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Dividend Signaling and Bank Payouts in the Great Financial Crisis*

Ragnar E. Juelsrud[†] Plamen T. Nenov[‡]

Abstract

We study the dividend payouts of U.S. banks during the 2008 financial crisis. Using a difference-in-differences methodology, we shows that banks with higher share of short-term liabilities to total liabilities, which were thus more exposed to the rollover crisis that took place in 2008, increased their dividend payouts relative to less exposed banks. This relative increase in dividend payouts is concentrated in relatively cash-rich banks. The dividend payout increase was associated with a short-run increase in stock valuations. We argue that this front-loading of dividends of more exposed banks is consistent with a theory of dividend payouts, in which the payout policy has a (short-run) stabilizing role on the bank's liquidity position by signaling information to short-term lenders about the bank's available liquidity.

Key words: payout policies, dividend signaling, rollover crises, bank runs, liquidity crises.

JEL Codes: G01, G21, G35

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1 Introduction

The dividend payout policies of banks during the Great Financial Crisis of 2007-2008 have served to provide important insights to both researchers and policy-makers about bank behavior under severe liquidity stress. The large increase in payouts in the midst of the crisis, was contemporaneously viewed as excessive by many commentators, and has shaped post-crisis financial stability policies, tying payouts to hard measures of bank balance sheet health, assessed via objective stress test criteria set forward by regulating authorities.

The main explanation for the observed bank payout policies during the financial crisis has been an agency problem between bank insiders and equity holders and outside debt holders (see, for example, Scharfstein and Stein (2008)). The misaligned incentives between these two groups became exacerbated after the arrival of bad news about the banks' loan portfolios, tied to the housing market, which in turn lead to insiders shifting risk onto debt holders by reducing bank equity via increased payouts. A complementary story focuses on the severe debt rollover problems that some banks experienced during the crisis, and in particular during its most acute phase in 2008. In that period many banks and non-bank financial institutions were exposed to counterparties either refusing to roll-over maturing short-term debt or terminating their trading relationships. In that situation, a bank's dividend payout policy may start having an important (short-run) stabilizing role on the bank's liquidity position by conveying valuable information to short-term lenders about the bank's available liquidity (Juelsrud and Nenov, 2020).

In this paper we empirically investigate the role this dividend signaling channel may have played in U.S. banks' dividend payout policies during and after the Great Financial Crisis. This episode is unique for understanding the underlying incentives of banks and their attempts to manage a liquidity crisis, since bank dividend payouts have been heavily regulated in its aftermath, so any analysis of subsequent crisis episodes is made substantially harder by the regulatory framework in place. Consistent with the signaling channel, we show, using a difference-in-differences methodology, that banks with higher reliance on short-term debt (which we also refer to as "short-term leverage" below) increased their dividend payouts relative to banks with lower short-term leverage during 2008, and moreover, this relative increase in dividend payouts was concentrated in relatively cash-rich banks. This was associated with a relative short-run increase in stock valuations of these cash-rich banks. However, this behavior around the crisis was associated with a persistent decline in dividend payouts and stock prices in the post-crisis period.

We start our analysis with a stylized model of intertemporal dividend payout choice in the midst of a rollover crisis with a short-run signaling role of dividends as in Juelsrud and

Nenov, 2020, which tends to elevate the optimal dividend payout rate. In the model a bank (owner) decides on the optimal duration of maintaining elevated dividend payouts by trading off the increase in expected payoff from "weathering the storm" (i.e. withstanding the rollover crisis) against the long-run impact a large draw-down of liquidity has on the bank's franchise value. We show that, relative to banks with lower short-term leverage, banks with higher short-term leverage front-load their dividend payouts – paying out relatively more in the beginning of the rollover crisis, and relatively less thereafter. Moreover, this front-loading occurs only for banks with sufficiently high values of initial available liquidity.

We then move on to our empirical analysis. We examine data on U.S. bank holding companies over the period 2004q1-2011q4. Specifically, we combine balance sheet and income statement information from banks FR-Y9C reports with data on dividend payouts and stock prices from CRSP. Using a flexible difference-in-differences framework, we identify the effects of the rollover crisis in 2008 by considering banks with different pre-crisis exposure to short-term debt defined as the ratio of 2006q4 short-term debt to total liabilities. Our baseline specification accounts for a systematic relation between short-term leverage and pre-crisis dividend payout capacity, proxied by the 2006q4 return on assets, as well as with differential regional exposure to the housing market and general economic downturn via state-by-quarter fixed effects. Our main identifying assumption is thus one of "parallel trends", namely that irrespective of short-term leverage, absent the liquidity and rollover crisis, banks would have had a similar evolution of dividend payouts.

Our main finding is that exposure to rollover risk given by short-term leverage has a significant and quantitatively large impact on bank dividend payouts in 2008. For instance, focusing on 2008q3 – which may represent a peak in the liquidity and rollover crisis in the U.S. banking system – we find that variation in exposure to rollover risk explains between 80% and 100% of the variation in dividend growth, conditional on a set of controls. In the aggregate, back-of-the-envelope calculations suggest that dividend signaling due to rollover risk increased aggregate dividend outflows of the U.S banking system by about 10 - 26 % (1 - 2.5 USD billion) from 2008q2 to 2008q3, relative to scenarios where U.S banks were relatively less exposed to rollover risk. Moreover, the relative increase in dividends of more exposed banks is driven by banks with high initial cash holdings. Both of these findings are consistent with our conceptual framework. We also find that more exposed banks experienced *higher* stock returns in the midst of the crisis, most likely as a direct effect of having higher dividend payouts.

A key identification concern is that exposure is correlated with agency problems resulting from differential loading on bad news about future returns on assets due to differences in the initial portfolio composition. As a robustness exercise, we therefore augment our baseline specification and explicitly incorporate portfolio differences by allowing for a time-varying impact of the 2006q4 share of mortgages to total assets, other loans to total assets, and securities to total assets. We also allow initial leverage to have time-varying effects on the subsequent growth in dividend payouts. Our results are qualitatively and quantitatively robust to these extensions.

Related literature Our paper contributes to an empirical literature on bank dividend payouts during the financial crisis (Acharya, Gujral, Kulkarni, and Shin (2011), Floyd, Li, and Skinner (2015), Acharya, Le, and Shin (2017), Hirtle (2014), Cziraki, Laux, and Loranth (forthcoming)). Floyd, Li, and Skinner (2015) compare the payout policies of non-financial firms and banks before and during the financial crisis of 2007-2008. They document that unlike non-financial firms, banks have relied on dividends over repurchases as the primary payout to shareholders since the 1980s. They also document the notable stickiness in bank dividend payouts during the financial crisis, with aggregate dividends exceeding aggregate earnings by 30% in 2008, and argue that this behavior is consistent with banks signaling financial strength to short-term lenders and depositors. Acharya, Gujral, Kulkarni, and Shin (2011) and Acharya, Le, and Shin (2017) show a similar pattern but also document substantial heterogeneity in the dividend payouts of large banks in 2008. Hirtle (2014) and Cziraki, Laux, and Loranth (forthcoming) compare the evolution of dividend payouts and share repurchases by U.S. banks prior to and during the crisis. While dividends and share repurchases followed similar patterns prior to the crisis, they diverged strongly in 2007 and 2008, with banks cutting their share repurchase programs substantially, while maintaining their dividend payouts. Furthermore, Cziraki, Laux, and Loranth (forthcoming) also argue that the cross-sectional evidence is not consistent with risk shifting, by examining the dependence of dividend payouts on bank characteristics associated with higher propensity towards risk shifting, such as leverage and higher risk-taking prior to the crisis. Relative to this literature, we provide new evidence in favor of the dividend signaling channel by showing that banks with higher short-term leverage tended to front-load their dividend payouts during the financial crisis and that this behavior was concentrated among cash-rich banks.

Our paper is also related to a broader literature that studies dividend payouts by firms. Given the generally less favorable tax treatment of dividend income, the persistent use of dividends as a way of paying shareholders has been a puzzle in economics and finance (Black, 1976).[1] One important explanation for this puzzle is that dividends are a signal of future profitability (Bhattacharya (1979), Miller and Rock (1985), John and Williams (1985), Bernheim

[1]See Allen and Michaely (2003), Frankfurter, Wood, and Wansley (2003), Baker (2009), DeAngelo, DeAngelo, and Skinner (2009), and Farre-Mensa, Michaely, and Schmalz (2014) for surveys of this literature.

(1991), Hausch and Seward (1993), Guttman, Kadan, and Kandel (2010), Baker, Mendel, and Wurgler (2016)).[2] In that literature paying dividends is relatively less costly for firms with higher future profitability, and is therefore used by such firms in equilibrium. However, the empirical evidence on this channel has been mixed. For example, Bernheim and Wantz (1995) argue in favor of dividends serving as a signal of future profitability by showing that higher dividend taxation is associated with a stronger response of stock prices to news about dividends. On the other hand, Benartzi, Michaely, and Thaler (1997), and Grullon, Michaely, and Swaminathan (2002) find limited support for dividend payouts forecasting future earnings. Instead dividend increases tend to correlate with *past* earnings growth.[3] In contrast to the literature that argues that dividends signal future profitability, Juelsrud and Nenov (2020) argue that dividends may be used to signal available liquidity to short-term lenders that are considering rolling over their debt. As we argue in this paper using a simple dynamic extension of Juelsrud and Nenov (2020), our findings of a crisis-induced front-loading of dividend payouts by more exposed cash-rich banks are consistent with the dividend signaling channel.

2 Conceptual framework

In this section we present a simple dynamic model of dividend payout choice in a liquidity crisis triggered by a rollover crisis. The model illustrates the dynamic incentives of banks in an environment where dividend payouts can impact the severity of the rollover crisis via a signaling effect as in Juelsrud and Nenov (2020). The key trade-off underpinning these dynamic incentives is the balancing of the increase in expected payoff from withstanding the rollover crisis against the long-run impact a large and prolonged draw-down of liquidity has on the bank's franchise value. We show that, relative to banks with lower short-term leverage, banks with higher short-term leverage front-load their dividend payouts – paying out relatively more in the beginning of the rollover crisis, and relatively less thereafter. Moreover, this front-loading occurs only for banks with sufficiently high values of initial available liquidity.

[2] The other main explanations for firms paying out dividends is that dividend payouts resolve the free cashflow agency problem between firm managers and shareholders (Jensen and Meckling (1976), Jensen (1986)) or that dividends are more valuable to a subset of investors (Shefrin and Statman, 1984).

[3] There is however a large empirical literature that documents a positive relationship between dividend updates and stock price responses. See, for example, Charest (1978), Aharony and Swary (1980), Brickley (1983), Asquith and Mullins Jr (1983), Bajaj and Vijh (1990), Denis, Denis, and Sarin (1994), Michaely, Thaler, and Womack (1995). Our findings of stock prices tracking the relative dividend payout profile of more exposed cash-rich banks is consistent with this literature.

Model set-up

Time is continuous and runs forever. There is a single bank that is facing a liquidity crisis due to lenders refusing to roll over their debt holdings. We assume as in He and Xiong (2012) that the bank has a staggered debt expiration schedule that is distributed uniformly over time. The bank's debt is held by a continuum of small creditors. In each instant, a measure b of debt matures with the corresponding creditors making a roll-over decision. Let $a\left(t, d\left(t\right)\right)$ denote the share of creditors who refuse to roll over their maturing debt at time t, where $d\left(t\right)$ is the bank's dividend payout rate at t. We do not model explicitly the lenders' rollover decisions but instead make the following two reduced-form assumptions about a. First, we assume that the rollover episode has an uncertain duration that ends with Poisson rate λ, that is the liquidity crisis ends at a random time $X \sim Exp\left(\lambda\right)$.[4] [5] Second, following Juelsrud and Nenov (2020), we assume that the run size a responds to d due to a static signaling effect of the dividend payout at time t, so that the dividend payout rate, $d\left(t\right)$, affects the magnitude of the (instantaneous) liquidity outflow but not the *expected duration* of the liquidity crisis.[6] The total liquidity outflow rate (including the direct payment of dividends) is then

$$l = d\left(t\right) + ba\left(t, d\left(t\right)\right). \tag{1}$$

As Juelsrud and Nenov (2020) show, l is non-monotone in d in the unique equilibrium of the static rollover game. Specifically, for sufficiently large values of b, there is a strictly positive value of the dividend payout, $d_{\min} > 0$, such that l is minimized at $d_{\min}$. Moreover, as lenders observe arbitrarily precise signals about the dividend payout rate, then $a\left(t, d\left(t\right)\right)$ converges to a step function with $a = 0$ for $d \geq d_{\min}$, and $a = 1$ for $d < d_{\min}$. Additionally, in that framework, $d_{\min}$ is increasing in the nominal value of maturing debt b (see Proposition 8 in Juelsrud and Nenov (2020)). Below we will utilize these observations directly and assume

[4] In a standard rollover global game (e.g. Morris and Shin (2004)), the roll-over decision of a lender depends on the ratio of the (expected) gain from rolling over given that the bank survives the rollover crisis and repays the lenders fully over the (expected) loss from rolling over given that the bank fails. He and Xiong (2012) generalize this trade-off in a dynamic context. Therefore, any shock that lowers the gain given bank survival or that increases the loss given bank failure weakens the incentives of lenders to roll over. In our rollover crisis episode we have in mind such a temporary shock which increases the share of lenders that choose to not roll over in a given period. After this shock dissipates, the economy reverts back to a normal time where the share of lenders that do not roll over goes back down to some steady state value. For simplicity, we assume that this value is 0.

[5] Note that the liquidity crisis may end on its own or it may end because of a government intervention. Therefore, expectations about the duration of the liquidity crisis may also reflect expectations of a future government intervention.

[6] The signaling effect arises whenever creditors observe (dispersed) signals about the dividend payout and make inference about the bank fundamental based on these signals. See Juelsrud and Nenov (2020) for a discussion about why dividends may be used to signal available liquidity relative to other available actions.

that

$$l=\begin{cases} d+b & ,\ d<d_{\min}(b) \\ d & ,\ d\geq d_{\min}(b) \end{cases}, \tag{2}$$

where $d_{\min}(b)<b$ is increasing in b, so that it is never optimal for the bank owner to choose $d<d_{\min}$.[7]

Given these assumptions, we now proceed to model the novel dynamic decision of the bank. The bank starts with an initial value of total available liquidity of $L(0)$, which captures all sources of short-term funding (e.g. cash holdings, available credit lines, unused borrowing capacity against the bank's portfolio, and liquidation of long-term assets, possibly at fire-sale prices). In any instant when the rollover crisis is still ongoing (i.e. for $t<X$), in addition to the choice of dividend payout rate, the bank faces an optimal stopping decision. Specifically, it may choose to "Give up" or "Continue". If the bank chooses to "Give up", it collects a termination payoff of $D_b(L(t))$, which is assumed to be twice continuously differentiable, strictly increasing in the available liquidity at t, $L(t)$, and strictly concave. If the bank chooses to "Continue", this leads to liquidity flowing out at rate l, so that

$$\dot{L}(t)=-l. \tag{3}$$

If the liquidity crisis ends before the bank has chosen to "Give up" (i.e. the bank has "weathered the storm"), it collects a termination payoff of V_b, with $V_b\geq D_b(L),\forall L$. If L crosses 0, then the bank is forced to "Give up" and collects $D(0)$.[8]

The termination payoffs V_b and $D_b(L)$ reflect the different costs and benefits to the bank (owner/manager) associated with enduring or not enduring the liquidity crisis. In particular, if the bank chooses to "Give up", it incurs reputational costs associated with seeking lender-of-last-resort financing from the Fed Discount Window. Moreover, the bank manager may face additional reputational costs due to career concerns. In addition, we assume that there is some irreversibility to the draw-down of liquidity given this outcome, so that the larger the draw-down of liquidity, the more costly it is for the bank to operate going forward, for example, because of persistently higher funding costs or because of persistent balance sheet impairment due to having to liquidate assets at fire-sale prices.

Finally, we assume that there is no discounting during the rollover crisis. This assumption is not without loss of generality, since it implies that banks care equally about surviving the

[7]For technical reasons we also assume that $d_{\min}(b)$ is bounded away from zero.

[8]For technical reasons we assume that Inada conditions hold on D, so that $\lim_{L\to 0}D'(L)=\infty$, and $\lim_{L\to\infty}D'(L)=0$. These conditions ensure that the bank always chooses to "Give up" before running out of liquidity and that banks with sufficiently high liquidity choose to not immediately "Give up". Also, to simplify the analysis below, we assume that $\lim_{L\to 0}-D''/D'=\infty$.

rollover episode irrespective of its length. Nevertheless, we view this as the appropriate assumption in the context of this model, given that rollover crises are usually relatively brief compared to the average length of time over which a bank operates.

Characterization

In what follows we suppress dependence on b for easier readability.[9] Let $\tau(L(0))$ be the optimal time the bank chooses to "Give up" and let $\tilde{L}$ denote the remaining liquidity at that time. By Eq. (3), it follows that

$$\tilde{L} = L(0) - \int_0^\tau l(t)\,dt.$$

The bank (owner) then solves

$$W(L(0)) = \max_{\{d(t)\}_0^\infty,\ 0\le\tau,\tilde{L}\ge 0} \left\{ \Pr\{X<\tau\} V + \Pr\{X>\tau\} D\left(\tilde{L}\right) \right\},$$

$$s.t.\ \tilde{L} = L(0) - \int_0^\tau l(t)\,dt.$$

In the Appendix we characterize the bank owner's problem and show three things about it. First, we show that the bank owner always chooses the dividend rate that generates the lowest possible liquidity outflow, namely $d_{\min}$. Intuitively, since "weathering the storm" is always preferred to "giving up", the bank would prefer to survive the longest possible time for any initial available liquidity $L(0)$. This requires choosing the lowest liquidity outflow rate possible, which is $d_{\min}$.

Second, the optimal time τ the bank chooses (for an interior value of τ) satisfies the equation:

$$\lambda\left[V - D\left(L(0) - d_{\min}\tau\right)\right] = \left[D'\left(L(0) - d_{\min}\tau\right)\right] d_{\min}. \tag{4}$$

Intuitively, at the margin, increasing the time that the bank chooses to withstand the liquidity crisis increases the probability that it will survive the liquidity crisis rather than incur the reputational cost associated with giving up (the left-hand side of Eq. (4)). On the other hand, it leads to a lower value of available liquidity, which decreases at rate $d_{\min}$ and impacts the payoff given no survival by D' (the right-hand side of Eq. (4)).

We can also express the optimality condition in Eq (4) in terms of the available liquidity

[9] Note that we assume that initial liquidity $L(0)$ and short-term leverage b are fully observable by market participants, so there are no strategic interactions between banks with different values of $L(0)$ and b.

at τ, $\tilde{L} = L(0) - d_{\min}\tau$, so that

$$\lambda \left[V - D\left(\tilde{L}\right) \right] = D'\left(\tilde{L}\right) d_{\min}. \tag{5}$$

Note that this equation does not depend on $L(0)$. Therefore, our third insight about the bank's problem is that banks with different values of $L(0)$ choose to "Continue" until they reach the *same amount* of available liquidity $\overline{L}$, which solves Eq. (5).[10] Moreover, banks that start with lower available liquidity than $\overline{L}$ (i.e. $L(0) < \overline{L}$) choose to "Give up" immediately.

Model predictions

Given that $d_{\min}$ is assumed to increase in b, by Eq. (5) and the implicit function theorem we have $\frac{\partial \overline{L}}{\partial b} \geq 0$. Since $\tau = \max\left\{0, \left(L(0) - \overline{L}\right)/d_{\min}\right\}$, it also follows that $\frac{\partial \tau}{\partial b} \leq 0$. Therefore, a bank with higher short-term leverage chooses to "Give up" faster. Intuitively, since such a bank faces a higher outflow of liquidity, it is more costly for it to try and withstand the liquidity crisis longer. Finally, it is immediate that $\frac{\partial \tau}{\partial L(0)} \geq 0$, so that a bank with higher available liquidity chooses to withstand the liquidity crisis longer.

We summarize these observations in the following result.

Proposition 1. *Let $\overline{L}$ be the unique solution to Eq. (5). Then $\tau = \max\left\{0, \left(L(0) - \overline{L}\right)/d_{\min}\right\}$. Moreover, $\frac{\partial \tau}{\partial b} \leq 0$ and $\frac{\partial \tau}{\partial L(0)} \geq 0$, with a strict inequality, whenever $L(0) > \overline{L}$.*

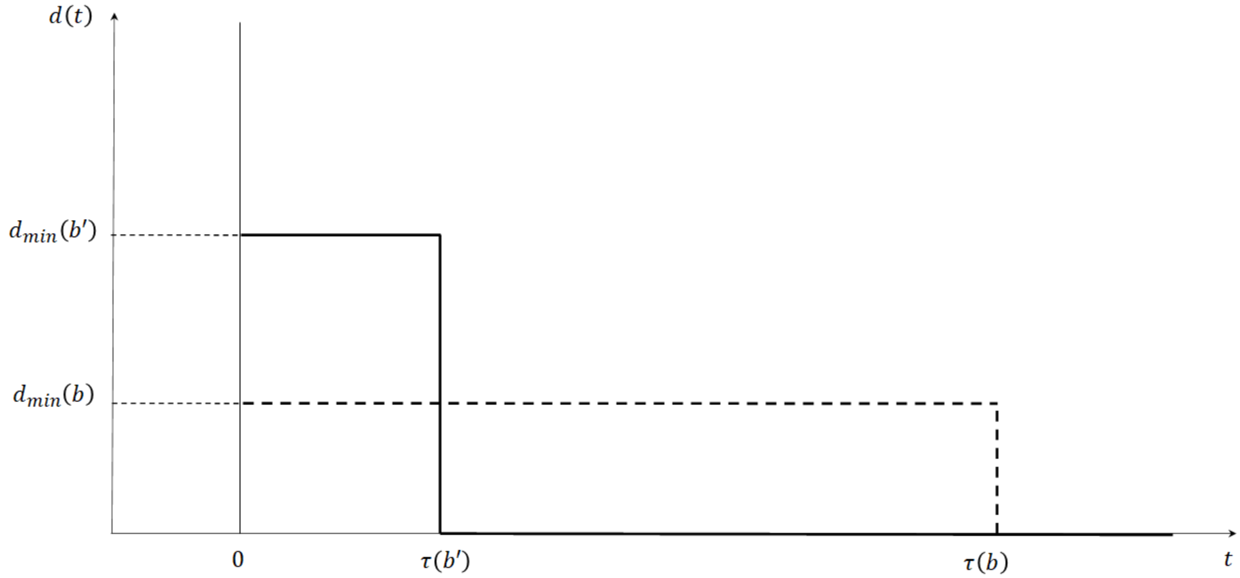
Therefore, our model makes the following predictions about the dynamics of bank dividend payouts and their dependence on short-term leverage b and the bank's available liquidity $L(0)$:

Prediction 1. Higher short-term leverage is associated with a higher dividend payout rate $d(t) = d_{\min}$ but with a lower "excessive" dividend payout duration τ. Specifically the time-profile of dividend payouts for two banks: one with a low value of b and another one with some $b' > b$ is as depicted in Figure 1. Similarly, the difference between the b'- and the b-bank's dividend payout, which is what we will be looking at with our empirical methodology is as given in Figure 2.

Prediction 2. The dividend profiles and profile difference in Figures 1 and 2 are only for banks with sufficiently high values of available liquidity $L(0)$. For banks with low values of available liquidity $L(0)$, b does not affect the dividend profiles, and so, there is no difference in dividend profiles by short-term leverage.

[10] To ensure that Eq. (5) has a unique solution, we assume that $\lambda < -D''\left(\overline{L}\right)/D'\left(\overline{L}\right) d_{\min}$.

Figure 1: Dividend payout profiles for banks with different values of b ($b' > b$).



In what follows we will show that dividend payouts of banks around and after the Great Financial Crisis are consistent with these two model predictions.

3 Data and methodology

3.1 Data sources

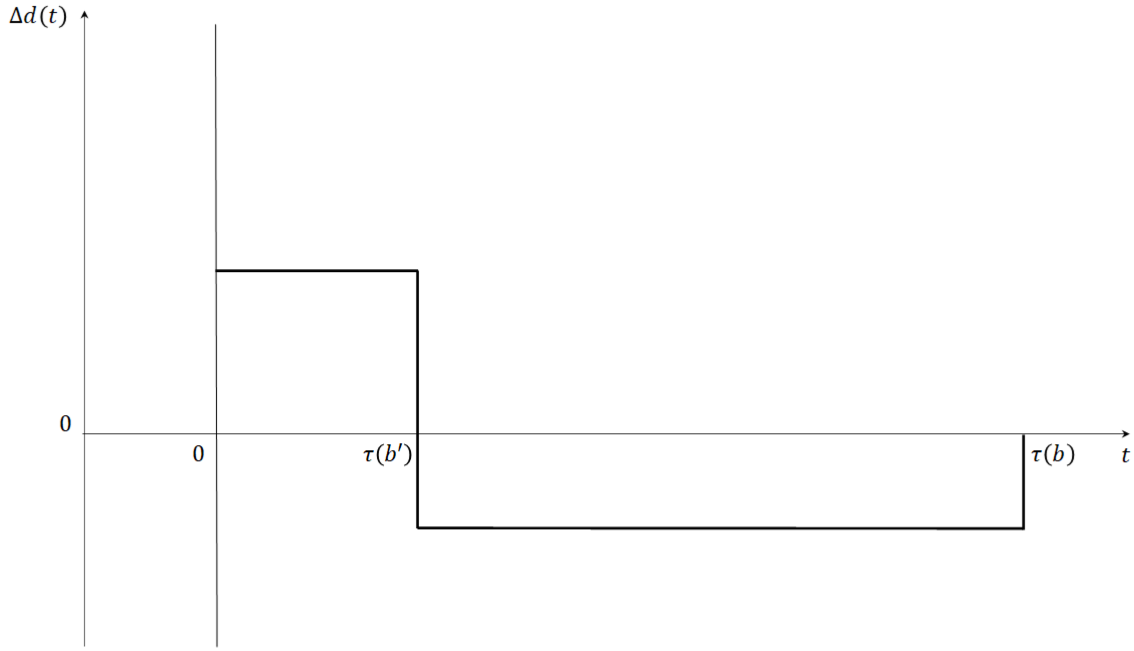
We use data from two sources: CRSP for data on dividend payouts and stock returns and the FR-Y9C report on balance sheet and income statement variables for U.S. bank holding companies (BHC). Our unit of observation is a bank holding company. Our final sample consists of 318 unique BHCs and runs from the period 2004q1 to 2008q4 in our baseline analysis.[11]

3.2 Descriptive statistics

In Table 1 we report summary statistics on some of the key variables used in our analysis. We measure exposure to on-going rollover risk by computing a bank's short-term liabilities relative to total liabilities. Short-term liabilities is the sum of fed funds, repurchase agreements and time deposits above 100k USD. The average exposure measure is 27%, highlighting that

[11]We choose to stop in 2008q4 in our baseline analysis, as several BHCs reduced dividend payouts in 2009 to recapitalize according to the capital need estimated in the Supervisory Capital Assessment Program. However, when considering the medim-run impact of exposure to rollover risk we also report results up until 2011q4.

Figure 2: Dividend payout difference ($\Delta d(t) = d(b') - d(b)$).



a relatively large fraction of the liabilities of banks in our sample are short-term. There is, however, substantial cross-sectional variation on the exposure measure (11% SD), which we utilize in our analysis. In parts of our analysis, we separate banks according to their initial cash position. The mean (median) ratio of cash to total liabilities is 0.04 (0.03).[12] Banks with cash to total assets above the median will sometimes be referred to as “cash-rich.”

	Mean	SD	Median	Min	Max	N
Log(Dividends)	-1.93	0.69	-1.83	-5.30	1.56	5,176
Log(Assets)	14.75	1.46	14.42	12.01	21.33	5,176
Log(Stock price)	3.13	0.53	3.15	-0.61	5.31	5,176
Return on Assets	0.01	0.01	0.01	-0.17	0.05	5,176
Exposure	0.27	0.11	0.25	0.05	0.85	7,891
Cash to total assets	0.04	0.03	0.03	0.01	0.24	5,176

Table 1: Summary statistics

Notes: All summary statistics are computed based on the full sample. Exposure is defined as the sum of Federal Funds borrower, repurchase agreements and time deposits above $100’000 scaled by total liabilities.

[12]This implies that cash relative to short-term liabilities is 0.04 / 0.27 $\approx$ 0.15 , suggesting that just paying down all of the short-term debt using existing liquidity is infeasible from the bank’s perspective.

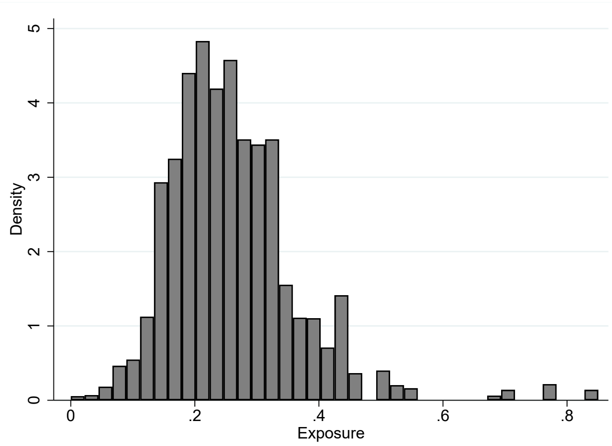


Figure 3: Cross-sectional variation in exposure to rollover risk during the financial crisis.
Notes: This figures shows the cross-sectional distribution in exposure measured in 2006q4. Exposure is defined as the sum of fed funds, repurchase agreements and time deposits above 100k USD, divided by total assets.

3.3 Rollover risk during the 2007-2008 financial crisis

To isolate the effects of rollover risk on dividend payouts we will compare the evolution of dividend payouts for banks with different exposures to short-term debt during the interbank market stress in the U.S. in 2007 and 2008. The large increase in interbank risk-premia, as captured in Figure 4, suggests that rollover risk increased substantially for U.S. banks. The rise in interbank stress followed two phases. Initially, in mid-2007, TED-spreads doubled from a little bit less than 1%. Although volatile, the level of interbank stress then abated somewhat until the second half of 2008. At that point, there was a sharp increase from approximately 1% to more than 4% – the largest increase ever documented in the TED-spread. The interbank stress quickly abated, and from 2009 and onward the TED spread was essentially at pre-crisis levels.

Apart from the dynamics of the TED spread, other events also suggest an elevation of rollover risk in the banking system. This includes the counterparty runs and collapses of the investment banks Bear Stearns in March, 2008 (taken over by JP Morgan Chase), and Lehman Brothers (which filed for bankruptcy protection in September, 2008), as well as the near collapse of Merrill Lynch (taken over by Bank of America in September, 2008).[13] In addition, more prominent banks that suffered classical depositor runs in that period include IndyMac (July, 2008), Washington Mutual (July and September, 2008), and Wachovia (September, 2008).[14]

[13]See Duffie (2010) for a thorough discussion of the dynamics of counterparty runs in the context of broker-dealers.

[14]See He and Manela (2016) for a detailed description of the depositor runs on Washington Mutual.

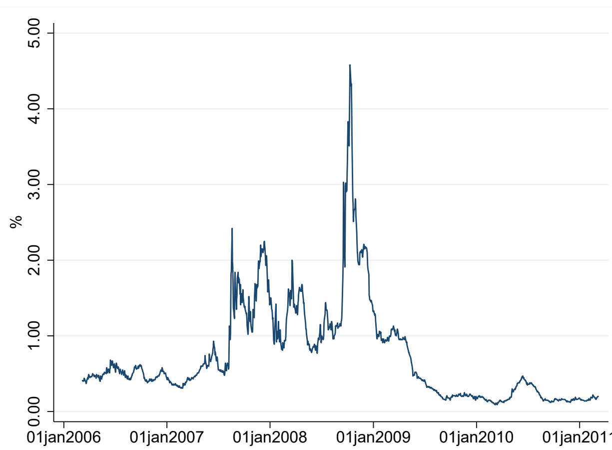


Figure 4: Rollover risk during the financial crisis, as captured by the TED-spread.
Notes: This figure shows the evolution of the TED-spread, defined as the difference between the 3m USD LIBOR rate and the 3m Treasury rate.

3.4 Methodology

3.4.1 Baseline regression

To isolate the effect of the rollover crisis on dividend payouts, we compare dividend-related outcomes for banks with a high reliance on short-term debt (i.e. banks with a high exposure) relative to less reliant banks. We compare banks according to their 2006q4 exposure.[15] This comparison allows us to isolate the impact of the rollover crisis from other, aggregate factors affecting the dividend payouts of the US banking system. Our baseline specification addresses two potential confounding factors. First, to ensure that high-exposure banks are not banks with a particularly high dividend payout capacity, we estimate the dynamic effects of having a high exposure to the rollover risk on dividend payouts *conditional* on the dynamic effects of the 2006q4 Return on Assets (RoA). Second, to ensure that high-exposure banks are not differentially affected by the contemporaneous downturn in the US-economy due to different regional exposures, we employ state$\times$time fixed effects. Thus, the estimated impact of rollover risk on dividend payouts is driven by within-state$\times$time variation. Our identifying assumptions is thus that high- and low-exposure banks would have had a similar evolution of dividend payouts during 2007-2008 absent any rollover risk, conditional on state$\times$time fixed effects and initial profitability as captured by the RoA (net income dividended by total assets) in 2006q4. In Section 3.4.2 we discuss further threats to identification and how our results are robust to those.

Our baseline specification is outlined in equation (6). The main outcome variable $Y_{i,t}$

[15]The capital structure of US banks is fairly sticky at short- and medium-run horizons, as illustrated by Table 4 in the Appendix. Our results are robust to defining exposure based on other time periods.

is the change in log(dividends) for a bank i between period $t-1$ and t. We also consider alternative outcomes variables, such as measures capturing the extensive margin of dividend payouts (i.e. a dummy for whether a bank initiates dividend payouts or discontinues its dividend payouts), as well as stock prices. $\text{Exposure}_{i,2006q4}$ is the exposure measure for bank i measured in 2006q4, while $\text{RoA}_{i,2006q4}$ captures RoA for bank i measured in 2006q4. As discussed above, the specification allows for state×quarter ($\gamma_{s(i),t}$) fixed effects, in addition to a bank fixed effect (α_i). We cluster standard errors on the bank-level to account for within-bank autocorrelation in the un-modeled shocks $\epsilon_{i,t}$.

The coefficients of interests are the β_k's, which capture the impact of the interaction term between exposure to the rollover risk and the time variable. The dynamic treatment effects are captured by $\beta_k's$ from 2007q1 and onward. An important test of the validity of our research design is whether $\beta_k \neq 0$ before the financial crisis, as that would indicate that there are systematic differences in the evolution of dividend payouts also before the crisis.

$$Y_{i,t} = \alpha_i + \sum_k \beta_k \left(\text{Exposure}_{i,2006q4} \times \mathbf{1}_{t=k}\right) + \sum_k \eta_k \left(\text{RoA}_{i,2006q4} \times \mathbf{1}_{t=k}\right) + \gamma_{s(i),t} + \epsilon_{i,t} \quad (6)$$

3.4.2 Threats to identification

In this section, we discuss three potential threats to our interpretation of β_k as mapping out the effect of the rollover crisis on dividend payouts, namely risk-shifting due to agency problems and bad news about portfolios, optimism about the future franchise value, and government interventions as a response to the stress in financial markets. Below we discuss each of these possible confounders, while in Section 4.4 we show that our baseline results are robust to them in a number of robustness exercises.

Risk-shifting One explanation for the increase in dividend payouts observed during the financial crisis is that they reflected a form of moral hazard. According to Scharfstein and Stein (2008), during 2007-2008 banks were realizing that latent losses were large and the franchise value low, and so increased their dividend payouts in "... an attempt by shareholders to beat creditors out the door". To the extent that high-exposure banks faced larger *ex post* losses compared to other banks or had higher total leverage, the risk-shifting hypothesis and the rollover crisis hypothesis would have similar predictions for dividend growth. To isolate the effect of the rollover crisis, we therefore include several measures of differential exposure to asset losses as well as leverage. Specifically, we control for portfolio heterogeneity via the 2006q4 share of real estate loans to total assets, other loans to total assets and securities to total assets. These variables capture, in a parsimonious way, the differential exposure of banks in our sample to the decline in the U.S housing market and the associated recession, as well as the general decline in international asset markets. We allow these controls to have a time-varying impact on our outcome variables, i.e. we augment equation (6) to include them multiplied with year-quarter dummies. Similarly, we control for a time-varying impact of bank leverage (defined as total assets over equity). Finally, we also perform a robustness exercise where we exclude banks that failed the 2009 Supervisory Capital Assessment Program (SCAP) stress test, i.e. banks that in 2009 were deemed by the Federal Reserve as having too low capital. While this may capture banks that were more prone to risk-shifting during the crisis, it has the drawback that it might also exclude the banks that were most exposed to the rollover crisis to the extent that higher exposure to the crisis implies reduced overall capitalization post-crisis (for example, precisely because of front-loading of dividends).

Optimism about future franchise value Another possible explanation is that high-exposure banks are banks that have lower latent losses due to exposure to fundamentally different sectors compared to other banks, higher franchise values, and therefore have a higher dividend growth compared to other banks. Note, however, that by controlling for the different initial portfolio shares in robustness, we also implicitly control for such a confounding factor. Moreover, our analysis of dividend payouts in the medium-run in Section 4.3 also does not provide support for this channel.

Troubled-Asset Relief Program U.S authorities implemented the Troubled-Asset Relief Program (TARP) towards the end of 2008. By and large, TARP entailed a recapitalization of the participating banks which left them with additional funds. Importantly, as Scharfstein and Stein (2008) highlight, TARP was not associated with a cap on dividends. The newly acquired funds via TARP could therefore, in principle, be used to pay dividends. To the extent that banks with a higher exposure were more likely to participate in TARP and that funds obtained in TARP were used for dividends due to risk-shifting, it could be a confounding factor when interpreting β_k. To ensure that this is not driving our results, we follow two alternative approaches. First, we use the high frequency of the data on dividend announcments and payouts to verify that changes in the dividend payouts observed is not related to the announcement and implementation of the TARP, but rather focused on the initial phases of increased rollover risk in the summer of 2008. Second, we augment our baseline specification by also including a dummy for whether the bank was one of the 18 banks obtaining additional funds via TARP.

4 Results

In this section, we present the main results of the paper. We start by considering the impact of being exposed to the rollover crisis on dividend payouts in Section 4.1. We show that banks that were more exposed in terms of higher short-term leverage had higher dividend growth compared to other banks during the crisis. We find limited effects on both dividend initiations and dividend discontinuations. Consistent with our model, we document that this increase in dividends is driven by banks with high ratios of initial liquidity. Next, we show in Section 4.2 that the same set of banks experienced more favorable stock returns during the crisis.

4.1 Dividends

4.1.1 Intensive margin

We start by investigating the intensive margin response of dividend payouts to rollover risk. Specifically, in Figure 5 we plot the evolution of average dividend growth for banks with an exposure below and above the median. While the evolution is fairly similar prior to the crisis, there is a sharp relative increase in dividend growth by high-exposure banks in 2008q2 and 2008q3, which reverses in 2008q4. The relative increase at the height of the rollover crisis is consistent with rollover risk causing upward pressures on dividends, in line with our theoretical framework.[16] However, Figure 5 only plots the unconditional evolution of dividend growth. In Figure 6 we, therefore, plot the estimated sequence of β_k estimated from equation (6). These coefficients captures the dynamic impact of exposure to rollover risk as measured by 2006q4. Note now that, in contrast to Figure 5, we now measure exposure as a continuous measure.

[16]Note that our theoretical framework abstracts from contemporaneous shocks to "fundamentals" that would result in a general decline in dividends and instead only makes predictions about the relative behavior of high vs. low short-term leverage banks and high vs. low cash banks.

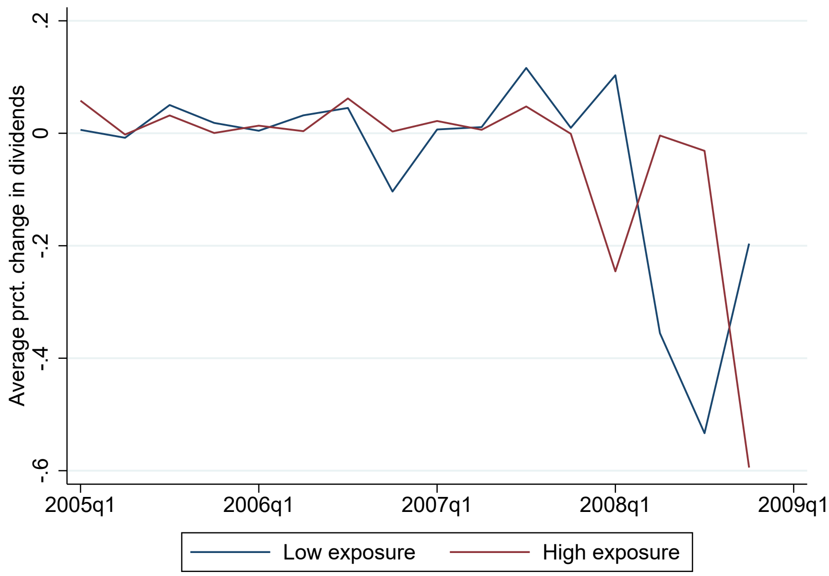


Figure 5: Evolution of dividends

Notes: This figure shows the evolution of the (size-weighted) average $\Delta \log(\text{dividends})$ for banks with an exposure above the median and banks with an exposure below the median.

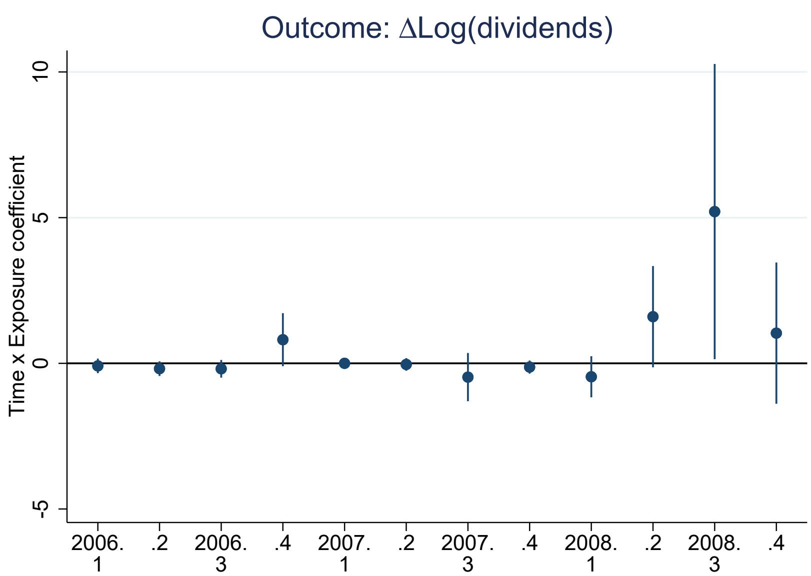


Figure 6: Rollover risk and dividend payouts

Notes: This figure shows the estimated β_k from equation (6) using $\Delta \log(\text{dividends})$ as outcome variable. Confidence intervals are at the 95% level, and standard errors are clustered at the bank level.

The figure illustrates that there are essentially no significant differences in the growth of dividends according to the 2006q4 exposure measure up to and including 2008q1 – a reflection of the well-known stickiness in bank dividend payouts. However, in 2008q2 and 2008q3 –

N	Number of clusters	R^2
5,176	318	0.662

Table 2: Summary statistics for Figure 6
Notes: This table contain accompanying summary statistics for Figure 6

precisely at the height of the rollover crisis – bank exposure has a significant positive impact on the growth of dividend payouts. This is particularly clear in 2008q3. In that quarter, a 10 percentage point higher exposure measure is associated with a 50 percentage points higher dividend growth. Quantitatively, a standard deviation change in the exposure measures explains nearly 100% of the dispersion in dividend growth in 2008q3 (conditional on bank and state x year fixed effects, as well as the dynamic effect of $\mathrm{RoA}_{b,2006q4}$), suggesting that exposures to the ongoing rollover crisis was key to understand dividend payout policies.

In line with our conceptual framework, we would expect more exposed banks with higher initial cash holdings to frontload their dividend payouts more strongly. To test whether this holds empirically, we partition the sample into cash-rich vs. other banks and estimate equation (6) for these two groups. Specifically, we measure cash as the sum of cash and trading assets, scale it by total liabilities, and define banks with a cash-ratio above the median in 2006q4 as cash-rich. We then estimate equation (6) for cash-rich and other banks. The results are shown in Figure 7. The estimated coefficients illustrates that all of the effect of rollover risk exposure on dividend growth is driven by banks with high initial cash holdings.

4.1.2 Extensive margin

Next we consider whether exposure to the rollover crises affected banks initiation or discontinuiton of dividend payouts. On average, dividend initiations were fairly unchanged in 2008 compared to previous years, as illustrated in Figure 8a. However, dividend discontinuiations became substantially more likely as the financial crisis unfolded as illustrated in Figure 8b. In that figure, we plot the fraction of banks discontinuing dividend payouts from $t-1$ to t. On average, the fraction is a little bit higher than 2% in the period prior to the financial crisis. From 2008q1, however, the fraction of banks discontinuing dividend payouts increase substantially, and reaches a peak in 2008q4.

It is unclear, however, whether the changes in dividend discontinuiations are driven by banks exposed to the rollover crises or not. Moreover, even though there is no increase in average dividend initiations, it could for instance be the case for high exposure banks. To investigate whether the rollover crisis affected banks dividend payouts along the extensive margin, we, therefore, estimate equation (6) with either a dummy for whether the bank

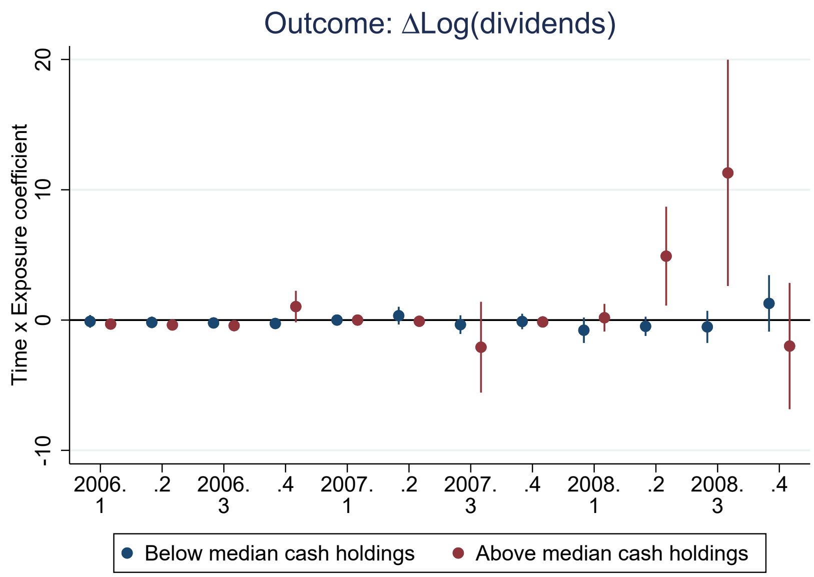
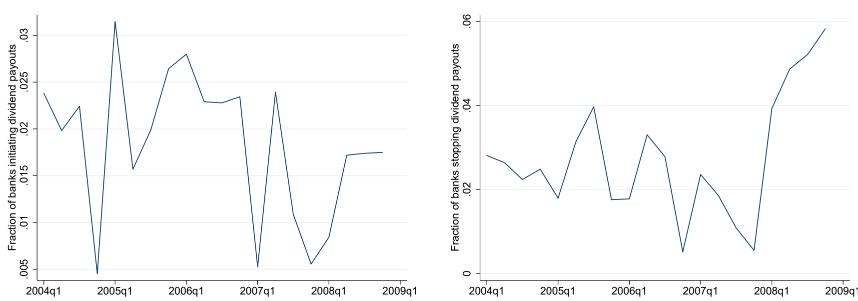


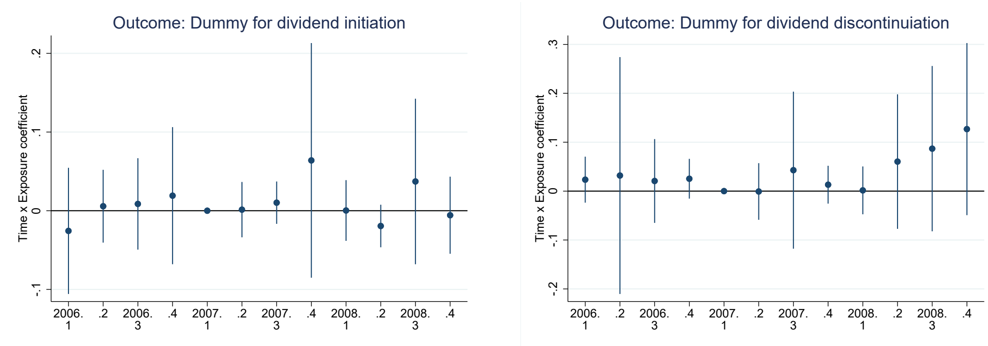
Figure 7: Rollover risk and dividend payouts, according to initial cash position.
Notes: This figure shows the estimated β_k from equation (6) using $\Delta\,\log(\text{dividends})$ as outcome variable. Confidence intervals are at the 95% level, and standard errors are clustered at the bank-level. "Above median cash holdings" refers to a sample where banks had cash to total liabilities above the median, where cash is defined as the sum of cash and trading assets. "Below median cash holdings" refers to a sample of all other banks.



(a) Fraction of dividend initiations

(b) Fraction of dividend discontinuiations

Figure 8: Dividend initiations and discontinuiations.
Notes: This figure shows the fraction of banks in our sample which initiated dividend payouts (a) and discontinuied dividends (b). Dividend initiations is defined as events where a bank holding company paid zero dividends in $t-1$ and a positive amount of dividends in t. Dividend discontinuiations is defined as events where a bank holding company paid positive amount of dividends in $t-1$ and paid zero dividends in t.



(a) Exposure the rollover crises and dividend initiations

(b) Exposure to the rollover crises and dividend discontinuations.

Figure 9: Exposure to the rollover crises and dividend payouts along the extensive margin.
Notes: This figure shows the estimated β_k from equation (6) using a dummy for dvidend initiations (a) or dividend discontinuiations (b) as outcome variable. Confidence intervals are at the 95% level, and standard errors are clustered at the bank-level. Dividend initiations is defined as events where a bank holding company paid zero dividends in $t-1$ and a positive amount of dividends in t. Dividend discontinuiations is defined as events where a bank holding company paid positive amount of dividends in $t-1$ and paid zero dividends in t.

initiates dividend payouts or discontinues dividend payouts. Figures 9a and 9b show the estimated effect of exposure to the rollover crisis on the propensity to initiate or discontinue dividend payouts. All estimated coefficients are relative to 2007q1. As is clear from both figures, exposure to the rollover crises does not have a significant impact on the propensity to initiate or discontinue dividends, suggesting that any potential adjustment of dividend payouts to rollover risk primarily operates along the intensive margin.

4.2 Stock price effects

In this section we investigate the financial markets impact of increasing dividend payouts in response to the rollover crisis. We focus on the effect on stock returns. Figure 10 shows the evolution of β_k using quarterly stock returns (ex dividend) as outcome variable. Interestingly, stock returns increase for banks with a higher exposure in 2008q3, which is also the quarter with highest growth in dividends for these banks. Quantitatively, dispersion in exposure explains approximately 80% of the dispersion in stock returns in that quarter with a 10 percentage point higher exposure being associated with around 7 percentage points higher stock return.

In line with Figure 7, we find that cash-rich banks also are the drivers of the differential stock return response to rollover risk, as documented in Figure 11 below. Specifically, among the cash-rich banks, a 10 percentage point higher exposure associated with around 20 percentage points higher stock return – a sizable effect.

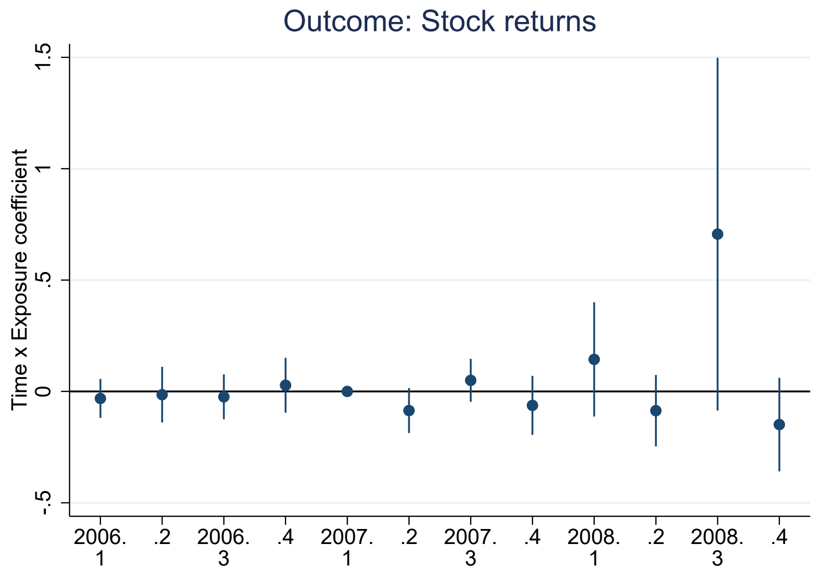


Figure 10: Stock returns

Notes: This figure shows the estimated β_k from equation (6) using stock returns (ex. dividend) as outcome variable. Confidence intervals are at the 95% level, and standard errors are clustered at the bank-level.

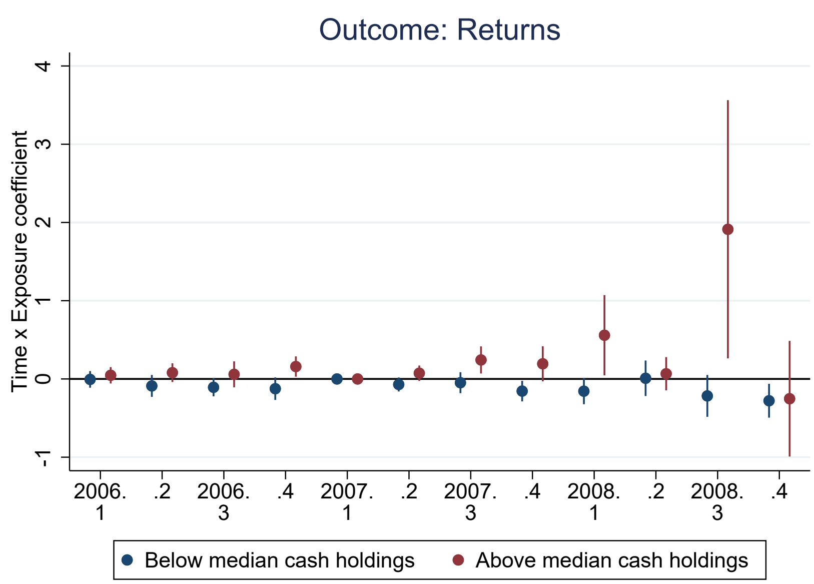


Figure 11: Stock returns and initial cash position

Notes: This figure shows the estimated β_k from equation (6) using stock returns (ex. dividend) as outcome variable. Confidence intervals are at the 95% level, and standard errors are clustered at the bank-level."Above median cash holdings" refers to a sample where banks had cash to total liabilities above the median, where cash is defined as the sum of cash and trading assets. "Below median cash holdings" refers to a sample of all other banks.

Therefore, we find a clear positive link between dividend payout changes and stock price responses that took place in 2008q3, consistent with a large empirical literature that has documented this relationship in other settings. Since exposed banks tend to only front-load dividends rather than permanently increase dividends (as we further document in Section 4.3 below), it is somewhat challenging to understand the mechanism through which stock prices respond to dividends.[17] One possible explanation is that given banks' reputation for stable dividend payouts any changes in dividend payouts tend to be interpreted by market participants as persistent and thus lead to changes in stock prices. A complementary explanation is that some investors may overreact to dividends because they consider dividend income separately from capital gains due to behavioral frictions like mental accounting (Shefrin and Statman, 1984, Baker, Nagel, and Wurgler (2007), Hartzmark and Solomon (2019), Di Maggio, Kermani, and Majlesi (2020), Hartzmark and Solomon (2021)).

4.3 Medium-run effects

We also examine the dividend payout and stock price effects in the quarters beyond the rollover crisis of 2008. Figure 12 shows the dynamic response of dividends and stock prices of more exposed banks through 2011q4.[18] As the Figure shows the relative increase in dividend payouts of more exposed banks was only short-lived and only during the rollover crisis. After that episode more exposed banks tended to permanently lower their dividend payouts. This pattern is consistent with the frontloading behavior of more exposed banks in our theoretical framework (cf. Figure 2). Figure 13 plots the dynamic response of stock prices. Stock prices track dividend payouts very closely, with the initial sharp (relative) increase in 2008q3 followed by the same persistent decline post 2009q1.

It is important to mention that there were substantial regulatory changes post-2008 (e.g. the Dodd-Frank act) which may have had a differential impact on profitability and hence dividend payouts and stock prices of banks with different levels of pre-crisis short-term leverage. Moreover, the SCAP stress test in 2009q1 may have played an important effect on post-crisis dividend payouts as well. In the Appendix we investigate this further by looking only at the medium-term response of banks that did not fail the 2009 stress test. We show that our results are qualitatively robust to excluding these banks though they are smaller in magnitude.

[17] In our theoretical framework, a rollover crisis leaves banks with higher short-term debt worse off compared to banks with lower short-term debt, irrespective of their deividend payouts. Therefore, if one equates stock prices to the payoffs of the bank owner in the model, one should expect a relative *decline* in stock prices for banks with higher short-term debt, not an increase.

[18] To estimate these responses we estimate Equation (6) in levels, i.e. we use log(dividends) and log(price) as outcome variables rather than the one-quarter log difference.

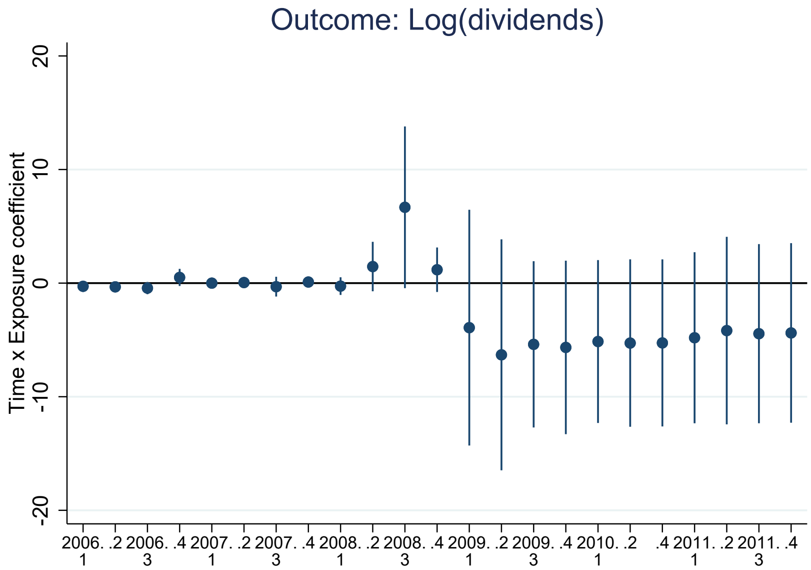


Figure 12: Differential (cumulative) response of dividend payouts relative to 2007q1, 2006q1-2011q4.

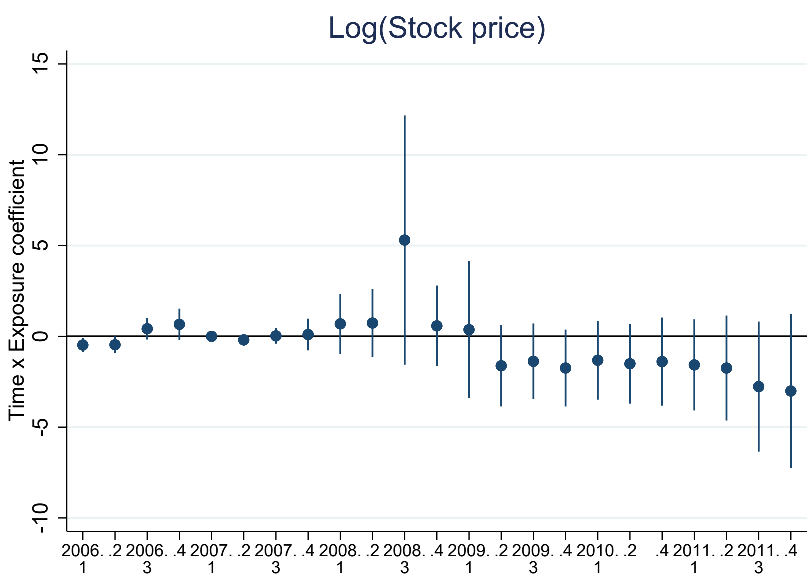


Figure 13: Differential (cumulative) response of stock prices relative to 2007q1, 2006q1-2011q4.

4.4 Robustness

In this section we discuss a number of robustness exercises, which address the counfounders discussed in Section 3.4.2. Details on the exercises and the actual results are included in the Appendix, while here we only summarize the results.

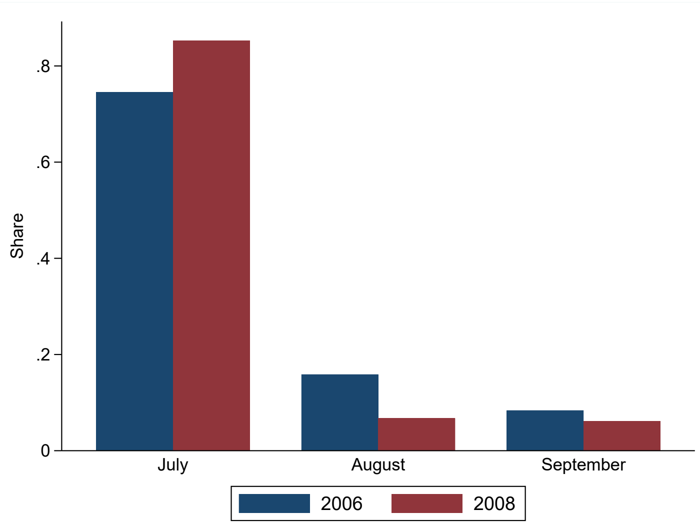
Additional controls Figures 15 - 18 in the Appendix show the equivalent of Figures 6 - 11, but where we augment equation (6) to also include the 2006q4 mortgage share, other loan share, securities share, as well as total leverage. All additional control variables are allowed to have a time-varying impact on the outcomes we consider, i.e. we interact them with time dummies. All results remain qualitatively and quantitatively unchanged. Dispersion in rollover risk exposure now explains roughly 80% of the dispersion in dividend growth in 2008q3.

Troubled-Asset Relief Program

A potential confounding event explaining the increase in dividend growth for high-exposure banks could be participation in the Troubled-Asset Relief Program (TARP) to the extent that our expousre measure correlates with TARP participation. Participation in TARP could be correlated with risk-shifting incentives, which in turn could contribute to higher dividend payouts. Moreover, TARP were not associated with a suspension of dividends which has been heavily critizied (Scharfstein and Stein, 2008).

To check whether participation in TARP affect the results, we do two things. First, in Figure 14 we exploit the high frequency of the data to look at the exact timing of the dividend changes. Most dividend announcements in 2008q3 were in July, 2008, which is two months prior to the failure of Lehman Brothers and three months prior to the announcement of TARP. However, the timing coincides with the runs on IndyMac and Washington Mutual. Moreover, a comparison with dividend announcements in the pre-crisis period of 2006q3 shows that relatively more banks made dividend announcements in July, 2008 compared to July, 2006. This is consistent with dividend signaling in response to the rollover crisis being the key driver of the observed dividend changes for high-exposure banks.

Second, in Figures (19) - (22) in the Appendix we show the estimation results from including the additional controls described above plus an indicator for whether the bank was participating in TARP or not. We allow all additional controls and the TARP-dummy to have a time-varying impact on the outcomes considered. The results remain largely unchanged, suggesting that participation in TARP is not driving our results.



Notes: This figure shows the weighted share of dividend announcements in 2006q3 (left-hand bars) and 2008q3 (right-hand bars) for high exposure banks by month of announcement with lagged assets as weights.

Figure 14: Dividend announcements, by month in 2006q3 (left-hand bars) and 2008q3 (right-hand bars).

Excluding low-capitalized banks according to the 2009 Supervisory Capital Assessment Program Figures (23) and (25) in the Appendix show the evolution of dividends and stock returns (on average) for banks that were not deemed undercapitalized by the Federal Reserve in the 2009 Supervisory Capital Assessment Program. The effects are qualitatively consistent with but somewhat muted relative to the baseline effects. The interpretation of this discrepancy is somewhat unclear, however, to the extent that banks failing the 2009 SCAP may have done so precisely because they were most exposed to the rollover crisis and thus engaged in stronger front-loading of dividends in 2008.

5 Aggregate dividend payouts and the rollover crisis

The results in the prevous sections illustrates that exposure to the rollover crisis contributed to higher dividend growth at the bank-level. In this section, we use our empirical estimates to shed light on the strength of this effect on *aggregate* dividend payouts. Specifically, we compute dividend growth for each bank holding company using counterfactual assumptions about the distribution of exposure to the rollover crisis and the estimated parameters of the model.

We impose an assumption of no general equilibrium effects on dividend payouts from the rollover crisis. In that case, the estimated regression evaluated at the actual empirical moments yields the expected change in log(dividends) for each bank:

	Scenario: Actual	Scenario: Median	Scenario: 1st quartile
Change in dividends from 2008q2 - 2008q3 (billion USD)	-3.1	-4.1	-5.6
Change (in abs. value) relative to 2008q2 (= 9.7 billion USD)	32 %	42 %	57 %

Table 3: Aggregate dividende flows with counterfactual exposure levels.

Notes: This table shows aggregate dividend volumes and changes in three scenarios. "Actual" refer to the case when using actual exposure levels. "Median" refers to the case where all banks with an exposure above the median are assumed to have an exposure equal to the sample median, while "1st quartile" refers to the case where all banks with an exposure above the 1st quartile are assumed to have an exposure equal to the 1st quartile in the sample.

$$\Delta\log(\widehat{\text{dividends}})_{i,t} = \widehat{\alpha}_i + \sum_k \widehat{\beta}_k \left(\text{Exposure}_{i,2006q4} \times \mathbf{1}_{t=k}\right) + \sum_k \widehat{\eta}_k \left(\text{RoA}_{i,2006q4} \times \mathbf{1}_{t=k}\right) + \widehat{\gamma}_{s(i),t} \tag{7}$$

Importantly, we use the estimated parameters in equation (6) to compute expected dividend growth under two alternative distributions of $\text{Exposure}_{i,2006q4}$. First, we truncate the distribution of $\text{Exposure}_{i,2006q4}$ from above at the median. Specifically, we set the exposure of all banks with an exposure above the sample median to be equal to the sample median, i.e.$\text{Exposure}^{\text{cf, median}}_{i,2006q4} = \text{Median}\left(\text{Exposure}_{i,2006q4}\right)$. We assume that other banks have a counterfactual exposure equal to the observed. We refer to this as the "median exposure"-scenario. Second, we truncate the distribution of $\text{Exposure}_{i,2006q4}$ at the 1st quartile. That is, we set the exposure of all banks with an exposure above the 25th percentile in the sample to be equal to the 25th percentile, i.e.$\text{Exposure}^{\text{cf, p(25)}}_{i,2006q4} = \text{p25}\left(\text{Exposure}_{i,2006q4}\right)$. We assume that other banks have a counterfactual exposure equal to the observed. We refer to this as the "1st quartile"-scenario

Under these two counterfactual measures of exposure, we can compute counterfactual dividend growth for a given bank i under a scenario j:

$$\Delta\log(\widehat{\text{dividends}})^{\text{cf,j}}_{i,t} = \widehat{\alpha}_i + \sum_k \widehat{\beta}_k \left(\text{Exposure}^{\text{cf,j}}_{i,2006q4} \times \mathbf{1}_{t=k}\right) + \sum_k \widehat{\eta}_k \left(\text{RoA}_{i,2006q4} \times \mathbf{1}_{t=k}\right) + \widehat{\gamma}_{s(i),t} \tag{8}$$

for $j \in \{\text{median, p(25)}\}$.

We then compute the (weighted-)average change in log(dividends) for the different scenarios. In each case, we compute the growth in dividends from 2008q2 to 2008q3, as dividend signaling was most present in 2008q3. The results are shown in Table 3

This exercise highlights that a lower exposure to the rollover crises in general decreases the outflow of dividends in 2008q3. Going from the actual distribution of exposure to rollover risk to one which is truncated above at the sample median, our calculations suggest that aggregate dividend outflows would be about 1 billion USD lower under the counterfactual distribution.

When considering a counterfactual exposure distribution truncated from above at the 1st quartile, dividend outflows in 2008 declines by approximately 2.5 billion USD compared to the observed outflows. Evaluated at the 2008q2 aggregate dividend levels in our sample (9.7 billion USD), this suggest that the actual exposure to the rollover crisis increased aggregate dividend outflows by about 26 %. As such, we interpret the results from this exercise as evidence that exposure to the rollover crisis not only has a statistically significant impact on dividend growth, but that dividend signaling during the rollover crisis contributed to a sizable reduction in the outflows of aggregate dividends.

6 Conclusion

In this paper we revisit the dividend payouts of banks in the midst of the Great financial crisis of 2008 to draw new insights on the underlying forces that shape dividend policies in a crisis. We argue that our main finding that banks with higher exposure to short-term debt increased their dividend payouts more during the rollover crisis and particularly, cash-rich banks, is more consistent with dividends being used to signal available liquidity to short-term lenders rather than being the result of a pure agency problem exacerbated by bad news about portfolio returns – the so called "risk-shifting" view.

Even though the evidence is not fully consistent with a pure risk-shifting story, it is important to emphasize that some form of risk-shifting could well have been taking place in tandem with dividend signaling. Indeed, it could very well be the case that banks engaged in excessively long periods of elevated dividend payouts during the rollover crisis relative to what is optimal from the perspective of debt holders in each individual bank, as well as from a social planner's perspective in the presence of potential dividend externalities (as in e.g. Acharya, Le, and Shin (2017)) or other financial stability externalities. Therefore, the socially optimal dividend policy when the dividend signaling channel is present need not be altogether very different relative to the case with pure risk-shifting by banks. For example, Juelsrud and Nenov (2020) show that a cap is the optimal dividend regulation policy during a rollover crisis when dividend payouts exert a signaling effect on the rollover decisions of short-term lenders. Nevertheless, having evidence in support of the signaling channel gives us a better appreciation of the central role rollover risk plays in bank behavior, including for their payout policies.

References

Acharya, V. V., I. Gujral, N. Kulkarni, and H. S. Shin (2011): "Dividends and bank capital in the financial crisis of 2007-2009," Discussion paper, National Bureau of Economic Research.

Acharya, V. V., H. T. Le, and H. S. Shin (2017): "Bank capital and dividend externalities," Discussion Paper 3.

Aharony, J., and I. Swary (1980): "Quarterly dividend and earnings announcements and stockholders' returns: An empirical analysis," *The Journal of finance*, 35(1), 1–12.

Allen, F., and R. Michaely (2003): "Payout policy," *Handbook of the Economics of Finance*, 1, 337–429.

Asquith, P., and D. W. Mullins Jr (1983): "The impact of initiating dividend payments on shareholders' wealth," *Journal of business*, pp. 77–96.

Bajaj, M., and A. M. Vijh (1990): "Dividend clienteles and the information content of dividend changes," *Journal of Financial Economics*, 26(2), 193–219.

Baker, H. K. (2009): *Dividends and dividend policy*, vol. 1. John Wiley & Sons.

Baker, M., B. Mendel, and J. Wurgler (2016): "Dividends as reference points: A behavioral signaling approach," *Review of Financial Studies*, 29(3), 697–738.

Baker, M., S. Nagel, and J. Wurgler (2007): "The Effect of Dividends on Consumption," *Brookings Papers on Economic Activity*, 38(1), 231–292.

Benartzi, S., R. Michaely, and R. Thaler (1997): "Do changes in dividends signal the future or the past?," *The Journal of finance*, 52(3), 1007–1034.

Bernheim, B. D. (1991): "Tax Policy and the Dividend Puzzle," *The Rand Journal of Economics*, pp. 455–476.

Bernheim, B. D., and A. Wantz (1995): "A Tax-Based Test of the Dividend Signaling Hypothesis," *American Economic Review*, 85(3), 532–51.

Bhattacharya, S. (1979): "Imperfect information, dividend policy, and "the bird in the hand" fallacy," *Bell Journal of Economics*, 10(1), 259–270.

Black, F. (1976): "The dividend puzzle," *The Journal of Portfolio Management*, 2, 5–8.

BRICKLEY, J. A. (1983): "Shareholder wealth, information signaling and the specially designated dividend: An empirical study," *Journal of Financial Economics*, 12(2), 187–209.

CHAREST, G. (1978): "Dividend information, stock returns and market efficiency-II," *Journal of financial Economics*, 6(2-3), 297–330.

CZIRAKI, P., C. LAUX, AND G. LORANTH (forthcoming): "Understanding bank payouts during the crisis of 2007-2009," *Review of Corporate Finance Studies*.

DEANGELO, H., L. DEANGELO, AND D. J. SKINNER (2009): *Corporate payout policy*. Now Publishers Inc.

DEANGELO, H., L. DEANGELO, AND R. M. STULZ (2006): "Dividend policy and the earned/contributed capital mix: a test of the life-cycle theory," *Journal of Financial economics*, 81(2), 227–254.

DENIS, D. J., D. K. DENIS, AND A. SARIN (1994): "The information content of dividend changes: Cash flow signaling, overinvestment, and dividend clienteles," *Journal of Financial and Quantitative Analysis*, 29(4), 567–587.

DI MAGGIO, M., A. KERMANI, AND K. MAJLESI (2020): "Stock market returns and consumption," *The Journal of Finance*, 75(6), 3175–3219.

DUFFIE, D. (2010): *How big banks fail and what to do about it*. Princeton University Press.

FARRE-MENSA, J., R. MICHAELY, AND M. SCHMALZ (2014): "Payout policy," *Annu. Rev. Financ. Econ.*, 6(1), 75–134.

FLOYD, E., N. LI, AND D. J. SKINNER (2015): "Payout policy through the financial crisis: The growth of repurchases and the resilience of dividends," *Journal of Financial Economics*, 118(2), 299–316.

FRANKFURTER, G., B. G. WOOD, AND J. WANSLEY (2003): *Dividend policy: Theory and practice*. Elsevier.

GRULLON, G., R. MICHAELY, AND B. SWAMINATHAN (2002): "Are dividend changes a sign of firm maturity?," *The journal of Business*, 75(3), 387–424.

GUTTMAN, I., O. KADAN, AND E. KANDEL (2010): "Dividend stickiness and strategic pooling," *Review of Financial Studies*, 23(12), 4455–4495.

HARTZMARK, S. M., AND D. H. SOLOMON (2019): "The dividend disconnect," *The Journal of Finance*, 74(5), 2153–2199.

——— (2021): "Predictable price pressure," *Available at SSRN 3853096.*

Hausch, D. B., and J. K. Seward (1993): "Signaling with dividends and share repurchases: A choice between deterministic and stochastic cash disbursements," *Review of Financial Studies*, 6(1), 121–154.

He, Z., and A. Manela (2016): "Information acquisition in rumor-based bank runs," *The Journal of Finance*, 71(3), 1113–1158.

He, Z., and W. Xiong (2012): "Dynamic debt runs," *The Review of Financial Studies*, 25(6), 1799–1843.

Hirtle, B. (2014): "Bank holding company dividends and repurchases during the financial crisis," *FRB of New York Staff Report*, (666).

Jensen, M. C. (1986): "Agency costs of free cash flow, corporate finance, and takeovers," *The American economic review*, 76(2), 323–329.

Jensen, M. C., and W. H. Meckling (1976): "Theory of the firm: Managerial behavior, agency costs and ownership structure," *Journal of financial economics*, 3(4), 305–360.

John, K., and J. Williams (1985): "Dividends, dilution, and taxes: A signalling equilibrium," *Journal of Finance*, 40(4), 1053–1070.

Juelsrud, R. E., and P. T. Nenov (2020): "Dividend payouts and rollover crises," *The Review of Financial Studies*, 33(9), 4139–4185.

Michaely, R., R. H. Thaler, and K. L. Womack (1995): "Price reactions to dividend initiations and omissions: Overreaction or drift?," *the Journal of Finance*, 50(2), 573–608.

Miller, M. H., and K. Rock (1985): "Dividend policy under asymmetric information," *Journal of Finance*, 40(4), 1031–1051.

Morris, S., and H. Shin (2004): "Coordination Risk and the Price of Debt," *European Economic Review*, 48(1), 133–153.

Scharfstein, D. S., and J. C. Stein (2008): "This bailout doesnt pay dividends," *New York Times*, 20.

Shefrin, H. M., and M. Statman (1984): "Explaining investor preference for cash dividends," *Journal of financial economics*, 13(2), 253–282.

Appendix

Characterizing the bank owner's problem from Section 2

The bank (owner) solves

$$W(L(0)) = \max_{\{d(t)\}_0^\infty,\, 0 \le \tau, \tilde{L} \ge 0} \left\{ \Pr\{X < \tau\} V + \Pr\{X > \tau\} D\left(\tilde{L}\right) \right\},$$

$$s.t.\ \tilde{L} = L(0) - \int_0^\tau l(t)\, dt.$$

We have that $\Pr\{X > \tau\} = \exp\{-\lambda \tau\}$. Moreover, by assumptions on l (Eq. (2)), it follows that $d(t) \ge d_{\min}$, and so $l(t) = d(t)\,,\ \forall t$. It then follows that $\int_0^\tau l(t) \ge d_{\min}\tau$ or equivalently

$$\tilde{L} \le L(0) - d_{\min}\tau.$$

Moreover, we can simplify the objective to

$$W(L(0)) = \max_{0 \le \tau, \tilde{L} \ge 0} \left\{ V - \exp(-\lambda\tau)\left[V - D\left(\tilde{L}\right)\right]\right\},$$

$$s.t. \tilde{L} \le L(0) - d_{\min}\tau.$$

Note that $\tilde{L} > 0$ by the Inada conditions, so we can disregard this constraint. Let μ denote the multiplier on the inequality constraint. The first-order conditions for this problem, assuming an interior value of τ, are

$$\tilde{L} : \exp(-\lambda\tau) D'\left(\tilde{L}\right) - \mu = 0, \tag{9}$$

and

$$\tau : \lambda \exp(\lambda\tau)\left[V - D\left(\tilde{L}\right)\right] - d_{\min}\mu = 0, \tag{10}$$

together with the complementary slackness condition

$$\mu\left(L(0) - d_{\min}\tau - \tilde{L}\right) = 0. \tag{11}$$

Note that condition (10) implies that $\mu > 0$, so that the constraint is binding at the optimum. Intuitively, since overcoming the liquidity crisis is always preferred to giving up, the bank would prefer to survive the longest possible time for any $L(0)$. This requires choosing the lowest liquidity outflow rate possible, which is $d_{\min}$.

Combining Eq. (9)-(11), we get

$$\lambda \left[V - D\left(L\left(0\right) - d_{\min}\tau\right)\right] = \left[D'\left(L\left(0\right) - d_{\min}\tau\right)\right] d_{\min}. \tag{12}$$

Finally, note that the optimal value of τ is at an interior point, provided that $\lambda \left[V - D\left(L\left(0\right)\right)\right] > D'\left(L\left(0\right)\right) d_{\min}$. This inequality holds for sufficiently high values of $L\left(0\right)$, i.e. for $L\left(0\right) > \overline{L}$, where $\overline{L}$ solves

$$\lambda \left[V - D\left(\overline{L}\right)\right] = D'\left(\overline{L}\right) d_{\min}. \tag{13}$$

For values of $L\left(0\right) \leq \overline{L}$, the bank optimally chooses to "Give up" immediately, so that $\tau = 0$.[19]

Note that we can also express the optimality condition in Eq (12) in terms of the available liquidity at τ, $\tilde{L} = L\left(0\right) - d_{\min}\tau$, so that

$$\lambda \left[V - D\left(\tilde{L}\right)\right] = D'\left(\tilde{L}\right) d_{\min}. \tag{14}$$

Observe that Eq. (13) and (14) coincide. Therefore, banks with different values of $L\left(0\right)$ choose to "Continue" until they reach the same amount of available liquidity $\overline{L}$. If they start with lower available liquidity than $\overline{L}$, then they choose to "Give up" immediately.

Robustness to a wider set of controls

In this section, we augment equation (6) to also include the 2006q4 mortgage share, corporate loan share, securities share, other loans share as well as leverage.[20] Figure 15 and 16 considers the impact of rollover risk exposure on dividend growth, on average and by initial cash holdings, respectively. Figure (17) and (18) investigates the impact on stock returns. In sum, the results are qualitatively and quantitatively robust to the inclusion of these additional controls. Once controlling for these other factors, the dispersion in exposure can explain roughly 80% of the dispersion in dividend growth in 2008q3.

[19] The assumption that $\lambda < -D''\left(\overline{L}\right)/D'\left(\overline{L}\right) d_{\min}$ ensures that $\overline{L}$ is unique.

[20] Controlling for leverage is also captures a broader measure of payout capacity, as banks also can pay out dividends based on retained earnings, see DeAngelo, DeAngelo, and Stulz (2006).

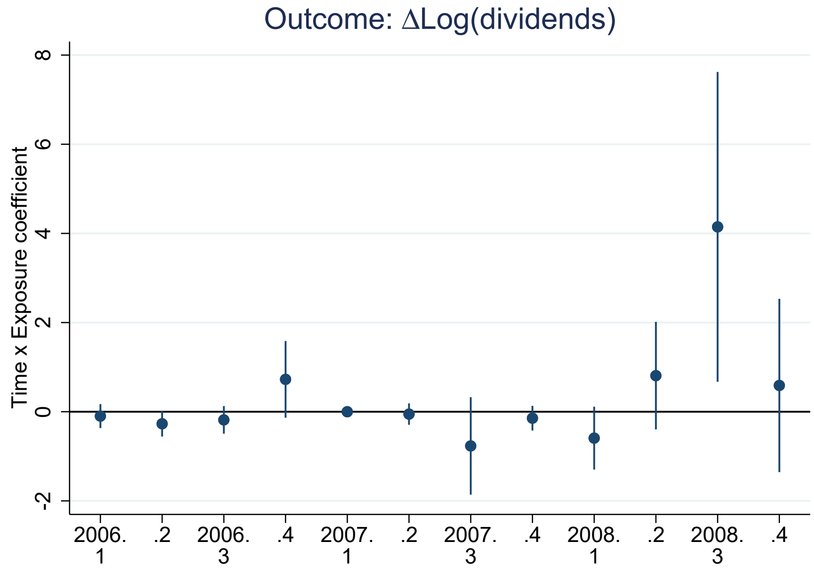


Figure 15: Rollover risk and dividend payouts

Notes: This figure shows the estimated β_k from equation (6) using $\Delta\log(\text{dividends})$ as outcome variable, and where we also include the 2006q4 share of mortgages to total assets, non-mortgage lending to total assets, securities to total assets, and leverage. Confidence intervals are at the 95% level, and standard errors are clustered at the bank-level.

Controlling for participation in the Troubled-Asset Relief Program

In this section, we show the results from estimating the same regression as in the last section but where we also allow participation in the Troubled-Asset Relief Program (TARP) to have a time-varying impact on the dividends paid. This is potentially important, as participation in TARP could influence the funds available and the incentives to pay dividends. Figure 19 and 20 considers the impact of rollover risk exposure on dividend growth, on average and by initial cash holdings, respectively. Figure (21) and (22) investigates the impact on stock returns. In sum, the results are qualitatively and quantitatively robust to the inclusion of these additional controls.

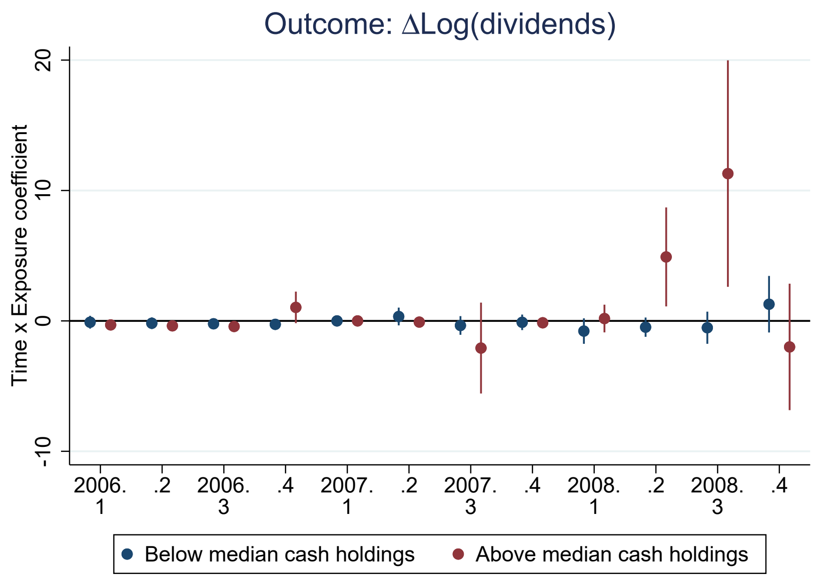


Figure 16: Rollover risk and dividend payouts, according to initial cash position.
Notes: This figure shows the estimated β_k from equation (6) using $\Delta\log(\text{dividends})$ as outcome variable, and where we also include the 2006q4 share of mortgages to total assets, non-mortgage lending to total assets, securities to total assets, and leverage. Confidence intervals are at the 95% level, and standard errors are clustered at the bank-level. "Above median cash holdings" refers to a sample where banks had cash to total liabilities above the median, where cash is defined as the sum of cash and trading assets. "Below median cash holdings" refers to a sample of all other banks.

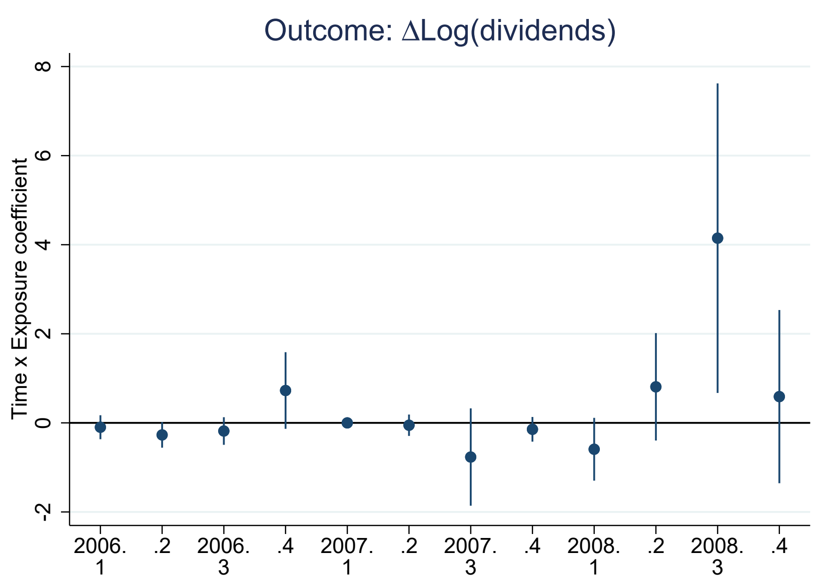


Figure 19: Rollover risk and dividend payouts
Notes: This figure shows the estimated β_k from equation (6) using $\Delta\log(\text{dividends})$ as outcome variable, and where we also include the 2006q4 share of mortgages to total assets, non-mortgage lending to total assets, securities to total assets, leverage and a dummy for whether the bank was a participant in the TARP program or not. Confidence intervals are at the 95% level, and standard errors are clustered at the bank-level.

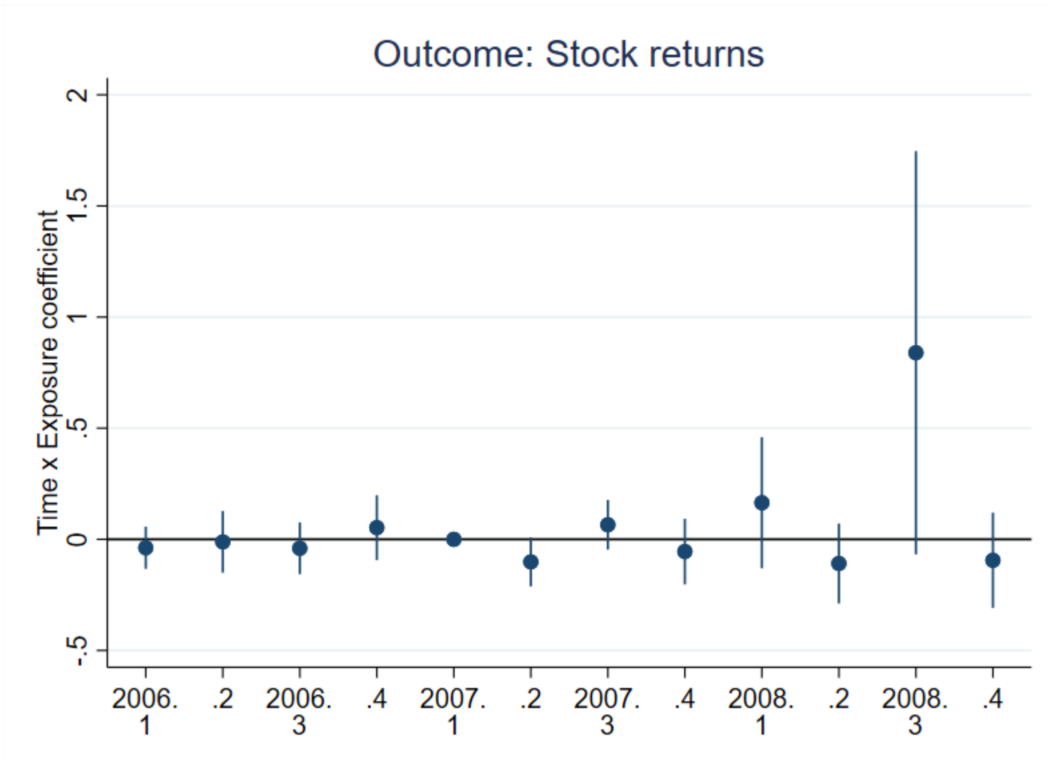


Figure 17: Stock returns

Notes: This figure shows the estimated β_k from equation (6) using stock returns (ex. dividend) as outcome variable, and where we also include the 2006q4 share of mortgages to total assets, non-mortgage lending to total assets, securities to total assets, and leverage. Confidence intervals are at the 95% level, and standard errors are clustered at the bank-level.

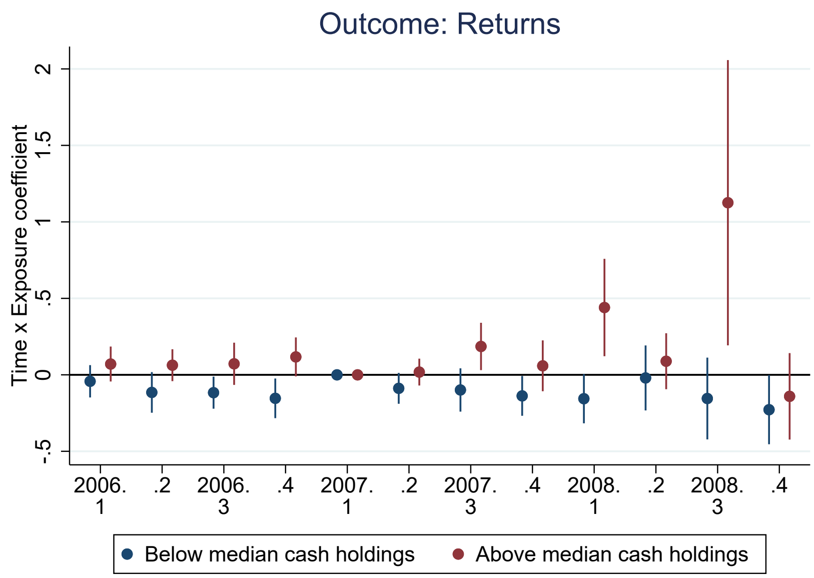


Figure 18: Stock returns and initial cash position

Notes: This figure shows the estimated β_k from equation (6) using stock returns (ex. dividend) as outcome variable, and where we also include the 2006q4 share of mortgages to total assets, non-mortgage lending to total assets, securities to total assets, and leverage. Confidence intervals are at the 95% level, and standard errors are clustered at the bank-level."Above median cash holdings" refers to a sample where banks had cash to total liabilities above the median, where cash is defined as the sum of cash and trading assets. "Below median cash holdings" refers to a sample of all other banks.

Excluding banks in the Supervisory Capital Assessment Program

In this section, we show the main (average) results using $\Delta \log(\text{dividends})$ and stock returns (ex. dividends) as outcome variables. For comparison, we also include the coefficient estimates obtained on the full sample. Our results are qualitatively robust to excluding the low-capitalized banks based on the stress tests, but the responses are somewhat muted. A potential interpretation of this, is that banks that failed the stress test of 2009 did so in particular because their dividend signaling in 2008 was particularly strong.

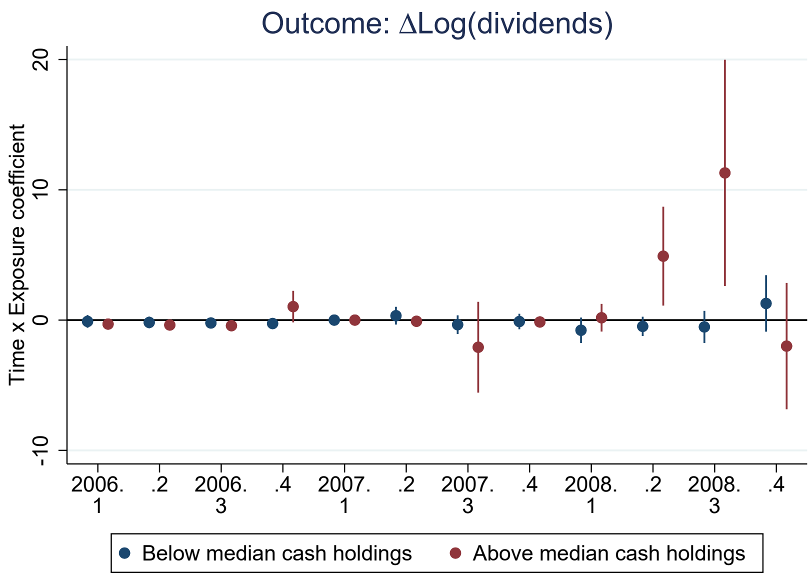


Figure 20: Rollover risk and dividend payouts, according to initial cash position.
Notes: This figure shows the estimated β_k from equation (6) using Δ log(dividends) as outcome variable, and where we also include the 2006q4 share of mortgages to total assets, non-mortgage lending to total assets, securities to total assets, leverage and a dummy for whether the bank was a participant in the TARP program or not. Confidence intervals are at the 95% level, and standard errors are clustered at the bank-level. "Above median cash holdings" refers to a sample where banks had cash to total liabilities above the median, where cash is defined as the sum of cash and trading assets. "Below median cash holdings" refers to a sample of all other banks.

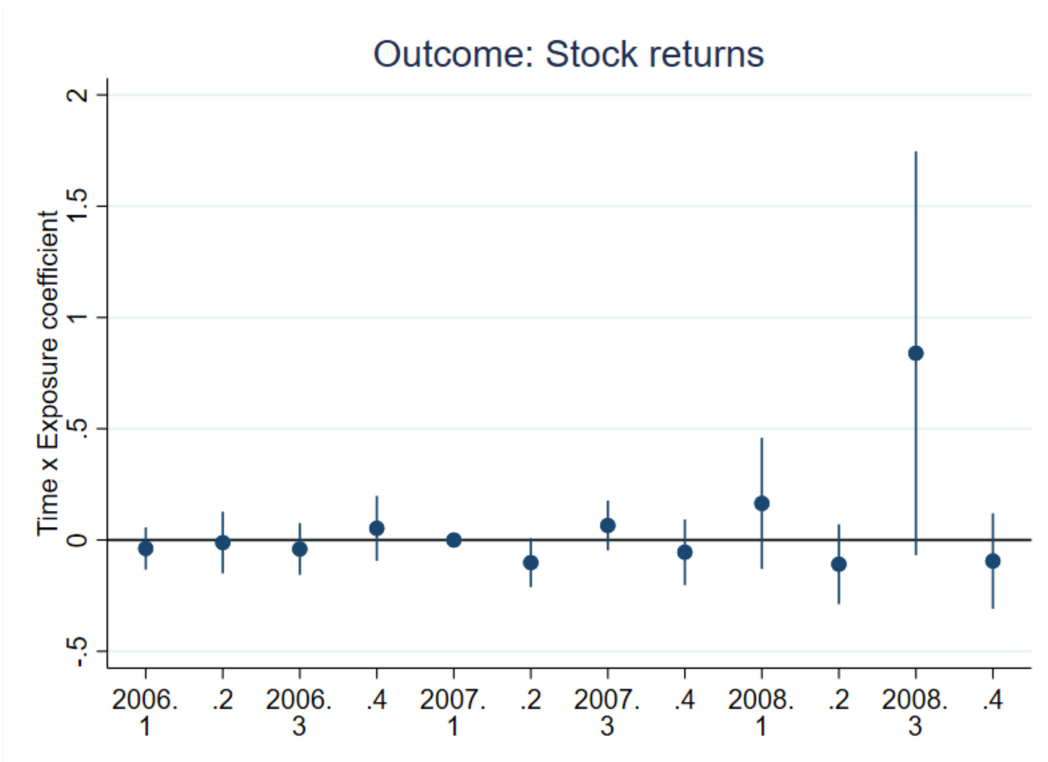


Figure 21: Stock returns

Notes: This figure shows the estimated β_k from equation (6) using stock returns (ex. dividend) as outcome variable, and where we also include the 2006q4 share of mortgages to total assets, non-mortgage lending to total assets, securities to total assets, leverage and a dummy for whether the bank was a participant in the TARP program or not. Confidence intervals are at the 95% level, and standard errors are clustered at the bank-level.

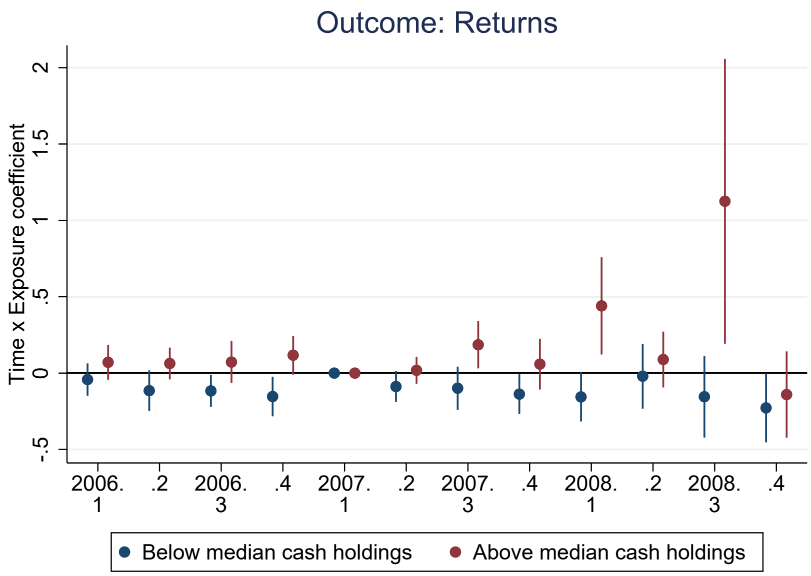


Figure 22: Stock returns and initial cash position

Notes: This figure shows the estimated β_k from equation (6) using stock returns (ex. dividend) as outcome variable, and where we also include the 2006q4 share of mortgages to total assets, non-mortgage lending to total assets, securities to total assets, leverage and a dummy for whether the bank was a participant in the TARP program or not. Confidence intervals are at the 95% level, and standard errors are clustered at the bank-level."Above median cash holdings" refers to a sample where banks had cash to total liabilities above the median, where cash is defined as the sum of cash and trading assets. "Below median cash holdings" refers to a sample of all other banks.

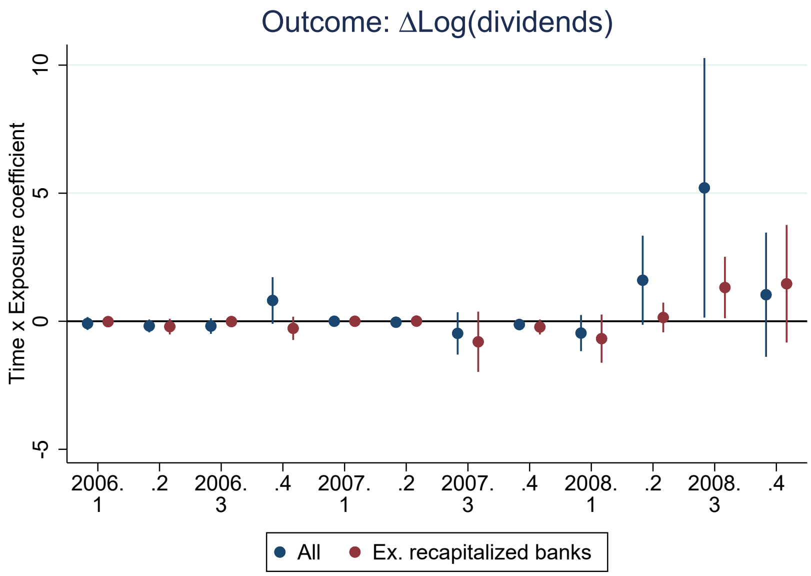


Figure 23: Rollover risk and dividend payouts

Notes: This figure shows the estimated β_k from equation (6) using $\Delta\log(\text{dividends})$ as outcome variable. Confidence intervals are at the 95% level, and standard errors are clustered at the bank-level.

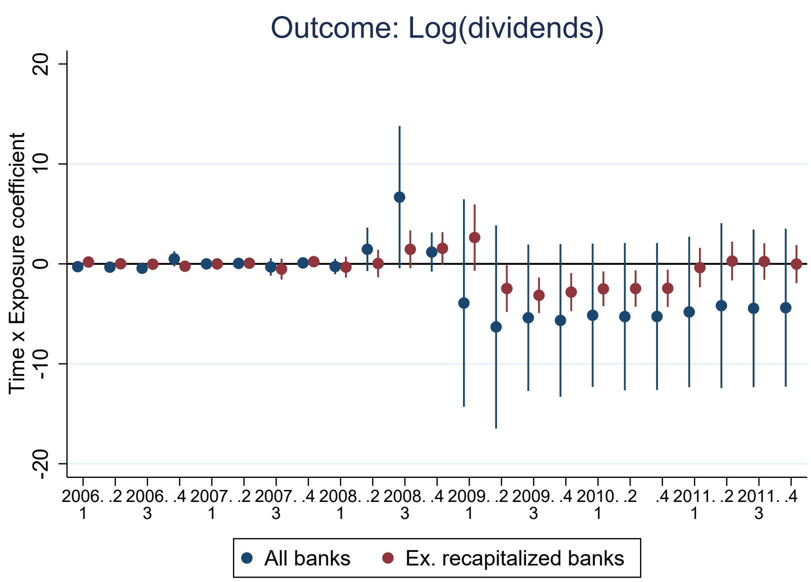


Figure 24: Rollover risk and dividend payouts

Notes: This figure shows the estimated β_k from equation (6) using log(dividends) as outcome variable. Confidence intervals are at the 95% level, and standard errors are clustered at the bank-level.

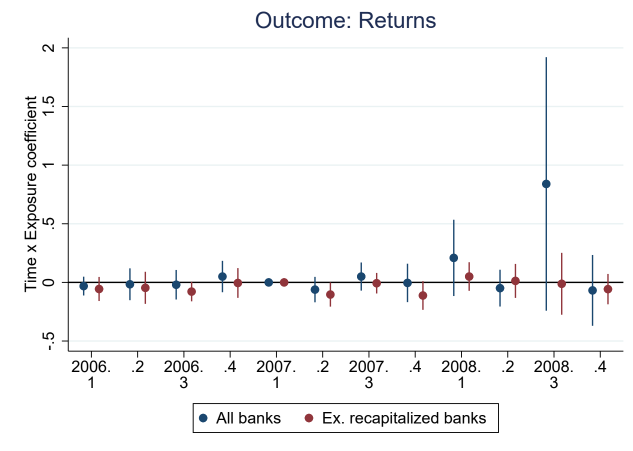


Figure 25: Stock returns

Notes: This figure shows the estimated β_k from equation (6) using stock returns (ex. dividend) as outcome variable. Confidence intervals are at the 95% level, and standard errors are clustered at the bank-level.

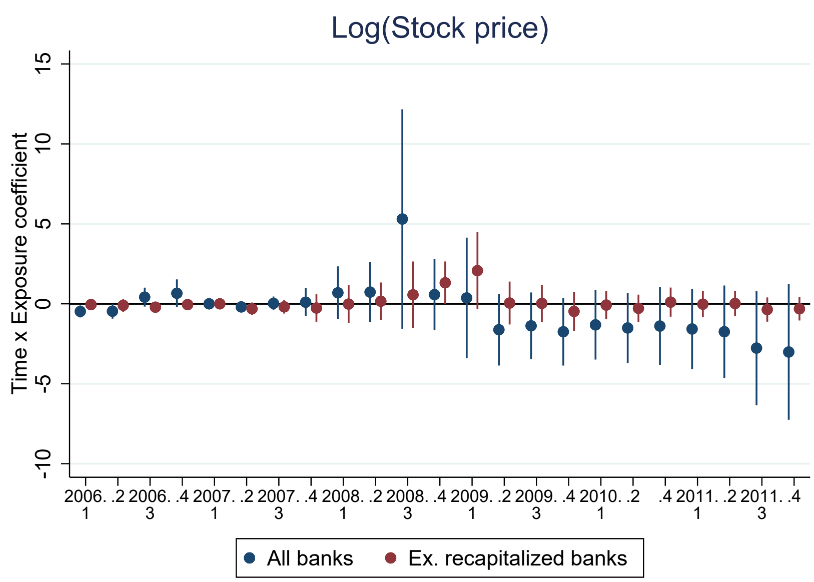


Figure 26: Stock returns

Notes: This figure shows the estimated β_k from equation (6) using log(stock price) as outcome variable. Confidence intervals are at the 95% level, and standard errors are clustered at the bank-level.

		High exposure$_t$ 0	High exposure$_t$ 1
High exposure$_{t-1}$	0	90.53 %	9.47 %
	1	9.88 %	90.12 %

Table 4: Transition matrix - high exposure status.

Stability of treatment measure

We measure treatment based on the exposure to rollover risk at the end of 2006q4. Given that the financial market stress primarily started summer 2007 and the height of the crisis was in 2008, a relevant question is whether our treatment measure properly captures banks that truly were exposed to rollover risk. To the extent that balance sheets are somewhat sticky, this would be the case. To gauge whether this is indeed the case, we here report the results from an exercise where we do follow two steps. First, for each year-quarter, we categorize a bank according to whether its exposure measure is above or below the median exposure that year. We refer to banks above the median as high exposure. Second, we then compute the transition matrix for the high exposure dummy over time.

Table 4 shows the results. The fraction of high exposure banks in $t-1$ that is also high exposure t is roughly 90 %. This suggests that there is a strong persistence in the the degree of exposure over time. As a result, our treatment definition based on the balance sheet in 2006q4 plausibly also captures subsequent exposure to rollover risk.