Market Discipline and Regulatory Arbitrage: Evidence from the Asset-backed Commercial Paper Exclusion

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Abstract

We investigate whether the U.S. stock market disciplines asset-backed commercial paper (ABCP) liquidity guarantor banks that exploit an arcane regulatory loophole, the "ABCP exclusion," which exempts the banks from holding risk capital against their guarantee obligations. We find that the market reduces liquidity guarantors' franchise value under a shortened ABCP maturity that obscurely raises the guarantee costs. Banks with franchise value more sensitive to the ABCP maturity maintain a higher risk capital buffer. We interpret our findings as evidence that market discipline—complexity of the shadow banking system notwithstanding—alleviates the consequence of regulatory arbitrage.

Keywords: Capital Regulation; Market Discipline; Regulatory Arbitrage; Bank Risk Capital.

JEL classification: G01, G21, G28

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1 Introduction

Market discipline, as per Bliss and Flannery (2002), includes two distinct components: market *monitoring* and market *influence*. Market monitoring, based on the semi-strong form of the efficient market hypothesis, means a bank's franchise value incorporates all relevant public information. Market influence means a change in franchise value would influence the bank's subsequent behavior. The Basel Committee on Banking Supervision (BCBS) designates market discipline, together with the minimum capital requirements and supervisory review, as "three pillars" of the Basel Accords. In nations such as the United States, where bank funding structure is complex, loopholes in the minimum capital requirement can be arcane enough to remain for an extended period. Loophole-exploiting banks took excessive risks beyond regulatory presumption and played a critical role in the recent financial crisis. How effective is the pillar of market discipline when the pillar of capital requirement is compromised? In particular, when banks are circumventing the minimum capital requirement under the nose of regulatory watchdogs, is the U.S. stock market efficient enough to spot them and lower their franchise value according to the excessive risk taken? Additionally, does market pressure force loophole-exploiting banks to increase their risk capital without explicit regulatory intervention? Answering these questions will deepen our insights on the "three pillars" framework of the Basel Accords.[1]

This paper examines the effect of market discipline on U.S. bank holding companies (BHCs) that exploit a risk-capital regulatory loophole regarding the asset-backed commercial paper (ABCP) conduit, an off-balance-sheet financing facility that gained popularity in the early 2000s. BHCs can transfer on-balance-sheet long-term risky assets to an ABCP conduit and finance it by issuing guaranteed ABCPs. Although there are two forms of guarantee—a stronger, "credit guarantee" and a weaker, "liquidity guarantee,"—in practice both ensure the ABCP facility's ability to obtain the highest credit rating and to profit from low-cost financing for risky assets. Furthermore, BHCs

[1] Many studies focus on how to refine capital requirements by focusing on macroprudential regulation and countercyclical capital buffer (Hanson, Kashyap, and Stein, 2011; Repullo and Suarez, 2012; Jiménez, Ongena, Peydró, and Saurina, 2017), bank liquidity management and regulation (Berger and Bouwman, 2009; Cornett, McNutt, Strahan, and Tehranian, 2011; Loutskina, 2011; Acharya and Naqvi, 2012), and stable funding measures (Brunnermeier and Pedersen, 2008), among others. Nevertheless, studies on the effectiveness of market discipline under the presence of capital requirement loophole is limited.

that offered liquidity guarantees could enjoy a lower regulatory risk capital requirement. Likely due to the complexity of off-balance-sheet financing facilities, U.S. regulators first offered an "ABCP exclusion" that features a minimum 90% reduction in the risk capital requirement toward the bank's liquidity guarantee obligation, then rescinded the ABCP exclusion in 2010 when many liquidity guarantors experienced financial stress. The rescission of the ABCP exclusion implies that, before 2010, guarantors might have taken risks that were not counted by their required risk capital.

We exploit the ABCP exclusion to study the effectiveness of market discipline, the third pillar of the Basel Accords. Specifically, we examine whether the financial market lowers the guarantors' franchise value when the capital requirement—the Basel Accords' first pillar—is compromised and whether the drop in franchise value causes the guarantor to maintain additional risk capital beyond the regulatory requirement.

To do so, we first develop a theoretical model to analyze how ABCP maturity affects the cost of liquidity guarantees.[2] Although a short ABCP maturity reduces the paper's credit risk and lowers the cost of rollover support, a shorter maturity also requires the guarantor to provide rollover support more frequently. Our model shows that the latter channel dominates, that is, a drop in ABCP maturity always increases liquidity guarantee costs. Hence, the ABCP exclusion, which offers a minimum 90% reduction in risk capital requirement even under a distressed market when newly issued ABCP has very short maturity, is a regulatory loophole.

More importantly, the theoretical model confirms that ABCP maturity variations, which affect the liquidity guarantee cost but are not concerned by capital regulations, create a testbed to investigate market monitoring on regulatory arbitrage. Subsequently, we can also evaluate the effectiveness of market influence by studying whether the liquidity guarantor, with franchise value pressed by the market, maintains a higher capital ratio above the minimum requirement.

Using Moody's panel data on the universe of ABCP conduits from April 2001 to September 2009, we obtain the outstanding ABCPs guaranteed by U.S. BHCs and the type of guarantee that BHCs provide. About 18% of our sample BHCs have exploited the ABCP exclusion regulatory loophole.

[2] The dynamic capital structure model literature includes Leland (1994b), Leland and Toft (1996), Leland (1994a), and Decamps, Rochet, and Roger (2004). The fair value of deposit insurance is related to Merton (1977) and Merton (1978), which study the pricing of insurance under dynamic settings.

Loophole-exploiting BHCs tend to be much larger, with more cash and fewer real estate loans on their balance sheets. The difference raises a concern that the observed equity returns and capital ratios of BHCs that do not take advantage of ABCP exclusion might not be the counterfactual observations of their loophole-exploiting counterparties' returns and capital ratios. To address such a concern, we match the loophole-exploiting BHCs with the rest of our sample BHCs on size, balance sheet ratios, and performance ratios. Moreover, to ensure the empirical results are not driven by a particular choice of matching methods, we adopt two distinct approaches: the propensity score method of Rosenbaum and Rubin (1983) and the Mahalanobis matching of Abadie and Imbens (2016).

We find evidence of market monitoring among BHCs who exploit the regulatory loophole of the ABCP exclusion under both matching approaches. When the quality of an off-balance-sheet ABCP conduit asset deteriorates, a shorter ABCP maturity causes the bank to face higher guarantee costs consistent with the mechanism depicted in the theoretical model. Specifically, both the propensity score estimates and Mahalanobis matching estimates show that, when facing an average mortgage delinquency rate and one standard deviation increase of the percentage share of the ABCP maturing overnight, the annualized return of an average-sized ABCP guarantor drops about 4.0%. Meanwhile, credit guarantors' equity return does not present a significant empirical pattern. Our findings indicate that the stock market prices in the risks associated with the regulatory arbitrage activities, despite the complexity of shadow bank funding facilities.

Turning to the market influence, we find that although loophole-exploiting BHCs tend to have lower capital ratios, they maintain higher Tier-1 capital ratios than average guarantor BHCs with similar characteristics. Specifically, the estimates from the propensity-score-weighted full sample implies the loophole-exploiting BHCs have a 1.7% higher Tier-1 capital ratio than average ABCP guarantors. The estimates using the Mahalanobis matched sample are similar: the loophole-exploiting BHCs have a 2.6% higher Tier-1 capital ratio. Furthermore, the high capital ratio among liquidity guarantors persists after adjusting for the impact of reduced total risk-weighted assets allowed by the ABCP exclusion, and the effect is more pronounced among BHCs that are more sensitive to ABCP maturity, suggesting that the stock market affects the loophole-exploiting

BHCs' risk capital choice. We interpret our findings as evidence that the stock market disciplines loophole-exploiting banks and alleviates the impact of regulatory arbitrage on bank capital adequacy.

Our paper belongs to the literature on market discipline. Flannery and James (1984) show that the market notices the maturity mismatch between bank assets and liabilities; therefore, bank stock returns vary with interest rates. Martinez Peria and Schmukler (2001) as well as Demirgüç-Kunt and Huizinga (2004) present market discipline by depositors as bank creditors. Subordinated notes and debentures can also serve as a market disciplinary tool (Avery, Belton, and Goldberg, 1988; Gorton and Santomero, 1990; Ashcraft, 2008). This paper, to the best of our knowledge, is the first to show the effectiveness of equity market discipline against regulatory arbitrage, notwithstanding the complexity of off-balance-sheet financing.[3]

Our paper also contributes to two additional strands of literature. The empirical finding on the high capital ratio of the loophole-exploiting BHCs extends the literature on optimal bank capital structure. The optimal bank capital structure literature suggests that, contrary to conventional belief, BHCs do not simply leverage up to the minimum capital requirement but maintain an optimal capital buffer above the regulatory minimum (Flannery, 1994; Myers and Rajan, 1998; Diamond and Rajan, 2000; Calomiris and Wilson, 2004; Allen, Carletti, and Marquez, 2011). Empirical studies confirm that banks maintain a capital buffer above the minimum requirement (Berger, DeYoung, Flannery, Lee, and Öztekin, 2008; Gropp and Heider, 2010).[4] This article reveals that loophole-exploiting BHCs adjust their risk capital level when facing the pressure of market discipline.

Finally, this paper adds to the literature of shadow banking, rollover risk, and capital regulation (Brunnermeier, 2008; Krishnamurthy, 2009; Acharya, Gale, and Yorulmazer, 2011; He and Xiong, 2012b; Covitz, Liang, and Suarez, 2013; Martin, Skeie, and von Thadden, 2014; Kisin and Manela, 2016) by focusing on the impact of rollover risk on the effectiveness of bank capital regulation. The model provides additional support to the belief that regulatory arbitrage is the primary

[3]Our paper does not intend to argue whether the regulators are aware of the existence of the ABCP loophole. Policy change and implementation in the United States must follow rules of procedure, which usually takes an extended period. Hence, a regulatory loophole may remain when regulatory bodies are aware of its existence.

[4]Flannery and Rangan (2008) find that regulatory innovations in the early 1990s weakened conjectural government guarantees and enhanced bank counterparties' incentive to monitor and price default risk.

driving force behind the growth of ABCP (Pozsar, Adrian, Ashcraft, and Boesky, 2010; Adrian and Ashcraft, 2012; Ordonez, 2018). The seminal paper by Acharya, Schnabl, and Suarez (2012) provides empirical evidence to support the hypothesis of regulatory arbitrage among ABCP guarantors. In contrast, our paper shows that the stock market disciplines the regulatory-arbitraging BHCs. Our empirical analysis provides evidence that the bank returns are affected by the liquidity guarantee cost both in the turmoil periods and in the quiet years before the ABCP crisis.[5]

2 Institutional background

2.1 ABCPs and credit versus liquidity guarantee

Total ABCP outstanding reached 1.21 trillion USD in 2007, approximately 12.3% the size of commercial bank liability in the United States, as Figure 1 shows. An ABCP conduit is a shadow banking funding facility that allows a bank to finance long-term assets off-balance-sheet by rolling over short-term ABCPs with the highest credit rating.[6] The conduit's risky assets value may fall below a pre-set threshold, upon when the conduit is deemed to be in default and forced into a costly liquidation. Nevertheless, the short maturity of ABCPs allows investors to close their position before the deteriorating conduit has reached the default threshold. Hence, institutional investors of ABCPs, mostly money market funds (MMFs), demand *rollover support* to ensure they can unwind their positions swiftly.[7] Additionally, the investors also demand *wind-down support*, that is, payment when the ABCP conduit defaults.

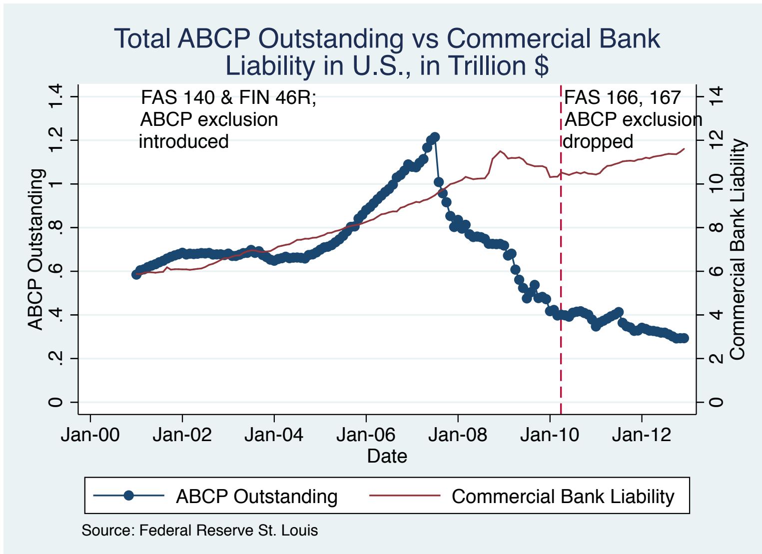
Each ABCP conduit has a guarantor bank to provide the rollover and wind-down support. In many cases, the guarantor is the same bank that creates the ABCP conduit and moves its risky assets off-balance-sheet. We focus on such cases in our study. There are two distinct types of

[5]Acharya et al. (2012) presents the evidence that regulatory arbitraging banks suffered a market value loss only during the ABCP run in August 2007 but not in months before the August.

[6]ABCP in the United States has maturity ranging from overnight to 270 days. In Europe, the maturity typically varies from overnight to 180 days.

[7]Under SEC Rule 2a-7, MMFs may only hold the highest rated debt and must maintain an overall portfolio weighted average maturity of 60 days or less. According to the Federal Reserve Financial Accounts of the United States, MMFs had aggregate assets up to 2.69 trillion USD by the end of 2008. The large size of MMFs leads to lower transaction costs of ABCP in the secondary market.

Figure 1: **Total ABCP outstanding vs commercial bank liability**
The left y-axis is for total ABCP outstanding, and the right y-axis (scaled ten times) is for commercial bank liabilities. In the early 2000s, the total ABCP outstanding is about 10% the size of total commercial bank liability in the United States. The ABCP market size picked up rapidly then, reaching 1.21 Trillion USD in July 2007. The ABCP market experienced a rapid drop in size in the summer of 2007, and never recovered since. The ABCP exclusion was dropped in March 2010, as the dashed line marks. Source: FRED Economic Data from the Federal Reserve Bank of St. Louis.



guarantees that banks can offer—credit guarantees and liquidity guarantees—with different levels of support to investors and distinct regulatory capital consequences. Both guarantees feature rollover support when the conduit has not reached the default threshold: when investors with maturing ABCPs no longer want to reinvest or "rollover" the commercial paper, the sponsoring bank pays the ABCP's principal amount back to the investors.[8]

A credit guarantee offers better *wind-down support*. When the underlying conduit is deemed to be in default, ABCP investors with a credit guarantee receive the full principal from the guarantor bank, whereas ABCP investors with a liquidity guarantee only recover the remaining collateral value of the conduit's underlying assets.[9]

[8]Usually, the bank then reissues the ABCP at a discounted price.

[9]Although the conduits typically have some credit enhancement measures, such as a subordinate or overcollateralization tranche as the first group to absorb the loss of default, ABCP investors are still subject to credit risk once the credit enhancement is depleted. The size of program credit enhancement is small, often covering less than 15% of conduit assets.

2.2 Capital requirements of guarantors

U.S. regulation demands each U.S. BHC to maintain a minimum of 6% Tier-1 capital ratio, calculated as its Tier-1 risk capital (core equity capital) over its total risk-weighted assets. Regulators consistently demand credit-guarantors count the ABCP facility in their total risk-weighted assets, since the facility's credit risks remain with the bank. Subsequently, the credit guarantor has to prepare risk capital for the facility, as if it is financed on balance sheet.

Before 2010, liquidity guarantors enjoyed an *ABCP exclusion* whereby they either did not need to count the ABCP facility assets in their risk-weighted assets at all, or they only needed to count 10%. In September 2000, when ABCP financing started to gain wide adoption, the Financial Accounting Standards Board (FASB) introduced Financial Accounting Standards (FAS) 140, which effectively allowed a bank that operates a liquidity-guaranteed ABCP conduit to book the assets as being "sold" to the conduit and to avoid the costly risk capital requirement completely.[10] Even though regulators increased the capital requirement in 2004, they demanded liquidity guarantors to include only 10% of the size of ABCP facilities into their risk-weighted assets.[11]

The ABCP exclusion finally ended on January 28, 2010, when financial regulators collectively demanded liquidity guarantors to count 100% of the conduit assets in their risk-weighted assets, effective on March 29, 2010. The change was a response to the mid-2007 ABCP market run, which was due to the deterioration of underlying mortgage-backed securities (MBS). The collapse of the

[10]Specifically, FAS 140 deems an ABCP conduit achieves a "qualifying SPE" status because first, the financial assets are isolated from the bank after the transfer and, second, the limited activities of the conduit are entirely specified in the legal documents. Third, the conduit holds only passive financial assets that were transferred in, guarantees, and servicing rights. Finally, sale or disposal of the conduit assets must be specified in the legal documents and exercised by a party that puts the holders' beneficial interest back to the SPE. Hence, a liquidity guarantor can claim the conduit is a "qualified SPE" and book the transfer of risky assets to the conduit as a "true sale," even though the bank still needs to provide liquidity guarantee in the future.

[11]In December 2003, the Office of the Comptroller of the Currency (OCC), Board of Governors of the Federal Reserve System, Federal Deposit Insurance Corporation (FDIC), and Office of Thrift Supervision (OTS) collectively permitted sponsoring banks to exclude those assets in ABCP programs that were consolidated as a result of FASB Interpretation 46(R) from their risk-weight asset base. For more details, please refer to Risk-based capital gudelines; capital adequacy guidelines; capital maintenance: consolidation of asset-backed commercial paper programs and other issues, 69 Fed. Reg. 44,908 (July 28, 2004), (to be codified at 12 C.F.R. pt. 3; 12 C.F.R. pts. 208, 225; 12 C.F.R. pt. 325; 12 C.F.R. pt. 567). Effective since September 30, 2004. These guidelines are responses to FASB Interpretation 46(R), which required banks to consolidate SPE assets to its balance sheet.

Figure 2: **Credit vs. liquidity guarantee**
The table illustrates the similarity and difference between a credit guarantor bank and a liquidity guarantor bank. When an investor with maturing ABCP no longer wants to reinvest or "rollover" her commercial paper, the guarantor bank pays the commercial paper's principal amount back to the investor regardless of the type of guarantee. When the investor's ABCP is deemed default, that is, under the wind-down trigger, the investor can receive the principal of ABCP only if the paper has credit guarantee. Investors of liquidity-guaranteed ABCP incur losses since they can only obtain the market value (sales proceedings) of the conduit assets. Finally, before 2010 when ABCP exclusion was effective, liquidity-guarantor banks were not required to prepare risk-capital according to the full-size of the conduit as credit-guarantors do, but only 0% to 10% instead.

	Credit guarantor	**Liquidity guarantor**
When ABCP matures:	- No payments to investors if they rollover. - Pays investors ABCP face value (rollover support), then re-issues ABCP, if investors leave.	
When ABCP conduit winds-down:	Pays investors the ABCP face value.	Pays investors the fair market value of underlying assets.
Capital requirement under ABCP exclusion:	Needs to prepare risk capital for 100% of the ABCP conduit assets.	Needs to prepare risk capital for only 0% to 10% of ABCP conduit assets.

ABCP market as a major funding source limited the U.S. banking sector's ability to raise capital and became an important reason for the subsequent financial crisis (Covitz et al., 2013).

Figure 2 illustrates the similarity and difference between the credit and liquidity guarantee, as well as the capital requirement when the ABCP exclusion was effective.[12] The ABCP exclusion *would* be a regulatory loophole *if* it underestimated the risk carried by liquidity guarantors. In this case, the ABCP exclusion provides an opportunity to test whether the stock market is aware of the risk associated with a loophole-exploiting bank. The next section presents analytical results on how ABCP maturity affects the risk transfer from an ABCP conduit to its guarantor bank.

[12]Our definitions of credit and liquidity guarantee are consistent with the definitions in Acharya et al. (2012), as well as in Kisin and Manela (2016). There are other alternative structures and supports in ABCP conduit, including but not limited to collateralized debt obligations, repurchase agreeements, and total return swaps. We do not include these alternative structures and analysis.

3 Theory

We start with a parsimonious model of an ABCP guarantor subject to a regulatory capital constraint. Consider a continuous time risk-neutral economy with time $t \in [0, +\infty)$ and riskless interest rate $r > 0$. The economy contains a bank with initial equity capital E, deposit D, and balance sheet asset $B = D + E$. There is also one unit of risky long-term project which, after an initial investment, pays risky cash flow following a geometric Brownian motion $dy_t = \mu y_t dt + \sigma y_t dW_t$, where W_t is a standard Brownian motion and $0 < \mu < r$. Hence, the project has an intrinsic value $V(y_t) = y_t / (r - \mu)$ as the risk-neutral expectation of cash flow. The initial investment to set up the project is $V(y_0) = y_0 / (r - \mu)$. At $t = 0$, the bank raises capital $V(y_0)$ for the risky project by setting up an off-balance-sheet ABCP conduit that issues and then rolls bank-guaranteed ABCP. The ABCP pays a fixed coupon k such that the paper is originated at par. We focus on the analysis of the off-balance-sheet financing and let the value of balance sheet asset B and of deposit D remain constant over t.

We let the ABCP guarantor issues commercial paper with a maturity that matches the investors' idiosyncratic shock of liquidity requirement.[13] In a similar vein as He and Xiong (2012a), we assume that the ABCP maturity $\tau \in (0, +\infty)$ follows an exponential distribution with probability density function $f(x) = me^{-mx}$ with parameter $m > 0$. Hence, m fraction of the outstanding paper will mature within the next time unit, and the expected remaining time-to-maturity of ABCP is $1/m$.

The bank offers an ABCP guarantee $G(y_t, m)$, which refers to either a credit guarantee $G^C(y_t, m)$ or a liquidity guarantee $G^L(y_t, m)$. Under both types of guarantee, the guarantor bank offers *rollover support* that pays investors the face value of their maturing ABCP if they choose not to roll over the paper. The bank then reissues the paper at the market price $A(y_t, m)$. The guarantee lasts until the ABCP conduit winds down, which is triggered by the conduit asset cash flow y_t hitting the wind-down threshold y_w. Credit guarantors have to pay investors ABCP face value upon conduit wind-down, whereas liquidity guarantors only pay investors the market value of conduit

[13] We choose not to model the consumption problem specifically for it is not the focus of our paper. In the standard financial intermediary theory literature, investors face idiosyncratic uncertainty about her preference type as an early or late consumer (Bencivenga and Smith, 1991; Allen and Gale, 2004b,a). Investors facing such uncertainty will adjust the maturity of investment accordingly.

assets. Panel (a) of Figure 3 demonstrates the timing of events for a credit guarantor bank and how investors holding maturing ABCP are paid, whereas Panel (b) of Figure 3 illustrates a liquidity guarantor bank.

We assume that the initial bank capital E, being E^C for a credit guarantor or E^L for a liquidity guarantor, is large enough to cover the guarantee such that $E^C + G^C(y_t, m) \geq 0$ or $E^L + G^L(y_t, m) \geq 0$ for all $y_t > y_w$. The assumption is consistent with the fact that no ABCP conduit has ever experienced guarantor default even during the crisis period: ABCP is a vital funding facility for the sponsoring bank such that defaulting on the guarantee obligation leads to severe reputational damage.

Following the essence of BCBS definition, we let a bank's capital ratio to be the value of equity capital over bank assets, with the ABCP guarantee cost explicitly included in both the capital and assets to highlight the impact of the guarantee to the capital ratio.[14] As the credit guarantor must prepare risk capital as though they finance the ABCP conduit assets on-balance-sheet, its capital ratio $K^C(y_t)$ at $t \geq 0$ is

$$K^C(y_t) \equiv \frac{E^C + G^C(y_t, m)}{D + E^C + G^C(y_t, m) + V(y_t)}. \tag{1}$$

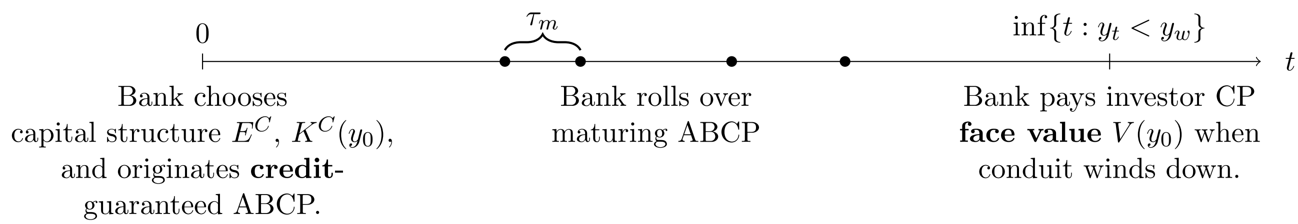
The risk capital reduction from the ABCP exclusion allows a liquidity guarantor to book only $\beta V(y_t)$ in the calculation of the capital ratio $K^L(y_t)$. We have $\beta = 0$ before December 2003, and $\beta = 0.1$ afterwards and until the ABCP exclusion was eliminated. In other words,

$$K^L(y_t) \equiv \frac{E^L + G^L(y_t, m)}{D + E^L + G^L(y_t, m) + \beta V(y_t)}. \tag{2}$$

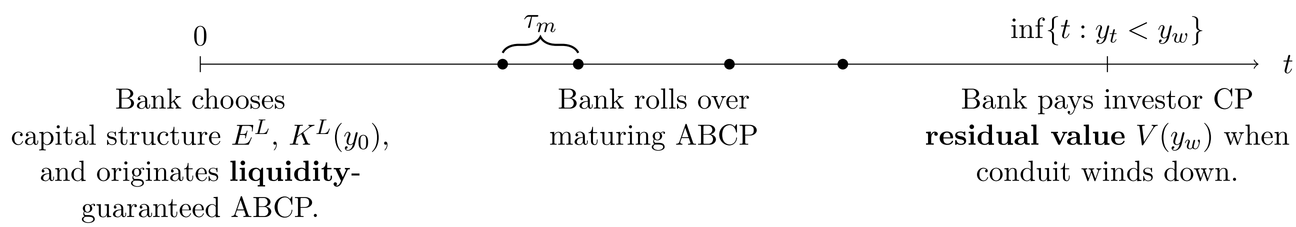
We assume the liquidity guarantor has a significant involvement in off-balance-sheet financing such that $V(y_w) \geq \sqrt{\beta} D$. Finally, we let the bank maintain its capital ratio above a minimum

[14] To focus on off-balance-sheet ABCP facility, our measure of capital ratio abstracts away the risk-weighting for on-balance-sheet assets and assume they have a risk weight of 100%. As a result, our capital ratio uses equity capital with guarantee cost as the numerator (risk capital) of the capital ratio, and uses the value of debt and equity—the book value of assets—plus the guarantee cost and off-balance-sheet assets as the denominator.

Figure 3: **Model timeline.**
Panel (a) and (b) presents timelines for credit and liquidity guarantors in the model respectively. There are multiple events of rolling over maturing ABCP, marked by black dots. The ABCP maturity follows an exponential distribution with parameter m, so $\tau_m \sim Exp(m)$. When incumbent ABCP matures, the bank needs to rollover the commercial paper under the cash flow y_t. Since the cash flow y_t may not be as high as y_0, the new commercial paper may be issued at a discount since the investor may demand a higher return. In this case, the bank equity holder has to post the margin and will suffer a loss. Once the ABCP conduit wind-down gets triggered, the credit guarantor needs to pay the face value of the commercial paper to investors, whereas the liquidity guarantor pays the residual value of underlying assets to investors.



(a) **Credit guaranteed ABCP**



(b) **Liquidity guaranteed ABCP**

requirement $\underline{K}$ or face a regulatory penalty.[15] Apparently, a credit guarantor would set $K^C(y_0) \geq \underline{K}$, and a liquidity guarantor would set $K^L(y_0) \geq \underline{K}$.

3.1 Market monitoring: ABCP maturity and cost of guarantee

ABCP maturity has two opposing effects on the cost of guarantees. First, as with many fixed-income securities with credit risk, ABCPs with shorter maturity trade at a (weakly) higher price level, since credit events are less likely to occur before the maturity date. Hence, when an investor is no longer willing to roll over his ABCP, the guarantor—obligated to buy back the discounted paper at par—incurs a lower cost when the paper maturity is shorter. However, under an ABCP market exodus, a shorter ABCP maturity means the bank has to buy back discount papers at par more

[15] Once a bank fails to maintain the capital ratio above the minimum requirement, it can continue to operate under the regulatory forbearance, which leads to more stringent regulatory oversight and higher operating costs. The bank may also be forced to replenish capital through other means such as fire selling high quality assets or raising equity when the share price is subdued.

frequently. Does the high rollover frequency dominate the low cost of rollover—a lower ABCP maturity leads to a higher liquidity guarantee cost—or not? To shed light on the comparative statics of guarantee cost, we first derive the value functions of credit- and liquidity-guaranteed ABCPs and study how they vary with ABCP maturities.

Proposition 1. *The value of ABCP under a credit guarantee does not vary with the maturity* $1/m$. *Specifically,* $A^C(y_t, m) = V(y_0)$.

Proposition 2. *The value function of ABCP with a liquidity guarantee* $A^L(y_t, m) = \mathbf{1}_{\{y_t \geq y_0\}} A_h^L(y_t, m) + \mathbf{1}_{\{y_t < y_0\}} A_l^L(y_t, m)$, *where*

$$\begin{aligned} A_h^L(y_t, m) &= \frac{k}{r} V(y_0) + C_h(m)\phi(y_t; y_w), \\ A_l^L(y_t, m) &= \frac{k+m}{m+r} V(y_0)(1 - \psi(y_t; y_w)) + V(y_w)\psi(y_t; y_w) - C_l(m)\left(\psi(y_t; y_w) - \bar{\psi}(y_t; y_w)\right), \end{aligned}$$

in which $\phi(y_t; y_w) = \left(\frac{y_t}{y_w}\right)^H$, $\psi(y_t; y_w) = \left(\frac{y_t}{y_w}\right)^G$, *and* $\bar{\psi}(y_t; y_w) = \left(\frac{y_t}{y_w}\right)^{\bar{G}}$. *Further,* $H = \frac{1}{2} - \frac{\mu}{\sigma^2} - \sqrt{\left(\frac{1}{2} - \frac{\mu}{\sigma^2}\right)^2 + \frac{2r}{\sigma^2}} < 0$, $G = \frac{1}{2} - \frac{\mu}{\sigma^2} - \sqrt{\left(\frac{1}{2} - \frac{\mu}{\sigma^2}\right)^2 + \frac{2(r+m)}{\sigma^2}} < 0$ *and* $\bar{G} = \frac{1}{2} - \frac{\mu}{\sigma^2} + \sqrt{\left(\frac{1}{2} - \frac{\mu}{\sigma^2}\right)^2 + \frac{2(r+m)}{\sigma^2}} > 0$. *Finally,* $C_h(m)$, $C_l(m)$, *and* k *satisfy the smooth pasting conditions at* $A_h^L(y_t, m) = A_l^L(y_t, m) = V(y_0)$ *and* $\frac{\partial}{\partial y} A_h^L(y_t, m) = \frac{\partial}{\partial y} A_l^L(y_t, m)$ *at* $y_t = y_0$.

Despite the complicated value function of an ABCP with a liquidity guarantee, Propositions 1 and 2 show that the value of liquidity guaranteed ABCP varies with the ABCP maturity $1/m$, whereas the value of credit guaranteed ABCP does not. Panel (a) of Figure 4 shows that when the ABCP maturity gets shorter, (i.e., from 6 months to 1 month), the value of a discounted ABCP (whose underlying asset value $y_t < y_0$) goes up. However, this does not mean the liquidity guarantee of the 1-month paper is cheaper to the bank: in fact, the opposite is true, as the rollover frequency also determines the cost of the guarantee.

Proposition 3. *When the ABCP maturity decreases, the liquidity support value function converges to the credit support value function. When the maturity* $1/m$ *approaches* 0, $\lim_{m\to\infty} G^L(y_t, m) = G^C(y_t, m)$ *for* $\forall y_t > y_w$.

Proposition 3 indicates that a drop in the ABCP maturity leads to a higher liquidity guarantee cost. In other words, the effect of high rollover frequency dominates the low cost of rollover each time. Therefore, the ABCP exclusion, which reduces the risk capital requirement for a liquidity guarantor bank to 10% of the ABCP principal amount regardless of the ABCP maturity, is a regulatory loophole when the ABCP maturity is sufficiently short. Ignoring the effect of ABCP maturity gives the regulator a false sense that the liquidity guarantee is safer than the credit guarantee. Subsequently, the liquidity guarantor receives an opportunity for regulatory arbitrage to take excessive risks by moving risky assets to a liquidity-guaranteed ABCP conduit.

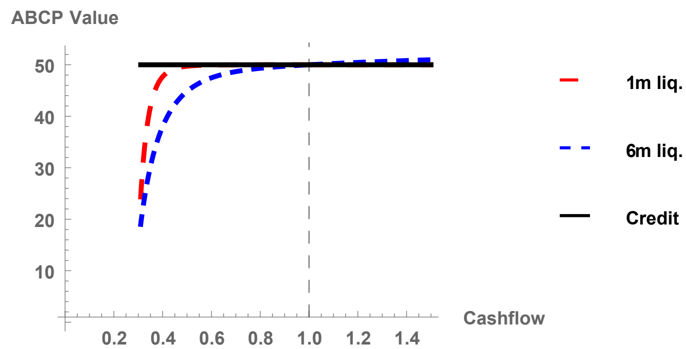
To further illustrate the intuition of Propositions 1, 2, and 3, Panel (a) of Figure 4 presents the value functions of credit- and liquidity-guaranteed ABCPs and the value of those guarantees under different maturities. Panel (b) of Figure 4 shows that the value function of the liquidity guarantee converges to the value function of the credit guarantee when the ABCP maturity shortens.

More importantly, Propositions 1, 2, and 3 suggest that the franchise value of a liquidity guarantor should vary with the ABCP maturity, as well as the underlying asset value, if the market is aware of the loophole, whereas the franchise value of a credit guarantor should not. We can then test whether the stock market is aware of the regulatory loophole in the ABCP exclusion.

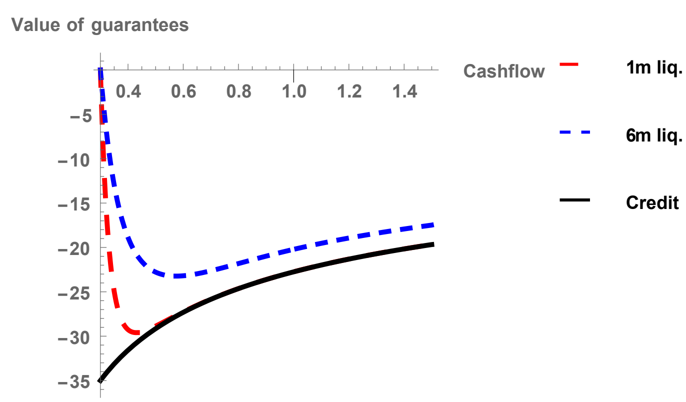
H1: The change in the maturity of the ABCP with a credit guarantee does not affect the risk transfer between the ABCP conduit and the guarantor. In other words, the interaction term between the maturity and the underlying asset value should not significantly affect a credit guarantor's abnormal return.

H2: The drop in the maturity of the ABCP with a liquidity guarantee allows more risk transfer from the ABCP conduit to the guarantor. In other words, the interaction term between a shortened ABCP maturity and the deteriorating underlying asset value lowers the liquidity guarantor's abnormal return.

Figure 4: **Value functions by ABCP maturity and guarantee type**
Panel (a) shows the value functions of credit guaranteed ABCP (solid line), liquidity guaranteed ABCP with one month maturity (long dashed line), and liquidity guaranteed ABCP with six months maturity (short dashed line). Panel (b) shows the value functions of credit guarantee (solid line), liquidity guarantee for one month ABCP (long dashed line), and liquidity guarantee for three month ABCP (short dashed line). Parameters are $r = 0.05$, $\mu = 0.03$, $\sigma = 0.5$, $y_w = 0.3$, and $y_0 = 1$.



(a) **Value functions of ABCP**



(b) **Value functions of credit vs. liquidity guarantee**

3.2 Market influence: Equilibrium capital ratios

Would the loophole-exploiting banks prepare more risk capital, conditional on an effective market monitoring? Specifically, would they be concerned whether the $K^C(y_t)$ or $K^L(y_t)$, which is driven by the market value of the equity capital and bank assets, can stay above the minimum requirement $\underline{K}$? How would such a concern affect the bank's choice of initial capital ratio $K^C(y_0)$ and $K^L(y_0)$? To address these questions, we first compare the dynamics of $K^L(y_t)$ and $K^C(y_t)$ under y_t.

Proposition 4. *When the ABCP maturity $1/m$ approaches zero, an ABCP liquidity guarantor—whose initial capital ratio is the same as a credit guarantor—has $K^L(y_t)$ that is more sensitive to the shock in the underlying asset value than the credit guarantor when $y_t < y_0$, or $\frac{dK^L(y_t)}{dy_t} > \frac{dK^C(y_t)}{dy_t}$. Subsequently, the liquidity guarantor is more likely to violate the minimum capital requirement under any realized path of y_t.*

Proposition 4 suggests that a liquidity guarantor with $K^L(y_0)$, *ceteris paribus*, finds itself violates the minimum requirement $\underline{\kappa}$ *earlier* than a credit guarantor with the same initial capital ratio $K^C(y_0) = K^L(y_0)$. In other words, the liquidity guarantor is more likely to breach the minimum capital requirement.

For guarantors that actively manage their capital level by weighting the inefficiency of holding more capital in normal times and the cost of failing to meet the minimum capital requirement $\underline{K}$ during adverse times (Flannery, 1994; Myers and Rajan, 1998; Diamond and Rajan, 2000; Allen et al., 2011), Proposition 4 suggests that the liquidity guarantors should maintain a higher level of equilibrium *initial* capital ratio $K^L(y_0)$, or the book-value based capital ratio, than their otherwise equivalent credit guarantor counter-parties.[16] We present the following hypothesis to test the effectiveness of market influence.

H3: Under an effective market influence, the ABCP liquidity guarantors keep a higher capital ratio than the credit guarantors.

We test the empirical hypotheses in the following sections.

[16]Standard results in stochastic optimization theory suggest that the bank should set the equilibrium initial capital ratio, be it $K^L(y_0)$ or $K^C(y_0)$, by keeping an optimal distance from the threshold level $\underline{K}$. This is also the intuition in the dynamic capital structure (Leland, 1994a; He and Xiong, 2012b)

4 Data and summary statistics

We combine the following six data sources for our empirical analysis: ABCP maturity and outstanding summary from the Federal Reserve, the financial statement information of U.S. BHCs from the Federal Reserve Board's FR Y-9C forms, ABCP conduit information from Moody's Investor Service, residential mortgage performance information from ABSNet, bank daily equity returns from Compustat and the Center for Research in Security Prices (CRSP), and general macroeconomic data from Federal Reserve Economic Data (FRED).

We start with the FR Y-9C quarterly data for publicly traded BHCs from April 2001, when FAS 140 became effective, to September 2009, when the ABCP exclusion ended.[17] We also follow the Federal Reserve's convention by dropping BHCs with total assets less than \$10 billion during our sample period, since they face much less stringent regulations.[18] This gives us $2,671$ bank-quarter observations from 100 publicly traded U.S. BHCs, which we name as the *full sample*.

We obtain the quarterly outstanding amount of ABCP conduits, conduit guarantee types, and the guarantor institution from Moody's Investors Service, then manually match each guarantor institution with BHCs in the FR Y-9C data by quarter. For each guarantor institution, we aggregage its quarterly outstanding principal amounts across sponsored ABCP conduits by guarantee type.[19] We note a BHC as a liquidity guarantor, hence exploiting the ABCP exclusion regulatory

[17]Although the ABCP exclusion was officially dropped in January 2010, the BHCs were aware of the coming policy change months before the final announcement. Therefore, we do not include 2009 Q4 in our sample.

[18]The Federal Reserve treats BHCs with \$10 billion or less in assets as small bank or community bank. See, e.g., Board of Governors of the Federal Reserve System, Community Banking, at `http://www.federalreserve.gov/bankinforeg/topics/community_banking.htm`. An alternative threshold is \$1 billion in assets, followed by the Office of the Comptroller of the Currency (OCC). See, e.g., Office of the Comptroller of the Currency (OCC), Community Bank Supervision: Comptrollers Handbook, January 2010, at `http://www.occ.treas.gov/publications/publications-by-type/comptrollers-handbook/cbs.pdf`. We choose the \$10 billion threshold over \$1 billion because ABCP guarantors are usually large BHCs with total assets greater than \$100 billion, so non-guarantor BHCs with book assets in the range of \$10 to \$1 billion are less comparable BHCs in the control group in our sample.

[19]We choose not to include the balance of alternative conduits, including Collateralized Debt Obligations (CDO), Asset Backed Securities (ABS), repurchase agreements, total return swaps, and mortgage warehouses. CDO and ABS are more complex structures in which some senior tranches are structured as ABCP. Some ABCP conduits have full credit guarantees as a repurchase agreement or a total return swap, which covers 100% of the ABCP balance with a counterparty other than the sponsoring bank. We drop these records because the repo and total return swap protection sellers, instead of BHCs, carry the credit risk. Some mortgage lenders use ABCP conduits as mortgage warehouses to provide the working capital and fund the newly originated mortgage loans that have not yet been moved into a mortgage pool for securitization.

Table 1: **List of loophole-exploiting BHCs**
This table lists all sample BHCs that have ever used liquidity guaranteed ABCP financing facilities during our sample period from April 2001 to September 2009. The total assets (FR Y-9C item BHCK2170) and liquidity guarantee positions are time-series averages by BHCs, in billions of U.S. dollar. The exposure is the size of liquidity guarantee exposure relative to total assets in percentage.

	Total assets (Bil.)	Liquidity Gurantee (Bil.)	Exposure (%)
Bank of America Corp.	1366.928	23.788	1.935
Bank of New York Mellon Co.	273.862	0.48	0.219
Bank One Corp	281.227	39.543	14.144
Capital One Financial Corp.	102.454	1.235	1.307
Citigroup, Inc.	1665.629	54.488	3.519
Compass Bancshares	27.190	1.394	5.205
Fifth Third	96.820	2.361	2.496
First Union Corp.	249.445	8.553	3.429
FleetBoston Financial Corp.	197.608	2.732	1.388
J. P. Morgan Chase & Co	741.875	17.558	2.379
Keycorp	85.249	0.613	0.73
Mellon Financial Corp.	37.973	1.75	4.447
National City Corp.	102.232	2.463	2.46
PNC Financial Services Group	165.753	3.744	2.984
State Street Corp.	130.651	7.075	6.198
Suntrust Banks Inc.	156.201	3.249	2.075
U.S. Bankcorp	200.152	7.514	4.125
Wachovia Corporation	406.111	4.003	1.051
Zions Bancorporation	37.891	3.391	9.963

loophole, in a quarter if any conduit receiving the BHC's liquidity guarantee shows a positive outstanding amount of ABCP. Within the sample period, there are 18 liquidity guarantors, resulting in 396 bank-quarter observations of regulatory arbitrage activities.[20] Table 1 lists their names, total assets, liquidity guarantee exposure, and the exposure relative to their total assets.

Table 2 reports summary statistics. Column (1) covers the full sample of publicly-traded U.S. BHCs with total assets greater than 10 billion USD. Column (2) shows the respective summary statistics of 18 loophole-exploiting liquidity guarantors, whereas Column (3) summarizes the remaining BHCs. Finally, Column (4) shows the difference in means, as well as the standard error of the difference, between liquidity guarantors and others. Consistent with the findings in Covitz

The mortgage lenders, as sponsors, are in many ways different from regular bank holding companies. Naturally, we also skip the conduits with non-bank guarantors, such as asset management firms and automotive manufacturers, for they are not matched with BHCs.

[20]Seven BHCs started to sponsor ABCP conduits later than 2001Q2. They appear as non-guarantors in the earlier periods and as guarantors later. Hence, the sum of the number of guarantor and non-guarantor BHCs is greater than the total number of BHCs 100.

et al. (2013), liquidity guarantors are significantly larger and hold more cash or cash equivalents, but much fewer real estate loans on balance sheet. The matching procedure we follow later in the study is designed to address the significance differences.

Notice that eight BHCs started to use liquidity-guaranteed ABCP conduits later than April 2001, so they appear as non-liquidity guarantors in the earlier periods and as liquidity guarantors later. Hence, the sum of the numbers of BHCs reported in Columns (2) and (3) is greater than the number of BHCs reported in Column (1), whereas the sum of bank-quarter observations in two subsamples equals the total number of bank-quarter observations.

We also create a bank-day level return dataset by merging both BHC's quarterly information with their daily returns from CRSP and the common market and macroeconomic factors, including daily riskless rate, Fama-French factors, U.S. GDP, and the magnitude of quantitative easing (QE).[21] We further augment the dataset with ABCP maturities and mortgage delinquency rates as follows.

To measure the maturities of outstanding ABCPs, we first calculate the daily distribution of maturities using the issuance balance of the U.S. ABCPs with different terms.[22] We then use the ratio of the outstanding amount of ABCP maturing overnight to the total ABCP outstanding on the same day as a measurement of ABCP maturity:

$$\%\mathrm{OVN}_t = \left[\frac{\text{Outstanding of ABCPs that are maturing overnight}}{\text{Total ABCP outstanding}}\right]_t .$$

The ABCP maturity measure $\%\mathrm{OVN}_t$ focuses on the guarantee obligation upon liquidity guarantors. A higher overnight share at day t implies that the bank must deliver more liquidity guarantees on that day. On average, 7.4% of the outstanding ABCPs mature overnight, whereas the ratio peaks at 21.68% during the ABCP run. Figure 5 displays the daily fractions of ABCP maturing overnight during the sample period.

[21] We match the BHCs' RSSD id with CRSP permno using the CRSP-FRB linking file by the Federal Reserve of New York. The GDP data are from Macroeconomic Advisers LLC, and the QE data are from the weekly MBS purchase amount published by the Federal Reserve.

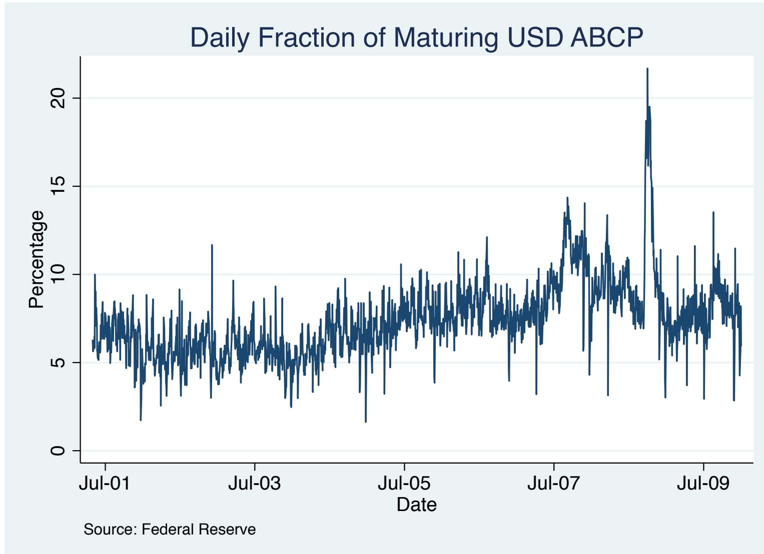
[22] We obtain the daily amount of newly issued U.S. ABCP with the highest credit rating from Federal Reserve at `https://www.federalreserve.gov/datadownload/choose.aspx?rel=CP`.

Table 2: **Summary statistics**

The sample consists of all publicly-traded U.S. BHCs, both ABCP guarantors and non-guarantors, with \$10B+ total assets from April 2001 to September 2009. Column (1) shows the sample means and standard deviations. Column (2) shows the means and standard deviations of variables for BHCs that exploited the ABCP exclusion through liquidity-guaranteed ABCP conduits, whereas Column (3) shows the means and standard deviations for the remaining sample BHCs. Column (4) shows the differences in means between two subsamples and the corresponding standard errors. The balance sheet variable definitions are provided in the Appendix. Notice that eight BHCs started to use liquidity-guaranteed ABCP conduits later than April 2001, so they appear as non-liquidity-guarantors in the earlier periods and as liquidity guarantors later. Hence, the sum of the numbers of BHCs reported in Columns (2) and (3) is greater than the number of BHCs reported in Column (1), whereas the sum of bank-quarter observations in two subsamples equals the total number of bank-quarter observations. Standard deviations are in parentheses and standard errors are in brackets. Significance: $^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$.

	All (1)	Liquidity Guarantor (2)	Other (3)	Diff. (4)
Total Assets (Bil.)	119.271	318.691	79.387	239.304***
	(265.791)	(434.857)	(197.891)	[64.914]
Liquidity guarantee (Bil.)	1.814	10.882	0.000	10.882***
	(8.141)	(17.682)	(0.000)	[1.828]
Credit guarantee (Bil.)	0.532	2.422	0.154	2.268***
	(2.248)	(4.277)	(1.310)	[0.540]
Cash Ratio (%)	4.506	7.197	3.968	3.229***
	(4.720)	(7.610)	(3.737)	[1.184]
Loan to assets (%)	59.606	53.395	60.848	-7.453
	(18.248)	(21.032)	(17.506)	[4.678]
RE loan to assets (%)	35.837	24.761	38.052	-13.291***
	(17.381)	(14.778)	(17.080)	[4.320]
Security to assets (%)	21.243	18.885	21.715	-2.830
	(12.190)	(9.406)	(12.665)	[3.150]
FS security to assets (%)	17.865	17.921	17.854	0.067
	(8.994)	(8.513)	(9.133)	[2.333]
Deposit to assets (%)	62.731	58.525	63.572	-5.047
	(18.261)	(9.261)	(19.499)	[4.712]
ROA (%)	0.256	0.277	0.252	0.026
	(0.354)	(0.151)	(0.383)	[0.092]
EPS	0.520	0.639	0.496	0.143
	(0.726)	(0.362)	(0.777)	[0.188]
N. of Banks	100	18	90	
Obs.	2671	396	2275	

Figure 5: **USD ABCP maturing overnight**
The daily time series of outstanding ABCP with overnight maturity. The maturity of ABCP shortened during the 2007 ABCP market freeze.

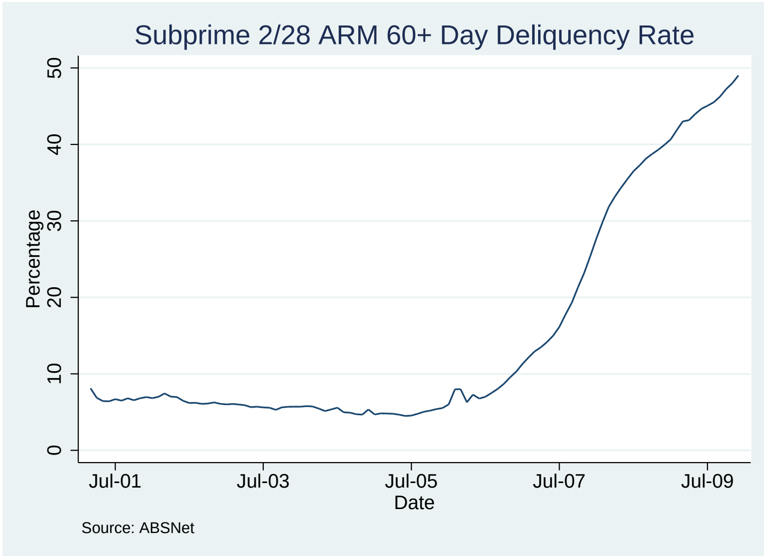


Following Covitz et al. (2013) who highlight the role of deteriorating subprime mortgage in the 2007 ABCP market run, we use the monthly subprime mortgage delinquency rate from ABSNet as a proxy for the expected future credit loss in ABCP conduit assets.[23] Hayre, Saraf, Young, and Chen (2008) and Fuster and Willen (2017) show that, among various kinds of subprime mortgages, the subprime 2/28 adjustable-rate mortgage (ARM) most significantly contributed to the marginal increase of credit loss.[24] They further highlight the importance of the 60-day delinquency rate, a closely watched indicator of the healthiness of ABCP collateral quality, since borrowers with low credit quality typically do not recover once they are over 60 days delinquent. Hence, we use the aggregate monthly balance of over 60-day delinquent subprime ARM 2/28 loans over their monthly

[23]In addition, Moody's Investors Service releases, on an irregular basis, the mix of underlying assets for a few large ABCP conduits and shows that residential MBS is the primary type of the underlying assets.

[24]Hayre et al. (2008) show that the subprime 2/28 adjustable-rate mortgage (ARM) first proliferated during the housing boom and later suffered massive credit loss at the early stage of the great financial crisis. The term 2/28 means the borrower will enjoy a low fixed teaser mortgage rate for the first two years followed by a floating rate thereafter. The total term of the mortgage is 30 years. Adjustable-rate subprime mortgages allowed the borrowers with low income to enjoy a low initial teaser rate, which made the mortgage loan more affordable than fixed-rate subprime mortgages in the first few years. During the housing boom, it was widely believed that the borrowers could accumulate housing equity from the rising house prices while enjoying the first two years of teaser rate. The borrowers could then either sell the house for a profit or refinance into a mortgage with a lower rate. When the growth in home prices began to soften in 2007, the subprime ARM borrowers show an increasing level of delinquency. Meanwhile, borrowers of other subprime mortgages, such as 5/25 ARMs, during the housing boom in 2005 to 2006 did not default as much in our sample period, since they can enjoy the low teasing rate until 2010 to 2011 (Fuster and Willen, 2017).

Figure 6: **Subprime ARM 2/28 60+ day delinquency ratio**
The delinquency status of 30-year adjustable-rate subprime mortgages with a fixed rate for the first two years. We aggregate the monthly balance of over 60-day delinquent subprime ARM 2/28 loans and normalize it with the monthly total current balance of subprime ARM 2/28 loans. The delinquency rate was stable before mid-2006, then started to pick up as the U.S. housing market softened. By the end of 2009, about 50% of the subprime ARM 2/28 borrowers are over 60 days delinquent.



total current balance as our proxy of the marginal credit loss of ABCP conduit:

$$\text{Mortgage Delinquency}_t = \left[\frac{\text{Balance of over 60-day delinquent subprime ARM 2/28 loans}}{\text{Balance of subprime ARM 2/28 loans}}\right]_t .$$

Figure 6 shows the subprime ARM 2/28 delinquency ratio during the sample period.[25]

5 Empirical analysis

5.1 Matching

The summary statistics in Table 2 show that the loophole-exploiting BHCs tend to be larger and have a different capital structure than the rest of the sample BHCs. These differences imply that neither the observed equity returns nor the risk capital ratios of the control group are the coun-

[25]Although the delinquency ratio presents a clear upward trend during the sample period, the trend is unlikely to lead to spurious regression estimates since we use the *change* in ABCP conduit credit risk, which is the product of the delinquency ratio and the bank's relative conduit exposure, as our regression variable.

terfactual outcomes to the regulatory-arbitraging BHCs' returns. We rely on matching methods to tackle such empirical challenges. Specifically, we use the full sample with the propensity score weights and construct a matched sample using the minimum Mahalanobis distance to ensure our empirical results are not the result of a particular choice of the matching methods.

5.1.1 Propensity score method

We develop the propensity score measure of Rosenbaum and Rubin (1983) by investigating the determinants of regulatory arbitrage and provide insights into a suitable control model for subsequent analysis. Specifically, we estimate the following logit model:

$$\log \frac{p_{i,q}}{1 - p_{i,q}} = \alpha_q + \beta \mathbf{X}_{i,q} + \epsilon_{i,q}, \tag{3}$$

where $p_{i,q}$ is the probability of bank i providing a liquidity guarantee to an ABCP conduit at quarter q. We include the quarter fixed effects, α_q, to the variation in the BHCs' likelihood of using an ABCP financing facility over time, including the development of the ABCP market, which can make the ABCP financing facility more accessible.

The matrix $\mathbf{X}_{i,q}$ contains our selected characteristics for bank i in quarter q. Specifically, we include the log of book assets, following the starking difference in bank sizes shown in Table 2. Moreover, as Acharya et al. (2011) and Covitz et al. (2013) have shown, the ABCP market freezes when the commercial paper rollover fails, upon which the guarantors are expected to provide liquidity. Hence, we also include the bank's cash ratio into $\mathbf{X}_{i,q}$. Furthermore, Covitz et al. (2013) prove that banks set up ABCP conduits as an alternative financing channel that allows them to move assets, in particular mortgages, off their balance sheets. Therefore, we pay attention to the balance sheet asset mix of the BHCs in two dimensions. First, we focus on the shares of loans and real estate loans in particular, since they might affect the bank's decision regarding the use of ABCP liquidity financing. Second, we follow the share of on-balance-sheet securities, another major category of long-term balance sheet assets. We also pay particular attention to securities that are marked as "for sale," instead of "held-to-maturity," because the former are more likely to be moved to ABCP conduits. Finally, following the standard bank capital structure literature (Gropp and Heider, 2010), we add additional controls, including the deposit-to-asset ratio to control for the bank liability mix, as well as return on assets (ROA) and earnings per share (EPS) to control for bank profitability.[26]

Columns (1) and (2) of Table 3 presents the results from regression (3), without and with the quarter fixed effects, respectively. We find that the BHCs' likelihood of exploiting the ABCP exclusion is positively associated with bank size, the loan-to-assets ratio, and the security-to-assets ratio, which is consistent with Covitz et al. (2013). In addition, we find that ABCP guarantors have fewer real estate loans on balance sheet, likely due to the fact that real-estate loans are a popular choice of long-term assets to be financed by the ABCP financing facility. Consistent with Boyson, Fahlenbrach, and Stulz (2016), our analysis shows the decision to exploit the ABCP exclusion varies systematically with the potential benefit of regulatory arbitrage. We use the propensity weighting calculated from the regression with quarter fixed effects, reported in Column (2) of Table 3, in the subsequent empirical tests of market discipline.

5.1.2 Mahalanobis matching

We also construct a matched sample of guarantors and non-guarantors following Abadie and Imbens (2016). First, following the analysis presented in subsection 5.1.1, which discusses how balance sheet characters and bank performance indicators might affect the bank's regulatory arbitrage decision, we calculate the Mahalanobis distance between the balance sheet characters of each liquidity guarantor in their *first* year of exploiting the ABCP exclusion and the remaining non-liquidity-guarantor BHCs in the same period.[27] Next, we match each liquidity guarantor with the smallest Mahalanobis distance counterparty without replacement. The resulting Mahalanobis matched sample contains 18 liquidity guarantors and 18 matched non-liquidity-guarantors.

Table 4 reports the summary statistics of the matched sample, in a structure similar to Table 2. Column (1) shows the summary statistics of the entire matched sample. Columns (2) and

[26]We choose not to include banks' capital ratios because doing so defies our analysis of market influence, in which we study how U.S. stock market influences a liquidity guarantor's choice of risk capital adequacy.

[27]We use the same set of balance sheet characters and bank performance indicators as in our propensity score analysis.

Table 3: **Logit regression**

The table provides the logit estimates of a BHC's probability of exploiting the ABCP exclusion in a quarter, using the quarterly data from Q1 2001 to Q3 2009 for all publicly-traded U.S. BHCs with \$10B+ total assets. Column (1) presents the estimates without time fixed effects, whereas Column (2) shows the estimates with the time fixed effects. Bank balance sheet variable definitions are provided in the Appendix. Standard errors are reported in parentheses. Significance: $^{*}\,p < 0.10$; $^{**}\,p < 0.05$; $^{***}\,p < 0.01$.

	Logit	
	(1)	(2)
log(Total assets)	1.511***	1.616***
	(0.0836)	(0.0892)
Cash ratio (%)	0.0904***	0.103***
	(0.0153)	(0.0155)
Loan to assets (%)	0.0812***	0.0859***
	(0.0110)	(0.0114)
RE loan to assets (%)	-0.0551***	-0.0531***
	(0.00819)	(0.00862)
Security to assets (%)	0.0359*	0.0419**
	(0.0189)	(0.0193)
FS security to assets (%)	0.0610***	0.0611***
	(0.0187)	(0.0191)
Deposit to assets (%)	0.0328***	0.0337***
	(0.00682)	(0.00692)
ROA (%)	0.559*	0.0288
	(0.329)	(0.392)
EPS	-0.0430	-0.0250
	(0.133)	(0.155)
Quarter FE	No	Yes
Obs.	2671	2671
Pesudo R^2	0.407	0.426
χ^2	913.6	954.0

(3) show the respective summary statistics of the loophole-exploiting BHCs and the Mahalanobis matched control group. Column (4) shows the differences in mean, as well as the standard error of the difference, between the two matched subsamples. The difference in size, capital structure, and ROAs between the matched subsamples are statistically insignificant.

Abadie and Imbens (2016) argue that the Mahalanobis matching is more robust than the propensity score method. Nevertheless, the propensity score method allows banks to have time-varying weights according to the estimated propensity, whereas the one-to-one Mahalanobis matching chooses a specific match for each liquidity guarantor throughout the sample period. Hence, we adopt both matching methods in the following sections.

5.2 Market monitoring: ABCP maturity and bank equity return

We start by investigating whether the capital market monitors loophole-exploiting BHCs. Although the regulatory capital requirement during our sample period did not take into account how the variation in ABCP maturity changes the risk of the ABCP guarantee, our theoretical analysis suggests that a bank's cost of the guarantee obligation depends on both the conduit's credit risk and the commercial paper maturity. Hence, if the capital market is effective in monitoring, it would not deem liquidity guarantors to be remote from the credit risk of the ABCP conduit (Acharya et al., 2012). Accordingly, we should note the ABCP liquidity guarantor return covaries with the ABCP conduit's credit risk and the ABCP maturity. Meanwhile, the credit guarantor's return should not be sensitive to the interaction between the ABCP maturity and the conduit credit risk, since the credit guarantee cost does not vary with the maturity.

We first measure each bank's exposure to the credit risk of an ABCP conduit with liquidity guarantee. The bank's exposure is larger when the outstanding ABCP is high compared to the size of the bank. In addition, when the conduit asset's credit quality deteriorates, the guarantor also faces a higher credit risk exposure conditional on the outstanding ABCP guaranteed and the bank size. Hence, we construct the measure for the liquidity guarantee conduit risk for each sponsoring bank i at date t as the product of relative conduit exposure and the percentage of over 60-day

Table 4: **Summary statistics of Mahalanobis matched sample**
The sample consists of all publicly-traded U.S. ABCP liquidity guarantors and the counterparties, among the remaining full sample of banks, with the smallest Mahalanobis distance by balance sheet characters. The matched balance sheet characters including asset size, cash ratio, loan to assets ratio, real estate loan to asset ratio, security to assets ratio, for-sale security to asset ratio, deposit to assets ratio, as well as bank performance information including return on equity and return on assets. Specifically, Column (1) shows the sample mean and standard deviations of the matched sample. Column (2) shows the means and standard deviations of variables for liquidity guarantors. Column (3) shows the means and standard deviations for the matched other BHCs. Column (4) shows the differences in means between two subsamples and the corresponding standard errors. Bank balance sheet variable definitions are provided in the Appendix. Standard deviations are in parentheses and standard errors are in brackets. Significance: $^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$.

	All (1)	Liquidity guarantor (2)	Matched other BHCs (3)	Diff. (4)
Total Assets (Bil.)	247.547	318.691	176.403	142.288
	(363.364)	(434.857)	(268.354)	[120.442]
Liquidity guarantee (Bil.)	5.441	10.882	0.000	10.882**
	(13.502)	(17.682)	(0.000)	[4.168]
Credit guarantee (Bil.)	1.211	2.422	0.000	2.422**
	(3.224)	(4.277)	(0.000)	[1.008]
Cash Ratio (%)	6.390	7.197	5.582	1.615
	(6.889)	(7.610)	(6.198)	[2.313]
Loan to assets (%)	54.934	53.395	56.473	-3.077
	(22.764)	(21.032)	(24.891)	[7.681]
RE loan to assets (%)	28.224	24.761	31.688	-6.927
	(16.553)	(14.778)	(17.897)	[5.471]
Security to assets (%)	17.833	18.885	16.782	2.103
	(10.070)	(9.406)	(10.861)	[3.387]
FS security to assets (%)	16.984	17.921	16.048	1.873
	(9.667)	(8.513)	(10.866)	[3.254]
Deposit to assets (%)	58.584	58.525	58.643	-0.118
	(19.181)	(9.261)	(25.916)	[6.487]
ROA (%)	0.285	0.277	0.293	-0.016
	(0.185)	(0.151)	(0.217)	[0.062]
EPS	0.807	0.639	0.975	-0.336
	(0.941)	(0.362)	(1.277)	[0.313]
N. of Banks	36	18	18	
Obs.	823	396	427	

subprime ARM 2/28 delinquent ratios, normalized by the book value of the bank:

$$\text{LG Conduit Risk}_{i,t} = \frac{\text{Outstanding of liquidity-guarantee}_{i,t} \times \text{Mortgage Delinquency}_t}{\text{Book value}_{i,t}}.$$

We also construct the CG Conduit $\text{Risk}_{i,t}$ in a similar fashion using bank i's outstanding amount of credit guarantee at date t.

We then test our hypotheses using the measure of conduit risk and $\Delta\%\text{OVN}_t$, which is the change in the ratio of outstanding ABCPs maturing overnight from period $t-1$ to t. Specifically, we run the following model

$$\begin{aligned} r_{i,t}^{FF} &= \alpha_i + \beta_0 \times \Delta\%\text{OVN}_t \\ &+\beta_1 \times \Delta\text{LG Conduit Risk}_{i,t} + \beta_2 \times \Delta\%\text{OVN}_t \times \Delta\text{LG Conduit Risk}_{i,t} \\ &+\beta_3 \times \Delta\text{CG Conduit Risk}_{i,t} + \beta_4 \times \Delta\%\text{OVN}_t \times \Delta\text{CG Conduit Risk}_{i,t} \\ &+\beta_5 \times \mathbf{X}_{i,t} + \beta_6 \times \mathbf{Y}_t + \varepsilon_{i,t}, \end{aligned} \tag{4}$$

under both the full sample using the propensity weight estimated using Equation (3) and the Mahalanobis matched sample. The dependent variable in Equation (4), $r_{i,t}^{FF}$ is the Fama-French abnormal return of bank i at holding period t. Besides the bank fixed effects α_i, bank balance sheet variables $\mathbf{X}_{i,t}$ contain the same set of bank characteristics we have used in the matching process, as in Equation (3). The macroeconomic and general market condition control variables $\mathbf{Y}_t$ include the magnitude of the Federal Reserve's QE during the financial crisis, using the weekly mortgage-backed security purchase amount, and GDP growth as an indicator of the general economy.

Columns (1) through (3) of Table 5 show the regression results using the full sample with propensity score weighting. Consistent with effective market monitoring (H2), the interaction between maturity and the bank's liquidity guarantee risk, $\Delta\%\text{OVN}_t \times \Delta\text{LG Conduit Risk}_{i,t}$, significantly affects the guarantors' returns. For a liquidity guarantor with average exposure (\$10.9 billion), size (\$319 billion), and facing an average monthly mortgage delinquency rate increase of 0.416%, a one standard deviation increase of percentage share of ABCPs maturing overnight (1.140%) leads to daily return of -1.12 basis points, or an annualized return of -4.0%.[28] , Columns (4) through (6) show the regression estimates using the Mahalanobis matched sample. The estimates suggest a daily return of -1.11 basis points, very close to the estimates of propensity score weighted analysis. On the other hand, consistent with H1, the interaction between maturity and the bank's credit guarantee risk does not significantly change the bank's returns.

So far, we have included BHCs that have never used ABCP financing in both the full sample and the matched sample. One might be concerned that the empirical results in Table 5 are driven by the inclusion of these non-guarantor BHCs. To alleviate such a concern, we rerun regression (4) with a subsample of ABCP guarantors only and present the estimates in Table 6. The significant effect of the interaction between maturity and the bank's liquidity guarantee risk, $\Delta\%\text{OVN}_t \times \Delta\text{LG Conduit Risk}_{i,t}$, remains in the guarantor-only subsample. Moreover, the estimates of market monitoring are very close to those in Table 5.

Our empirical estimates demonstrate the U.S. stock market's awareness of the excessive risk taken by the liquidity guarantors through an ABCP exclusion. This finding extends the literature of market discipline beyond BHCs' on-balance-sheet activities, such as maturity mismatches (Flannery and James, 1984), deposit credits (Martinez Peria and Schmukler, 2001; Demirgüç-Kunt and Huizinga, 2004), and subordinated debentures (Avery et al., 1988; Gorton and Santomero, 1990; Ashcraft, 2008). Moreover, even though shadow banking systems are more complex and obscure (Pozsar et al., 2010), the U.S. stock market is efficient enough to differentiate the loophole-exploiting guarantee exposure from seemingly similar credit guarantee obligations that do not facilitate regulatory arbitrage.

Our findings also relate to Acharya et al. (2012), who provide empirical evidence of regulatory arbitrage among ABCP guarantors. Our research shows that the stock market disciplines loophole-exploiting BHCs. Acharya et al. (2012) found that BHCs that had built up a high conduit exposure—more regulatory arbitrage positions—turned out to be the riskier BHCs during the ABCP run in August 2007, from August 8–10 in particular, but *not* in other months. Our paper explicitly recognizes the effect of ABCP maturity on the liquidity guarantee cost and addresses the

[28]Specifically, the daily return is $-0.00689 \times \frac{10.9}{319} \times 0.416 \times 1.140$, which equals -1.12 basis points.

Table 5: **Market monitoring: bank abnormal returns and guarantee exposure**
The table provides estimates for the model presented in Equation (4) using sample data from Q1 2001 to Q3 2009. Columns (1) through (3) present the propensity score weighted estimates using all publicly-traded U.S. BHCs with \$10B+ total assets. Columns (4) through (6) present the OLS estimates using the matched sample. The dependent variable, $r_{i,t}^{FF}$, is the holding period equity abnormal return of bank i at period t, after controlling for the Fama-French factors. For the explanatory variables, $\Delta\%\text{OVN}_t$ measures the change in the ratio of ABCP outstanding matures overnight from period $t-1$ to t. $\Delta\text{Conduit Risk}_{i,t}$ is the product of the change in subprime mortgage delinquency rate between period $t-1$ and t, multiplies the bank's exposure to ABCP liquidity guarantee aforementioned, which is the principal of ABCP relative to the bank's book value. Bank balance sheet variable definitions are provided in the Appendix. Robust standard errors are reported in parentheses. Significance: * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

Variable	$r_{i,t}^{FF}$ (%)					
	Propensity score weighted			Matched		
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta\%$OVN $\times$ Δ LG Conduit Risk	-0.00689***	-0.00685***	-0.00689***	-0.00685**	-0.00679**	-0.00681**
	(0.00118)	(0.00119)	(0.00119)	(0.00289)	(0.00289)	(0.00289)
$\Delta\%$OVN $\times$ Δ CG Conduit Risk	-0.00548	-0.00542	-0.00547	-0.00296	-0.00285	-0.00290
	(0.00505)	(0.00503)	(0.00504)	(0.00404)	(0.00403)	(0.00401)
Δ LG Conduit Risk	-0.00340***	-0.00281*	-0.00365**	-0.00181	0.00183	0.00102
	(0.00108)	(0.00169)	(0.00161)	(0.00348)	(0.00475)	(0.00479)
Δ CG Conduit Risk	0.000281	0.00814	0.00910	0.000703	0.00284	0.00375
	(0.0116)	(0.0104)	(0.0109)	(0.00975)	(0.0116)	(0.0116)
$\Delta\%$OVN	-0.000970	-0.000880	-0.000323	-0.00229	-0.00203	-0.00162
	(0.00987)	(0.00991)	(0.00988)	(0.00698)	(0.00691)	(0.00690)
log(Total assets)		-0.0853***	-0.0632***		-0.0623	-0.0360
		(0.0223)	(0.0233)		(0.0435)	(0.0478)
Cash ratio (%)		0.00433	0.00614*		0.00902*	0.0104**
		(0.00314)	(0.00311)		(0.00468)	(0.00483)
Loan to assets (%)		0.00313	0.00360		0.00880**	0.00964**
		(0.00312)	(0.00317)		(0.00411)	(0.00425)
RE loan to assets (%)		-0.00254	-0.00251		-0.00846***	-0.00888***
		(0.00226)	(0.00226)		(0.00284)	(0.00284)
Security to assets (%)		0.00374	0.00430		0.00780**	0.00825**
		(0.00301)	(0.00306)		(0.00361)	(0.00393)
FS security to assets (%)		-0.00371*	-0.00344*		-0.00464	-0.00436
		(0.00203)	(0.00204)		(0.00330)	(0.00357)
Deposit to assets (%)		-0.00226	-0.00171		-0.00353	-0.00280
		(0.00177)	(0.00170)		(0.00301)	(0.00289)
ROA (%)		-0.0450	-0.0480		-0.207***	-0.209***
		(0.0476)	(0.0439)		(0.0668)	(0.0659)
EPS		0.0589***	0.0535***		0.0874***	0.0821***
		(0.0134)	(0.0132)		(0.0247)	(0.0250)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Macro Controls	No	No	Yes	No	No	Yes
Obs.	177530	177530	177530	59461	59461	59461
Adj. R^2	0.000235	0.00100	0.00161	-0.0000132	0.000634	0.00108
F-Statistics	32.87	19.88	23.03	17.24	21.76	25.46

Table 6: **Market monitoring: ABCP guarantor BHCs subsample**
Columns (1) through (3) present OLS estimates for the model presented in Equation (4) using the sample data of ABCP guarantor BHCs only, from Q1 2001 to Q3 2009. The dependent variable, $r^{FF}_{i,t}$, is the holding period equity abnormal return of bank i at period t, after controlling for the Fama-French factors. For the explanatory variables, $\Delta\%\text{OVN}_t$ measures the change in the ratio of ABCP outstanding matures overnight from period $t-1$ to t. $\Delta\text{Conduit Risk}_{i,t}$ is the product of the change in subprime mortgage delinquency rate between period $t-1$ and t, multiplies the bank's exposure to ABCP liquidity guarantee aforementioned, which is the principal of ABCP relative to the bank's book value. Bank balance sheet variable definitions are provided in the Appendix. Robust standard errors are reported in parentheses. Significance: $^{*}\,p < 0.10$; $^{**}\,p < 0.05$; $^{***}\,p < 0.01$.

Variable	$r^{FF}_{i,t}$ (%)		
	(1)	(2)	(3)
$\Delta\%$OVN $\times$ Δ LG Conduit Risk	-0.00697**	-0.00688**	-0.00690**
	(0.00293)	(0.00295)	(0.00294)
$\Delta\%$OVN $\times$ Δ CG Conduit Risk	-0.00300	-0.00300	-0.00306
	(0.00408)	(0.00403)	(0.00400)
Δ LG Conduit Risk	-0.00181	-0.000960	-0.00158
	(0.00354)	(0.00327)	(0.00350)
Δ CG Conduit Risk	0.000704	0.00399	0.00526
	(0.00990)	(0.00933)	(0.00945)
$\Delta\%$OVN	-0.000594	-0.000387	0.0000161
	(0.00833)	(0.00830)	(0.00833)
Bank FE	Yes	Yes	Yes
Balance Sheet Controls	No	Yes	Yes
Macro Controls	No	No	Yes
Obs.	29282	29282	29282
Adj. R^2	0.0000584	0.00101	0.00152
F-Statistics	18.31	142.9	639.5

endogeneity issues in the empirical estimation. By including the ABCP maturity in the regression, our analysis reveals that bank returns are affected by the cost of the liquidity guarantee in our sample period of Q1 2001 to Q3 2009, which includes both turmoil and the quiet years before the ABCP crisis.

5.2.1 Robustness: Sample periods

One might be concerned that the guarantors equity price drop is solely driven by the financial crisis period, since the ABCP market run happened when investors started to become concerned about the housing bubble (Covitz et al., 2013). To address such a concern, we separate the regression in the periods before and after the beginning of 2006, when the housing market first showed its softness (Foote, Gerardi, and Willen, 2012). The first period observed a steady growth in the ABCP market, whereas the second period witnessed the markets toppling and decline. Table 7 shows that the results are significant both before and after the housing market peak. Therefore, the empirical result presented using the whole sample data is not driven solely by the post-ABCP crisis period.

A similar concern is that the low-interest environment from 2002 to 2004 could make ABCPs attractive to yield-seeking investors who were bound to hold only high-quality assets, whereas the increasing interest rate after 2004 caused the ABCP run to be more likely. The interest rate was also one of the primary reasons behind the housing price change and MBS defaults. Hence, we run separate regressions for the periods before and after the beginning of 2005 to capture the regression under different interest rate environments. Table 8 shows the results are robust under both interest rate environments.

In summary, the stock market is responsive to the BHCs' off-balance-sheet activity during the entire sample period of Q2 2001 to Q3 2009, rather than only during an earlier or later period.

5.3 Market influence: Bank capital ratio

The ABCP exclusion, together with the variation in the ABCP market condition, provides us a testbed to identify the effectiveness of the market influence. On the one hand, regulators did not

Table 7: **Market monitoring by subperiods: Rapid ABCP market growth**
The table provides estimates for the model presented in Equation (4) under two subperiods. The first subperiod is from Q1 2001 to Q4 2005 when U.S. ABCP market enjoyed rapid growth. The second subperiod is from Q1 2006 till Q3 2009. Columns (1) and (2) present the propensity score weighted estimates using all publicly-traded U.S. BHCs with \$10B+ total assets under the first and second subperiods, respectively. Columns (3) and (4) present the OLS estimates using the matched sample under the first and second subperiods, respectively. The dependent variable, $r_{i,t}^{FF}$, is the holding period equity abnormal return of bank i at period t, after controlling for the Fama-French factors. For the explanatory variables, $\Delta\%\text{OVN}_t$ measures the change in the ratio of ABCP outstanding matures overnight from period $t-1$ to t. $\Delta\text{Conduit Risk}_{i,t}$ is the product of the change in subprime mortgage delinquency rate between period $t-1$ and t, multiplies the bank's exposure to ABCP liquidity guarantee aforementioned, which is the principal of ABCP relative to the bank's book value. Bank balance sheet variable definitions are provided in the Appendix. Robust standard errors are reported in parentheses. Significance: $^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$.

Variable	$r_{i,t}^{FF}$ (%)			
	Propensity score weighted		Matched	
	2001-2005 (1)	2006-2009 (2)	2001-2005 (3)	2006-2009 (4)
$\Delta\%$OVN $\times$ Δ LG Conduit Risk	-0.00713***	-0.00903***	-0.00708***	-0.00927**
	(0.00187)	(0.00227)	(0.00229)	(0.00353)
$\Delta\%$OVN $\times$ Δ CG Conduit Risk	-0.0179	-0.00524	-0.0162	-0.00220
	(0.0186)	(0.00603)	(0.0134)	(0.00470)
Δ LG Conduit Risk	-0.00477***	-0.00541***	-0.00685*	0.00118
	(0.00178)	(0.00150)	(0.00382)	(0.00543)
Δ CG Conduit Risk	-0.0147	0.00553	-0.0131	0.00153
	(0.0284)	(0.0113)	(0.0276)	(0.0130)
$\Delta\%$OVN	-0.0246***	0.0194	-0.0236***	0.0191
	(0.00571)	(0.0200)	(0.00713)	(0.0123)
Bank FE	Yes	Yes	Yes	Yes
Balance Sheet Controls	Yes	Yes	Yes	Yes
Macro Controls	Yes	Yes	Yes	Yes
Obs.	84235	93295	30736	28725
Adj. R^2	0.00106	0.00207	0.00136	0.00151
F-Statistics	15.10	25.72	15.50	46.03

Table 8: **Regression by periods: Low mortgage rate**
The table provides estimates for the model presented in Equation (4) under two subperiods. The first subperiod is from Q1 2001 to Q4 2004 when U.S. mortgage borrower enjoyed historical low mortgage rates. The second subperiod is from Q1 2005 till Q3 2009. Columns (1) and (2) present the propensity score weighted estimates using all publicly-traded U.S. BHCs with \$10B+ total assets under the first and second subperiods, respectively. Columns (3) and (4) present the OLS estimates using the matched sample under the first and second subperiods, respectively. The dependent variable, $r_{i,t}^{FF}$, is the holding period equity abnormal return of bank i at period t, after controlling for the Fama-French factors. For the explanatory variables, $\Delta\%\mathrm{OVN}_t$ measures the change in the ratio of ABCP outstanding matures overnight from period $t-1$ to t. $\Delta\text{Conduit Risk}_{i,t}$ is the product of the change in subprime mortgage delinquency rate between period $t-1$ and t, multiplies the bank's exposure to ABCP liquidity guarantee aforementioned, which is the principal of ABCP relative to the bank's book value. Bank balance sheet variable definitions are provided in the Appendix. Robust standard errors are reported in parentheses. Significance: $^{*}\,p < 0.10$; $^{**}\,p < 0.05$; $^{***}\,p < 0.01$.

Variable	$r_{i,t}^{FF}$ (%)			
	Propensity score weighted		Matched	
	2001-2004 (1)	2005-2009 (2)	2001-2004 (3)	2005-2009 (4)
$\Delta\%\mathrm{OVN} \times \Delta$ LG Conduit Risk	-0.0101***	-0.00804***	-0.00817**	-0.00835**
	(0.00372)	(0.00156)	(0.00327)	(0.00319)
$\Delta\%\mathrm{OVN} \times \Delta$ CG Conduit Risk	-0.0567*	-0.00534	-0.0494	-0.00230
	(0.0321)	(0.00566)	(0.0338)	(0.00438)
Δ LG Conduit Risk	0.00744	-0.00662***	-0.00433	0.000942
	(0.0130)	(0.00189)	(0.00716)	(0.00590)
Δ CG Conduit Risk	-0.0732***	0.00890	-0.0598**	0.00452
	(0.0212)	(0.0119)	(0.0228)	(0.0120)
$\Delta\%\mathrm{OVN}$	-0.0330***	0.0130	-0.0293***	0.0121
	(0.00656)	(0.0153)	(0.00936)	(0.00963)
Bank FE	Yes	Yes	Yes	Yes
Balance Sheet Controls	Yes	Yes	Yes	Yes
Macro Controls	Yes	Yes	Yes	Yes
Obs.	63070	114460	23701	35760
Adj. R^2	0.000878	0.00185	0.000636	0.00128
F-Statistics	14.53	24.04	16.06	47.70

condition the liquidity guarantors risk capital requirement on ABCP maturity, which can change the bank's riskiness. On the other hand, effective market monitoring, which we have shown existence of in subsection 5.2, means the liquidity guarantee bank's franchise value would vary with the ABCP market condition. Subsequently, our theoretical model suggests that effective market influence would force loophole-exploiting BHCs to set their capital levels higher than an otherwise identical BHC who does not participate in regulatory arbitrage.

Specifically, we study how U.S. BHCs choose their risk capital level, conditional on whether the bank participates in regulatory arbitrage through an ABCP liquidity guarantee. With both the full sample with propensity score weighting and the matched sample, we regress the bank capital ratio:

$$K_{i,q+1} = \alpha_q + \gamma_0 \times 1_{i,q}^{\{\text{Liquidity guarantor}\}} + \gamma_1 \times 1_{i,q}^{\{\text{ABCP guarantor}\}} + \gamma_2 \times \mathbf{X}_{i,q} + \varepsilon_{i,q}, \tag{5}$$

in which $K_{i,q+1}$ is bank i's Tier-1 capital ratio at quarter $q+1$. In addition, $1_{i,q}^{\{\text{Liquidity guarantor}\}}$ is the indicator variable equals 1 if bank i is a liquidity guarantor at quarter q, and 0 otherwise. $\mathbf{X}_{i,q}$ is the vector of control variables for bank i at quarter q. Finally, we include the time fixed effects α_q to capture the quarterly variation in the economy.[29]

As predicted (H3), Column (1) of Table 9 shows the regression estimates using the full sample with propensity score weighting. The results show that, on average, an ABCP guarantor has a 2.092% lower Tier-1 capital ratio than a non-guarantor with similar characteristics; this is consistent with the existing ABCP market literature (Acharya et al., 2011, 2012; Covitz et al., 2013). More importantly, our results show that a liquidity guarantor has a 1.739% higher Tier-1 capital ratio on average than the rest of the ABCP guarantors. Column (2) presents similar estimates obtained from the Mahalanobis matched sample: although an ABCP guarantor has, on average, a 3.790% lower Tier-1 capital ratio, a loophole-exploiting guarantor has a 2.637% higher Tier-1 capital ratio.

Additionally, the signs of the coefficients for control variables are consistent with the literature. A higher Tier-1 capital ratio is associated with a higher market-to-book ratio, which maps to a higher franchise value. More collateral on the balance sheet or lower asset risks are associated with

[29]Bank fixed effects are co-linear with the two indicator variables.

Table 9: **Market influence: bank capital ratios and ABCP guarantee**
The table presents capital ratios of liquidity guarantors in the sample period of Q2 2001 to Q3 2009. Columns (1) and (2) show estimates of Tier-1 capital ratio using propensity score weighted regression and the matched sample regression respectively, whereas Columns (3) and (4) show the corresponding estimates of adjusted Tier-1 capital ratio. Bank balance sheet control variables are described in Appendix. Robust standard errors are reported in parentheses. Significance: $^{*}\,p < 0.10$; $^{**}\,p < 0.05$; $^{***}\,p < 0.01$.

Variable	Tier-1 cap. ratio (%)		Adj. Tier-1 cap. ratio (%)	
	Propensity score weighted	Matched	Propensity score weighted	Matched
	(1)	(2)	(3)	(4)
Liquidity guarantor	1.739**	2.637***	1.219*	2.153***
	(0.646)	(0.422)	(0.669)	(0.428)
ABCP guarantor	-2.092**	-3.790***	-2.147**	-3.818***
	(0.771)	(0.499)	(0.814)	(0.514)
log(Total assets)	-1.612***	-0.649***	-1.591***	-0.673***
	(0.129)	(0.0568)	(0.130)	(0.0471)
Cash ratio (%)	-0.0140	-0.0104	-0.0262	-0.0174
	(0.0276)	(0.0140)	(0.0283)	(0.0112)
Loan to assets (%)	-0.114***	0.0173	-0.105***	0.0319**
	(0.0106)	(0.0133)	(0.0109)	(0.0122)
RE loan to assets (%)	0.00680	-0.120***	-0.00154	-0.128***
	(0.00913)	(0.0120)	(0.00945)	(0.0117)
Security to assets (%)	-0.0419**	0.159***	-0.0383*	0.136***
	(0.0190)	(0.0192)	(0.0193)	(0.0141)
FS security to assets (%)	-0.0526***	-0.183***	-0.0546***	-0.164***
	(0.0144)	(0.0202)	(0.0143)	(0.0143)
Deposit to assets (%)	-0.114***	0.0125	-0.116***	0.00540
	(0.0137)	(0.00823)	(0.0137)	(0.00705)
ROA (%)	13.99***	1.015**	14.18***	0.942**
	(1.367)	(0.411)	(1.365)	(0.399)
EPS	-3.566***	0.0156	-3.696***	0.0427
	(0.424)	(0.129)	(0.425)	(0.129)
Quarter FE	Yes	Yes	Yes	Yes
Obs.	2671	855	2671	855
Adj. R^2	0.609	0.555	0.619	0.582
F-Statistics	600.6	346.8	607.4	497.6

more available risk capital and, hence, higher capital ratios. Finally, larger BHCs with higher total assets have lower capital ratios partly because they are more likely to receive government aid under adverse scenarios, as in Boyson et al. (2016).

5.3.1 Robustness: Alternative interpretation

In the theoretical and empirical analysis so far, we follow the bank capital structure literature's standard assumption that the guarantor optimizes its capital structure to maximize bank value by balancing the cost of breaching the regulatory required minimum and the benefit of high leverage (Flannery, 1994; Myers and Rajan, 1998; Diamond and Rajan, 2000; Calomiris and Wilson, 2004; Allen et al., 2011).[30] Specifically, after the ABCP facility is exempted from a liquidity guarantor's total risk-weighted assets, the bank would maintain the optimal capital ratio by reducing the Tier-1 risk capital accordingly. Hence, the ABCP exclusion *per se* does not lead to an outright increase in the guarantor's capital ratio. Instead, the rise in the bank's capital ratio, as we observe, is the consequence of the bank adjusting its capital ratio according to the increased risk.

However, one might argue that the liquidity guarantor might not fully optimize its capital ratio in practice. As a result, the smaller amount of total risk-weighted assets due to the ABCP exclusion might lead to an outright increase in the guarantor's capital ratio. Such an argument offers an alternative explanation to our baseline empirical results in Table 9, and challenges whether the higher capital ratios among liquidity guarantors are indeed the consequence of market discipline.

To address such a challenge, we calculate an adjusted Tier-1 capital ratio $\tilde{K}$ as a counterfactual that adjusts away the possible increase in the capital ratio due to the reduced risk-weighted assets. In other words, given a liquidity guarantor that enjoys an ABCP exclusion that lowers its total risk-weighted asset by a factor $x < 1$ and maintains a capital ratio K, we let the adjusted capital ratio $\tilde{K} \equiv xK \leq K$.[31] For other BHCs, $\tilde{K} = K$ since their total risk-weighted assets are unaffected by the ABCP exclusion.

[30]Berger et al. (2008) show that U.S. BHCs actively manage their capital ratios by optimally setting and rapidly adjusting their target "excess" capital levels substantially above well-capitalized regulatory minima.

[31]Specifically, using the notation in the theoretical model Equation (2), we have $x \equiv \frac{D+E^L+G^L(y_t,m)+\beta V(y_t)}{D+E^L+G^L(y_t,m)+V(y_t)} \leq 1$ for liquidity guarantors since $\beta \leq 1$.

We then re-estimate the regression in Equation (3) by using the adjusted capital ratio $\tilde{K}$. Columns (3) and (4) of Table 9 respectively report the estimates from the full sample with propensity score weighting and the Mahalanobis matched sample. Although the liquidity guarantors indeed show lower estimates for the adjusted Tier-1 capital ratios, they still have a 1.219% higher Tier-1 capital ratio according to the propensity score weighted regression or a 2.153% higher adjusted capital ratio according to the matched sample. The results prove that liquidity guarantors still present a higher Tier-1 capital ratio, even after we revert the impact of reduced total risk-weighted assets under the ABCP exclusion. Therefore, we can exclude the alternative explanation aforementioned and confirm that the capital ratios observed among liquidity guarantors are not driven entirely by the reduction of risk-weighted assets due to the ABCP exclusion.

5.3.2 Bank capital ratio and return sensitivity to liquidity guarantee cost

Next, we prove that the high capital ratios observed among liquidity guarantors are driven by market influence. We investigate how the pressure from the stock market, measured by the sensitivity of bank equity return to ABCP conduit risk, affects the guarantors' risk capital buffer. To construct the sensitivity of a bank's stock return to its ABCP guarantee exposure for *each* quarter q and guarantor bank i, we run *separate* regressions on Fama-French abnormal return with the interaction of the bank's guarantee exposure and the ABCP maturity change on date t:

$$\begin{aligned} r^{FF}_{i,q,t} &= \alpha_{i,q} + \beta_0 \times \Delta\%\text{OVN}_{q,t} + \beta_1 \times \Delta\text{LG Conduit Risk}_{i,q,t} \\ &+ \beta^{ABCP}_{i,q} \times \Delta\%\text{OVN}_{q,t} \times \Delta\text{LG Conduit Risk}_{i,q,t} + \varepsilon_{i,q,t}, \end{aligned} \tag{6}$$

where t is the trading days within quarter q.

From each regression, we obtain the coefficient $\beta^{ABCP}_{i,q}$, which represents each ABCP guarantor bank i's average stock price sensitivity to the risk from the ABCP guarantee obligation in quarter q. Panel (a) of Table 10 presents the summary statistics of $\beta^{ABCP}_{i,q}$. A more negative $\beta^{ABCP}_{i,q}$ means the daily abnormal return of guarantor bank i in quarter q is more sensitive to the cost of the guarantee, measured as an increased share of ABCP with overnight maturity and an increased conduit asset delinquency.

We then use the estimates of $\beta_{i,q}^{ABCP}$ to regress the guarantor's choice of Tier-1 capital ratio $K_{i,q+1}$ in the next quarter, using the panel regression specification as

$$K_{i,q+1} = \alpha_i + \alpha_q + \gamma_0 \times \beta_{i,q}^{ABCP} + \gamma_1 \times \mathbf{X}_{i,q} + \varepsilon_{i,q}, \tag{7}$$

to evaluate how the guarantor's choice of capital ratio responds to the sensitivity of its franchise value being impacted by the market monitoring.[32] As in regression (5), we control for quarter fixed effects α_q as well as the usual control variables $\mathbf{X}_{i,q}$ for bank i at quarter q. Moreover, we include the bank fixed effects α_i and run both an unweighted regression and a bank total asset weighted regression to ensure the results are not disproportionally driven by small or large BHCs.

The results presented in Panel (b) of Table 10 provide additional evidence that market influence contributes to the high Tier-1 capital ratio reported in Table 9, by showing that liquidity guarantors more sensitive to the ABCP risk (more negative β^{ABCP}) tend to maintain a higher Tier-1 capital ratio next quarter. This finding provides new evidence on how the market changes bank behavior: similar to the capital market's response to the financing cost of deposits (Martinez Peria and Schmukler, 2001; Demirgüç-Kunt and Huizinga, 2004) and subordinate debentures (Avery et al., 1988; Gorton and Santomero, 1990; Ashcraft, 2008), the stock market's response to a loophole-exploiting bank's off-balance-sheet ABCP exposure also presses the bank to increase its risk capital cushion. Our findings also provide additional empirical support for how BHCs choose their optimal capital structure (Berger et al., 2008). As Gropp and Heider (2010) show that BHCs adjust their leverage ratios when shifting their liability structures away from deposits toward non-deposit liabilities, we provide further empirical evidence to exemplify how U.S. BHCs adjust their leverage following the stock market's response to their off-balance-sheet liability structures.

[32] Alternatively, one can use an event study base on the ABCP market freeze in August 2007 to evaluate the change in bank capital ratio. However, this method has the following limitations. First, the ABCP market freeze had a profound impact on the banking system. Therefore, the change in bank capital ratio may not be a response to the ABCP market condition only. Second, the limited number of ABCP guarantor leads to a sample size that is too small to yield a robust statistical inference.

Table 10: **Market influence: bank capital ratios and β^{ABCP}**
Panel (a) presents the summary statistics of ABCP beta of liquidity guarantors in the sample period of Q2 2001 to Q3 2009, estimated from Equation (6). Panel (b) presents the OLS estimates of Equation (7) for the liquidity guarantors. Column (1) of Panel (b) presents the unweighted estimates, whereas Column (2) shows the estimates with bank size weighting. Bank balance sheet control variables are described in Appendix. Robust standard errors are reported in parentheses. Significance: $^{*}\ p < 0.10$; $^{**}\ p < 0.05$; $^{***}\ p < 0.01$.

(a) **Summary statistics of β^{ABCP}**

	mean	sd	min	max	count
β_{ABCP}	-0.197	0.978	-3.810	1.531	396

(b) **Capital ratios and β^{ABCP}**

Variable	Tier-1 cap. ratio (%)	
	Unweighted (1)	Weighted (2)
β_{ABCP}	-0.164**	-0.161**
	(0.0651)	(0.0646)
log(Total assets)	1.262*	1.273*
	(0.652)	(0.638)
Cash ratio (%)	0.179**	0.182**
	(0.0657)	(0.0678)
Loan to assets (%)	-0.0307	-0.0286
	(0.0785)	(0.0775)
RE loan to assets (%)	-0.0959	-0.0952
	(0.0999)	(0.0991)
Security to assets (%)	0.151***	0.158***
	(0.0477)	(0.0473)
FS security to assets (%)	-0.119	-0.126
	(0.0817)	(0.0786)
Deposit to assets (%)	0.0620*	0.0621*
	(0.0332)	(0.0327)
ROA (%)	1.756	1.796
	(1.250)	(1.244)
EPS	-0.779	-0.788
	(0.535)	(0.534)
Bank FE	Yes	Yes
Quarter FE	Yes	Yes
Obs.	396	396
Adj. R^2	0.706	0.707
F-Statistics	281.5	293.4

6 Conclusion

Does the stock market recognize banks exploiting a regulatory loophole using shadow banking financing facilities? Our theoretical model proves that the ABCP exclusion is a regulatory loophole and permits investigation as to whether the stock market is aware of the regulatory arbitrage opportunity. The empirical test confirms our assertion by showing that the interaction between the change in ABCP maturity and conduit asset credit loss affects the abnormal returns of the loophole-exploiting liquidity guarantors but not the returns of the credit guarantors.

Subsequently, does the pressure emanating from the stock market influence the liquidity guarantors? Our theoretical prediction and empirical evidence shows that the loophole-exploiting liquidity guarantors have a higher Tier-1 capital ratio beyond the impact of reduced total risk-weighted assets allowed by the ABCP exclusion. Additionally, a guarantor whose franchise value is more sensitive to the risk from the ABCP guarantee obligation maintains a higher risk capital buffer.

In summary, our study reveals both active market monitoring and influence on U.S. BHCs participating in regulatory arbitrage, and notes the effectiveness of market discipline when the minimum capital requirements are compromised. One possibly fruitful research avenue for future studies is how market discipline could affect the originate-to-distribute process, which is the model adopted by ABCP facilities and the shadow banking system in general (Bord and Santos, 2012). More stringent market discipline would help to reduce the moral hazard issue in the originate-to-distribute model. Future studies in this area would further expand the understanding of market discipline as a critical pillar of the Basel Accords.

A Appendix

A.1 Proof of Propositions

The non-arbitrage condition suggests that the ABCP value function $A(y_t, m)$ satisfies the differential equation

$$rA(y_t, m) = kV(y_0) + m(V(y_0) - A(y_t, m))\mathbf{1}_{\{A(y_t,m)<V(y_0)\}} + \mu y_t \frac{\partial A(y_t, m)}{\partial y_t} + \frac{1}{2}\sigma^2 y_t^2 \frac{\partial^2 A(y_t, m)}{\partial y_t^2}, \tag{A.1}$$

in which $A(y_t, m)$ may refer to both ABCP with a credit guarantee $A^C(y_t, m)$ and a liquidity guarantee $A^L(y_t, m)$.[33] Nevertheless, $A^C(y_t, m)$ and $A^L(y_t, m)$ do not share the same boundary conditions due to their different obligations at $y_t = y_w$. Specifically, $A^C(y_w, m) = V(y_0)$ whereas $A^L(y_w, m) = V(y_w)$.[34]

Proposition 1. *The value of ABCP under a credit guarantee does not vary with the maturity $1/m$. Specifically, $A^C(y_t, m) = V(y_0)$.*

Proof. Since the maturity of ABCP is finite with probability 1, together with limited liability, we also have the boundary condition for $A^L(y_t)$ at singular point $y_t \to \infty$ as $\lim_{y_t \to \infty} \left|A^C(y_t)\right| < +\infty$.

The credit guarantee ensures that the ABCP investor will always be able to collect the coupon payment, and have no credit risk even if the conduit defaulted. Since the ABCP with a credit guarantee is a riskless investment, the par coupon, by non-arbitrage, has to be r. Therefore, the ODE in Equation (A.1) becomes

$$\left(r - m\mathbf{1}_{\{A^C(y_t,m)<V(y_0)\}}\right)\left(V(y_0) - A^C(y_t, m)\right) = \mu y_t \frac{\partial A^C(y_t, m)}{\partial y_t} + \frac{1}{2}\sigma^2 y_t^2 \frac{\partial^2 A^C(y_t, m)}{\partial y_t^2}.$$

[33] Specifically, the required return of ABCP equals the sum of the ABCP coupon payment $kV(y_0)$, the change of market value $A(y_t, m)$ with the fluctuation of underlying assets, and the value of rollover support. Incentive compatibility implies that the ABCP investor only chooses to rollover his paper when its market price $A(y_t, m)$ is no less than the face value. Hence, the value of rollover support is the difference between face value $V(y_0)$ and ABCP value $A(y_t, m)$ multiplies the maturity intensity m, controlled by the rollover condition $A(y_t, m) < V(y_0)$.

[34] There are secondary boundary conditions for $A^C(y_t, m)$ and $A^L(y_t, m)$, at $y_t \to \infty$ based on the regularity condition. We relegate the discussion of both secondary boundary conditions to the Appendix.

Together with boundary conditions at wind-down trigger $A^{C}(y_w) = V(y_0)$, it is easy to see this ODE has a unique solution $A^{C}(y_t) = V(y_0)$. $\square$

Proposition 2. *The value function of ABCP with a liquidity guarantee* $A^{L}(y_t, m) = \mathbf{1}_{\{y_t \geq y_0\}} A_h^{L}(y_t, m) + \mathbf{1}_{\{y_t < y_0\}} A_l^{L}(y_t, m)$, *where*

$$\begin{aligned}
A_h^{L}(y_t, m) &= \frac{k}{r}V(y_0) + C_h(m)\phi(y_t; y_w), \\
A_l^{L}(y_t, m) &= \frac{k+m}{m+r}V(y_0)(1 - \psi(y_t; y_w)) + V(y_w)\psi(y_t; y_w) - C_l(m)\left(\psi(y_t; y_w) - \bar{\psi}(y_t; y_w)\right),
\end{aligned}$$

in which $\phi(y_t; y_w) = \left(\frac{y_t}{y_w}\right)^{H}$, $\psi(y_t; y_w) = \left(\frac{y_t}{y_w}\right)^{G}$, *and* $\bar{\psi}(y_t; y_w) = \left(\frac{y_t}{y_w}\right)^{\bar{G}}$. *Further,* $H = \frac{1}{2} - \frac{\mu}{\sigma^2} - \sqrt{\left(\frac{1}{2} - \frac{\mu}{\sigma^2}\right)^2 + \frac{2r}{\sigma^2}} < 0$, $G = \frac{1}{2} - \frac{\mu}{\sigma^2} - \sqrt{\left(\frac{1}{2} - \frac{\mu}{\sigma^2}\right)^2 + \frac{2(r+m)}{\sigma^2}} < 0$ *and* $\bar{G} = \frac{1}{2} - \frac{\mu}{\sigma^2} + \sqrt{\left(\frac{1}{2} - \frac{\mu}{\sigma^2}\right)^2 + \frac{2(r+m)}{\sigma^2}} > 0$. *Finally,* $C_h(m)$, $C_l(m)$, *and* k *satisfy the smooth pasting conditions at* $A_h^{L}(y_t, m) = A_l^{L}(y_t, m) = V(y_0)$ *and* $\frac{\partial}{\partial y}A_h^{L}(y_t, m) = \frac{\partial}{\partial y}A_l^{L}(y_t, m)$ *at* $y_t = y_0$.

Proof. As in Section 3, the ABCP creditor's value function $A^{L}(y_t, m)$ satisfies the ODE

$$rA^{L}(y_t, m) = kV(y_0) + m\left(V(y_0) - A^{L}(y_t, m)\right)\mathbf{1}_{\{A^{L}(y_t, m) < V(y_0)\}} + \mu y_t \frac{\partial A^{L}(y_t, m)}{\partial y_t} + \frac{1}{2}\sigma^2 y_t^2 \frac{\partial^2 A^{L}(y_t, m)}{\partial y_t^2},$$

with boundary condition $A^{L}(y_w, m) = V_m(y_w)$.

The regularity condition under $y_t \to \infty$, when the probability of having y_t hits y_w converges to zero, gives out the second boundary condition. Since the maturity of ABCP is finite with probability 1, together with limited liability which leads to positive ABCP value, we have the boundary condition for $A^{L}(y_t, m)$ at singular point $y_t \to \infty$ as $\lim_{y_t \to \infty} \left|A^{L}(y_t, m)\right| < +\infty$.

We can write the differential equation into region l in which $y < y_0$ and region h in which $y > y_0$ as:

$$\begin{aligned}
rA_h^{L}(y_t, m) &= kV(y_0) + \mu y_t \frac{\partial A_h^{L}(y_t, m)}{\partial y_t} + \frac{1}{2}\sigma^2 y_t^2 \frac{\partial^2 A_h^{L}(y_t, m)}{\partial y_t^2} \\
rA_l^{L}(y_t, m) &= kV(y_0) + m\left(V(y_0) - A_l^{L}(y_t, m)\right) + \mu y_t \frac{\partial A_l^{L}(y_t, m)}{\partial y_t} + \frac{1}{2}\sigma^2 y_t^2 \frac{\partial^2 A_l^{L}(y_t, m)}{\partial y_t^2},
\end{aligned}$$

in which the boundary conditions become $A_l^{L}(y_w, m) = V_m(y_w)$ and $\lim_{y_t \to \infty} \left|A_h^{L}(y_t, m)\right| < +\infty$.

Standard theorems about stochastic differential equation suggest the smooth pasting condition at $y_t = y_0$ as $A_h^L(y_t, m) = A_l^L(y_t, m)$ and $\frac{\partial}{\partial y_t} A_h^L(y_t, m) = \frac{\partial}{\partial y_t} A_l^L(y_t, m)$. We then obtain the value functions of A_h^L, A_l^L, and A^L following the standard technique for second order ODE. $\square$

With the value function of the ABCP, we are ready to model the value function of the ABCP guarantee G, being credit guarantee G^C or liquidity guarantee G^L, which satisfies

$$rG(y_t, m) = m(A(y_t, m) - V(y_0)) \mathbf{1}_{\{A(y_t,m)<V(y_0)\}} + \mu y_t \frac{\partial G(y_t, m)}{\partial y_t} + \frac{1}{2}\sigma^2 y_t^2 \frac{\partial^2 G(y_t, m)}{\partial y_t^2}, \quad \text{(A.2)}$$

in which $A(y_t, m) = A^C(y_t, m)$ for the credit guarantee case and $A(y_t, m) = A^L(y_t, m)$ otherwise.[35] Only under credit guarantee G^C does the guarantor need to provide credit protection upon the conduit wind-down. Hence, the credit guarantee has a boundary condition $G^C(y_w, m) = -V(y_0) + V(y_w) < 0$ whereas the liquidity guarantee has $G^L(y_w, m) = 0$.[36]

To prove Proposition 3, we first prove the following Lemma:

Lemma A.1. *When the ABCP maturity $1/m$ approaches zero, the liquidity guarantee ABCP value $\lim_{m\to\infty} A^L(y_t, m) = V(y_0)$ for $\forall y_t > y_w$. In other words, the value of liquidity guaranteed ABCP converges to that of credit guaranteed ABCP when the maturity $1/m$ drops.*

Proof. Following the value function of ABCP with liquidity guarantee given in Proposition 2, it is easy to see when $m \to \infty$, we have $G = \frac{1}{2} - \frac{\mu}{\sigma^2} - \sqrt{\left(\frac{1}{2} - \frac{\mu}{\sigma^2}\right)^2 + \frac{2(r+m)}{\sigma^2}} \to -\infty$, and $\bar{G} = \frac{1}{2} - \frac{\mu}{\sigma^2} + \sqrt{\left(\frac{1}{2} - \frac{\mu}{\sigma^2}\right)^2 + \frac{2(r+m)}{\sigma^2}} \to \infty$. Therefore, $\psi(y_t; y_w) = \left(\frac{y}{y_w}\right)^G \to 0$, and $\bar{\psi}(y_t; y_w) = \left(\frac{y}{y_w}\right)^{\bar{G}} \to \infty$. So the value function of ABCP, under a finite coupon k, becomes

$$\begin{aligned}
\lim_{m\to\infty} A_h^L(y_t, m) &= \frac{k}{r} V(y_0) + \lim_{m\to\infty} C_h(m)\phi(y_t; y_w), \\
\lim_{m\to\infty} A_l^L(y_t, m) &= \lim_{m\to\infty} \frac{k+m}{m+r} V(y_0) + C_l(m)\bar{\psi}(y_t; y_w) \\
&= V(y_0) + \lim_{m\to\infty} C_l(m)\bar{\psi}(y_t; y_w).
\end{aligned}$$

The smooth pasting conditions, $A_h^L(y_t, m) = A_l^L(y_t, m) = V(y_0)$ and $\frac{\partial}{\partial y} A_h^L(y_t, m) = \frac{\partial}{\partial y} A_l^L(y_t, m)$

[35] The differential equation follows the similar non-arbitrage argument used in the ABCP value functions.
[36] There are secondary boundary conditions for $G^C(y_t, m)$ and $G^L(y_t, m)$, at $y_t \to \infty$ based on the regularity condition. We relegate the discussion of the secondary boundary conditions to the Appendix.

at $y_t = y_0$, suggest that

$$\frac{k}{r}V(y_0) + \lim_{m\to\infty} C_h(m)\phi\left(y_t; y_w\right) = V(y_0) + \lim_{m\to\infty} C_l(m)\bar{\psi}\left(y_t; y_w\right) = V(y_0), \tag{A.3}$$

$$\lim_{m\to\infty} C_h(m)\frac{\partial}{\partial y}\phi\left(y_t; y_w\right) = \lim_{m\to\infty} C_l(m)\frac{\partial}{\partial y}\bar{\psi}\left(y_t; y_w\right). \tag{A.4}$$

It is then easy to see Equation (A.3) suggests that $\lim_{m\to\infty} C_l(m)\bar{\psi}\left(y_t; y_w\right) = 0$. Hence, $\lim_{m\to\infty} C_l(m) = 0$. With $\frac{\partial}{\partial y_t}\phi\left(y_t; y_w\right) = \frac{\partial}{\partial y_t}\left(\frac{y_t}{y_w}\right)^G = G\left(\frac{y_t}{y_w}\right)^{G-1} < 0$, Equation (A.4) suggests $\lim_{m\to\infty} C_h(m) = 0$ as well. Use Equation (A.3) again, with $\frac{k}{r}V(y_0) + \lim_{m\to\infty} C_h(m)\phi\left(y_t; y_w\right) = V(y_0)$ together with $\lim_{m\to\infty} C_h(m) = 0$ and $\lim_{m\to\infty} \phi\left(y_t; y_w\right) = 0$, we have $k = r$. Summarize the value of C_l, C_h, G and $\bar{G}$ under $m \to \infty$, we get $\lim_{m\to\infty} A^L\left(y_t, m\right) = V(y_0)$ for $\forall y_t \in (y_w, \infty)$. □

Proposition 3. *When the ABCP maturity decreases, the liquidity support value function converges to the credit support value function. When the maturity $1/m$ approaches 0, $\lim_{m\to\infty} G^L\left(y_t, m\right) = G^C\left(y_t, m\right)$ for $\forall y_t > y_w$.*

Proof. By Equation (A.2), together with the value function of ABCP with credit guarantee $A^C = V(y_0)$, we can obtain that the value ABCP with credit guarantee, as well as the value of credit guarantee, does not vary with maturity $1/m$. Hence, we can drop the m in $G^C(y_t, m)$, and the differential equation for credit guarantee G^C is

$$rG^C\left(y_t\right) = \mu y_t \frac{\partial G^C\left(y_t\right)}{\partial y_t} + \frac{1}{2}\sigma^2 y_t^2 \frac{\partial^2 G^C\left(y_t\right)}{\partial y_t^2}, \tag{A.5}$$

with boundary condition $G^C\left(y_w\right) = -V(y_0) + V\left(y_w\right) < 0$. On the other hand, when $y_t \to \infty$, the stopping time $\tau = \inf\{t : y_t < y_w\} \to \infty$. Hence, $\lim_{y_t\to\infty} G^C(y_t) = 0$.

Let $\bar{G}^L\left(y_t\right) = \lim_{m\to\infty} G^L\left(y_t, m\right)$. Starting from the differential equation for liquidity guarantee G^L

$$rG^L\left(y_t, m\right) = m\left(A^L\left(y_t, m\right) - V(y_0)\right)\mathbf{1}_{\{A^L(y_t,m)<V(y_0)\}} + \mu y_t \frac{\partial G^L\left(y_t, m\right)}{\partial y_t} + \frac{1}{2}\sigma^2 y_t^2 \frac{\partial^2 G^L\left(y_t, m\right)}{\partial y_t^2},$$

and using Lemma A.1, we have $\lim_{m\to\infty} A^L\left(y_t, m\right) = V(y_0)$ for $\forall y_t \in (y_w, \infty)$, and $A^L\left(y_w, m\right) =$

$V(y_w)$. Therefore, with $G^C(y_w) = -V(y_0) + V(y_w)$

$$r\bar{G}^L(y_t) = mG^C(y_w)\,\mathbf{1}_{\{y_t=y_w\}} + \mu y_t \frac{\partial \bar{G}^L(y_t)}{\partial y_t} + \frac{1}{2}\sigma^2 y_t^2 \frac{\partial^2 \bar{G}^L(y_t)}{\partial y_t^2}, \tag{A.6}$$

with boundary condition $\bar{G}^L(y_w) = 0$. Similar to the credit guarantee case, $\lim_{m\to\infty} \bar{G}^L(y_t) = 0$.

Clearly, the differential equations (A.5) and (A.6) share the same general solution, and the inhomogeneous term $mG^C(y_w)\,\mathbf{1}_{\{y_t=y_w\}}$ in differential equation (A.6) is a delta function on $y_t = y_w$. Following the standard Green function method, we have $G^C(y_t) = \bar{G}^L(y_t)$ for $\forall y_t \in (y_w, \infty)$. $\square$

Proposition 4. *When the ABCP maturity $1/m$ approaches zero, an ABCP liquidity guarantor—whose initial capital ratio is the same as a credit guarantor—has $K^L(y_t)$ that is more sensitive to the shock in the underlying asset value than the credit guarantor when $y_t < y_0$, or $\frac{dK^L(y_t)}{dy_t} > \frac{dK^C(y_t)}{dy_t}$. Subsequently, the liquidity guarantor is more likely to violate the minimum capital requirement under any realized path of y_t.*

Proof. First, it is easy to see that

$$K^C(y_t) \equiv \frac{E^C + G^C(y_t, m)}{D + E^C + G^C(y_t, m) + V(y_t)} = \frac{\kappa^C(y_t)}{1 + \kappa^C(y_t)}.$$

Notice that $K^C(y_t)$ is strictly increasing in $\kappa^C(y_t)$. Hence, using $\kappa^C(y_t) > 0$ instead of $K^C(y_t)$ does not change the behavior of a bank that is trying to maintain a capital ratio above the minimum requirement. Similar arrangement applies to $\kappa^L(y_t)$. We also let $\underline{K} \equiv \frac{\underline{\kappa}}{1+\underline{\kappa}}$.

The initial capital ratio of a credit guarantor with balance sheet equity capital E^C is $\kappa^C(y_0) = \frac{E^C + G^C(y_0)}{D + V(y_0)}$ and the initial capital ratio of a liquidity guarantor, who only needs to recognize a β fraction of ABCP exposure, to be $\kappa^L(y_0) = \frac{E^L + G^L(y_0)}{D + \beta V(y_0)}$. Hence, $\kappa^C(y_0) = \kappa^L(y_0)$ suggests that

$$\frac{E^L + G^L(y_0)}{D + \beta V(y_0)} = \frac{E^C + G^C(y_0)}{D + V(y_0)}. \tag{A.7}$$

With $\hat{G}^C(y_t) = G^C(y_t) - G^C(y_0)$ and similarly for liquidity guarantee as $\hat{G}^L(y_t) = G^L(y_t) -$

$G^L(y_0)$, we can write $\kappa^C(y_t) = \frac{E^C+G^C(y_0)+\hat{G}^C(y_t)}{D+V(y_t)}$ and $\kappa^L(y_t) = \frac{E^L+G^L(y_0)+\hat{G}^L(y_t)}{D+\beta V(y_t)}$. Subsequently,

$$\begin{aligned}\frac{d\kappa^L(y_t)}{dy_t} - \frac{d\kappa^C(y_t)}{dy_t} &= \frac{d}{dy_t}\frac{E^L+G^L(y_0)}{D+\beta V(y_t)} - \frac{d}{dy_t}\frac{E^C+G^C(y_0)}{D+V(y_t)} \\ &\quad + \frac{d}{dy_t}\frac{\hat{G}^L(y_t)}{D+\beta V(y_t)} - \frac{d}{dy_t}\frac{\hat{G}^C(y_t)}{D+V(y_t)},\end{aligned}$$

whereas

$$\begin{aligned}\frac{d}{dy_t}\frac{E^L+G^L(y_0)}{D+\beta V(y_t)} - \frac{d}{dy_t}\frac{E^C+G^C(y_0)}{D+V(y_t)} &= \left[-\beta\frac{E^L+G^L(y_0)}{[D+\beta V(y_t)]^2} + \frac{E^C+G^C(y_0)}{[D+V(y_t)]^2}\right]\frac{dV(y_t)}{dy_t} \\ &= [f(1)-f(\beta)]\frac{\kappa^C(y_0)}{r-\mu},\end{aligned}$$

where the second equality follows Equation (A.7) and $f(\beta) = \beta\frac{D+\beta V(y_0)}{[D+\beta V(y_t)]^2}$. Following $r > \mu$, it is easy to see $\frac{df(\beta)}{d\beta} > 0$ when $y_t \in (y_w, y_0)$. Therefore, $f(1) - f(\beta) > 0$ so

$$\frac{d}{dy_t}\frac{E^L+G^L(y_0)}{D+\beta V(y_t)} - \frac{d}{dy_t}\frac{E^C+G^C(y_0)}{D+V(y_t)} > 0. \tag{A.8}$$

In addition, we have $\frac{d}{dy_t}\frac{\hat{G}^L(y_t)}{D+\beta V(y_t)} = \frac{1}{D+\beta V(y_t)}\frac{d\hat{G}^L(y_t)}{dy_t} - \frac{\beta\hat{G}^L(y_t)}{[D+\beta V(y_t)]^2}\frac{dV(y_t)}{dy_t}$ and $\frac{d}{dy_t}\frac{\hat{G}^C(y_t)}{V(y_t)} = \frac{1}{D+V(y_t)}\frac{d\hat{G}^C(y_t)}{dy_t} - \frac{\hat{G}^C(y_t)}{[D+V(y_t)]^2}\frac{dV(y_t)}{dy_t}$. Notice Proposition 3 suggests that $\lim_{m\to\infty} G^L(y_t) \to G^C(y_t)$ for all $y_t > y_w$. Hence, when the ABCP maturity $1/m$ is small enough, we have $\lim_{m\to\infty}\frac{d\hat{G}^L(y_t)}{dy_t} \to \frac{d\hat{G}^C(y_t)}{dy_t} > 0$. With a small enough β

$$\frac{1}{D+\beta V(y_t)}\frac{d\hat{G}^L(y_t)}{dy_t} > \frac{1}{D+V(y_t)}\frac{d\hat{G}^C(y_t)}{dy_t}. \tag{A.9}$$

Finally, $V(y_t) > V(y_w) > \sqrt{\beta}D$ gives $\frac{\beta}{[D+\beta V(y_t)]^2} > \frac{1}{[D+V(y_t)]^2}$. From Proposition 3, we have $\frac{\beta\hat{G}^L(y_t)}{[D+\beta V(y_t)]^2} < \frac{\hat{G}^C(y_t)}{[D+V(y_t)]^2}$ when $m \to \infty$. Combine this with Equation (A.8) and (A.9), we have $\frac{d\kappa^L(y_t)}{dy_t} > \frac{d\kappa^C(y_t)}{dy_t}$ and therefore $\frac{dK^L(y_t)}{dy_t} > \frac{dK^C(y_t)}{dy_t}$ for $y_t \in (y_w, y_0)$. □

A.2 Bank balance sheet variable definitions

Table A.1: **Bank balance sheet variable definitions**
This table presents the data mnemonic, as well as the FR-Y9C data used, for the bank balance sheet variables used in the summary statistics and regressions.

Variable	Mnemonic	Expression
Total Assets (Bil.)	Book value of assets in Billion USD.	$\frac{BHCK2170}{1000000}$
Cash Ratio (%)	Ratio of cash or cash equivalent to asset book value.	$\frac{BHCK0081+BHCK0395+BHCK0397}{BHCK2170}$
Loan to assets (%)	Ratio of loan balance to asset book value.	$\frac{BHCK2122}{BHCK2170}$
RE loan to assets (%)	Ratio of RE loan balance to asset book value.	$\frac{BHCK1410}{BHCK2170}$
Security to assets (%)	Ratio of held-to-maturity and for-sale security balance to asset book value.	$\frac{BHCK1773+BHCK1754}{BHCK2170}$
FS security to assets (%)	Ratio of for-sale security balance to asset book value.	$\frac{BHCK1754}{BHCK2170}$
Deposit to assets (%)	Ratio of deposit balance to asset book value.	$\frac{BHDM6631+BHFN6631}{BHCK2170} + \frac{BHDM6636+BHFN6636}{BHCK2170}$
ROA (%)	Return on assets. The ratio in percentage of quarterly increase in net income divided by book value of assets.	$\frac{\Delta BHCK4340}{BHCK2170}$
EPS	Earnings per share. The ratio of quarterly increase in net income to total outstanding number of shares.	$\frac{\Delta BHCK4340}{BHCK3459}$
Tier-1 cap. ratio (%)	The ratio of Tier-1 risk capital to total risk-weighted assets.	$BHCK7206$
Total cap. ratio (%)	The ratio of Tier-1 and Tier-2 risk capital to total risk-weighted assets.	$BHCK7205$

A.3 More robustness: Alternative matching methods

We provide further robustness checks to address the potential concern that the empirical results presented in Tables 5 and 9 are driven by the particular choice of matching. To address such a concern, we present empirical results under two alternative matching methods. First, instead of using a logit model to estimate a BHC's choice to use liquidity guaranteed ABCP financing, we use the probit model

$$p_{i,q} = \Phi(\alpha_q + \beta \mathbf{X}_{i,q} + \epsilon_{i,q}), \tag{A.10}$$

where $p_{i,q}$ is the probability of BHC i being a liquidity guarantor at quarter q, α_q is the time fixed effects that captures the change in the adoption of ABCP financing channels among banks over time, the matrix $\mathbf{X}_{i,q}$ contains characteristics for BHC i in quarter q, and β is a vector of coefficients.

Table A.2 presents the probit estimates, which are quantitatively similar to the logit estimates in Table 3. Hence, the propensity score from probit and logit approaches are comparable.

Second, we also generate a larger Mahalanobis matched sample by matching each liquidity guarantor with two BHCs that do not participate in regulatory arbitrage, and repeat the empirical analysis.

Table A.3 shows the robustness of market monitoring using both the probit propensity score weighted regression and the alternative Mahalanobis matched sample. Under both samples, we notice the main empirical results are similar to the results shown in Table 5.

Finally, we repeat our empirical estimate of regression (5), and present the estimates in Table A.4. Under the alternative construction of the empirical samples, liquidity guarantors keep a higher risk capital, with and without the adjustment, than ABCP guarantors in general, confirming that the market influence is robust under alternative matching schemes.

Table A.2: **Probit regression**

The table provides the probit estimates of a BHC's probability of exploiting the ABCP exclusion in a quarter, using the quarterly data from Q1 2001 to Q3 2009 for all publicly-traded U.S. BHCs with $10B+ total assets. Column (1) presents the estimates without time fixed effects, whereas Column (2) shows the estimates with the time fixed effects. Bank balance sheet variable definitions are provided in the Appendix. Standard errors are reported in parentheses. Significance: $^{*}\, p < 0.10$; $^{**}\, p < 0.05$; $^{***}\, p < 0.01$.

	Probit	
	(1)	(2)
log(Total assets)	0.838***	0.903***
	(0.0440)	(0.0479)
Cash ratio (%)	0.0513***	0.0575***
	(0.00890)	(0.00922)
Loan to assets (%)	0.0421***	0.0438***
	(0.00610)	(0.00645)
RE loan to assets (%)	-0.0277***	-0.0260***
	(0.00454)	(0.00478)
Security to assets (%)	0.0223**	0.0247**
	(0.00976)	(0.0101)
FS security to assets (%)	0.0269***	0.0276***
	(0.00963)	(0.00995)
Deposit to assets (%)	0.0174***	0.0186***
	(0.00386)	(0.00399)
ROA (%)	0.308*	0.0125
	(0.173)	(0.213)
EPS	-0.0185	-0.0142
	(0.0684)	(0.0806)
Quarter FE	No	Yes
Obs.	2671	2671
Pesudo R^2	0.412	0.430
χ^2	923.9	963.4

Table A.3: **Market monitoring: alternative propensity score and matching**

This table presents the robustness of matching methods in both the propensity score and Mahalanobis matching sample construction for the estimates of model (4), in the same sample period of Q2 2001 to Q3 2009. Columns (1) through (3) present the probit propensity score weighted estimates using all U.S. BHCs with \$10B+ total assets. Columns (4) through (6) present the OLS estimates using the sample, in which each loophole-exploiting bank is matched with two banks that do not participate in regulatory arbitrage. The dependent variable, $r_{i,t}^{FF}$, is the holding period equity abnormal return of bank i at period t, after controlling for the Fama-French factors. For the explanatory variables, $\Delta\%\text{OVN}_t$ measures the change in the ratio of ABCP outstanding matures overnight from period $t-1$ to t. $\Delta\text{Conduit Risk}_{i,t}$ is the product of the change in subprime mortgage delinquency rate between period $t-1$ and t, multiplies the bank's exposure to ABCP liquidity guarantee aforementioned, which is the principal of ABCP relative to the bank's book value. Bank balance sheet variable definitions are provided in the Appendix. Robust standard errors are reported in parentheses. Significance: $^{*}p < 0.10$; $^{**}p < 0.05$; $^{***}p < 0.01$.

Variable	$r_{i,t}^{FF}$ (%)					
	Propensity score weighted			Matched		
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta\%$OVN $\times$ Δ LG Conduit Risk	-0.00688***	-0.00684***	-0.00688***	-0.00581*	-0.00573*	-0.00576*
	(0.00113)	(0.00114)	(0.00114)	(0.00294)	(0.00294)	(0.00293)
$\Delta\%$OVN $\times$ Δ CG Conduit Risk	-0.00571	-0.00565	-0.00570	-0.00258	-0.00253	-0.00259
	(0.00546)	(0.00543)	(0.00546)	(0.00412)	(0.00411)	(0.00408)
Δ LG Conduit Risk	-0.00331***	-0.00288*	-0.00370**	-0.00178	0.00193	0.000882
	(0.000978)	(0.00158)	(0.00149)	(0.00346)	(0.00414)	(0.00422)
Δ CG Conduit Risk	-0.000405	0.00763	0.00855	0.000695	0.00565	0.00674
	(0.0120)	(0.0108)	(0.0113)	(0.00971)	(0.0100)	(0.0105)
$\Delta\%$OVN	0.000244	0.000341	0.000899	-0.0164**	-0.0163**	-0.0157**
	(0.0107)	(0.0107)	(0.0107)	(0.00694)	(0.00692)	(0.00689)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Balance Sheet Controls	No	Yes	Yes	No	Yes	Yes
Macro Controls	No	No	Yes	No	No	Yes
Obs.	177530	177530	177530	91813	91813	91813
Adj. R^2	0.000232	0.00104	0.00163	0.000218	0.000623	0.00151
F-Statistics	33.01	21.95	25.50	17.24	11.60	14.82

Table A.4: **Market influence: Tier-1 capital ratios under alternative propensity score and matching**

The table presents the higher risk capital buffer of liquidity guarantor BHCs in the sample period of Q2 2001 to Q3 2009, under alternative propensity score weighting and matching sample construction. Columns (1) and (3) show the probit propensity score weighted estimates using all U.S. BHCs with $10B+ total assets. Columns (2) and (4) shows the OLS regression results using the matched sample, in which each guarantor is matched with two similar non-guarantors. The dependent variables are the Tier-1 capital ratio, presented in Columns (1) and (2), and Adjusted Tier-1 capital ratio, presented in Columns (3) and (4). Bank balance sheet control variables are described in Appendix. Robust standard errors are reported in parentheses. Significance: $^{*}\, p < 0.10$; $^{**}\, p < 0.05$; $^{***}\, p < 0.01$.

Variable	Tier-1 cap. ratio (%)		Adj. Tier-1 cap. ratio (%)	
	Propensity score weighted (1)	Matched (2)	Propensity score weighted (3)	Matched (4)
Liquidity guarantor	1.776**	2.279***	1.248*	1.760***
	(0.654)	(0.330)	(0.677)	(0.340)
ABCP guarantor	-2.113**	-2.883***	-2.158**	-2.882***
	(0.779)	(0.391)	(0.821)	(0.411)
log(Total assets)	-1.613***	-0.710***	-1.592***	-0.705***
	(0.126)	(0.0500)	(0.127)	(0.0474)
Cash ratio (%)	-0.0118	0.00508	-0.0237	-0.0108
	(0.0265)	(0.0134)	(0.0273)	(0.0120)
Loan to assets (%)	-0.114***	-0.0224**	-0.105***	-0.0148
	(0.0104)	(0.0104)	(0.0107)	(0.0101)
RE loan to assets (%)	0.00482	-0.0576***	-0.00312	-0.0634***
	(0.00882)	(0.00839)	(0.00915)	(0.00843)
Security to assets (%)	-0.0406**	0.0494***	-0.0373*	0.0477***
	(0.0188)	(0.0136)	(0.0191)	(0.0144)
FS security to assets (%)	-0.0521***	-0.0347***	-0.0541***	-0.0363***
	(0.0145)	(0.00694)	(0.0144)	(0.00686)
Deposit to assets (%)	-0.113***	0.00987	-0.115***	0.00838
	(0.0135)	(0.00775)	(0.0135)	(0.00738)
ROA (%)	14.17***	0.730*	14.35***	0.767*
	(1.322)	(0.410)	(1.319)	(0.400)
EPS	-3.626***	0.0766	-3.747***	0.0623
	(0.402)	(0.111)	(0.402)	(0.113)
Quarter FE	Yes	Yes	Yes	Yes
Obs.	2671	1375	2671	1375
Adj. R^2	0.615	0.508	0.624	0.518
F-Statistics	627.4	436.8	629.4	489.7

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