Lecture 5 - Financial Frictions

UCLA - Econ 221 - Fall 2018

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Outline

1. Evidence
    - Bernanke and Blinder (1992)
    - Kashyap et al. (1993)
    - Kashyap and Stein (2000)
    - Mitchell et al. (2007)
    - Krishnamurthy and Vissing-Jorgensen (2011)
    - Gilchrist and Zakrajsek (2012)
    - Jiménez et al. (2014)
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    - Gertler and Karadi (2015)
    - Giroud and Mueller (2017)
2. Models
    - Benchmark: Deterministic Q-theory
    - Holmström and Tirole (1998)
    - Brunnermeier and Sannikov (2017)

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Bernanke and Blinder (1992) Abstract

We show that the interest rate on Federal funds is extremely informative about future movements of real macroeconomic variables. Then we argue that the reason for this forecasting success is that the **funds rate sensitively records shocks to the supply of bank reserves**; that is, the funds rate is a good indicator of monetary policy actions. Finally, using innovations to the funds rate as a measure of changes in policy, we present evidence consistent with the view that **monetary policy works at least in part through "credit" (i.e., bank loans)** as well as through "money" (i.e., bank deposit).

Results

TABLE 1—MARGINAL SIGNIFICANCE LEVELS OF MONETARY INDICATORS FOR FORECASTING ALTERNATIVE MEASURES OF ECONOMIC ACTIVITY: SIX-VARIABLE PREDICTION EQUATIONS

Forecasted variable	M1	M2	BILL	BOND	FUNDS
A. *Sample Period 1959:7–1989:12:*					
Industrial production	0.92	0.10	0.071	0.26	0.017
Capacity utilization	0.74	0.22	0.16	0.40	0.031
Employment	0.45	0.27	0.0040	0.085	0.0004
Unemployment rate	0.96	0.37	0.0005	0.024	0.0001
Housing starts	0.50	0.32	0.52	0.014	0.22
Personal income	0.38	0.24	0.35	0.59	0.049
Retail sales	0.64	0.036	0.33	0.74	0.014
Consumption	0.96	0.11	0.12	0.46	0.0052
Durable-goods orders	0.87	0.22	0.28	0.19	0.039
B. *Sample Period 1959:7–1979:12:*					
Industrial production	0.99	0.084	0.0092	0.61	0.0001
Capacity utilization	0.96	0.40	0.025	0.18	0.0003
Employment	0.57	0.41	0.0005	0.15	0.0004
Unemployment rate	0.56	0.88	0.0006	0.13	0.0000
Housing starts	0.34	0.17	0.73	0.72	0.11
Personal income	0.43	0.095	0.20	0.91	0.037
Retail sales	0.96	0.86	0.27	0.050	0.061
Consumption	0.79	0.017	0.010	0.050	0.0000
Durable-goods orders	0.080	0.030	0.014	0.0071	0.0002

Notes: For each forecasted variable, the entries across each row are the marginal significance levels for omitting six lags of the monetary-policy variable indicated in the column heading from an unrestricted ordinary-least-squares (OLS) prediction equation that also included a constant, six lags of the forecasted variable, and six lags of the CPI. Data are monthly. M1, M2, industrial production, employment, and housing starts are in log levels. Personal income, retail sales, and consumption are deflated and in log levels. The data are from the DRI database; see the Data Appendix for details. FUNDS is the Federal funds rate; BILL is the three-month Treasury bill rate; BOND is the ten-year government bond rate.

Results

- Fed Funds Rate is far and away the best predictive variable among the five considered.
- Superior to M1, M2, the Treasury bill rate.
- The Federal Reserve reduced its reliance on the Federal funds rate as an intermediate target in October 1979. Therefore, predictive power of the funds rate should have been even stronger in a subsample that ends in September 1979. This is what is found.
- Problems with Granger-causality tests to assess predictive power?
- A stylized example will illustrate the potential problem. Suppose, say, that M1 were truly an exogenous policy variable which moved the Treasury bill rate (BILL), which in turn moved the real economy. Then M1 might be insignificant in a regression that includes BILL, even though it is the genuine driving force.

Results

TABLE 2—VARIANCE DECOMPOSITIONS OF FORECASTED VARIABLES

Forecasted variable	Own lags	CPI	M1	M2	BILL	BOND	FUNDS
A. *Sample Period 1959:7–1989:12:*							
Industrial production	36.6	3.1	15.4	8.7	8.0	0.8	27.4
Personal income	39.7	1.3	21.0	3.5	9.5	1.7	23.3
Employment	38.9	7.0	10.5	0.6	9.8	2.7	30.6
Unemployment rate	31.9	7.2	10.5	0.6	9.9	1.9	37.9
Housing starts	28.8	1.4	3.9	1.8	38.6	14.3	11.2
Personal income	48.2	4.3	20.8	0.1	6.9	3.3	16.3
Retail sales	32.4	15.5	5.1	4.4	27.4	1.1	14.1
Consumption	18.2	13.1	16.0	2.2	28.4	5.3	16.8
Durable-goods orders	41.3	6.8	14.7	5.5	10.3	2.6	18.8
B. *Sample Period 1959:7–1979:9:*							
Industrial production	36.3	2.7	11.8	6.5	11.5	3.3	27.8
Capacity utilization	39.9	2.4	12.4	4.5	10.8	5.6	24.3
Employment	41.4	1.8	5.8	0.2	10.4	3.2	37.9
Unemployment rate	44.9	1.3	4.9	1.3	11.6	2.2	33.8
Housing starts	45.2	9.9	8.3	6.3	11.8	9.6	9.0
Personal income	34.5	17.7	7.0	0.5	11.9	14.9	13.4
Retail sales	49.2	6.0	9.9	2.7	16.7	4.1	11.2
Consumption	18.9	21.1	13.2	3.3	11.7	16.4	15.5
Durable-goods orders	41.9	1.2	16.9	5.8	7.9	7.4	18.9

Notes: Entries are the percentages of the variance of the forecasted variable accounted for by variation in the column variable at a 24-month horizon. Estimates are based on vector autoregressions with six monthly lags of each variable. The ordering of the variables in the variance decomposition is the same as the ordering (left to right) of the columns. M1, M2, industrial production, employment, and housing starts are in log levels. Personal income, retail sales, and consumption are deflated and in log levels. The data are from the DRI database; see the Data Appendix for details. FUNDS is the Federal funds rate; BILL is the three-month Treasury bill rate; BOND is the ten-year government bond rate.

Results

TABLE 2—VARIANCE DECOMPOSITIONS OF FORECASTED VARIABLES

Forecasted variable	Own lags	CPI	M1	M2	BILL	BOND	FUNDS
A. *Sample Period 1959:7–1989:12:*							
Industrial production	36.6	3.1	15.4	8.7	8.0	0.8	27.4
Personal income	39.7	1.3	21.0	3.5	9.5	1.7	23.3
Employment	38.9	7.0	10.5	0.6	9.8	2.7	30.6
Unemployment rate	31.9	7.2	10.5	0.6	9.9	1.9	37.9
Housing starts	28.8	1.4	3.9	1.8	38.6	14.3	11.2
Personal income	48.2	4.3	20.8	0.1	6.9	3.3	16.3
Retail sales	32.4	15.5	5.1	4.4	27.4	1.1	14.1
Consumption	18.2	13.1	16.0	2.2	28.4	5.3	16.8
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Employment	41.4	1.8	5.8	0.2	10.4	3.2	37.9
Unemployment rate	44.9	1.3	4.9	1.3	11.6	2.2	33.8
Housing starts	45.2	9.9	8.3	6.3	11.8	9.6	9.0
Personal income	34.5	17.7	7.0	0.5	11.9	14.9	13.4
Retail sales	49.2	6.0	9.9	2.7	16.7	4.1	11.2
Consumption	18.9	21.1	13.2	3.3	11.7	16.4	15.5
Durable-goods orders	41.9	1.2	16.9	5.8	7.9	7.4	18.9

Notes: Entries are the percentages of the variance of the forecasted variable accounted for by variation in the column variable at a 24-month horizon. Estimates are based on vector autoregressions with six monthly lags of each variable. The ordering of the variables in the variance decomposition is the same as the ordering (left to right) of the columns. M1, M2, industrial production, employment, and housing starts are in log levels. Personal income, retail sales, and consumption are deflated and in log levels. The data are from the DRI database; see the Data Appendix for details. FUNDS is the Federal funds rate; BILL is the three-month Treasury bill rate; BOND is the ten-year government bond rate.

Results

TABLE 3—MARGINAL SIGNIFICANCE LEVELS OF MONETARY INDICATORS FOR FORECASTING ALTERNATIVE MEASURES OF ECONOMIC ACTIVITY: SIX-VARIABLE PREDICTION EQUATIONS (SAMPLE PERIOD 1961:7–1989:12)

Forecasted variable	M1	M2	CPBILL	TERM	FUNDS
Industrial production	0.72	0.86	0.0049	0.55	0.86
Capacity utilization	0.50	0.71	0.0008	0.64	0.85
Employment	0.79	0.82	0.032	0.55	0.63
Unemployment rate	0.47	0.54	0.049	0.53	0.28
Housing starts	0.56	0.23	0.21	0.38	0.55
Personal income	0.40	0.29	0.020	0.37	0.76
Retail sales	0.59	0.16	0.48	0.96	0.41
Consumption	0.99	0.53	0.021	0.78	0.41
Durable-goods orders	0.60	0.52	0.021	0.96	0.39

Notes: See notes to Table 1. CPBILL is the difference between the six-month commercial paper rate and the six-month Treasury bill rate. TERM is the difference between the ten-year and one-year government bond rates.

Results

TABLE 4—VARIANCE DECOMPOSITIONS OF FORECASTED VARIABLES

A. *Sample period 1961:7–1989:12:*

Forecasted variable	M1	M2	CPBILL	TERM	FUNDS	OWN	CPI
Industrial production	13.5	19.6	10.7	11.3	6.6	34.3	4.0
Capacity utilization	17.0	8.7	14.2	7.1	18.7	32.5	1.7
Employment	16.1	8.6	13.1	8.0	11.6	37.3	5.3
Unemployment rate	6.8	0.9	14.1	7.9	18.5	45.0	6.8
Housing starts	13.5	3.8	1.3	47.4	2.7	30.5	0.8
Personal income	18.7	0.1	4.1	9.7	1.4	64.3	1.6
Retail sales	8.4	2.7	4.1	33.5	5.7	38.1	7.4
Consumption	24.9	1.4	2.5	36.9	5.6	22.5	6.2
Durable-goods orders	11.9	8.2	11.5	6.4	12.5	43.3	6.3

B. *Sample period 1961:7–1989:12:*

Forecasted variable	M1	M2	FUNDS	TERM	CPBILL	OWN	CPI
Industrial production	13.5	19.6	21.8	0.8	5.9	34.3	4.0
Capacity utilization	17.0	8.7	30.3	0.9	8.9	32.5	1.7
Employment	16.1	8.6	26.7	0.1	6.0	37.3	5.3
Unemployment rate	6.8	0.9	32.9	0.9	6.6	45.0	6.8
Housing starts	13.5	3.8	26.5	22.6	2.3	30.5	0.8
Personal income	18.7	0.1	11.0	2.6	1.6	64.3	1.6
Retail sales	8.4	2.7	30.6	9.8	3.0	38.1	7.4
Consumption	24.9	1.4	33.3	10.9	0.8	22.5	6.2
Durable-good orders	11.9	8.2	22.6	0.7	7.1	43.3	6.3

Notes: See notes to Table 2. CPBILL is the difference between the six-month commercial paper rate and the six-month Treasury bill rate. TERM is the difference between the ten-year and one-year government bond rates.

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Kashyap et al. (1993) Abstract

In this paper, we use the relative moments in **bank loans and commercial paper** to provide evidence on the existence of a **loan-supply channel** of monetary-policy transmission. We find that tighter monetary policy leads to a shift in firms' mix of external financing: **commercial paper issuance rises while bank loans fall**. This suggests that contractionary policy can indeed reduce loan supply. Furthermore, such shifts in loan supply seem to affect investment, even controlling for interest rates and output.

Results

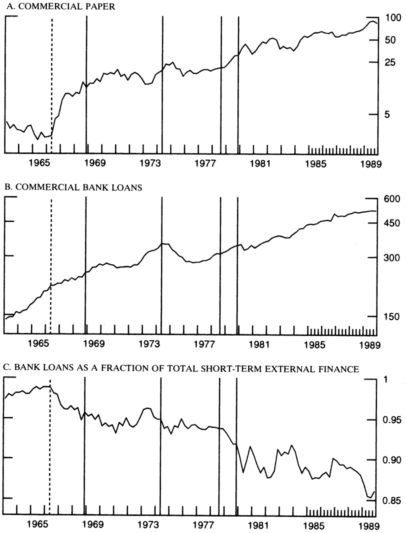

Figure 1. The Composition of Short-Term External Finance (Flow-of-Funds Data, Quarterly, 1963–1989)

Notes: Solid vertical lines mark Romer dates; the dotted line represents the 1966 credit crunch. Nominal values are deflated using the GNP implicit deflator. Commercial paper and bank loan values are in billions of 1982 dollars.

Results

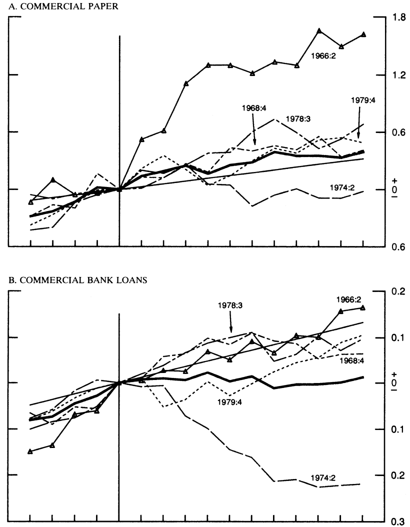

FIGURE 2. CHANGES IN SHORT-TERM EXTERNAL FINANCE AROUND ROMER DATES

Notes: All series are shown as log deviations from their values as of the Romer dates. Ticks along the *x*-axis mark quarters. Averages across Romer dates, excluding the 1966 episode, are shown by the bold lines in each panel. Average growth over 1963–1989 is shown as the straight line.

Results

C. BANK LOANS AS A FRACTION OF TOTAL SHORT-TERM EXTERNAL FINANCE

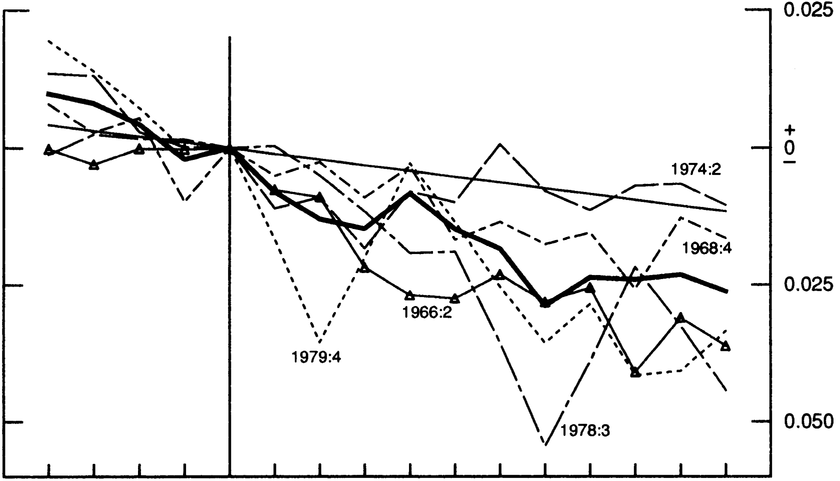

FIGURE 2. (*Continued*)

Results

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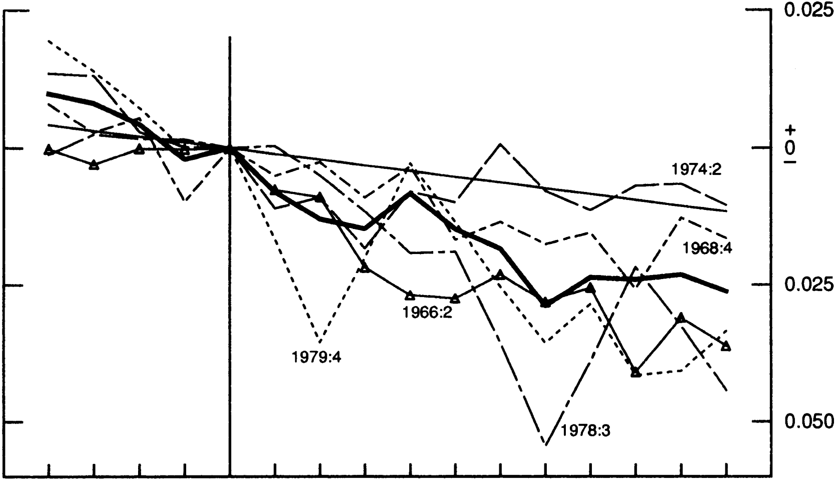

FIGURE 2. (*Continued*)

Results

TABLE 1—CAUSALITY TESTS BETWEEN FINANCING VARIABLES AND INDICATORS OF THE STANCE OF MONETARY POLICY

Indicator	Mix		Log real paper		Log real loans		Prime–CP spread	
	Exclusion	Summation	Exclusion	Summation	Exclusion	Summation	Exclusion	Summation
A. *Romer Date Indicators:*								
Romer dates (bivariate)	0.09	−2.10	0.84	0.61	0.17	−2.16	0.0002	2.17
Romer dates plus 1966 (bivariate)	0.08	−2.55	0.13	1.99	0.07	−1.99	0.002	2.27
Romer dates (multivariate)	0.02	−2.91	0.57	1.63	0.45	−1.02	0.0009	2.35
Romer dates plus 1966 (multivariate)	0.05	−3.02	0.07	2.96	0.12	−1.18	0.02	1.98
B. *Interest Rate Indicators:*								
Funds rate (bivariate)	0.003	−3.06	0.06	2.23	0.24	−1.46	0.001	4.10
Spread: 10-year government bond–funds (bivariate)	0.03	1.92	0.14	−1.10	0.55	1.61	0.003	−1.48
Funds rate (multivariate)	0.007	−1.92	0.20	1.35	0.58	−0.15	0.002	2.44
Spread: 10-year government bond–funds (multivariate)	0.04	2.36	0.10	−2.73	0.99	−0.48	0.028	−1.10

Notes: In each case, the variable at the top of the column is regressed against eight lags of itself and eight lags of the variable in the row. In the multivariate cases, eight lags of GNP growth are added to the regression. The following variables have been differenced so that they enter the regressions in stationary form: mix, log real paper, log real loans, prime–CP spread, and funds rate. Entries in the "exclusion" columns report the marginal significance levels on tests that variables shown in rows do not help forecast the variable at the top of the column. Entries in the "summation" columns report the *t* statistic for the test that the sum of the coefficients on the eight lags of the variable shown in the row is zero.

Results

Table 2—Tests for Explanatory Power of Mix and Prime–CP Spread in Structural Inventory and Investment Equations

	Mix			Prime–CP spread		
Category	Accelerator	Neoclassical	Q	Accelerator	Neoclassical	Q
Nondurable inventories	0.173	0.009	—	0.022	0.001	—
Durable inventories	0.002	0.049	—	0.500	0.302	—
Producer's durable equipment	10^{-6}	0.003	0.026	10^{-7}	0.003	0.027
Nonresidential structures	0.460	0.391	0.175	0.537	0.011	0.037

Notes: The number in each cell is the significance level in an F test that tests whether a distributed lag of either the mix or the prime–CP spread enters the inventory and investment equations described in the text. "Nondurable inventories" are inventories held by manufacturers, wholesalers, and retailers of nondurable goods; "durable inventories" are inventories held by manufacturers and wholesalers of durable goods.

Interpretation

- An unconditional correlation between the mix and real activity could arise if monetary policy moved the mix around but influenced the real economy solely through its effect on security-market interest rate.
- In the case of fixed investment, there are several well-known empirical models. We examine three: the "accelerator," the "neoclassical," and the securities-value (or "Q") models.
- The first, which we label the **"accelerator" model**, contains only the terms pertaining to **expected sales**.
- The second, labeled "neo-classical" in what follows, includes both the sales and interest-expense proxies.

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Kashyap and Stein (2000) Abstract

We study the monetary-transmission mechanism with a data set that includes **quarterly observations of every insured U.S. commercial bank from 1976 to 1993**. We find that the impact of monetary policy on lending is **stronger for banks with less liquid balance sheets**—i.e., banks with **lower ratios of securities to assets**. Moreover, this pattern is largely attributable to the **smaller banks**, those in the bottom 95 percent of the size distribution. Our results support the existence of a "bank lending channel" of monetary transmission, though they do not allow us to make precise statements about its quantitative importance.

Summary Statistics

TABLE 1—BALANCE SHEETS FOR BANKS OF DIFFERENT SIZES

Panel A: Composition of Bank Balance Sheets as of 1976 Q1	Below 75th percentile	Between 75th and 90th percentile	Between 90th and 95th percentile	Between 95th and 98th percentile	Between 98th and 99th percentile	Above 99th percentile
Number of banks	10,784	2,157	719	431	144	144
Mean assets (1993 $ millions)	32.82	119.14	247.73	556.61	1,341.45	10,763.44
Median assets (1993 $ millions)	28.43	112.63	239.00	508.06	1,228.66	3,964.55
Fraction of total system assets	0.13	0.09	0.06	0.09	0.07	0.56
Fraction of total assets in size category						
Cash	0.09	0.09	0.10	0.12	0.13	0.22
Securities	0.34	0.33	0.32	0.29	0.27	0.15
Federal funds lent	0.05	0.04	0.04	0.05	0.04	0.03
Total domestic loans	0.52	0.53	0.53	0.53	0.54	0.41
Real estate loans	0.17	0.19	0.20	0.18	0.17	0.09
C & I loans	0.10	0.13	0.15	0.16	0.17	0.17
Loans to individuals	0.15	0.16	0.15	0.15	0.14	0.06
Total deposits	0.90	0.90	0.89	0.87	0.84	0.81
Demand deposits	0.31	0.30	0.30	0.31	0.33	0.25
Time and savings deposits	0.59	0.60	0.59	0.55	0.51	0.33
Time deposits > $100K	0.07	0.10	0.12	0.14	0.14	0.16
Federal funds borrowed	0.00	0.01	0.02	0.04	0.07	0.08
Subordinated debt	0.00	0.00	0.00	0.00	0.01	0.01
Other liabilities	0.01	0.01	0.01	0.01	0.02	0.06
Equity	0.08	0.08	0.07	0.07	0.07	0.05

Summary Statistics

Panel B: Composition of Bank Balance Sheets as of 1993 Q2

	Below 75th percentile	Between 75th and 90th percentile	Between 90th and 95th percentile	Between 95th and 98th percentile	Between 98th and 99th percentile	Above 99th percentile
Number of banks	8,404	1,681	560	336	112	113
Mean assets (1993 $ millions)	44.42	165.81	380.14	1,072.57	3,366.01	17,413.41
Median assets (1993 $ millions)	38.59	155.73	362.75	920.78	3,246.33	9,297.70
Fraction of total system assets	0.10	0.08	0.06	0.10	0.11	0.55
Fraction of total assets in size category						
Cash	0.05	0.05	0.05	0.07	0.07	0.09
Securities	0.34	0.32	0.29	0.27	0.25	0.22
Federal funds lent	0.04	0.04	0.03	0.04	0.04	0.04
Total loans	0.53	0.56	0.60	0.59	0.60	0.59
Real estate loans	0.30	0.33	0.34	0.30	0.25	0.21
C & I loans	0.09	0.10	0.11	0.12	0.13	0.18
Loans to individuals	0.09	0.10	0.12	0.14	0.17	0.10
Total deposits	0.88	0.87	0.85	0.79	0.76	0.69
Transaction deposits	0.26	0.26	0.25	0.24	0.26	0.19
Large deposits	0.17	0.21	0.22	0.25	0.24	0.21
Brokered deposits	0.00	0.00	0.01	0.02	0.02	0.01
Federal funds borrowed	0.01	0.02	0.04	0.06	0.10	0.09
Subordinated debt	0.00	0.00	0.00	0.00	0.00	0.02
Other liabilities	0.01	0.02	0.03	0.05	0.06	0.13
Equity	0.10	0.09	0.08	0.09	0.08	0.07

Summary Statistics

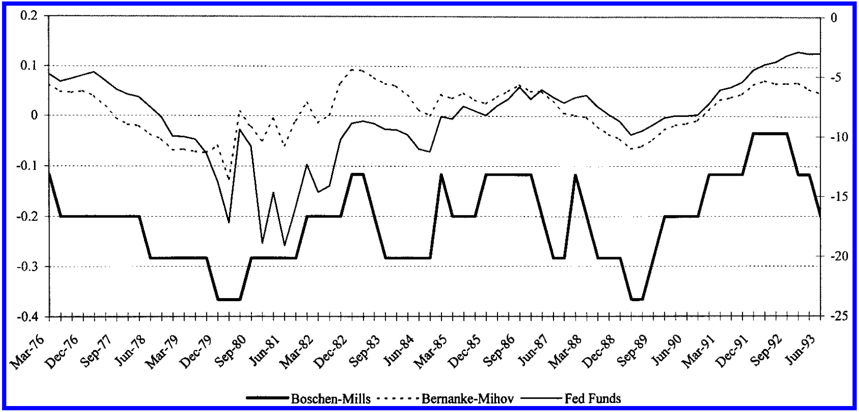


FIGURE 1. MEASURES OF MONETARY POLICY

1. Evidence
   - Bernanke and Blinder (1992)
   - Kashyap et al. (1993)
   - Kashyap and Stein (2000)
   - Mitchell et al. (2007)
   - Krishnamurthy and Vissing-Jorgensen (2011)
   - Gilchrist and Zakrajsek (2012)
   - Jiménez et al. (2014)
   - Chodorow-Reich (2014)
   - Gertler and Karadi (2015)
   - Giroud and Mueller (2017)
2. Models
   - Benchmark: Deterministic Q-theory
   - Holmström and Tirole (1998)
   - Brunnermeier and Sannikov (2017)

Mitchell et al. (2007): "Slow Moving Capital"

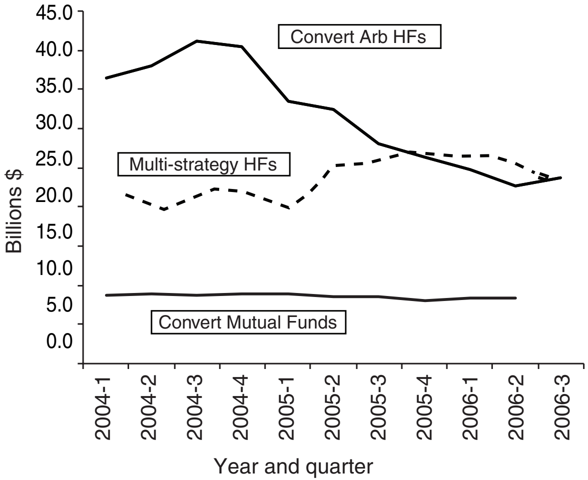


FIGURE 1. ADJUSTED HOLDINGS OF CONVERTIBLE BONDS IN BILLIONS OF DOLLARS

Mitchell et al. (2007)

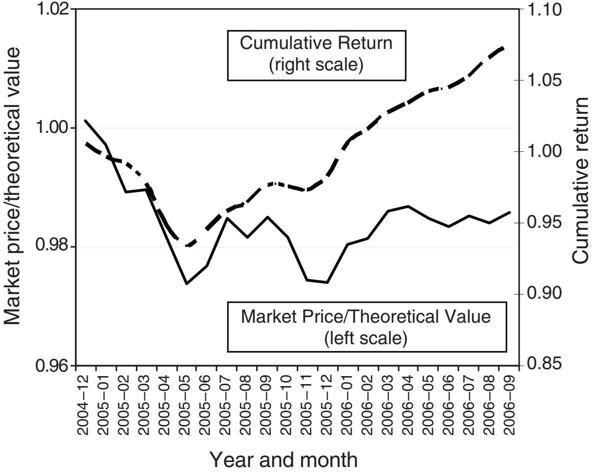


FIGURE 2. PRICE-TO-THEORETICAL-VALUE OF CONVERTIBLE BONDS, AND RETURN OF CONVERTIBLE BOND HEDGE FUNDS (2004/12-2006/09)

Mitchell et al. (2007)

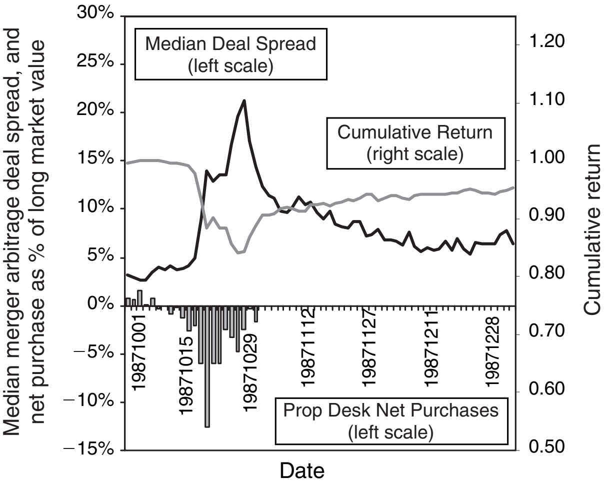
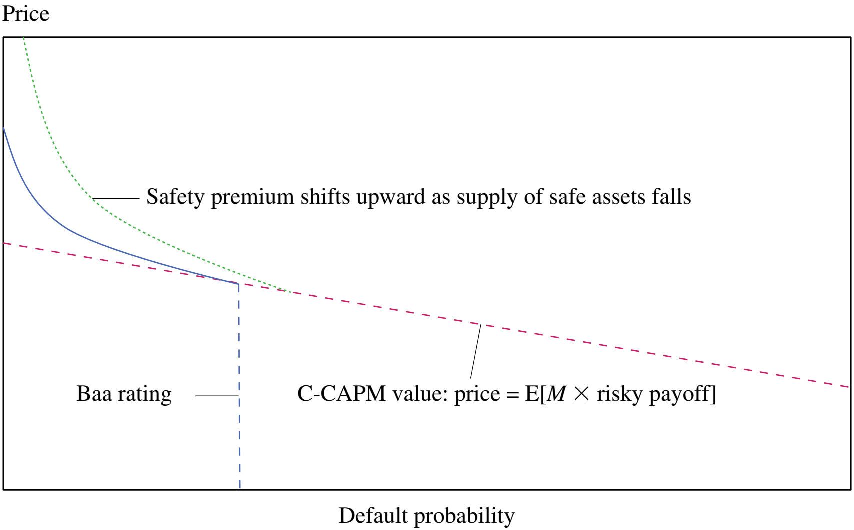


FIGURE 4. MERGER DEAL SPREADS, MERGER ARBITRAGE RETURNS, AND NET PURCHASES BY MERGER-ARB

1. Evidence
   - Bernanke and Blinder (1992)
   - Kashyap et al. (1993)
   - Kashyap and Stein (2000)
   - Mitchell et al. (2007)
   - Krishnamurthy and Vissing-Jorgensen (2011)
   - Gilchrist and Zakrajsek (2012)
   - Jiménez et al. (2014)
   - Chodorow-Reich (2014)
   - Gertler and Karadi (2015)
   - Giroud and Mueller (2017)
2. Models
   - Benchmark: Deterministic Q-theory
   - Holmström and Tirole (1998)
   - Brunnermeier and Sannikov (2017)

Krishnamurthy and Vissing-Jorgensen (2011) Theory

Figure 1. The Safety Premium on Bonds with Near-Zero Default Risk

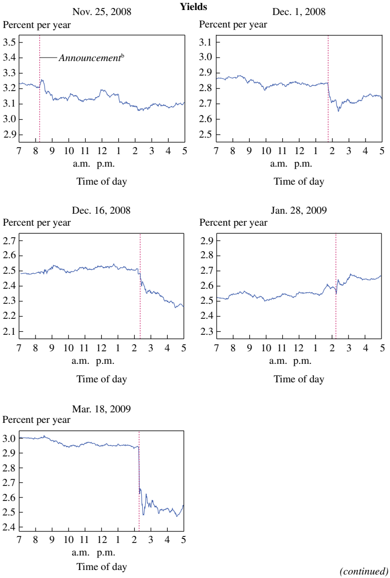


Summary

- **QE1.** in 10-year equivalents, the Federal Reserve had purchased \$169 billion of Treasuries, \$59 billion of agency debt, and \$573 billion of agency MBSs by February 1, 2010. The Treasury purchases were complete at \$300 billion, whereas \$164 billion of up to \$200 billion of agency securities had been purchased.
- **QE2.** purchase \$600 billion of Treasuries and roll over the maturing MBSs in its portfolio into long-term Treasuries

Results

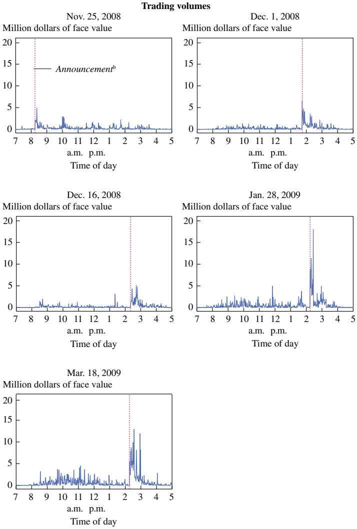
Figure 2. Intraday Yields and Trading Volumes on QE1 Event Days[a]



(continued)

Results

Figure 2. Intraday Yields and Trading Volumes on QE1 Event Days[a] *(Continued)*



Source: BG Cantor data.

a. Yields and trading volumes are minute-by-minute averages and total volume by minute, respectively, for the on-the-run 10-year bond on the indicated dates.

b. Minute of the appearance in Factiva of the first article covering the QE-related announcement.

Results

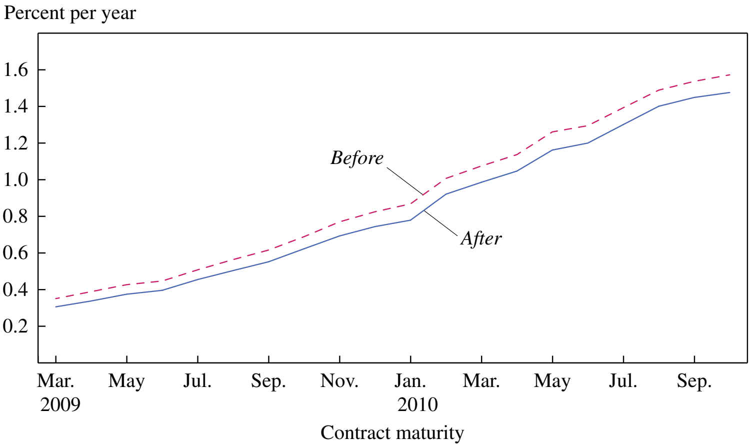
Table 1. Changes in Treasury, Agency, and Agency MBS Yields around QE1 Event Dates[a]
Basis points

		Treasury yields (constant maturity)					*Agency (Fannie Mae) yields*				*Agency MBS yields*[b]	
Date	*Event*	*30-year*	*10-year*	*5-year*	*3-year*	*1-year*	*30-year*	*10-year*	*5-year*	*3-year*	*30-year*	*15-year*
Nov. 25, 2008	Initial announcement	−24	−36	−23	−15	−2	−57	−76	−57	−42	−72	−88
Dec. 1, 2008	Bernanke speech	−27	−25	−28	−15	−13	−52	−67	−50	−33	−14	12
Dec. 16, 2008	FOMC statement	−32	−33	−15	−4	−5	−37	−39	−26	−25	−26	−16
Jan. 28, 2009	FOMC statement	31	28	28	19	4	33	28	27	14	31	20
Mar. 18, 2009	FOMC statement	−21	−41	−36	−24	−9	−31	−45	−44	−35	−27	−16
Sum of above five dates[c]		−73*	−107**	−74	−39	−25**	−144**	−200***	−150***	−123***	−107*	−88

Sources: FRED, Federal Reserve Bank of St. Louis; Bloomberg.
a. All changes are over 2 days, from the day before to the day after the event. Asterisks denote statistical significance at the ***1 percent, **5 percent, and *10 percent level.
b. Averages across current-coupon Ginnie Mae, Fannie Mae, and Freddie Mac MBSs.
c. May differ from the sum of the values reported for individual dates because of rounding.

Results

Figure 3. Yield Curves Calculated from Federal Funds Futures before and after QE1 Event Days



Source: Bloomberg data.

a. Yields are computed the day before each QE1 event date and again the day after. All the before-event yields are then averaged across events, and likewise for the after-event yields.

Results

Table 2. Changes in Federal Funds Futures Yields around QE1 and QE2 Event Dates[a]
Basis points

	Federal funds futures, contract maturity			
Date[b]	*3rd month*	*6th month*	*12th month*	*24th month*
QE1[c]	−6	−5	−8	−16
Nov. 25, 2008	−6	−3	−7	−20
Dec. 1, 2008	−13	−15	−10	−11
Dec. 16, 2008	−1	−1	−1	19
Jan. 28, 2009	−2	−4	−8	−11
Mar. 18, 2009	−28*	−27	−33**	−40
Sum[d]				
QE2				
Aug. 10, 2010				
One-day change	0	0	−2	−3
Two-day change	0	0	−3	−8
Sep. 21, 2010				
One-day change	0	−1	−3	−8
Two-day change	0	−1	−3	−8
Sum[d]				
One-day changes	0***	−1	−4***	−11***
Two-day changes	0***	−1	−5***	−16***

Source: Authors' calculations using Bloomberg data.

a. Asterisks denote statistical significance at the ***1 percent, **5 percent, and *10 percent level.

b. See table 1 for descriptions of events on QE1 dates; QE2 dates are those of FOMC statements regarding QE2.

c. All changes in yields for QE1 are 2-day changes, from the day before to the day after the event.

d. Because our significance tests are based on comparing changes on QE announcement days with changes on other days, changes on QE announcement days of zero can be statistically significant. For the 3-month federal funds futures, changes on non-QE days were on average slightly negative. Values may differ from the sum of the values reported for individual dates because of rounding.

Results

Table 3. Changes in Corporate Yields, Unadjusted and Adjusted by Credit Default Swap Rates, around QE1 Event Dates[a]
Basis points

	Corporate yields											
	Long-term						*Intermediate-term*					
Date[b]	*Aaa*	*Aa*	*A*	*Baa*	*Ba*	*B*	*Aaa*	*Aa*	*A*	*Baa*	*Ba*	*B*
Nov. 25, 2008	−28	−18	−23	−19	−4	4	−17	−15	−18	−18	1	−47
Dec. 1, 2008	−24	−24	−21	−17	−13	28	−21	−15	−18	−8	−5	6
Dec. 16, 2008	−43	−37	−45	−39	1	−11	−19	−21	−24	−27	−28	−42
Jan. 28, 2009	34	17	17	14	−16	−25	12	8	7	3	−32	−25
Mar. 18, 2009	−16	−21	−21	−20	−28	−39	−43	−50	−39	−26	−18	−22
Sum[c]	−77	−83**	−93**	−81**	−60**	−43	−88**	−93**	−92**	−76**	−82***	−130***
	Credit default swap rates[d]											
	10-year maturity						*5-year maturity*					
Nov. 25, 2008	−1	10	−17	−13	−31	−798	−1	−6	−20	−18	−32	−573
Dec. 1, 2008	1	0	9	11	21	1	1	3	13	7	28	33
Dec. 16, 2008	−2	−8	−18	−17	−23	−308	−2	−15	−20	−21	−40	−172
Jan. 28, 2009	−3	−15	−6	−13	−26	−231	−3	−7	−9	−11	−27	−255
Mar. 18, 2009	−2	−1	0	−7	−18	−18	−2	8	2	−8	−27	−25
Sum[c]	−7***	−14	−32	−40*	−78*	−1,354**	−6***	−17	−33	−51**	−98*	−991**

(continued)

Results

Table 3. Changes in Corporate Yields, Unadjusted and Adjusted by Credit Default Swap Rates, around QE1 Event Dates[a] ***(Continued)***
Basis points

	Adjusted corporate yields[e]											
	Long-term						*Intermediate-term*					
Date[b]	*Aaa*	*Aa*	*A*	*Baa*	*Ba*	*B*	*Aaa*	*Aa*	*A*	*Baa*	*Ba*	*B*
Nov. 25, 2008	−27	−28	−6	−6	27	802	−16	−9	2	0	33	526
Dec. 1, 2008	−25	−24	−30	−28	−34	27	−22	−18	−31	−15	−33	−27
Dec. 16, 2008	−41	−29	−27	−22	24	297	−17	−6	−4	−6	12	130
Jan. 28, 2009	37	32	23	27	10	206	15	15	16	14	−5	230
Mar. 18, 2009	−14	−20	−21	−13	−10	−21	−41	−58	−41	−18	9	3
Sum[c]	−70	−69	−61	−41	18	1,311**	−82*	−76	−59	−25	16	861**

Sources: Authors' calculations using data from Barclays, Credit Market Analysis (CMA), the Mergent Fixed Investment Securities Database (FISD), and the Trade Reporting and Compliance Engine (TRACE) of the Financial Industry Regulatory Authority.

a. All changes are over 2 days, from the day before to the day after the event. Asterisks denote statistical significance at the ***1 percent, **5 percent, and *10 percent level.

b. See table 1 for descriptions of the events on these dates.

c. May differ from the sum of the values reported for individual dates because of rounding.

d. Constructed using CMA data and ratings from FISD; changes are value-weighted averages using information on issue sizes from FISD and prices from TRACE.

e. Change in the unadjusted corporate yield minus the change in the corresponding CDS rate.

Results

Table 4. Changes in Inflation Swap Rates, TIPS Yields, and Implied Interest Rate Volatility around QE1 Event Dates[a]
Basis points

	Inflation swap rates				*TIPS real yield (constant maturity)*			*Implied interest rate volatility*[c]
Date[b]	*30-year*	*10-year*	*5-year*	*1-year*	*20-year*	*10-year*	*5-year*	
Nov. 25, 2008	1	–6	–28	48	–22	–43	5	1
Dec. 1, 2008	15	27	12	–40	–38	–34	–52[d]	–7
Dec. 16, 2008	4	37	35	–17	–45	–57	–83	–20
Jan. 28, 2009	14	15	–6	5	15	6	13	0
Mar. 18, 2009	2	22	24	45	–45	–59	–43	–11
Sum[e]	35**	96**	38	41	–135***	–187***	–160**	–38***

Sources: FRED, Federal Reserve Bank of St. Louis; Bloomberg.

a. All changes are over 2 days, from the day before to the day after the event. Asterisks denote statistical significance at the ***1 percent, **5 percent, and *10 percent level.

b. See table 1 for descriptions of the events on these dates.

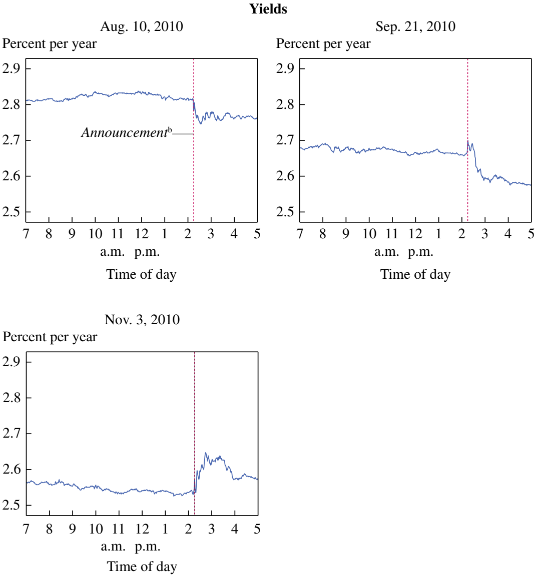
c. Volatility implied from swaptions as measured using the Barclays implied volatility index.

d. The constant-maturity TIPS data from FRED indicate that the 5-year TIPS fell by 244 bp around this event. We think this is a data error. Using data from FRED on the 5-year and 10-year underlying TIPS with remaining maturities near 5 years around QE1 (the 5-year TIPS maturing April 15, 2013, and the 10-year TIPS maturing January 15, 2014), we found yield changes of –58 bp and –46 bp, respectively. The value reported in the table is the average of these changes.

e. May differ from the sum of the values reported for individual dates because of rounding.

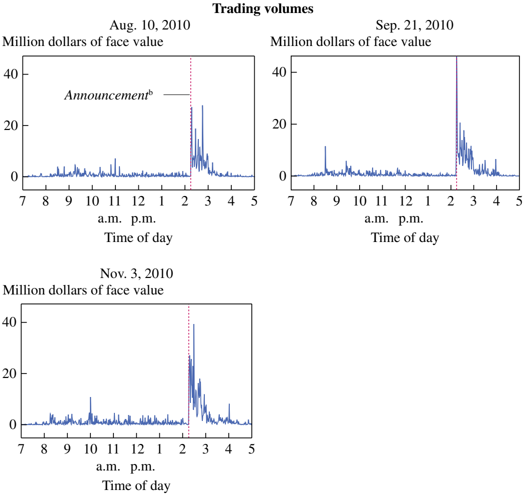
Results

Figure 4. Intraday Yields and Trading Volumes on QE2 Event Days[a]



Results

Figure 4. Intraday Yields and Trading Volumes on QE2 Event Days[a] *(Continued)*



Source: BG Cantor data.

a. Yields and trading volumes are minute-by-minute averages and total volume by minute, respectively, for the on-the-run 10-year bond on the indicated dates.

b. Minute of the appearance in Factiva of the first article covering the QE-related announcement.

Results

Table 5. Changes in Treasury, Agency, and Agency MBS Yields around QE2 Event Dates[a]
Basis points

	Treasury yields (constant maturity)					*Agency (Fannie Mae) yields*				*Agency MBS yields*[b]	
Date	*30-year*	*10-year*	*5-year*	*3-year*	*1-year*	*30-year*	*10-year*	*5-year*	*3-year*	*30-year*	*15-year*
Aug. 10, 2010											
One-day change	−1	−7	−8	−3	−1	−2	−7	−8	−4	−1	−4
Two-day change	−8	−14	−10	−3	−1	−8	−13	−9	−7	−4	−8
Sep. 21, 2010											
One-day change	−8	−11	−9	−5	0	−8	−11	−9	−6	−8	−8
Two-day change	−13	−16	−10	−5	−1	−14	−16	−10	−6	−4	−5
Nov. 3, 2010											
One-day change	16	4	−4	−2	0	13	5	−5	−3	−4	−4
Two-day change	11	−10	−11	−6	−1	4	−10	−14	−8	−10	−9
Sum of Aug. 10 and Sep. 21[c]											
One-day change	−9*	−18***	−17***	−8***	−1	−9**	−17***	−17***	−10***	−9*	−12***
Two-day change	−21***	−30***	−20***	−8***	−2	−22***	−29***	−20***	−13***	−8	−13**

Sources: FRED, Federal Reserve Bank of St. Louis; Bloomberg.
a. Dates are those of FOMC statements regarding QE2. Asterisks denote statistical significance at the ***1 percent, **5 percent, and *10 percent level.
b. Averages across current-coupon Ginnie Mae, Fannie Mae, and Freddie Mac MBSs.
c. May differ from the sum of the values reported for individual dates because of rounding.

Results

Table 6. Changes in Corporate Yields, Unadjusted and Adjusted by Credit Default Swap Rates, around QE2 Event Dates[a]

Basis points

	Corporate yields											
	Long-term						*Intermediate-term*					
Date	*Aaa*	*Aa*	*A*	*Baa*	*Ba*	*B*	*Aaa*	*Aa*	*A*	*Baa*	*Ba*	*B*
Aug. 10, 2010												
One-day change	0	3	1	1	−3	−9	−4	−2	−2	−3	0	6
Two-day change	−10	−5	−7	−7	−3	−5	−8	−5	−6	−6	9	23
Sep. 21, 2010												
One-day change	−9	−9	−9	−8	−7	2	−9	−9	−10	−10	−4	−3
Two-day change	−13	−12	−13	−11	−15	1	−10	−8	−10	−11	−3	2
Nov. 3, 2010												
One-day change	10	11	12	9	28	−1	−2	−2	−1	−1	−1	−5
Two-day change	5	2	4	−1	22	−10	−10	−11	−13	−14	−12	−18
Sum of Aug. 10 and Sep. 21[b]												
One-day change	−9	−6	−8	−7	−10***	−7	−13***	−11**	−12**	−13**	−4	3**
Two-day change	−23***	−17*	−20***	−18**	−18***	−4	−18***	−13**	−16**	−17***	6	25
	Credit default swap rates[c]											
	10-year maturity						*5-year maturity*					
Aug. 10, 2010												
One-day change	−1	5	2	2	4	4	1	5	3	4	5	9
Two-day change	0	10	7	7	16	23	1	15	7	9	20	26
Sep. 21, 2010												
One-day change	2	−3	0	0	2	4	−1	−1	0	0	4	4
Two-day change	3	0	2	2	9	8	1	3	3	4	11	12
Sum of Aug. 10 and Sep. 21[b]												
One-day change	2	2	2	2	6	8	0	4	3	4	9	13
Two-day change	3	10	10**	8*	25***	31	2*	18*	10**	13***	31***	38

(continued)

Results

Table 6. **Changes in Corporate Yields, Unadjusted and Adjusted by Credit Default Swap Rates, around QE2 Event Dates**[a] ***(Continued)***

Basis points

	Adjusted corporate yields[d]											
	Long-term						*Intermediate-term*					
Date	*Aaa*	*Aa*	*A*	*Baa*	*Ba*	*B*	*Aaa*	*Aa*	*A*	*Baa*	*Ba*	*B*
Aug. 10, 2010												
One-day change	1	−2	−1	−1	−7	−13	−5	−7	−5	−7	−5	−3
Two-day change	−10	−15	−14	−14	−19	−28	−9	−20	−13	−15	−11	−3
Sep. 21, 2010												
One-day change	−11	−6	−9	−8	−9	−2	−8	−8	−10	−10	−8	−7
Two-day change	−16	−12	−15	−13	−24	−7	−11	−11	−13	−15	−14	−10
Sum of Aug. 10 and Sep. 21[b]												
One-day change	−11	−8**	−10*	−9	−16***	−15	−13***	−15***	−15***	−17***	−13***	−10
Two-day change	−26***	−27***	−30***	−26***	−43***	−35	−20***	−31***	−26***	−30***	−25***	−13

Sources: Authors' calculations using data from Barclays, Credit Market Analysis (CMA), the Mergent Fixed Investment Securities Database (FISD), and the Trade Reporting and Compliance Engine (TRACE) of the Financial Industry Regulatory Authority.

a. Dates are those of FOMC statements regarding QE2. Asterisks denote statistical significance at the ***1 percent, **5 percent, and *10 percent level.

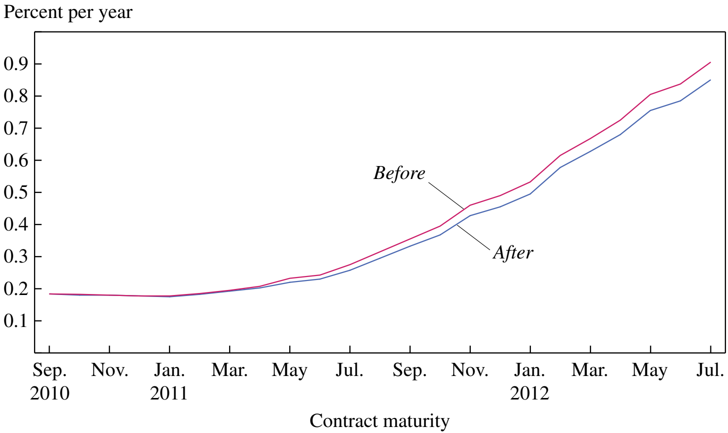
b. May differ from the sum of the values reported for individual dates because of rounding.

c. Constructed using CMA data and ratings from FISD; changes are value-weighted averages using information on issue sizes from FISD and prices from TRACE. Data for the November 3 event are unavailable.

d. Change in the unadjusted corporate yield minus the change in the corresponding CDS rate.

Results

Figure 5. Yield Curves Calculated from Federal Funds Futures before and after QE2 Event Days[a]



Source: Bloomberg data.

a. Yields are computed the day before each QE2 event date and again the day after. All the before-event yields are then averaged across events, and likewise for the after-event yields.

Results

Table 7. Changes in Inflation Swap Rates, TIPS Yields, and Implied Interest Rate Volatility around QE2 Event Dates[a]
Basis points

	Inflation swaps				TIPS real yield (constant maturity)			Implied interest rate volatility[b]
Date	*30-year*	*10-year*	*5-year*	*1-year*	*20-year*	*10-year*	*5-year*	
Aug. 10, 2010								
One-day change	5	−1	−3	0	−7	−9	−8	−2
Two-day change	−2	0	−3	−4	−5	−9	−5	−3
Sep. 21, 2010								
One-day change	6	6	6	−1	−13	−16	−14	−1
Two-day change	6	4	7	9	−18	−20	−18	−2
Nov. 3, 2010								
One-day change	6	−3	2	1	8	1	−6	−2
Two-day change	1	−11	4	14	12	−5	−14	−3
Sum of Aug. 10 and Sep. 21[c]								
One-day change	11***	5	3	−1	−20***	−25***	−22***	−3***
Two-day change	4	4	4	5	−23***	−29***	−23***	−5***

Sources: FRED, Federal Reserve Bank of St. Louis; Bloomberg.

a. Dates are those of FOMC statements regarding QE2. Asterisks denote statistical significance at the ***1 percent, **5 percent, and *10 percent level.

b. Volatility implied from swaptions as measured using the Barclays implied volatility index.

c. May differ from the sum of the values reported for individual dates because of rounding.

Gilchrist and Zakrajšek (2012) Summary Statistics

TABLE 1—SUMMARY STATISTICS OF CORPORATE BOND CHARACTERISTICS

Variable	Mean	SD	Min	P50	Max
Number of bonds per firm/month	2.91	3.64	1.00	2.00	74.0
Market value of issue ($mil.)[a]	322.9	326.6	1.22	238.6	5,628
Maturity at issue (years)	13.0	9.3	1.0	10.0	50.0
Term to maturity (years)	11.3	8.5	1.0	8.1	30.0
Duration (years)	6.47	3.20	0.91	6.06	16.0
Callable (pct.)	67.2	47.0	—	—	—
Credit rating (S&P)	—	—	D	BBB1	AAA
Coupon rate (pct.)	7.34	1.99	1.80	7.00	17.5
Nominal effective yield (pct.)	7.68	3.24	0.54	7.16	44.3
Credit spread (basis points)	204	281	5	118	3,499

Notes: Sample period: 1973:1–2010:9; Observations = 346,126; Number of bonds = 5,982; Number of firms = 1,112. Sample statistics are based on trimmed data (see text for details).

[a] Market value of the outstanding issue deflated by the CPI (2000 = 100).

Results

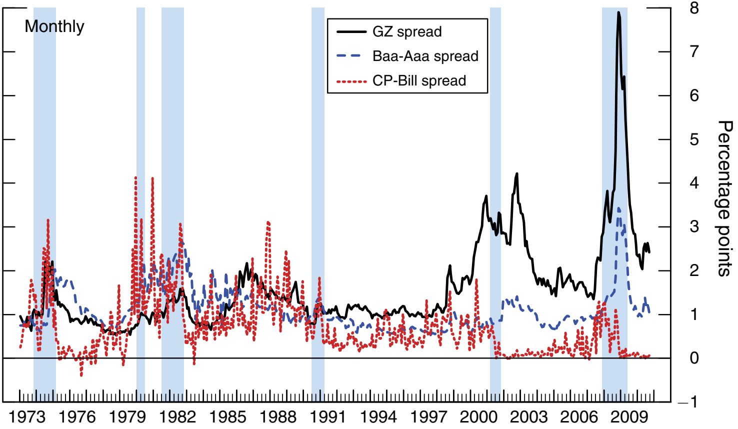


FIGURE 1. SELECTED CORPORATE CREDIT SPREADS

Notes: Sample period: 1973:1–2010:9. The figure depicts the following credit spreads: GZ spread = the average credit spread on senior unsecured bonds issued by nonfinancial firms in our sample (the solid line); Baa–Aaa = the spread between yields on Baa- and Aaa-rated long-term industrial corporate bonds (the dashed line); and CP–Bill = the spread between the yield on one-month A1/P1 nonfinancial commercial paper and the one-month Treasury yield (the dotted line). The shaded vertical bars represent the NBER-dated recessions.

Results

Table 2—Financial Indicators and Monthly Measures of Economic Activity

Financial indicator	Forecast horizon: 3 months				Forecast horizon: 12 months			
Panel A. Payroll employment								
Term spread	−0.096	−0.102	−0.110	−0.110	−0.252	−0.255	−0.241	−0.277
	[2.12]	[2.27]	[2.44]	[2.42]	[4.94]	[5.05]	[4.93]	[5.53]
Real FFR	−0.058	0.050	−0.038	−0.113	−0.116	−0.064	−0.129	−0.204
	[1.18]	[0.78]	[0.75]	[2.23]	[2.10]	[0.96]	[2.45]	[3.84]
CP–bill spread	—	−0.165	—	—	—	−0.080	—	—
		[3.80]				[2.29]		
Baa–Aaa spread	—	—	−0.075	—	—	—	0.054	—
			[2.05]				[1.15]	
GZ spread	—	—	—	−0.322	—	—	—	−0.497
				[8.50]				[13.4]
Adjusted R^2	0.622	0.639	0.625	0.685	0.422	0.424	0.422	0.579
Panel B. Unemployment rate								
Term spread	0.164	0.179	0.215	0.199	0.375	0.386	0.394	0.419
	[7.71]	[8.42]	[10.2]	[9.37]	[46.7]	[48.4]	[50.6]	[51.8]
Real FFR	0.029	−0.152	−0.024	0.107	0.037	−0.089	0.019	0.131
	[1.24]	[5.22]	[1.06]	[4.50]	[4.60]	[9.72]	[2.45]	[16.4]
CP–bill spread	—	0.268	—	—	—	0.191	—	—
		[13.8]				[36.0]		
Baa–Aaa spread	—	—	0.198	—	—	—	0.074	—
			[10.4]				[11.2]	
GZ spread	—	—	—	0.351	—	—	—	0.453
				[19.5]				[83.0]
Adjusted R^2	0.335	0.378	0.362	0.425	0.270	0.292	0.273	0.417
Panel C. Industrial production								
Term spread	−0.182	−0.202	−0.239	−0.224	−0.358	−0.371	−0.357	−0.400
	[2.54]	[2.83]	[3.43]	[3.15]	[4.03]	[4.91]	[4.06]	[4.59]
Real FFR	−0.035	0.183	0.016	−0.126	−0.094	0.052	−0.095	−0.175
	[0.44]	[1.86]	[0.20]	[1.62]	[0.98]	[0.48]	[1.02]	[1.90]
CP–bill spread	—	−0.332	—	—	—	−0.226	—	—
		[4.75]				[3.67]		
Baa–Aaa spread	—	—	−0.211	—	—	—	0.004	—
			[3.08]				[0.05]	
GZ spread	—	—	—	−0.386	—	—	—	−0.412
				[5.28]				[5.11]
Adjusted R^2	0.251	0.319	0.283	0.360	0.227	0.258	0.225	0.346

Notes: Sample period: 1973:1–2010:9. Dependent variable is $\nabla^h Y_{t+h}$, where Y_t denotes an indicator of economic activity in month t and h is the forecast horizon. In addition to the specified financial indicator in month t, each specification also includes a constant and p lags of ∇Y_{t-1} (not reported), where p is determined by the AIC. Entries in the table denote the standardized estimates of the OLS coefficients associated with each financial indicator; absolute asymptotic t-statistics reported in brackets are computed according to Hodrick (1992) (see text for details).

Results

TABLE 3—FINANCIAL INDICATORS AND REAL GDP

Financial indicator	Forecast horizon: 1 quarter				Forecast horizon: 4 quarters			
Term spread	−0.198	−0.217	−0.250	−0.247	−0.398	−0.406	−0.413	−0.460
	[1.77]	[1.92]	[2.07]	[2.26]	[2.79]	[2.81]	[2.70]	[3.22]
Real FFR	−0.016	0.175	0.020	−0.123	−0.036	0.042	−0.026	−0.131
	[0.12]	[1.12]	[0.15]	[0.95]	[0.24]	[0.22]	[0.17]	[0.87]
CP–bill spread	—	−0.254	—	—	—	−0.105	—	—
		[2.16]				[0.82]		
Baa–Aaa spread	—	—	−0.229	—	—	—	−0.066	—
			[1.95]				[0.52]	
GZ spread	—	—	—	−0.437	—	—	—	−0.482
				[4.96]				[5.74]
Adjusted R^2	0.170	0.197	0.209	0.313	0.215	0.215	0.213	0.369

Notes: Sample period: 1973:I–2010:III. Dependent variable is $\nabla^h Y_{t+h}$, where Y_t denotes the real GDP in quarter t and h is the forecast horizon. In addition to the specified financial indicator in quarter t, each specification also includes a constant and p lags of ∇Y_{t-1} (not reported), where p is determined by the AIC. Entries in the table denote the standardized estimates of the OLS coefficients associated with each financial indicator; absolute asymptotic t-statistics reported in brackets are computed according to Hodrick (1992) (see text for details).

Results

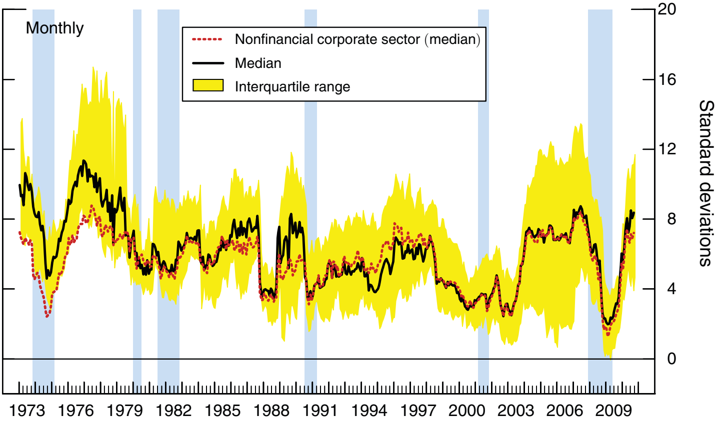


FIGURE 2. DISTANCE TO DEFAULT

Notes: Sample period: 1973:1–2010:9. The solid line depicts the (weighted) median DD of the firms in our sample, and the shaded band depicts the corresponding (weighted) interquartile range. The dotted line depicts the (weighted) median DD in the US nonfinancial corporate sector; all percentiles are weighted by the firm's outstanding liabilities. The shaded vertical bars represent the NBER-dated recessions.

Results

TABLE 4—CREDIT SPREADS AND THE DISTANCE TO DEFAULT

Explanatory variable	Est.	Standard error	Est.	Standard error
$-DD_{it}$	0.075	0.005	0.093	0.005
$\ln(DUR_{it}[k])$	0.106	0.018	0.201	0.019
$\ln(PAR_{it}[k])$	0.171	0.018	0.121	0.022
$\ln(CPN_{i}[k])$	0.439	0.074	0.031	0.062
$\ln(AGE_{it}[k])$	0.047	0.008	0.135	0.010
$CALL_{i}[k]$	0.262	0.029	−0.427	0.210
$-DD_{it} \times CALL_{i}[k]$	—	—	−0.030	0.004
$\ln(DUR_{it}[k]) \times CALL_{i}[k]$	—	—	−0.120	0.023
$\ln(PAR_{it}[k]) \times CALL_{i}[k]$	—	—	−0.122	0.024
$\ln(CPN_{i}[k]) \times CALL_{i}[k]$			0.915	0.078
$\ln(AGE_{it}[k]) \times CALL_{i}[k]$	—	—	−0.132	0.013
$LEV_{t} \times CALL_{i}[k]$	—	—	−0.385	0.027
$SLP_{t} \times CALL_{i}[k]$	—	—	−0.088	0.017
$CRV_{t} \times CALL_{i}[k]$	—	—	−0.041	0.019
$VOL_{t} \times CALL_{i}[k]$	—	—	0.134	0.021
Adjusted R^2	0.649		0.700	
Industry effects[a]	0.000		0.000	
Credit rating effects[b]	0.000		0.000	

Notes: Sample period: 1973:1–2010:9. Obs. = 346,126; Number of bonds/firms = 5,982/1,112. Dependent variable is $\ln(S_{it}[k])$, the log of the credit spread on bond k (issued by firm i) in month t. The Treasury term structure is represented by the following three factors: LEV_t = level; SLP_t = slope; and CRV_t = curvature; VOL_t = (annualized) realized monthly volatility of the daily ten-year Treasury yield. Asymptotic standard errors are clustered in both the firm (i) and time (t) dimensions, according to Cameron, Gelbach, and Miller (2011).

[a] p-value of the exclusion test of industry fixed effects.

[b] p-value of the exclusion test of credit rating fixed effects.

Results

TABLE 5—SELECTED MARGINAL EFFECTS BY TYPE OF BOND

	Noncallable		Callable			
Explanatory variable	Est.	Standard error	Est.	Standard error	Mean[a]	STD[b]
Distance to default: $-DD_{it}$	0.190	0.010	0.129	0.008	6.610	3.946
Term structure: LEV_t	—	—	−0.783	0.055	0.000	1.000
Term structure: SLP_t	—	—	−0.179	0.034	0.000	1.000
Term structure: CRV_t	—	—	−0.082	0.038	0.000	1.000
Term structure: VOL_t (%)	—	—	0.273	0.043	1.862	1.239

Notes: The table contains the estimates of the marginal effect of a one-unit change in the specified variable on the level of credit spreads (in percentage points) for noncallable and callable bonds based on the parameter estimates reported in Table 4. All marginal effects are evaluated at sample means; by construction, the level, slope, and curvature factors are standardized to have mean equal to zero and standard deviation equal to one. Asymptotic standard errors are computed according to the delta method.

[a] Sample mean of the specified variable.

[b] Sample standard deviation of the specified variable.

Results

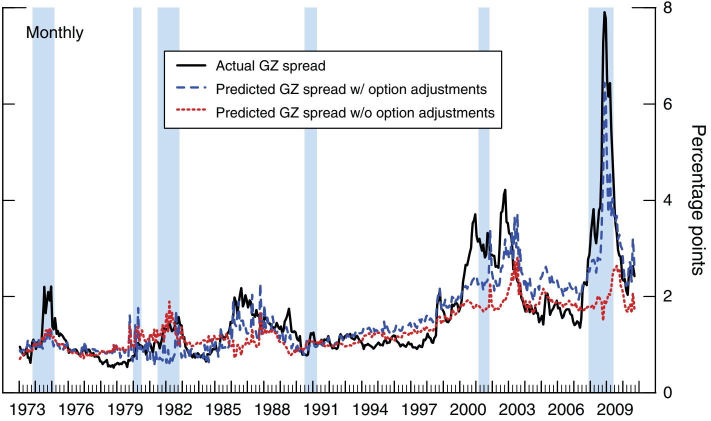


FIGURE 3. ACTUAL AND PREDICTED CREDIT SPREADS

Notes: Sample period: 1973:1–2010:9. The solid line depicts the actual GZ credit spread. The dashed line depicts the predicted GZ credit spread based on the specification that includes the term structure option-adjustment terms; the dotted line depicts the predicted GZ credit spread based on the specification that excludes the term structure option-adjustment terms (see text for details). The shaded vertical bars represent the NBER-dated recessions.

Results

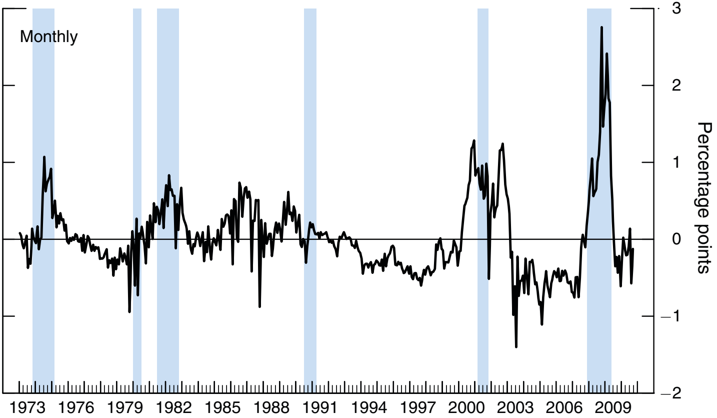


FIGURE 4. THE EXCESS BOND PREMIUM

Notes: Sample period: 1973:1–2010:9. The figure depicts the estimated (option-adjusted) excess bond premium. The shaded vertical bars represent the NBER-dated recessions.

Results

TABLE 6—THE EXCESS BOND PREMIUM AND MONTHLY MEASURES OF ECONOMIC ACTIVITY

	Forecast horizon: 3 months			Forecast horizon: 12 months		
Financial indicator	EMP	UER	IPM	EMP	UER	IPM
Term spread	−0.122	0.221	−0.256	−0.291	0.440	−0.435
	[2.67]	[10.3]	[3.60]	[5.78]	[55.4]	[4.99]
Real FFR	−0.044	0.007	−0.018	−0.112	0.022	−0.079
	[0.87]	[0.30]	[0.23]	[2.06]	[2.70]	[0.81]
Predicted GZ spread[a]	−0.202	0.134	−0.186	−0.355	0.213	−0.283
	[5.65]	[8.41]	[3.62]	[9.63]	[38.5]	[4.18]
Excess bond premium	−0.259	0.331	−0.386	−0.369	0.414	−0.388
	[8.52]	[20.9]	[5.87]	[14.5]	[91.6]	[5.42]
Adjusted R^2	0.687	0.430	0.381	0.588	0.433	0.384

Notes: Sample period: 1973:1–2010:9. Dependent variable is $\nabla^h Y_{t+h}$, where Y_t denotes an indicator of economic activity in month t and h is the forecast horizon: EMP = private nonfarm payroll employment; UER = civilian unemployment rate; and IPM = index of manufacturing industrial production. In addition to the specified financial indicators in month t, each specification also includes a constant and p lags of ∇Y_{t-1} (not reported), where p is determined by the AIC. Entries in the table denote the standardized estimates of the OLS coefficients associated with each financial indicator; absolute asymptotic t-statistics reported in brackets are computed according to Hodrick (1992) (see text for details).

[a] Excludes the effect of option adjustment on callable bonds.

Results

TABLE 7—THE EXCESS BOND PREMIUM, REAL GDP, AND ITS MAIN COMPONENTS

Financial indicator	GDP	C-NDS	C-D	I-RES	I-ES	I-HT	I-NRS	INV
Panel A. 1973:I–2010:III (*Forecast horizon: Four quarters*)								
Term spread	−0.478	−0.452	−0.551	−0.564	−0.398	−0.098	0.317	−0.123
	[3.33]	[3.89]	[2.55]	[5.23]	[3.16]	[0.83]	[2.73]	[1.43]
Real FFR	−0.036	0.106	0.106	−0.003	−0.086	−0.092	−0.111	0.014
	[0.24]	[0.99]	[0.58]	[0.03]	[0.82]	[0.67]	[0.87]	[0.15]
Predicted GZ spread[a]	−0.258	−0.209	0.014	−0.159	−0.221	−0.426	−0.186	−0.287
	[2.56]	[2.39]	[0.11]	[2.10]	[2.48]	[4.43]	[2.07]	[4.11]
Excess bond premium	−0.364	−0.260	−0.127	−0.018	−0.558	−0.374	−0.587	−0.656
	[5.36]	[4.36]	[1.00]	[0.29]	[5.87]	[4.42]	[5.77]	[9.39]
Adjusted R^2	0.365	0.349	0.224	0.419	0.481	0.432	0.557	0.580
Panel B. 1985:I–2010:III (*Forecast horizon: Four quarters*)								
Term spread	−0.509	−0.362	−0.456	−0.596	−0.340	−0.071	0.392	−0.321
	[4.09]	[4.07]	[2.00]	[6.52]	[2.75]	[0.60]	[2.46]	[4.08]
Real FFR	0.424	0.181	0.395	0.331	0.032	−0.130	0.000	0.301
	[2.67]	[1.53]	[1.49]	[2.96]	[0.18]	[0.90]	[0.00]	[2.47]
Predicted GZ spread[a]	−0.023	−0.093	0.194	0.045	−0.088	−0.294	−0.061	−0.047
	[0.20]	[0.82]	[0.99]	[0.47]	[0.63]	[2.11]	[0.49]	[0.46]
Excess bond premium	−0.501	−0.362	−0.260	−0.035	−0.650	−0.382	−0.613	−0.701
	[6.80]	[5.02]	[1.51]	[0.50]	[5.41]	[3.39]	[4.76]	[8.20]
Adjusted R^2	0.357	0.508	0.101	0.484	0.448	0.405	0.624	0.635

Notes: Dependent variable is $\nabla^4 Y_{t+4}$, where Y_t denotes real GDP or one of its components in quarter t; C-NDS = PCE on nondurable goods & services; C-D = PCE on durable goods; I-RES = residential investment; I-ES = business fixed investment in E&S (excluding high tech); I-HT = business fixed investment in high-tech equipment; I-NRS = business fixed investment in structures; INV = business inventories. In addition to the specified financial indicators in quarter t, each specification also includes a constant and p lags of ∇Y_{t-1} (not reported), where p is determined by the AIC. Entries in the table denote the standardized estimates of the OLS coefficients associated with each financial indicator; absolute asymptotic t-statistics reported in brackets are computed according to Hodrick (1992) (see text for details).

[a] Excludes the effect of option adjustment on callable bonds.

Results

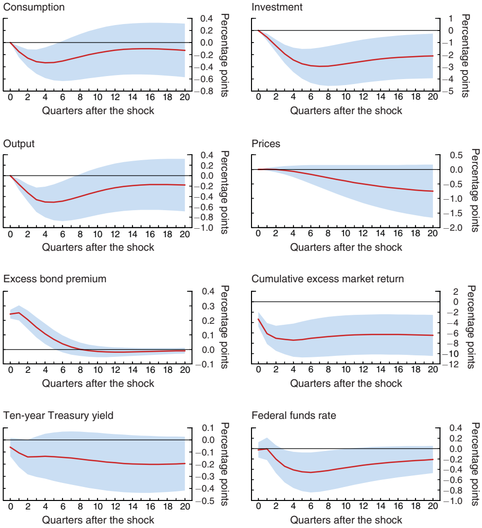


FIGURE 5. MACROECONOMIC IMPLICATIONS OF A FINANCIAL SHOCK

Notes: The figure depicts the impulse responses to a one-standard-deviation orthogonalized shock to the excess bond premium (see text for details). The responses of consumption, investment, and output growth and that of the excess market return have been accumulated. Shaded bands denote 95-percent confidence intervals based on 2,000 bootstrap replications.

Results

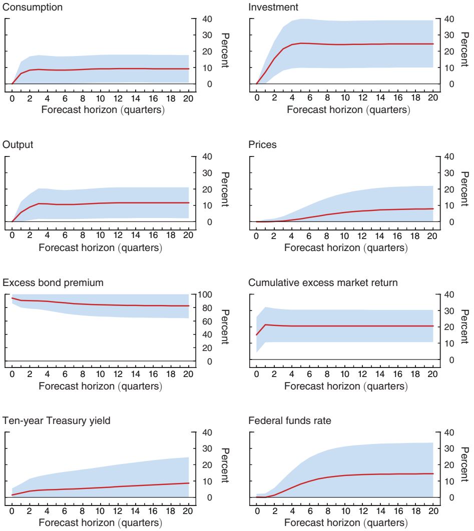


Figure 6. Forecast Error Variance Decomposition of a Financial Shock

Notes: The figure depicts the forecast error variance decomposition from a one-standard-deviation orthogonalized shock to the excess bond premium (see text for details). The forecast error variance decomposition of consumption, investment, and output growth and that of the excess market return is based on the level of the variables. Shaded bands denote 95-percent confidence intervals based on 2,000 bootstrap replications.

Results

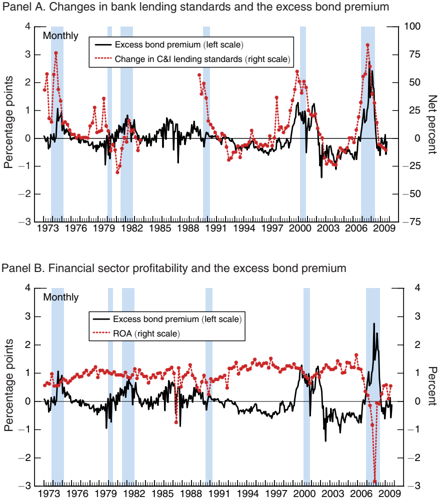


Figure 7. The Excess Bond Premium and Financial Market Conditions

Notes: Sample period: 1973:1–2010:9. The solid line in both panels depicts the estimated (option-adjusted) excess bond premium. The overlayed dots in panel A depict the net percent of SLOOS respondents that reported tightening their credit standards on C&I loans over the past three months. (There was no survey conducted during the 1984–89 period.) The overlayed dots in panel B depict the quarterly (annualized) ROA for the US financial corporate sector, calculated using Compustat data. The shaded vertical bars denote the NBER-dated recessions.

Results

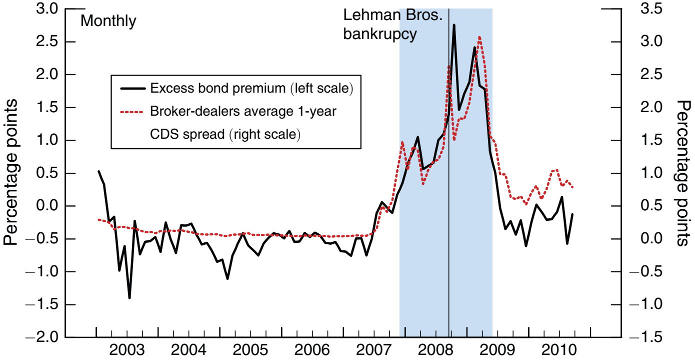


Figure 8. The Excess Bond Premium and Financial Intermediary CDS Spreads

Notes: Sample period: 2003:1–2010:9. The solid line depicts the estimated excess bond premium. The overlayed dotted line depicts the average one-year CDS spread of broker-dealers. The shaded vertical bar represents the 2007–09 NBER-dated recession.

Results

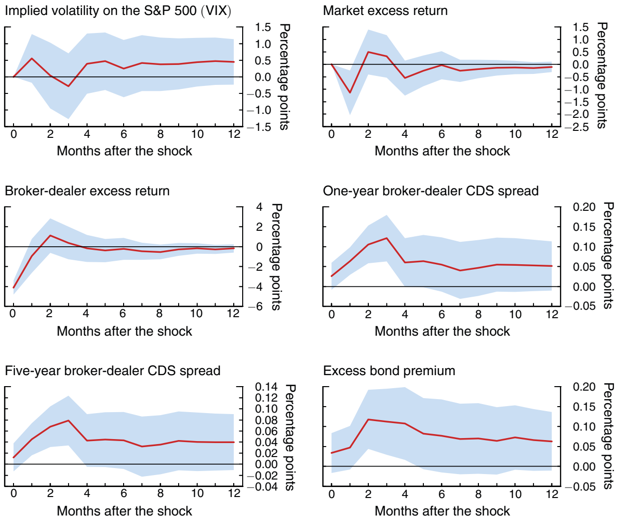


FIGURE 9. IMPLICATIONS OF A SHOCK TO THE PROFITABILITY OF FINANCIAL INTERMEDIARIES

Notes: The figure depicts the impulse responses to a one-standard-deviation orthogonalized shock to the average excess return of broker-dealers (see text for details). Shaded bands denote 95-percent confidence intervals based on 2,000 bootstrap replications.

Jiménez et al. (2014) Abstract

Hazardous times for monetary policy: what do twenty-three million bank loans say about the effects of monetary policy on credit risk-taking?

We identify the effects of monetary policy on credit risk-taking with an exhaustive credit register of **loan applications and contracts**. We separate the changes in the composition of the supply of credit from the concurrent changes in the volume of supply and quality, and the volume of demand. We employ a **two-stage model that analyzes the granting of loan applications in the first stage and loan outcomes for the applications granted in the second stage**, and that **controls for both observed and unobserved**, time-varying, **firm and bank heterogeneity** through **time∗firm** and time∗bank fixed effects. We find that a **lower overnight interest rate induces lowly capitalized banks to grant more loan applications to ex ante risky firms** and to commit larger loan volumes with **fewer collateral requirements to these firms, yet with a higher ex post likelihood of default**. A lower long-term interest rate and other relevant macroeconomic variables have no such effects.

Identification

- Risk-taking channel implies that expansionary monetary policy spurs banks into risky lending. However, this **testable prediction can also be consistent with demand channels**, in particular, with the firm balance sheet and the **interest rate channel of monetary policy** (Bernanke and Gertler (1995)). Therefore, to suppress concurrent changes in the quality (along balance-sheet strength, as risky firms may have improved their net worth, investment opportunities, and collateral values) and volume of the firm demand for credit, we **saturate our benchmark specifications with time∗firm fixed effects**.
- **Identification comes from comparing changes in lending in the same month by different banks (with respect to their capital-to-asset ratios) to the same firm**.
- With observed and unobserved time-varying bank heterogeneity accounted for, **identification resides in comparing changes in lending during the same month by the same bank to firms that differ in credit risk**.

Summary Statistics

TABLE I

SUMMARY STATISTICS OF ALL VARIABLES USED IN THE ESTIMATIONS ON THE SAMPLE SELECTION MODEL USING LOAN APPLICATIONS[a]

Variable Name	Mean	Minimum	Q1	Median	Q3	Maximum	Standard Deviation
Dependent Variables							
I(GRANTING OF LOAN APPLICATIONS$_{tbi}$)	0.36	0	0	0	1	1	0.48
COMMITTED AMOUNT OF GRANTED LOANS$_{tbi}$	287	2	30	69	180	77,704	1315
LN(CREDIT AMOUNT$_{tbi}$)	4.41	0.69	3.40	4.23	5.19	11.26	1.32
I(FUTURE DEFAULT$_{tbi}$)	0.35	0	0	0	1	1	0.48
I(WITHOUT COLLATERAL$_{tbi}$)	0.89	0	1	1	1	1	0.31
Independent Variables							
Firm Credit Risk Variables							
Firm Credit Risk Variable With 4 Years Horizon							
I(FIRM RISK$_{ti}$)	0.03	0	0	0	0	1	0.17
Firm Credit Risk Variables With Other Horizons							
I(FIRM RISK 5 YEARS$_{ti}$)	0.03	0	0	0	0	1	0.17
I(FIRM RISK 3 YEARS$_{ti}$)	0.03	0	0	0	0	1	0.16
I(FIRM RISK 2 YEARS$_{ti}$)	0.02	0	0	0	0	1	0.14
I(FIRM RISK 1 YEAR$_{ti}$)	0.02	0	0	0	0	1	0.12
Macro Variables							
ΔOVERNIGHT RATE$_{t-1}$	0.26	−1.52	−0.08	0.23	0.74	1.48	0.71
ΔGDP$_{t-1}$	3.19	−0.27	3.00	3.46	3.83	3.98	0.88
ΔCPI$_{t-1}$	3.41	2.14	2.67	3.47	4.03	5.27	0.80
Bank Variables							
Bank Risk-Taking Variable							
BANK CAPITAL$_{t-1b}$	5.51	3.18	4.20	4.94	6.09	63.10	1.96
LN(BANK CAPITAL$_{t-1b}$)	1.66	1.16	1.44	1.60	1.81	4.14	0.30
Bank Controls							
LN(TOTAL ASSET$_{t-1b}$)	17.33	9.94	16.34	17.37	18.50	19.91	1.45
LIQUIDITY RATIO$_{t-1b}$	14.96	0.03	9.59	13.94	18.87	91.21	7.52
ROA$_{t-1b}$	0.98	−8.93	0.68	0.92	1.17	10.84	0.53
NPL RATIO$_{t-1b}$	0.90	0.00	0.36	0.62	1.03	16.08	0.89
I(COMMERCIAL BANK$_b$)	0.39	0	0	0	1	1	0.49
I(SAVINGS BANK$_b$)	0.54	0	0	1	1	1	0.50

[a]This table reports summary statistics for the sample with 241,052 observations from the 2002:02–2008:12 period. To improve the readability of the estimated coefficients, we divide the ΔOVERNIGHT RATE by 100 in all subsequent estimations.

Main results

TABLE II

MAIN RESULTS[a]

	(1)	(2)	(3)	(4)	(5) BENCHMARK	(6) TIME∗BANK FE
FIRST STEP						
Dependent Variable: I(GRANTING OF LOAN APPLICATIONS$_{tbi}$)						
I(FIRM RISK$_{ti}$)	−0.04***	−0.04***	−0.04***	−0.06***		
	(0.01)	(0.01)	(0.01)	(0.02)		
ΔOVERNIGHT RATE$_{t-1}$ ∗ I(FIRM RISK$_{ti}$)		−2.65**	−2.62*	1.26		
	(1.22)	(1.53)	(2.37)			
ΔOVERNIGHT RATE$_{t-1}$ ∗ I(FIRM RISK$_{ti}$) ∗ LN(BANK CAPITAL$_{t-1b}$)				6.97*	9.89**	9.73*
				(4.12)	(4.72)	(5.59)
Impact of 1 pp Decrease in Overnight Rate on Granting to Risky Firms						
– By the Mean Bank		*7.4%*	*7.4%*	*−3.5%*		
– By Lowly versus Highly Capitalized Bank (1 St. Dev. Difference)				*5.9%*	*8.4%*	*8.2%*
SECOND STEP						
Dependent Variable: LN(CREDIT AMOUNT$_{tbi}$)						
I(FIRM RISK$_{ti}$)	−0.23***	−0.17**	−0.15	−0.30		
	(0.08)	(0.08)	(0.10)	(0.24)		
ΔOVERNIGHT RATE$_{t-1}$ ∗ I(FIRM RISK$_{ti}$)		−27.39***	−25.68*	−62.59*		
		(9.93)	(13.14)	(37.51)		
ΔOVERNIGHT RATE$_{t-1}$ ∗ I(FIRM RISK$_{ti}$) ∗ LN(BANK CAPITAL$_{t-1b}$)				59.56**	58.94**	53.49^{+}
				(25.41)	(24.96)	(32.62)
Impact of 1 pp Decrease in Overnight Rate on Credit to Risky Firms						
– By the Mean Bank		*27.4%*	*25.7%*	*62.6%*		
– By Lowly versus Highly Capitalized Bank (1 St. Dev. Difference)				*18.0%*	*17.8%*	*16.1%*
Total Impact of 1 pp Decrease in Overnight Rate on Credit to Risky Firms						
– By the Mean Bank		*19.8%*	*19.2%*	*18.0%*		
– By Lowly versus Highly Capitalized Bank (1 St. Dev. Difference)				*14.6%*	*18.5%*	*17.8%*

(*Continues*)

Main results

TABLE II—*Continued*

	(1)	(2)	(3)	(4)	(5) BENCHMARK	(6) TIME∗BANK FE
(Year–Month) Fixed Effects	Yes	Yes	Yes	Yes	—	—
Firm Fixed Effects	No	No	No	Yes	—	—
Bank Fixed Effects	No	No	Yes	Yes	Yes	—
[(Year–Month)∗Firm] Fixed Effects	No	No	No	No	Yes	Yes
[(Year–Month)∗Bank] Fixed Effects	No	No	No	No	No	Yes
Bank Controls	Yes	Yes	Yes	Yes	Yes	—
$\{\Delta\text{GDP}_{t-1}, \Delta\text{CPI}_{t-1}\} * I(\text{FIRM RISK}_{ti}) * \text{LN}(\text{BANK CAPITAL}_{t-1b})$	No	No	No	Yes	Yes	Yes
$\Delta\text{OVERNIGHT RATE}_{t-1} * I(\text{FIRM RISK}_{ti}) * \{\text{Bank Controls}_{t-1b}\}$	No	No	No	Yes	Yes	Yes

[a]This table reports estimates from type-2 Tobit sample selection models, which explain the probability that a loan application is approved by a bank and the loan is granted to a firm that is new to the bank (extensive margin of new lending) and the committed amount of granted loans by the bank to a firm given its loan application was successful (intensive margin of new lending). The estimates of the first step in this table come from linear probability models using ordinary least squares and 241,052 observations from the 2002:02–2008:12 period. The estimates of the second step come from the second stage of a two-step estimation procedure for panel data sample selection models outlined by Kyriazidou (1997) using kernel least squares. It uses 38,334 observations. The dependent variables are $I(\text{GRANTING OF LOAN APPLICATIONS}_{tbi})$, which equals 1 if the loan application made in month t to bank b by firm i is successful and the loan is granted in t to $t+3$, and equals 0 otherwise; and $\text{LN}(\text{CREDIT AMOUNT}_{tbi})$, which following a successful application filed in month t to bank b by firm i is the logarithm of the committed loan amount granted by bank b to firm i in t to $t+3$. The definition of the independent variables can be found in the Appendix (FIRM RISK is based on a 4-year credit history). Where possible, a constant is included but its coefficient is left unreported. When firm fixed effects are not included, firm observables are included; see the main text. Where possible, all macro, bank, and firm variables in triple interactions are included in levels and in double interactions but their coefficients are left unreported. Fixed effects are either included ("Yes"), not included ("No"), or spanned by another set of effects ("—"). For each variable the first row lists the coefficient, the second row lists the robust standard error that is corrected for multiclustering at the year–month, bank and firm level; the corresponding significance levels are adjacent to the coefficient in the second column. The single-stage/total impact is calculated as the percent change in the mean granting probability or/times the credit amount following a one percentage point decrease in the overnight interest rate and lending to firms with doubtful loans in the previous four years by a mean bank or by a lowly versus highly capitalized bank that differ by one standard deviation in capitalization. [+]The coefficient has a p-value that equals 10.1 percent. $^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$.

Main results

FIGURE 1.—The probability a loan application is granted (left-hand scale) by a bank with low versus high capital (by median) to an otherwise average firm with non-performing loans outstanding in the previous 4 years (HR) versus a firm without (LR), and the change in the overnight interest rate (right-hand scale).

Main results

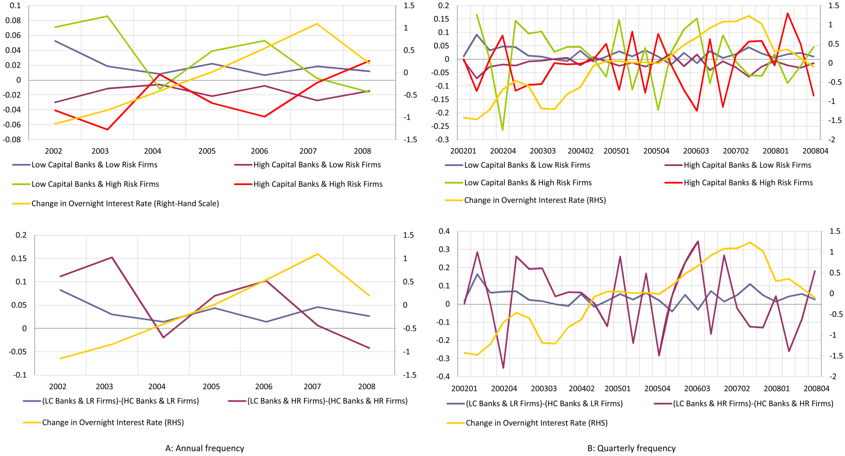


FIGURE 2.—The logarithm of the committed amount of granted loans (left-hand scale) by a bank with low versus high capital (by median) to an otherwise average firm with non-performing loans outstanding in the previous 4 years (HR) versus a firm without (LR), and the change in the overnight interest rate (right-hand scale).

1. Evidence
    - Bernanke and Blinder (1992)
    - Kashyap et al. (1993)
    - Kashyap and Stein (2000)
    - Mitchell et al. (2007)
    - Krishnamurthy and Vissing-Jorgensen (2011)
    - Gilchrist and Zakrajsek (2012)
    - Jiménez et al. (2014)
    - Chodorow-Reich (2014)
    - Gertler and Karadi (2015)
    - Giroud and Mueller (2017)
2. Models
    - Benchmark: Deterministic Q-theory
    - Holmström and Tirole (1998)
    - Brunnermeier and Sannikov (2017)

Chodorow-Reich (2014) Abstract

The employment effects of credit market disruptions: firm-level evidence from the 2008–9 financial crisis

This article investigates the effect of bank lending frictions on employment outcomes. I construct a new data set that combines information on **banking relationships and employment at 2,000 nonfinancial firms during the 2008–9 crisis**. The article first verifies **empirically the importance of banking relationships, which imply a cost to borrowers who switch lenders**. I then use the dispersion in lender health following the Lehman crisis as a source of **exogenous variation in the availability of credit to borrowers**. I find that **credit matters**. Firms that had **precrisis relationships with less healthy lenders had a lower likelihood of obtaining a loan following the Lehman bankruptcy, paid a higher interest rate if they did borrow, and reduced employment by more compared to precrisis clients of healthier lenders**. Consistent with frictions deriving from asymmetric information, the effects vary by firm type. Lender health has an economically and statistically significant effect on employment at small and medium firms, but the data cannot reject the hypothesis of no effect at the largest or

Results

TABLE I

BANKING RELATIONSHIP REGRESSIONS

	(1)	(2)	(3)	(4)
	Lender chosen as lead		Lender chosen as participant	
Explanatory variables				
Previous lead	0.71**	0.67**	0.022**	-0.023**
	(0.011)	(0.012)	(0.0040)	(0.0045)
Previous participant	0.029**	0.020**	0.50**	0.46**
	(0.0014)	(0.0015)	(0.011)	(0.011)
Previous lead × Public (Unrated)	−0.052**	−0.043*		
	(0.016)	(0.017)		
Previous lead × Public (Rated)	−0.058**	−0.086**		
	(0.014)	(0.016)		
Previous participant × Public (Unrated)			0.039*	0.033+
			(0.018)	(0.018)
Previous participant × Public (Rated)			0.012	−0.038*
			(0.014)	(0.015)
Lender FE	Yes	Yes	Yes	Yes
2-digit SIC × lender FE	No	Yes	No	Yes
State × lender FE	No	Yes	No	Yes
Year × lender FE	No	Yes	No	Yes
Public/private × lender FE	No	Yes	No	Yes
All in drawn quartile × lender FE	No	Yes	No	Yes
Sales quartile × lender FE	No	Yes	No	Yes
R^2	0.480	0.504	0.285	0.334
Borrower clusters	3,253	3,253	3,253	3,253
Observations	349,008	349,008	349,008	349,008

Notes. The dependent variable is an indicator for whether the lender serves in the role indicated in the table header. For each loan in which the borrower has previous accessed the syndicated market, the data set contains one observation for each potential lender, where a potential lender is a lender active in the syndicated loan market in that year. The variables Previous lead and Previous participant equal 1 if the lender served as the lead or as a participant on the borrower's previous loan, respectively. The sample covers 2001 to June 2009 and excludes loans to borrowers in finance, insurance, or real estate, and for which the purpose of the loan is not working capital or general corporate purposes. Estimation is via OLS. Standard errors in parentheses and clustered by borrower. +, *, and ** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Results

TABLE I

Banking Relationship Regressions

	(1)	(2)	(3)	(4)
	Lender chosen as lead		Lender chosen as participant	
Explanatory variables				
Previous lead	0.71**	0.67**	0.022**	-0.023**
	(0.011)	(0.012)	(0.0040)	(0.0045)
Previous participant	0.029**	0.020**	0.50**	0.46**
	(0.0014)	(0.0015)	(0.011)	(0.011)
Previous lead × Public (Unrated)	−0.052**	−0.043*		
	(0.016)	(0.017)		
Previous lead × Public (Rated)	−0.058**	−0.086**		
	(0.014)	(0.016)		
Previous participant × Public (Unrated)			0.039*	0.033+
			(0.018)	(0.018)
Previous participant × Public (Rated)			0.012	−0.038*
			(0.014)	(0.015)
Lender FE	Yes	Yes	Yes	Yes
2-digit SIC × lender FE	No	Yes	No	Yes
State × lender FE	No	Yes	No	Yes
Year × lender FE	No	Yes	No	Yes
Public/private × lender FE	No	Yes	No	Yes
All in drawn quartile × lender FE	No	Yes	No	Yes
Sales quartile × lender FE	No	Yes	No	Yes
R^2	0.480	0.504	0.285	0.334
Borrower clusters	3,253	3,253	3,253	3,253
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Notes. The dependent variable is an indicator for whether the lender serves in the role indicated in the table header. For each loan in which the borrower has previous accessed the syndicated market, the data set contains one observation for each potential lender, where a potential lender is a lender active in the syndicated loan market in that year. The variables Previous lead and Previous participant equal 1 if the lender served as the lead or as a participant on the borrower's previous loan, respectively. The sample covers 2001 to June 2009 and excludes loans to borrowers in finance, insurance, or real estate, and for which the purpose of the loan is not working capital or general corporate purposes. Estimation is via OLS. Standard errors in parentheses and clustered by borrower. +, *, and ** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Results

TABLE II

SAMPLE SUMMARY STATISTICS

	N	Mean	Std. Dev.	p10	p50	p90
	Panel A: Firm variables					
Loan size (millions of 2005 dollars)						
All lenders	4,791	287	530	23	119	693
Top 43 lenders	4,391	302	542	26	129	720
Merged Dealscan-LDB	2,040	305	544	27	131	703
Sales at close (millions of 2005 dollars)						
All lenders	3,954	1,836	4,059	53	433	4,661
Top 43 lenders	3,623	1,928	4,149	60	478	4,869
Merged Dealscan-LDB	1,721	2,024	4,310	68	551	4,813
Employment growth rate, 2008:3–2009:3	2,040	−0.09	0.23	−0.29	−0.06	0.08
2008 employment level	2,040	2,985	9,993	77	620	6,128
	Panel B: Bank variables					
%Δ number of loans	43	−52.4	29.3	−87.4	−58.8	−7.5
Lehman cosyndication exposure (%)	42	1.15	1.20	0.34	0.72	1.91
ABX exposure	40	1.16	0.46	0.71	1.07	1.77
2007–8 trading revenue/assets (%)	42	−0.08	0.62	−0.72	0.01	0.39
2007–8 real estate net charge-offs/assets (%)	21	0.24	0.23	0.04	0.18	0.49
2007 deposits/assets (%)	43	42.2	25.4	3.0	47.4	68.2

Notes. The sample includes non-FIRE U.S. borrowers that obtained a loan for working capital or corporate purposes and with valid state, industry, and public/private status identifiers, excluding the top 1% by sales. Statistics for loan size and borrower sales correspond to information as of the last loan obtained by each borrower prior to September 2008. Rows indicated by Top 43 lenders include only borrowers whose last precrisis loan included one of the most active 43 lenders as a lead arranger. Rows indicated by merged Dealscan-LDB and the employment statistics include only borrowers matched to the LDB. The variable %Δ loans equals the change in the annualized number of loans made by the bank between the periods October 2005 to June 2007 and October 2008 to June 2009. The variable Lehman co-syndication exposure equals the fraction of the bank's syndication portfolio where Lehman Brothers had a lead role in the loan deal. The variable ABX exposure equals the loading of the bank's stock return on the ABX AAA 2006-H1 index between October 2007 and December 2007.

Results

(3 month Treasury–Eurodollar spread, basis points)

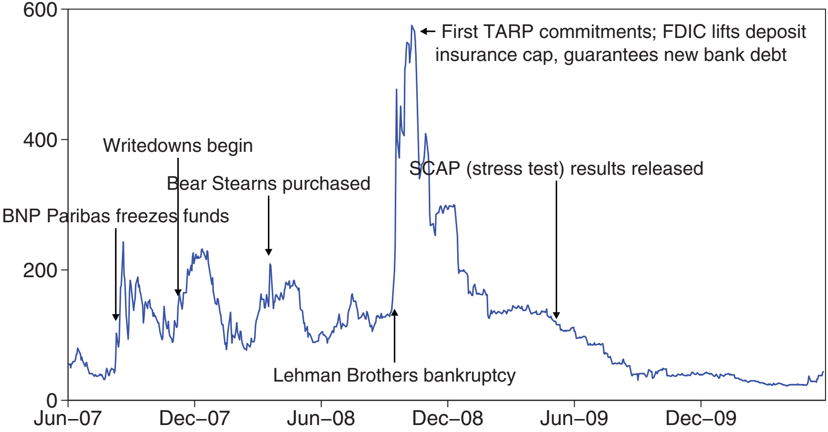

FIGURE I

Stress in the Interbank Lending Market

Source: Federal Reserve Board of Governors (H.15 Release).

Results

TABLE III

Determinants of Bank Lending

	(1)	(2)	(3)
	Change in lending during the crisis		
Explanatory variables			
Lehman cosyndication exposure	−0.14**		
	(0.049)		
ABX exposure		−0.11*	
		(0.041)	
2007–8 trading revenue/assets			0.046
			(0.040)
Real estate charge-offs flag			0.012
			(0.050)
2007–8 real estate net charge-offs/assets			−0.092+
			(0.051)
2007 Bank Deposits/Assets			0.19**
			(0.059)
Joint test p-value	0.008	0.013	0.002
R^2	0.16	0.15	0.35
Observations	42	40	42

Notes. The dependent variable is the change in the annualized number of loans made by the bank between the periods October 2005 to June 2007 and October 2008 to June 2009, with each loan scaled by the importance of the lender in the loan syndicate as described in Section IV.C of the text. Observations weighted by number of precrisis borrowers. The explanatory variables have been normalized to have unit variance. +, *, and ** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Results

TABLE IV

BALANCING OF COVARIATES IN THE SAMPLE

	Quantile of lender health 1	2	3	4	Memo: std. dev.
Mean employment change in					
Borrower's industry, 2008:3–2009:3	−0.086	−0.081	−0.085	−0.089	0.083
Borrower's county, 2008:3–2009:3	−0.056	−0.056	−0.056	−0.056	0.009
Share with bond market access	0.455	0.540	0.458	0.236	0.494
Share private, no bond market access	0.418	0.331	0.363	0.525	0.492
Share public, no bond market access	0.127	0.129	0.179	0.239	0.374
Mean all in drawn spread	266	155	156	199	133
Median sales at close ($2005 billions)	0.366	0.837	0.701	0.285	4.146
Mean year of last precrisis loan	2005.83	2005.98	2006.03	2006.05	1.50
Share with loan due during crisis	0.193	0.188	0.183	0.205	0.394

Notes. The table splits the sample into four quantiles based on the change in the annualized number of loans made by the borrower's last precrisis syndicate between the periods October 2005 to June 2007 and October 2008 to June 2009. Employment change by borrower industry computed at the four-digit SIC level using six-digit NAICS employment levels from the Quarterly Census of Wages and Employment and a SIC-NAICS concordance table available from the BLS. Employment change by borrower county computed by averaging the employment change in all counties in which a firm operates establishments using establishment employment shares as weights. The last column reports the standard deviation of the variable summarized in each row.

Results

TABLE VI

The Effect of Bank Health on the Likelihood of Obtaining a Loan

	(1)	(2)	(3)	(4)	(5)	(6)
	Firm obtains a new loan or positive modification					
	Probit		$\Delta\tilde{L}_{i,s}$ instrumented using			
			Lehman exposure	ABX exposure	Bank statement items	All
Explanatory variables						
%Δ loans to other firms ($\Delta\tilde{L}_{i,s}$)	2.19**	2.00**	3.65**	2.33*	2.28**	2.32**
	(0.79)	(0.53)	(1.28)	(1.12)	(0.64)	(0.63)
2-digit SIC, state, loan year FE	No	Yes	Yes	Yes	Yes	Yes
Bond access/public/private FE	No	Yes	Yes	Yes	Yes	Yes
Additional Dealscan controls	No	Yes	Yes	Yes	Yes	Yes
First stage F-statistic			14.0	8.2	18.2	19.8
J-statistic p-value			.	.	.	0.206
$E[borrow]$	0.134	0.134	0.134	0.134	0.134	0.134
$E[\widehat{borrow}:\Delta\tilde{L}_{p_{90}} - \Delta\tilde{L}_{p_{10}}]$	0.052	0.048	0.087	0.055	0.054	0.055
Lead lender 1 clusters	43	43	43	40	43	40
Lead lender 2 clusters	43	43	43	40	43	40
Observations	4,391	4,391	4,391	4,354	4,391	4,354

Notes. The dependent variable is an indicator for whether the borrower signed a new loan or received a favorable modification to an existing loan between October 2008 and June 2009. The variable $\Delta\tilde{L}_{i,s}$ equals the change in the annualized number of loans made by the bank between the periods October 2005 to June 2007 and October 2008 to June 2009, and has been normalized to have unit variance. The variable Lehman cosyndication exposure equals the fraction of the bank's syndication portfolio where Lehman Brothers had a lead role in the loan deal. The variable ABX exposure equals the loading of the bank's stock return on the ABX AAA 2006-H1 index between October 2007 and December 2007. The balance sheet and income statement items include the ratio of deposits to assets at the end of 2007, the ratio of trading revenue over 2007–8 to assets, the ratio of net real estate charge-offs over 2007–8 to assets, and an indicator for reporting real estate charge-offs. The last column includes all of the instruments. For each firm, the bank-level measures are averaged over the members of the firm's last precrisis loan syndicate, with weights given according to each bank's role. In columns (1) and (2) estimation is via probit, and the table reports marginal coefficients. In columns (3)–(6) $\Delta\tilde{L}_{i,s}$ is instrumented using the variable indicated in the column heading and estimation is via two-stage least squares. Borrower-level covariates are as of the last precrisis loan taken by each borrower. Additional Dealscan controls: multiple lead lenders indicator, loan due during crisis indicator, credit line indicator, log sales at close, all in drawn spread, credit line * all in drawn. Standard errors in parentheses and two-way clustered on the lead lenders in the borrower's last precrisis loan syndicate. +, *, and ** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Results

TABLE VII

THE EFFECT OF BANK HEALTH ON INTEREST RATE SPREADS

	(1)	(2)	(3)	(4)	(5)	(6)
	Change in interest rate spread					
	OLS		$\Delta\tilde{L}_{i,s}$ instrumented using			
			Lehman exposure	ABX exposure	Bank statement items	All
Explanatory variables						
%Δ loans to other firms ($\Delta\tilde{L}_{i,s}$)	−14.6**	−12.2**	−23.1*	−20.0	−17.2*	−17.6**
	(5.26)	(4.15)	(11.2)	(13.3)	(7.63)	(6.68)
1-digit SIC, loan year FE	No	Yes	Yes	Yes	Yes	Yes
Bond access/public/private FE	No	Yes	Yes	Yes	Yes	Yes
Additional Dealscan controls	No	Yes	Yes	Yes	Yes	Yes
First stage F-statistic			60.5	7.8	14.3	14.5
J-statistic p-value	.	.	.	.	.	0.967
$E[\Delta Spread]$	130.6	130.6	130.6	130.7	130.6	130.7
$E[\widehat{Spread}{:}\Delta\tilde{L}_{p_{90}} - \Delta\tilde{L}_{p_{10}}]$	−39.7	−33.0	−62.8	−54.3	−46.6	−47.7
Lead lender 1 clusters	34	34	34	32	34	32
Lead lender 2 clusters	30	30	30	28	30	28
Observations	350	350	350	346	350	346

Notes. The dependent variable is the interest spread, in basis points, charged to a firm on a loan starting between October 2008 and June 2009, less the interest spread charged to the same firm on its last loan of the same type (credit line or term loan) obtained prior to September 15, 2008. The regressions exclude loan pairs with an increase of >400 basis points. See the text for further details of the sample construction. The variable $\Delta\tilde{L}_{i,s}$ equals the change in the annualized number of loans made by the bank between the periods October 2005 to June 2007 and October 2008 to June 2009 and has been normalized to have unit variance. The variable Lehman cosyndication exposure equals the fraction of the bank's syndication portfolio where Lehman Brothers had a lead role in the loan deal. The variable ABX exposure equals the loading of the bank's stock return on the ABX AAA 2006-H1 index between October 2007 and December 2007. The balance sheet and income statement items include the ratio of deposits to assets at the end of 2007, the ratio of trading revenue over 2007–8 to assets, the ratio of net real estate charge-offs over 2007–8 to assets, and an indicator for reporting real estate charge-offs. For each firm, the bank-level measures are averaged over the members of the firm's last precrisis loan syndicate, with weights given according to each bank's role. Additional Dealscan controls: multiple lead lenders indicator, loan due during crisis indicator, credit line indicator, log sales at close, all in drawn spread, credit line * all in drawn. Standard errors in parentheses and two-way clustered on the lead lenders in the borrower's last precrisis loan syndicate. +, *, and ** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Results

TABLE VIII

Bond Market Access and Employment

	(1)	(2)
	Employment growth rate 2008:3–2009:3	
Explanatory variables		
No bond market access	–2.65**	–3.15**
	(0.98)	(1.10)
2-digit SIC and state FE	No	Yes
Firm size bin FE	No	Yes
Firm age bin FE	No	Yes
Lagged employment growth	No	Yes
County employment growth	No	Yes
R^2	0.003	0.172
Observations	2,040	2,040

Notes. The dependent variable is the symmetric growth rate g_j^y of employment. Firms that do not have access to the bond market do not have a credit rating from either Moody's or Standard and Poors, and have never issued public debt. Firms divided into size bin classes of 1–250, 250–999, and 1,000+, and age bins for birth in the 2000s, 1990s, or earlier. Eicker-White standard errors in parentheses. +, *, and ** indicate significance at the 0.1, 0.05, and 0.01, levels respectively.

Results

TABLE IX

The Effect of Lender Credit Supply on Employment

	(1)	(2)	(3)	(4)	(5)	(6)
	Employment growth rate 2008:3–2009:3					
	OLS		$\Delta\tilde{L}_{i,s}$ instrumented using			
			Lehman exposure	ABX exposure	Bank statement items	All
Explanatory variables						
%Δ loans to other firms ($\Delta\tilde{L}_{i,s}$)	1.17*	1.67**	2.49*	3.17*	2.13*	2.38**
	(0.58)	(0.61)	(1.00)	(1.35)	(0.88)	(0.77)
Lagged employment growth		0.0033	0.0039	0.0045	0.0036	0.0039
		(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
Emp. change in firm's county		0.89*	0.85+	0.86+	0.87+	0.89+
		(0.43)	(0.46)	(0.48)	(0.45)	(0.46)
2-digit SIC, state, loan year FE	No	Yes	Yes	Yes	Yes	Yes
Firm size bin FE	No	Yes	Yes	Yes	Yes	Yes
Firm age bin FE	No	Yes	Yes	Yes	Yes	Yes
Bond access/public/private FE	No	Yes	Yes	Yes	Yes	Yes
Additional Dealscan controls	No	Yes	Yes	Yes	Yes	Yes
First-stage F-statistic			15.5	8.5	18.5	23.1
J-statistic p-value			.	.	.	0.190
$E[g_j^y]$	−0.092	−0.092	−0.092	−0.093	−0.092	−0.093
$E[\tilde{g}_j^y{:}\Delta\tilde{L}_{p_{90}} - \Delta\tilde{L}_{p_{10}}]$	0.027	0.039	0.058	0.074	0.050	0.055
Lead lender 1 clusters	43	43	43	40	43	40
Lead lender 2 clusters	43	43	43	40	43	40
Observations	2,040	2,040	2,040	2,015	2,040	2,015

Notes. The dependent variable is the symmetric growth rate g_j^y of employment. The variable $\Delta\tilde{L}_{i,s}$ equals the change in the annualized number of loans made by the bank between the periods October 2005 to June 2007 and October 2008 to June 2009 and has been normalized to have unit variance. The variable Lehman co-syndication exposure equals the fraction of the bank's syndication portfolio where Lehman Brothers had a lead role in the loan deal. The variable ABX exposure equals the loading of the bank's stock return on the ABX AAA 2006-H1 index between October 2007 and December 2007. The balance sheet and income statement items include the ratio of deposits to assets at the end of 2007, the ratio of trading revenue over 2007–8 to assets, the ratio of net real estate charge-offs over 2007–8 to assets, and an indicator for report real estate charge-offs. For each firm, the bank-level measures are averaged over the members of the firm's last precrisis loan syndicate, with weights given according to each bank's role. In columns (1) and (2) estimation is via OLS. In columns (3)–(6) $\Delta\tilde{L}_{i,s}$ is instrumented using the variable indicated in the column heading. Borrower-level covariates are as of the last precrisis loan taken by each borrower. Firms divided into size bin classes of 1–250, 250–999, and 1,000+, and age bins for birth in the 2000s, 1990s, or earlier. Additional Dealscan controls: multiple lead lenders indicator, loan due during crisis indicator, credit line indicator, log sales at close, all in drawn spread, credit line * all in drawn. Standard errors in parentheses and two-way clustered on the lead lenders in the borrower's last precrisis loan syndicate. +, *, and ** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

1. Evidence
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   - Giroud and Mueller (2017)

2. Models
   - Benchmark: Deterministic Q-theory
   - Holmström and Tirole (1998)
   - Brunnermeier and Sannikov (2017)

Gertler and Karadi (2015) Abstract

We provide evidence on the transmission of monetary policy shocks in a setting with both economic and financial variables. We first show that shocks identified using high frequency surprises around policy announcements as external instruments produce responses in output and inflation that are typical in monetary VAR analysis. We also find, however, that the resulting "modest" movements in short rates lead to "large" movements in credit costs, which are due mainly to the reaction of both term premia and credit spreads. Finally, we show that forward guidance is important to the overall strength of policy transmission.

Results

TABLE 1—YIELD EFFECTS OF MONETARY POLICY SHOCKS (*Daily,* 1991–2012)

Indicator and instruments	2 year (1)	5 year (2)	10 year (3)	30 year (4)	5 × 5 forw (5)	Baa+ (6)	Mortg.+ (7)
FF, FF1	0.367***	0.233**	0.0980	0.00637	−0.0369	0.139	0.170
	(3.467)	(2.241)	(1.053)	(0.103)	(−0.388)	(1.475)	(1.445)
1 YR, FF1	0.739***	0.469***	0.197	0.0128	−0.0744	0.280	0.343
	(8.493)	(3.094)	(1.173)	(0.103)	(−0.379)	(1.544)	(1.416)
1 YR, FF4	0.880***	0.683***	0.375***	0.145*	0.0668	0.333**	0.427**
	(15.81)	(8.201)	(4.410)	(1.694)	(0.614)	(2.176)	(2.239)
2 YR, FF4		0.778***	0.432***	0.169*	0.0848	0.355**	0.483**
		(11.80)	(5.306)	(1.839)	(0.702)	(1.986)	(2.141)
2 YR, GSS		0.878***	0.575***	0.234***	0.271***	0.231*	0.350**
		(18.70)	(11.84)	(4.139)	(3.601)	(1.844)	(2.049)

Note: Robust *z*-statistics in parentheses; QE dates and crisis period are excluded, 188 observations.
+Two-week cumulative changes
***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

1. Evidence
   - Bernanke and Blinder (1992)
   - Kashyap et al. (1993)
   - Kashyap and Stein (2000)
   - Mitchell et al. (2007)
   - Krishnamurthy and Vissing-Jorgensen (2011)
   - Gilchrist and Zakrajsek (2012)
   - Jiménez et al. (2014)
   - Chodorow-Reich (2014)
   - Gertler and Karadi (2015)
   - **Giroud and Mueller (2017)**
2. Models
   - Benchmark: Deterministic Q-theory
   - Holmström and Tirole (1998)
   - Brunnermeier and Sannikov (2017)

Giroud and Mueller (2017) Overview

This article argues that firms' balance sheets were instrumental in the transmission of **consumer demand shocks** during the Great Recession. Using **micro-level data from the U.S. Census Bureau**, we find that **establishments of more highly levered firms experienced significantly larger employment losses** in response to declines in local consumer demand. These results are not driven by firms being less productive, having expanded too much prior to the Great Recession, or being generally more sensitive to fluctuations in either aggregate employment or house prices. Likewise, at the **county level**, we find that counties with more highly levered firms experienced significantly larger declines in employment in response to **local consumer demand shocks**. Accordingly, firms' balance sheets also matter for aggregate employment. Our results suggest a **possible role for employment policies that target firms directly besides conventional stimulus**.

Summary Statistics

TABLE I
SUMMARY STATISTICS

	Mean	Std. dev.	Correlation with Leverage_{06}	p-value of correlation
Panel A: Establishment level (N = 284,800)				
Employees_{06}	39	63	−0.028	.283
$\Delta\text{Log(Emp)}_{07-09}$	−8.2	24.2	−0.047**	.020
$\Delta\text{Log(HP)}_{06-09}$	−14.5	16.1	0.005	.718
Housing supply elasticity	1.799	0.927	0.011	.345
Census regions				
Northeast	0.17	0.38	0.004	.801
Midwest	0.21	0.41	−0.006	.610
South	0.38	0.49	0.002	.894
West	0.24	0.42	−0.000	.978
Industry sectors				
Tradable	0.03	0.18	0.001	.954
Nontradable	0.44	0.5	−0.146**	.014
Other	0.53	0.5	0.145**	.013
Panel B: Firm level 2006 (N = 2,800)				
$\text{Establishments}_{06}$	101	451	−0.015	.495
Employees_{06}	4,005	16,384	−0.008	.191
Assets_{06}	3,040	18,515	−0.003	.655
ROA_{06}	0.045	0.177	−0.073***	.003
NPM_{06}	0.024	0.28	−0.041**	.032
TFP_{06}	−0.002	0.599	−0.083***	.004
Leverage_{06}	0.227	0.253	1.000***	.000
WW_{06}	−0.251	0.135	0.189***	.000
KZ_{06}	−4.067	44.295	0.259***	.000

Summary Statistics

TABLE I

(CONTINUED)

	Mean	Std. dev.	Correlation with Leverage$_{06}$	p-value of correlation
Panel C: Firm level 2002–2006 (N = 2,800)				
ΔEstablishments$_{02-06}$	4.4	10.2	0.089***	.000
ΔLog(Emp)$_{02-06}$	0.052	0.093	0.048***	.009
ΔLog(Assets)$_{02-06}$	0.110	0.133	0.087***	.000
ΔROA$_{02-06}$	0.022	0.127	−0.061***	.003
ΔNPM$_{02-06}$	0.020	0.225	−0.032**	.015
ΔTFP$_{02-06}$	−0.001	0.569	−0.017	.649
ΔLeverage$_{02-06}$	−0.023	0.153	0.379***	.000
ΔWW$_{02-06}$	−0.006	0.08	0.085***	.000
ΔKZ$_{02-06}$	−0.370	49.633	0.188***	.000
Panel D: 10th and 90th percentiles of ΔLog(HP)$_{06-09}$ and leverage$_{06}$				
	10th	90th		
ΔLog(HP)$_{06-09}$	−0.402	0.035		
Leverage$_{06}$	0.000	0.568		

Notes. Panel A provides summary statistics at the establishment level. Leverage$_{06}$ is the ratio of the sum of debt in current liabilities and long-term debt to total assets associated with the establishment's parent firm in 2006. ΔLog(Emp)$_{07-09}$ is the percentage change in establishment-level employment from 2007 to 2009. ΔLog(HP)$_{06-09}$ is the percentage change in house prices in the establishment's zip code or county (if the zip code information is missing) from 2006 to 2009. Housing Supply Elasticity is described in Saiz (2010). Tradable and nontradaable industries are described in Mian and Sufi (2014a). "Other" industries are those that are neither tradable nor nontradable. Panels B and C provide summary statistics at the firm level. Assets is the book value of total assets. ROA (return on assets) is the ratio of operating income before depreciation to total assets. NPM (net profit margin) is the ratio of operating income before depreciation to sales. TFP (total factor productivity) is the residual from a regression of log(sales) on log(employees) and log(PP&E) across all Compustat firms in the same two-digit SIC industry. WW is the financial constraints index of Whited and Wu (2006). KZ is the financial constraints index of Kaplan and Zingales (1997). Panel D shows the 10th and 90th percentiles of Δ Log(HP)$_{06-09}$ and Leverage$_{06}$, respectively, used in counterfactual analyses in Section III.A. **, and *** denotes significance at the 5%, and 1% levels, respectively.

Results

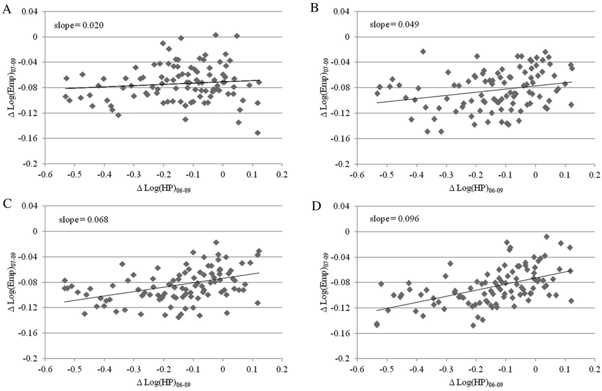

FIGURE I

Firm Leverage, House Prices, and Employment at the Establishment Level

The figure plots the percentage change in establishment-level employment between 2007 and 2009, $\Delta\text{Log(Emp)}_{07-09}$, against the percentage change in house prices in the establishment's zip code or county between 2006 and 2009, $\Delta\text{Log(HP)}_{06-09}$, for different quartiles of firm leverage. For each percentile of $\Delta\text{Log(HP)}_{06-09}$, the scatterplot depicts the mean values of $\Delta\text{Log(HP)}_{06-09}$ and $\Delta\text{Log(Emp)}_{07-09}$, respectively.

Results

TABLE II

FIRM LEVERAGE, CONSUMER DEMAND, AND EMPLOYMENT

	ΔLog(Emp)$_{07-09}$						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ΔLog(HP)$_{06-09}$	0.066***	0.029	0.029		0.027		
	(0.019)	(0.022)	(0.019)		(0.019)		
ΔLog(HP)$_{06-09}$ $\times$ Leverage$_{06}$		0.111***	0.114***	0.113***	0.084**	0.076**	0.075**
		(0.039)	(0.040)	(0.038)	(0.035)	(0.031)	(0.038)
Leverage$_{06}$		−0.028**	−0.032**	−0.020**			
		(0.014)	(0.015)	(0.009)			
Industry fixed effects	No	No	Yes	Yes	Yes	Yes	—
Firm fixed effects	No	No	No	No	Yes	Yes	Yes
Zip code fixed effects	No	No	No	Yes	No	Yes	—
Zip code $\times$ industry fixed effects	No	No	No	No	No	No	Yes
R-squared	0.00	0.00	0.04	0.13	0.17	0.25	0.31
Observations	284,800	284,800	284,800	284,800	284,800	284,800	284,800

Notes. The dependent variable, ΔLog(Emp)$_{07-09}$, is the percentage change in establishment-level employment from 2007 to 2009. ΔLog(HP)$_{06-09}$ is the percentage change in house prices in the establishment's zip code or county (if the zip code information is missing) from 2006 to 2009. Leverage$_{06}$ is the ratio of the sum of debt in current liabilities and long-term debt to total assets associated with the establishment's parent firm in 2006. Industry fixed effects are based on four-digit NAICS codes. All regressions are weighted by establishment size. Standard errors (in parentheses) are clustered at both the state and firm level. **, and *** denote significance at the 5%, and 1% levels, respectively.

Results

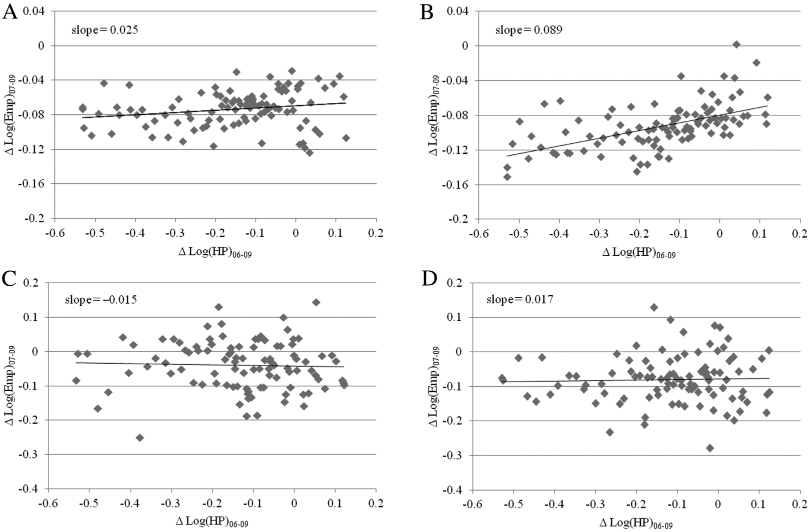

FIGURE II

Nontradable and Tradable Employment at the Establishment Level

Results

TABLE IV

TRADABLE AND NONTRADABLE INDUSTRIES

	ΔLog(Emp)$_{07-09}$			
	(1) Nontradable	(2) Tradable	(3) Nontradable	(4) Tradable
ΔLog(HP)$_{06-09}$	0.074**	0.009	0.029	−0.015
	(0.035)	(0.019)	(0.019)	(0.043)
ΔLog(HP)$_{06-09}$ × Leverage$_{06}$			0.131***	0.037
			(0.034)	(0.120)
Leverage$_{06}$			−0.038**	−0.026
			(0.015)	(0.020)
Industry fixed effects	Yes	Yes	Yes	Yes
R-squared	0.04	0.03	0.04	0.03
Observations	124,100	9,900	124,100	9,900

Notes. This table presents variants of the regressions in Table II in which the sample is restricted to tradable and nontradable industries, respectively. Tradable and nontradable industries are described in Mian and Sufi (2014a). All regressions are weighted by establishment size. Standard errors (in parentheses) are clustered at both the state and firm level. **, and *** denote significance at the 5%, and 1% levels, respectively.

Results

TABLE V

FIRM-LEVEL ANALYSIS

	External finance			Employment and investment		
	ΔST debt$_{07-09}$ (1)	ΔLT debt$_{07-09}$ (2)	ΔEquity$_{07-09}$ (3)	ΔLog(Emp)$_{07-09}$ (4)	Est. Closure$_{07-09}$ (5)	ΔCAPEX$_{07-09}$ (6)
ΔLog(HP)$_{06-09}$	−0.025**	−0.040**	0.005	0.020	−0.008	0.002
	(0.011)	(0.019)	(0.037)	(0.033)	(0.015)	(0.005)
ΔLog(HP)$_{06-09}$ × Leverage$_{06}$	0.035**	0.059**	−0.011	0.122***	−0.046**	0.014**
	(0.014)	(0.021)	(0.047)	(0.040)	(0.019)	(0.007)
Leverage$_{06}$	−0.011*	−0.019*	0.009	−0.024**	0.018**	−0.005*
	(0.006)	(0.011)	(0.021)	(0.010)	(0.008)	(0.003)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.09	0.08	0.03	0.11	0.11	0.14
Observations	2,800	2,800	2,800	2,800	2,800	2,800

Notes. This table presents firm-level variants of the regressions in Table II. Short-term (ST) debt is the ratio of debt in current liabilities divided by total assets. Long-term (LT) debt is the ratio of long-term debt divided by total assets. Equity is the ratio of the book value of equity divided by total assets. Establishment (Est.) closure is the number of establishments closed between 2007 and 2009 divided by the number of establishments in 2007. CAPEX is the ratio of capital expenditures to property, plant and equipment (PP&E). ΔLog(HP)$_{06-09}$ is aggregated at the firm level by computing the employment-weighted average value of Δ Log(HP)$_{06-09}$ across all of the firm's establishments. Industry fixed effects are based on four-digit NAICS codes. Standard errors (in parentheses) are clustered at the state level. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

1. Evidence
   - Bernanke and Blinder (1992)
   - Kashyap et al. (1993)
   - Kashyap and Stein (2000)
   - Mitchell et al. (2007)
   - Krishnamurthy and Vissing-Jorgensen (2011)
   - Gilchrist and Zakrajsek (2012)
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   - Gertler and Karadi (2015)
   - Giroud and Mueller (2017)
2. Models
   - Benchmark: Deterministic Q-theory
   - Holmström and Tirole (1998)
   - Brunnermeier and Sannikov (2017)

Introduction

- Models of frictionless investment (benchmark) imply that the capital structure should not affect firm value or investment, and that investment should depend only on q, and should be forward looking.
- Empirical evidence suggests borrowing constraints may matter.
- We want to build a model with such financial frictions.
- Today: a lecture based on:
  - Neoclassical models of investment.
  - Frictional model: Holmström and Tirole (1998)
  - Brunnermeier and Sannikov (2014)

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   - Gertler and Karadi (2015)
   - Giroud and Mueller (2017)

2. Models
   - **Benchmark: Deterministic Q-theory**
   - Holmström and Tirole (1998)
   - Brunnermeier and Sannikov (2017)

Set-up

- Demand for capital, in neoclassical theory given by the rental rate of capital $r_{K,t}$, so that firms solve:

$$\max_{k_t} \int_0^\infty e^{-\rho t} \left(\pi(k_t) - r_{K,t} k_t\right) dt.$$

- The optimal amount of capital is given by: $\boxed{\pi'(k_t) = r_{K,t}}$.
- But most capital is not rented. (and more importantly, we don't like to look at interest rate evidence. asset prices work better) Q-theory:

$$V(k_0) = \max_{i_t} \int_0^\infty e^{-\rho t} \left(\pi(k_t) - p_t i_t\right) dt$$
$$s.t. \quad \dot{k}_t = i_t - \delta k_t.$$

Set-up

- The profits nets of capital costs of the firm are given by:

$$\Pi(k_t) = \pi(k_t) - p_t i_t.$$

- If $\Pi(k_t) > 0$, firm pumps out cash in period t (repays debt, pays dividends).
- If $\Pi(k_t) < 0$, firm borrows in period t (issues debt, etc.)
- Implicit in this formulation is that the firm can invest more than it is producing in period t.
- In other words, any positive net present value is undertaken.
- This will remain true under the assumption of adjustment costs to capital.
- Hence, everything we'll do today will be referred to as "frictionless".

Hamiltonian I

- Detour: Optimal Control theory in continuous time.
- Consider the classic:

$$\max_{c_t} V(0) = \int_0^T v(k_t, c_t, t)dt$$
$$\text{s.t.} \quad \dot{k}_t = g(k_t, c_t, t), \quad t \in [0, T]$$
$$\text{s.t.} \quad k_0 \text{ given}$$
$$\text{s.t.} \quad k_T \geq 0$$

- T is finite or infinite.
- FOCs are:

$$\frac{\partial H}{\partial c_t} = 0, \quad \frac{\partial H}{\partial k_t} = -\dot{\mu}_t$$
$$\mu_T = 0 \quad \text{or} \quad k_T = 0.$$

- Intuition ?

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Set-up

- Objective: presenting the simplest model of a net worth channel.
- Two dates $t = 0, 1$ and one consumption good.
- Two Types of agents:
  - Entrepreneurs "E's"
  - Financiers (potential investors) "F's"
- Linear Preferences: $U = C_1 + \beta C_2$. Assume that the interest rate is $r = 1/\beta$.
- Entrepreneur E has endowment (net worth, equity) of N dollars at date 0. He has access to a fixed scale project:
  - Investing 1 dollar at date 0 yields output at date 1.
  - We have that $N < 1$ so that entrepreneurs need money.

  Entrepreneurs operate productive technologies, but do not have the money.

Moral Hazard

- The average return to the project is R, there are two states: high or low. If it succeeds, the project yields R/p_H, or fail.
- Problem: the entrepreneur may shirk and choose a project with lower chance of probability but that gives him a higher benefit. Because only one version of the project is observed ex-post, it is impossible to know whether the entrepreneur shirked or not. (information friction)
- Two versions of the project: the bad project has probability of success only $p_L < p_H$ but yields a private benefit B to the agent. Project yields 0 if it fails.

Moral Hazard

- A contract specifies a split of the output in case of success between financiers and entrepreneurs:

$$\frac{R^F}{p_H} \text{ and } \frac{R^E}{p_H}, \text{with } R^F + R^E \leq R.$$

- Assume that the problem is (at least a little bit) interesting so that:

$$\beta \left(p_L \frac{R}{p_H} + B \right) < 1 < \beta R,$$

so the project is positive NPV if E behaves, but negative NPV if he misbehaves.

Feasibility

- For Financiers to want to participate, they need in expectation to at least receive the market rate of return (entrepreneurs make the offer, so get the surplus):

$$\beta p_H \frac{R^F}{p_H} = 1 - N.$$

- For entrepreneurs not to shirk, (and this is necessary because otherwise project is negative NPV, so there is nothing to share) we need:

$$p_H \frac{R^E}{p_H} \geq p_L \frac{R^E}{p_H} + B,$$

which using a well-known notation in this literature (see Tirole, *The Theory of Corporate Finance*), $\Delta p = p_H - p_L$ gives:

$$R^E \geq \frac{p_H}{\Delta p} B.$$

Feasibility

- We then get that the maximum amount in the project which can be pledged to financiers, from the return R, is actually given by ρ such that R^F is never greater than ρ:

$$R^F \leq \rho = R - \frac{p_H}{\Delta p} B.$$

- Finance matters ! Some positive NPV projects may not be undertaken, if in particular the financiers are worse off than using the safe interest rate of $1/\beta$, which appears through their participation constraint:

$$1 - N \leq \beta \rho.$$

- That means that net worth of entrepreneurs needs to be at least as large as $\bar{N}$ so that financiers can at least break even and be maintained up against their participation constraint:

$$N \geq \bar{N} = 1 - \beta \rho.$$

Credit Rationing

- E's would be willing to pay a higher interest rate, were they able to commit to doing the "right thing". But they cannot pledge this future revenue because financiers know they will then have an incentive to divert it for their own use. (promise a higher R^F)
- **Credit rationing.** Prices have incentive effects, so market may clear through quantities rather than prices.

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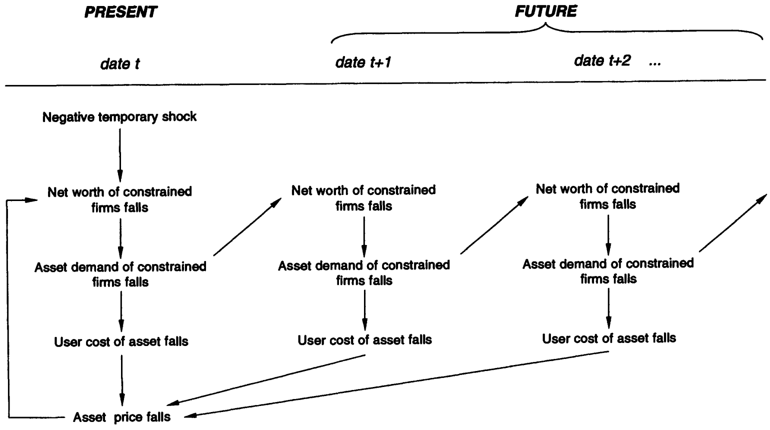
Key feature: Heterogeneity

- One does not only need financial frictions, but also heterogeneity.
- Why heterogeneity ?
- In Kiyotaki-Moore (1997): farmers and gatherers.
- In this paper: experts and households.
- But what are we really talking about? Banks? Types of financial institutions? Very general, but evidence needs to focus on "clean identification": specialized arbitragers, etc.

Set-up

- Very similar to Kiyotaki and Moore (1997): fire sales to non-experts, reduces prices further, experts' net worth, and so on...
- Only in continuous time instead of discrete time. More simple in some respects, more complicated in others.



Leveraged Financial Institutions

- Is that important? Yes, potentially.

	Assets ($bn)	Liabilities ($bn)	Capital ($bn)	Leverage
Commercial banks	11194	10050	1144	9.8
Savings Inst	1815	1607	208	8.7
Credit Unions	759	672	87	8.7
Finance Companies	1911	1720	191	10.0
Brokers/hedge funds	5597	5390	207	27.1
GSEs	1669	1598	71	23.5
Leveraged Sector	**22945**	**21037**	**1908**	**12.0**

Source: Authors' calculations based on Flow of Funds, FDIC Statistics on Banking, Adrian and Shin (2007), and balance sheet data for Fannie Mae, Freddie Mac, and broker-dealers under Goldman Sachs equity analysts' coverage.

Disclaimer: Models of information asymmetries usually get a key moment wrong

- Leverage is countercyclical in the model, but procyclical in the data.

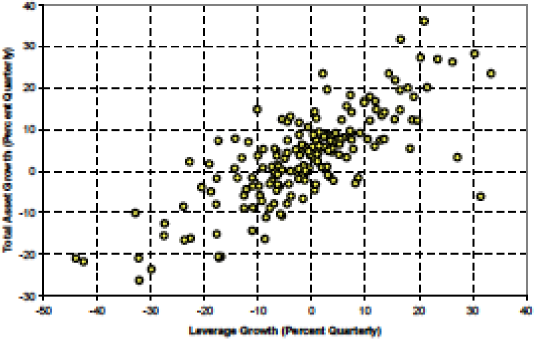


Figure 2.5: Total Assets and Leverage of Security Brokers and Dealers

Set-up in Brunnermeier and Sannikov (2014)

- Experts and Households. Only experts can invest in the asset, and issue riskless debt to households (exogenous).
- Technology available to experts is the following: capital k_t is able to produce an amount of goods y_t equal to:

$$y_t dt = a k_t dt.$$

- Experts' invest at a rate ι_t such that the dividends coming out of capital k_t in period dt are given by:

$$D_t dt = (a - \iota_t) k_t dt \quad \Rightarrow \quad \frac{D_t dt}{q_t k_t} = \frac{a - \iota_t}{q_t} dt.$$

- Agents' utility:

$$\max_{c_t, \text{portfolio}} \left[\int_0^\infty e^{-\rho t} \log(c_t) dt \right].$$

- Experts choose their portfolio, given they want compensation for risk.

Set-up

- The capital accumulation equation is:

$$\frac{dk_t}{k_t} = (\Phi(\iota_t) - \delta)\, dt + \sigma dZ_t.$$

- The endogenous price of capital is:

$$\frac{dq_t}{q_t} = \mu_t^q dt + \sigma_t^q dZ_t.$$

- q_t is given by the amount of "technological illiquidity":

$$\frac{1}{q_t} = \Phi'(\iota_t).$$

- Example:

$$\phi(\iota) = \frac{\log(\kappa\iota + 1)}{\kappa} \quad \Rightarrow \quad \iota_t = \frac{q_t - 1}{\kappa}$$

Coming back to last Time 1/2

- w_t is a Standard Brownian Motion (next denoted dZ_t):
  - The increments dw_t between t and $t + dt$ are i.i.d.
  - The increments are normally distributed with mean 0 and standard error $\sqrt{dt}$. This is a lot !!

$$\sqrt{dt} = \frac{1}{\sqrt{dt}} dt.$$

- We have:

$$dw_t = w(t + \Delta t) - w(t) = \epsilon_t \sqrt{\Delta t}, \quad \epsilon_t \sim N(0, 1).$$

- It is clear that:

$$\mathbb{E}_t(dw_t) = 0.$$

- We used:

$$\mathbb{E}_t\left(dw_t^2\right) = dt.$$

- In fact heuristically we even have:

$$dw_t^2 = dt.$$

Coming back to last Time 2/2

- Because $w(t+\Delta t) - w(t)$ is normal, we have that $(w(t+\Delta t) - w(t))^2$ is a χ_1^2 random variable:

$$\frac{(w(t+\Delta t) - w(t))^2}{\Delta t} \sim \chi_1^2.$$

- We have:

$$\text{var}\left[(w(t+\Delta t) - w(t))^2\right] = (\Delta t)^2 \text{var}(\chi_1^2) = 2(\Delta t)^2.$$

- This is of order 2 so that we have with certainty:

$$dw_t^2 = dt.$$

Reminder: Ito's Product / Division Rules

- Take two processes X_t, Y_t:

$$\frac{dX_t}{X_t} = \mu_t^X dt + \sigma_t^X dZ_t \qquad \frac{dY_t}{Y_t} = \mu_t^Y dt + \sigma_t^Y dZ_t.$$

- Multiplying these two processes (later useful for total capital):

$$\text{Careful !:} \quad d(X_t Y_t) = X_t dY_t + Y_t dX_t + dX_t dY_t.$$

$$\frac{d(X_t Y_t)}{X_t Y_t} = \left(\mu_t^X + \mu_t^Y + \sigma_t^X \sigma_t^Y\right) dt + \left(\sigma_t^X + \sigma_t^Y\right) dZ_t.$$

- Dividing the two processes (later useful for leverage ratios):

$$\frac{d(X_t/Y_t)}{X_t/Y_t} = \left(\mu_t^X - \mu_t^Y + \left(\sigma_t^Y\right)^2 - \sigma_t^X \sigma_t^Y\right) dt + \left(\sigma_t^X - \sigma_t^Y\right) dZ_t.$$

Applying

- Applying the formulas:

$$\frac{dk_t}{k_t} = (\Phi(\iota_t) - \delta)\,dt + \sigma dZ_t \qquad \frac{dq_t}{q_t} = \mu_t^q dt + \sigma_t^q dZ_t$$

$$\Rightarrow \quad \frac{dq_t k_t}{q_t k_t} = \left(\Phi(\iota_t) - \delta + \mu_t^q + \sigma\sigma_t^q\right) dt + (\sigma + \sigma_t^q) dZ_t.$$

- The total return on risky capital:

$$dr_t^K = \underbrace{\frac{a - \iota_t}{q_t} dt}_{\text{Dividend}} + \underbrace{\left(\Phi(\iota_t) - \delta + \mu_t^q + \sigma\sigma_t^q\right) dt + (\sigma + \sigma_t^q) dZ_t}_{\text{Capital Gain}}.$$

- Market clearing for consumption:

$$\rho q_t k_t = (a - \iota(q_t))k_t.$$

- Example:

$$q_t = \frac{a + 1/\kappa}{\rho + 1/\kappa}.$$

- In all cases, note that market clearing for consumption and q rule gives that q_t is constant (therefore i_t also) through:

$$\rho q_t k_t = (a - \iota(q_t))k_t \quad \Rightarrow \quad \boxed{\rho q_t = (a - \iota(q_t))}.$$

- Therefore $\sigma_t^q = 0$.
- Define the key state variable:

$$\frac{N_t}{q_t K_t} = \eta_t \in [0, 1].$$

- Experts absorb all net worth, so per unit N_t the risk is:

$$\frac{q_t K_t}{N_t}\sigma = \frac{\sigma}{\eta_t}$$

- The portfolio decision (subsumes stochastic discount factor) can be written in the form of the Sharpe Ratio (Volatility of wealth? = Sharpe Ratio of risky investment):

$$\frac{\sigma}{\eta_t} = \frac{\rho + \Phi(\iota) - \delta - r_t^F}{\sigma}.$$

Reminder: Asset Pricing in Continuous Time 1/2

- The analog to the one-period pricing equation $p = \mathbb{E}(mx)$, in an interval dt is, if θ_t is the marginal utility of consumption above $\theta_t = u'(c_t)$:

$$\mathbb{E}_t\left[d(e^{-\rho t}\theta_t p_t)\right] = 0$$

- Imagine that p_t is the price of a risky asset A paying no dividend, such that:

$$dr_t^A = \mu_t^A dt + \sigma_t^A dZ_t.$$

- Denoting the process for the marginal utility of consumption as:

$$\frac{d\theta_t}{\theta_t} = \mu_t^\theta dt + \sigma_t^\theta dZ_t.$$

- We have:

$$\frac{\mu_t^A - r_t^F}{\sigma_t^A} = -\sigma_t^\theta.$$

Reminder: Asset Pricing in Continuous Time 2/2

- Imagine that utility is CRRA with parameter γ:

$$u(c) = \frac{c^{1-\gamma}}{1-\gamma} \quad \Rightarrow \quad \theta_t = c_t^{-\gamma}.$$

- From Ito's lemma:

$$\frac{dc^{-\gamma}}{c^{-\gamma}} = \left(-\gamma\mu_t^c + \frac{\gamma(\gamma+1)}{2}\left(\mu_t^c\right)^2\right) dt - \gamma\sigma_t^c dZ_t.$$

- We then have that the portfolio condition writes:

$$\frac{\mu_t^A - r_t^F}{\sigma_t^A} = \gamma\sigma_t^c.$$

- We have:

$$\frac{dN_t}{N_t} = r_t^F dt + \frac{\sigma}{\eta_t} dZ_t + \frac{\sigma}{\eta_t}\frac{\sigma}{\eta_t} dt - \rho dt.$$

- And also (same dividend yield):

$$\frac{d(q_t K_t)}{q_t K_t} = r_t^F dt + \sigma \frac{\sigma}{\eta_t} dt + \sigma dZ_t - \rho dt.$$

- Using the division rule we get the law of motion for state variable:

$$\boxed{\frac{d\eta_t}{\eta_t} = \left(\frac{\sigma}{\eta_t} - \sigma\right)^2 dt + \left(\frac{\sigma}{\eta_t} - \sigma\right) dZ_t}.$$

- Price of capital q_t and ι_t do not fluctuate, risk free rate fluctuates, therefore risk premium fluctuates:

$$\boxed{r_t^F = \rho + \phi(\iota) - \delta - \frac{\sigma^2}{\eta_t}}.$$

- Total volatility is $\eta_t \sigma_t^\eta$ (relative volatility is σ_t^η):

$$\eta_t \sigma_t^\eta = \sigma(1 - \eta_t).$$

Summary of the model

- Mapping from shocks dZ_t to state variable:

$$\boxed{\frac{d\eta_t}{\eta_t} = \left(\frac{\sigma}{\eta_t} - \sigma\right)^2 dt + \left(\frac{\sigma}{\eta_t} - \sigma\right) dZ_t}.$$

- Mapping from state to endogenous variables:
  - Expected return on risky capital constant:

$$dr_t^K = (\rho + \phi(\iota) - \delta)dt + \sigma dZ_t \quad \Rightarrow \quad \boxed{\mathbb{E}\left[\frac{dr_t^K}{dt}\right] = \rho + \phi(\iota) - \delta}$$

  - All movements in risk premia come from risk free rate:

$$\boxed{r_t^F = \rho + \phi(\iota) - \delta - \frac{\sigma^2}{\eta_t}}.$$

- q, ι constant. No endogenous risk. All risk comes from fundamental risk. Risk premia come from reductions in risk free interest rate.

Next time

- We will see a more complicated version of that model, where households can also invest in equity, but will be more productive.
- Prices q_t will then fluctuate, there will be "endogenous risk" σ_t^q.
- We will treat risk neutral case/ log case in all generality.
- We will learn how to solve computationally these kinds of problems in different ways. (“shooting problems”)

Conclusion of this simple model

- In this lecture, we continue on the Brunnermeier-Sannikov (2014) model.
- Last time, we saw a very simplified version of this model. Basic ingredient: **households could never hold capital, by assumption**.
- Therefore, all capital had to be held by experts. Because of log utility for everyone, we had the key equation:

$$\rho q_t k_t = (a - \iota(q_t))k_t$$

  This determines q_t as a constant through time, just as ι.
- Therefore $\sigma_t^q = 0$, etc. Everything went through risk free rate.

More interesting model

- Key assumption now: HH can actually hold capital, they are just less productive at using it. This will change everything, and give interesting insights.
- More precisely, with experts the total return on risky capital was:

$$dr_t^K = \underbrace{\frac{a - \iota_t}{q_t}}_{\text{Dividend}} dt + \underbrace{\left(\Phi(\iota_t) - \delta + \mu_t^q + \sigma\sigma_t^q\right) dt + (\sigma + \sigma_t^q) dZ_t}_{\text{Capital Gain}}.$$

- Households can also buy equity but get return:

$$d\underline{r}_t^K = \underbrace{\frac{\underline{a} - \iota_t}{q_t}}_{\text{Dividend}} dt + \underbrace{\left(\Phi(\iota_t) - \delta + \mu_t^q + \sigma\sigma_t^q\right) dt + (\sigma + \sigma_t^q) dZ_t}_{\text{Capital Gain}}.$$

- We assume $\underline{a} < a$.

Additional ingredients

- We want entrepreneurs to potentially be hit badly by shocks.
- This will not happen if they can save their way out of constraints. So like in those models (HK or BGG do the same), we could "kill" entrepreneurs or make them become households stochastically.
- Instead, we make entrepreneurs more impatient so they really want to consume (issue dividends):

$$\underbrace{\mathbb{E}\left[\int_0^\infty e^{-\rho t} u(c_t) dt\right]}_{\text{Utility of experts}}, \qquad \underbrace{\mathbb{E}\left[\int_0^\infty e^{-rt} u(\underline{c}_t) dt\right]}_{\text{Utility of households}}.$$

- r discount rate of households $r < \rho$.
- ψ_t is the fraction of capital allocated to experts.

Additional ingredients

- Denoting by r_t^F the risk free rate, again asset pricing condition for experts is that:

$$\frac{\frac{a-\iota_t}{q_t} + \Phi(\iota_t) - \delta + \mu_t^q + \sigma\sigma_t^q - r_t^F}{\sigma + \sigma_t^q} = -\sigma_t^\theta.$$

- With σ_t^θ the marginal utility of wealth of experts:

$$\frac{d\theta_t}{\theta_t} = \mu_t^\theta dt + \sigma_t^\theta dZ_t$$

- Analogous relationship for households:

$$\text{if } \psi_t < 1, \qquad \frac{\frac{\underline{a}-\iota_t}{q_t} + \Phi(\iota_t) - \delta + \mu_t^q + \sigma\sigma_t^q - r_t^F}{\sigma + \sigma_t^q} = -\sigma_t^{\theta}$$

$$\text{if } \psi_t = 1, \qquad \frac{\frac{\underline{a}-\iota_t}{q_t} + \Phi(\iota_t) - \delta + \mu_t^q + \sigma\sigma_t^q - r_t^F}{\sigma + \sigma_t^q} \leq -\sigma_t^{\theta}$$

Additional ingredients

- Simple way to write this:

$$\psi_t = 1 \quad \text{or} \quad \frac{\frac{\underline{a}-\iota_t}{q_t} + \Phi(\iota_t) - \delta + \mu_t^q + \sigma\sigma_t^q - r_t^F}{\sigma + \sigma_t^q} = -\sigma_t^\theta$$

- We will not be using the second one, since we'll focus on the "normal regime".
- But this second equation potentially determines ψ_t.

Solving for Log-utility

- Assume log-utility for experts and households. It simplifies things a lot (as often with log...). Resource constraint is now:

$$r(1-\eta_t)q_t k_t + \rho\eta_t q_t k_t = \psi_t a k_t + (1-\psi_t)\underline{a}k_t - \iota(q_t)k_t.$$

- "Normal regime": experts manage all capital (no fire sale prices). Then $\psi_t = 1$.

- Remember in the simple case last time we had:

$$\frac{dN_t}{N_t} = r_t^F dt + \frac{\sigma}{\eta_t}dZ_t + \frac{\sigma}{\eta_t}\frac{\sigma}{\eta_t}dt - \rho dt.$$
$$\frac{d(q_t K_t)}{q_t K_t} = r_t^F dt + \sigma\frac{\sigma}{\eta_t}dt + \sigma dZ_t - \rho dt.$$

Close the model: Ito's Lemma

- Assume log-utility for experts and households. It simplifies things a lot (as often with Ito's Lemma is that if:

$$dx_t = \mu(x_t)dt + \sigma(x_t)dZ_t.$$

then the process $y_t = f(x_t)$ follows:

$$dy_t = \left[f'(x_t)\mu(x_t) + \frac{1}{2}f''(x_t)\sigma(x_t)^2\right]dt + f'(x_t)\sigma(x_t)dZ_t.$$

- Use Ito's Lemma repeatedly, for a function of η_t. For example, for $q(\eta_t)$:

$$\sigma_t^q = \frac{q'(\eta_t)}{q(\eta_t)}\eta_t\sigma_t^\eta.$$

- Similarly:

$$\sigma_t^\theta = \frac{\theta'(\eta_t)}{\theta(\eta_t)}\eta_t\sigma_t^\eta$$

Close the model: Ito's Lemma

- Symmetrically we have:

$$\frac{dN_t}{N_t} = r_t^F dt + \frac{\psi_t}{\eta_t}\left(\sigma + \sigma_t^q\right)\left(-\sigma_t^\theta\right) dt + ...$$

$$\frac{\psi_t}{\eta_t}(\sigma + \sigma_t^q) dZ_t - \frac{C_t}{N_t} dt$$

$$\frac{d(q_t K_t)}{q_t K_t} = r_t^F dt + (\sigma + \sigma_t^q)\left(\psi_t(-\sigma_t^\theta) + (1-\psi_t)(-\sigma_t^{\underline{\theta}})\right) dt + ...$$

$$(\sigma + \sigma_t^q) dZ_t - \frac{\psi_t a + (1-\psi_t)\underline{a} - \iota_t}{q_t} dt.$$

- This gives through Ito's division Rule, a formula for $\eta_t = N_t/(q_t K_t)$:

$$\frac{d\eta_t}{\eta_t} = ...$$

with, for example:

$$\sigma_t^\eta = \left(\frac{\psi_t}{\eta_t} - 1\right)(\sigma + \sigma_t^q).$$

Close the model: Ito's Lemma

- From this we get:

$$\sigma + \sigma_t^q = \frac{\sigma}{1 - \frac{q'(\eta_t)}{q(\eta_t)}(\psi_t - \eta_t)}.$$

- Similarly:

$$\sigma_t^\theta = \frac{\theta'(\eta_t)}{\theta(\eta_t)} \frac{(\psi_t - \eta_t)\sigma}{1 - \frac{q'(\eta_t)}{q(\eta_t)}(\psi_t - \eta_t)}.$$

- First is the no-crisis regime, with $\psi_t = 1$.
- Second if the crisis regime, with $\psi_t < 1$.
- For lack of time, let us look only at the no-crisis regime, to see how one can numerically solve the model.

No-crisis Regime $\psi_t = 1$

- Don't forget the resource constraint with $\iota(q_t)$ defined by the q-theory (equation $\Phi'(\iota_t) = 1/q_t$):

$$(r(1-\eta_t) + \rho\eta_t)q_t = a - \iota(q_t).$$

- This gives straightforwardly $q(\eta_t)$. Then compute the volatility of q_t which is given by:

$$\sigma + \sigma_t^q = \frac{\sigma}{1 - \frac{q'(\eta_t)}{q(\eta_t)}(1-\eta_t)}.$$

- From there one finds that of η_t through:

$$\sigma_t^\eta = \left(\frac{\psi_t}{\eta_t} - 1\right)(\sigma + \sigma_t^q).$$

- And the drift of η_t through:

$$\mu_t^\eta = (r-\rho)(1-\eta_t) + \frac{1-\psi_t}{1-\eta_t}(\sigma + \sigma_t^q)\sigma_t^\eta + (\sigma_t^\eta)^2.$$

No-crisis Regime $\psi_t = 1$

- One then has the law of motion of η_t in the no-crisis regime.
- One can then draw functions $q(\eta_t)$, $\theta(\eta_t)$, and so on.
- The same can be done for the case where $\psi_t < 1$, that is the crisis regime. In that case one needs another equation, to determine $\psi_t < 1$. Again, it is the fact that households now invest (fire sales) so the sharpe ratio of the risky investment has to be equal to the marginal utility of their wealth.
- Everything else follows.
- Brunnermeier-Sannikov first go through the **risk neutral case**. Problem: maybe this is why agents are taking all this risk !
- They do the extension with log utility, as a robustness check.

Results: Risk-Neutral Case

- Equilibrium functions obtained.
- η_ψ is the value for the state variable delimiting the crisis and the normal regimes.
- Note that agents are effectively risk averse, despite being really risk neutral ! (marginal utility of wealth is higher in crises...)
- Would like to buy cheap capital in crisis periods.

Results

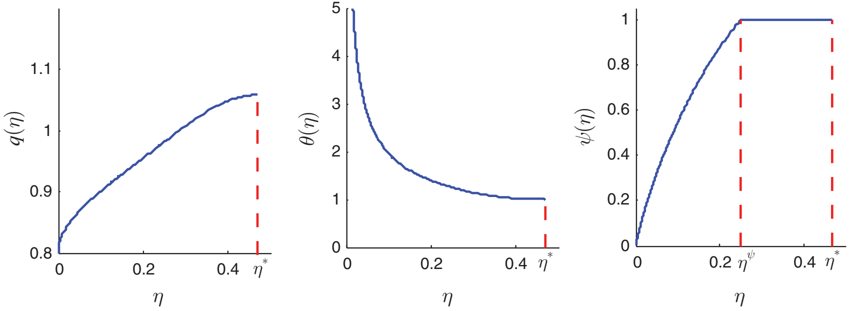


FIGURE 1. EQUILIBRIUM FUNCTIONS $q(\eta)$, $\theta(\eta)$, AND $\psi(\eta)$

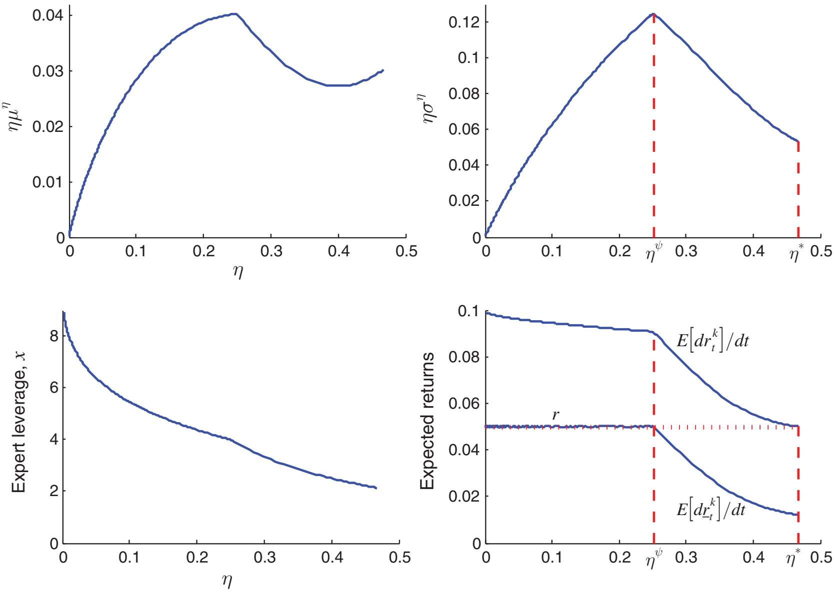


Figure 2. The Drift and Volatility of η_t, Expert Leverage, and Expected Asset Returns

Kiyotaki-Moore mechanism

- Feedback mechanism, like Kiyotaki-Moore.

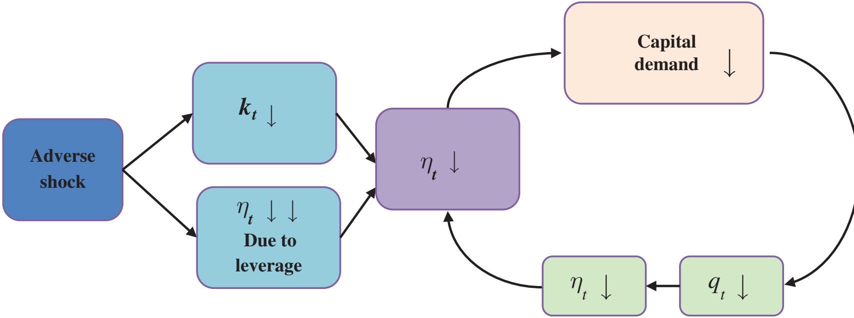


Figure 3. Adverse Feedback Loop

- Stationary density: coming from Kolmogorov forward equation.

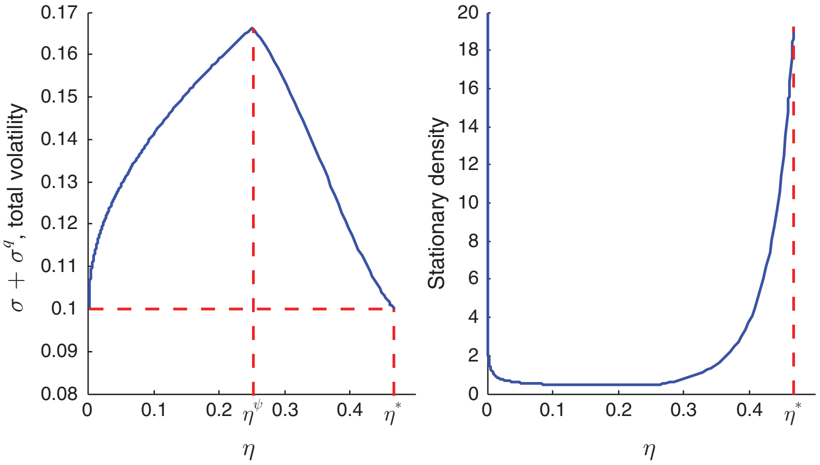


FIGURE 4. SYSTEMIC RISK: TOTAL VOLATILITY OF CAPITAL AND THE STATIONARY DENSITY OF η_t

Volatility Paradox

- Decreased exogenous risk can actually lead to MORE endogenous risk !! (Great moderation?)
- Overcomes the Kocherlakota critique (effect of expected price appreciations in the future: if recovery is certain in a not so distant future, then price change is low).
- Advantage of having a non log-linearized model: non-linear dynamics, amplification.

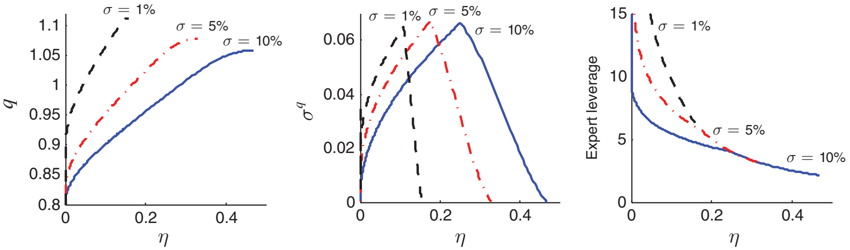


FIGURE 6. EQUILIBRIUM FOR THREE LEVELS OF EXOGENOUS RISK, $\sigma = 10$ PERCENT, 5 PERCENT, AND 1 PERCENT

Technological Illiquidity

- How bad are households? More interestingly: how severe is market illiquidity (or how worse are second-best uses of the capital? - cf. Shleifer and Vishny (1997))

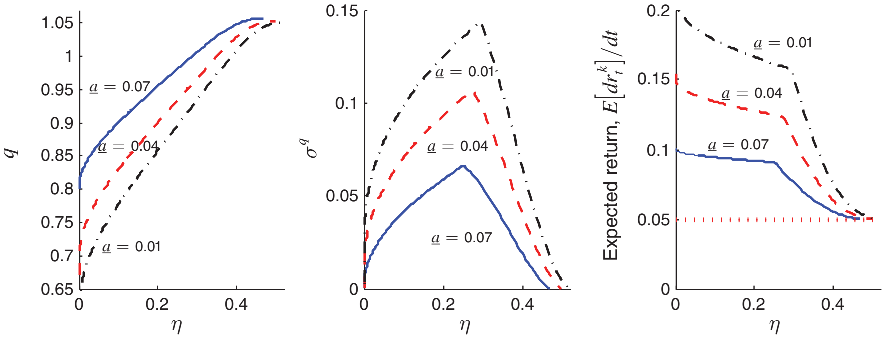
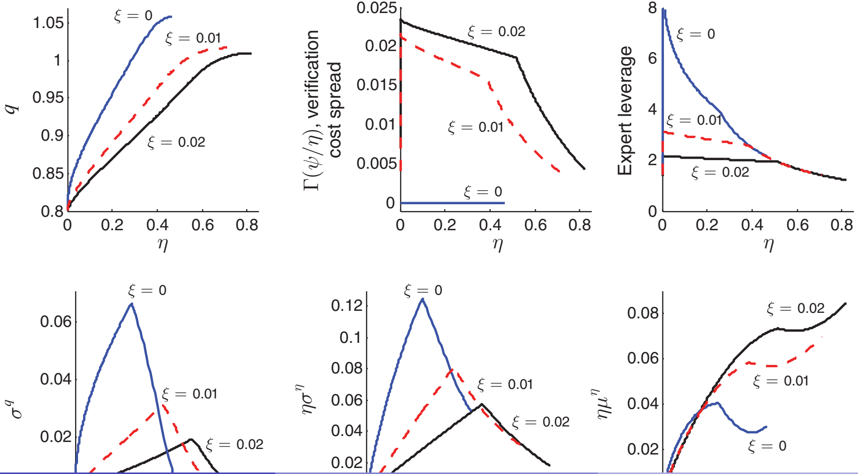


FIGURE 7. ENDOGENOUS RISK AND RISK PREMIA FOR $\underline{a} = 0.07, 0.04, 0.01$

Financial Frictions (in the form of CSV) are good

- How bad are households? More interestingly: how severe is market illiquidity (or how worse are second-best uses of the capital? - cf. Shleifer and Vishny (1997))



Policies

- In the last part of the paper, Brunnermeier-Sannikov cautiously investigate the potential impact of several policy interventions:
  - Controlling Consumption (that is, dividend payouts !)
  - Open-Market Operations
  - Tail risk insurance

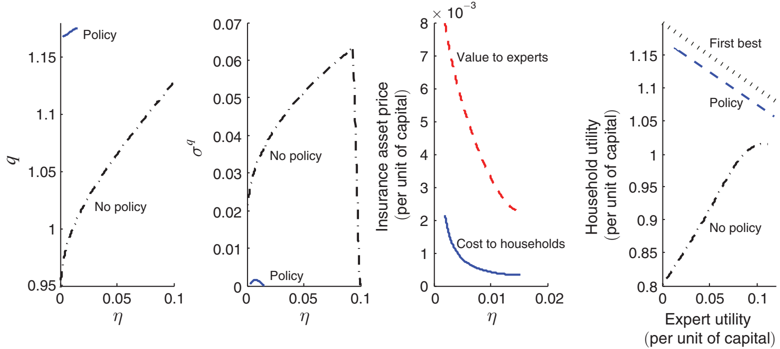


FIGURE 9. EQUILIBRIUM WITH AND WITHOUT INSURANCE

Policies

- Even if agents are risk neutral they behave as if they were risk averse.
- One of the previous comparative statics allows to think about the effect of more risk sharing (securitization, options?...) Which one is that?
- Key assumption maintained throughout: aggregate risk cannot be hedged, but stays in the hands of entrepreneurs. Alternative: one cannot observe if the project fails because of the entrepreneur or because of the recession hitting everyone.
- Why were banks, taking Mortgage-Backed Securities on their Balance Sheets, paying dividends?

Bibliography I

Bernanke, Ben S. and Alan S. Blinder, "The Federal Funds Rate and the Channels of Monetary Transmission," *The American Economic Review*, 1992, *82* (4), 901–921.

Brunnermeier, Markus K. and Yuliy Sannikov, "A Macroeconomic Model with a Financial Sector," *American Economic Review*, February 2014, *104* (2), 379–421.

Chodorow-Reich, Gabriel, "The Employment Effects of Credit Market Disruptions: Firm-level Evidence from the 2008–9 Financial Crisis," *The Quarterly Journal of Economics*, February 2014, *129* (1), 1–59.

Gertler, Mark and Peter Karadi, "Monetary Policy Surprises, Credit Costs, and Economic Activity," *American Economic Journal: Macroeconomics*, January 2015, *7* (1), 44–76.

Gilchrist, Simon and Egon Zakrajšek, "Credit Spreads and Business Cycle Fluctuations," *American Economic Review*, June 2012, *102* (4), 1692–1720.

Giroud, Xavier and Holger M. Mueller, "Firm Leverage, Consumer Demand, and Employment Losses During the Great Recession," *The Quarterly Journal of Economics*, February 2017, *132* (1), 271–316.

Holmström, Bengt and Jean Tirole, "Private and Public Supply of Liquidity," *Journal of Political Economy*, February 1998, *106* (1), 1–40.

Bibliography II

Jiménez, Gabriel, Steven Ongena, José-Luis Peydró, and Jesús Saurina, "Hazardous Times for Monetary Policy: What Do Twenty-Three Million Bank Loans Say About the Effects of Monetary Policy on Credit Risk-Taking?," *Econometrica*, March 2014, *82* (2), 463–505.

Kashyap, Anil K and Jeremy C. Stein, "What Do a Million Observations on Banks Say about the Transmission of Monetary Policy?," *The American Economic Review*, 2000, *90* (3), 407–428.

Kashyap, Anil K., Jeremy C. Stein, and David W. Wilcox, "Monetary Policy and Credit Conditions: Evidence from the Composition of External Finance," *The American Economic Review*, 1993, *83* (1), 78–98.

Kiyotaki, Nobuhiro and John Moore, "Credit Cycles," *Journal of Political Economy*, April 1997, *105* (2), 211–248.

Krishnamurthy, Arvind and Annette Vissing-Jorgensen, "The Effects of Quantitative Easing on Interest Rates: Channels and Implications for Policy," *Brookings Papers on Economic Activity*, 2011, pp. 215–287.

Mitchell, Mark, Lasse Heje Pedersen, and Todd Pulvino, "Slow Moving Capital," *American Economic Review*, May 2007, *97* (2), 215–220.