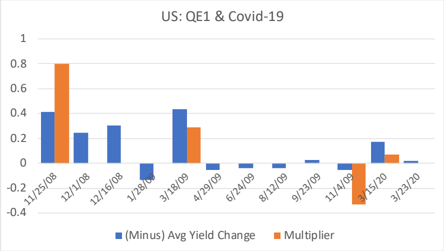
- Results support belief of future purchase in crash
  - rather than "one-time" small purchase with state-dependent $\mathcal{M}$ to explain option price patterns
- Announcement of purchase if crash today likely far less "effective" (priced in)
- Investment grade debt issuance: Boyarchenko Kovner Shachar 2021

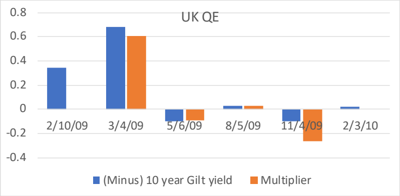


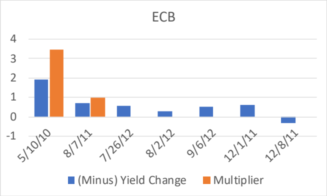
  - IG issuance boom but no HY issuance boom (Becker Benmelech 2021)

Weakening QE Announcement Effects

- Markets react strongly to initial QE announcements, but much less to later ones
  - Both for raw return (Meaning and Zhu (2011), Hesse et al. (2018),..) and implied multiplier







Weakening Announcement Response $\neq$ Weakening Policy

- Promise view explains weakening announcement without weakening policy
  - Markets form beliefs during initial event: *overestimate* multiplier
  - Expect later events based on state of economy: *underestimate* multiplier (Bernanke 2020)
- Alternative of time-varying multiplier less consistent with the data
  - Subsequent effects weak even in economic distress: U.S. QE∞ in 2020, or U.K. 2009
  - Key feature is *first* intervention: 2020 Canada vs U.S. 2020
- Markets behave as if asset purchase policies here to stay
  - Persistently large central bank balance sheets
  - Suggests focus on a "Taylor rule of asset purchases" instead of thinking of one-off responses

Conclusion

- **Measuring the state-contingent impact of policy announcements**
  - Easy-to-implement method using option prices
- **Markets systematically perceive promises when central banks step into markets**
  - Corporate bonds during COVID-19 Crisis
    - Much more price support in bad states
    - Big impact on announcement effect (50% comes just from extra left tail)
    - Persistent lower crash risk priced in corp bonds
  - Quantitative easing in Treasuries or stocks, support to financial system, etc.

APPENDIX

Pricing Assumption

Price of contract with payoff function $h(.)$:

- Before announcement:

$$\int h(p_1)dF(p_1)$$

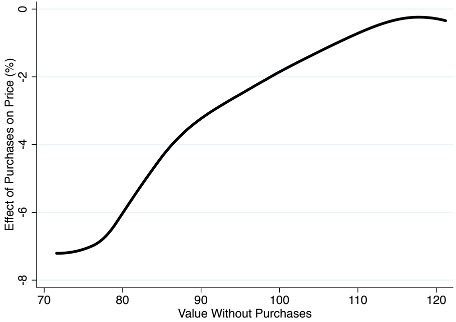
- After announcement:

$$\int h(\underbrace{p_1(1+g(p_1))}_{p_1'})dF(p_1)$$

▸ back

Comparison to High-Yield

- High-yield over same window falls, evidence against (broad) pricing kernel view



- Typically, HY and IG highly correlated w/ IG beta$\ll$1

Back

A model in the style of Vayanos and Vila (2021)

- Three dates: 0, 1, and 2. Risky asset pays $ln(X) \sim N(\mu_0, \sigma^2)$ at date 2

- Three agents: specialists, inelastic investors, and policy maker

- **Inelastic investors** have W_I dollars of risky asset, expected to sell B dollars of the asset in date 1

- **Specialist** has log-utility over wealth and chooses portfolio at date 0 and 1

- **Policy maker** announces at date 0 policy to purchase $Q(p_1)$ bonds at date 1

A model in the style of Vayanos and Vila (2021)

(1) Prices may be initially “dislocated” or depressed because of fears of future fire sales by inelastic investors rather than cash flows (though the source of depressed prices is effectively irrelevant)

(2) Purchases affect asset prices through their effect on future risk premiums, multiplier $\mathcal{M}$ determined by risk, risk-aversion and relative size of specialists

(3) Announcements of purchases affect prices immediately even if purchases happen later

(4) Non-contingent purchases of assets require no additional risk adjustment between announcement and purchase dates

(5) State-contingent purchases (state-dependent Q) can alter the pricing of risk between announcement and purchases through their effect on the risk of the asset.

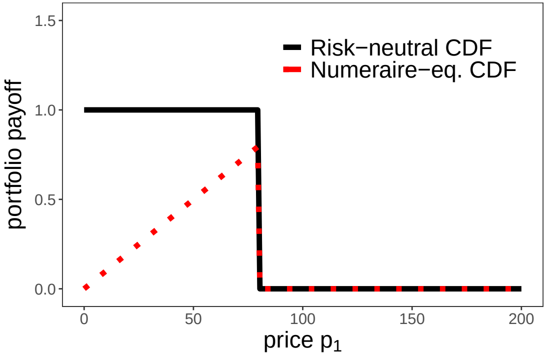
▸ Back

SDF Adjustment

- If SDF follows $M = R^{-1}\tilde{M}$, then $MR = \tilde{M}$ is invariant to announcement

SDF Adjustment

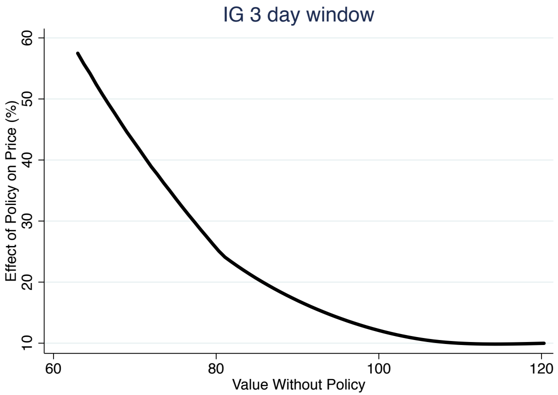
- If SDF follows $M = R^{-1}\tilde{M}$, then $MR = \tilde{M}$ is invariant to announcement
- Recovering the invariant distribution:
  - Risk-neutral measure: $E^{\mathbb{Q}}[X] = E[MR_f X] \rightarrow$ recovered from digital options
  - Numeraire-equivalent measure: $E^{\mathcal{N}}[X] = E[MRX] \rightarrow$ recovered using a different portfolio of options: digital minus put



back

Longer 3-day Window

- Pro: more time to digest announcement
- Con: identification, potentially other shocks



Corporate Bond ETFs

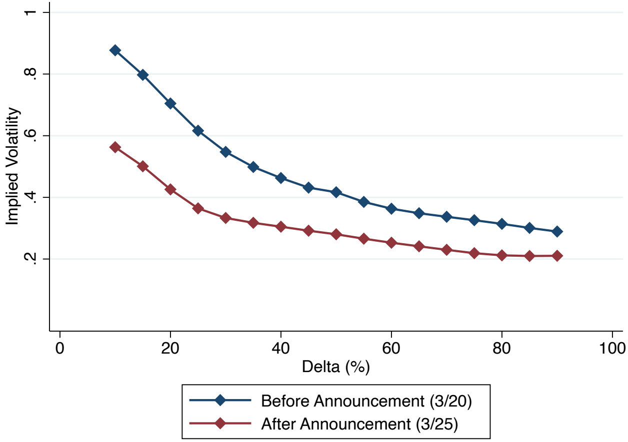
- Corp Bond ETFs $\approx$ \$500 billion assets.

- ETFs trade claims on basket of underlying bonds.

- Authorized Participants can convert ETF to bond basket (or issue ETF shares and deliver basket)
  - Mostly coincide with Primary Dealers

Investment Grade Bond Options

- Volatility curve for LQD options before and after announcement of SMCCF



→ *disproportionate volatility drop in the left tail*

Comparing Results to Statements

- "Markets are functioning pretty well, so our purchases will be at the bottom end of the range that we have written down" (Powell, June 2020)
    - Yes! 0.2% mkt cap would have been much higher if spreads widened

- "The announcement of the corporate bond facility without putting up one dollar of taxpayer money unlocked the entire primary and secondary market for corporate bonds" (Mnuchin, June 2020)
    - Selling a put option *does* put up taxpayer money in bad states, can't ignore just bc not in money ex-post

April 9th, 2020: High-Yield Purchases